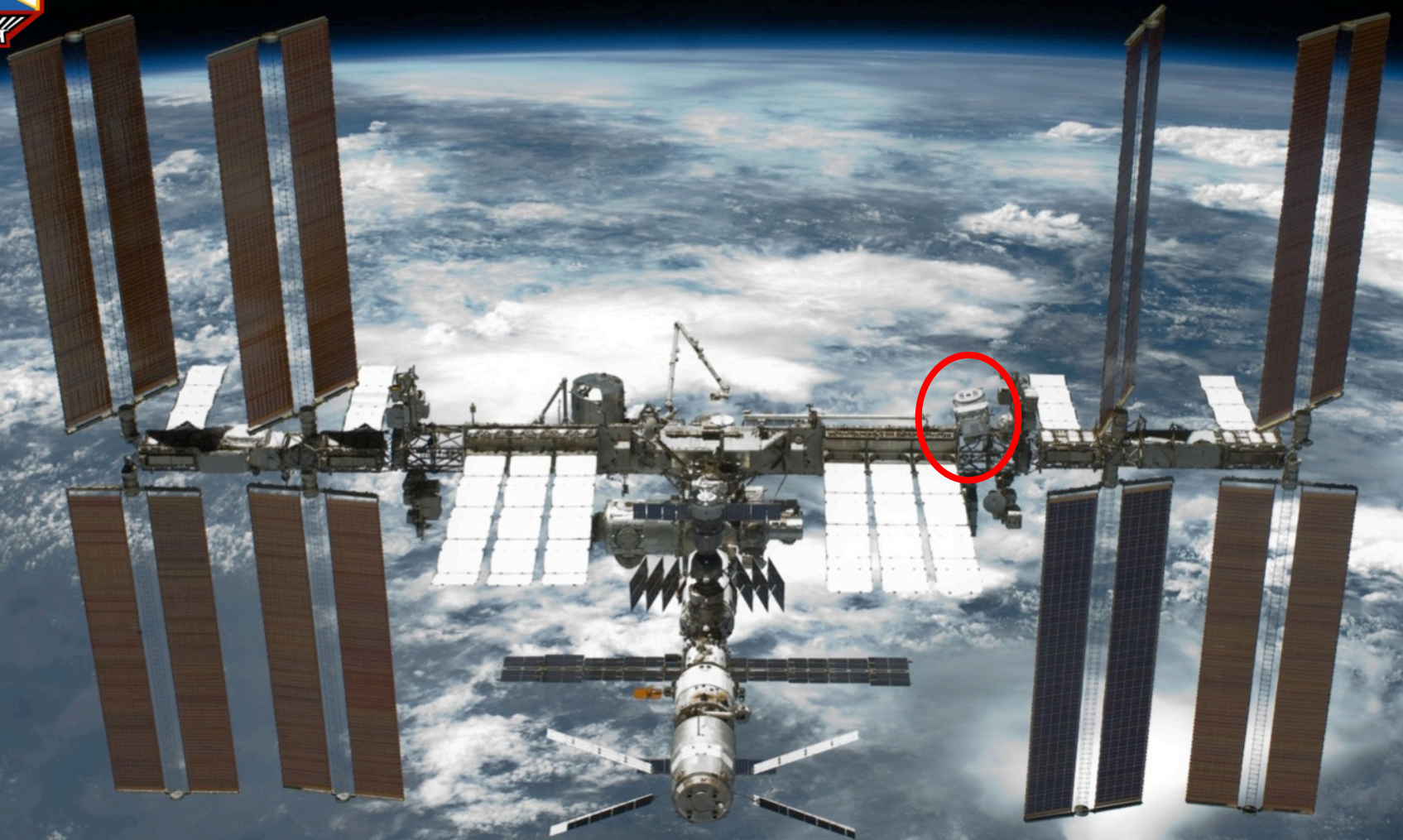




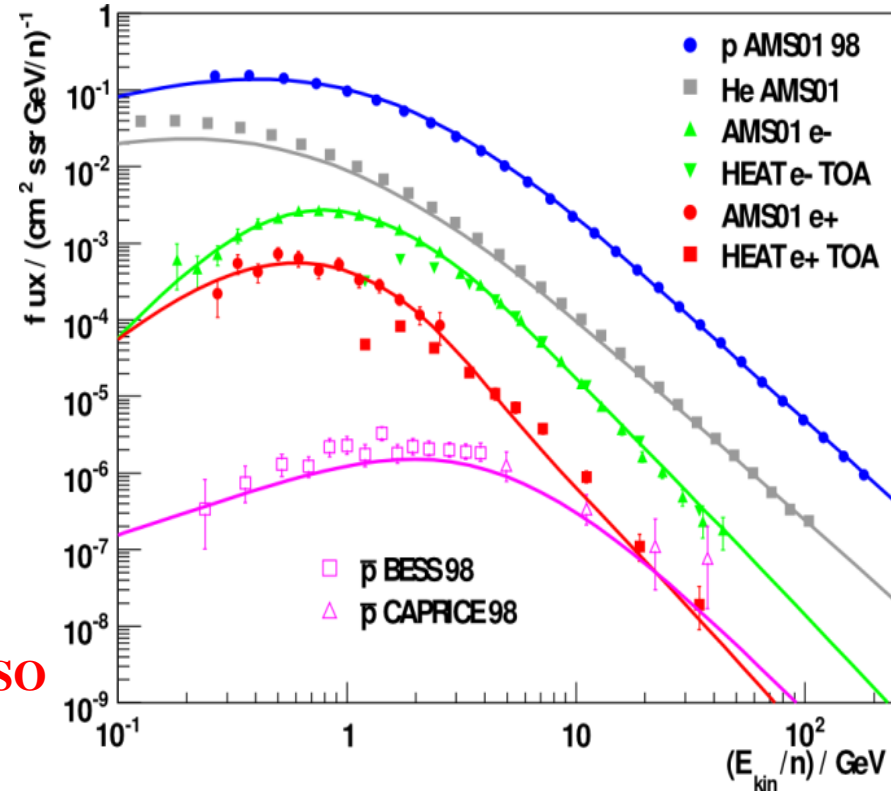
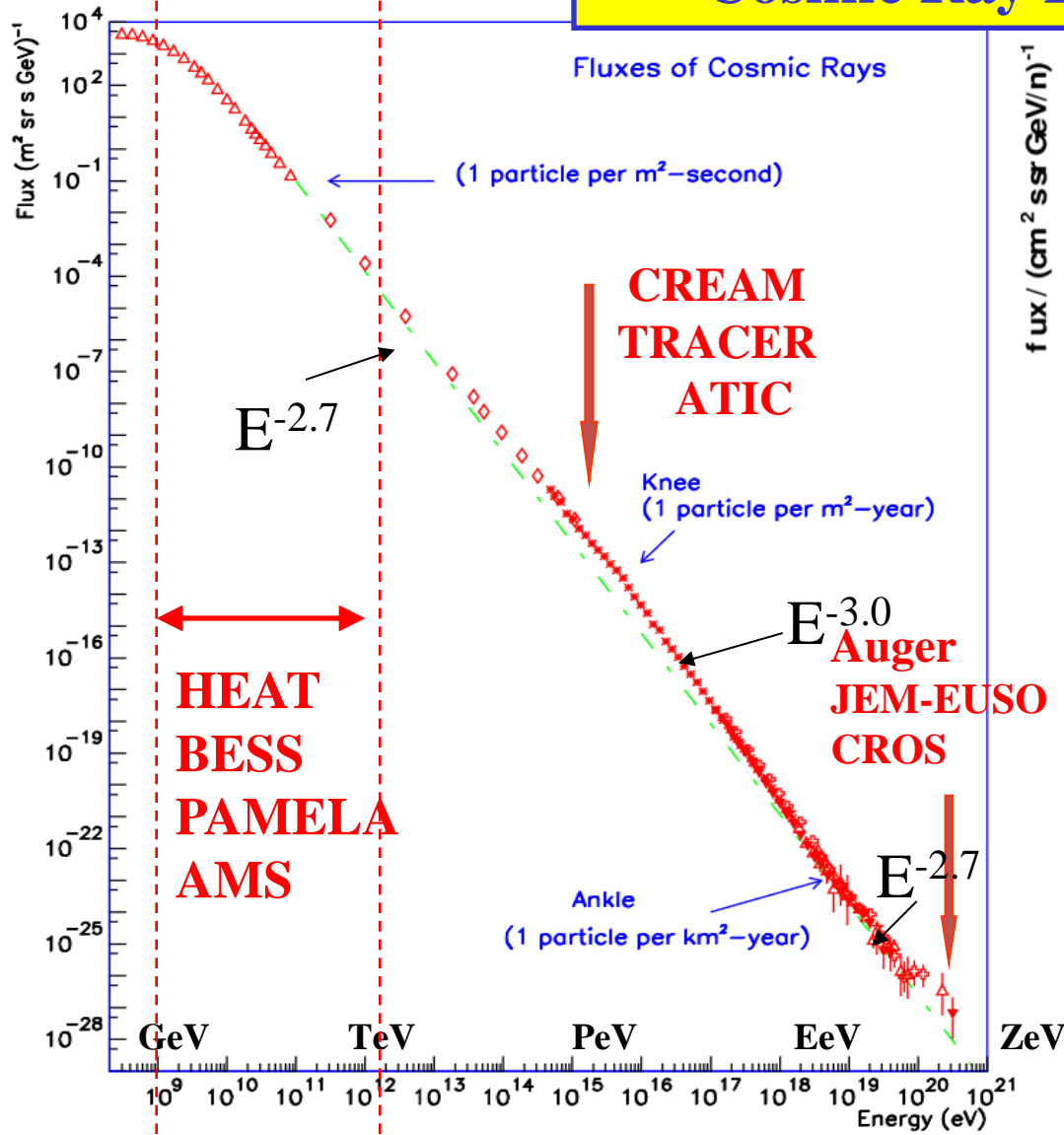
AMS-02 TRD



Thomas Kirn
RWTH Aachen University
CERN, November 28th

AMS-02 TRD

Cosmic Ray Fluxes



Cosmic Ray Composition:

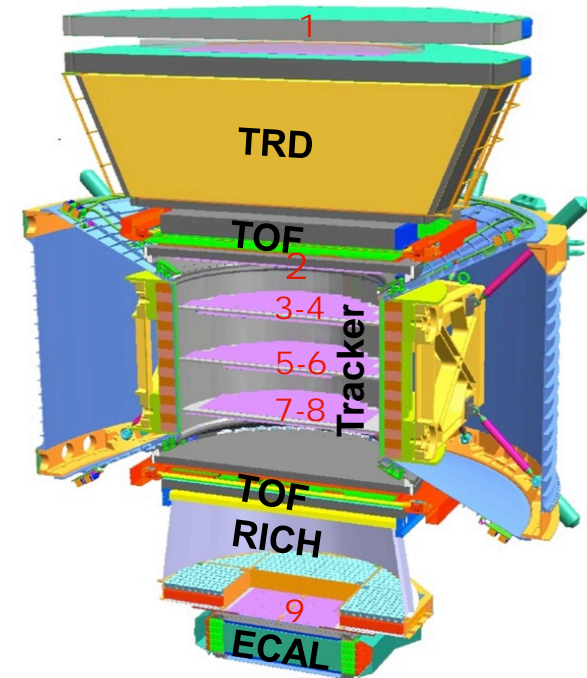
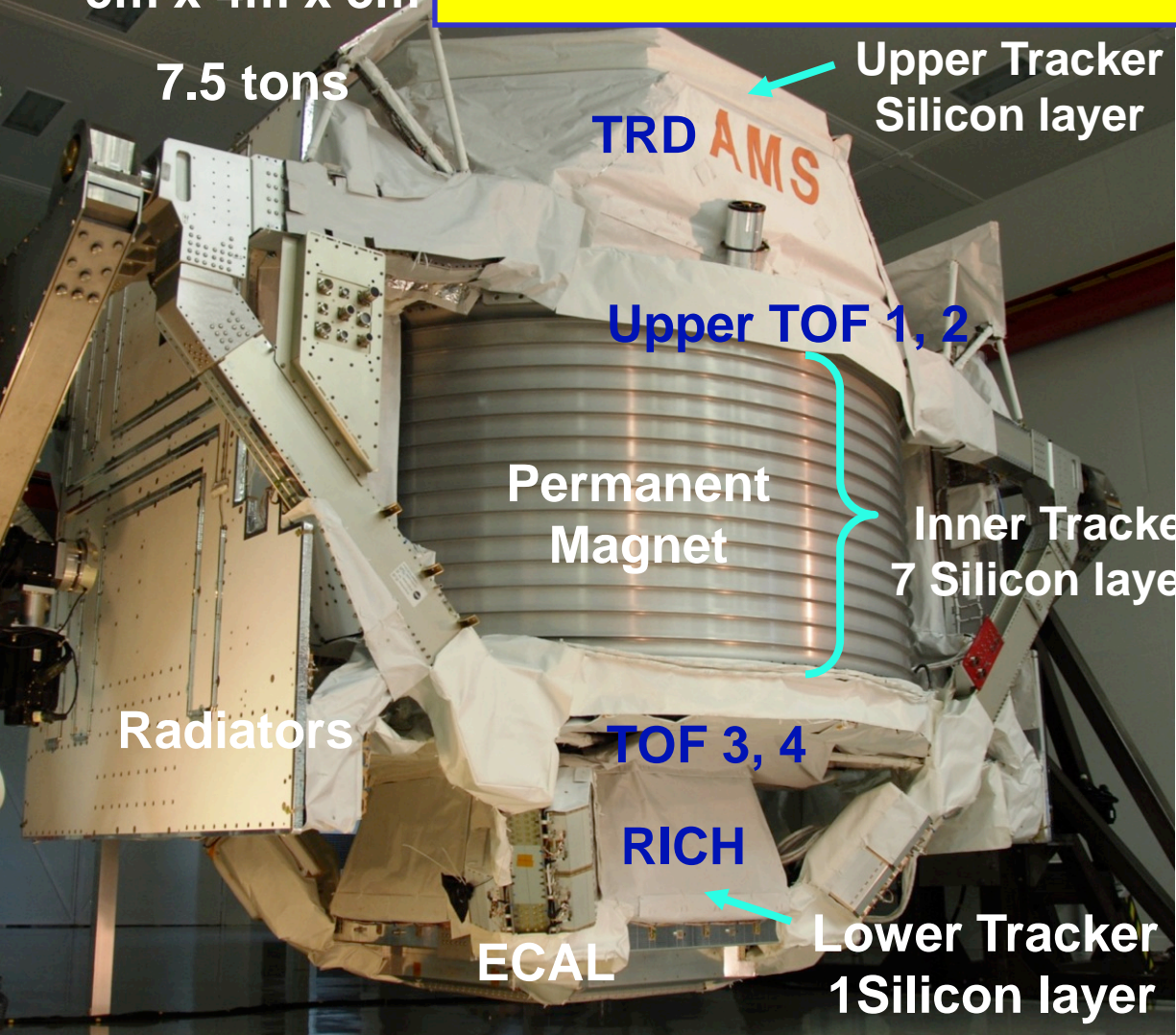
Protons	88 %
Helium	10 %
e ⁻	1 %
e ⁺	0.1 %
Antiprotons	0.01 %



AMS-02 – A TeV Particle Spectrometer

5m x 4m x 3m

7.5 tons



ISS Lifetime extended until at least 2020 / 2028 (March 2010)

- Switch to AMS-01 permanent magnet ($B=0.14\text{T}$)
- Tracker reconfigured
- 'external' layers



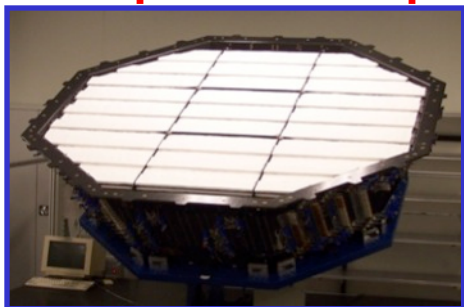
Th. Kirn

AMS-02 TRD

AMS-02 – A TeV Particle Spectrometer

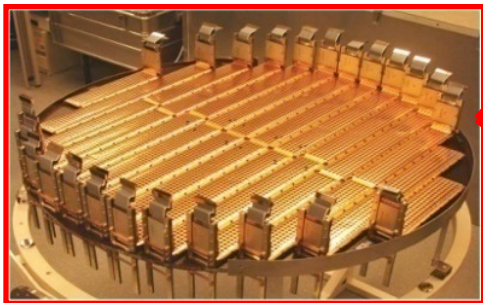
TRD

Separation $e^\pm:p$



Silicon Tracker

Z, P

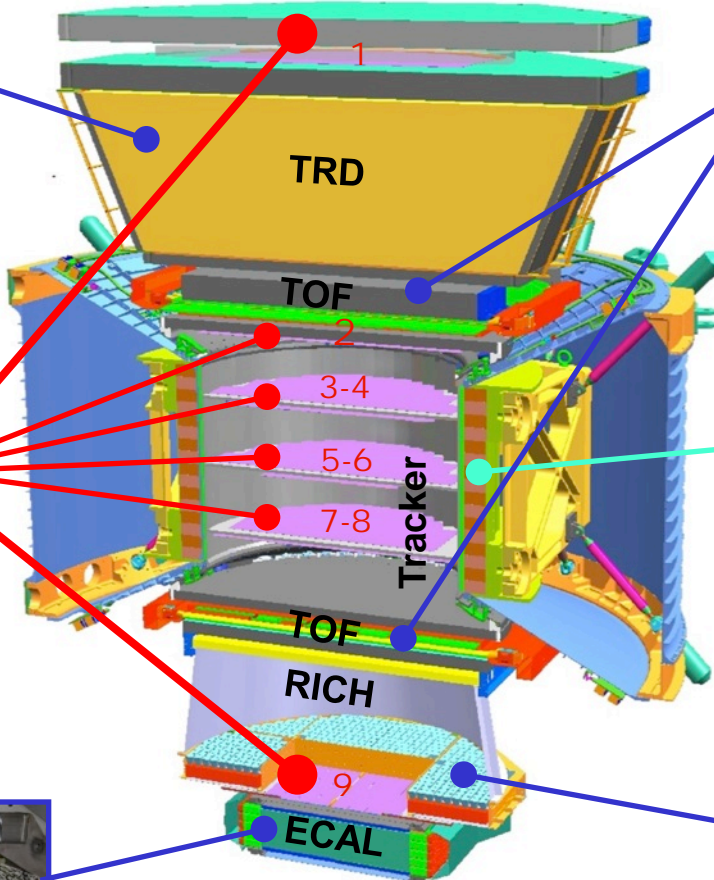


ECAL

E of e^\pm, γ



Particles and nuclei are defined by their charge (Z) and energy (E ~ P)



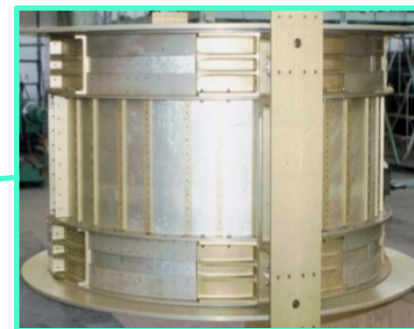
TOF

Z, E



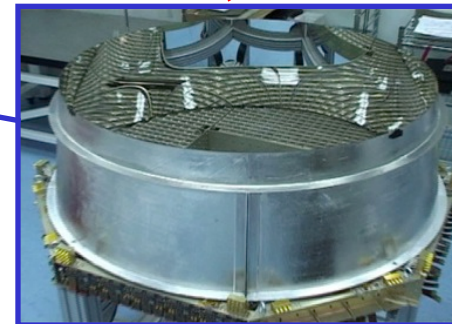
Magnet

$\pm Z$



RICH

Z, E



Z, P are measured independently by the Tracker, RICH, TOF and ECAL

Th. Kim

AMS-02 TRD



AMS-02 – Transition Radiation Detector (TRD)

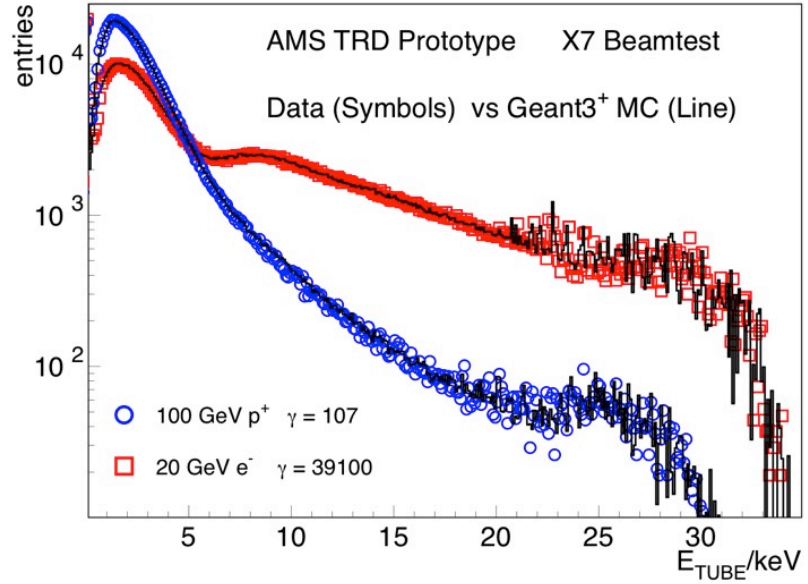
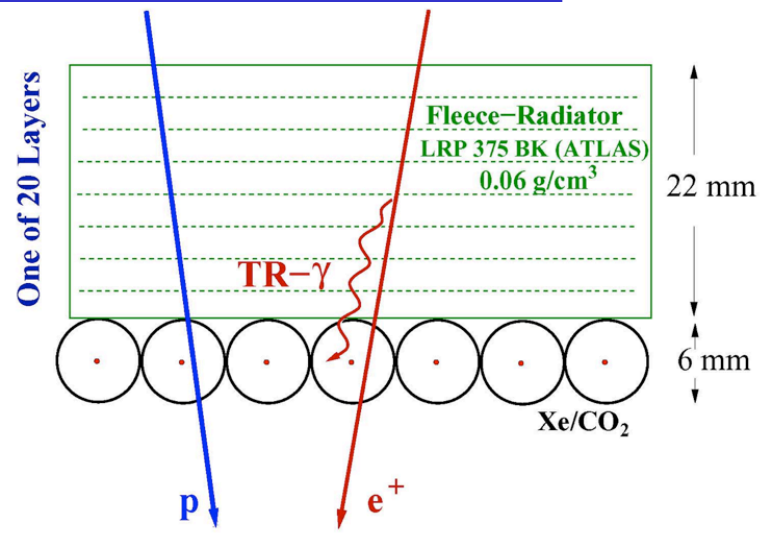
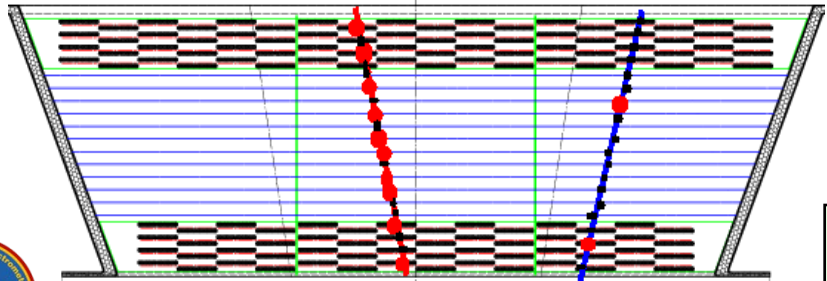
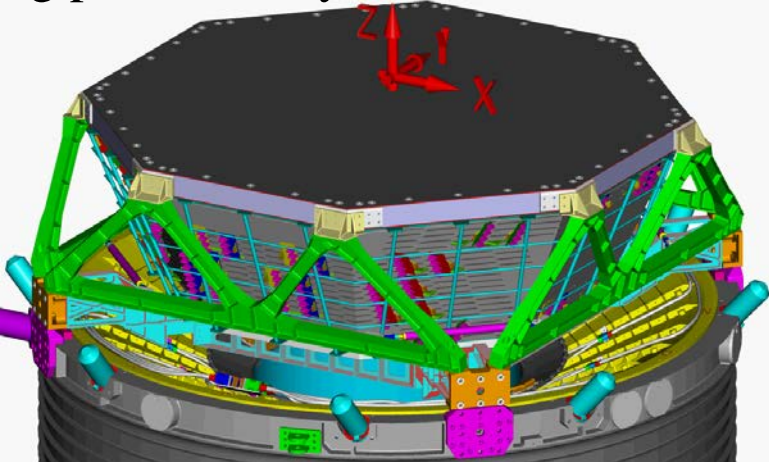
Chosen configuration for 60 cm height:

20 Layers each existing of:

- 22 mm fibre fleece
- Ø 6 mm straw tubes (Xe/CO₂ 80%/20%)

Non-bending plane: 2x4 layers

Bending plane: 12 layers



p⁺ rejection >10² 1-300 GeV 0.5m²sr

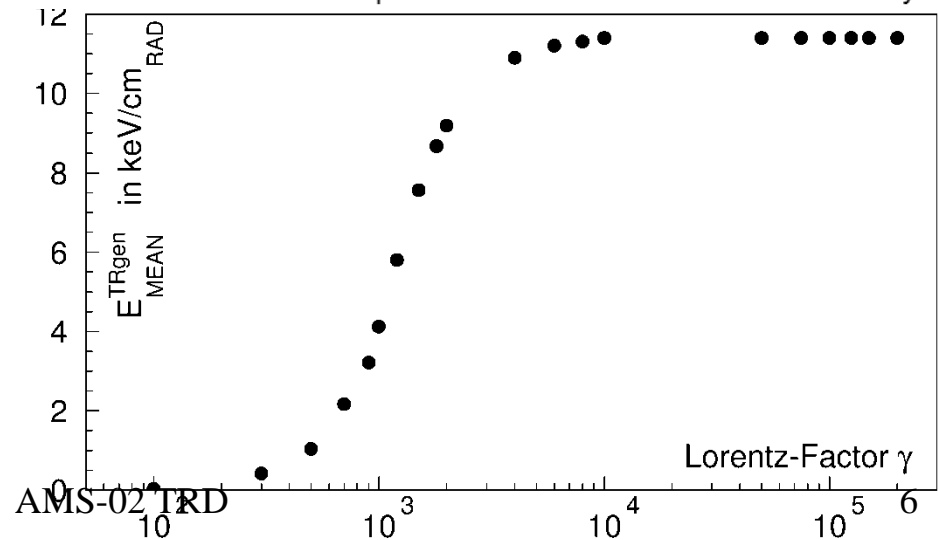
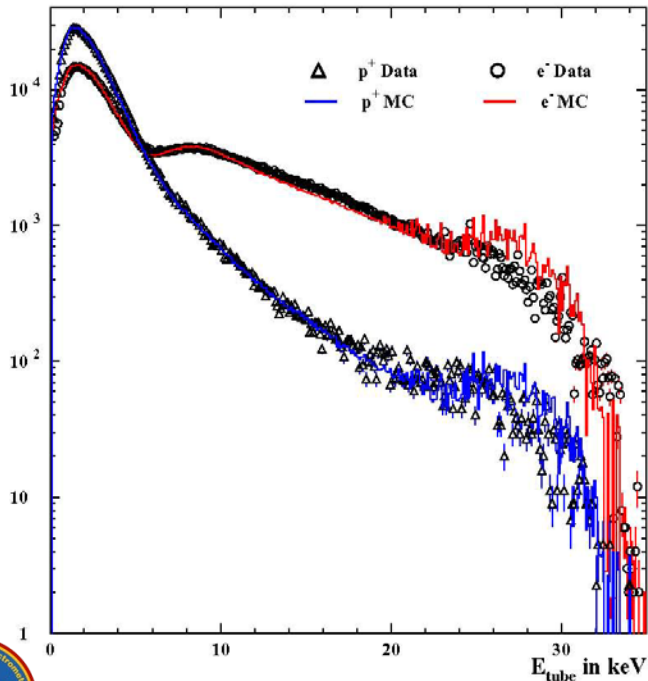
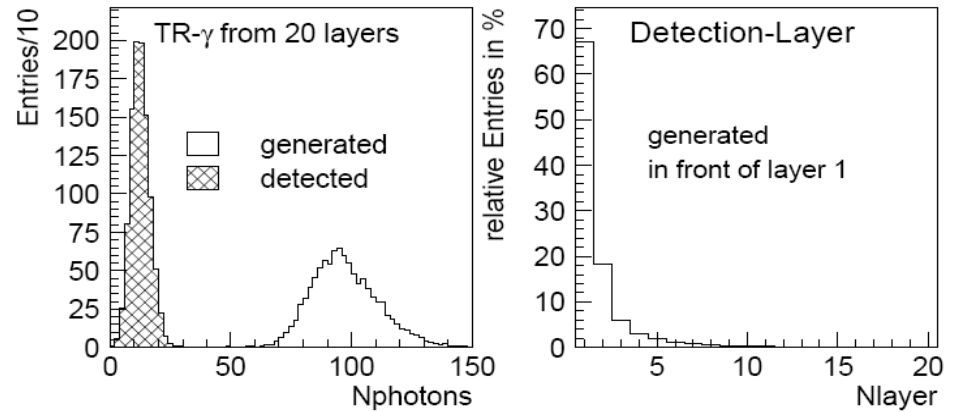
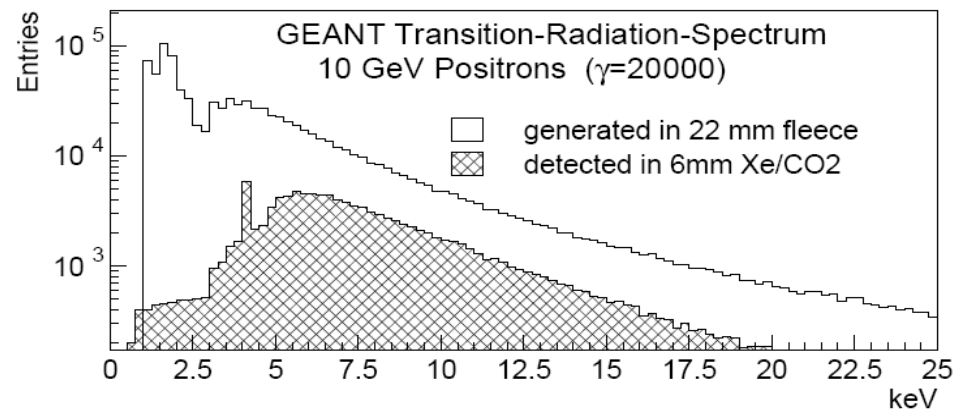
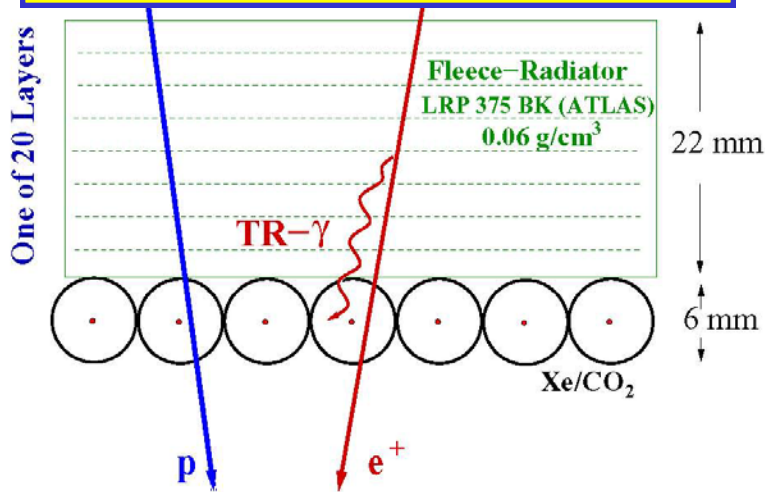


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AMS-02 TRD



AMS-02 - TRD

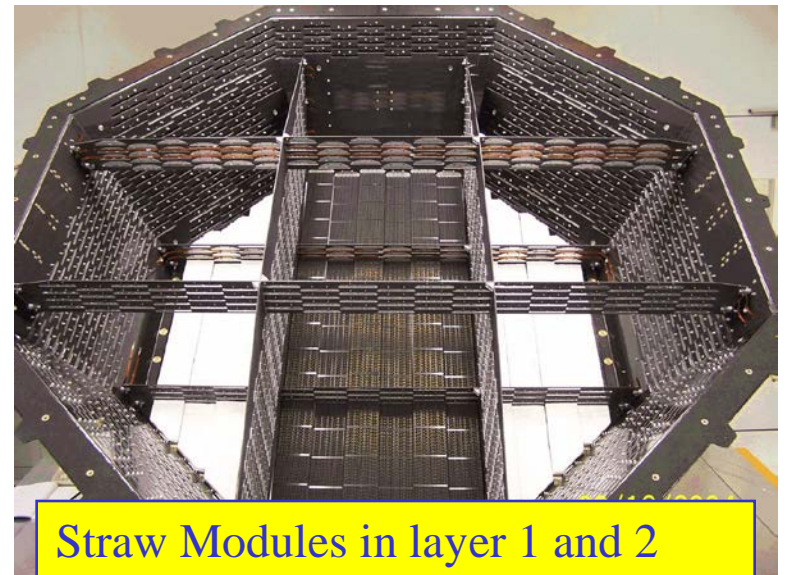
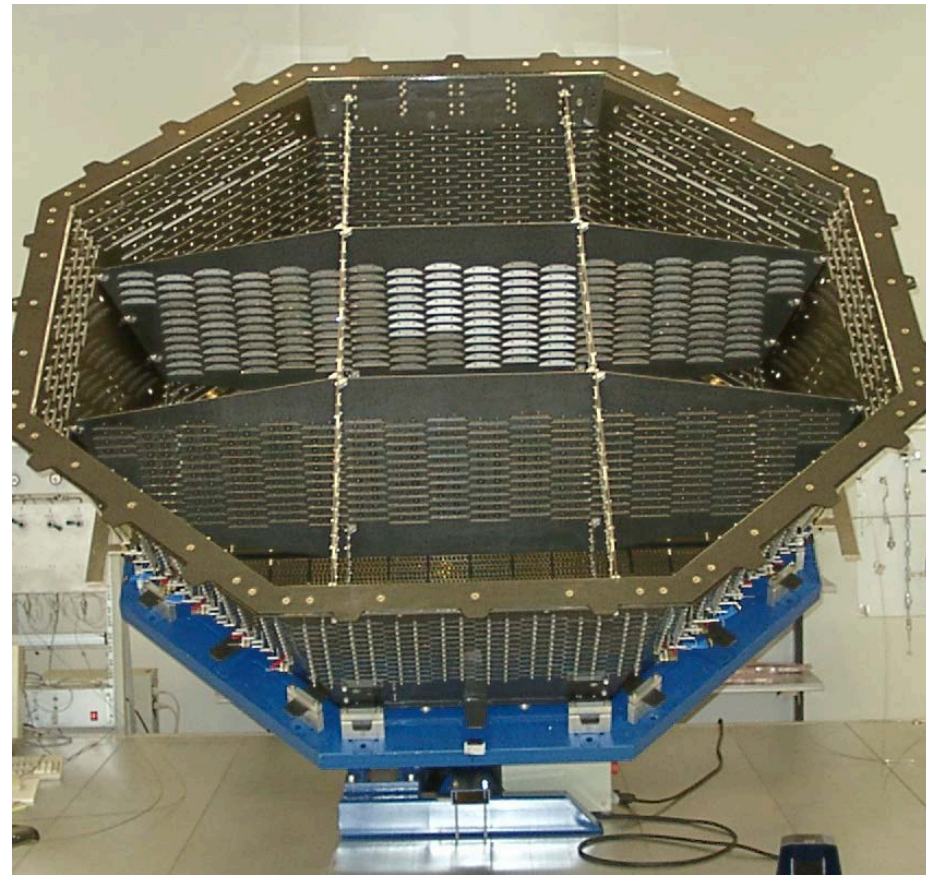


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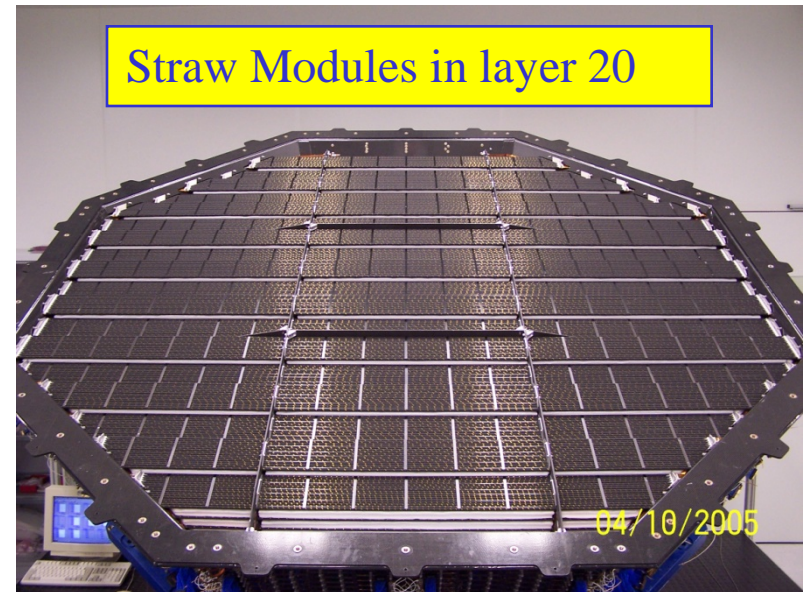
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UNIVERSITY



AMS-02 – Transition Radiation Detector (TRD)



Straw Modules in layer 1 and 2

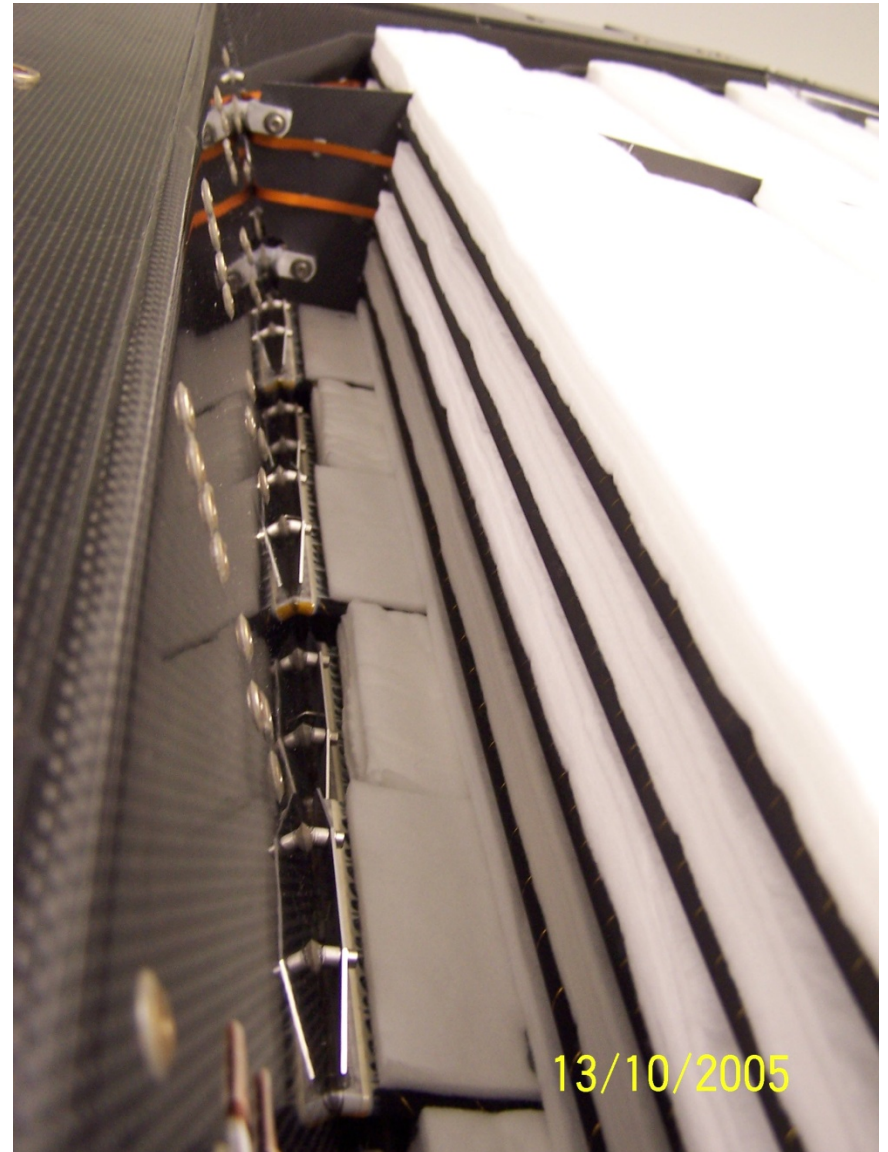
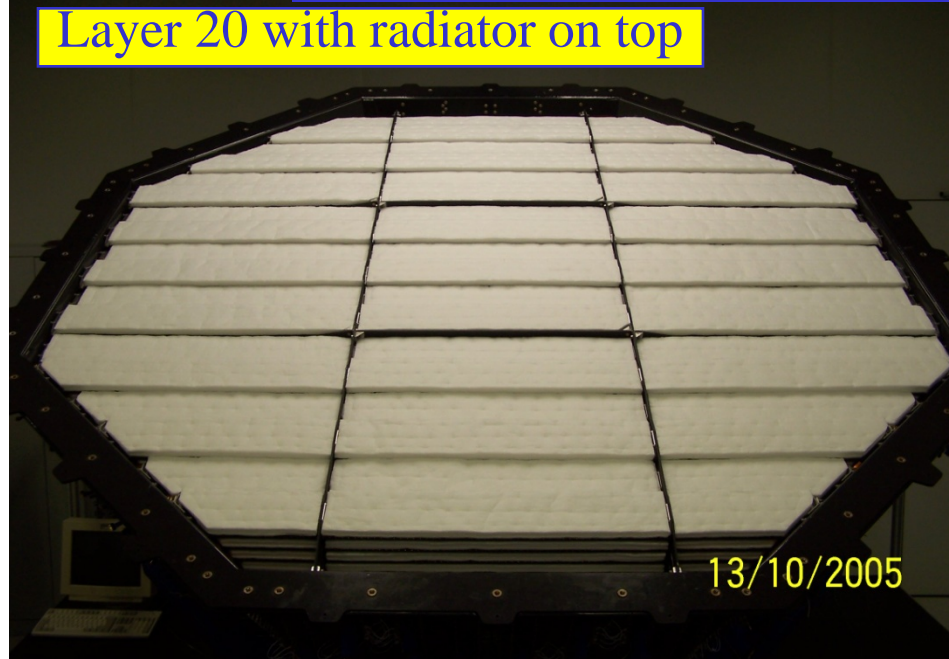


Straw Modules in layer 20



AMS-02 – Transition Radiation Detector (TRD)

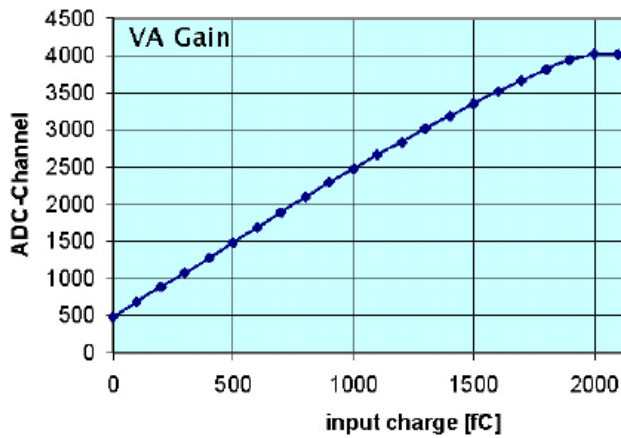
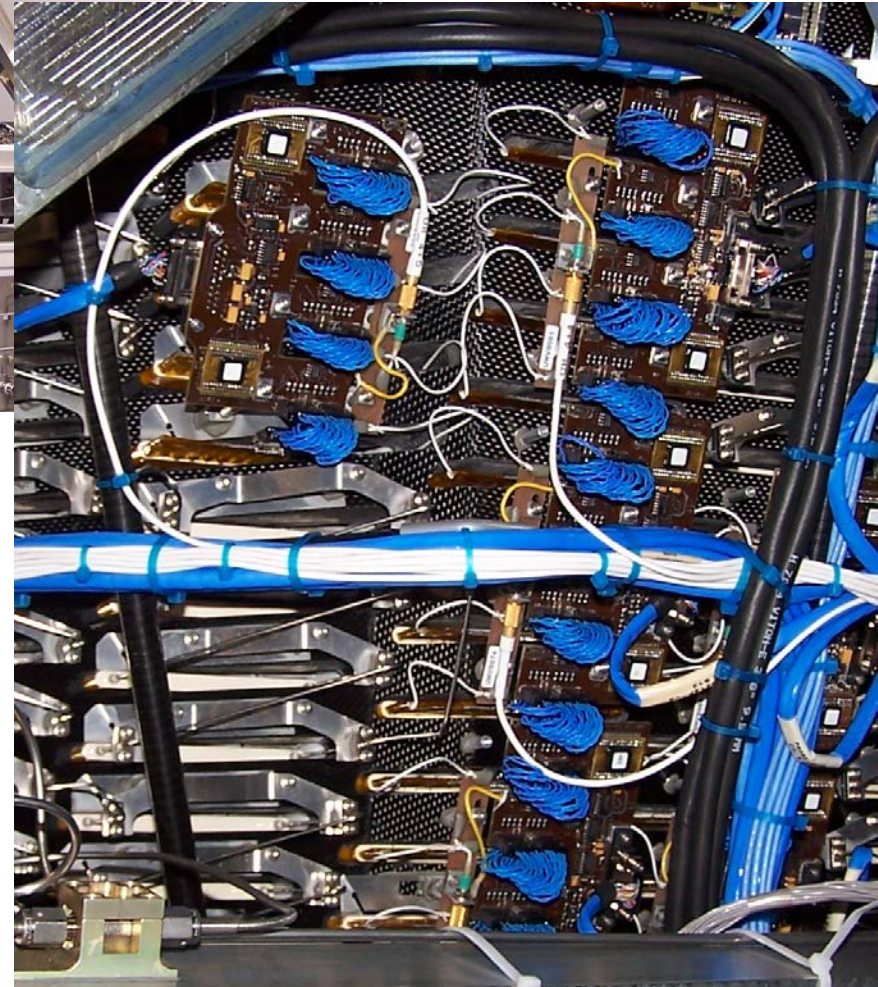
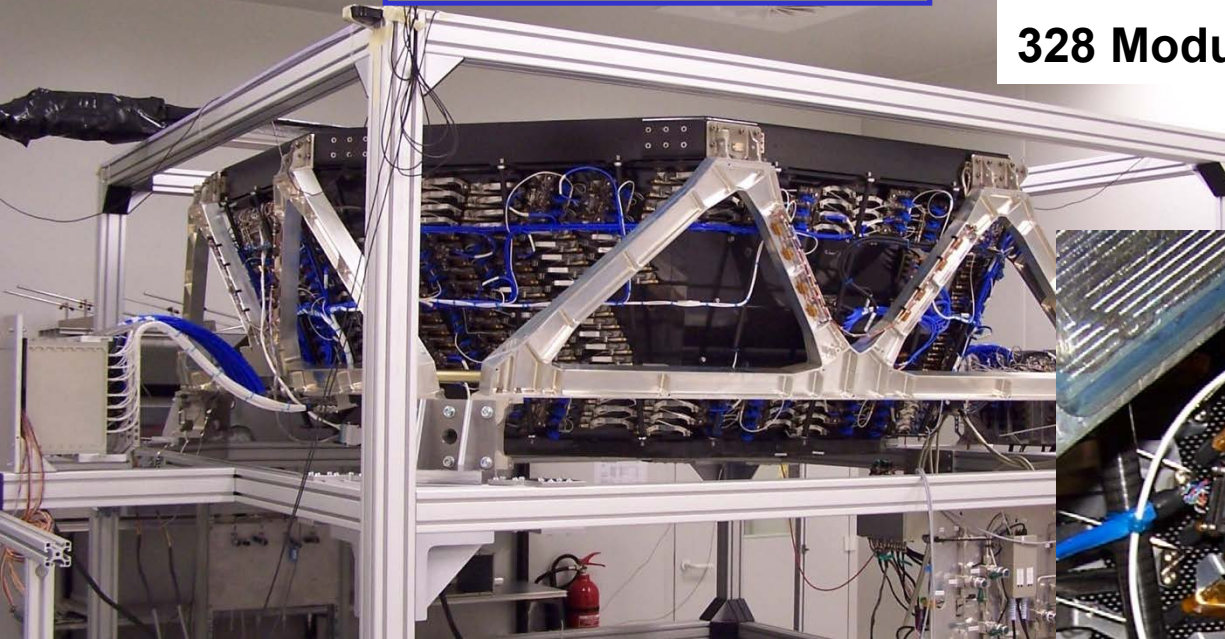
Layer 20 with radiator on top



AMS-02 TRD

4 Straw Modules → 1 Readout Group

328 Modules → 82 Readout Groups



Power: 20W/5248 Channels

MIP MOP 30 fC
(G=3000) 60 bins

MIP S/N > 60/2

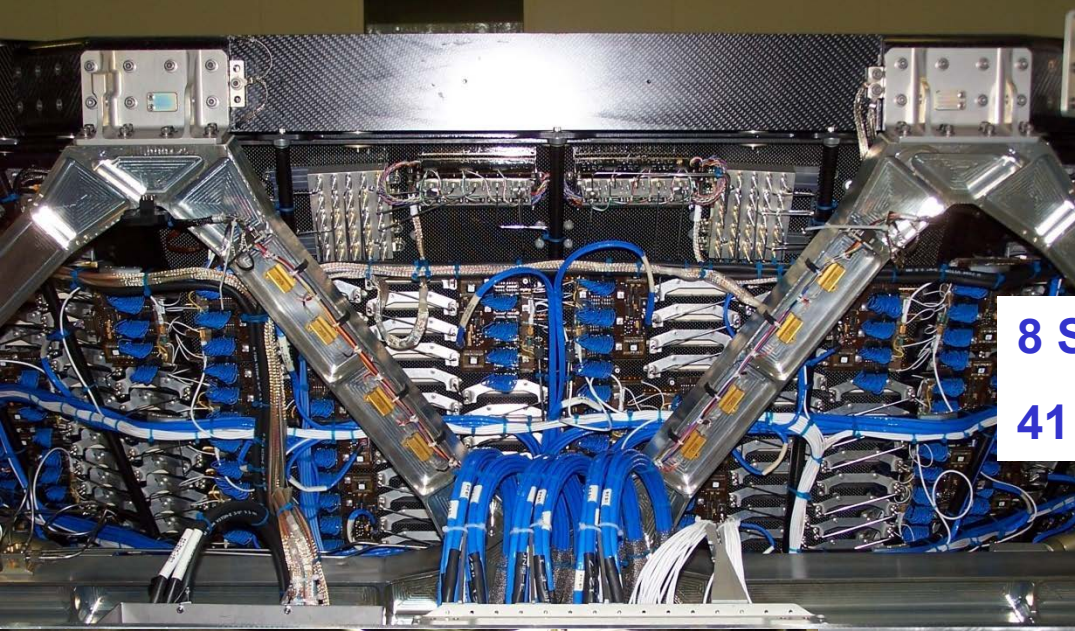
Range 60 MIPs



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AMS-02 TRD

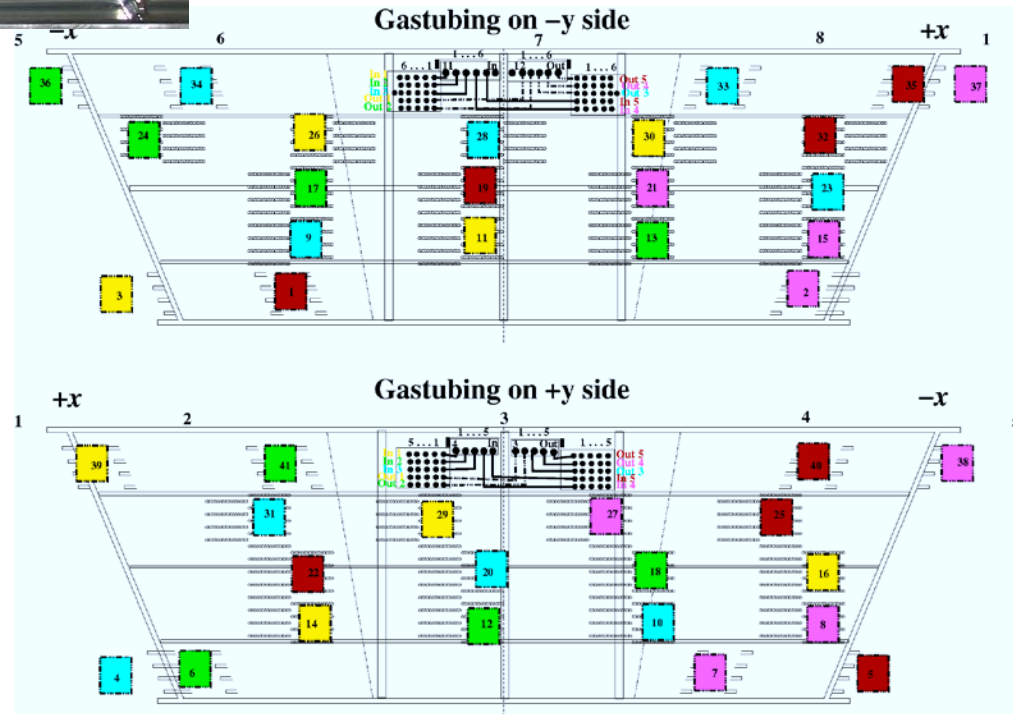




8 Straw Modules \rightarrow 1 Gas Tower
 41 Gas Towers \rightarrow 10 Gas Circuits



41 Gas Towers

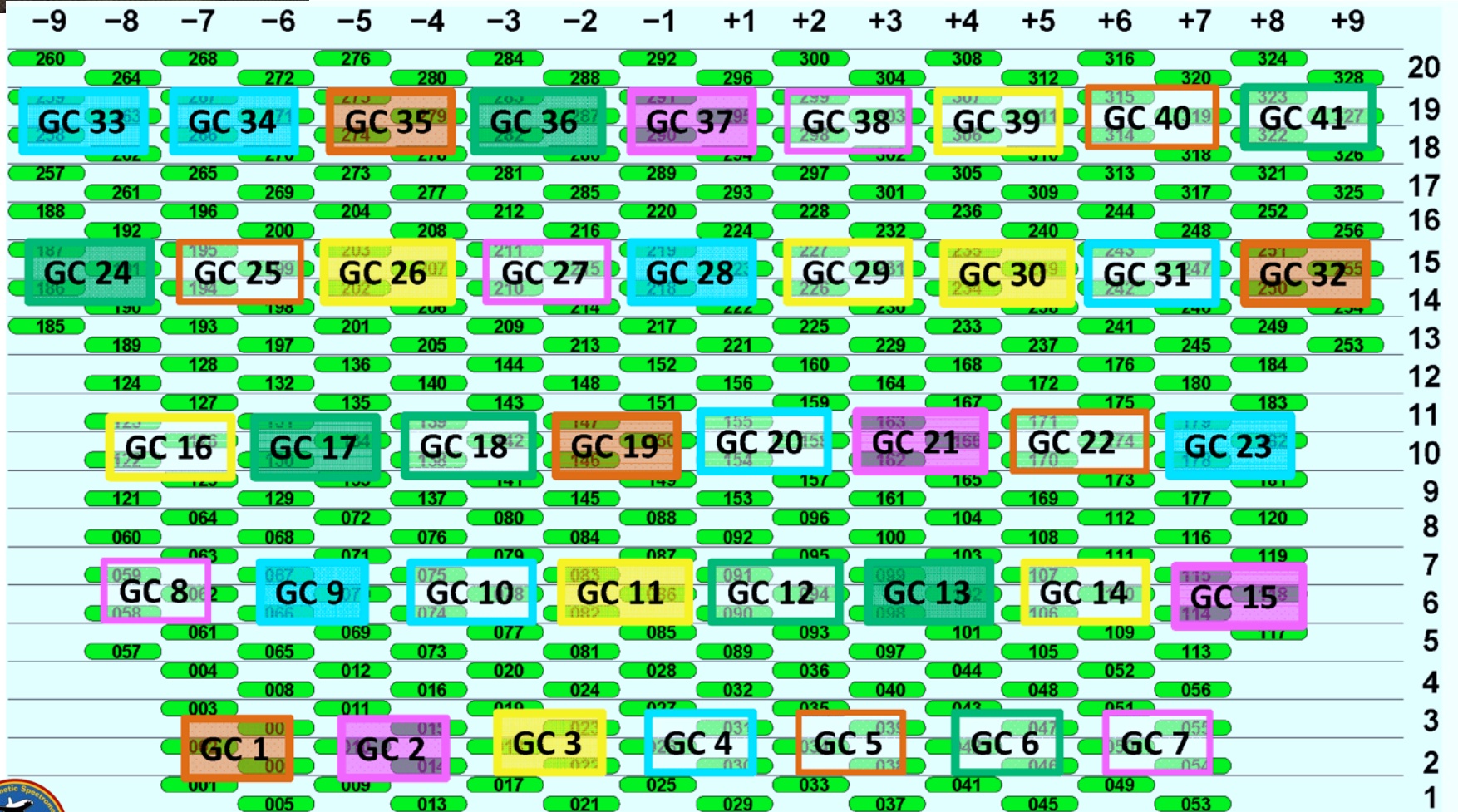


AMS-02 TRD: Gas System

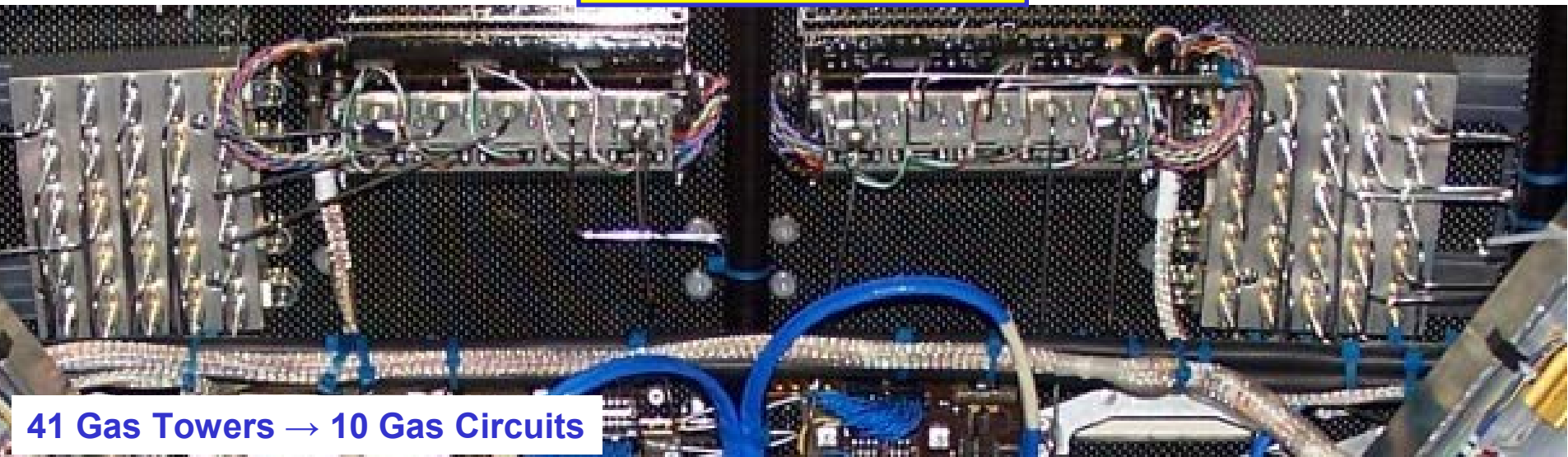


AMS-02 TRD

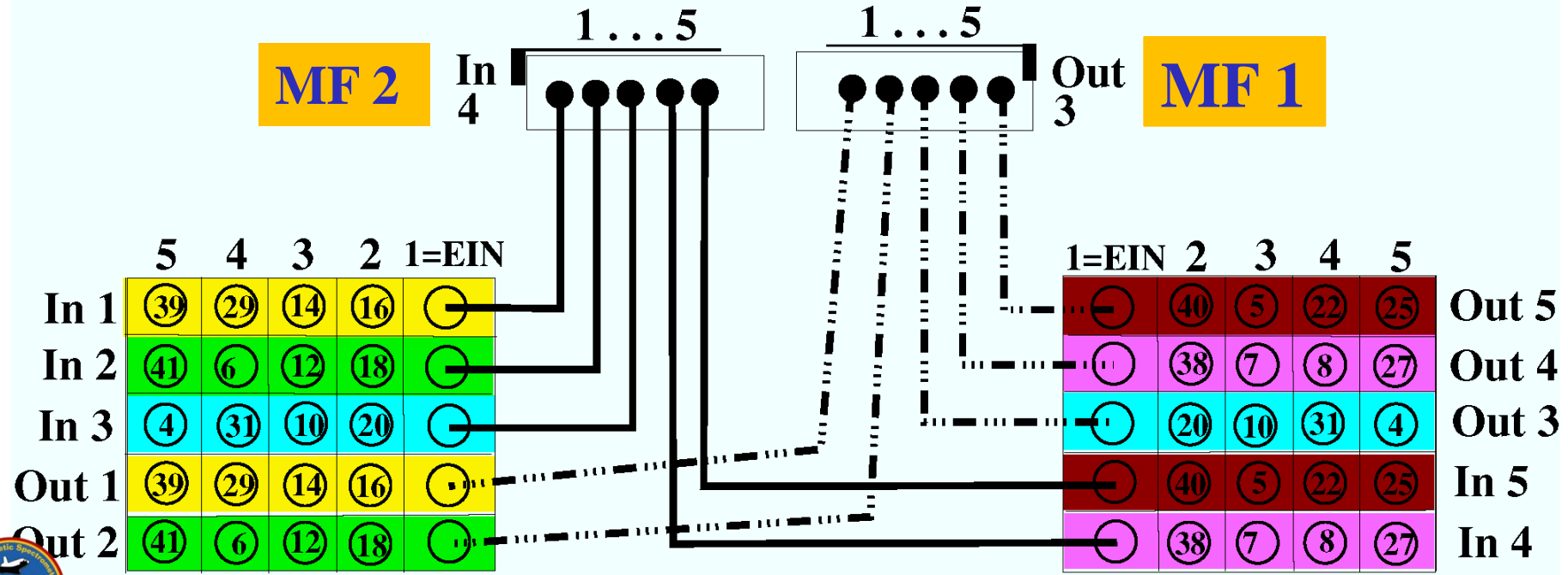
8 Straw Modules → 1 Gas Tower → 41 Gas Towers



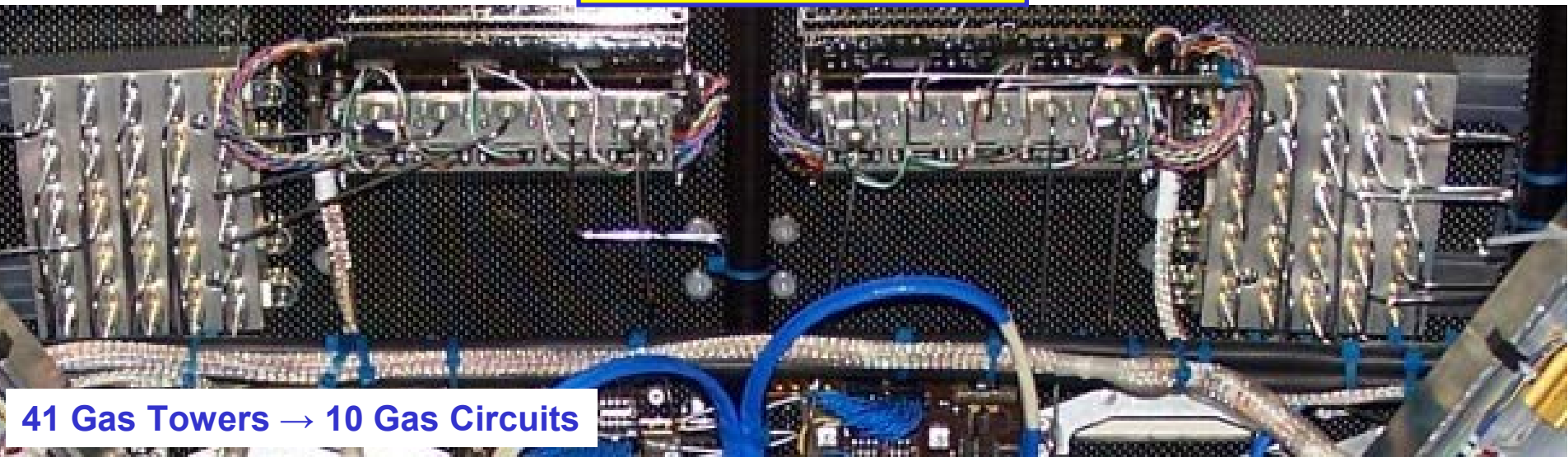
AMS-02 TRD



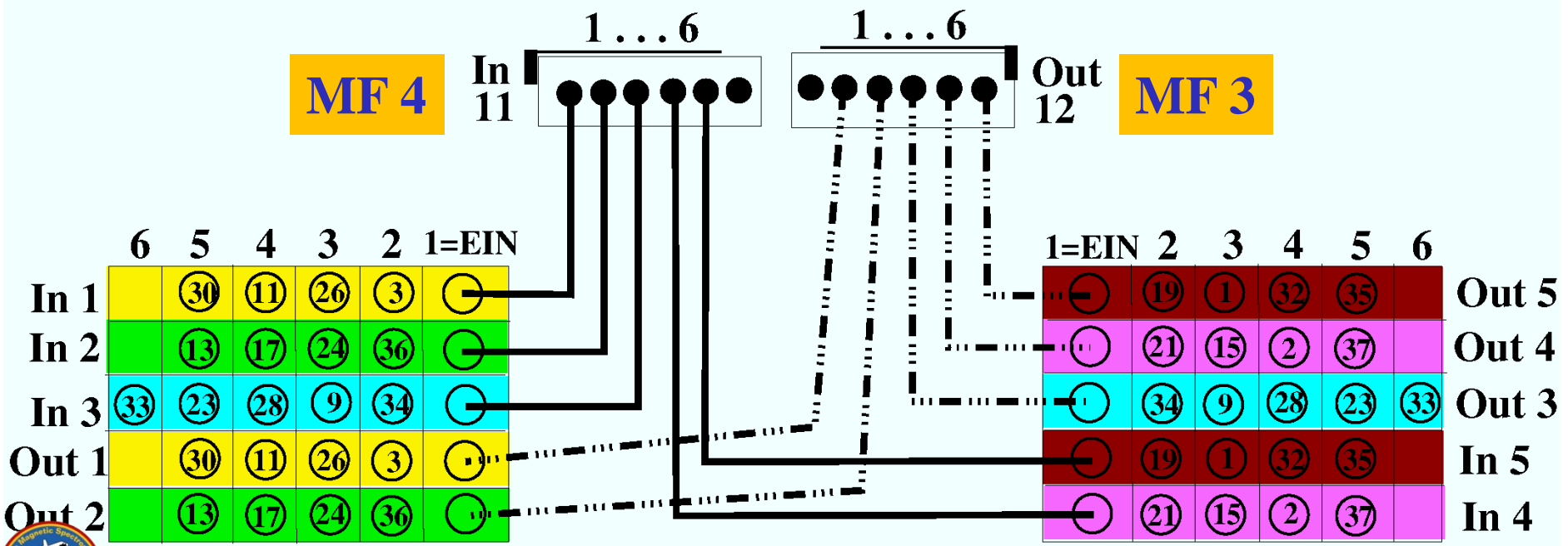
41 Gas Towers → 10 Gas Circuits



AMS-02 TRD



41 Gas Towers → 10 Gas Circuits

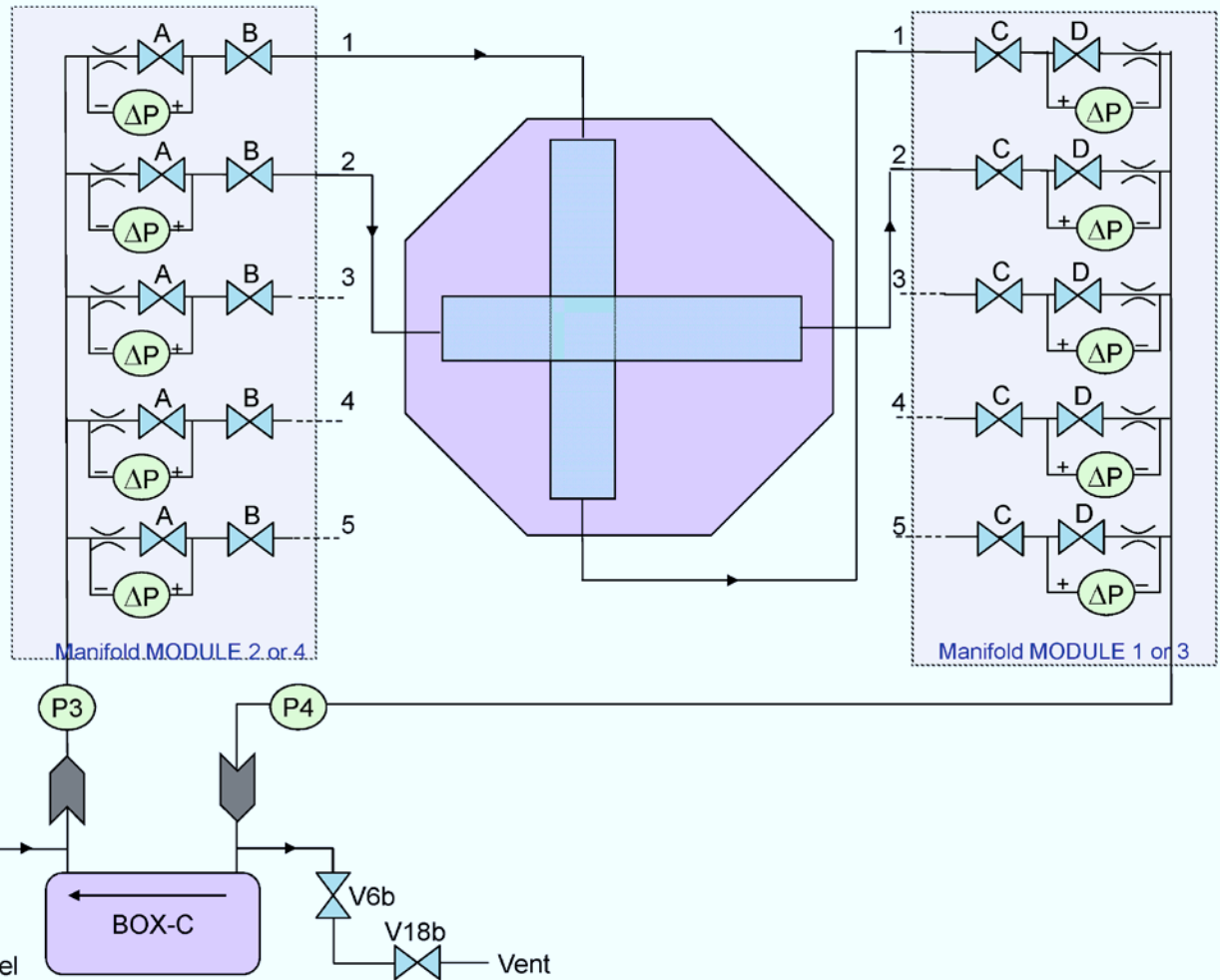


	6	5	4	3	2	1=EIN
In 1		30	11	26	3	⊖
In 2		13	17	24	36	⊖
In 3	33	23	28	9	34	⊖
Out 1		30	11	26	3	⊖
Out 2		13	17	24	36	⊖

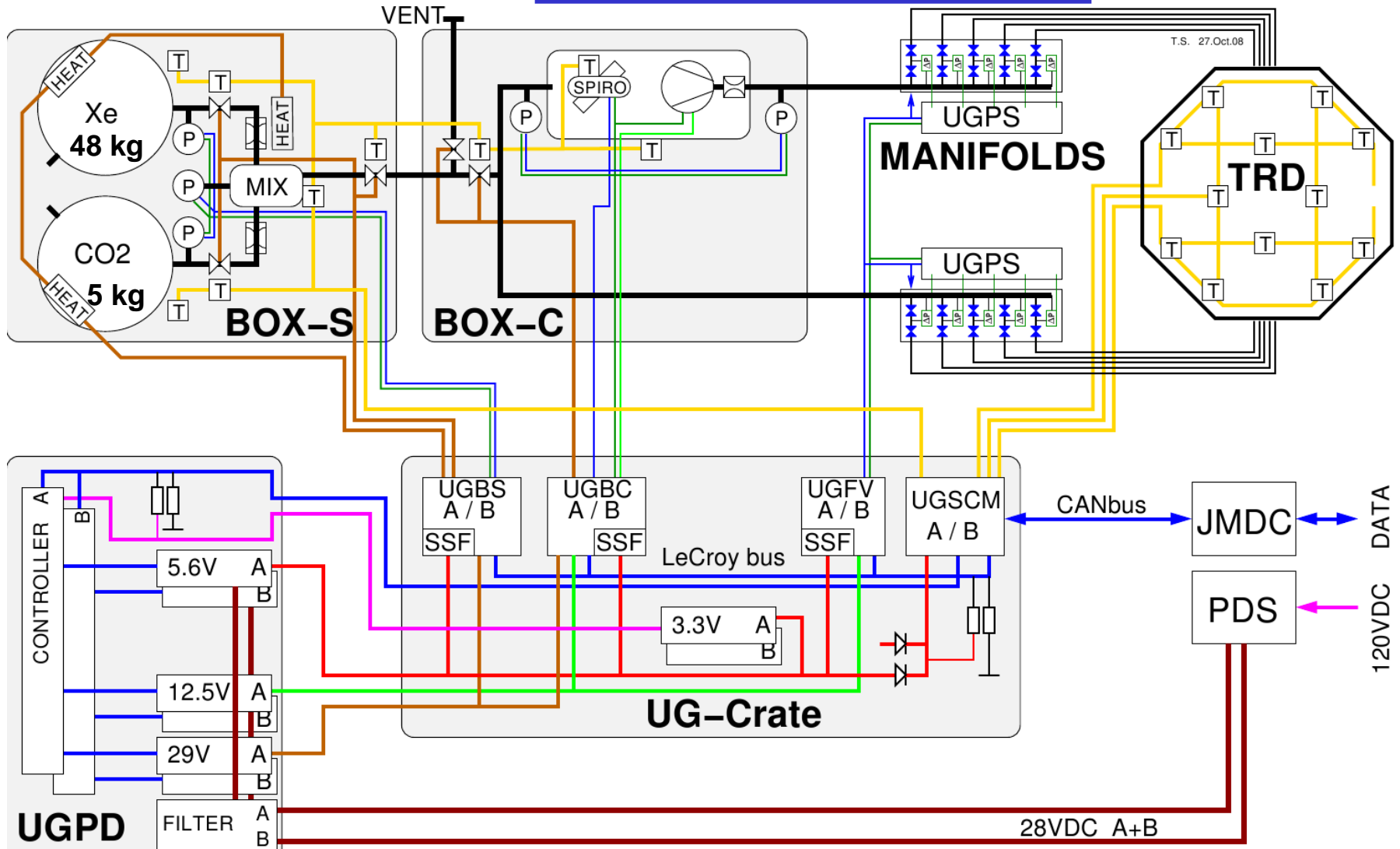
	1=EIN	2	3	4	5	6
Out 5	⊖	19	1	32	35	
Out 4	⊖	21	15	2	37	
Out 3	⊖	34	9	28	23	33
In 5	⊖	19	1	32	35	
In 4	⊖	21	15	2	37	



AMS-02 TRD Gassystem



AMS-02 TRD Gassystem



AMS-02 TRD: Radiator



AMS-02 TRD: Radiator

Radiator LRP 375 BK:

Polyethylene/Polypropylene fibers

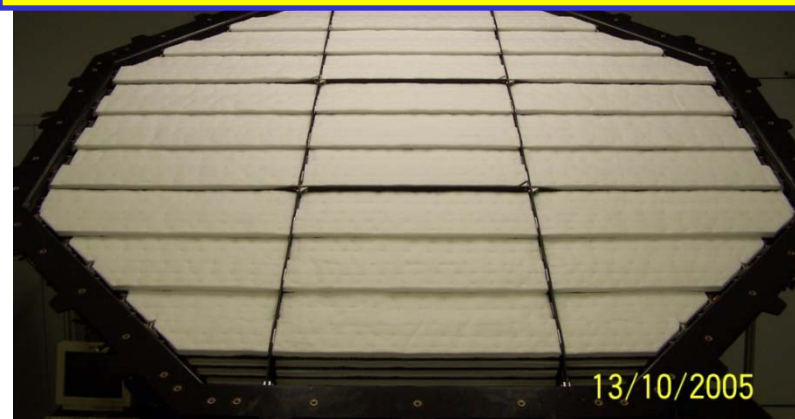
Effective fiber diameter: $10\ \mu\text{m}$

Radiator thickness: 22 mm

Density: $0.06\ \text{g/cm}^3$

Cleaning with Dichlormethane CH_2Cl_2

$\rightarrow dM/dt \approx 10^{-12}\ \text{g/s/cm}^2$



4000 individual pieces cut to length

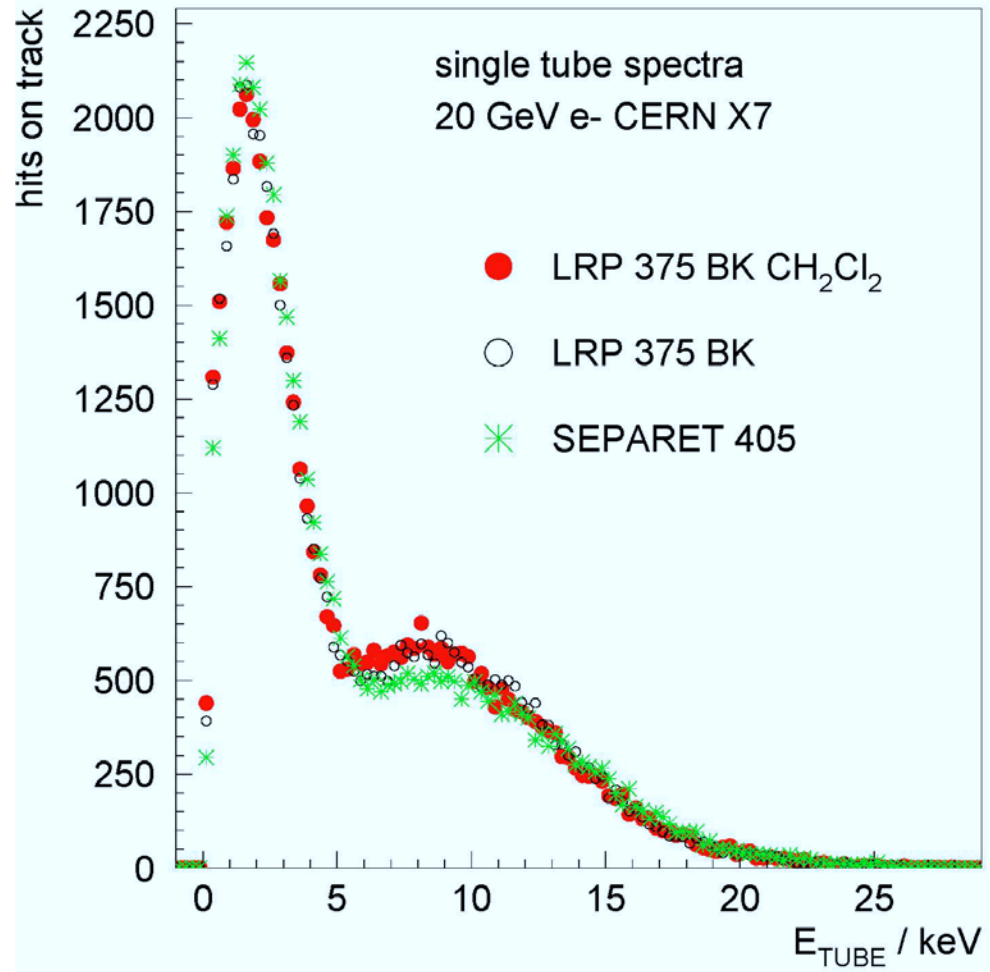
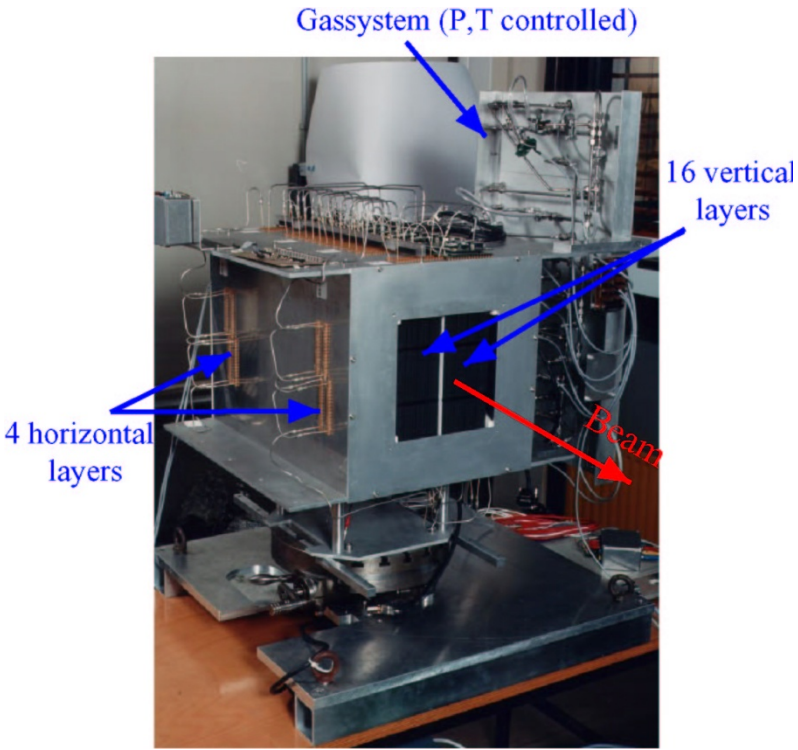


Inst. f. Organic Chemistry
Dichlormethan (CH_2Cl_2)



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AMS-02 TRD: Radiator



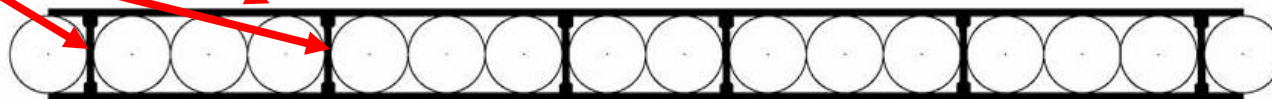
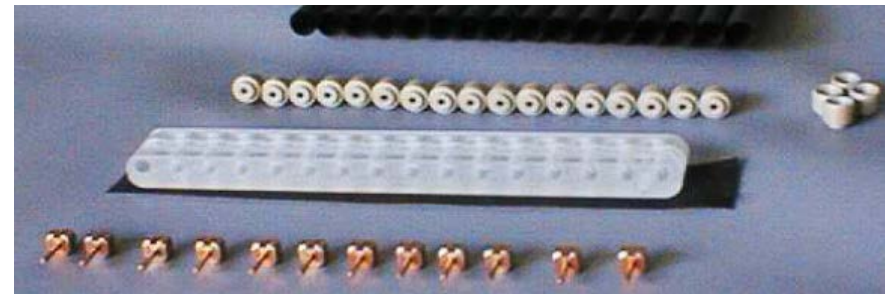
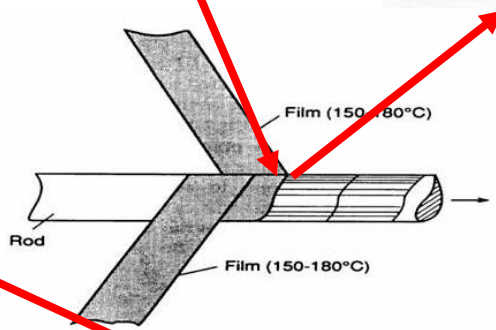
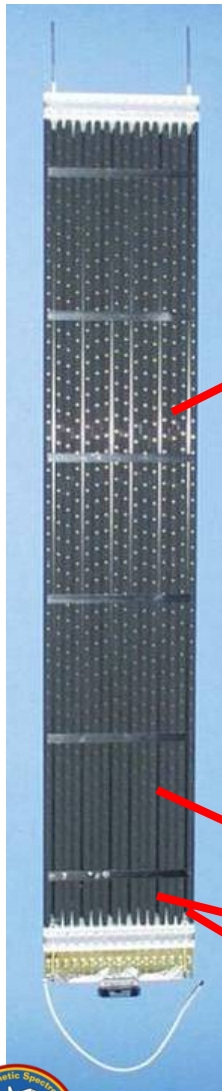
AMS-02 TRD: Straw Modules



AMS-02 – TRD: Straw Modules

Straw tube proportional counter modules:

- Straw tubes: $72\ \mu\text{m}$ multilayer aluminium kapton foil, $\text{Ø } 6\ \text{mm}$, $0.8\text{--}2.0\ \text{m}$ length
- Wire: tungsten anode wire, $30\ \mu\text{m}$ Ø , tension $\approx 100\ \text{g}$
- Gas mixture: Xe / CO_2 (80% / 20%) \rightarrow to be optimized
- Operating HV $\sim 1460\ \text{V}$ \rightarrow Gasgain of ~ 3000
- 1 Module \rightarrow 16 Straws, $100\ \mu\text{m}$ mechanical accuracy
- 328 Modules \rightarrow 5248 Straws



6 longitudinal stiffeners

Strips across every 10 cm

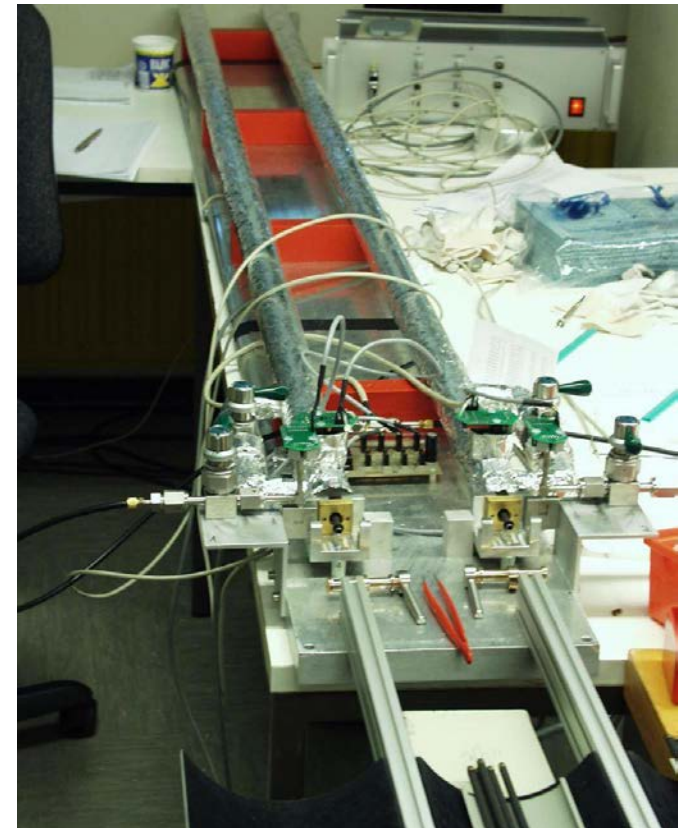
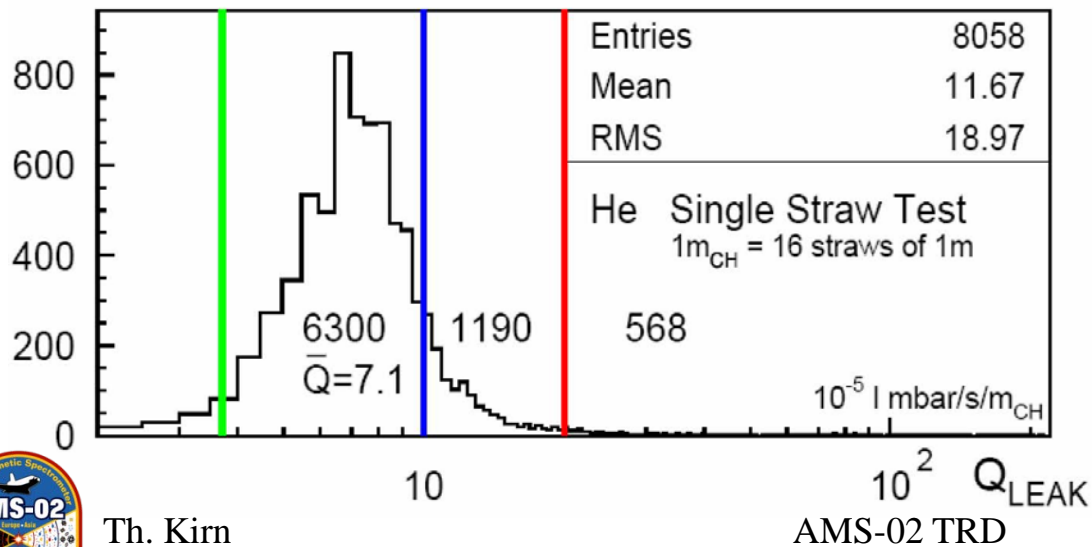
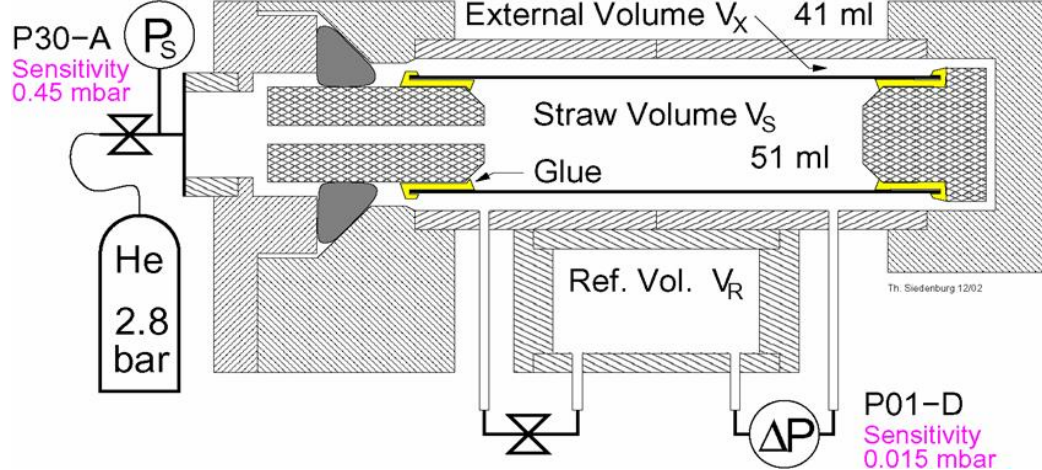
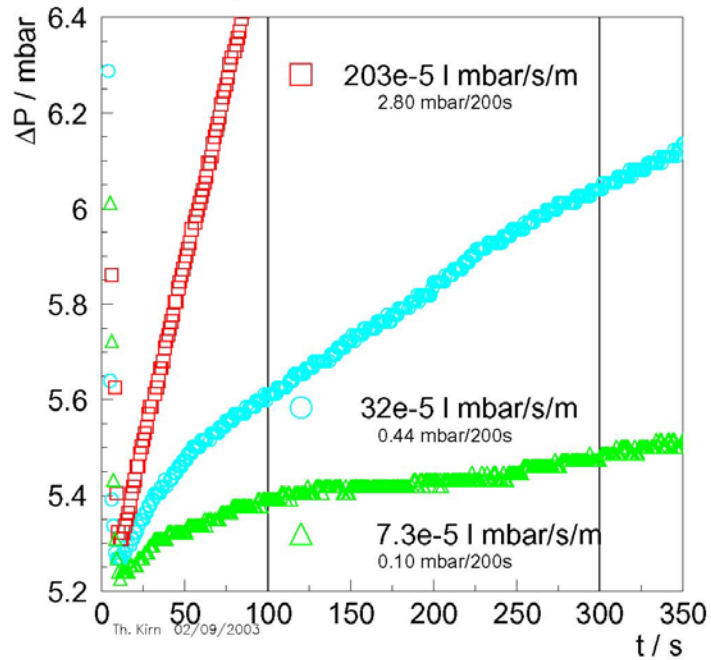
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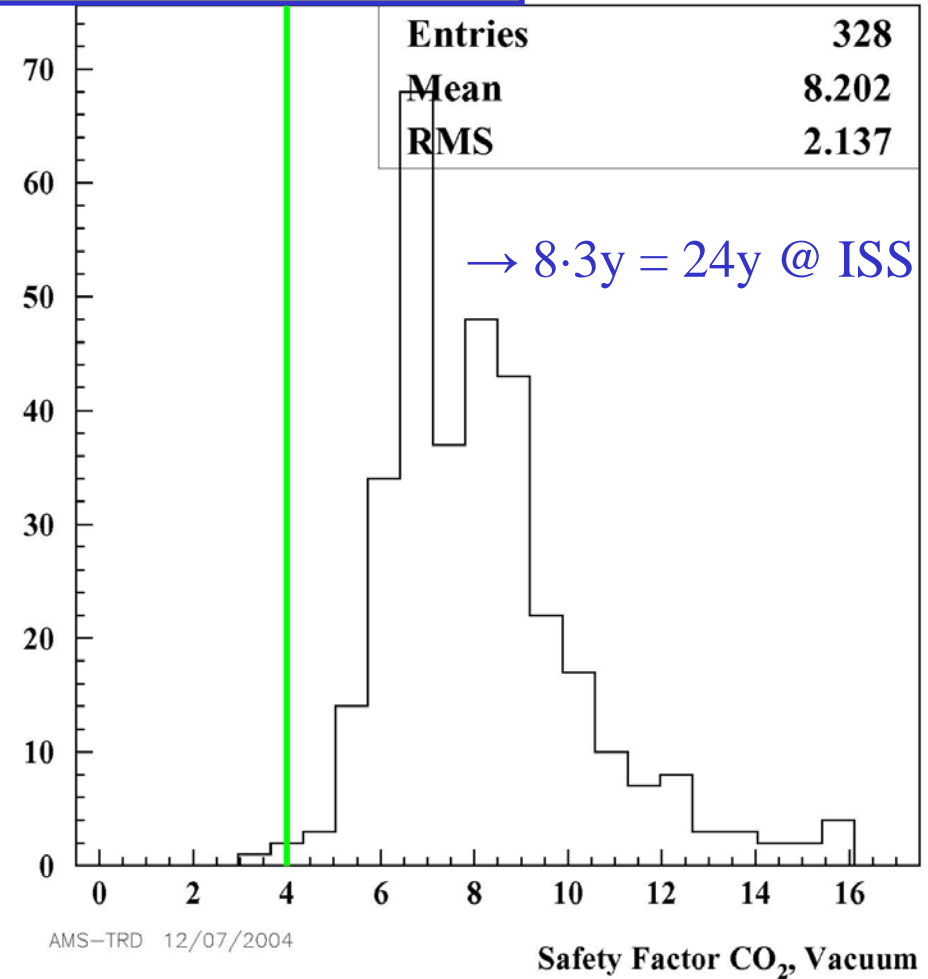


AMS-02 TRD: Gastightness

Single Straw ΔP 5min



AMS-02 TRD: Straw Module Gastightness



CO₂ Leaktest in Vacuum

Straws @ 1bar

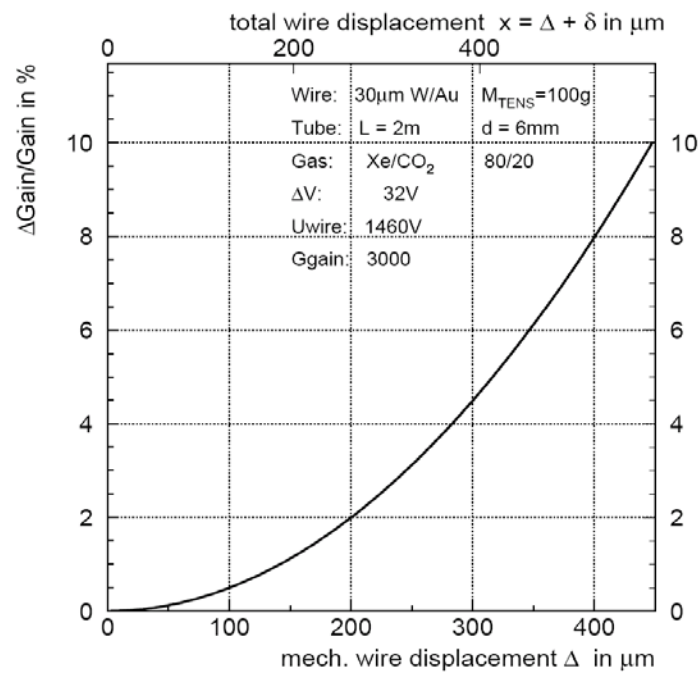
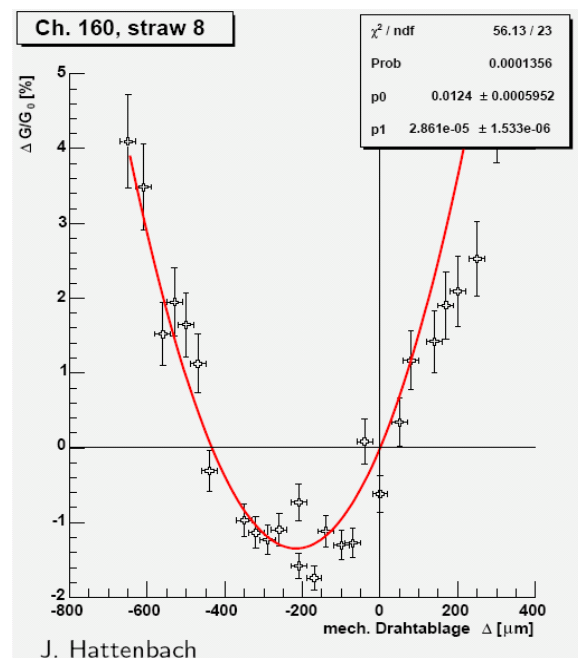
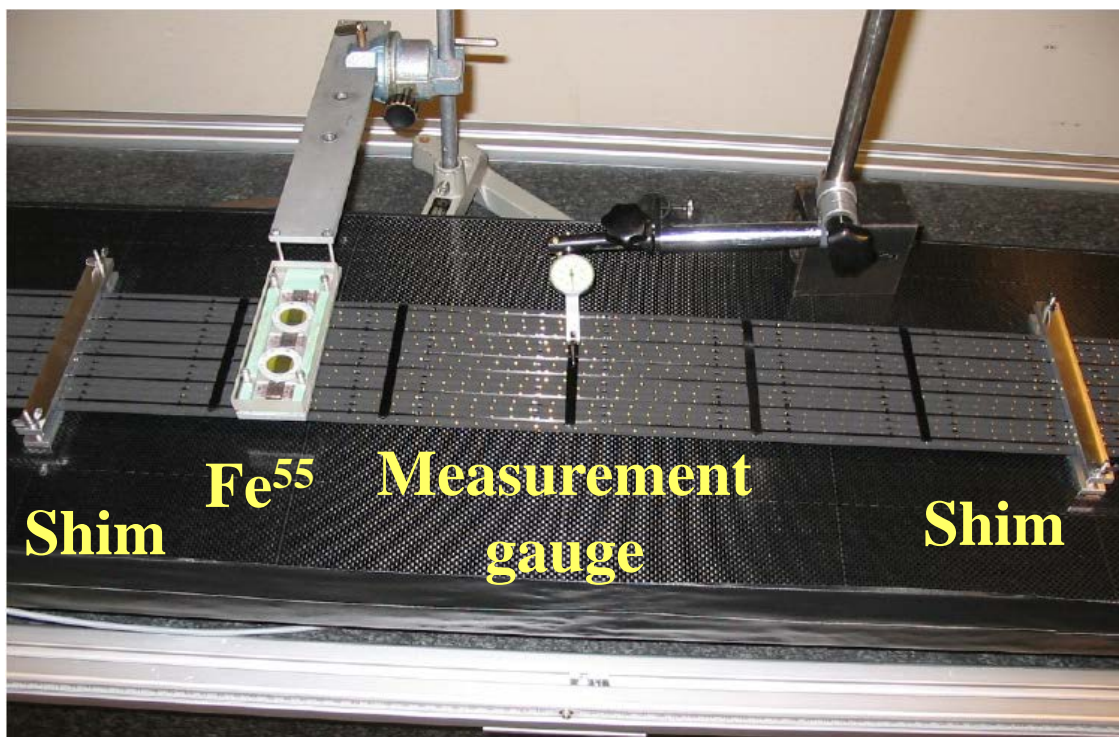
1m_{CH} = 16 straws of 1m [+2 endpcs]

Typ. Module [1.5m]: $3.1 \cdot 10^{-5}$ l mbar/s/m_{CH} \equiv SF 8.2

Gas Tightness measured in safety factors SF, SF=1 $\rightarrow 25.3 \cdot 10^{-5}$ l mbar/s/m_{CH}



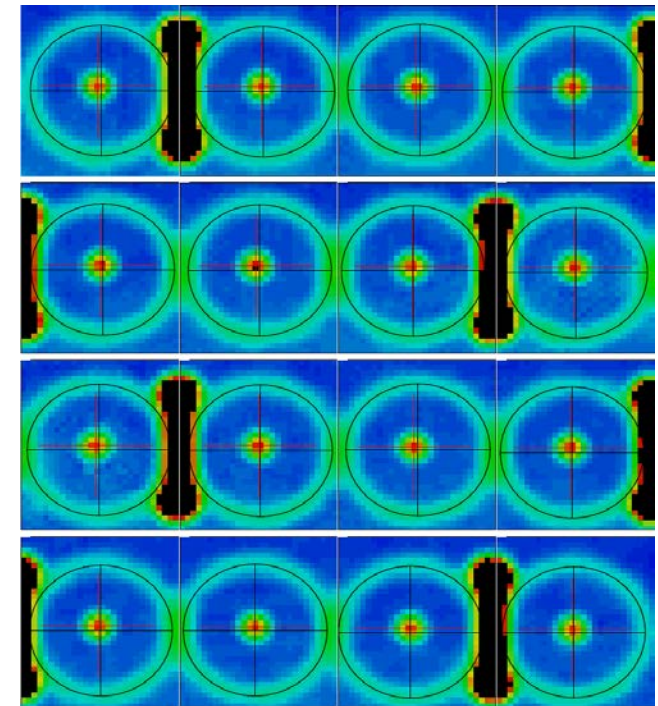
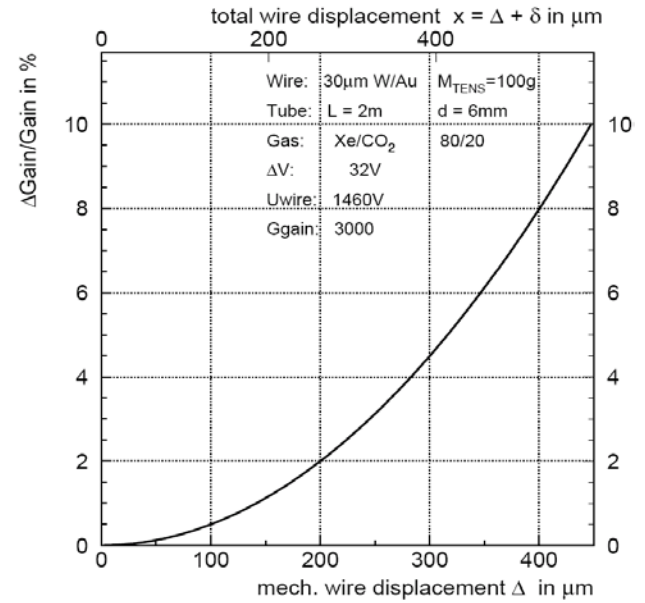
AMS-02 TRD: Straw Modules; Wire displacement detection by Fe^{55} – Gasgain-Measurement for controlled shimming



AMS-02 TRD: Straw Modules, Wire displacement detection, Computer Tomography X-Ray



Luisenhospital Aachen (GE 16-Channel CT)



Wire- and Tube-xy-Fit ($\sigma \approx 10\mu m$)

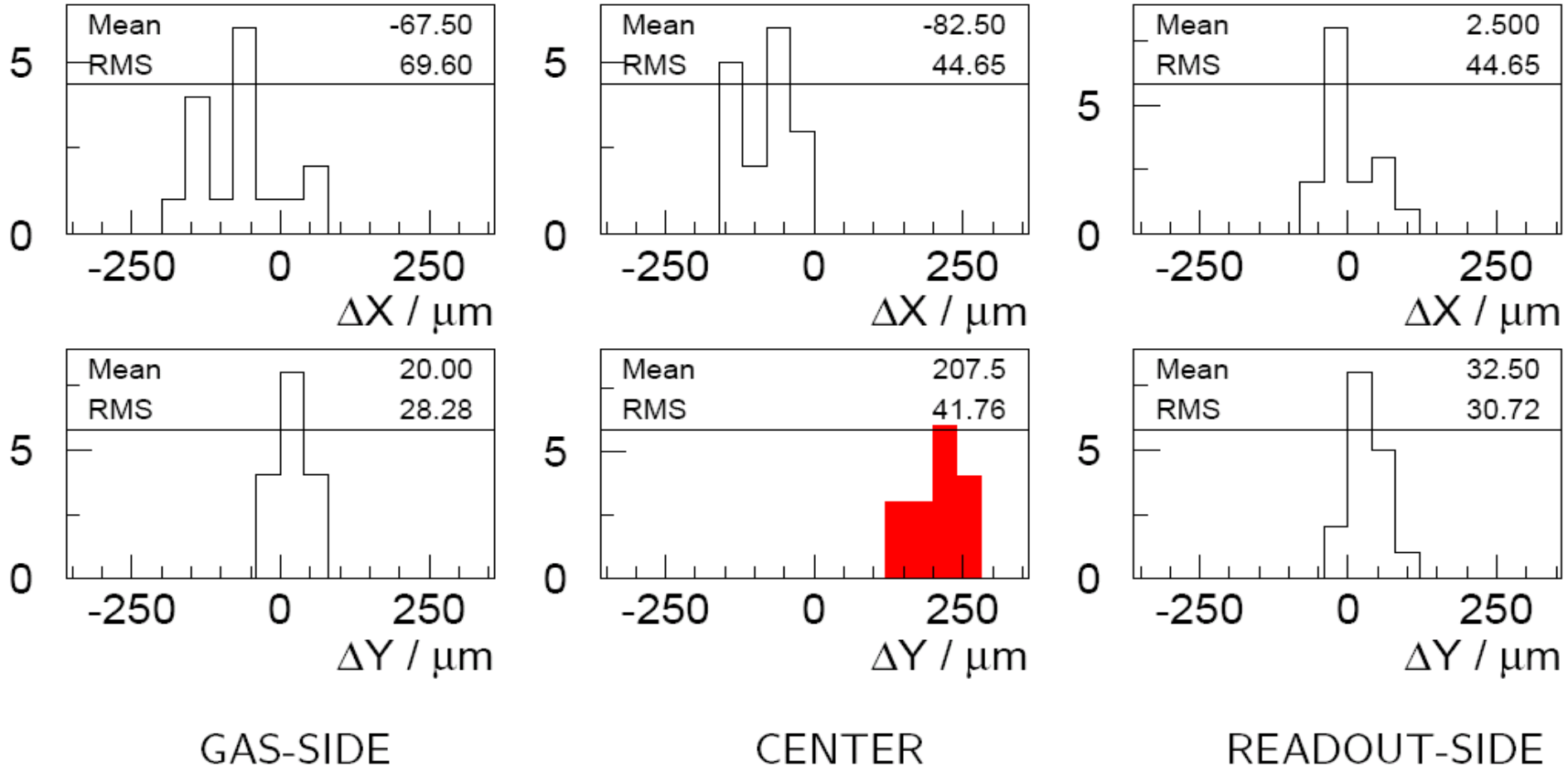


Dicom Image File



AMS-02 TRD: Straw Modules, Wire displacement detection by Computer Tomography X-Ray

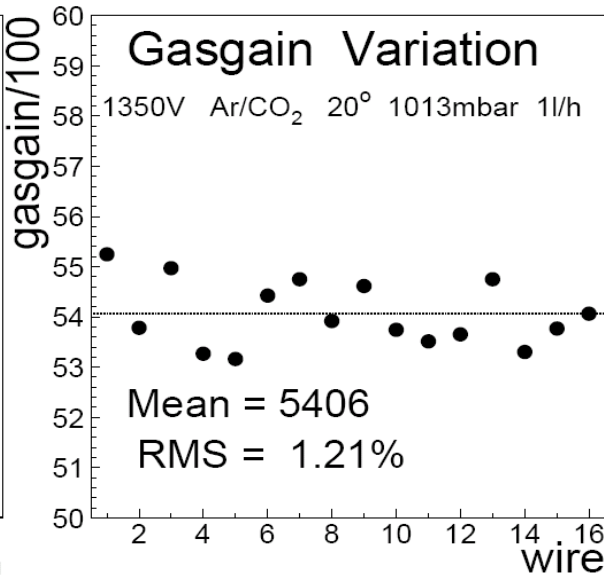
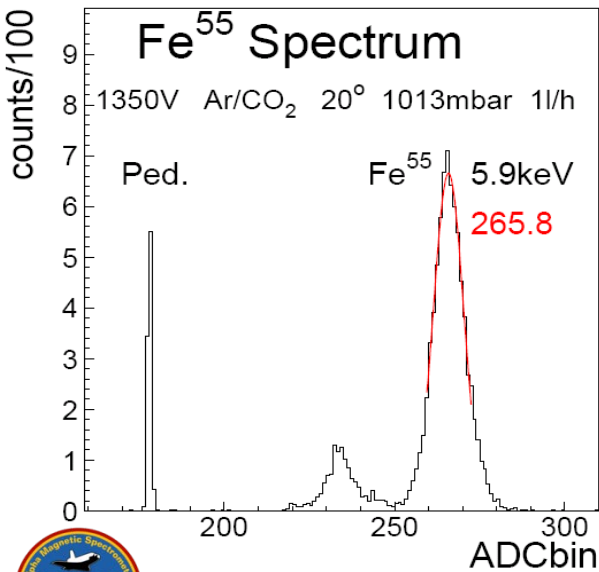
Controlled Shimming of +200 μm y-direction in middle of module



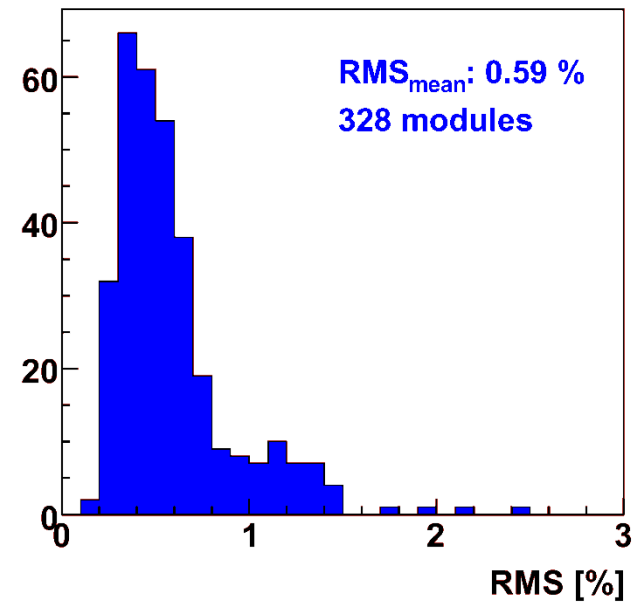
AMS-02 TRD: Fe⁵⁵ – Gasgain-Measurements of 328 Flight Straw Modules



	0.1	0.3	0.5	0.7	0.9	1.1	1.3	1.5	1.7	1.9m	Straw
1	3.2	1.5	4.2	1.8	5.7	7.1	5.2	4.2	0.2	-0.9	1
2	0.1	-0.1	0.2	1.0	4.1	3.8	2.9	1.8	-1.2	-2.4	2
3	-2.0	-0.7	0.2	0.5	0.1	3.2	4.2	-0.6	-2.9	-3.8	3
4	-2.6	-1.3	-2.1	0.4	0.6	2.5	2.8	-0.6	-2.8	-4.6	4
5	-2.9	-3.3	-1.4	-1.1	0.8	3.2	1.7	0.7	-3.0	-3.7	5
6	-3.7	-1.4	-4.0	-1.2	-0.9	1.4	2.8	-0.6	-1.9	-4.7	6
7	-1.9	-2.6	-1.1	-2.1	0.7	2.7	1.9	0.6	-2.9	-3.0	7
8	-2.4	-0.5	-1.0	0.8	1.1	2.3	2.1	-0.6	-2.0	-3.6	8
9	0.6	-1.0	1.0	0.4	5.8	5.6	1.6	2.8	-1.1	-1.1	9
10	-0.1	-1.2	0.3	0.5	2.8	3.6	0.9	0.8	-1.4	-2.7	10
11	-2.1	-0.6	-1.4	-1.0	0.4	1.6	2.1	-1.7	-3.6	-4.4	11
12	-2.3	-1.7	-0.5	-1.5	1.3	2.0	-0.1	-0.3	-4.8	-5.0	12
13	-2.1	-0.3	-0.6	0.7	2.2	1.9	3.4	0.4	-3.1	-5.1	13
14	-0.7	-1.4	0.8	-1.1	1.9	4.2	1.7	0.5	-3.0	-3.1	14
15	-1.6	-0.1	-2.1	1.8	2.6	2.2	2.7	1.0	-0.7	-2.9	15
16	-1.9	1.3	-0.7	2.4	1.6	3.1	4.5	1.6	-0.6	-4.2	16



RMS gasgain



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AMS-02 TRD



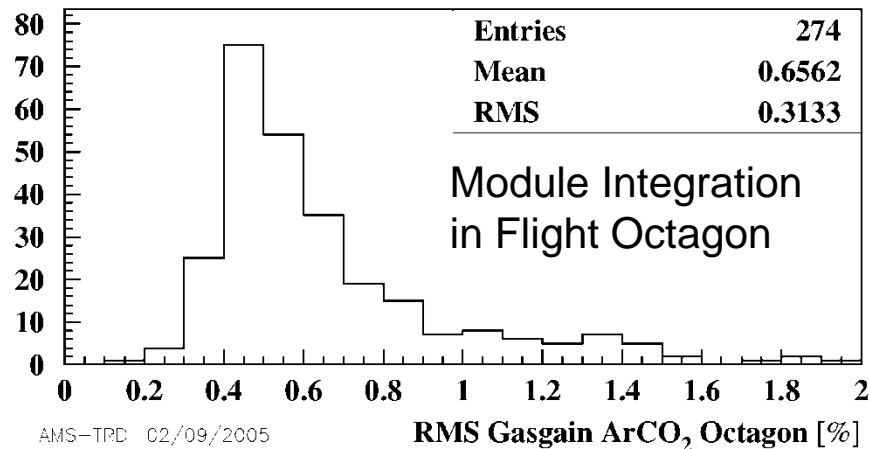
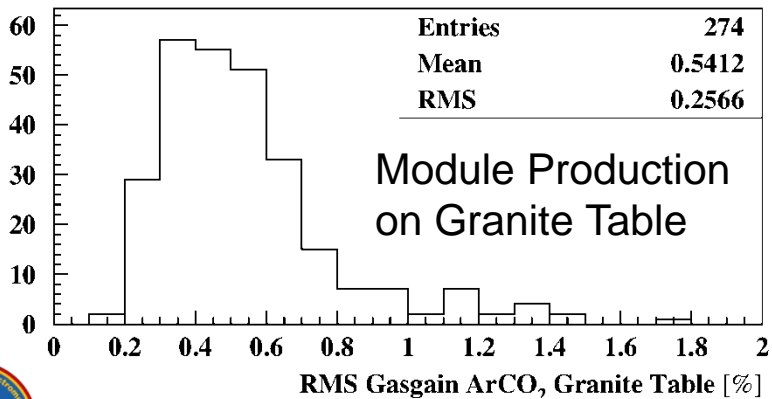
AMS-02 – TRD Straw Modules



**Start TRD Integration
September 2004**



**End TRD Module Integration
October 2005**



RMS Gasgain ArCO, Octagon [%]
RWTH AACHEN UNIVERSITY

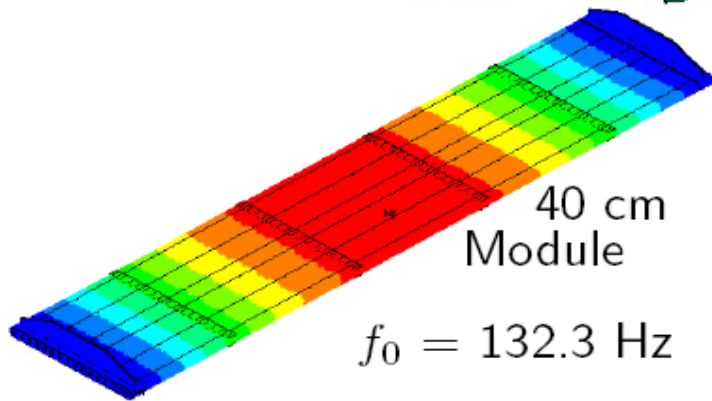
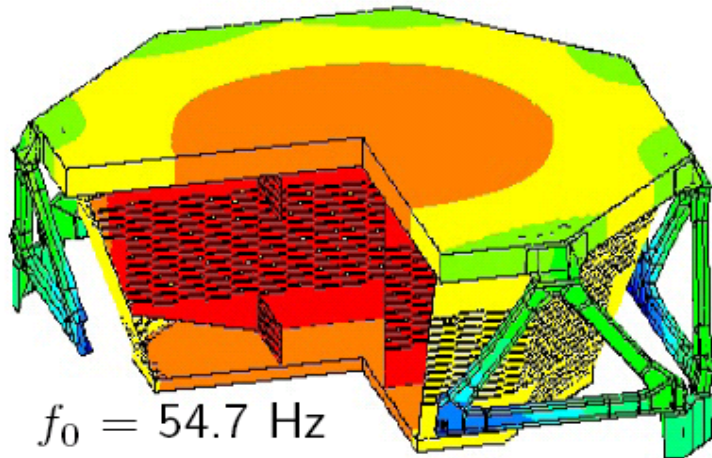
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AMS-02 TRD

29



AMS-02 TRD: Straw Modules: Space Qualification Tests



FEC coupled load modal analysis

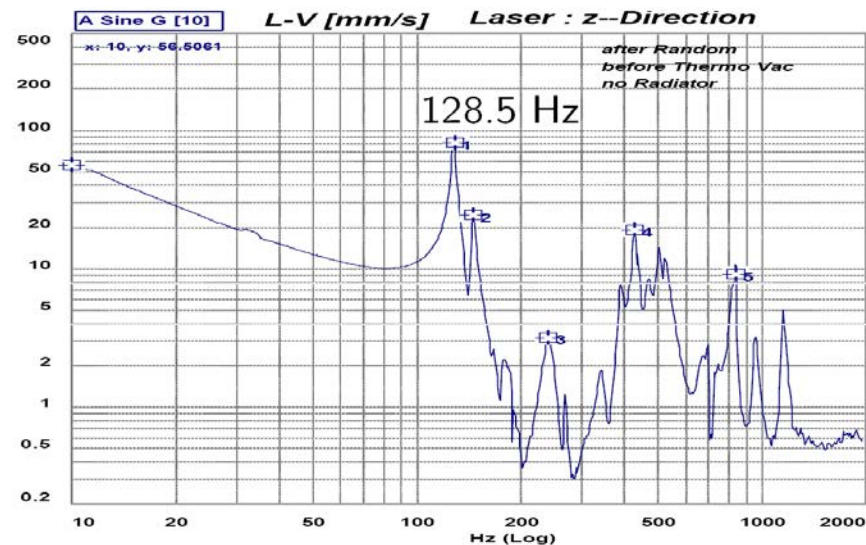
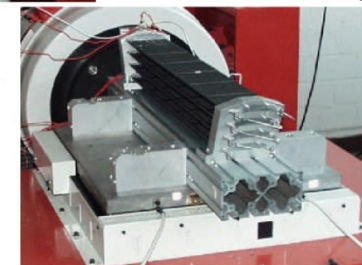
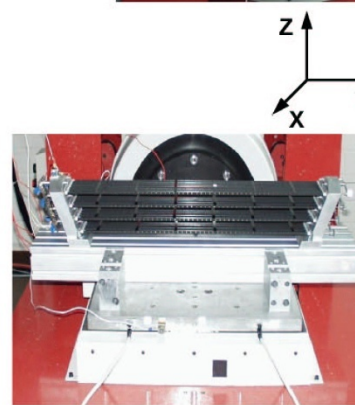
Parameters from static measurements

Verify with component vibration tests



Vibration-Test-Cycle:

- Sine Sweep 0.5g (10-2000Hz)
- Random Spectrum $a_{RMS} = 6.8g$
- Sine Sweep 0.5g (10-2000Hz)



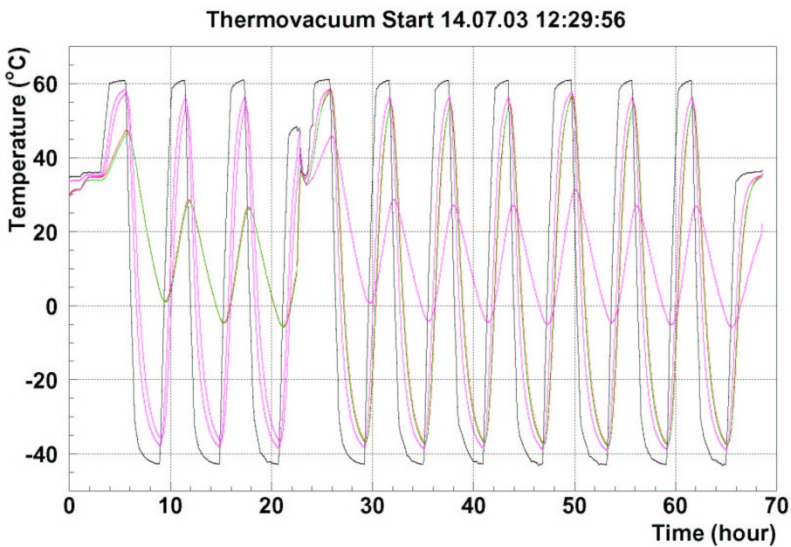
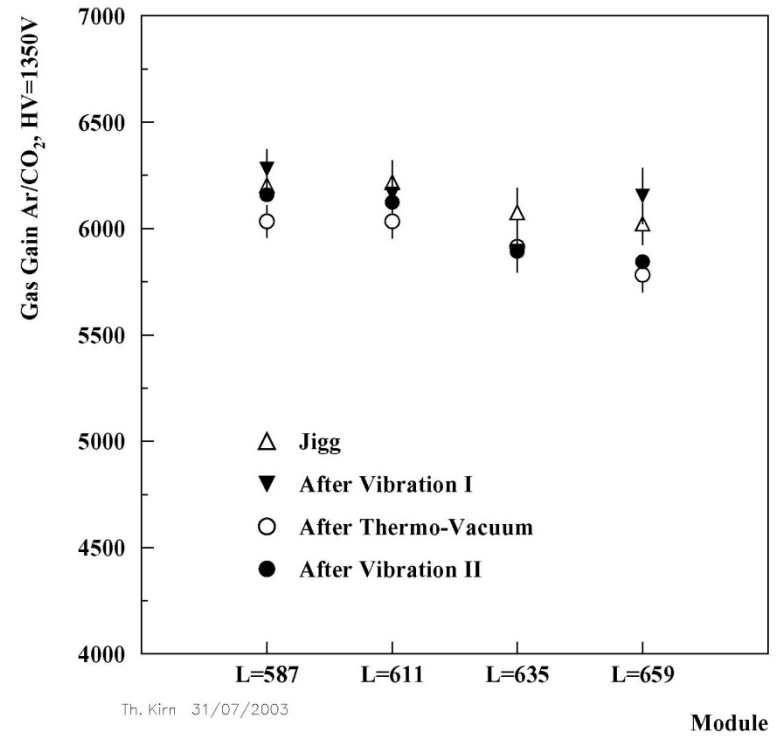
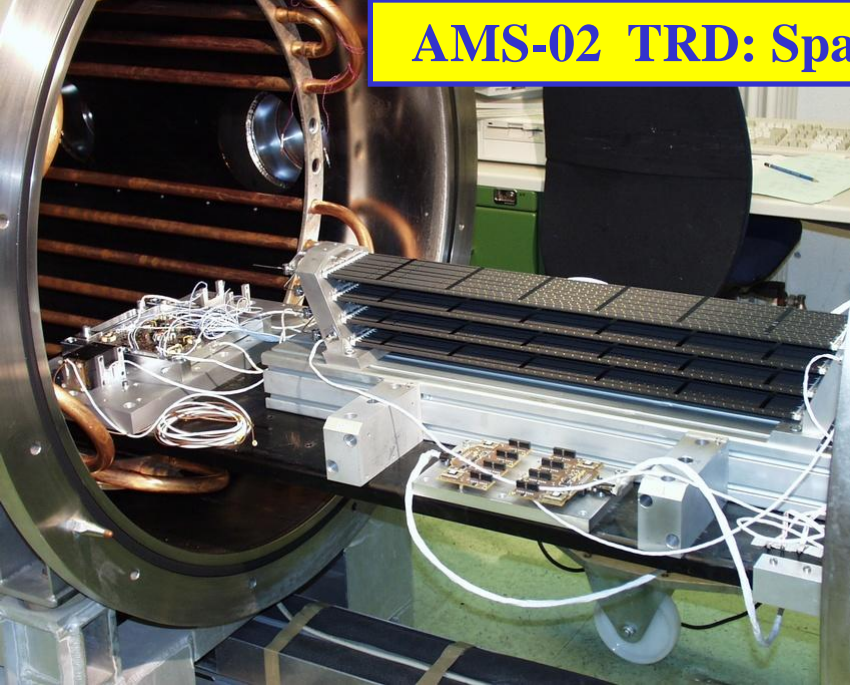
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AMS-02 TRD



30

AMS-02 TRD: Space Qualification Tests



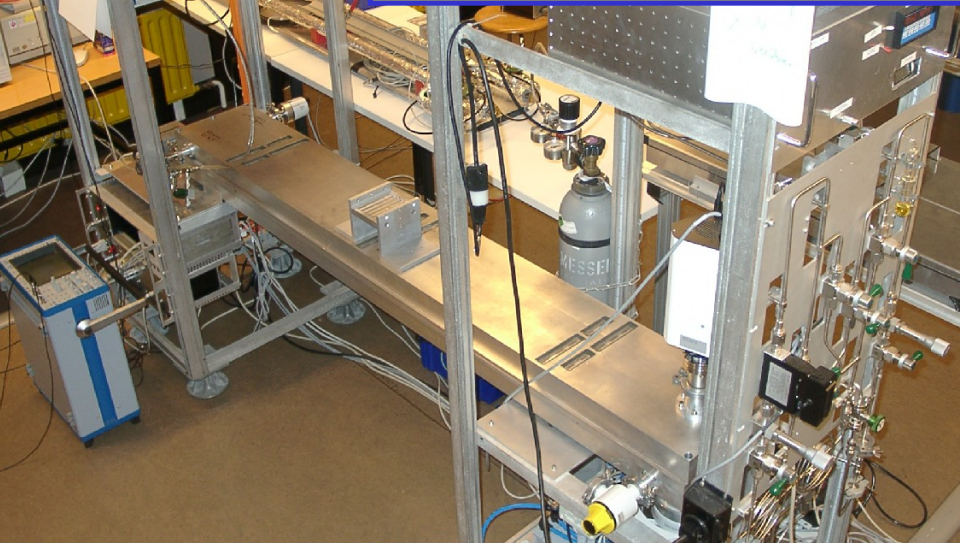
No significant changes in:

- Gasgain
- Gastightness

→ Straw Modules space qualified



AMS-02 TRD: Straw Module Longterm Tests

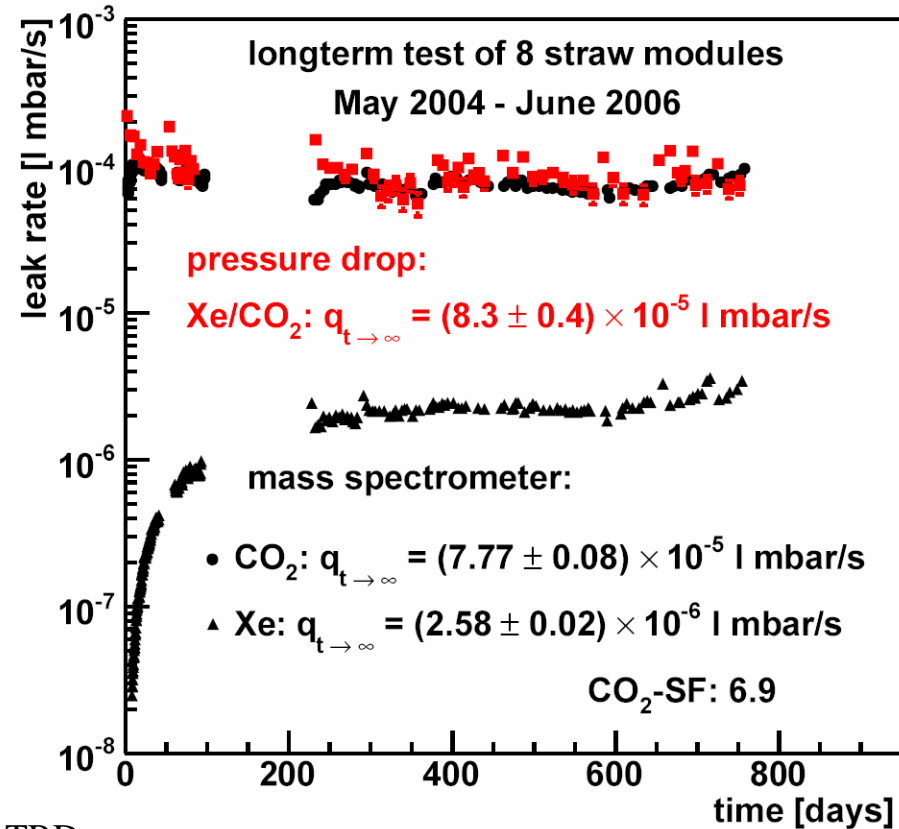
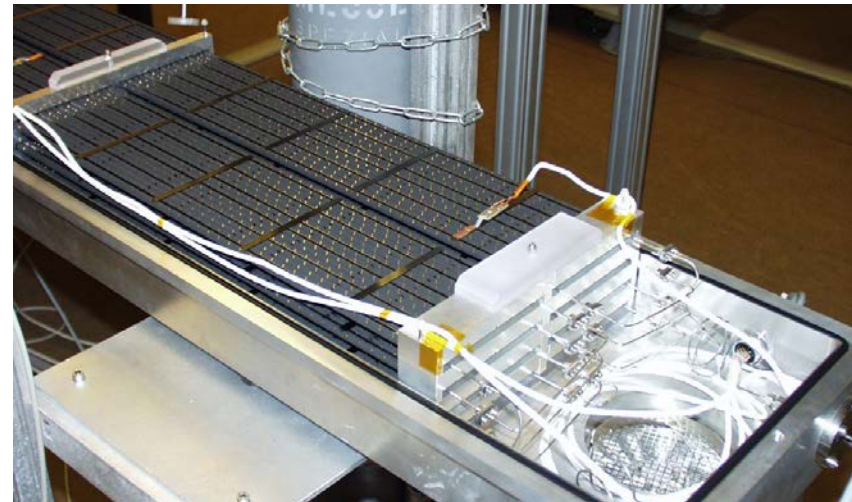


1 Gasgroup → 8 Modules

Fe⁵⁵ – Monitoring

Pressure-Drop Measurements

Mass-Spectrometer Measurements



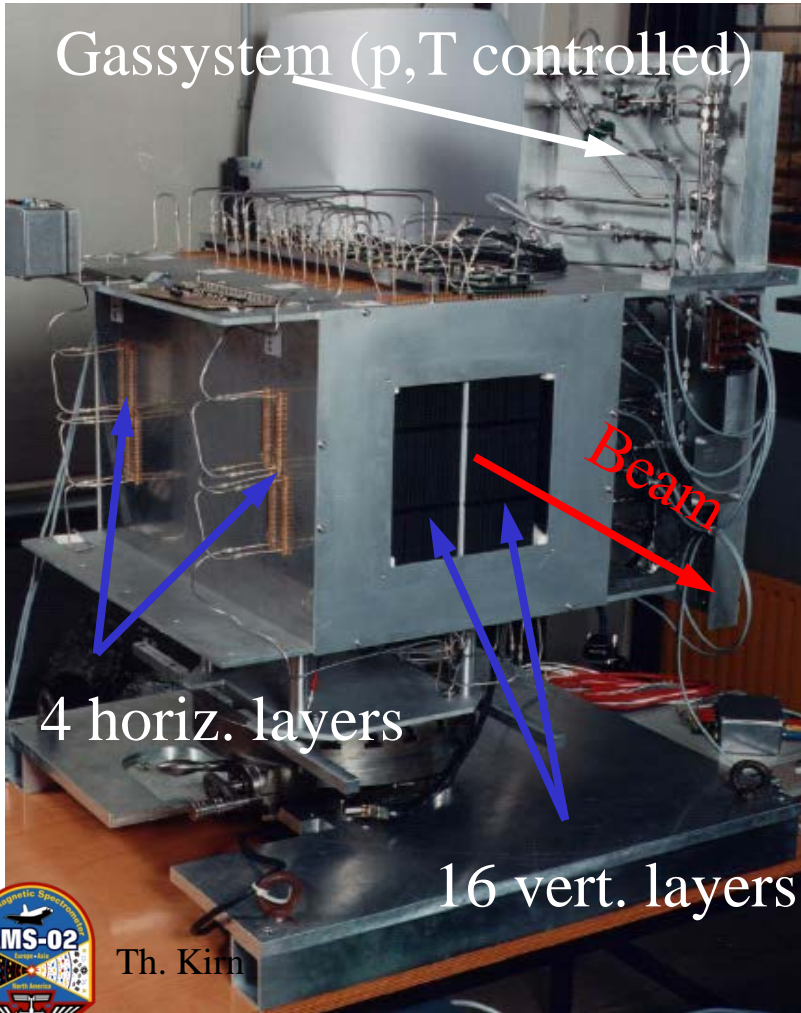
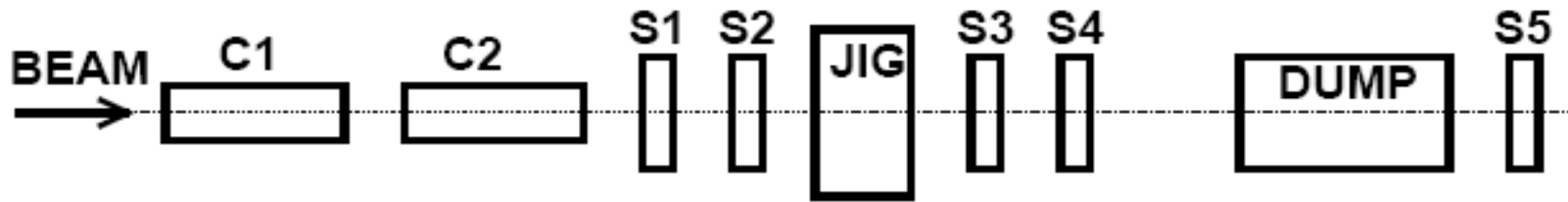
Stable Operation for 2 years

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AMS-02 – TRD: Performance, 20 Layer Prototype



Beamtest @ CERN 2000

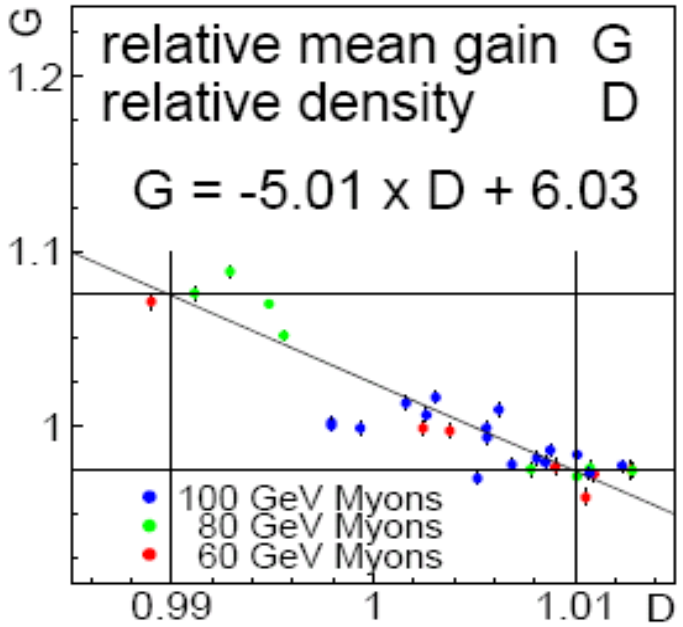
PS (T9) & SPS (X7, H6):

Recorded events: $3 \cdot 10^6$

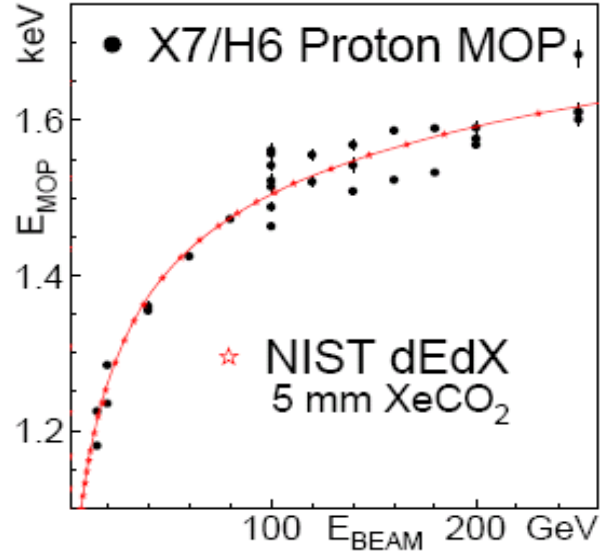
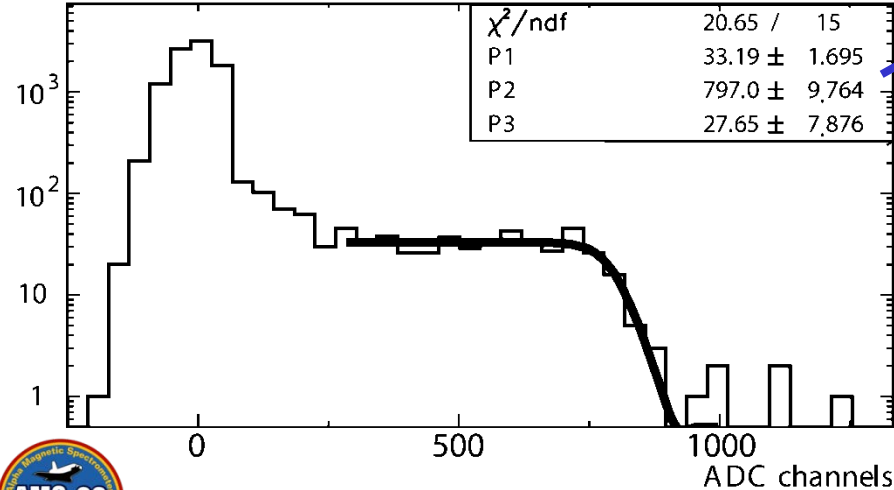
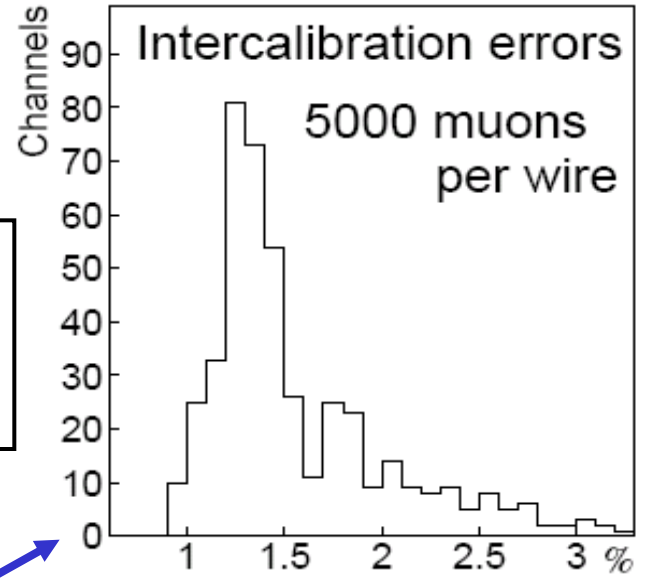
Particles: e^- , μ^- , π^+ 10 - 100 GeV

Protons 10 - 250 GeV

AMS-02 – TRD: Performance, 20 Layer Prototype



Tube Intercalibration
 Gasgain-Density-Corr.
 Fe⁵⁵ Energy Calibration



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AMS-02 TRD

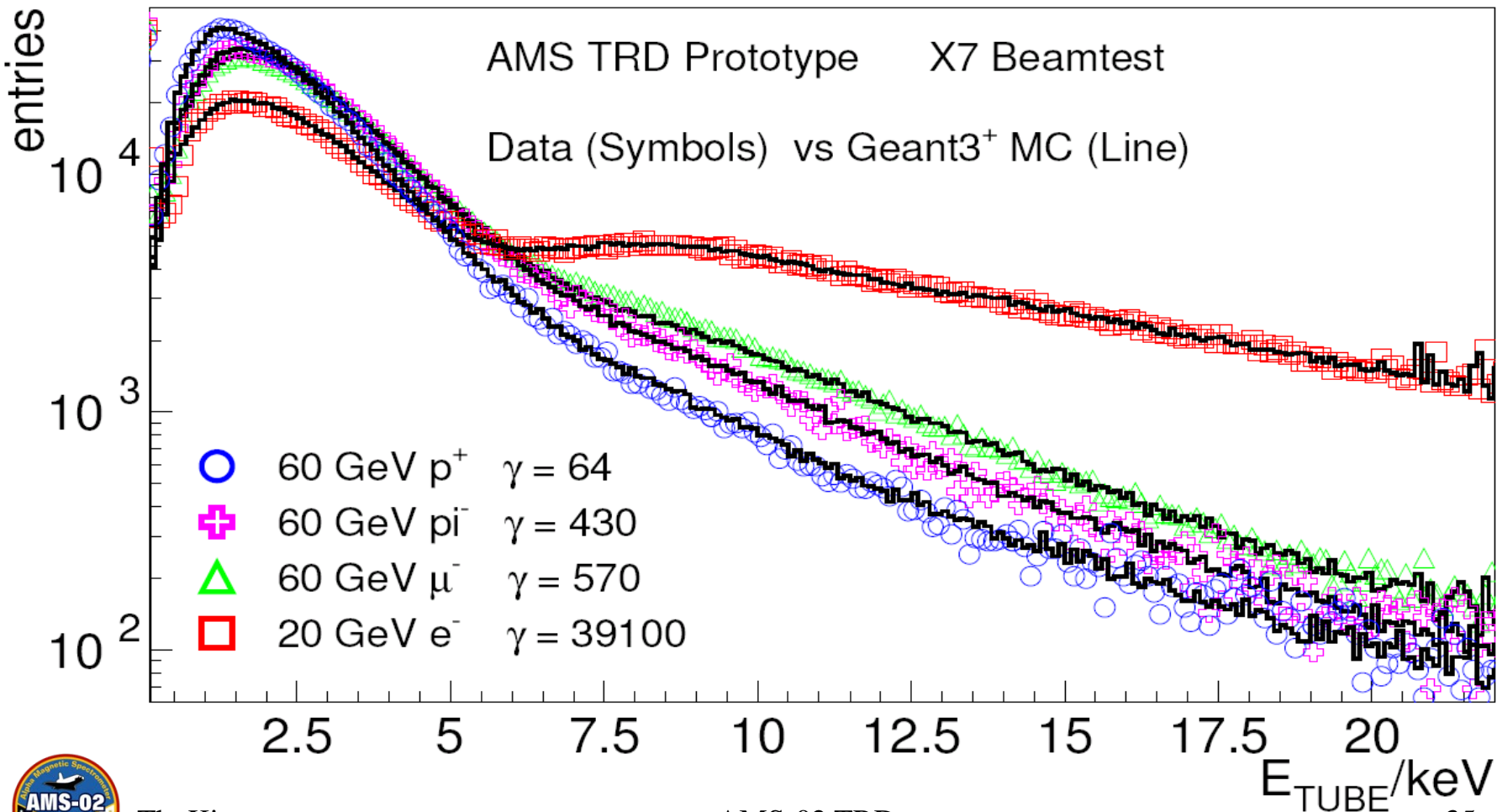


AMS-02 – TRD: TRD Spectra with Geant 3+ MC

dE/dX in thin gas-layers V. Ermilova, NIM A **145** (1977) 555

TR gener. and absorp. M. Cherry, Phys.Rev.Lett. D **10** (1974) 3594

Implement. V. Saveliev (HERA-B) G.M. Garibian, NIM A **125** (1975) 133

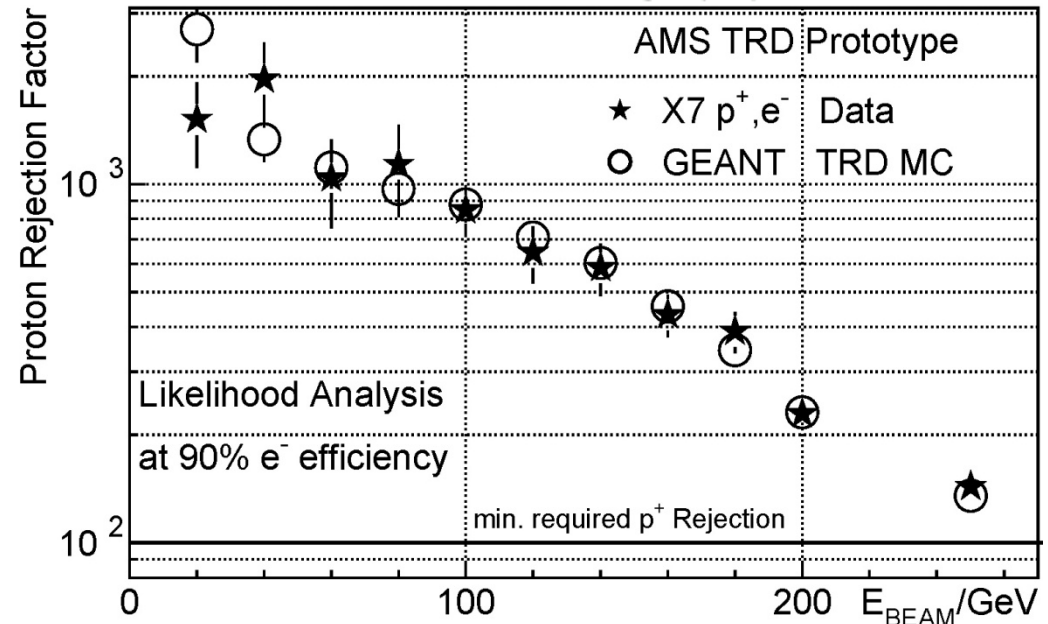
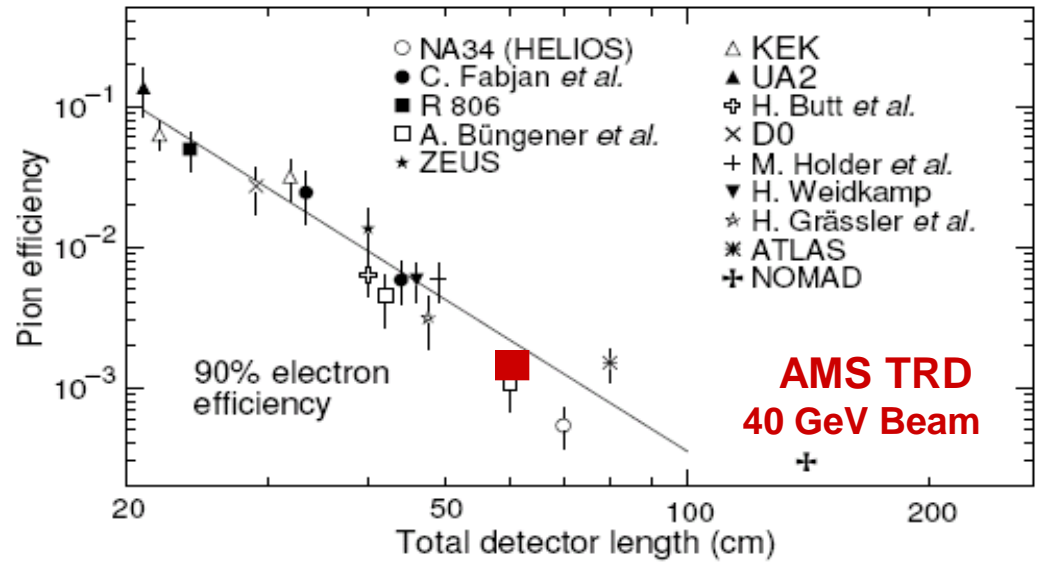
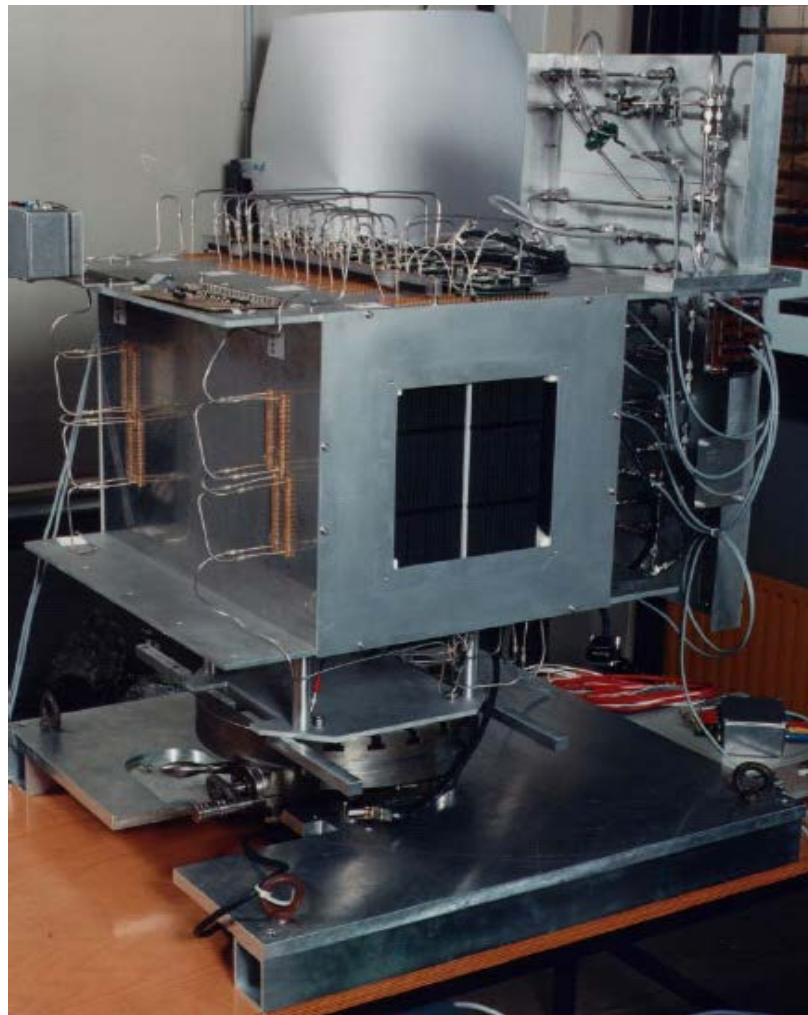


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AMS-02 – TRD: Performance, 20 Layer Prototype

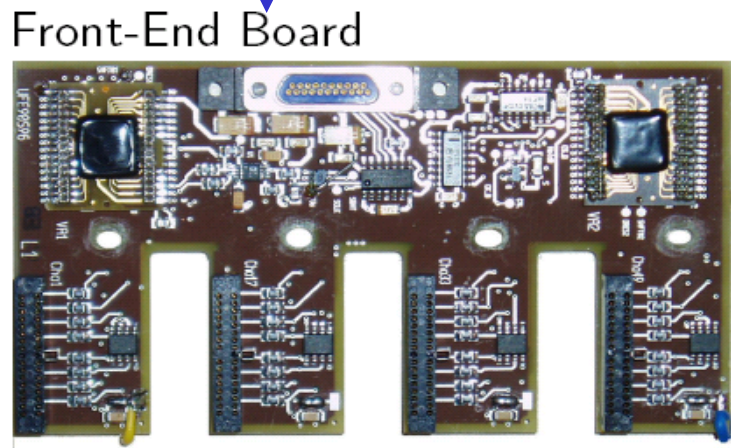
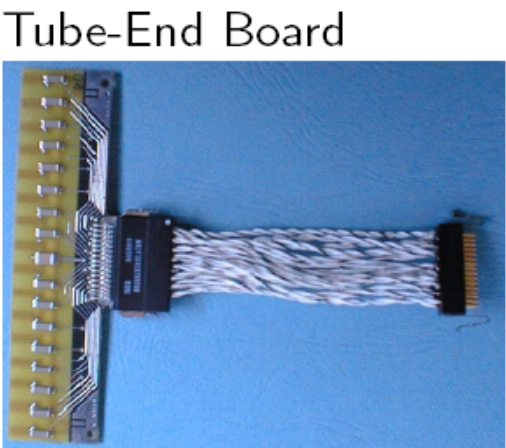
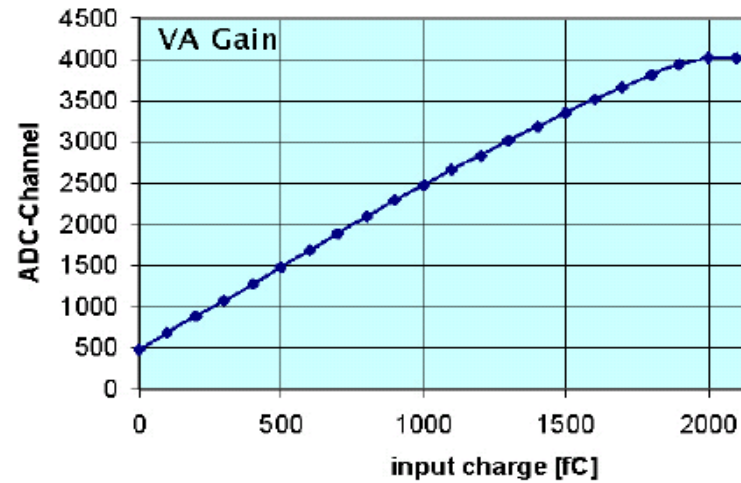
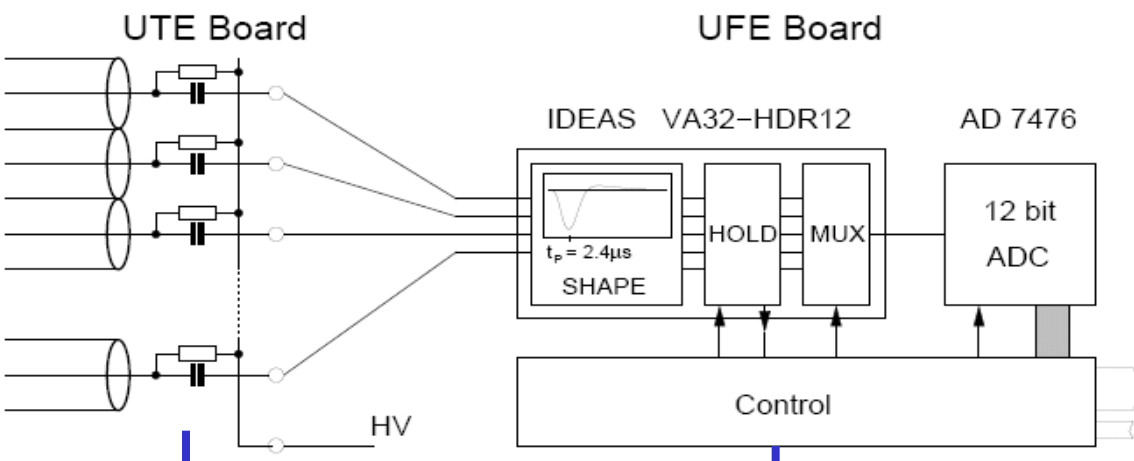


AMS-02 TRD: Frontend Electronic UFE-Boards



AMS-02 – TRD: Front End Electronic

VA-Chip Multiplexed Pulsheight Readout



Power: 20W/5248 Channels

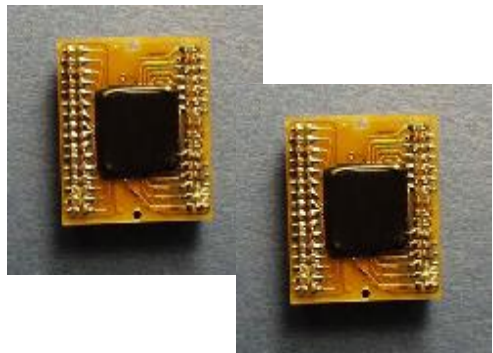
- MIP MOP 30 fC
- (G=3000) 60 bins
- MIP S/N > 60/2
- Range 60 MIPs



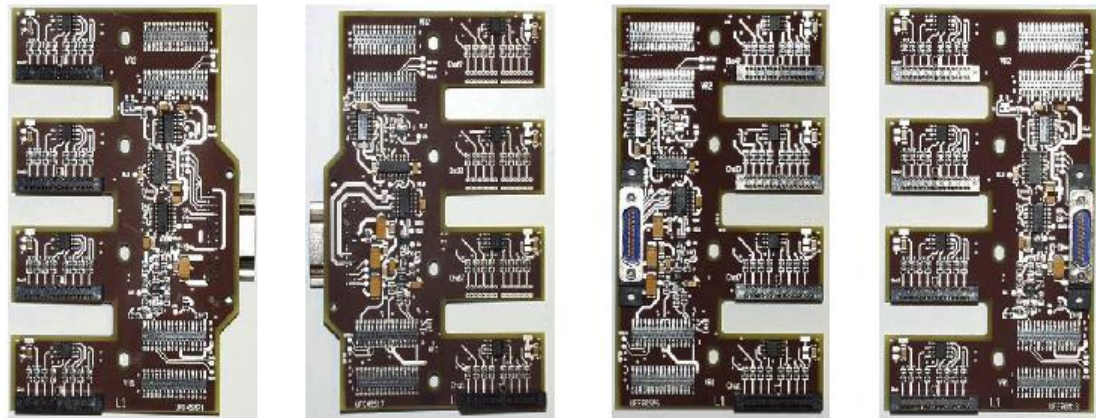
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AMS-02 – TRD: Production of UFE-board (FM)

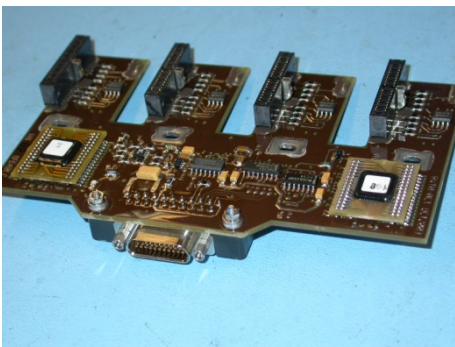


+

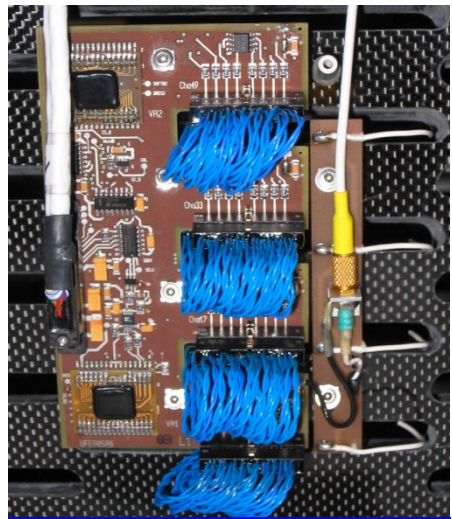


358 VA Chips Tests
Select 202 Chips

101 Production of 4 Types PCB



Series of
Space Qualification
Tests



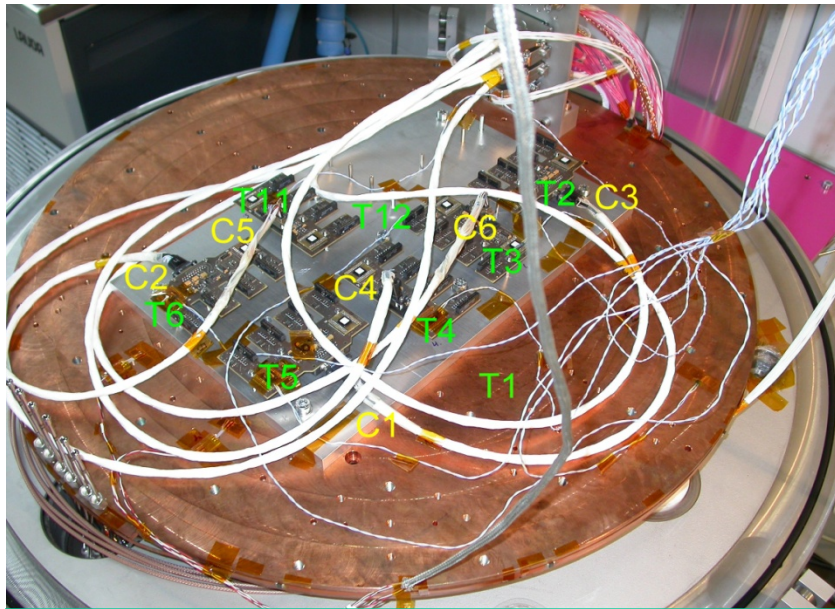
Functional Tests

TVT → 3D Vibration
→ Coating → TVT

Integration



AMS-02 – TRD: Space Qualification Tests of UFE-board (FM)



1st TVT

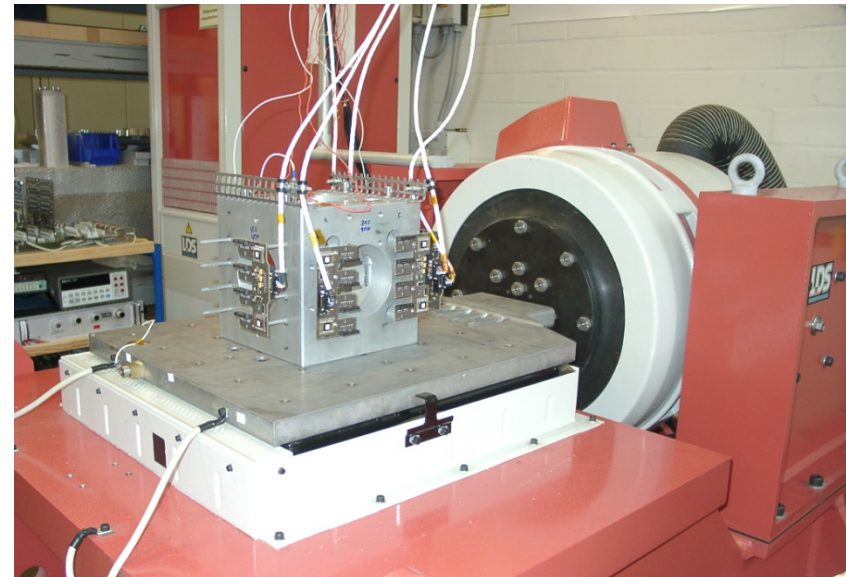
Temperature : $-40^{\circ}\text{C} \dots +80^{\circ}\text{C}$

Pressure : 1×10^{-5} mbar

Functional test without failure

2nd TVT

Same as 1st TVT condition



Random Vibration

X, Y and Z-Direction

$a_{\text{RMS}} = 6.8\text{g}$, 20-2000 Hz for 120 sec

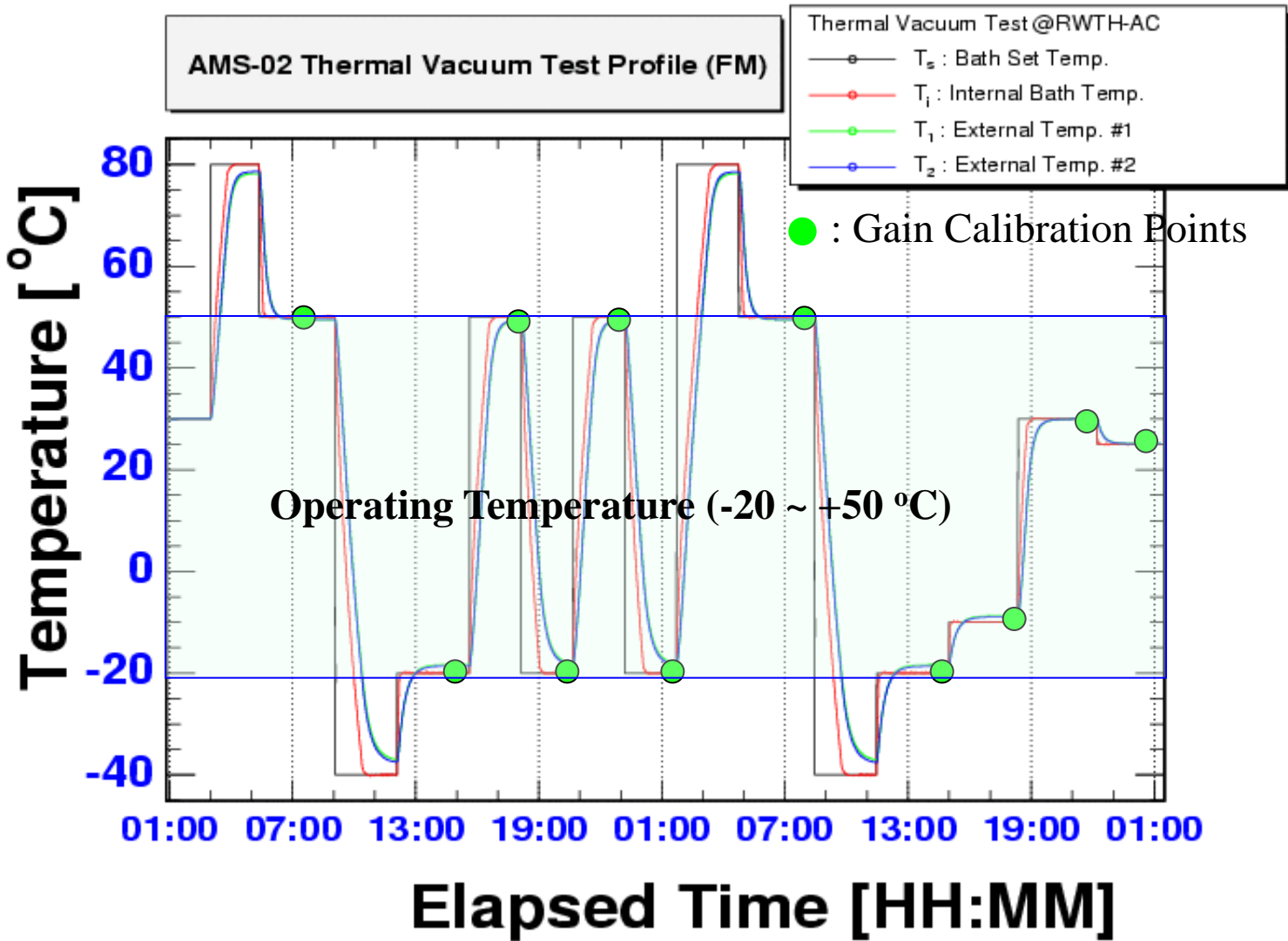
Functional test without failure



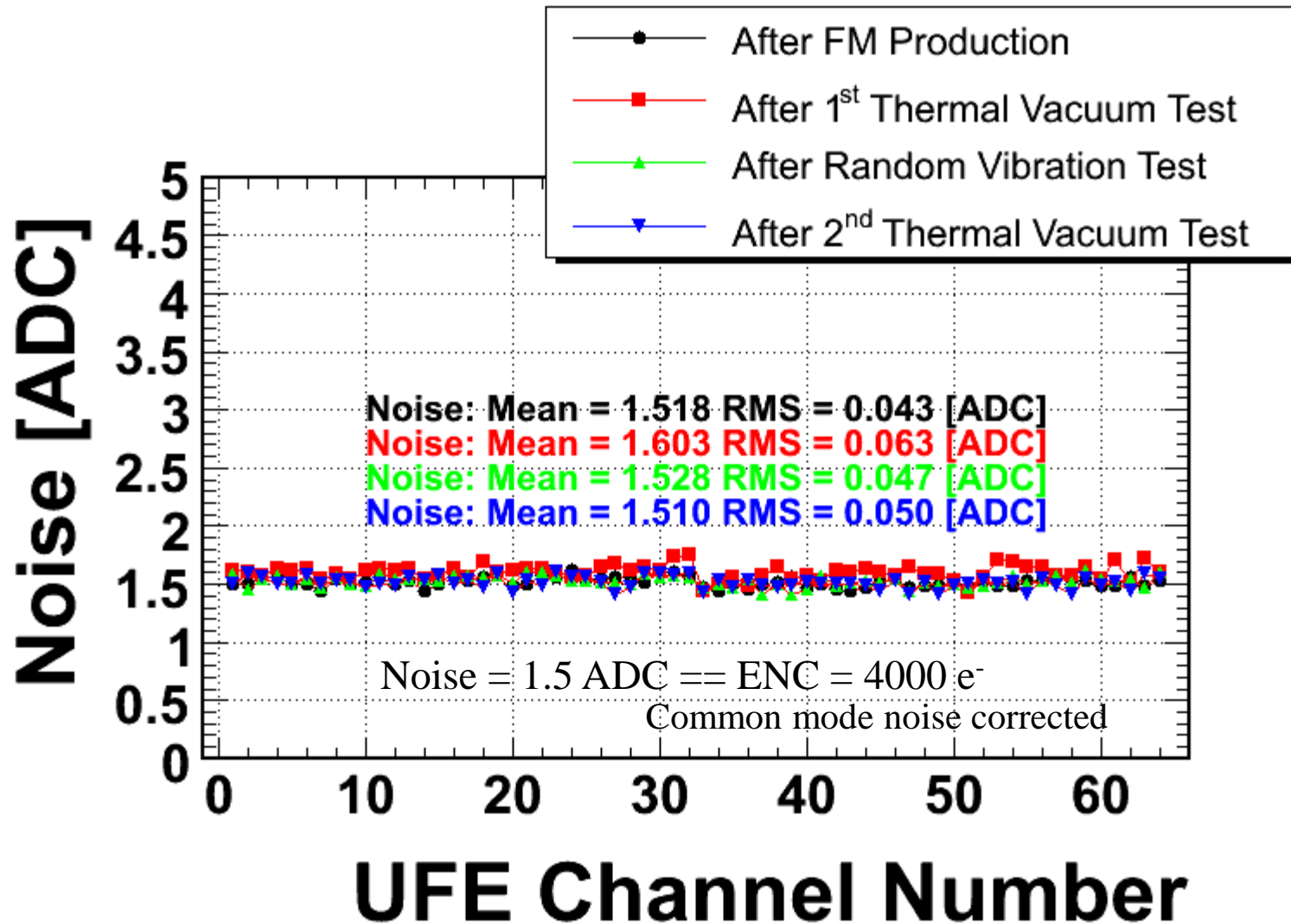
Conformal Coating



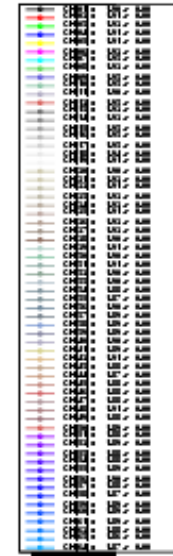
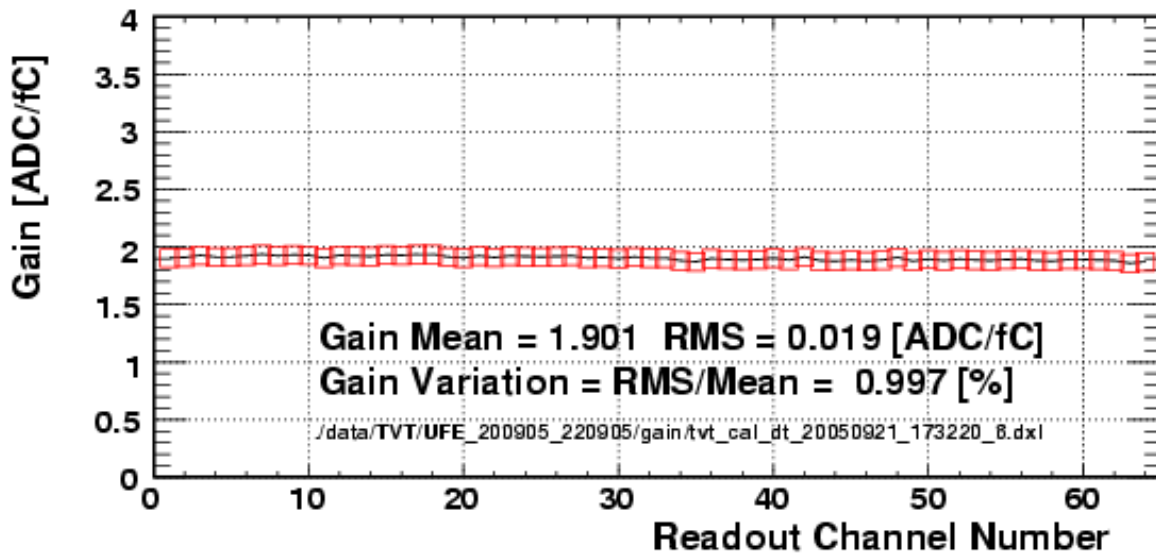
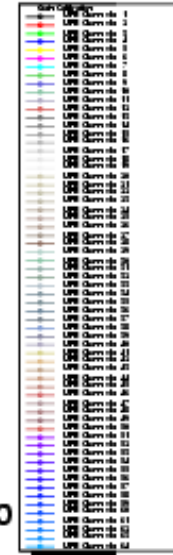
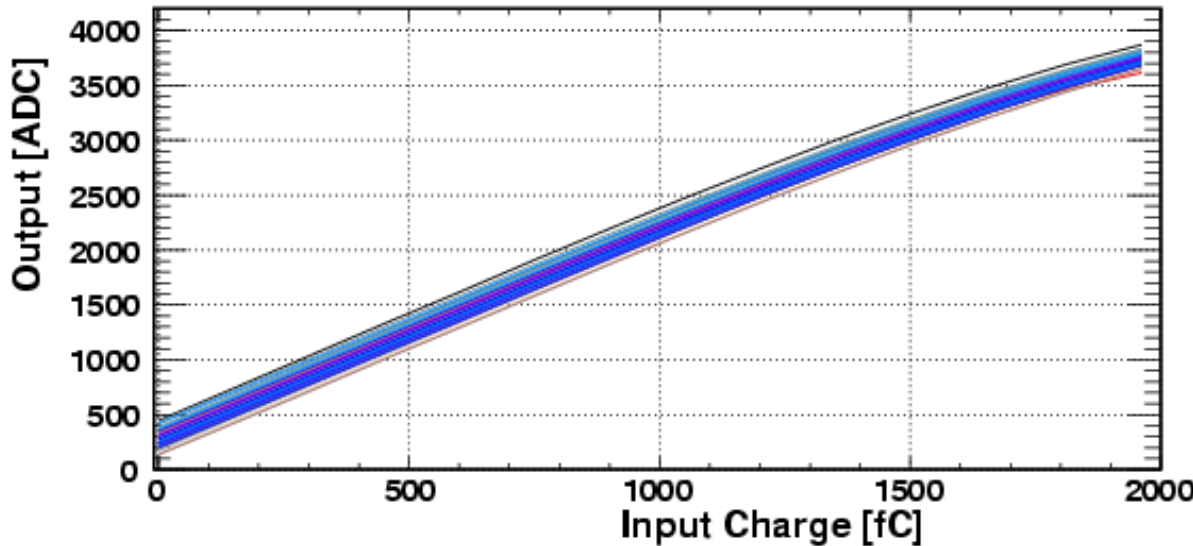
AMS-02 – TRD: Thermal Profile of TVT Test for FM-UFE-Boards



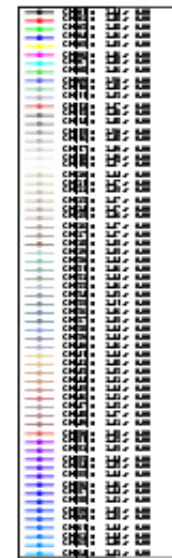
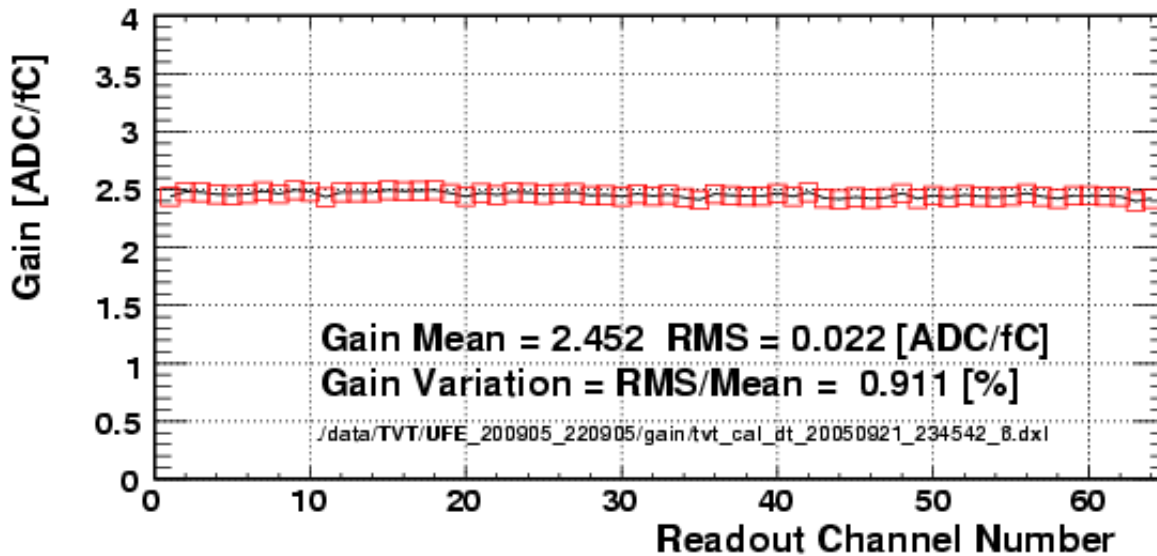
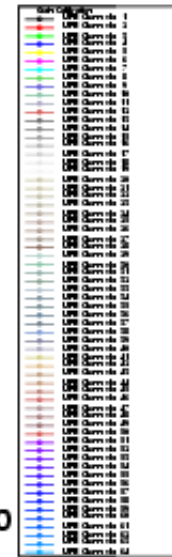
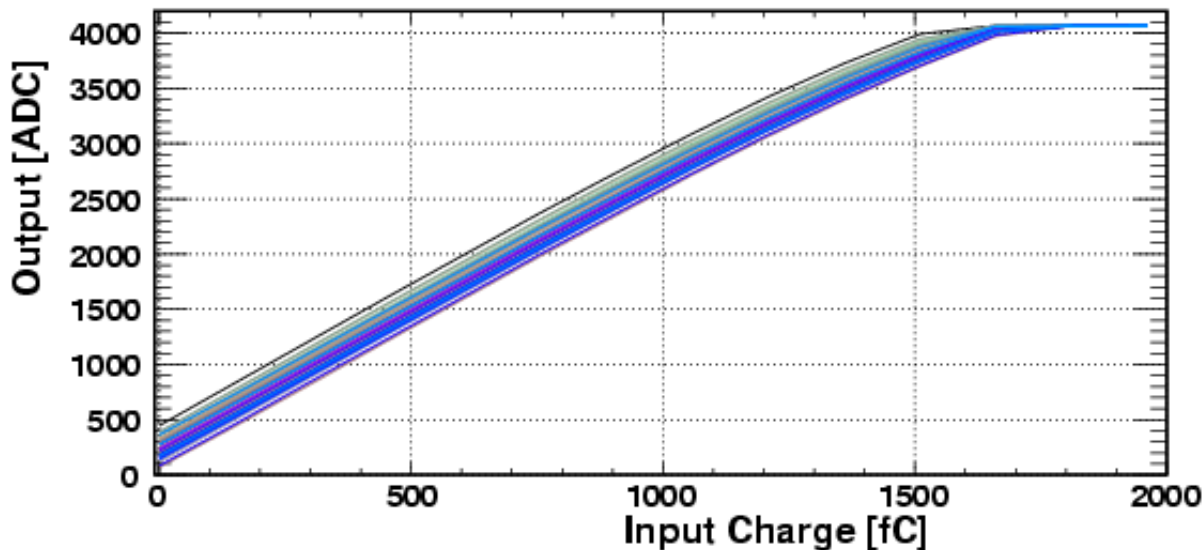
AMS-02 – TRD: UFE-Board Noise Measurement after TVT Test



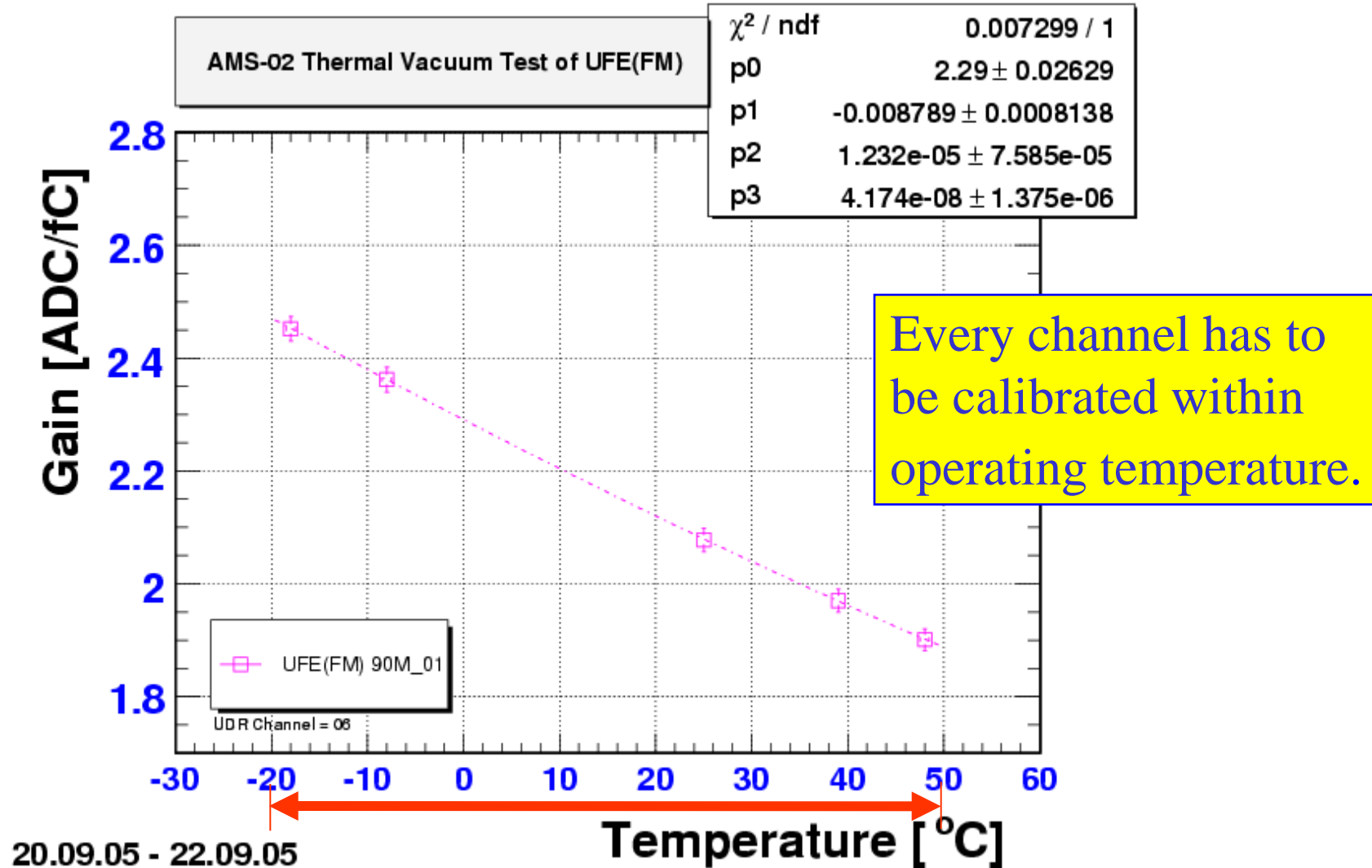
AMS-02 – TRD: UFE-Board Gain Calibration @ +50°C



AMS-02 – TRD: UFE-Board Gain Calibration @ -50°C



AMS-02 – TRD: UFE-Board Gain versus Temperature



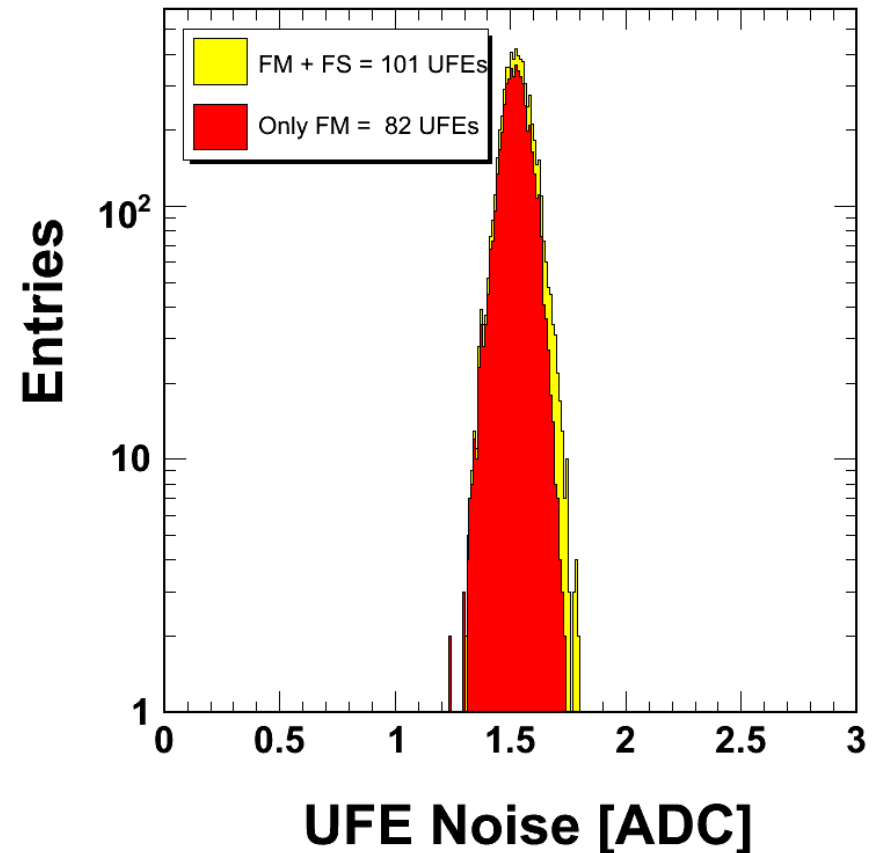
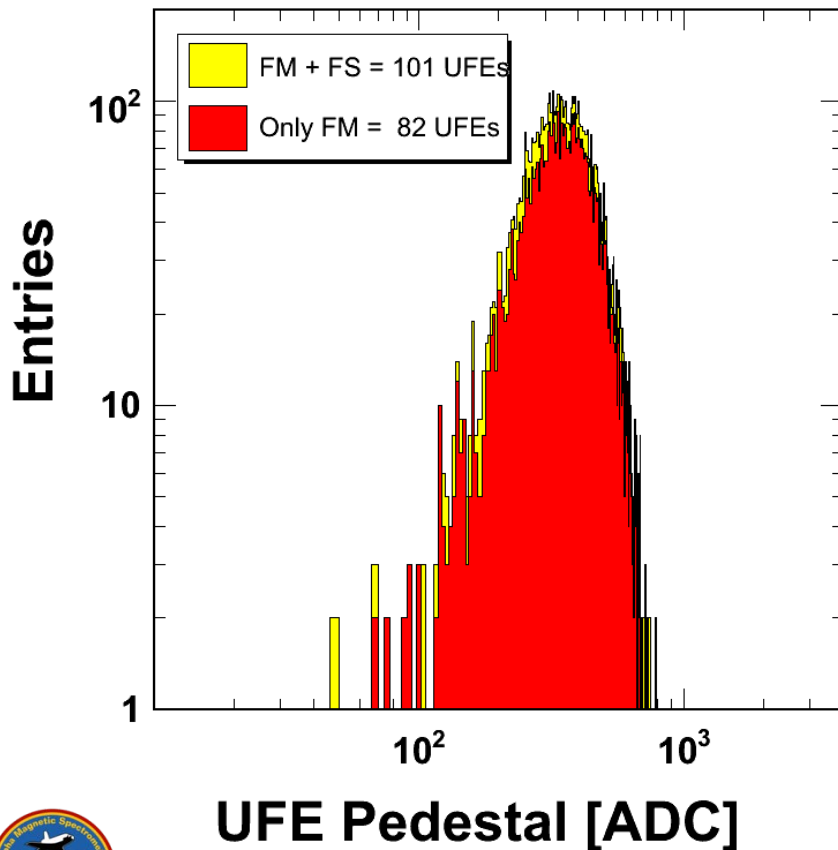
AMS-02 – TRD: FM-UFE-Board Pedestal & Noise Distribution

Pedestal Distribution :
~ 10% of full range

Noise RMS Spread :
~ 4%

Mean/RMS = 372.21/106.66 [ADC]

Mean/RMS = 1.52/ 0.06 [ADC]

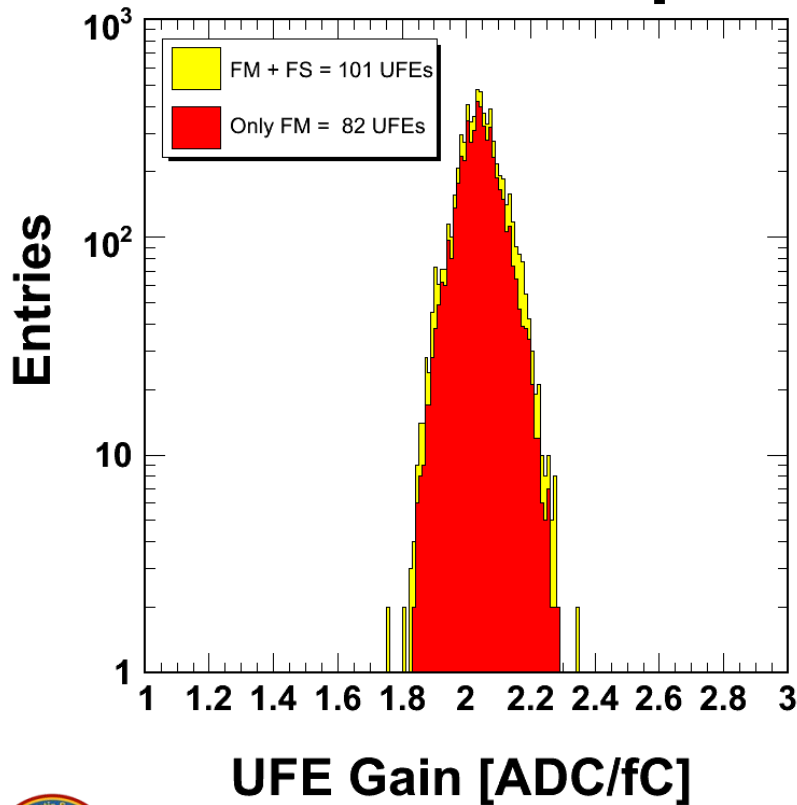


AMS-02 – TRD: FM-UFE-Board Gain & Nonlinearity Distribution

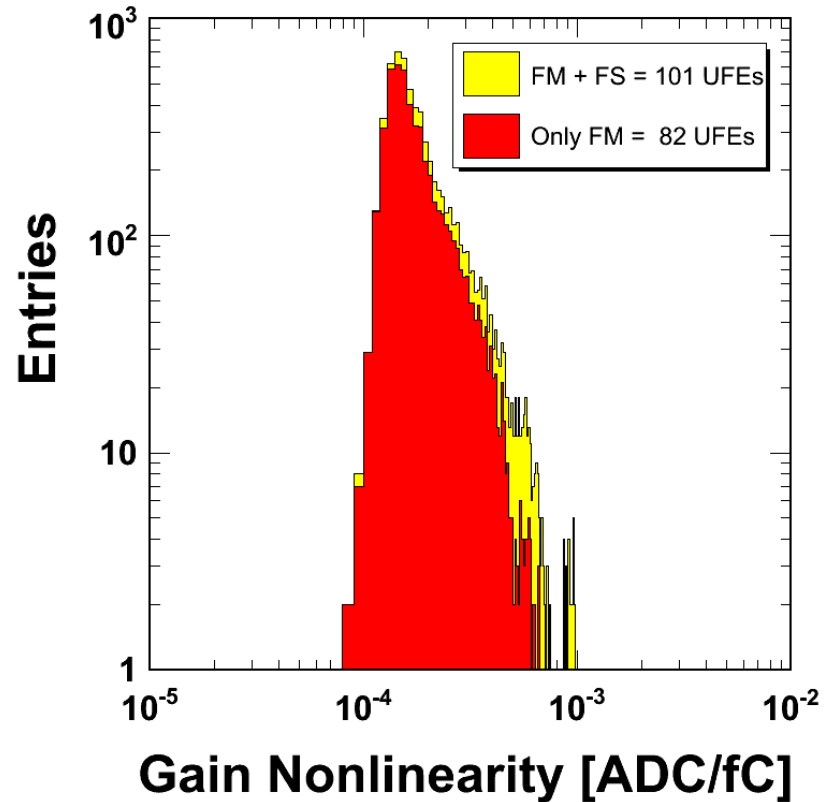
Gain RMS Spread :
~ 3%

Nonlinearity
~ 2E-04 [ADC/fC]

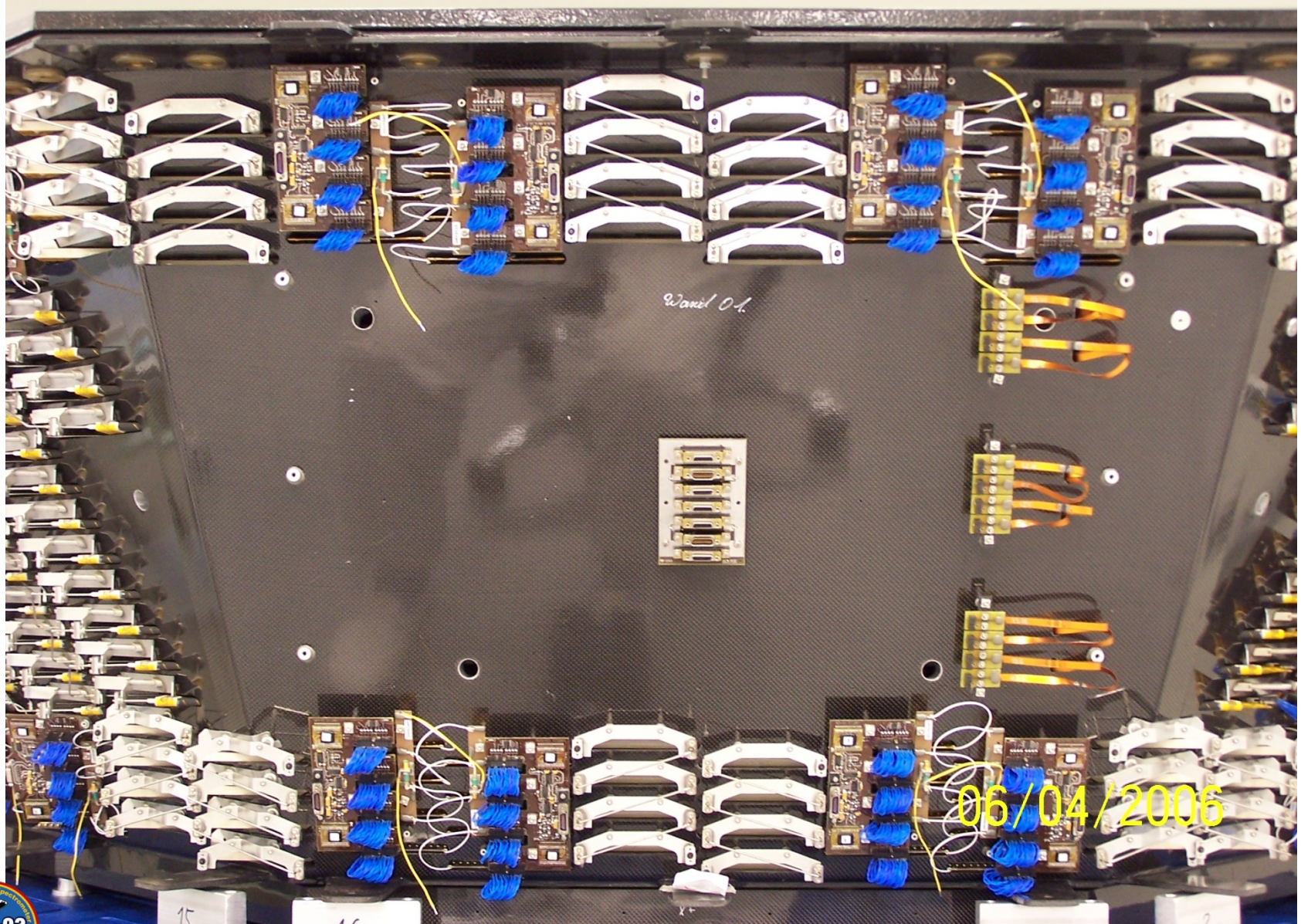
Mean/RMS = 2.04/ 0.07 [ADC/fC]



Mean/RMS = 1.99E-04/8.34E-05 [ADC/fC]



AMS-02 – TRD: Integration of FM-UFE-Boards on Octagon Wall 1

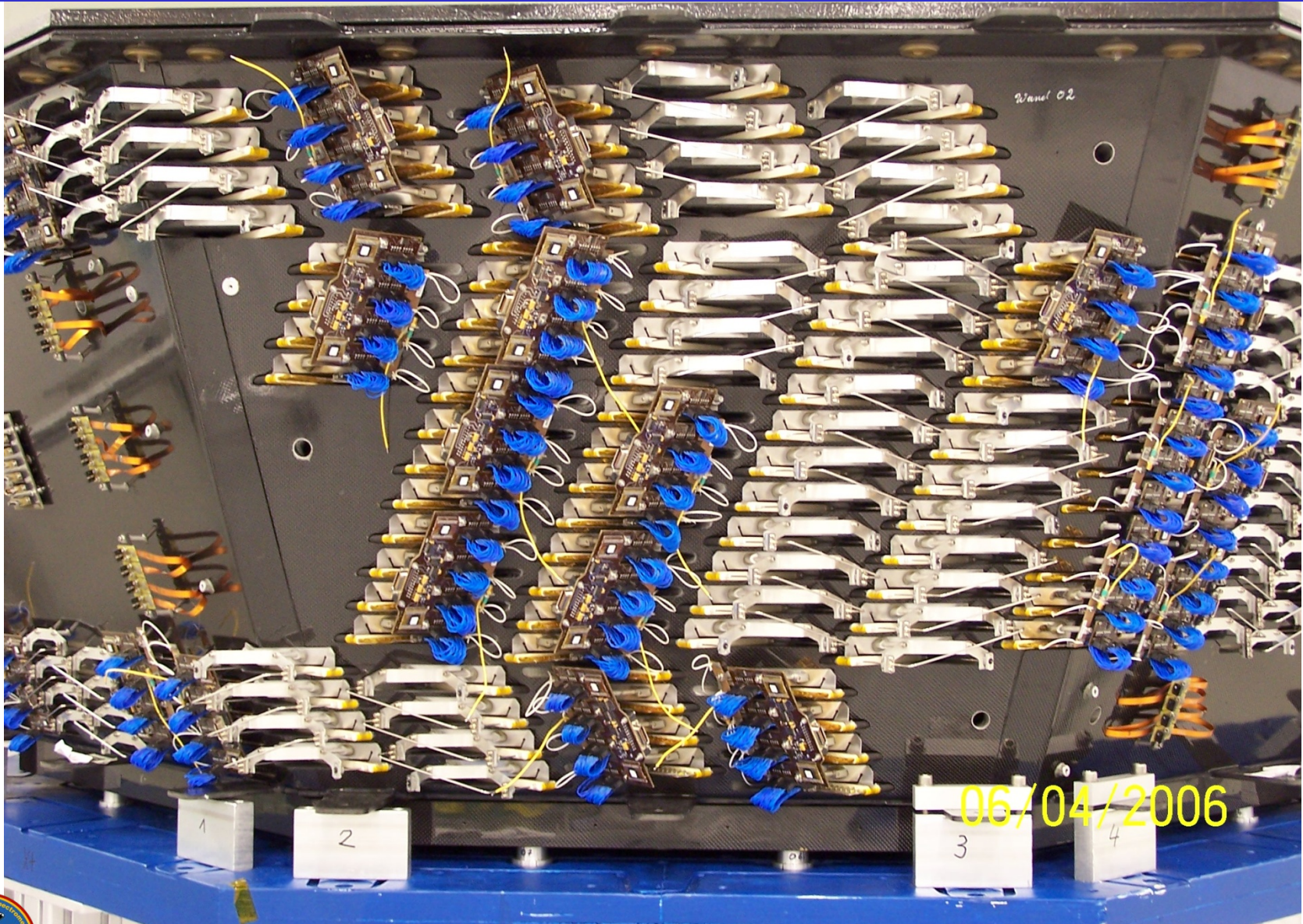


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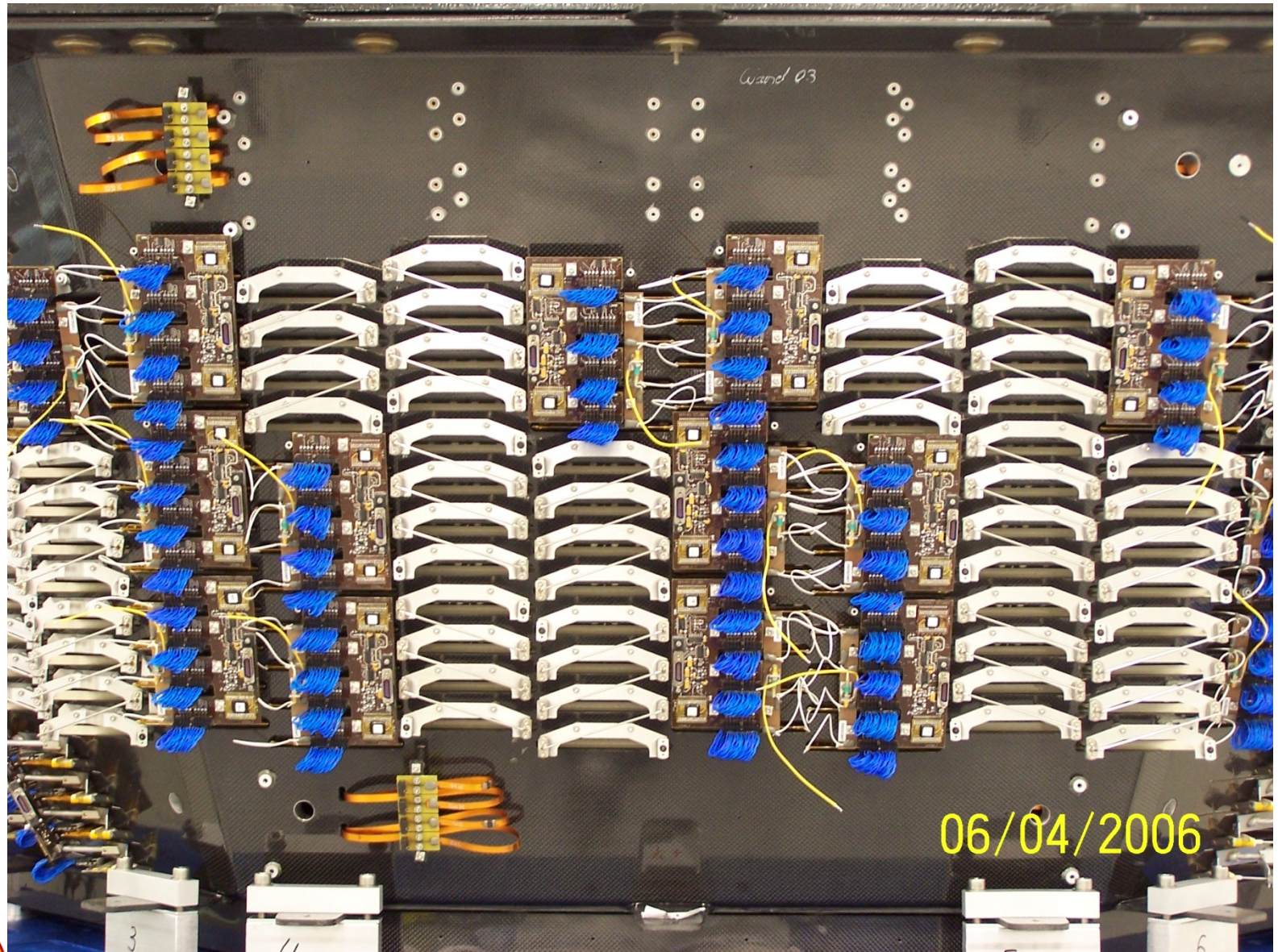
AMS-02 TRD



AMS-02 – TRD: Integration of FM-UFE-Boards on Octagon Wall 2



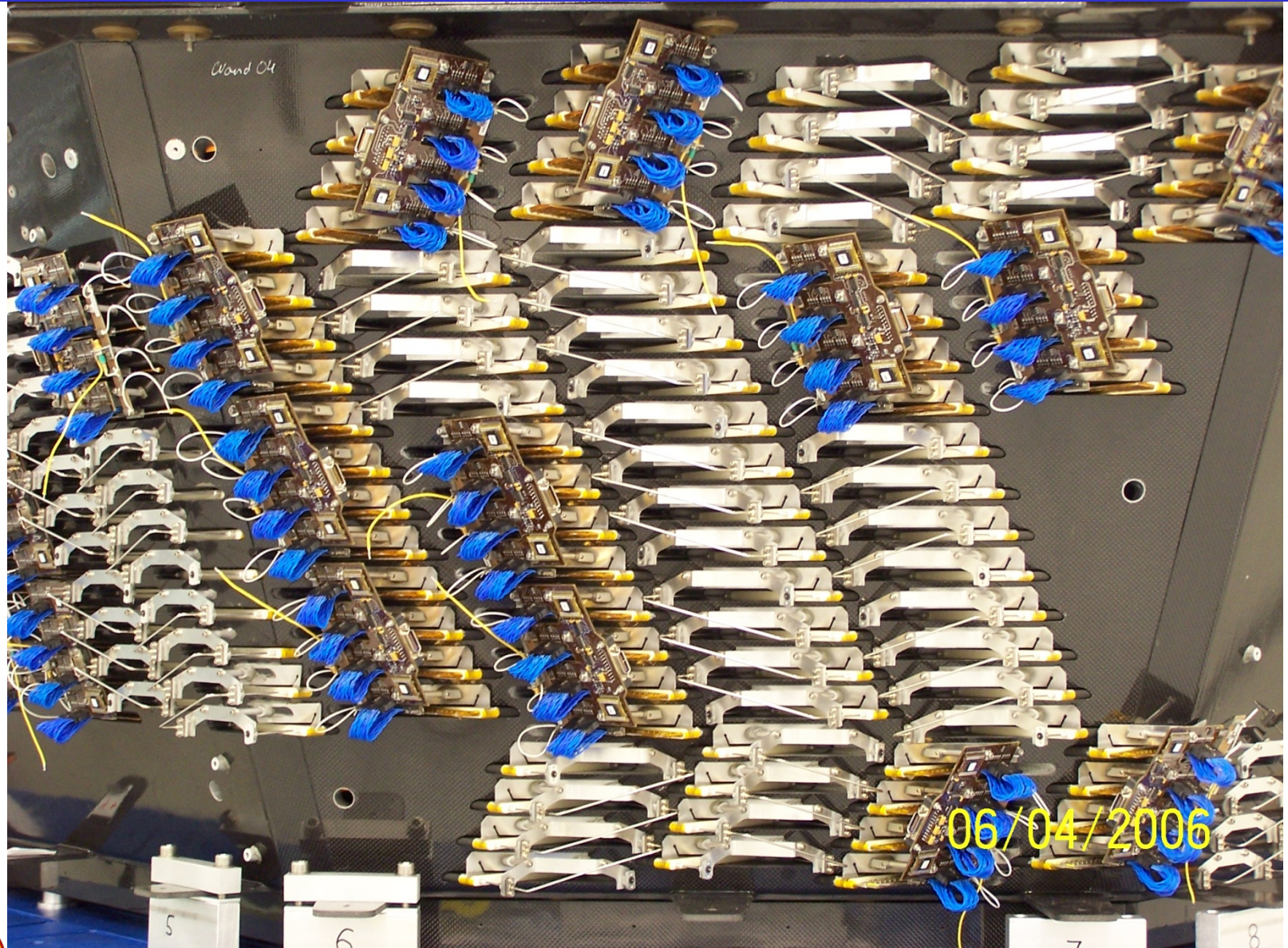
AMS-02 – TRD: Integration of FM-UFE-Boards on Octagon Wall 3



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AMS-02 TRD

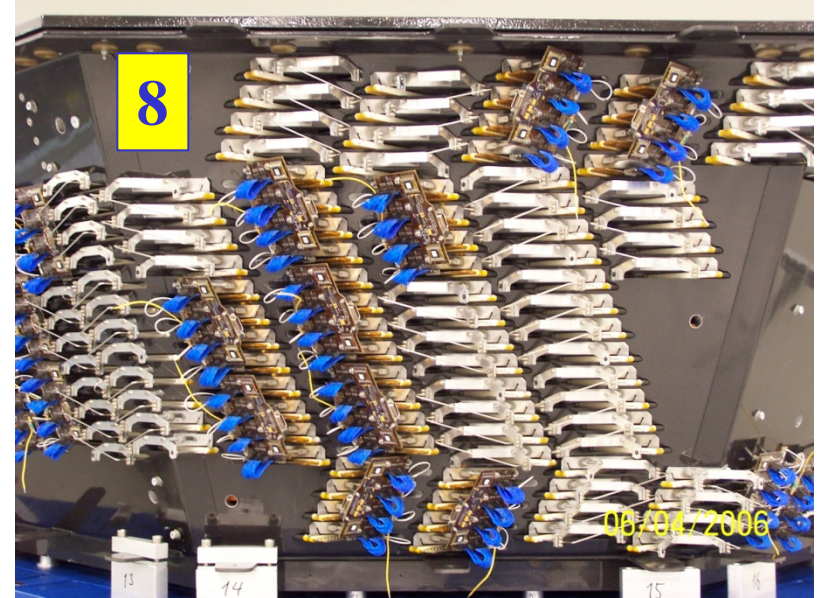
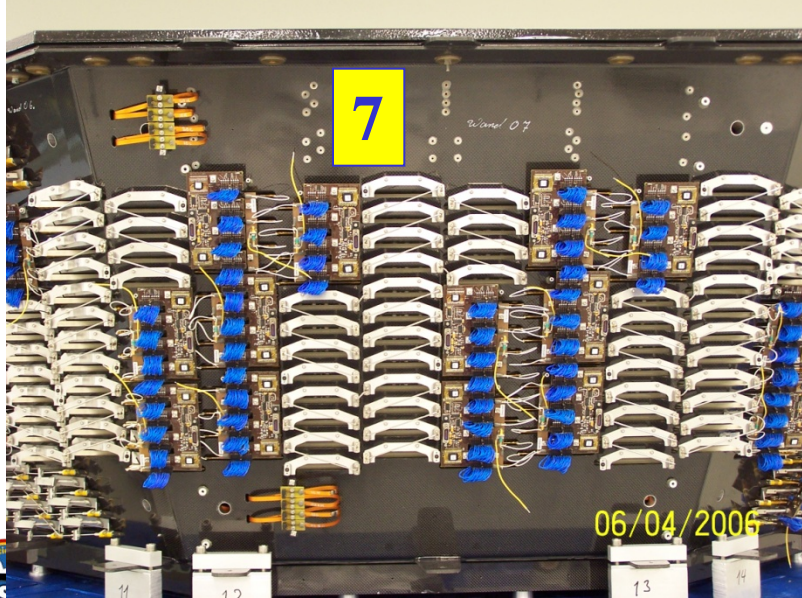
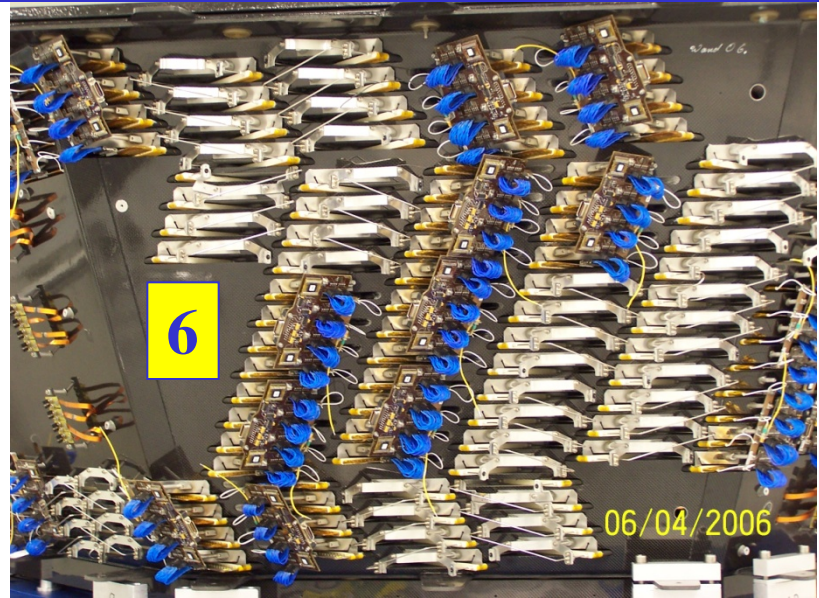
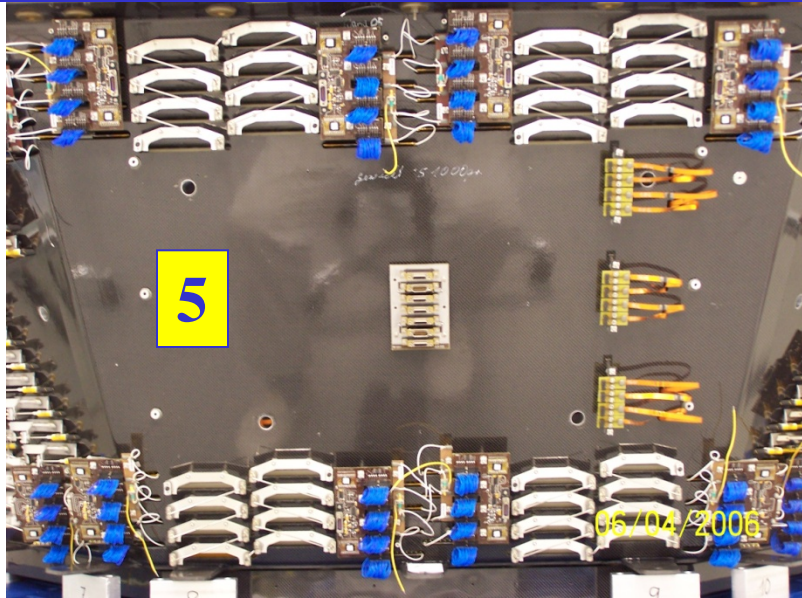
AMS-02 – TRD: Integration of FM-UFE-Boards on Octagon Wall 4



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AMS-02 TRD

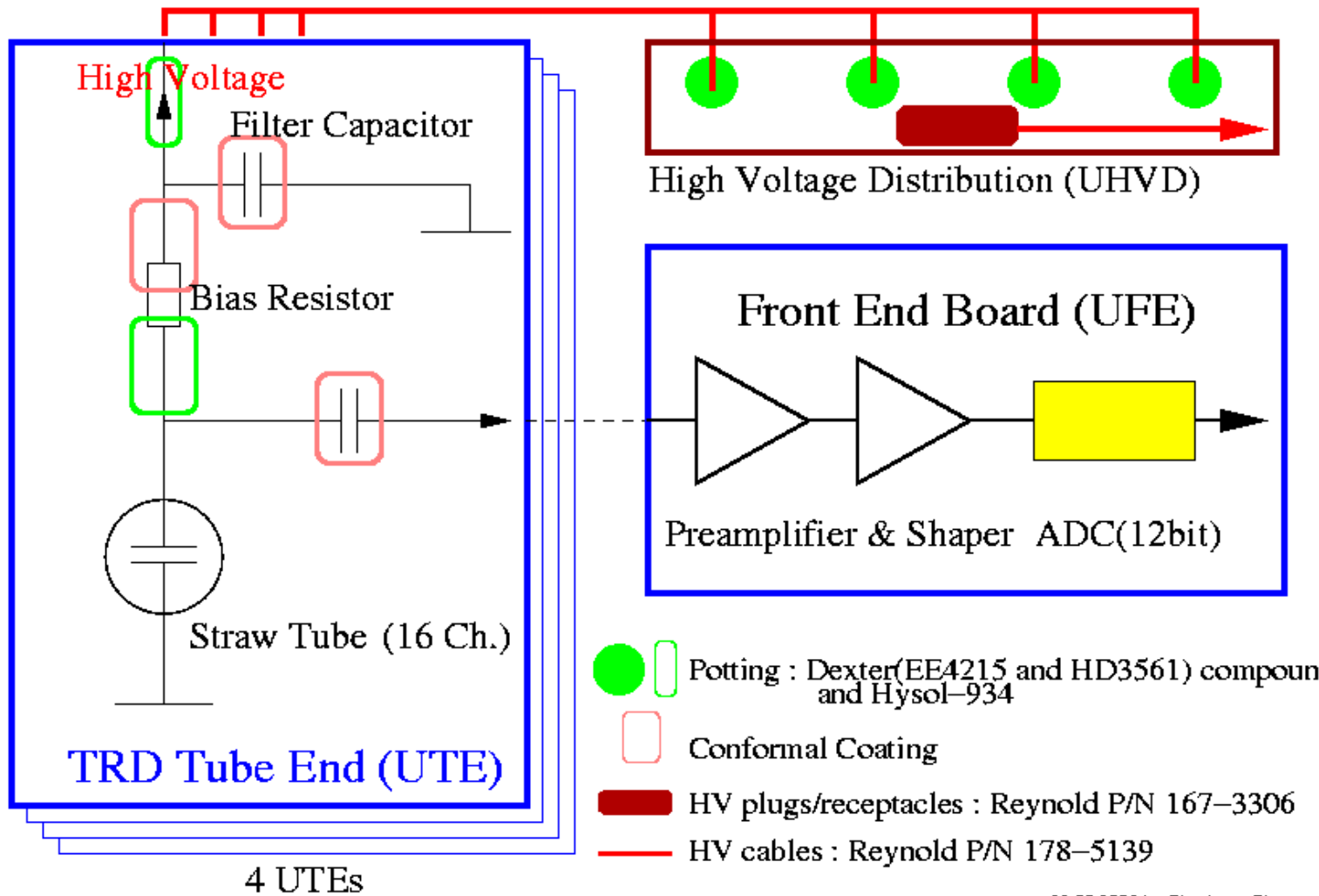
AMS-02 – TRD: Integration of FM-UFE-Boards on Octagon Walls



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AMS-02 TRD

AMS-02 TRD: Straw Module+Frontend-Readout, Corona Discharges

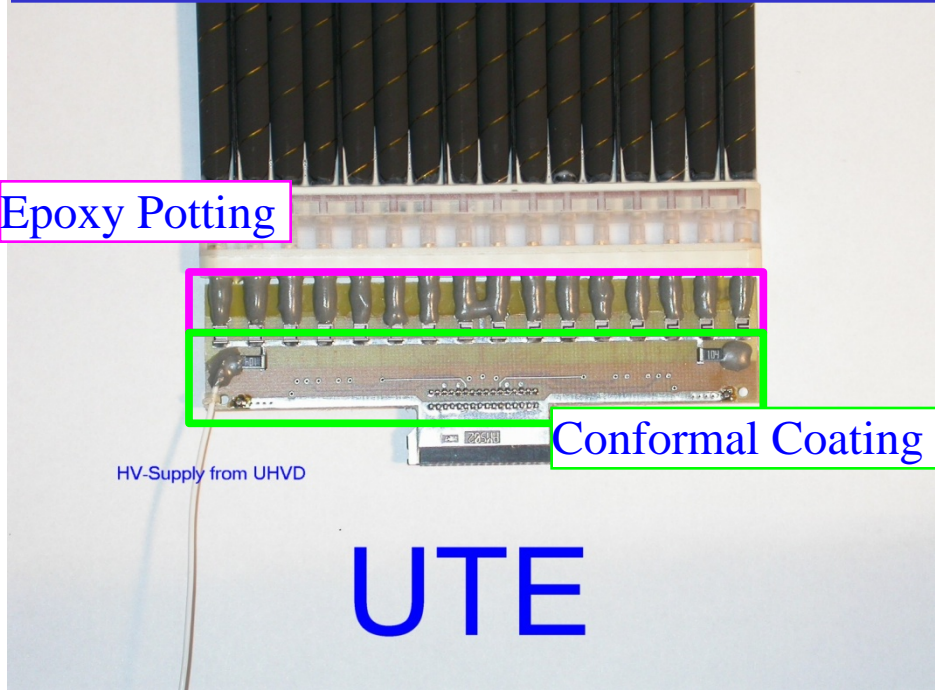


29.03.2005 by Chanhoon Chung

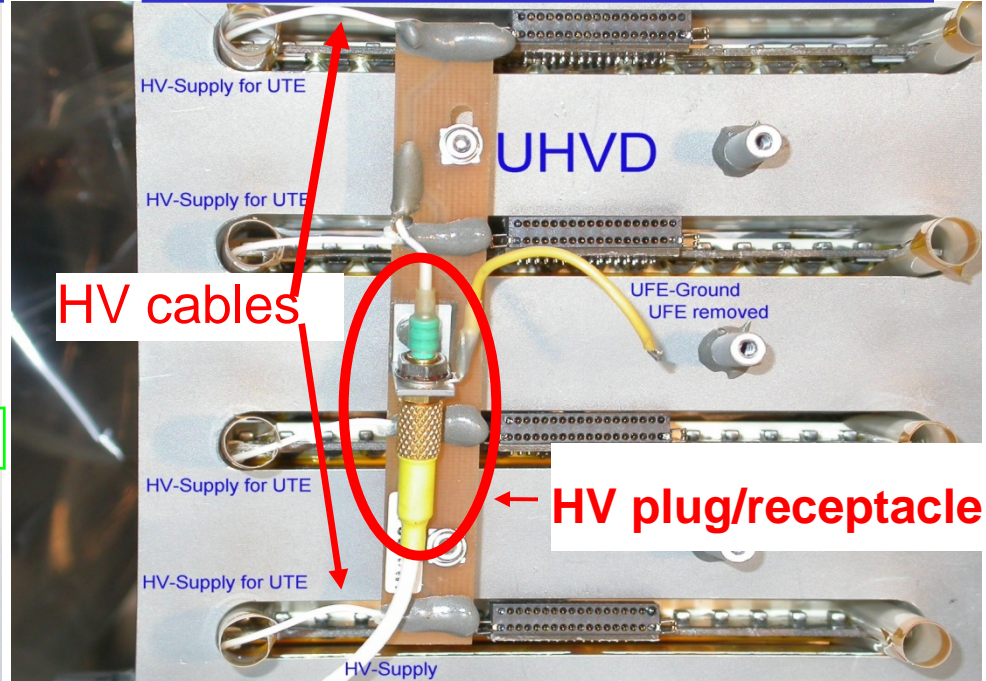


AMS-02 TRD: Corona Discharge Test

Straw Module UTE-board

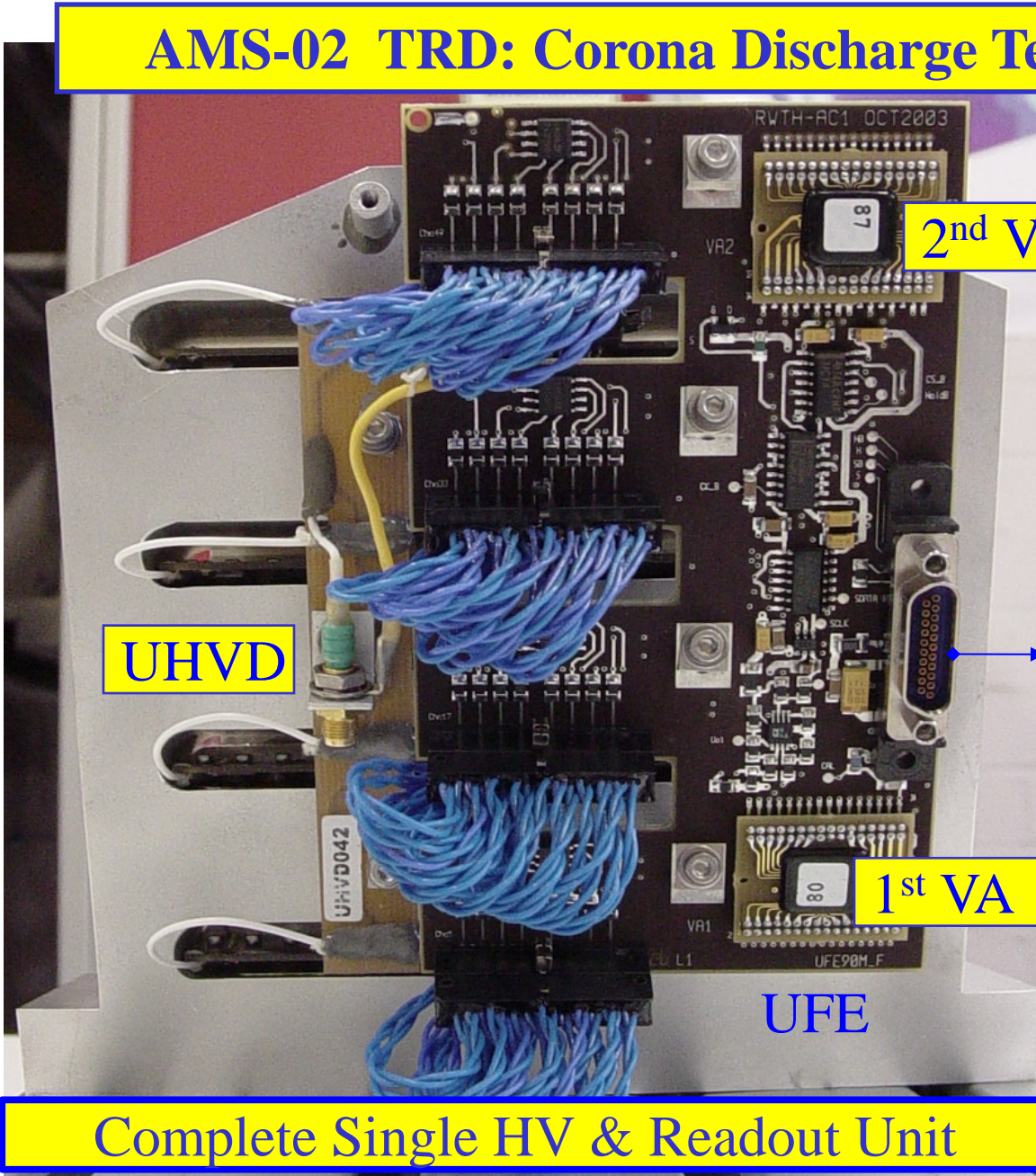


HV-Distribution (UHVD) board



AMS-02 TRD: Corona Discharge Test

Octagon-Like Al. Panel



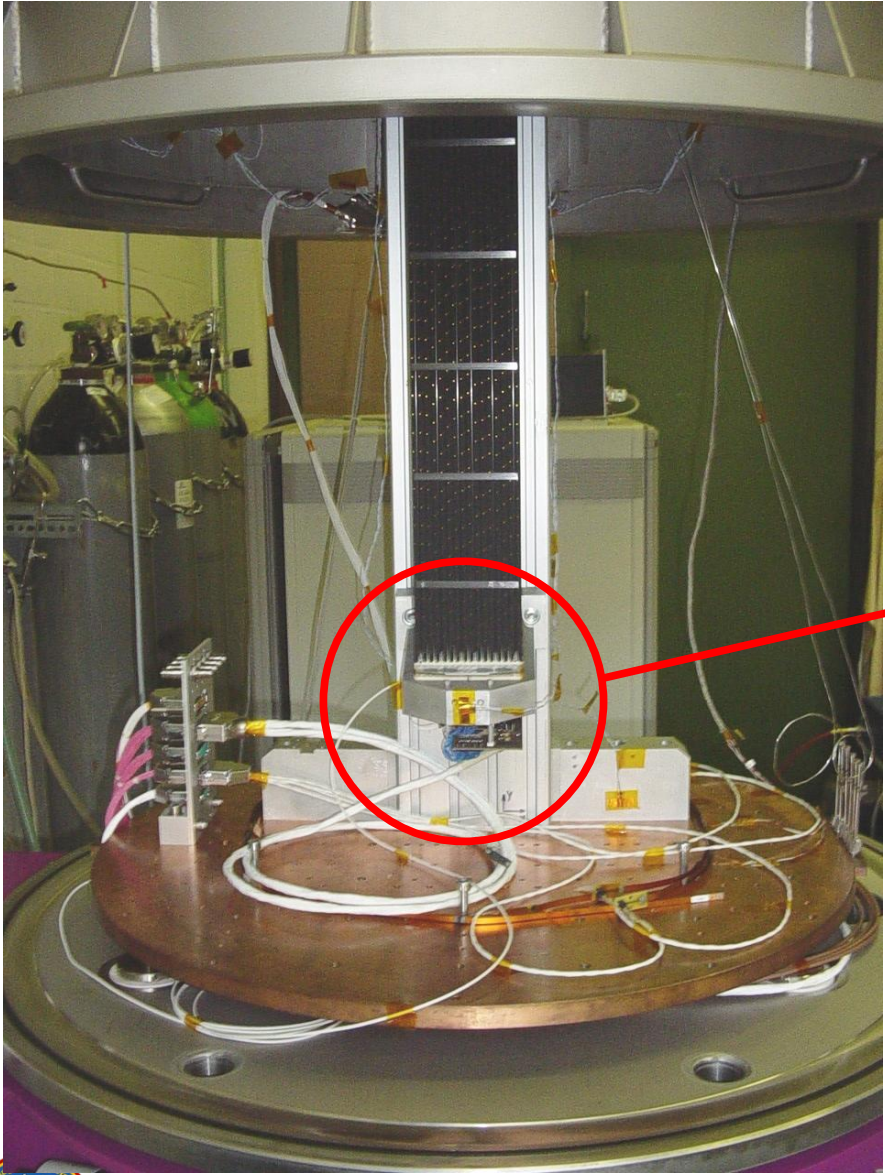
Complete Single HV & Readout Unit

Th. Kim

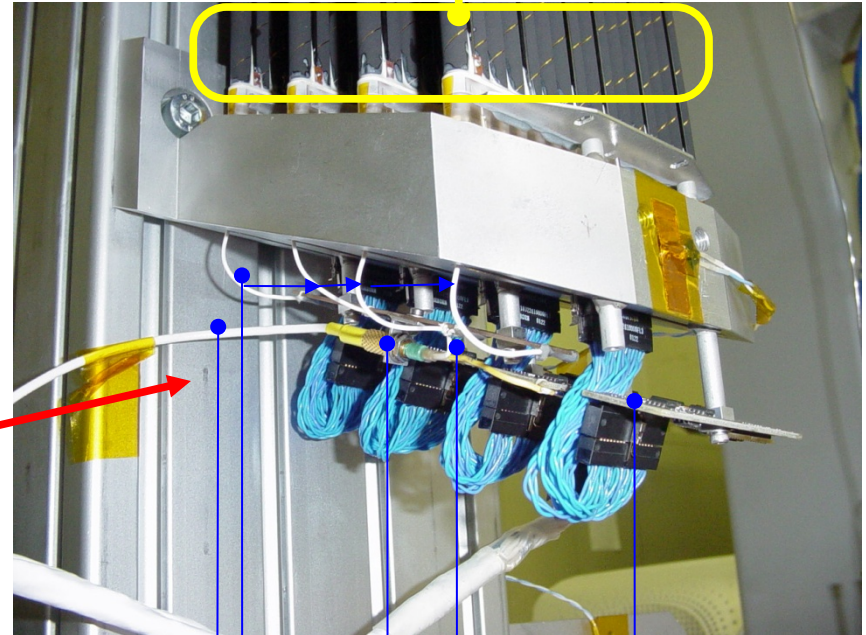
AMS-02 TRD



AMS-02 TRD: Corona Discharge Test



TRD 4 layers straw modules



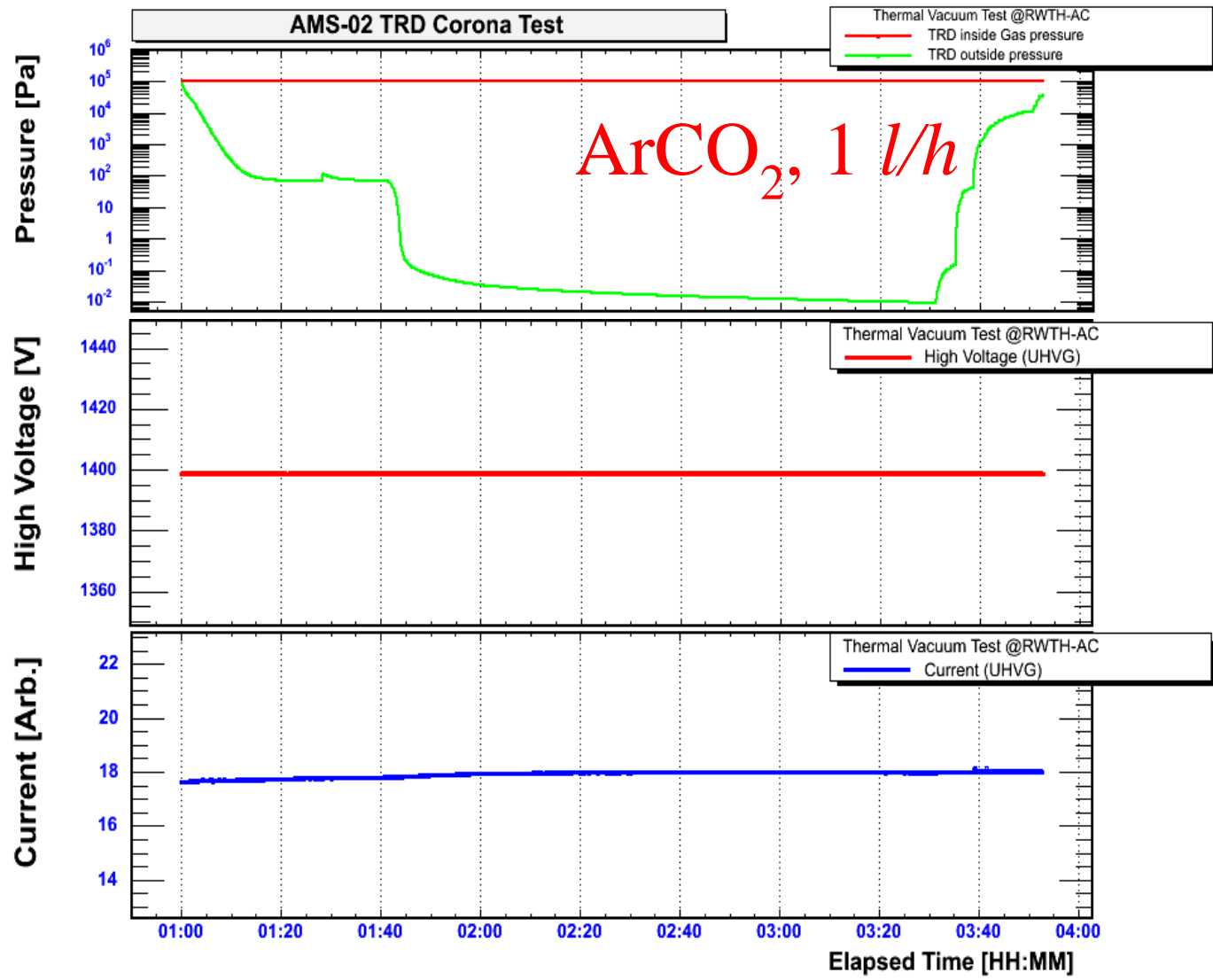
HV Cables
HV Plug/Receptacle
UHVD^{UFE}



Th. Kim

AMS-02 TRD

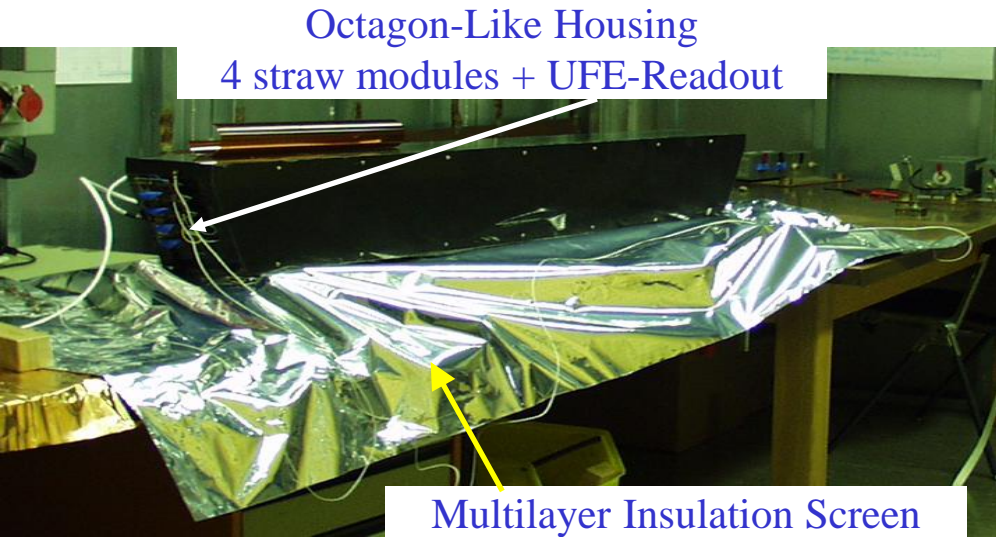
AMS-02 TRD: Corona Discharge Test



With Kapton Screening of UTE-boards no Corona discharges observed!



AMS-02 TRD: ElectroMagnetic InterferenceTest



EMI Test @KMW Co. Munich

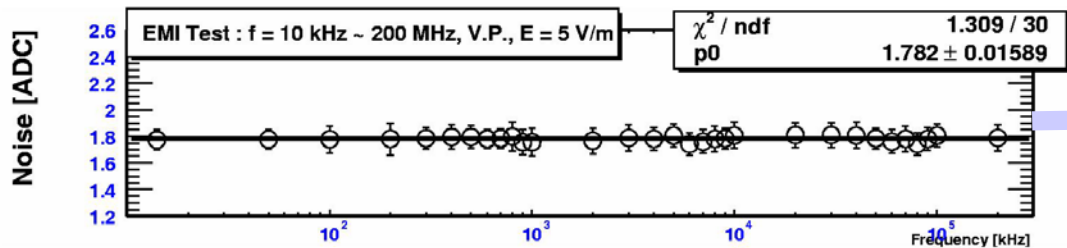
According to
“Space Station Electromagnetic Emission and
Susceptibility Requirements for the Electromagnetic
Compatibility”

SSP30237 paragraphs RS02, RS03, and RE02

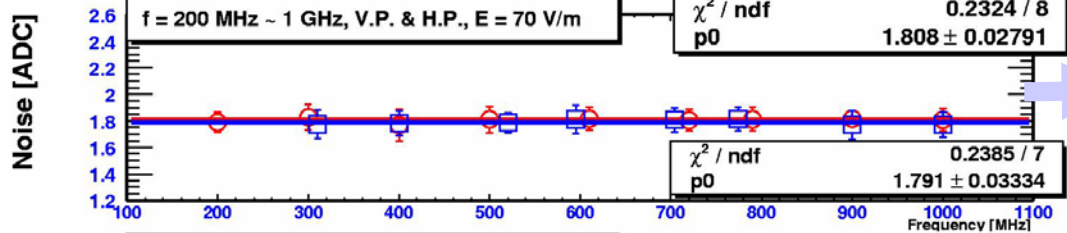


Wave : Horizontal / Vertical Polar.
Frequency range : 10 kHz ~ 1 GHz
Electric Field : 5 ~ 100 [V/ m]

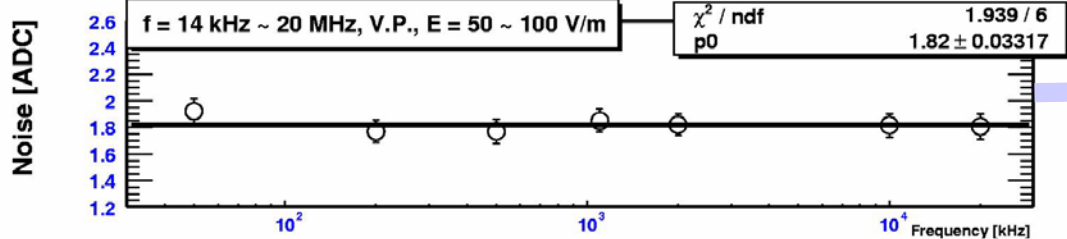
AMS-02 TRD: ElectroMagnetic Interference Test



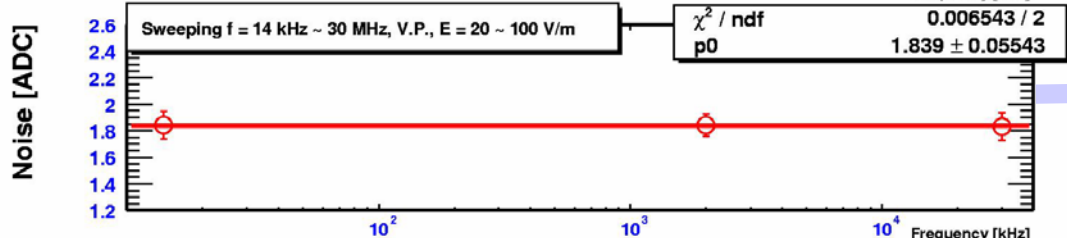
Freq. = 10 kHz ~ 200MHz
 $|E|_{\text{rms}} = 5 \text{ [V/m]}$ w. V.P.
Noise VP = 1.782 ± 0.0159[ADC]



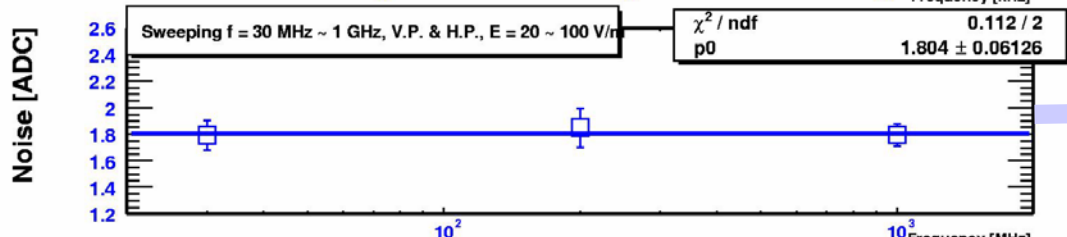
200MHz ~ 1GHz, 70 [V/m]
Noise VP = 1.808 ± 0.0279[ADC]
Noise HP = 1.781 ± 0.0333[ADC]



14kHz ~ 20MHz, 50~100[V/m]
Noise VP = 1.82 ± 0.0332[ADC]

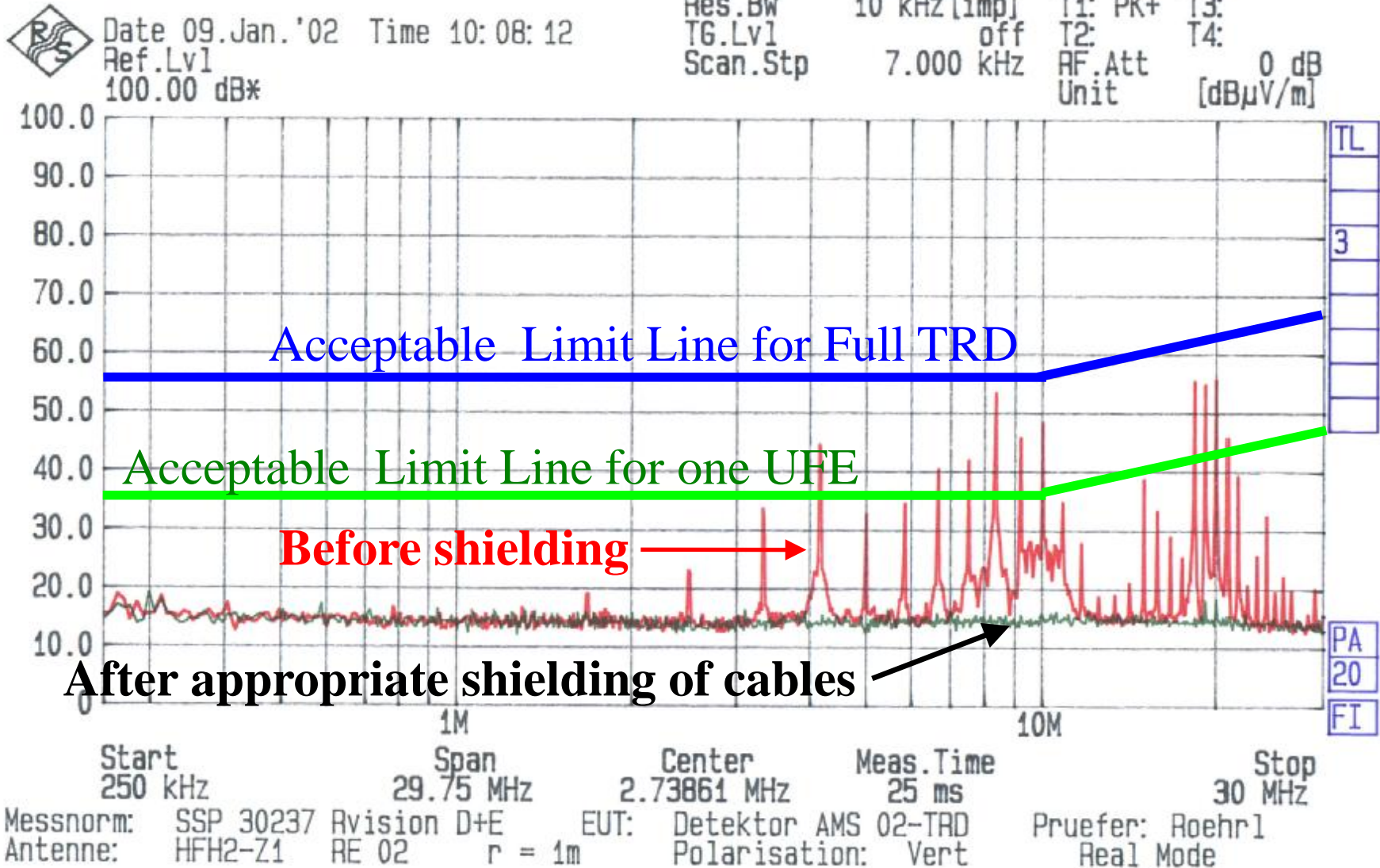


Sweeping Freq. = 14 kHz ~ 30MHz
 $|E|_{\text{rms}} = 20 \sim 100 \text{ [V/m]}$ w. V.P.
Noise VP = 1.839 ± 0.0554[ADC]



Sweeping Freq. = 30MHz ~ 1GHz
 $|E|_{\text{rms}} = 20 \sim 100 \text{ [V/m]}$ w. V(H).P.
Noise V&H = 1.804 ± 0.0613[ADC]

AMS-02 TRD: ElectroMagnetic InterferenceTest



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AMS-02 TRD

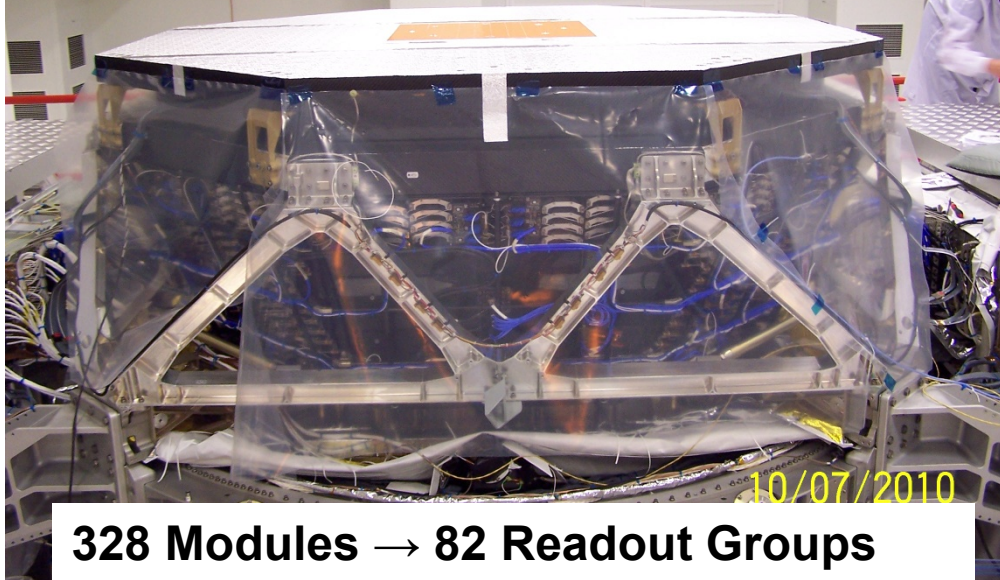
AMS-02 TRD DAQ



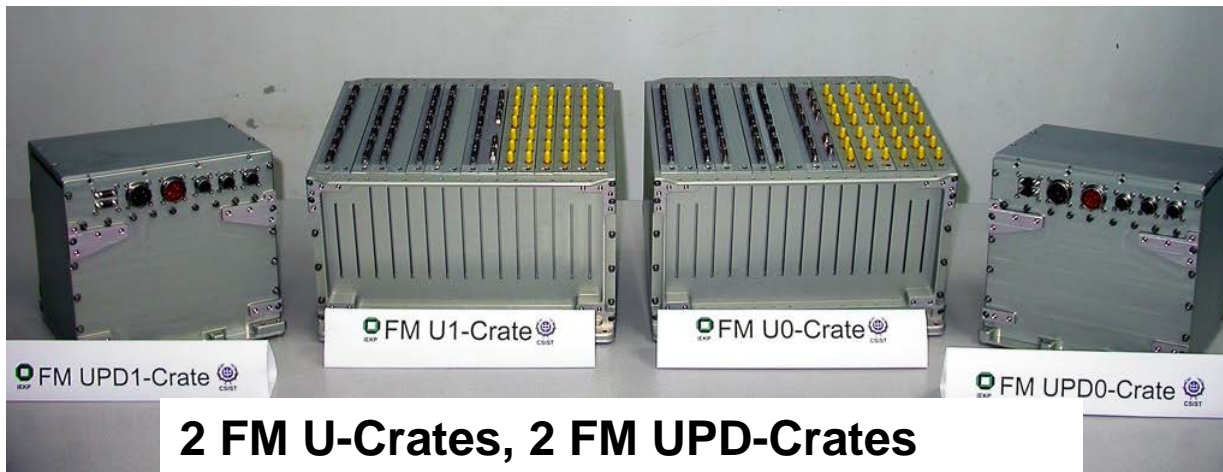
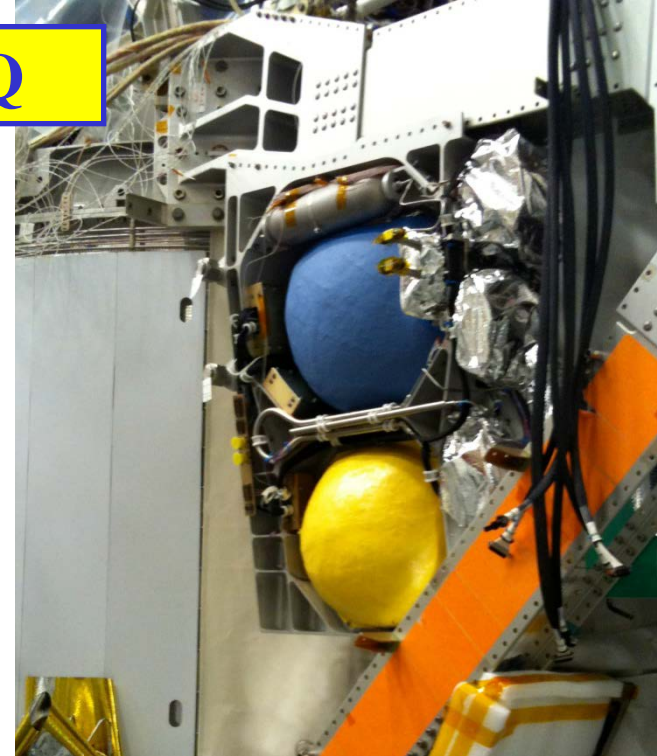
Th. Kim

AMS-02 TRD

AMS-02 TRD DAQ



328 Modules → 82 Readout Groups



2 FM U-Crates, 2 FM UPD-Crates



AMS-02 TRD DAQ

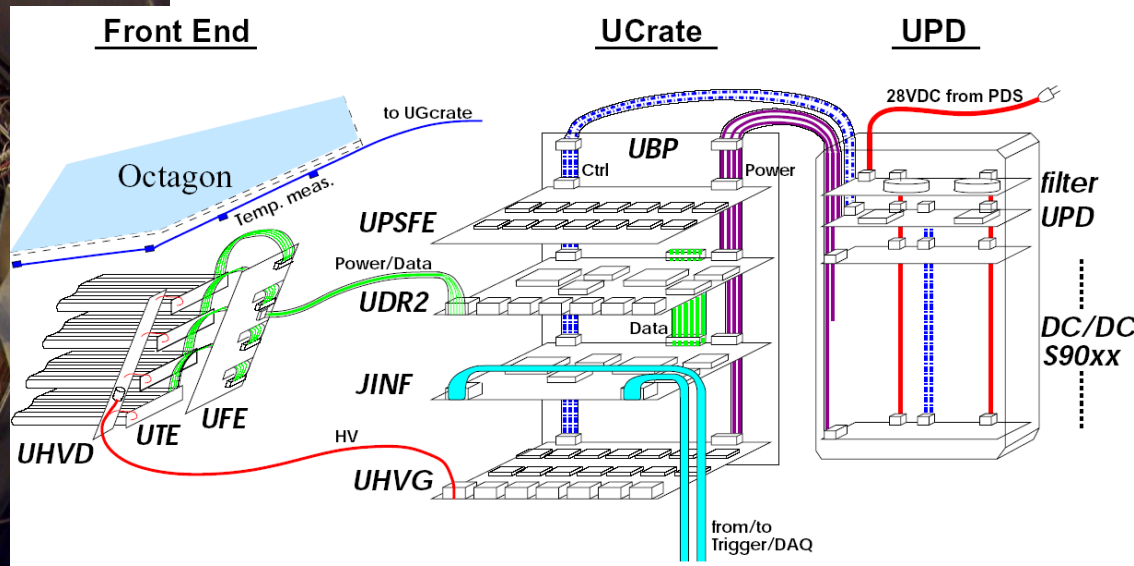
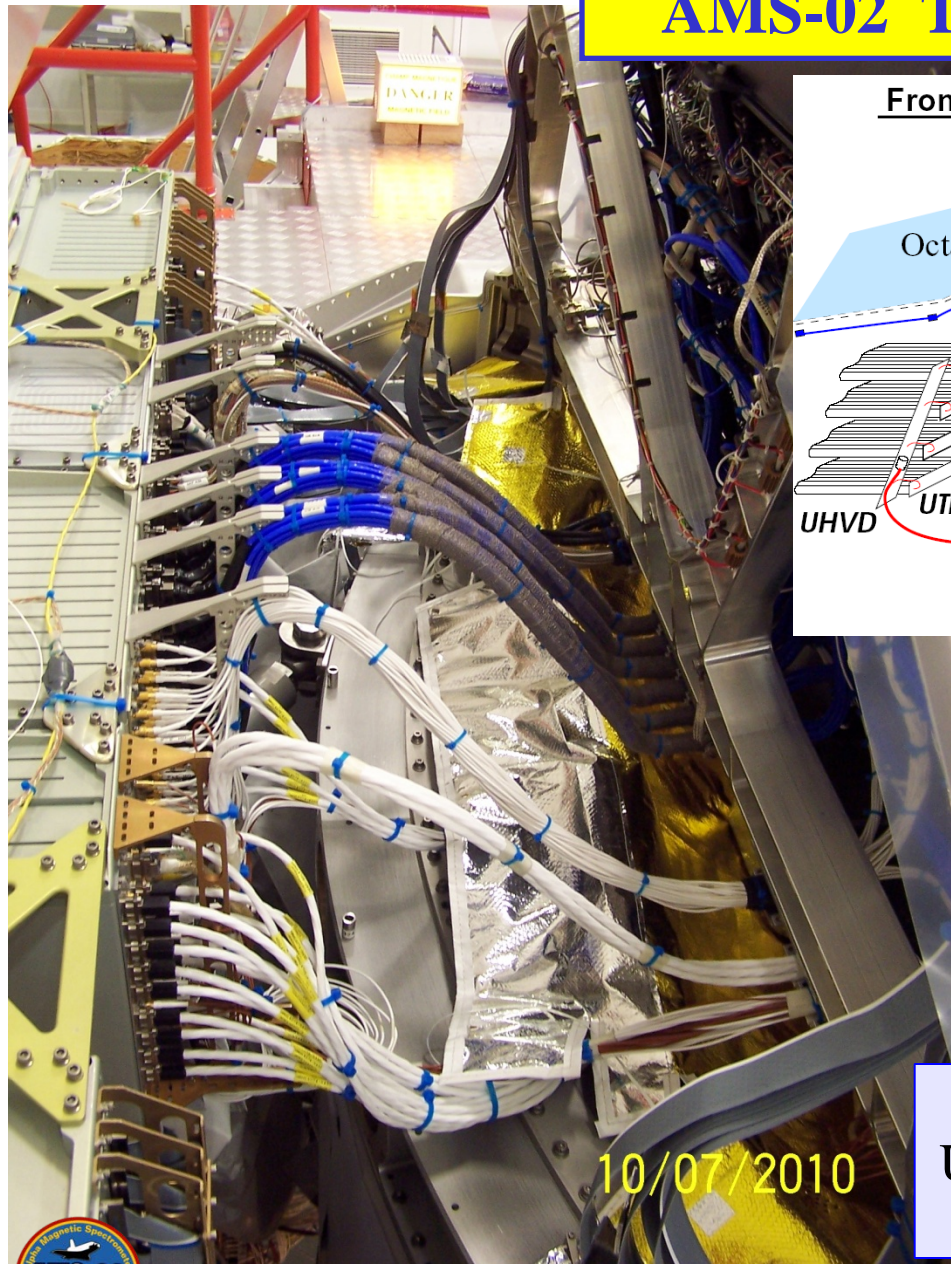


All AMS-02 electronics is mounted on two main radiators (RAM and WAKE) to dissipate about 1000W into space

TRD readout electronics (RAM side):
U-Crate and UPD



AMS-02 TRD DAQ



Space requirements issued by NASA :

- Electromagnetic Interference
- Electromagnetic Compatibility
- Mechanical Vibration
- Thermal Vacuum Test

TRD Power Consumption
 UFE (20W) + UCrate (41W) + UPD (36W)
 ≈ 100W

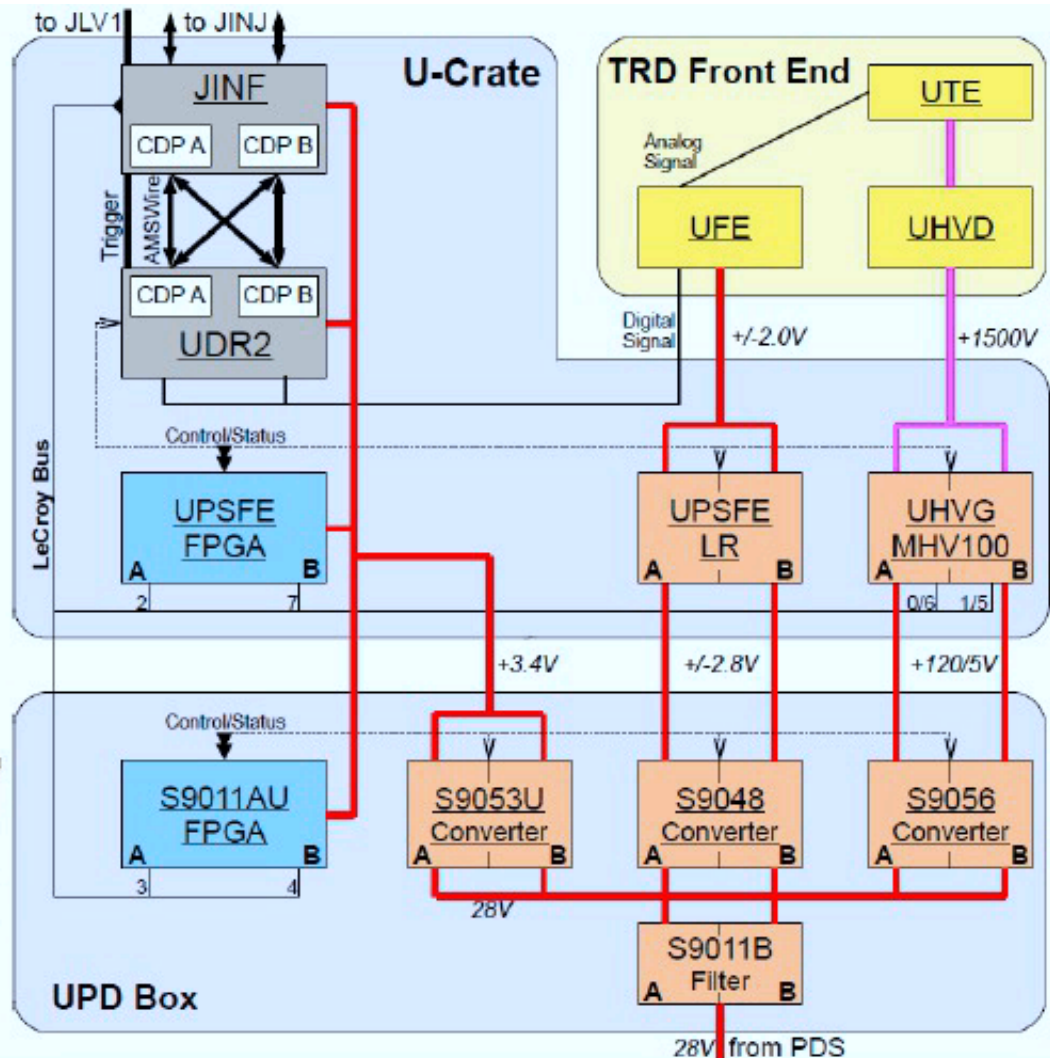
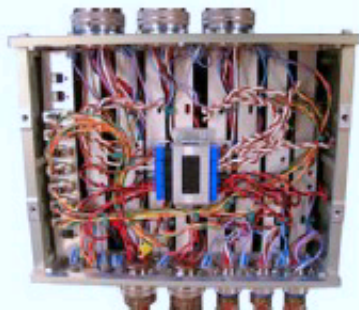
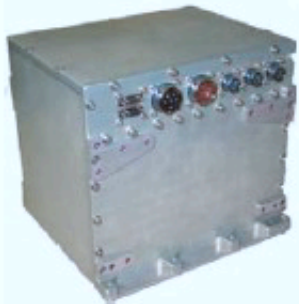
10/07/2010



AMS-02 TRD DAQ

...space qualification:

- Space Debris impact
- Heavy ions radiation
- + redundancy!
- + testing!!!

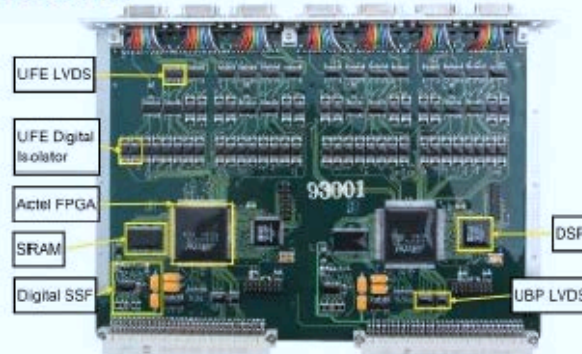


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AMS-02 TRD

TRD Electronics Production

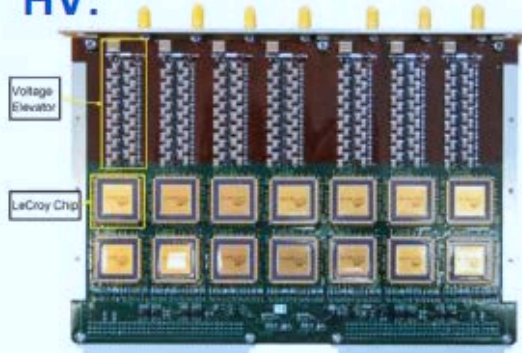
Readout:



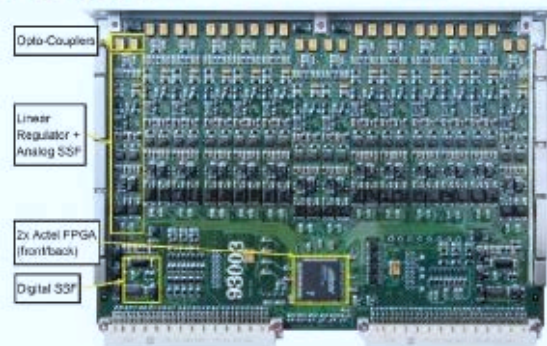
Phases:

EM = Engineering
QM = Qualification
QM2 = QM at production line
FM = Flight Model

HV:



Power:



Production of qualification and flight model at CSIST in Taiwan



Board-level qualification and acceptance testing performed during production in Taiwan with specialized CSIST technicians and physicists.



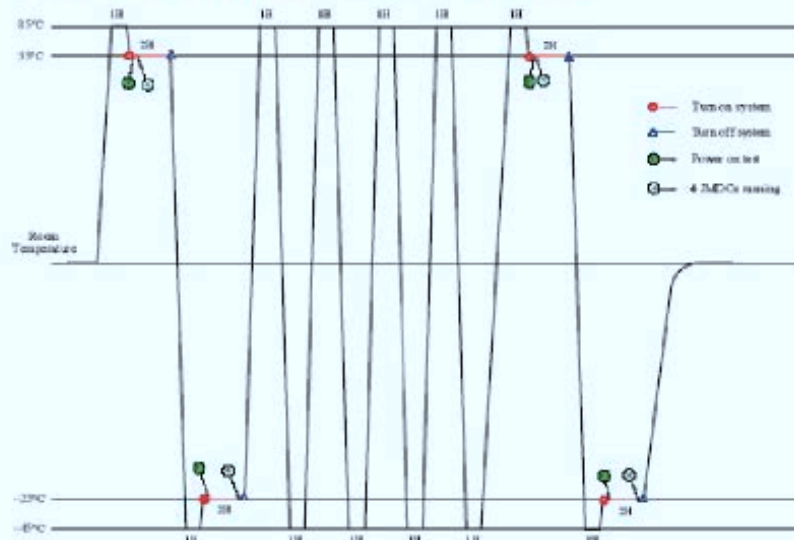
KIT - IEKP
Karlsruhe

AMS-02 TRD DAQ

QM/FM Thermal-Vacuum-Test



Repeated temperature profile



- Storage temperature cycles -45°C to $+85^{\circ}\text{C}$
- Functional tests -25°C to $+55^{\circ}\text{C}$
- Heat dissipated to cool plate only (on ISS this is the main radiator)



10-09-21

TWEPP-10, Aachen

IEKP, Andreas Sabellek p.10

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AMS-02 TRD

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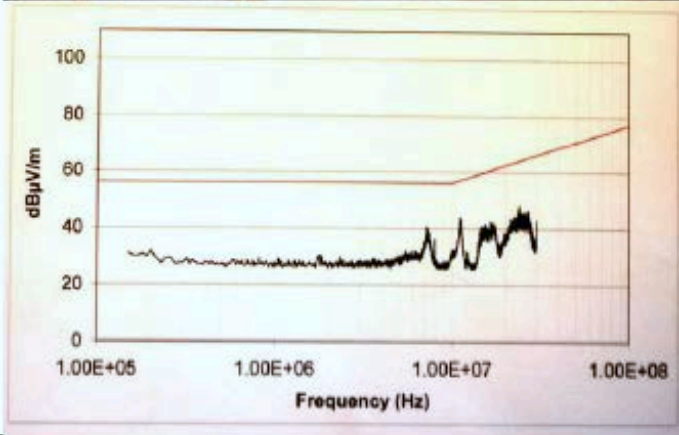
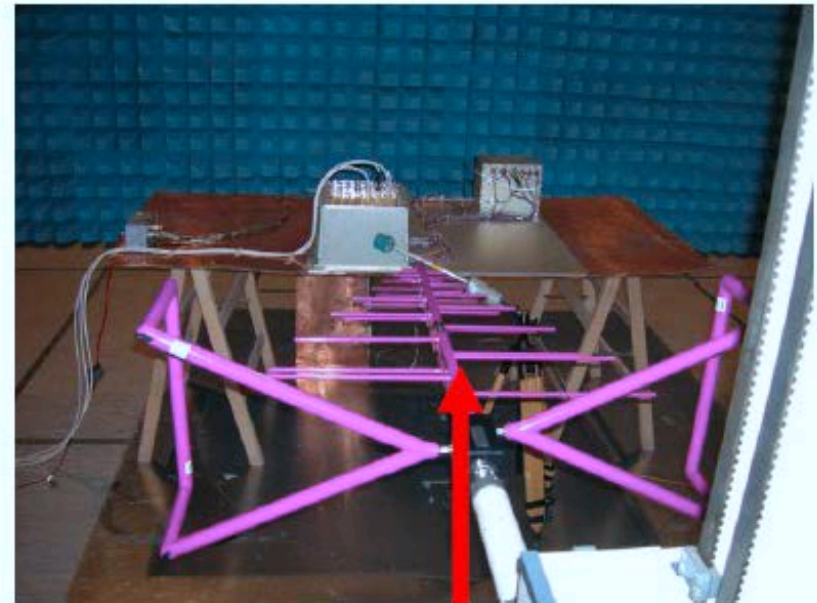
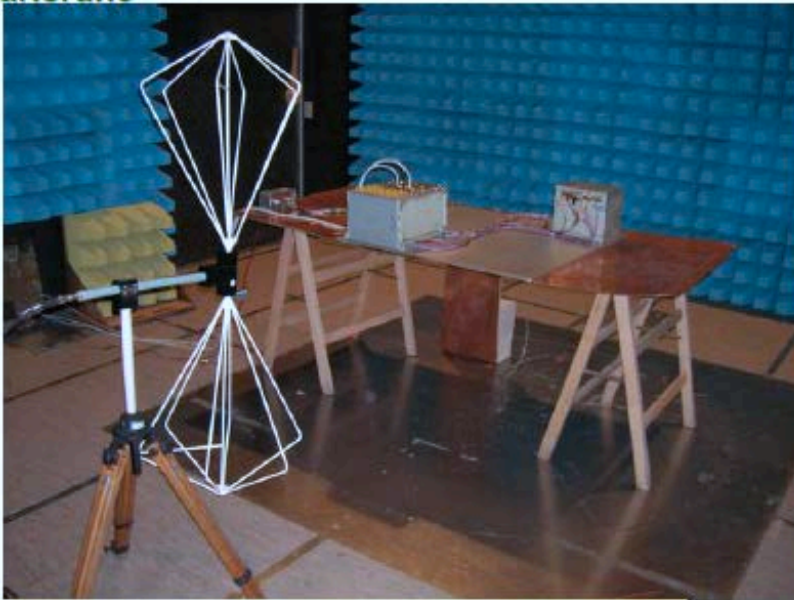




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Karlsruhe

AMS-02 TRD DAQ

QM EMI/EMC Test



- *EMC*: operation during conducted or radiated disturbing pulses without failure
- *EMI*: test of radiated frequency spectrum in kHz to GHz range within NASA limits



010-09-21
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AMS-02 TRD

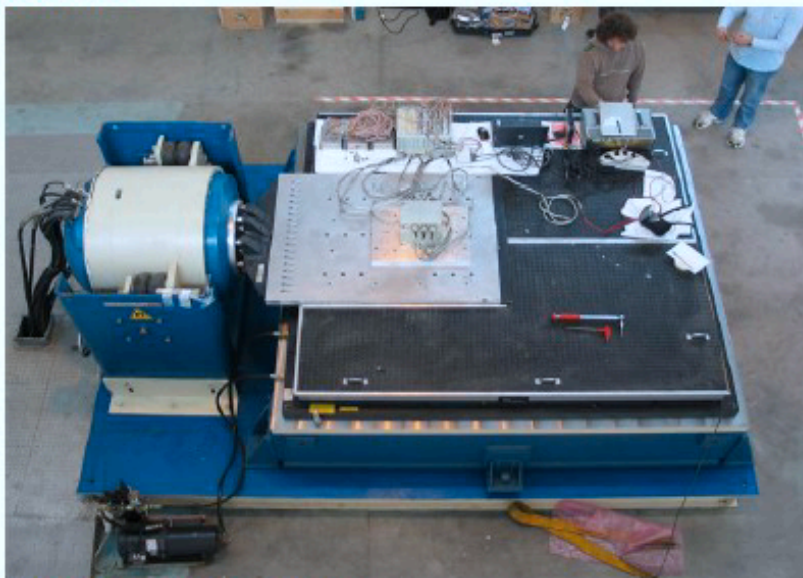
IEKP, Andreas Sabellek p.11
RWTH AACHEN
UNIVERSITY 68



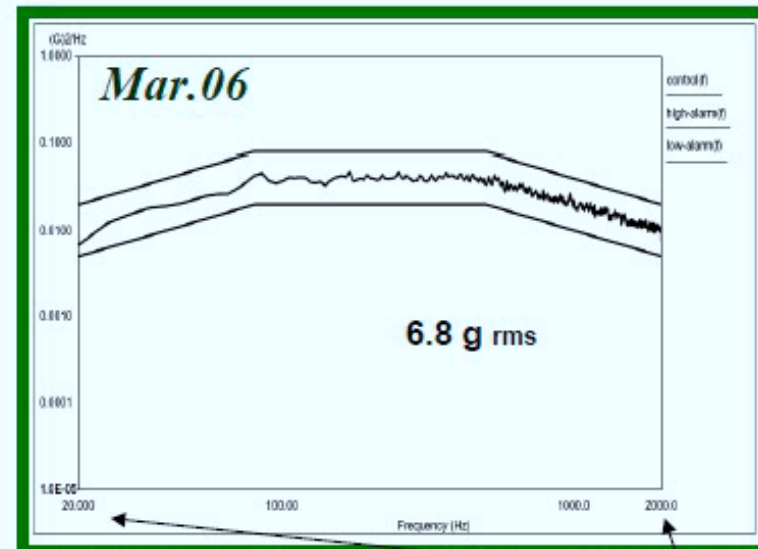
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Karlsruhe

AMS-02 TRD DAQ

QM/FM Vibration test



S.E.R.M.S, Italy



Frequency spectrum 20Hz to 2kHz

- Simulation of vibration frequencies occurring during shuttle launch of up to 6.8g rms (duration about 10min – duration of shuttle launch about 4min)
- After test careful inspection for damage

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TWEPP-10, Aachen

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IEKP, Andreas Sabellek p.12

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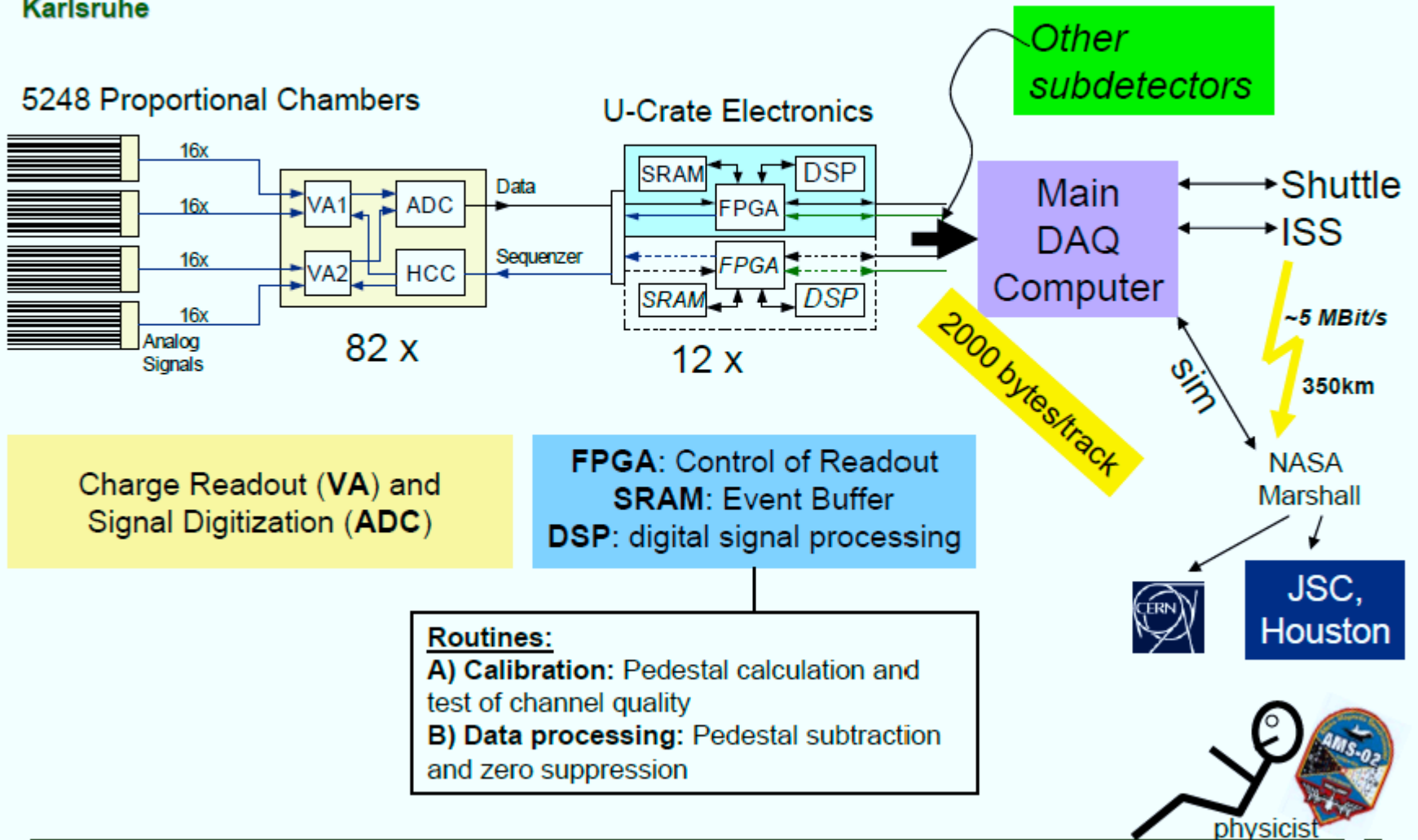




KIT - IEKP
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AMS-02 TRD DAQ

TRD Readout in AMS-02



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TWEPP-10, Aachen

IEKP, Andreas Sabellek p.16

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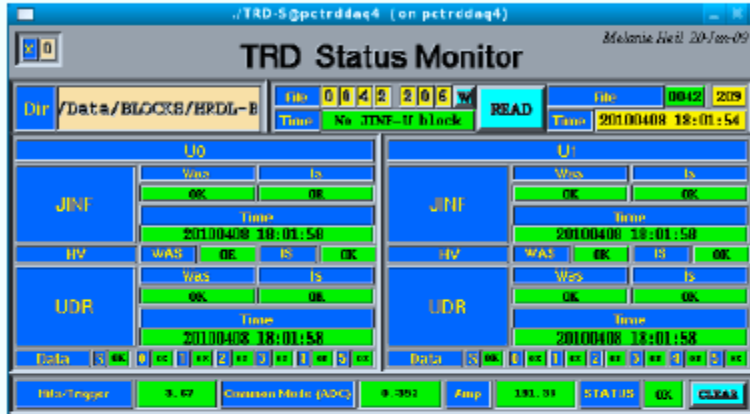




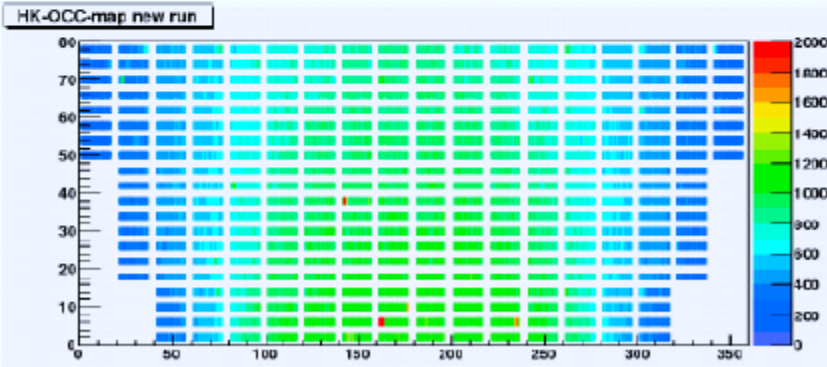
KIT - IEKP
Karlsruhe

AMS-02 TRD DAQ

TRD Monitoring



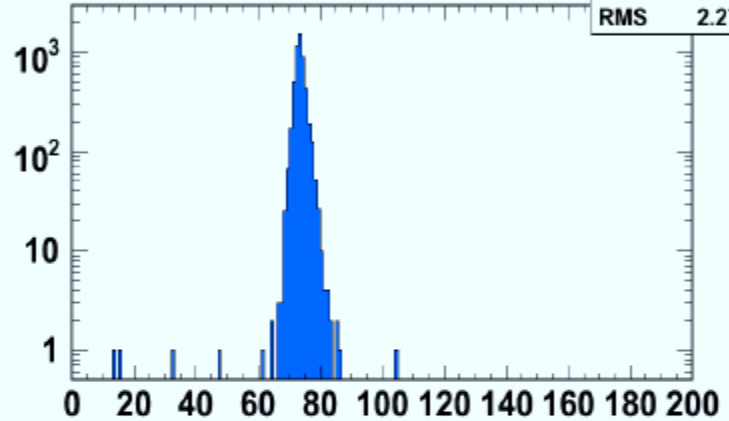
Extract from data stream, what instrument sends



map for occupancy

MPV fitted to on track amplitudes

Entries



histo_mpv	
Entries	5216
Mean	73.53
RMS	2.273

Landau MPV [ADC]

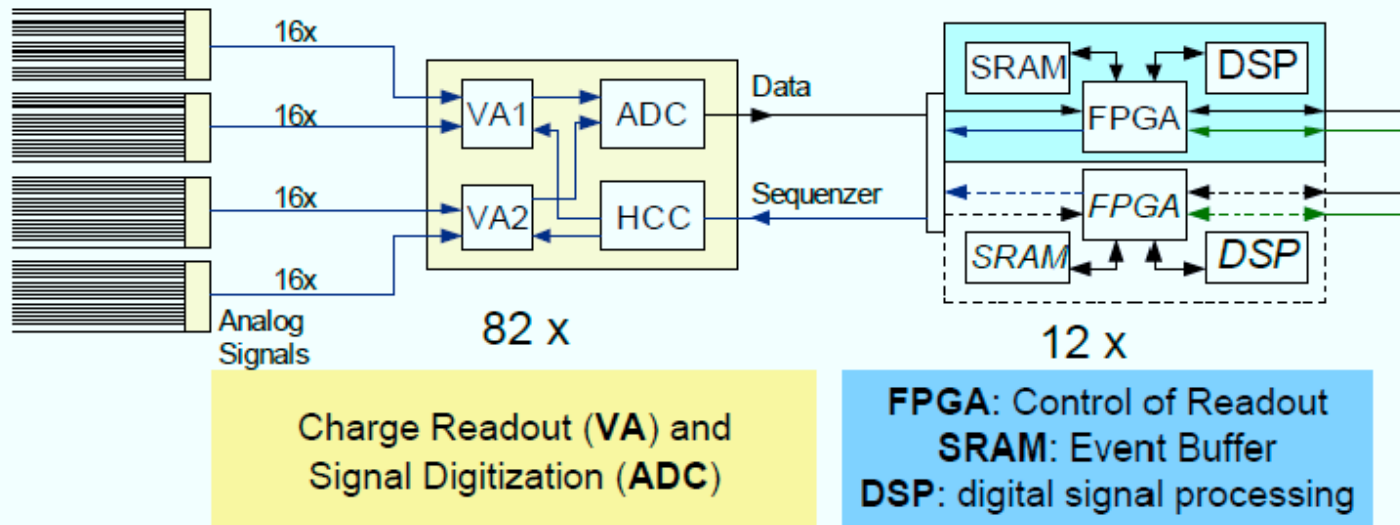
(status of power supplies, temperature, gas parameters, data acquisition, etc)



UDR DSP Code Description

5248 Proportional Chambers

U-Crate Electronics



Each UDR2 board reads and processes raw data of 448 strawtube channels. **Raw data** consists of 12-bit adc values.



Three main detector-specific parts:

- a) **Data calibration:** pedestal calculation and test of channel quality
- b) **Event processing:** pedestal subtraction and zero-suppression, dynamic pedestal calculation
- c) **DAQ monitoring:** Assembly of housekeeping data, calculation of average hit amplitude and occupancy



AMS-02 – TRD M-Structure, Heating



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AMS-02 TRD

AMS-02 – TRD M-Structure Heating

TRD Component Temperature Range

Item	Experim. Setup	Quantity tested	Temperature Range [°C]	Operative	Survival (no damage)	Comment
DOR-Connector	LN ₂ (15 min)	8	-77	No	Yes	
DOR-Connector	TVT AC	20	T<-20	No	Yes	
			-20<T<+40	Yes	Yes	
Manifold FVs unswitched	TVT AC	1 x 5 channels potted, no Stycast	-20<T<+40	Yes	Yes	
			-25<T<-20	-	Yes	
FV Operation	TVT AC	2 x 2 FV	0<T<+40	Yes	Yes	
			-25<T<0	No	Yes	No switching
TRD Straw Module	TVT AC	4 SQ-Modules	-20<T<+45	Yes	Yes	With (Gas, HV, Power)
	TVT MPE		-45<T<+60	-	Yes	No (Gas, HV, Power)
UFE	TVT AC	82 FM(+19 FS)	-20<T<+50	Yes	Yes	
			-35<T<-20	-	Yes	
			+50<T<+80	-	Yes	
UHVD	TVT AC	5 QM	-45<T<+63	-	Yes	

TRD Requirements ICD 27.01.2006

Non Operative (Survival) -20<T<40°C

Operative -10<T<40°C

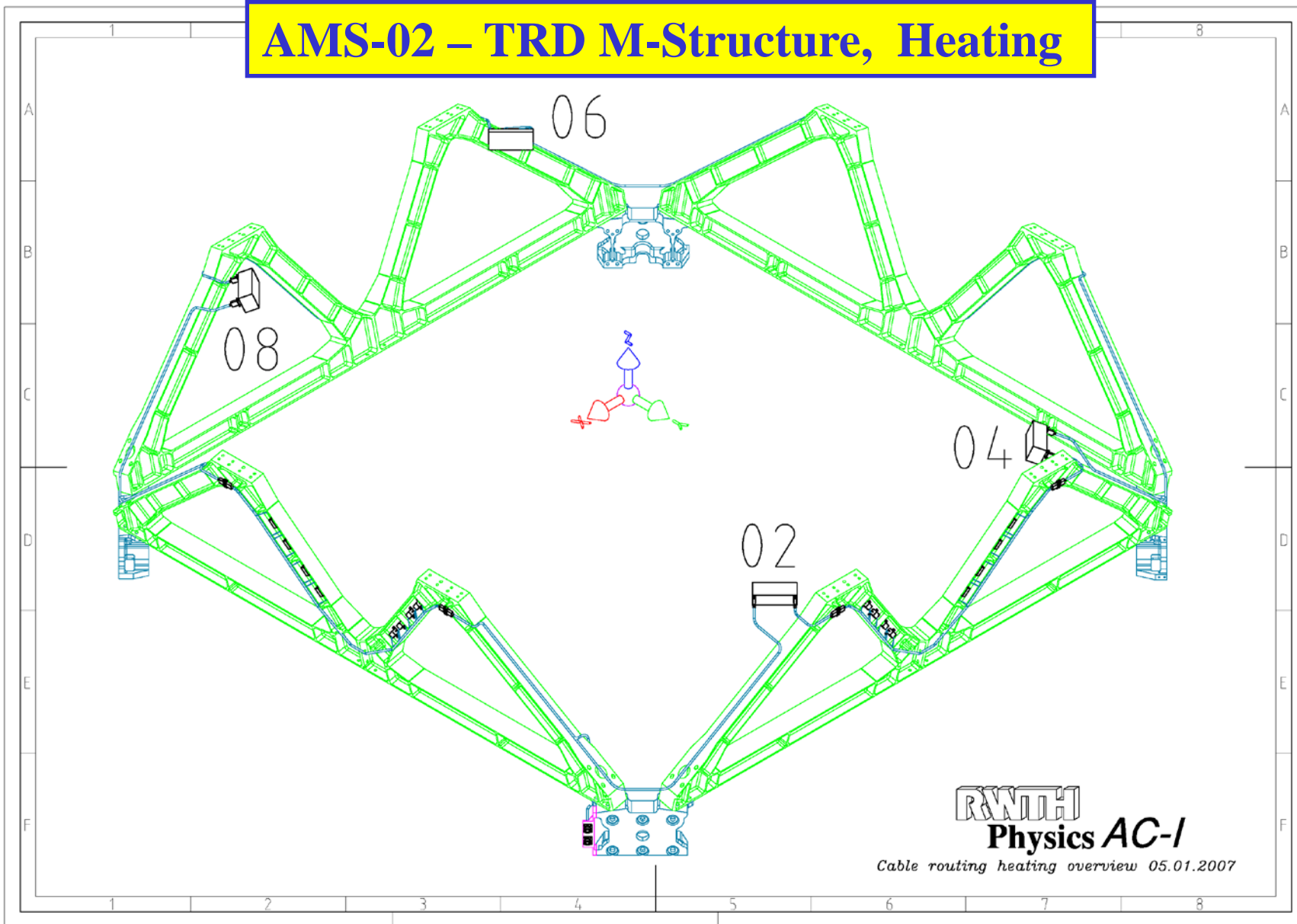
TRD Component Space Qualification:

Non Operative (Survival) -25<T<40°C

Operative -20<T<40°C



AMS-02 – TRD M-Structure, Heating

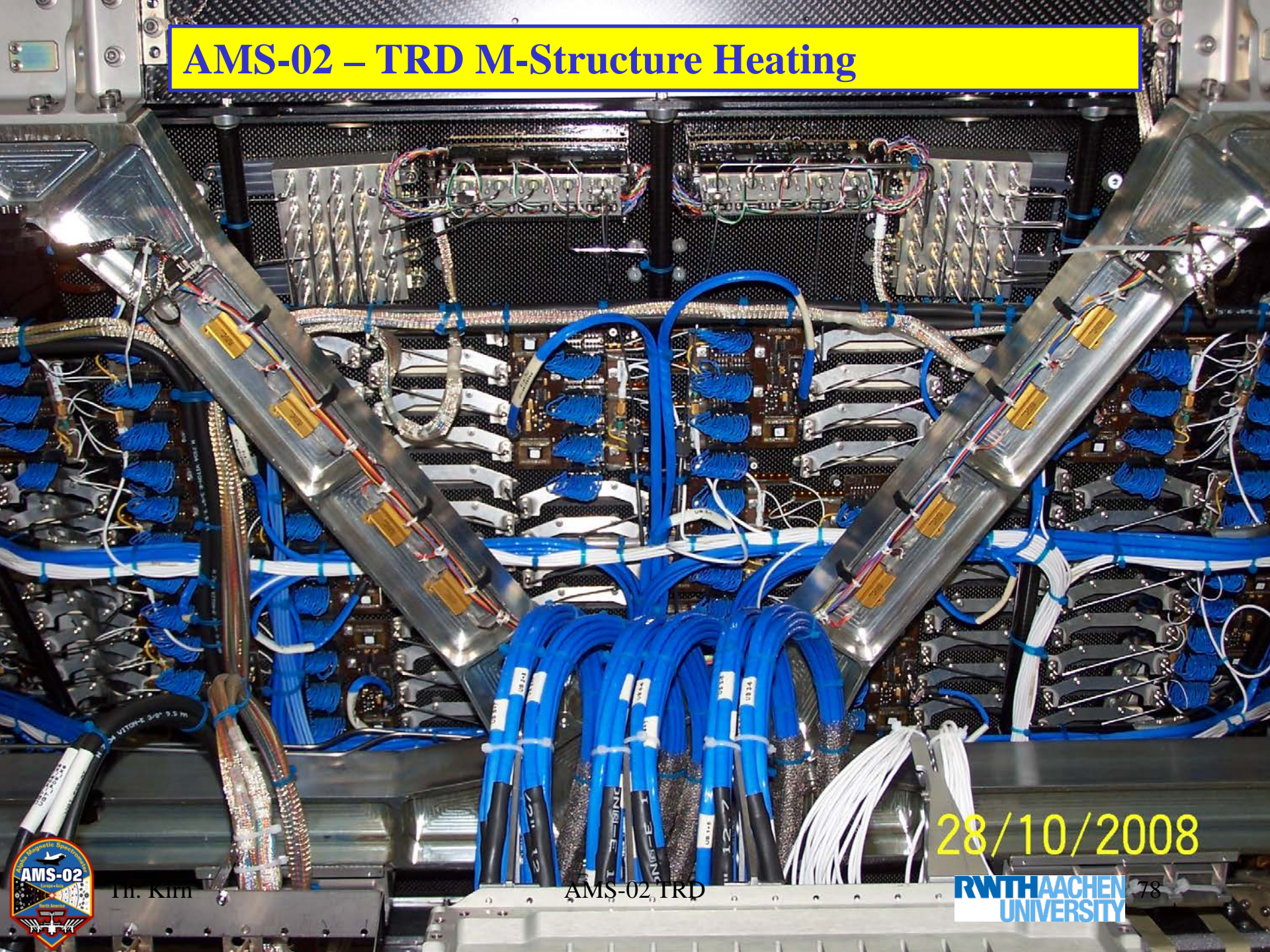


AMS-02 – TRD M-Structure Heating



28/10/2008

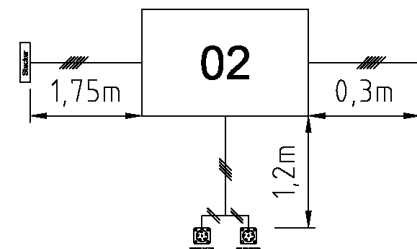
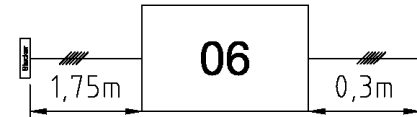
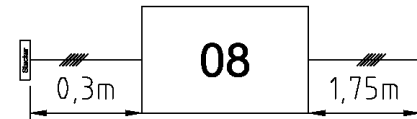
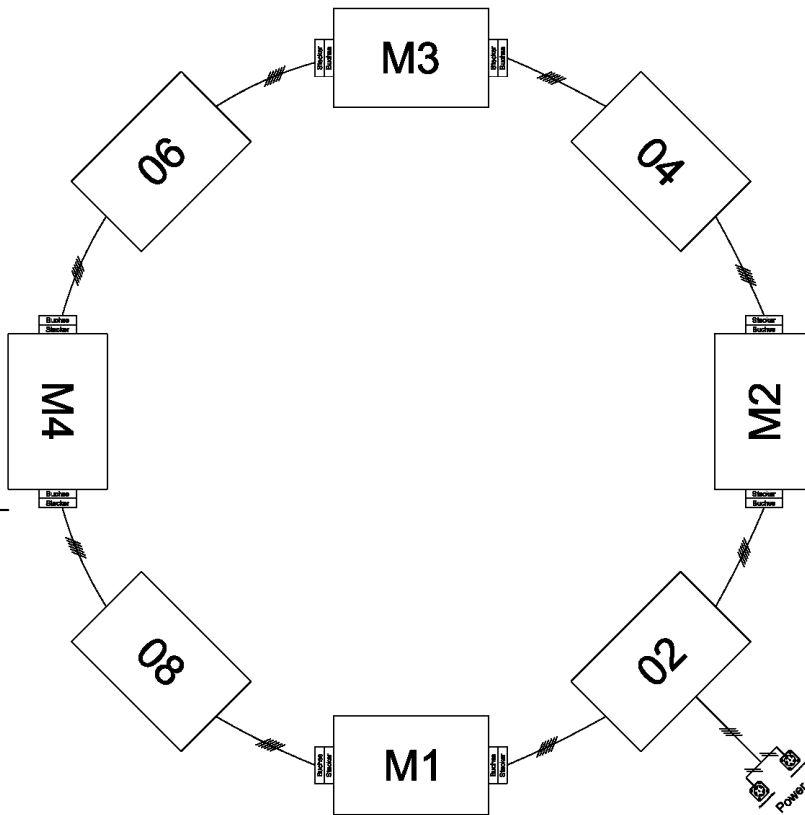
AMS-02 – TRD M-Structure Heating



28/10/2008



AMS-02 – TRD M-Structure Heating



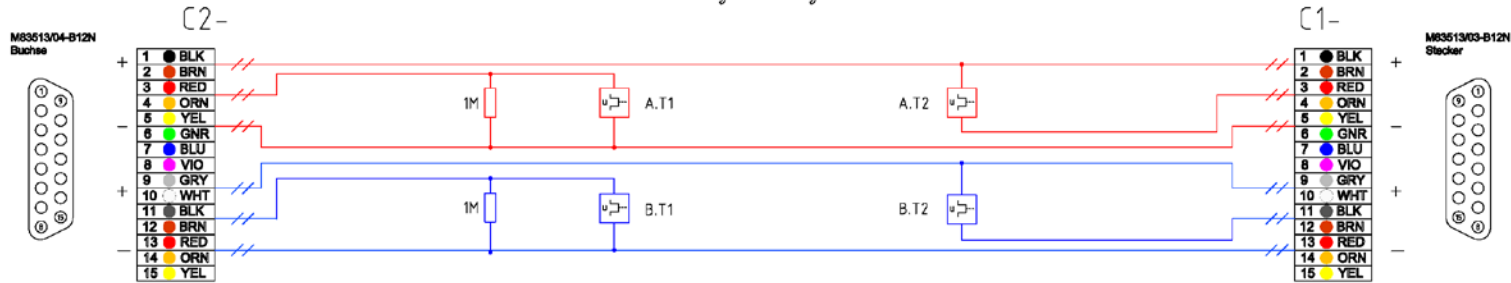
Verwendungsbereich	Zul. Abw.	Oberfläche	Maßstab	Gewicht
		✓	Werkstoff, Halbzeug	
	2006	Datum	Benennung	
	Bearb.	25.11	M-Structure schematics	
	Gepr.		Thermostats & heaters	
	Name		Zeichnungsnummer	Blatt
				3
				AS Bl.
Rev.	Änderung	Revision/Name	Ers. f.:	Ers. d.:
				Plot Datum:

RWTH
Physics AC-1

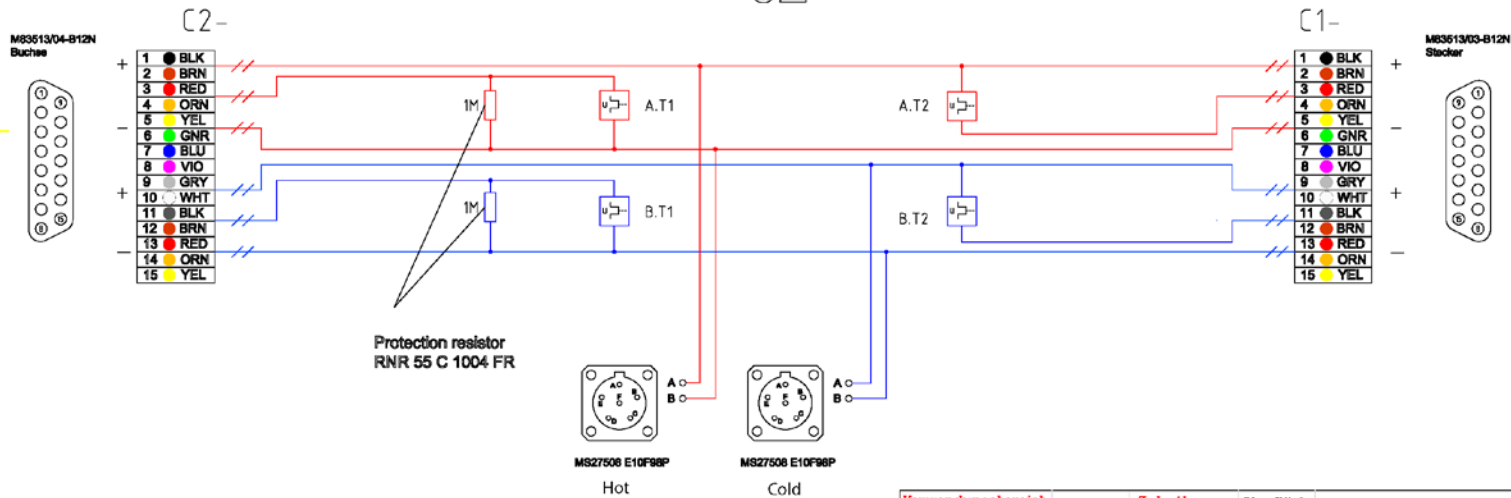


AMS-02 – TRD M-Structure Heating

04, 06, 08



02



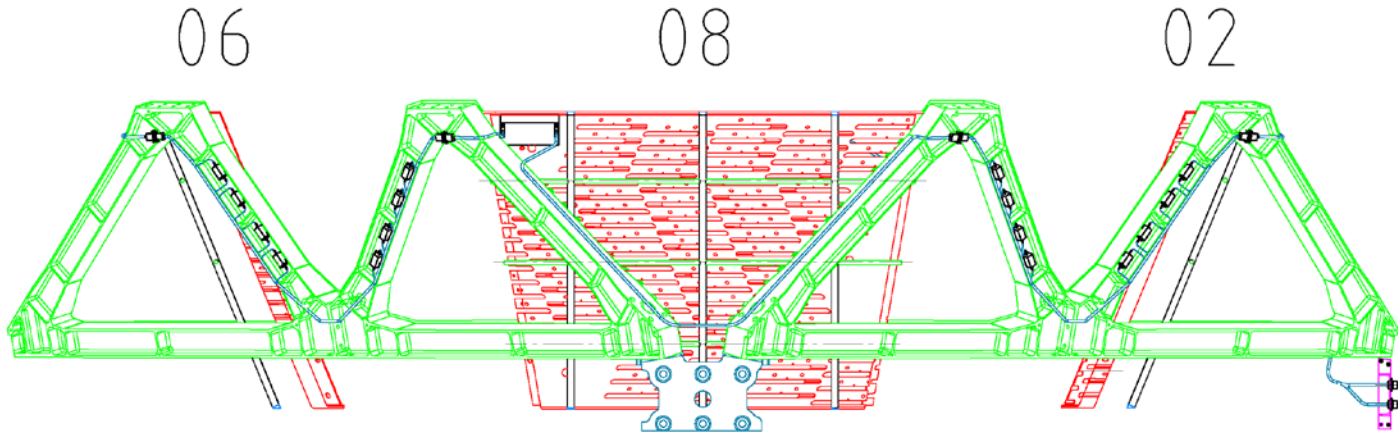
Verwendungsbereich	Zul. Abw.	Oberfläche	Maßstab	Gewicht
			Werkstoff, Halbzeug	
	2006 Datum	Name	Benennung	
	Bearb. 25.11	ßßer	M-Structure schematics Thermostats	
	Gepr.		Zeichnungsnummer	Blatt 1
	Name			Bl.
Rev.	Änderung	Revision/Name	Ers. f.:	Ers. d.:
			Plot Datum:	

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AMS-02 TRD



AMS-02 – TRD M-Structure Heating



+X / -Y

RWTH
Physics AC-1
Cable routing Wall08 03.01.2007



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AMS-02 – TRD M-Structure Heating



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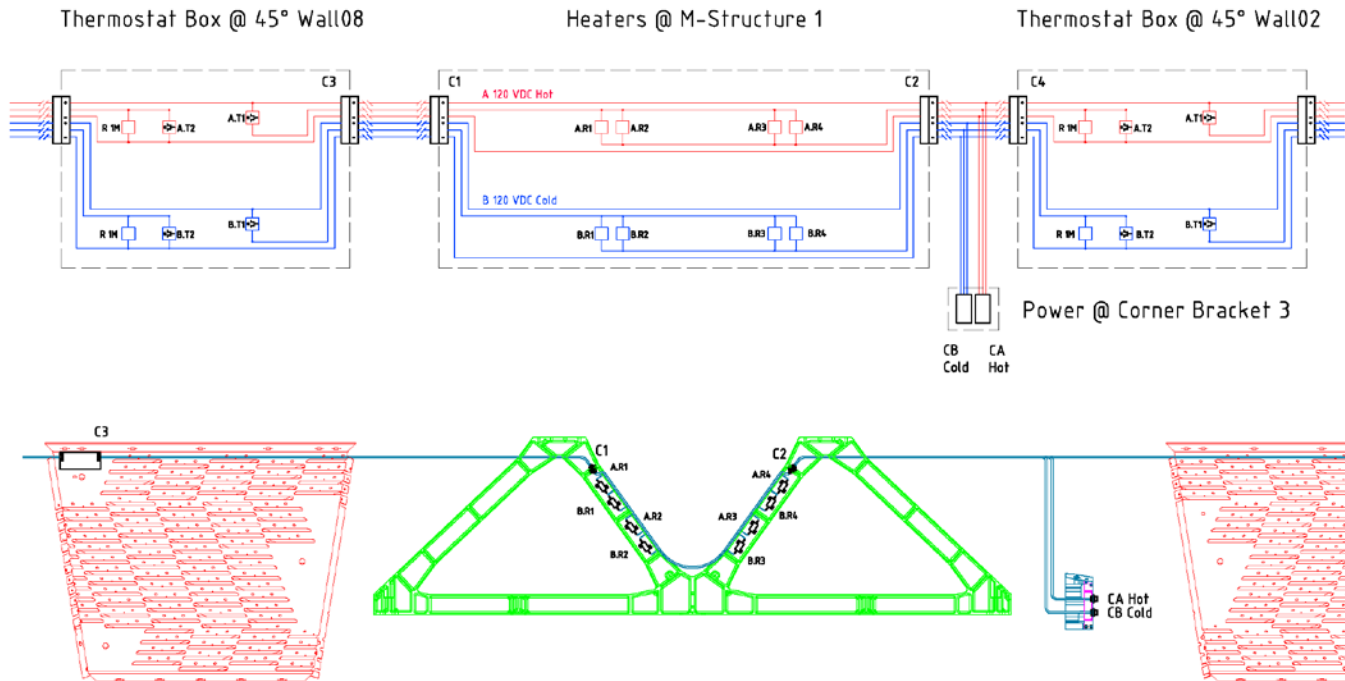
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AMS-02 – TRD M-Structure Heating



Verwendungsbereich:	Zul. Abw. DIN ISO 2768 mittel	Oberfläche N10	Maßstab 1:12	Gewicht
	2007 Datum: 29.06.2007	Name: Kersch	Werkstoff: Halbleitung	
	Gepr. Name:		Benennung	
			M-Structure schematics	
			Thermostats & heaters	
			Zeichnungsnummer	Blatt 1/1
			ams02-06-4100g	A3 Bl.
Rev. Änderung	Revision/Verf.		Ers. f.:	Ers. d.:
5	6		7	8



AMS-02 – TRD Thermostats Space Qualification

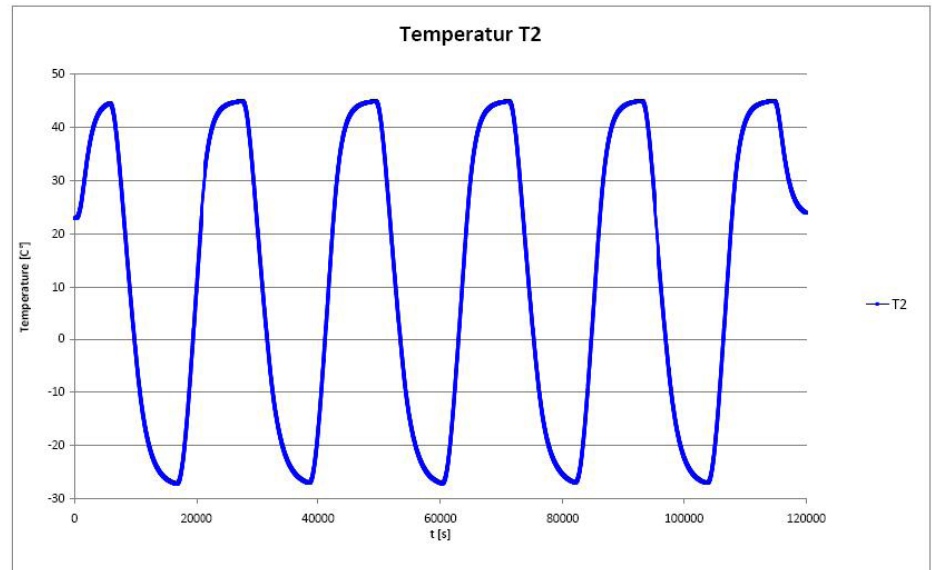
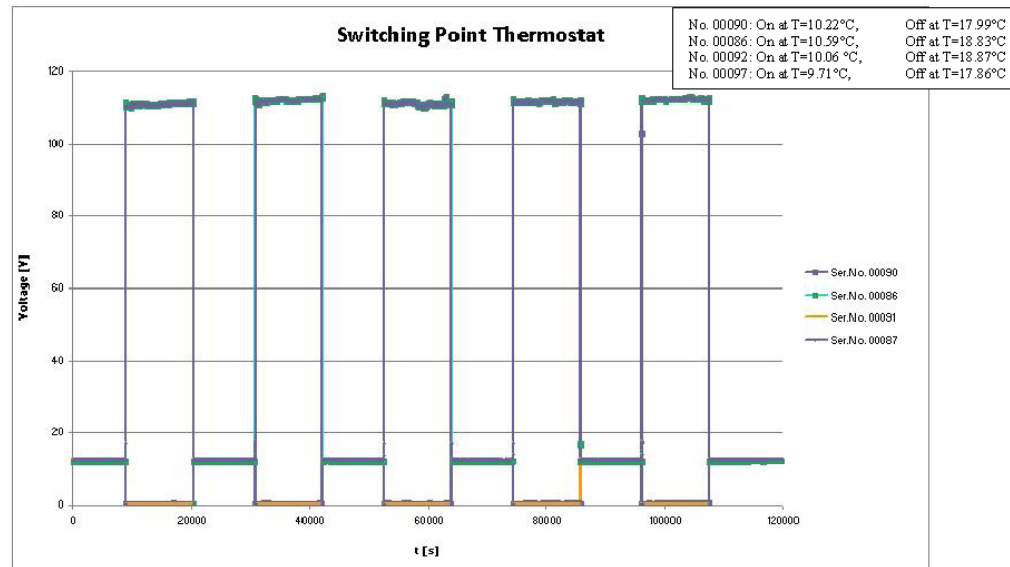
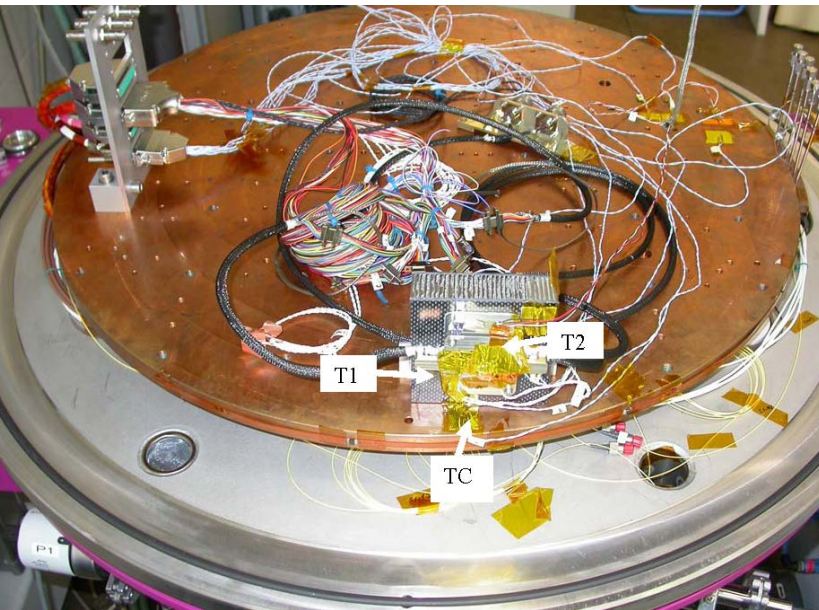
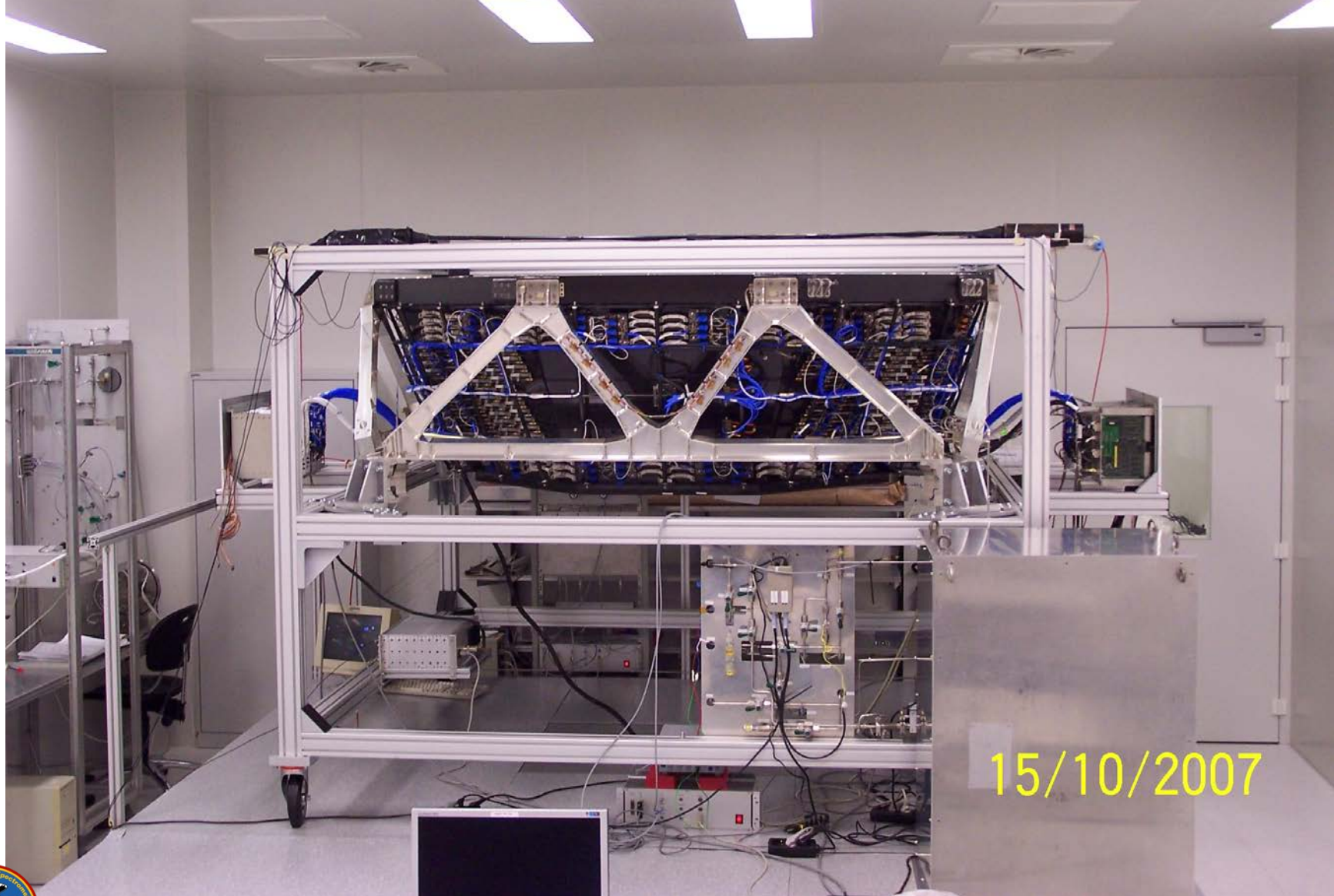


Fig. 5 Environment, Temperature sensor T2 on Thermostat Box 04



AMS-02 – TRD Flight Integration, System Test



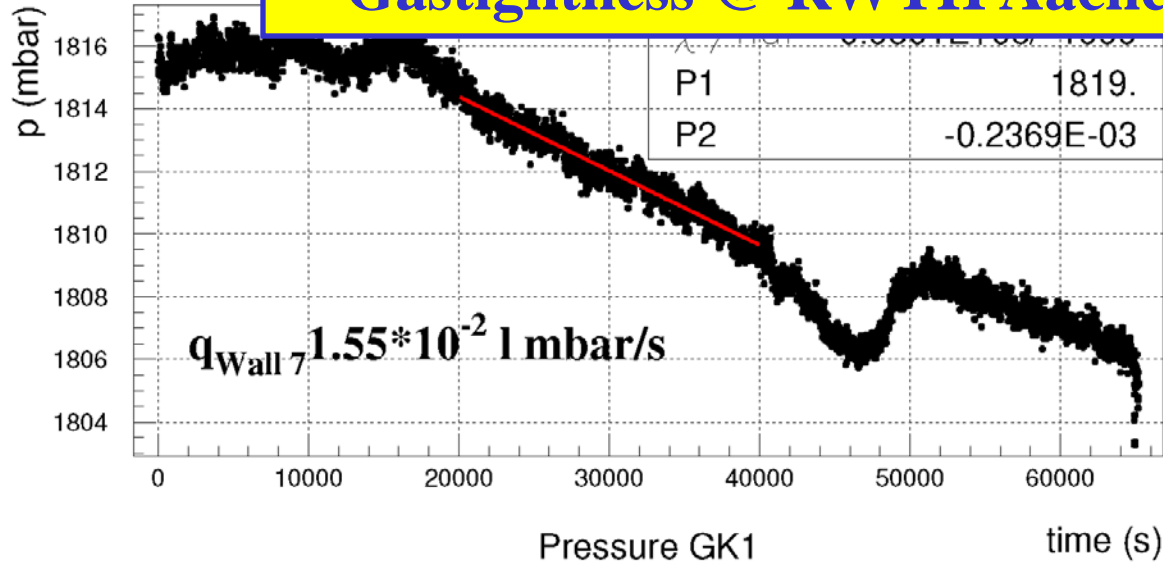
15/10/2007



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AMS-02 TRD

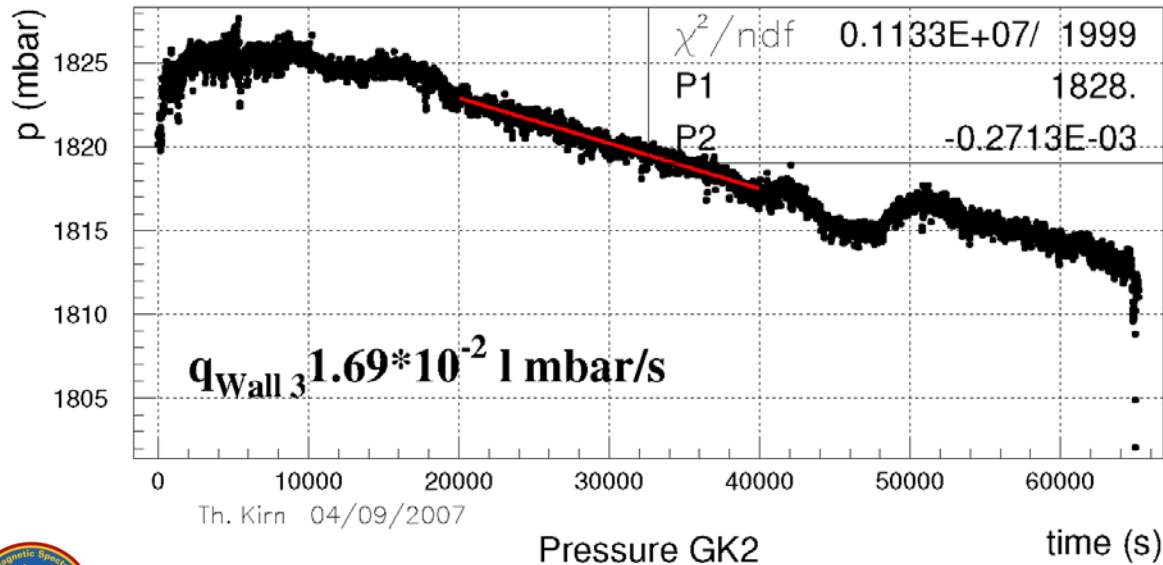
AMS-02 – TRD Flight Integration, Gastightness @ RWTH Aachen Cleanroom



He-dp/dt-Measurements of individual straw modules during production:

$$q_{\text{Wall } 7} = 1.56 \cdot 10^{-2} \text{ l mbar/s}$$

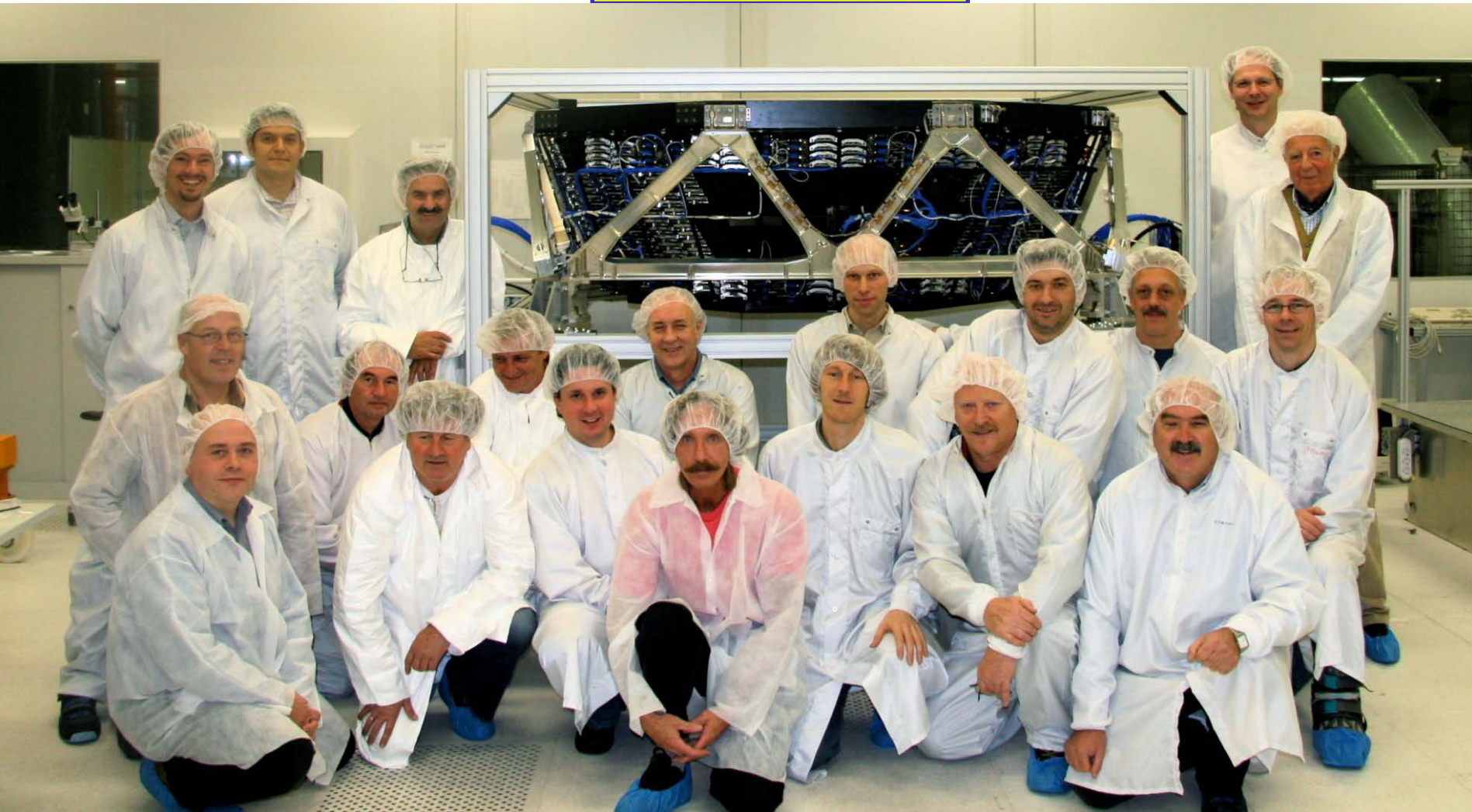
$$q_{\text{Wall } 3} = 1.53 \cdot 10^{-2} \text{ l mbar/s}$$



→ Safety Factor 8 for CO₂



AMS-02 – TRD



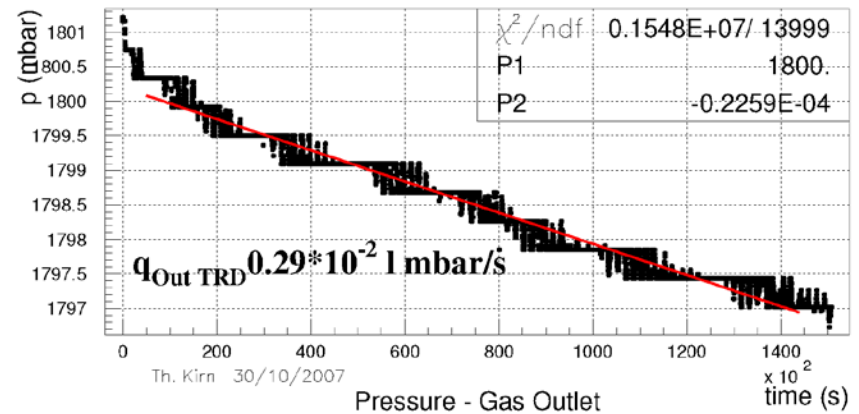
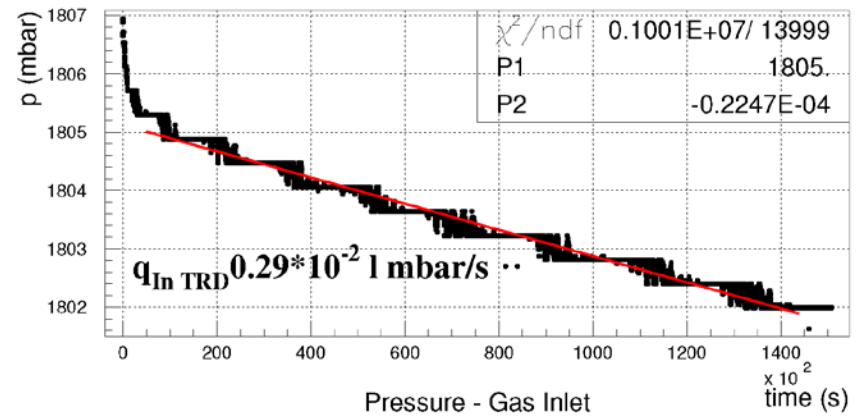
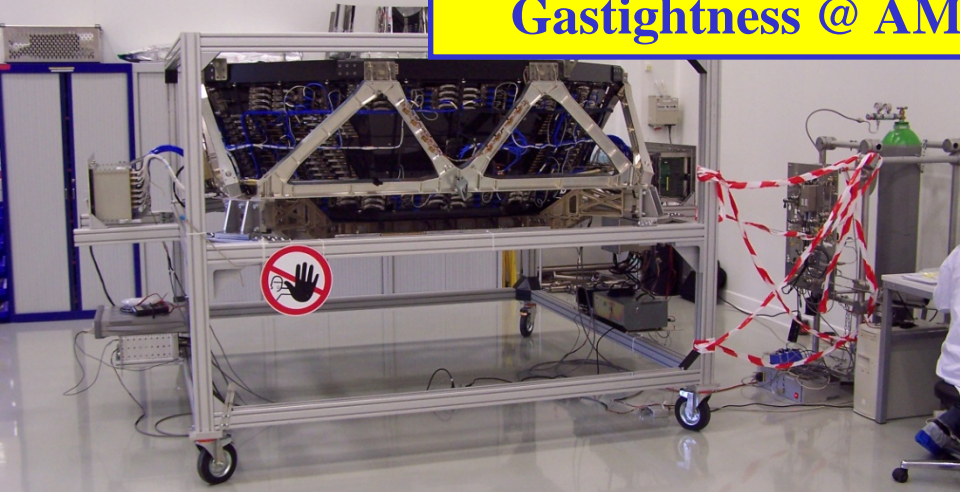
TRD Delivery to CERN October 2007



Th. Kim

AMS-02 TRD

AMS-02 – TRD Flight Integration, Gastightness @ AMS Cleanroom CERN



Ar/CO₂- (80%/20%) dp/dt-Measurements
of whole TRD after delivery to CERN
end of 2007:

$$q_{\text{CO}_2} = 0.29 \cdot 10^{-2} \text{ l mbar/s}$$

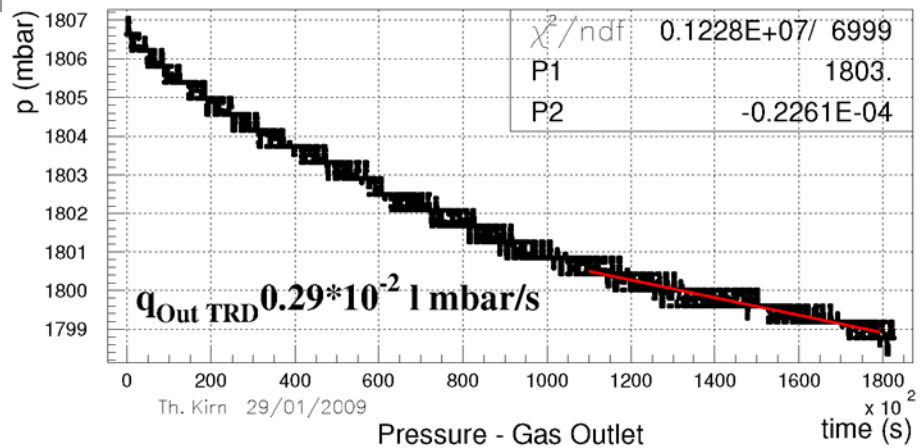
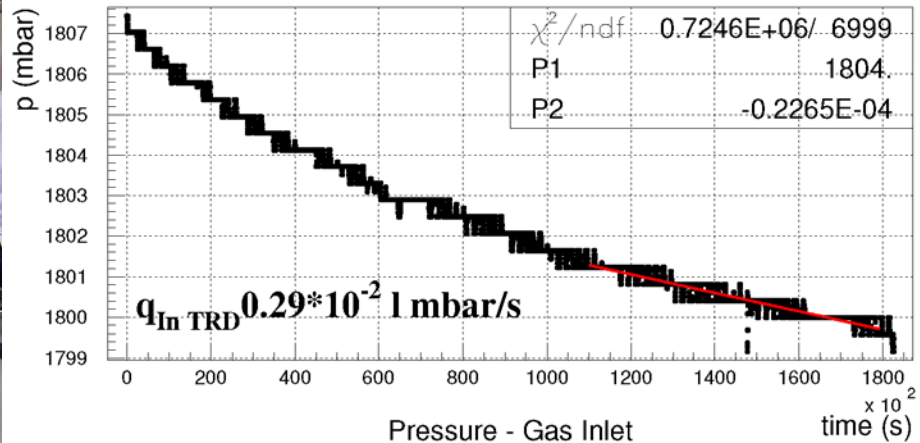
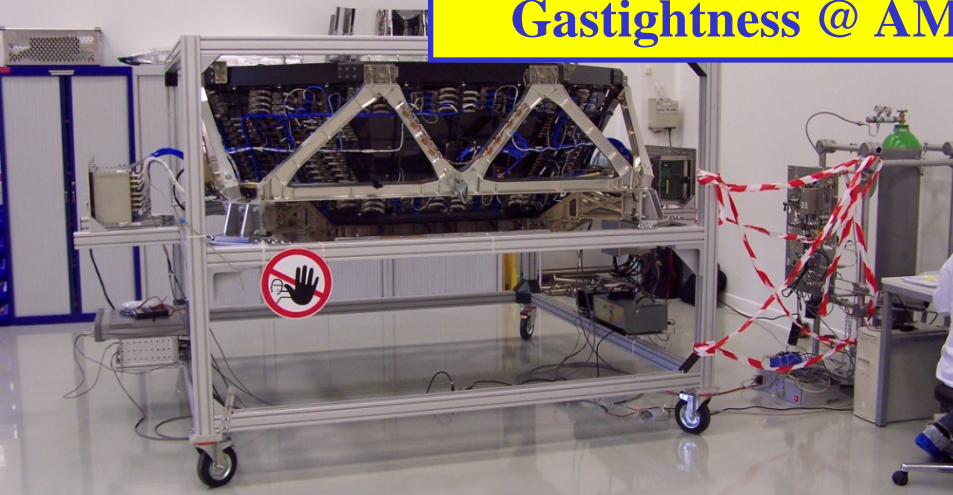
- Comparison Measurement dp/dt in air:
He ↔ CO₂ Factor of 2
- Factor 5 20% to 100 % CO₂

$$\hookrightarrow q_{\text{He}} = 3.09 \cdot 10^{-2} \text{ l mbar/s}$$

→ TRD gastight



AMS-02 – TRD Flight Integration, Gastightness @ AMS Cleanroom CERN



Ar/CO₂- (80%/20%) dp/dt-Measurements
of whole TRD after pre- & de-integration
End of 2008:

$$q_{\text{CO}_2} = 0.29 \cdot 10^{-2} \text{ l mbar/s}$$

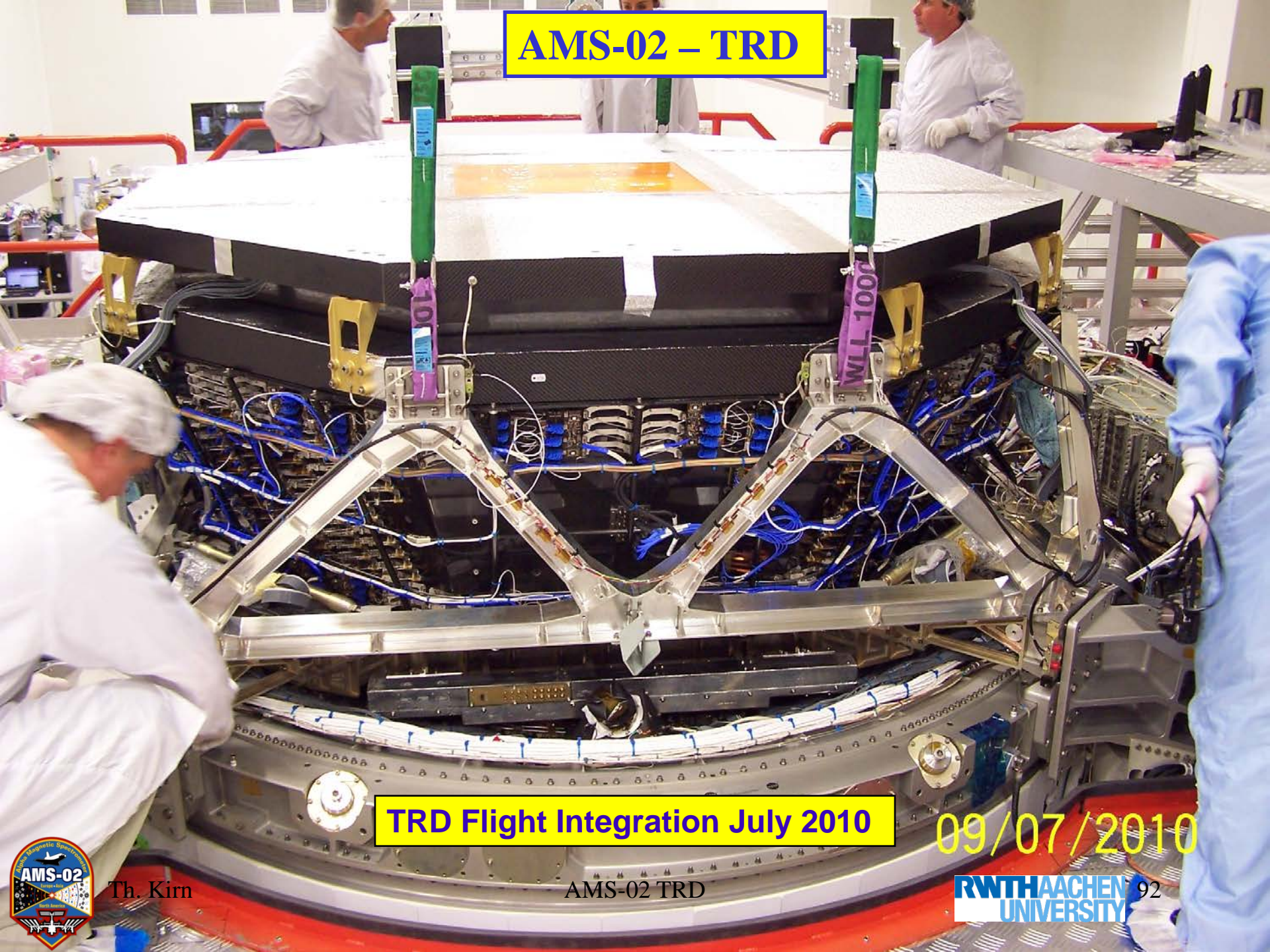
- Comparison Measurement dp/dt in air:
He ↔ CO₂ Factor of 2
- Factor 5 20% to 100 % CO₂

$$\hookrightarrow q_{\text{He}} = 3.09 \cdot 10^{-2} \text{ l mbar/s}$$

→ TRD gastight



AMS-02 – TRD



TRD Flight Integration July 2010

09/07/2010



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AMS-02 TRD



AMS-02 @ CERN Cleanroom



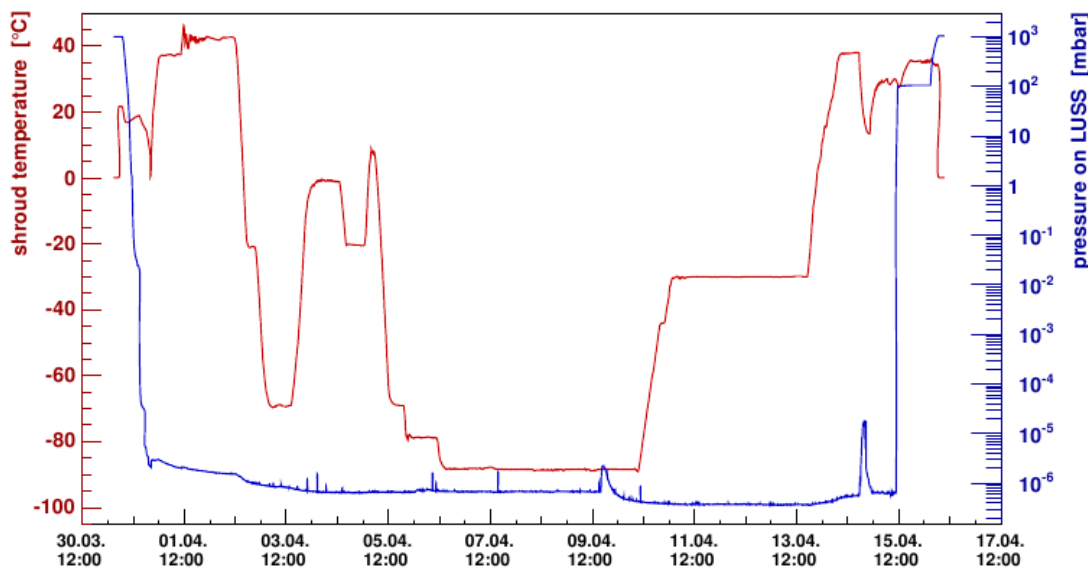
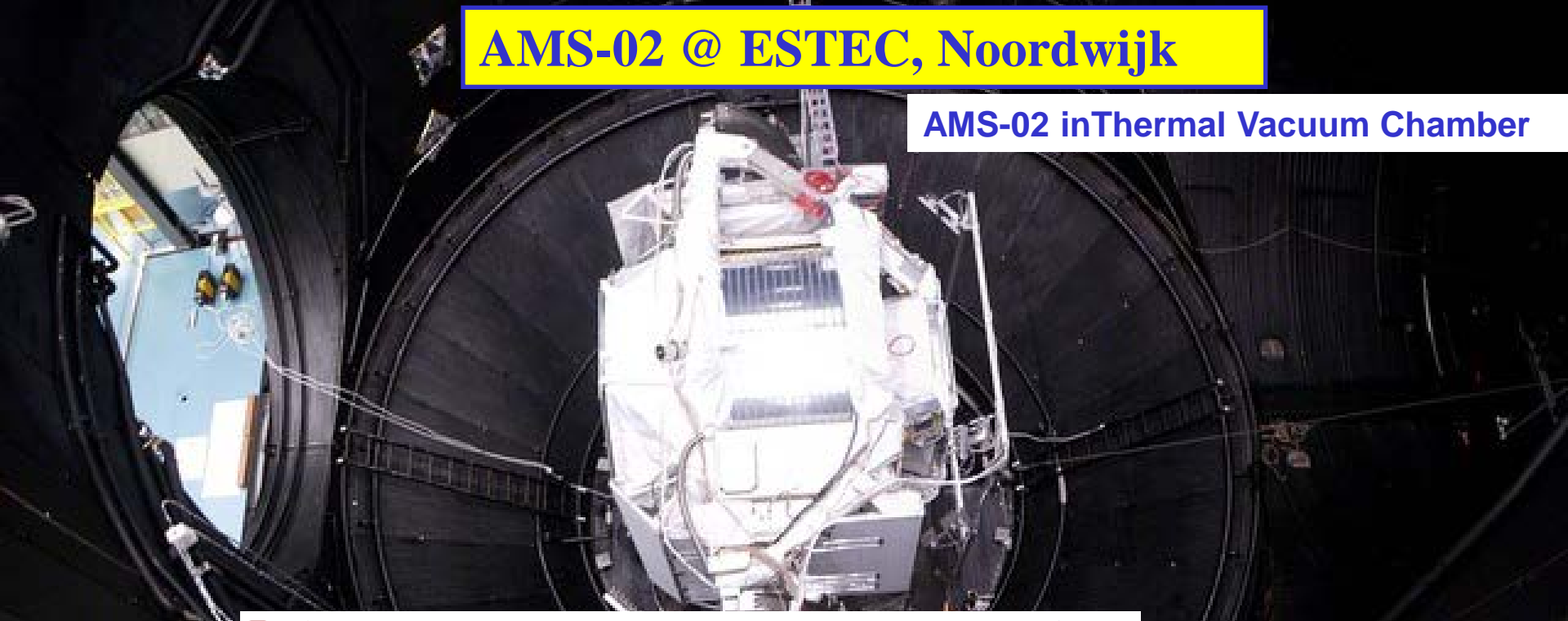
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AMS-02 @ ESTEC, Noordwijk

AMS-02 in Thermal Vacuum Chamber



No major issues

AMS-02 TRD

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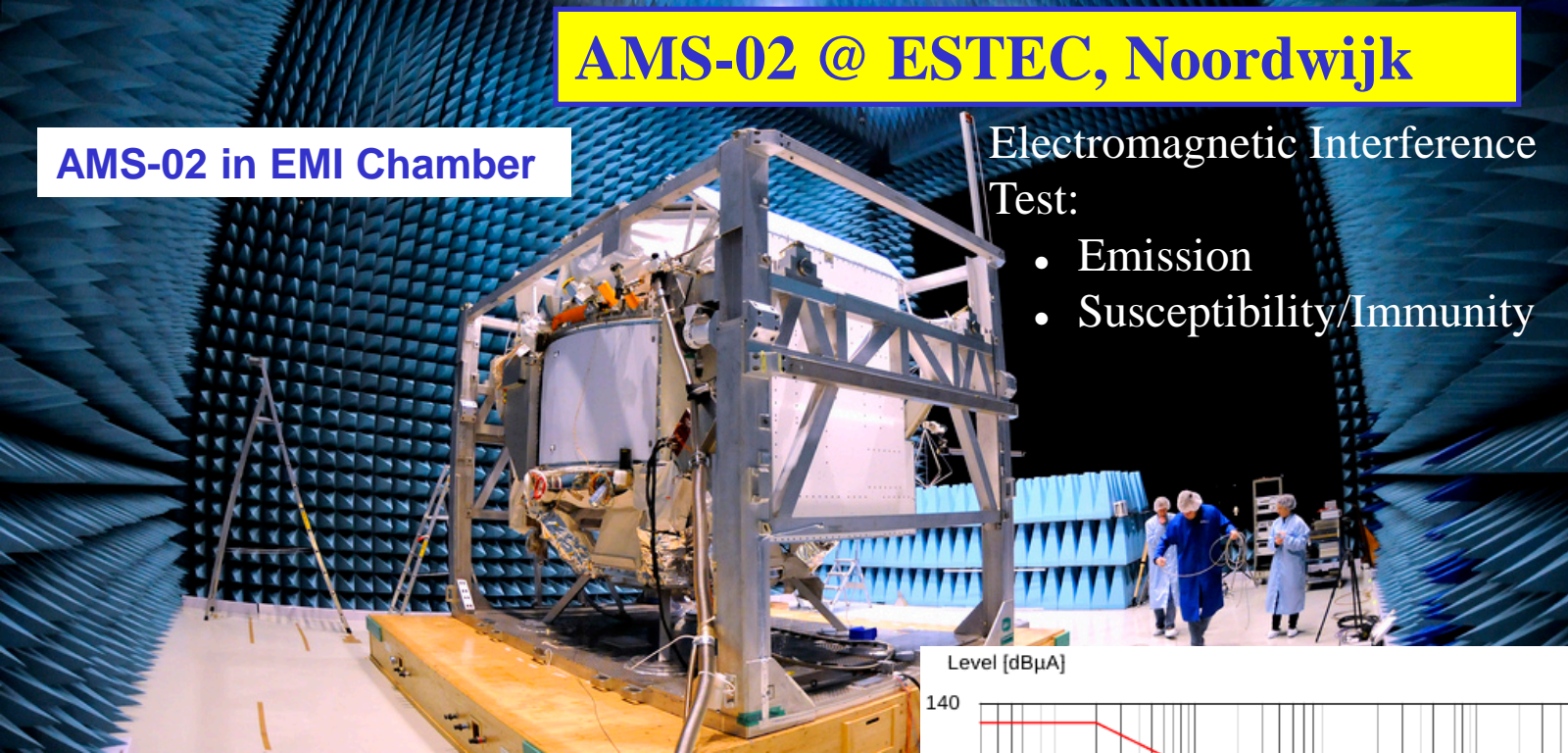


AMS-02 @ ESTEC, Noordwijk

AMS-02 in EMI Chamber

Electromagnetic Interference Test:

- Emission
- Susceptibility/Immunity

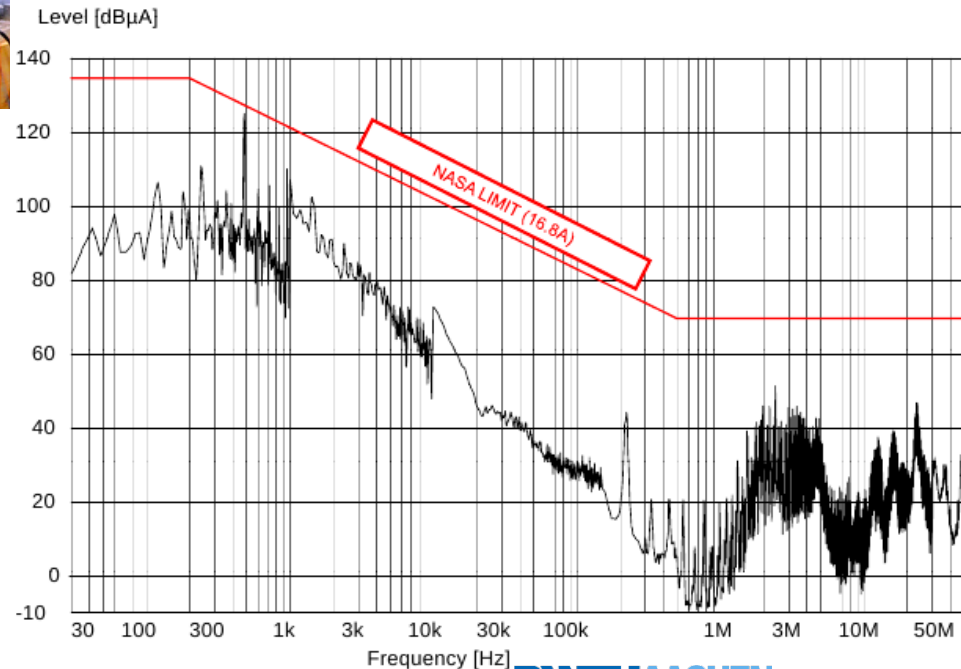


EMI emission profile:

- Range 30 Hz – 50 MHz
- Limit set by Nasa not exceeded

EMI susceptibility (not shown):

- Interference at 80 MHz (TDCs)
- No major issues



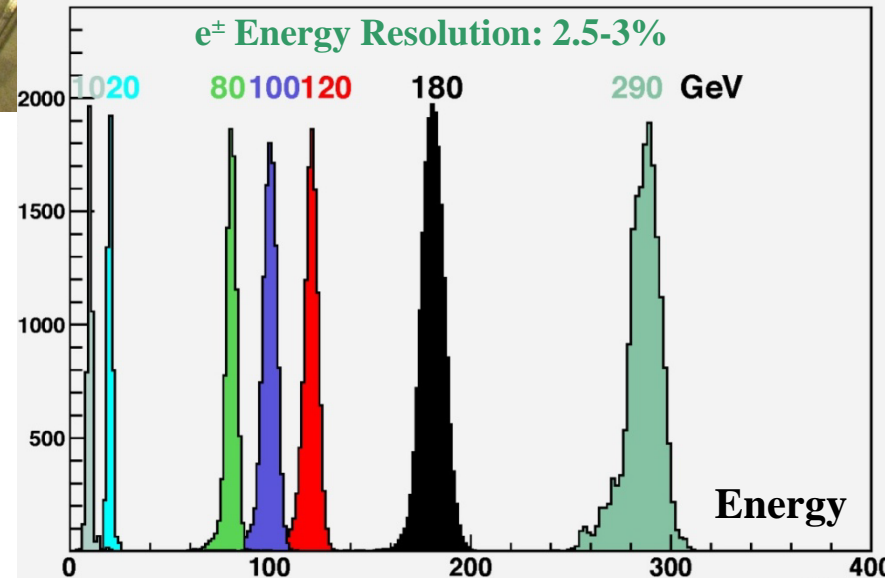
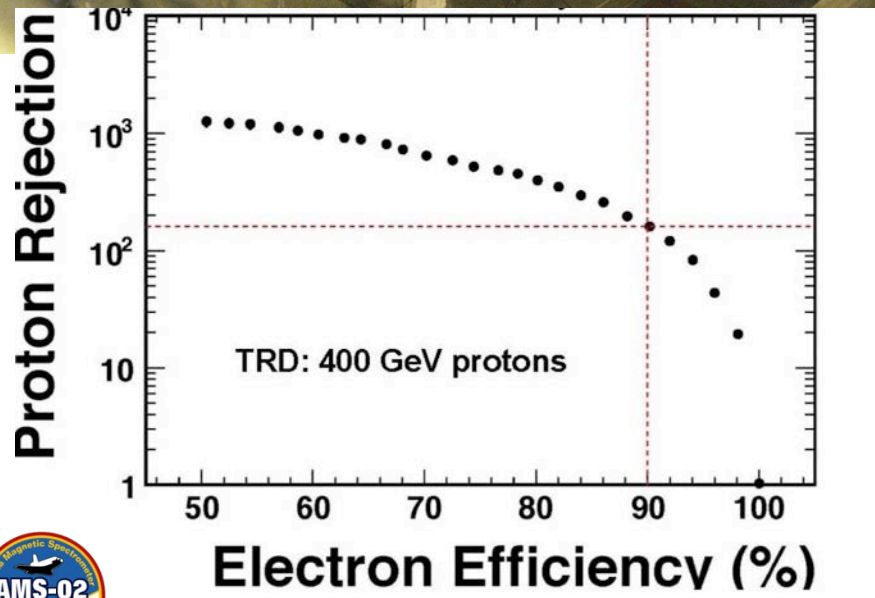
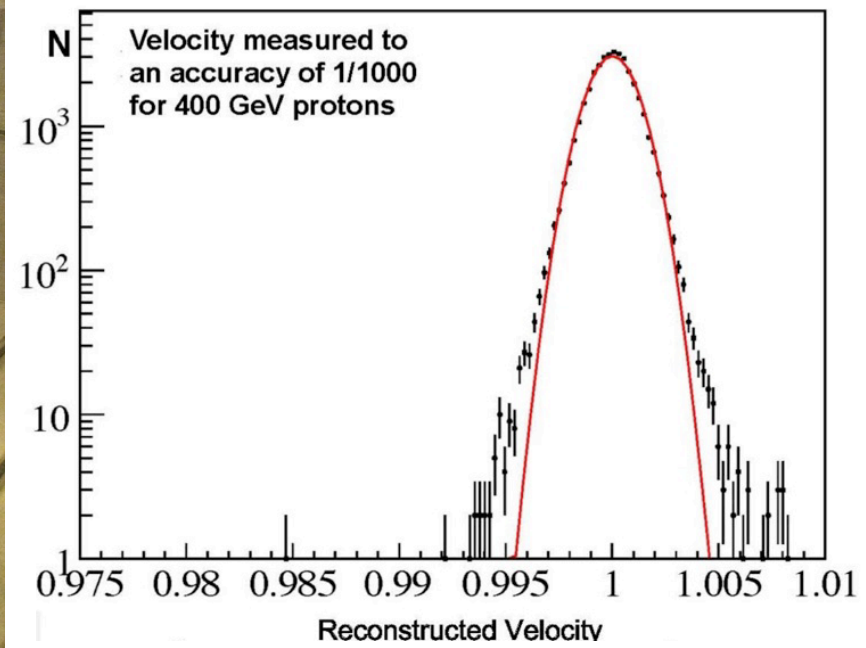
AMS-02 TRD



AMS-02 – Test Beam H8 CERN



8-20 Aug 2010



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AMS-02 TRD

AMS-02 Transport CERN to KSC



Arrival of US Air Force C5 Galaxy
at Geneva – 25 Aug 2010



© Michele Famiglietti / AMS Collaboration

February 2011

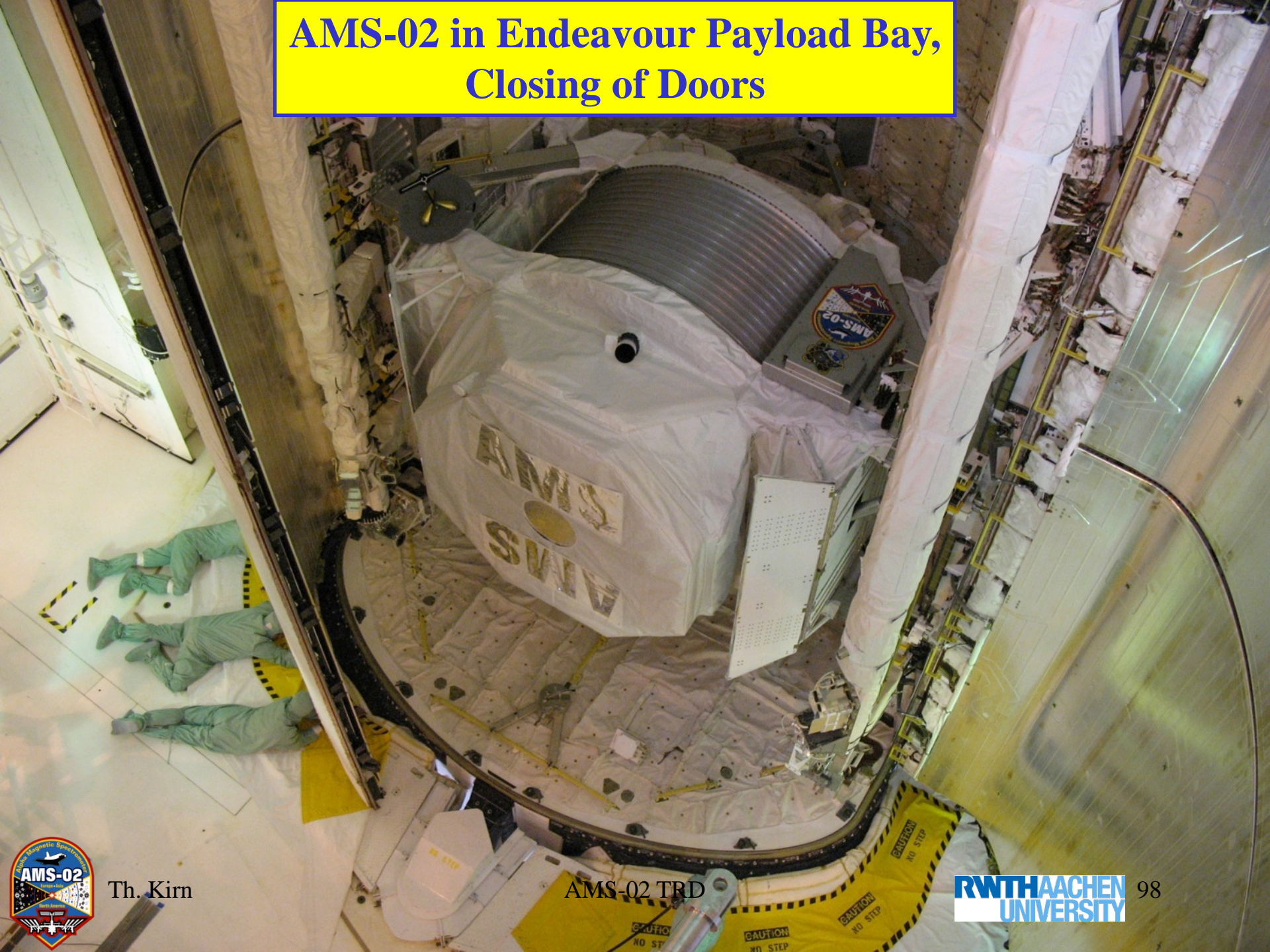


**AMS-02 in the Space Station
Processing Facility (SSPF), ready
for installation into the Space
Shuttle**

**Extended data taking periods to
verify detector performance**



AMS-02 in Endeavour Payload Bay, Closing of Doors



Th. Kirm

AMS-02 TRD



AMS-02 - STS 134 Launch 16th of May



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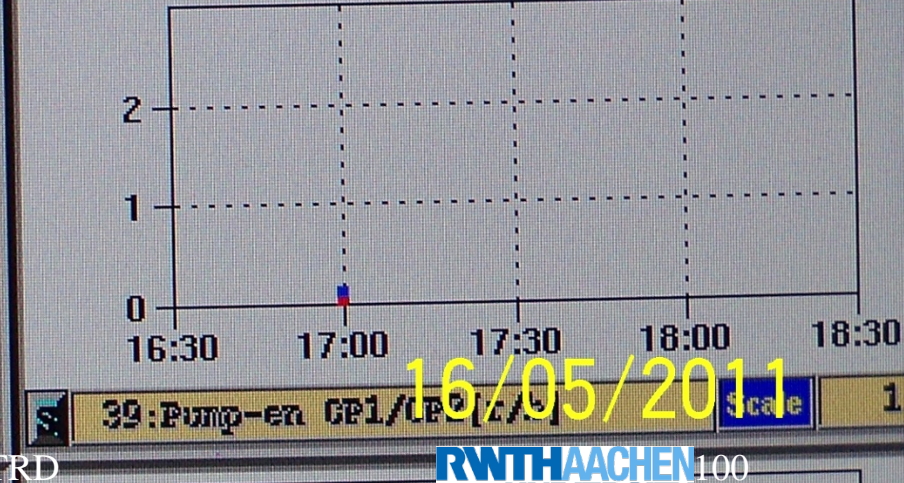
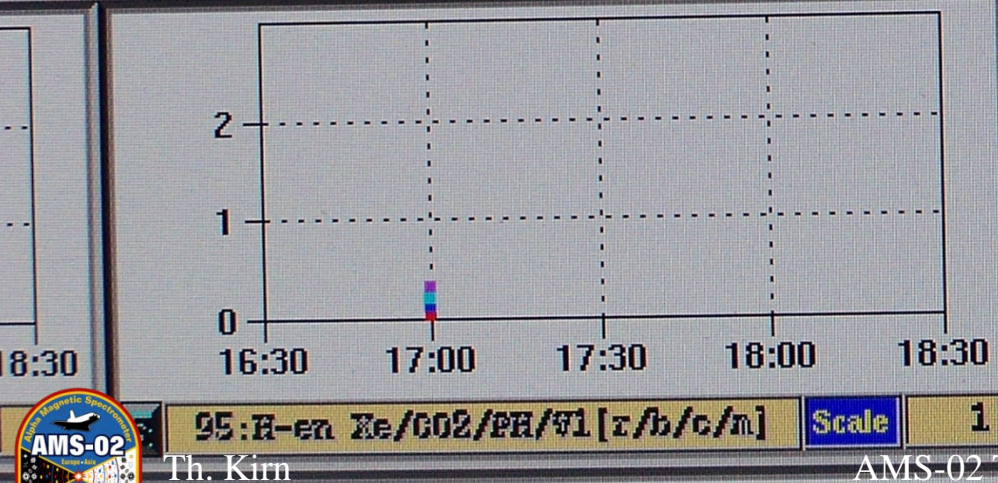
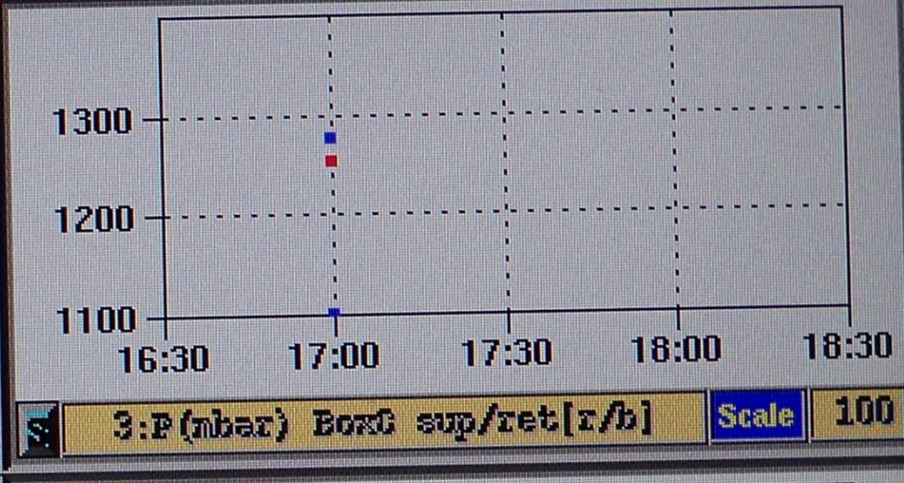
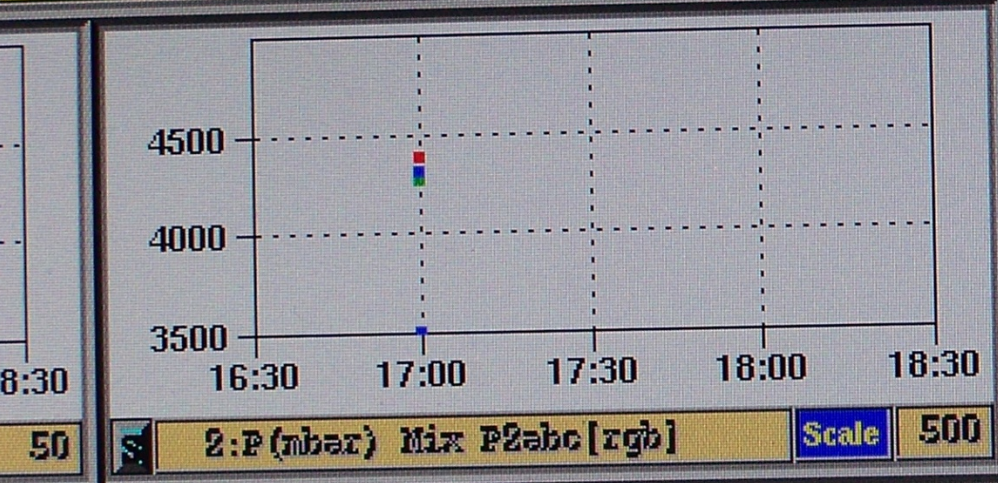
AMS-02 TRD

AMS-02 - TRD: First Slow Control Data

FS, TS 11-May-2011

TRD-Gas Monitor

0001063 No UG block File 0081 200 READ CLEAR
Time 20110516 16:59:06 READ PRINT
Time Scale 30 min/div



16/05/2011



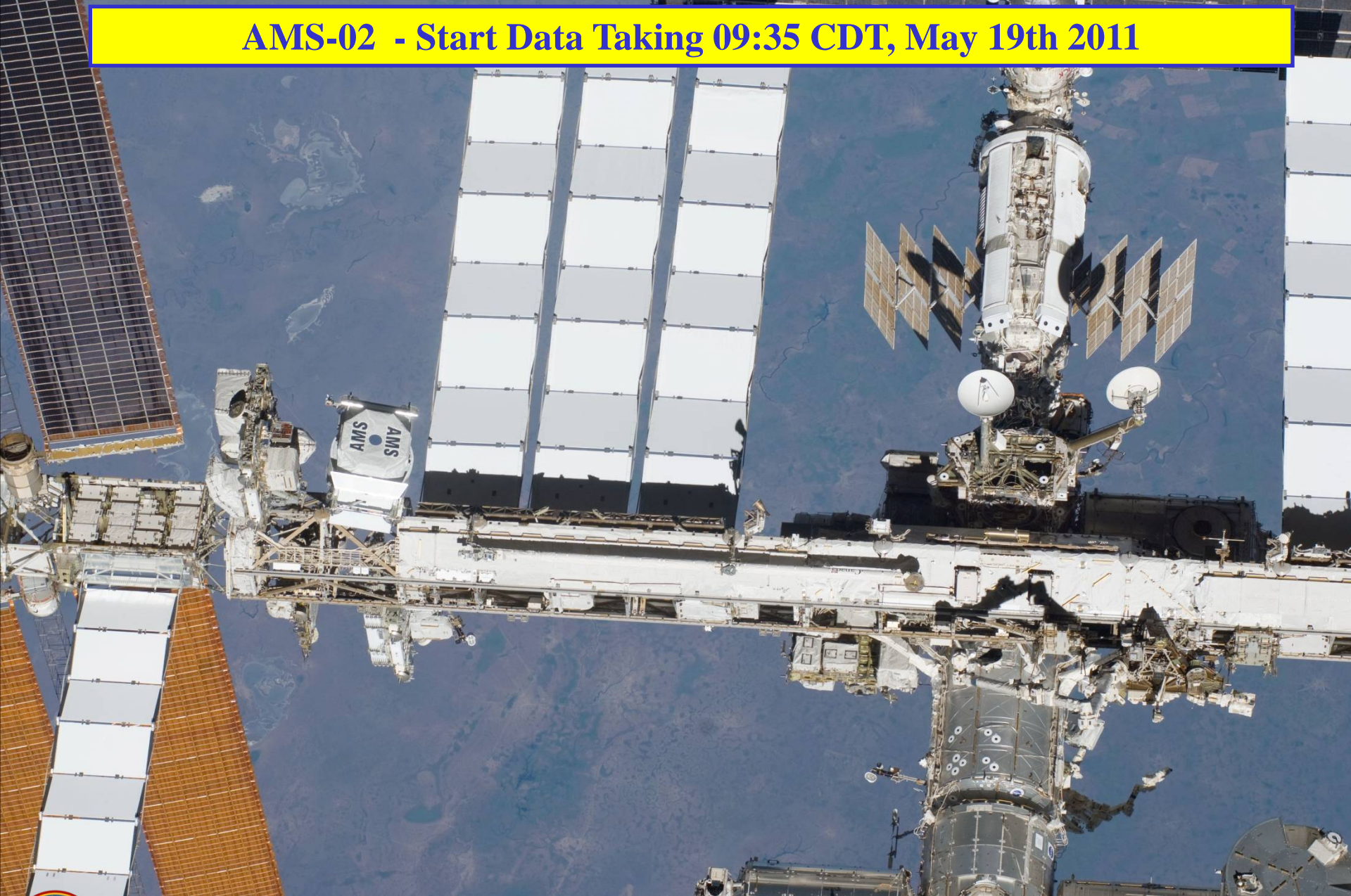
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AMS-02 TRD



100

AMS-02 - Start Data Taking 09:35 CDT, May 19th 2011



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AMS-02 TRD

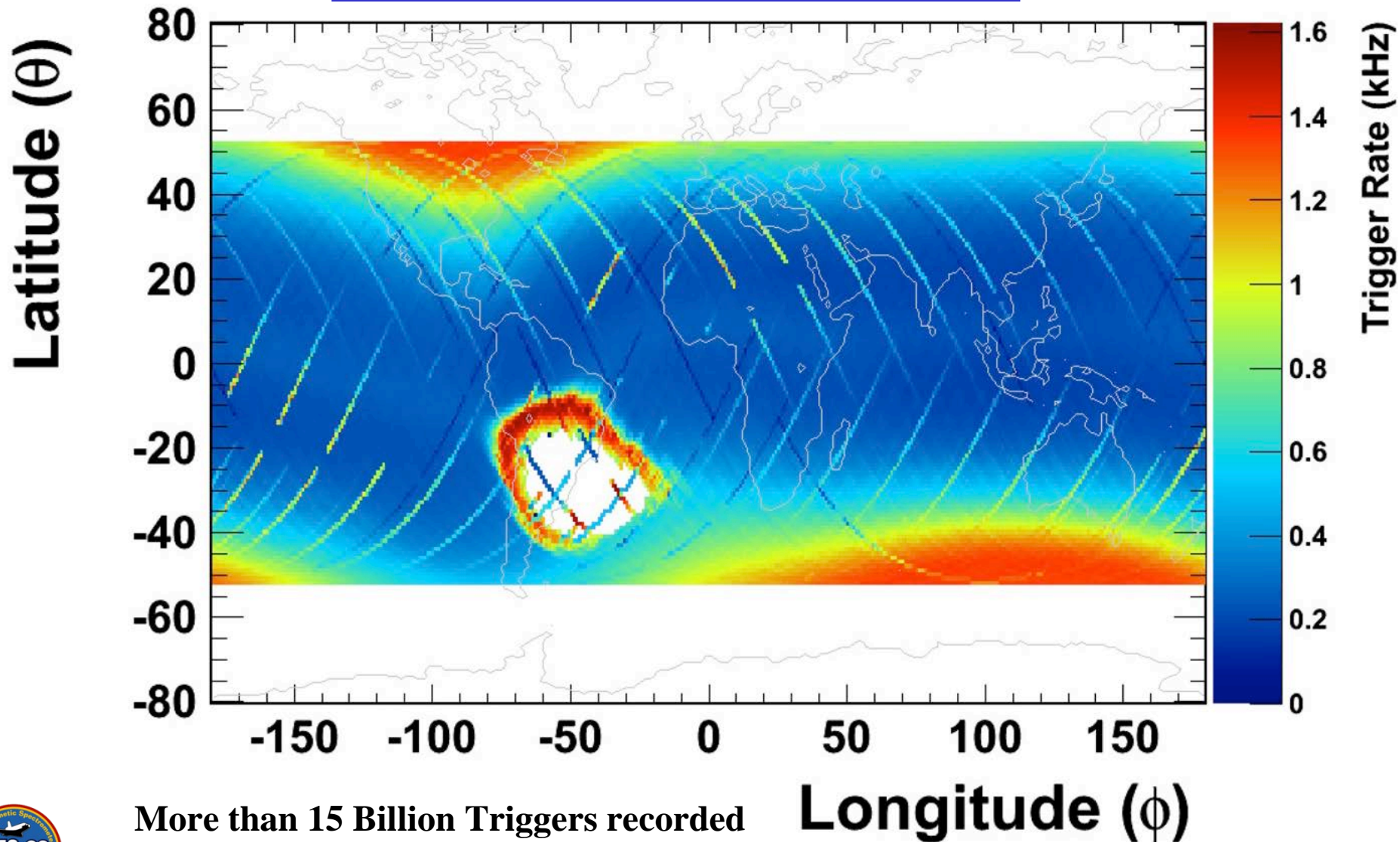


Th. Kirn

AMS-02/TRD

RWTHAACHEN
UNIVERSITY 102

AMS-02 - Trigger Rate



More than 15 Billion Triggers recorded

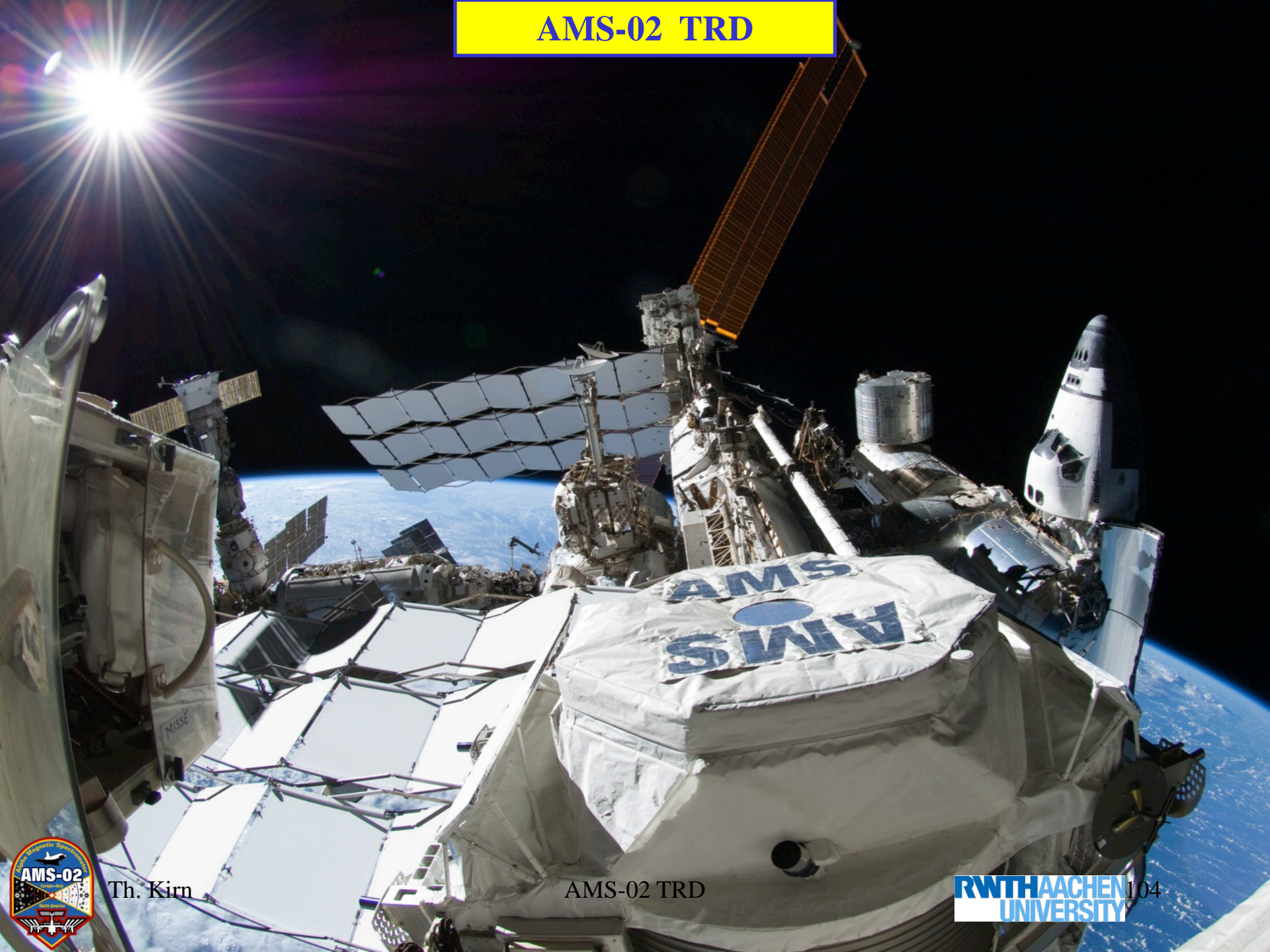
Longitude (ϕ)

Th. Kim

AMS-02 TRD



AMS-02 TRD

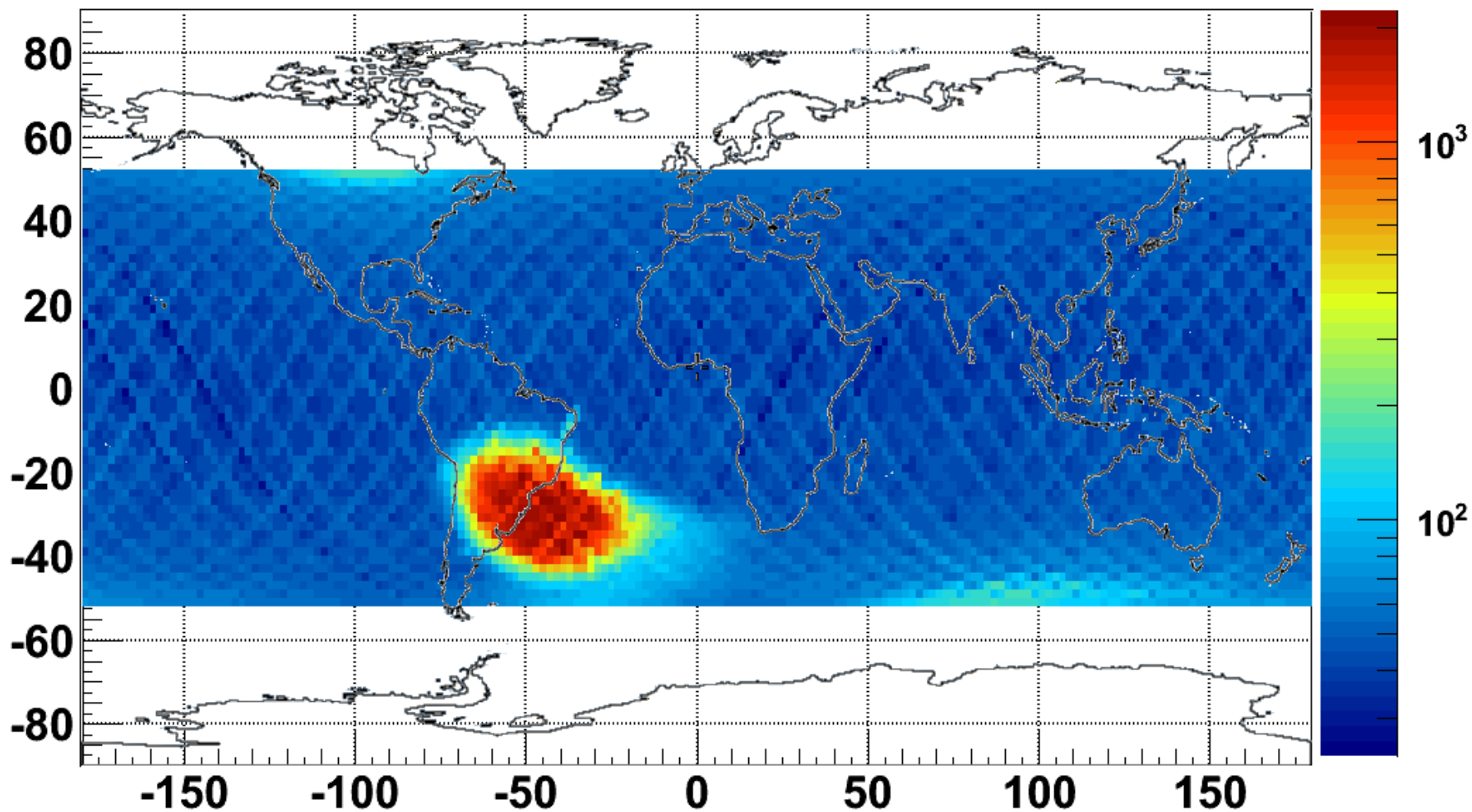


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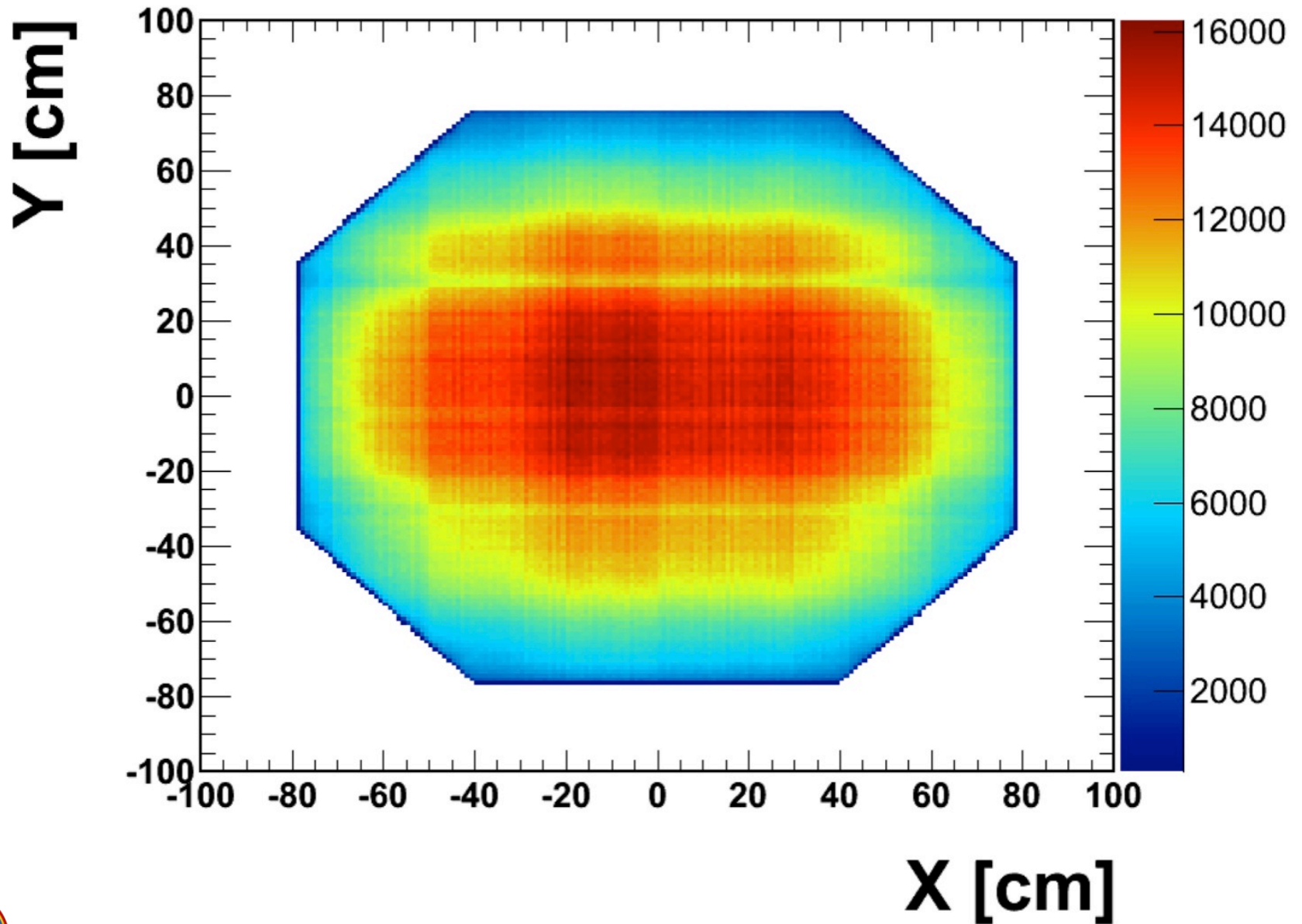
AMS-02 TRD

AMS-02 TRD

TRD Hits per event



AMS-02 TRD - Occupancy

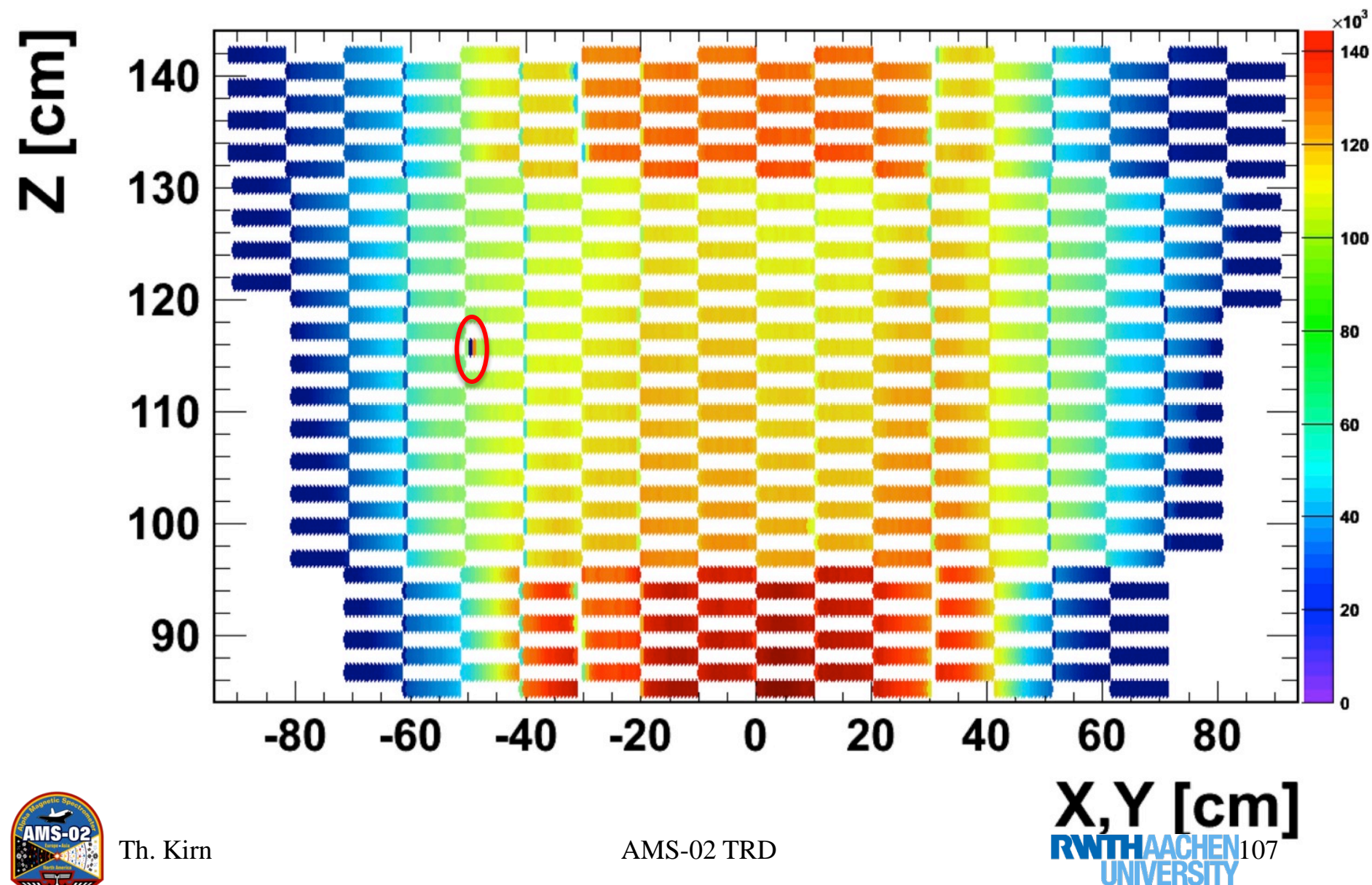


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AMS-02 TRD

AMS-02 TRD - Occupancy

AMS TRD Occupancy
5246/5248 Channels within specification.



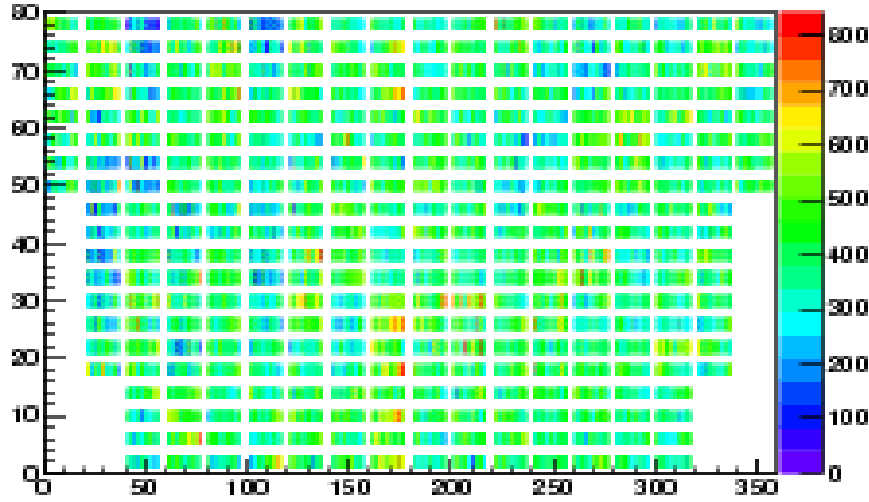
Th. Kim

AMS-02 TRD

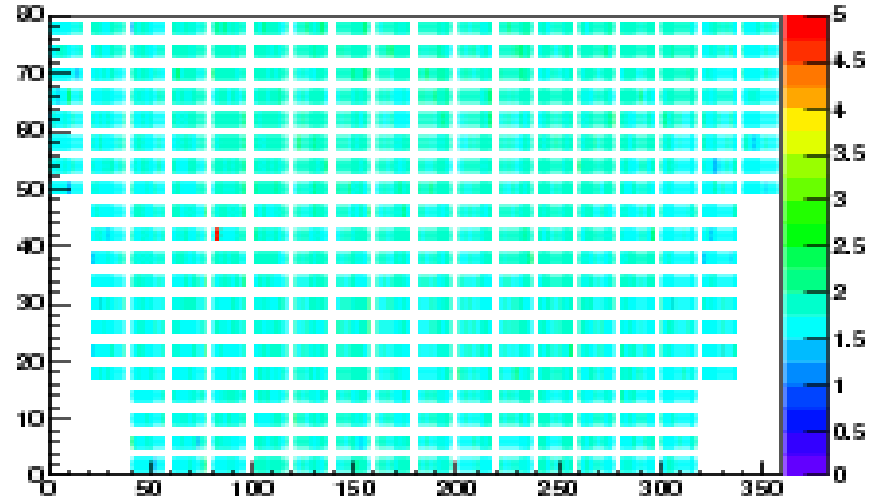


AMS-02 TRD – Amplitude/Noise

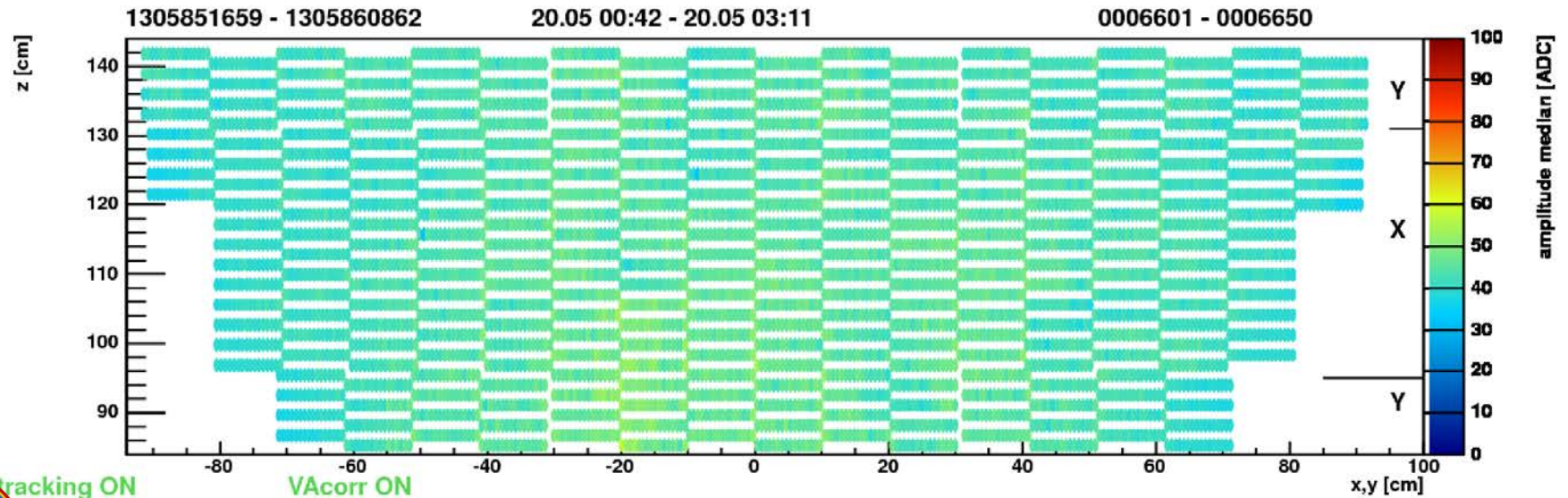
Pedestal



Noise



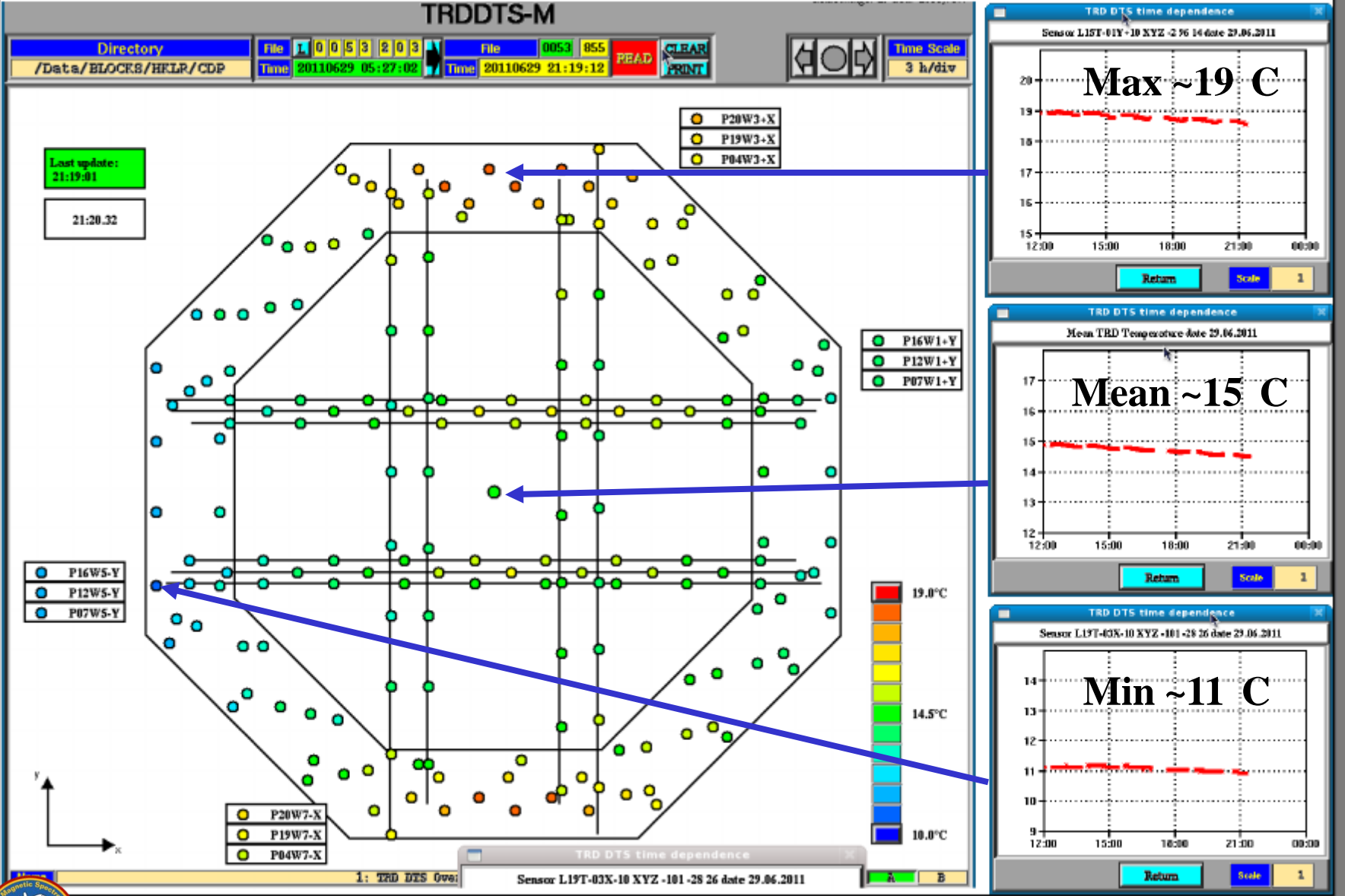
Amplitude on track



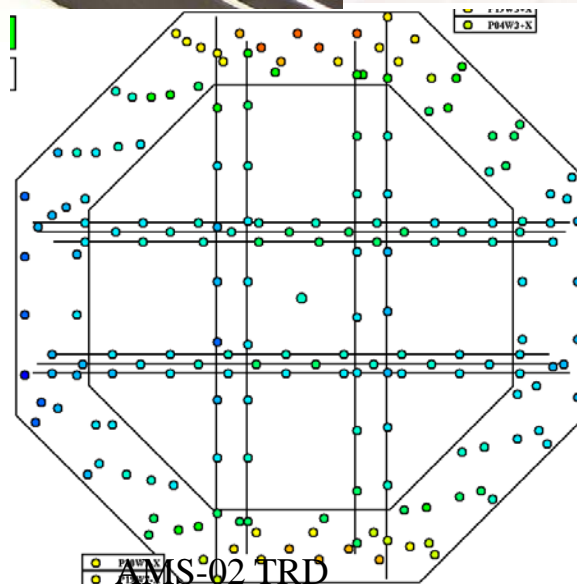
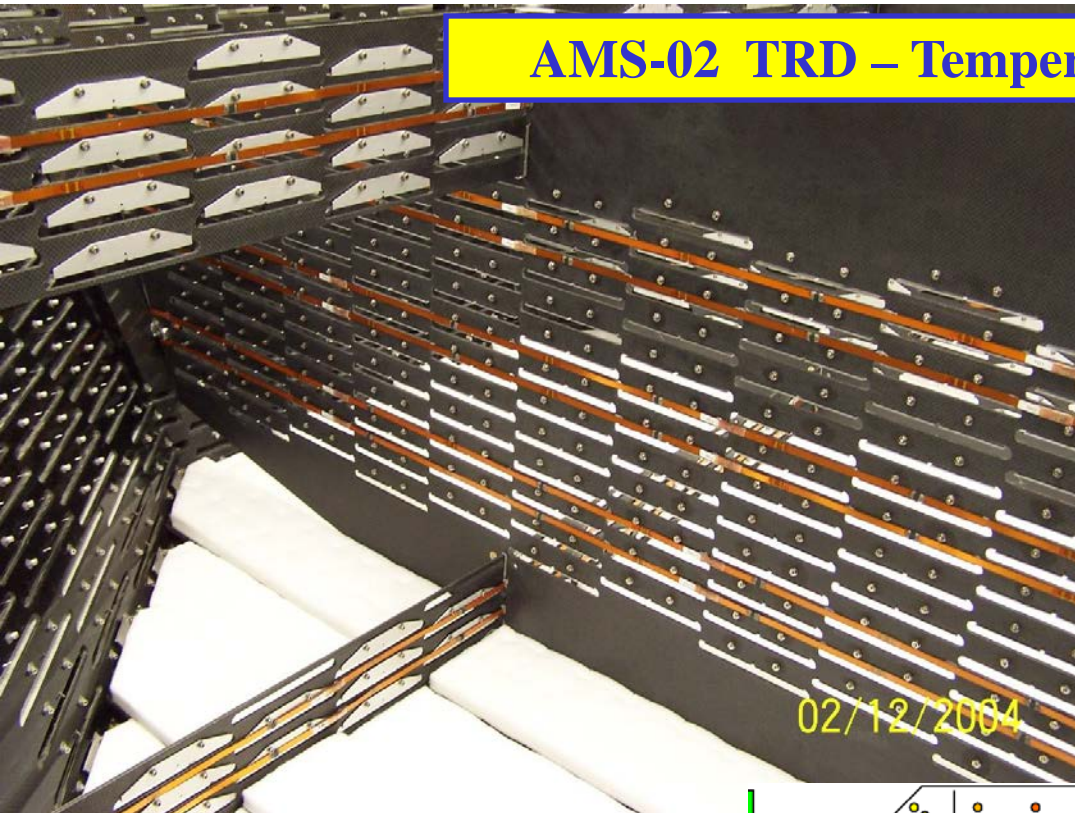
Th. Kim

AMS-02 TRD

AMS-02 TRD – Temperature Monitoring

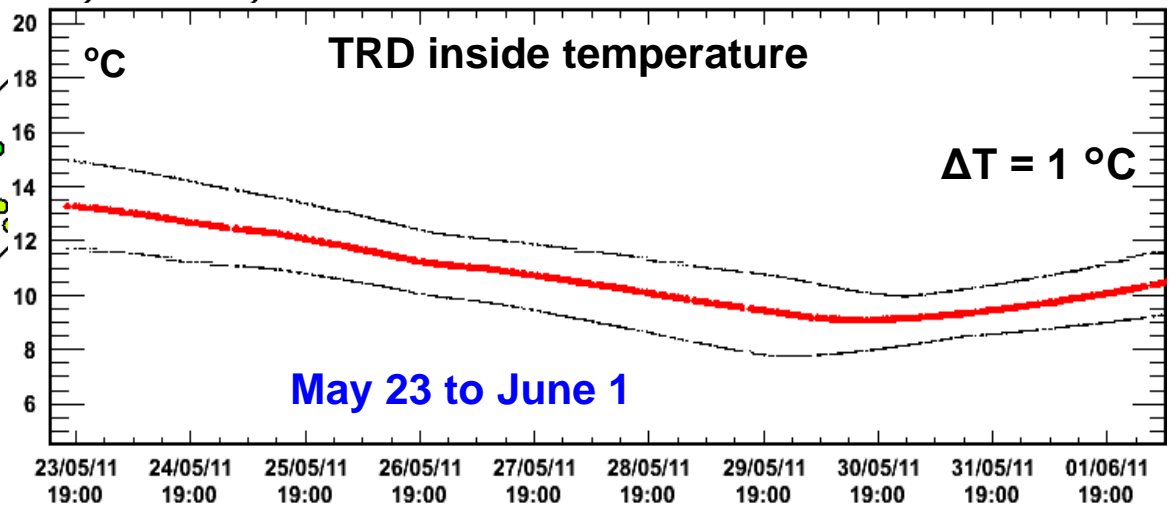
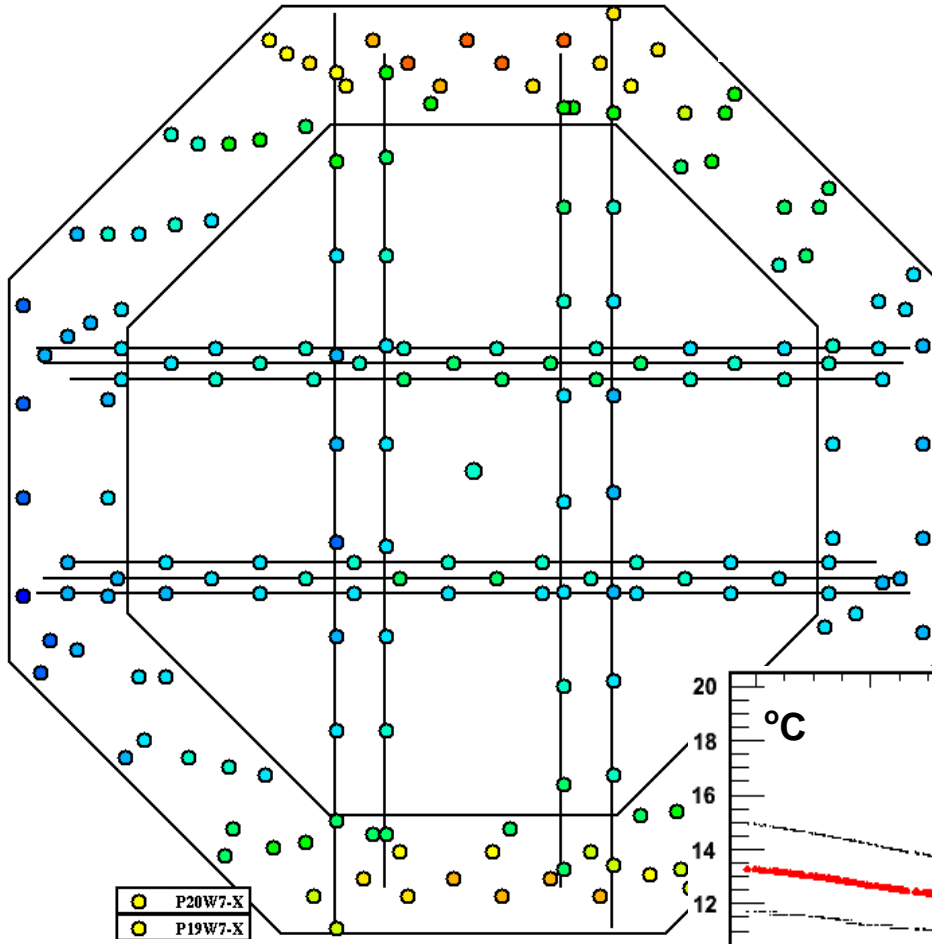


AMS-02 TRD – Temperature Monitoring



Th. Kim

AMS-02 TRD – Temperature Monitoring



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AMS-02 TRD

AMS-02 TRD – Pressure Monitor

Total leak rate of 4.2 mbar/day:

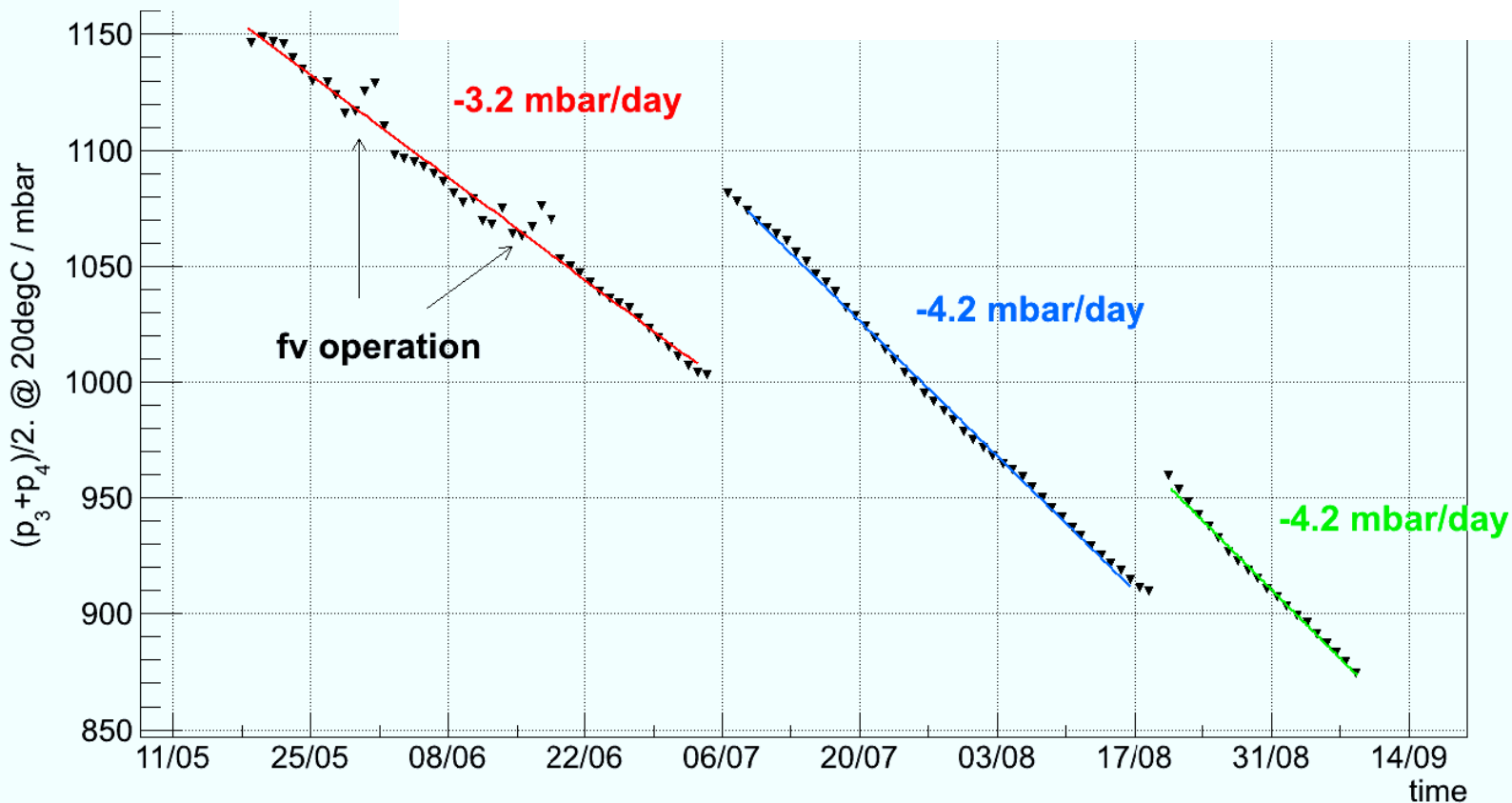
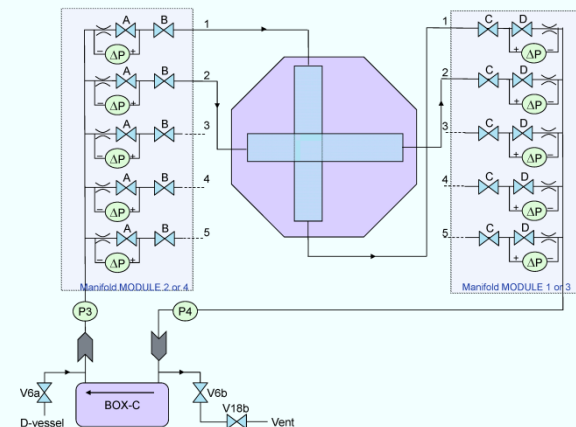
→ CO₂: $(1.5 + 0.125 \cdot 2.7)$ mbar/d = 1.84 mbar/day

Volume* leak rate = 230 l · 1.84 mbar/day = 422.6 l mbar / day

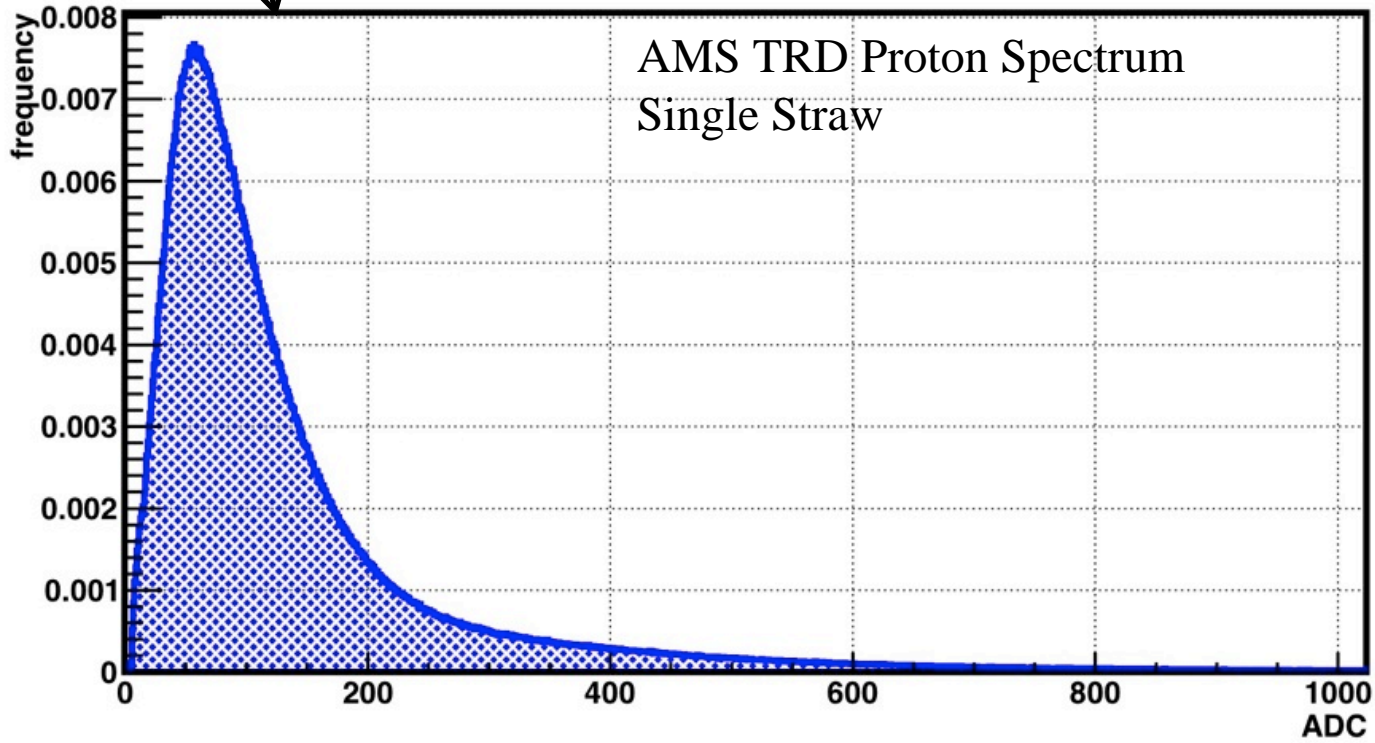
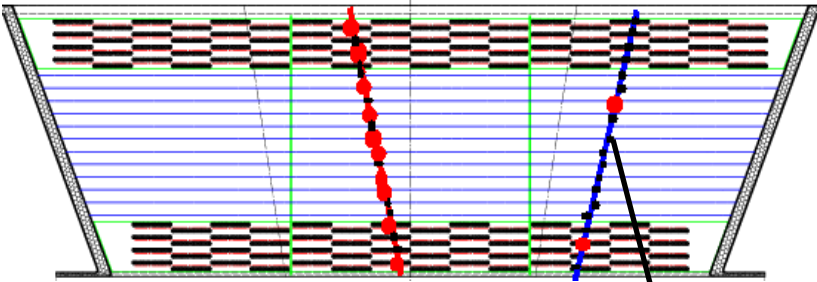
→ 0.764 g /day = 8.85 μg / s (before launch 6 μg / s)

Total storage: 5kg

→ CO₂ lasts for 17.9 years > ISS Lifetime



AMS-02 TRD Raw Data, before 1st Calibration

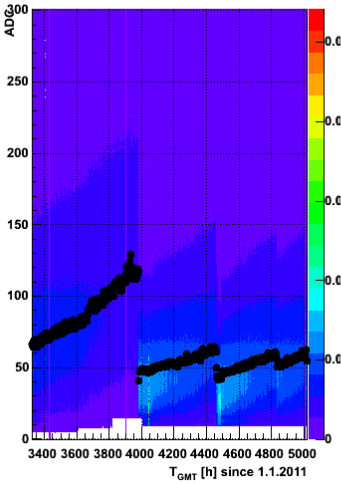


Th. Kim

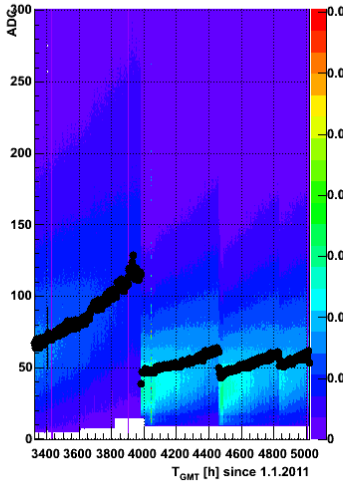
AMS-02 TRD

AMS-02 TRD Raw Data, before 1st Calibration

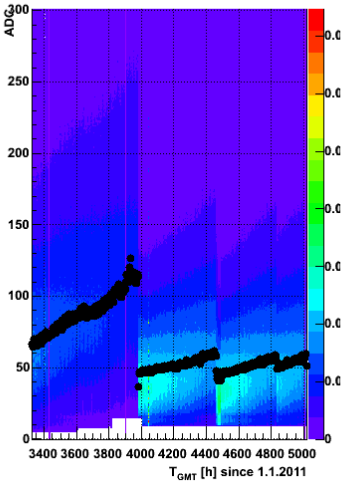
Wall 3, Manifold 1 MPV vs Time



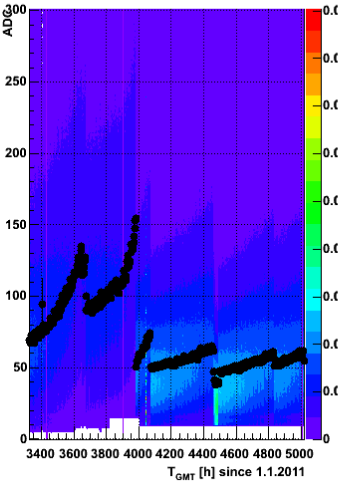
Wall 3, Manifold 2 MPV vs Time



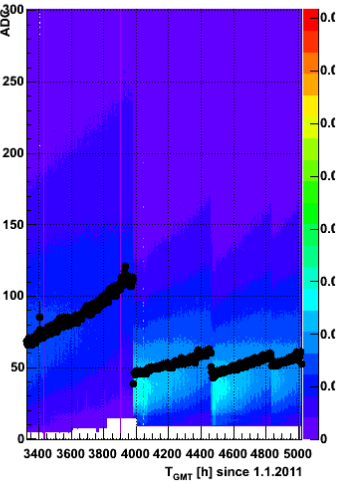
Wall 3, Manifold 3 MPV vs Time



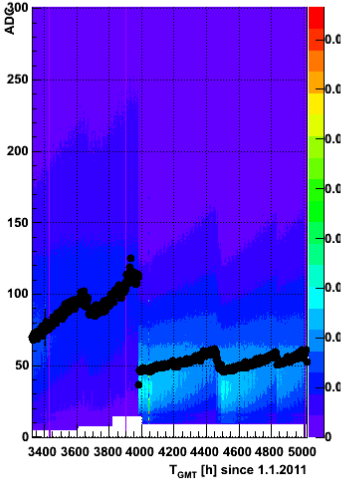
Wall 3, Manifold 4 MPV vs Time



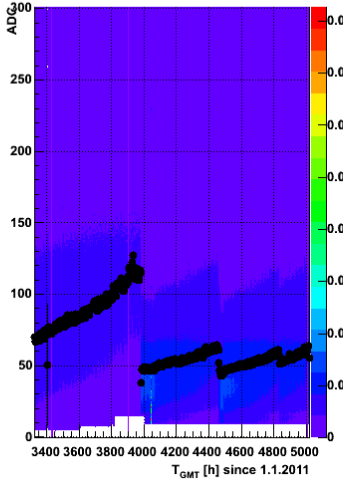
Wall 3, Manifold 5 MPV vs Time



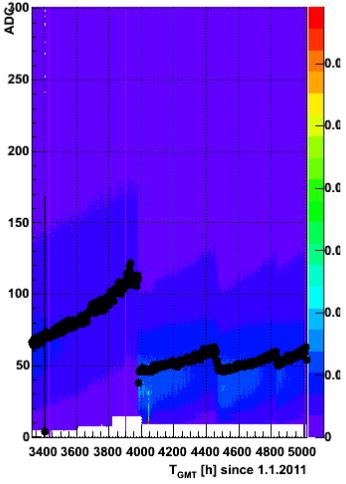
Wall 7, Manifold 1 MPV vs Time



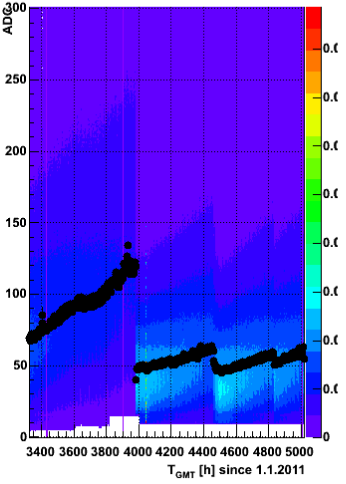
Wall 7, Manifold 2 MPV vs Time



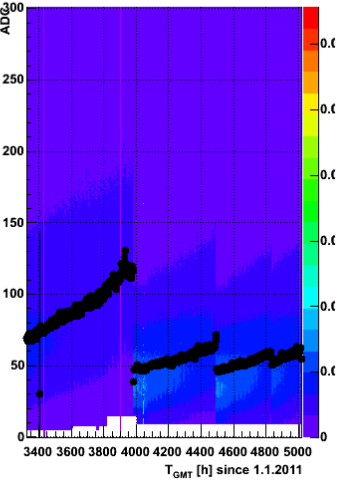
Wall 7, Manifold 3 MPV vs Time



Wall 7, Manifold 4 MPV vs Time



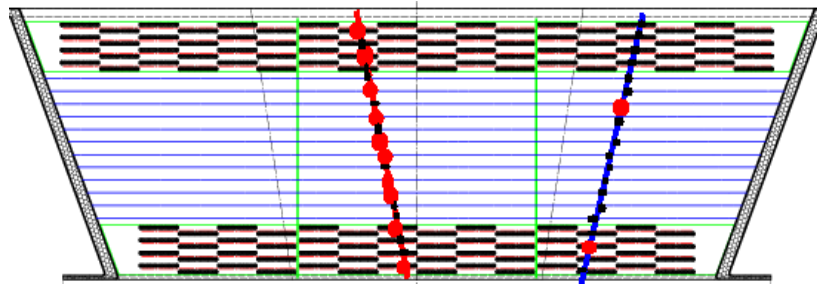
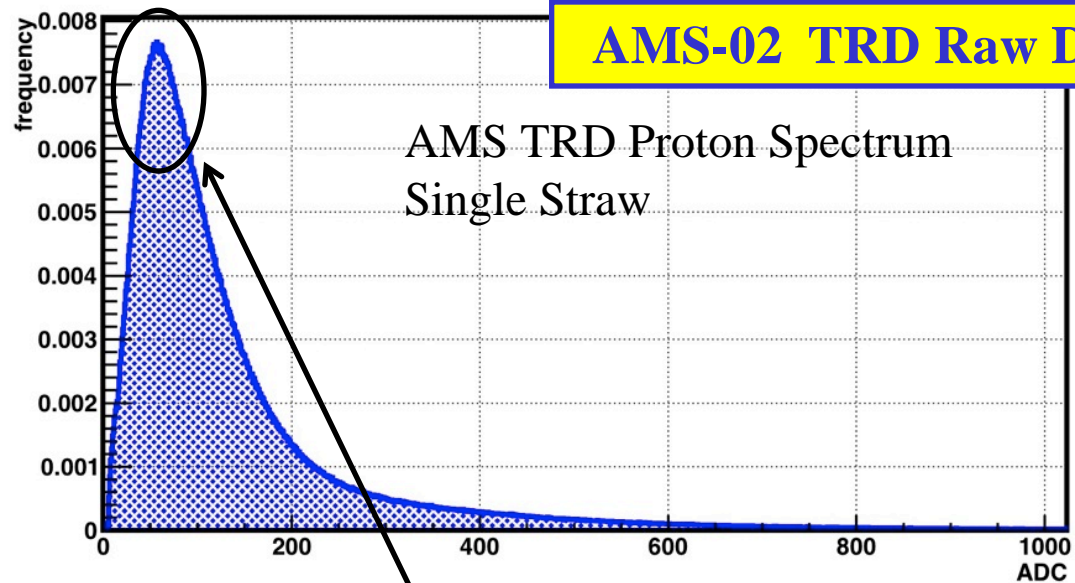
Wall 7, Manifold 5 MPV vs Time



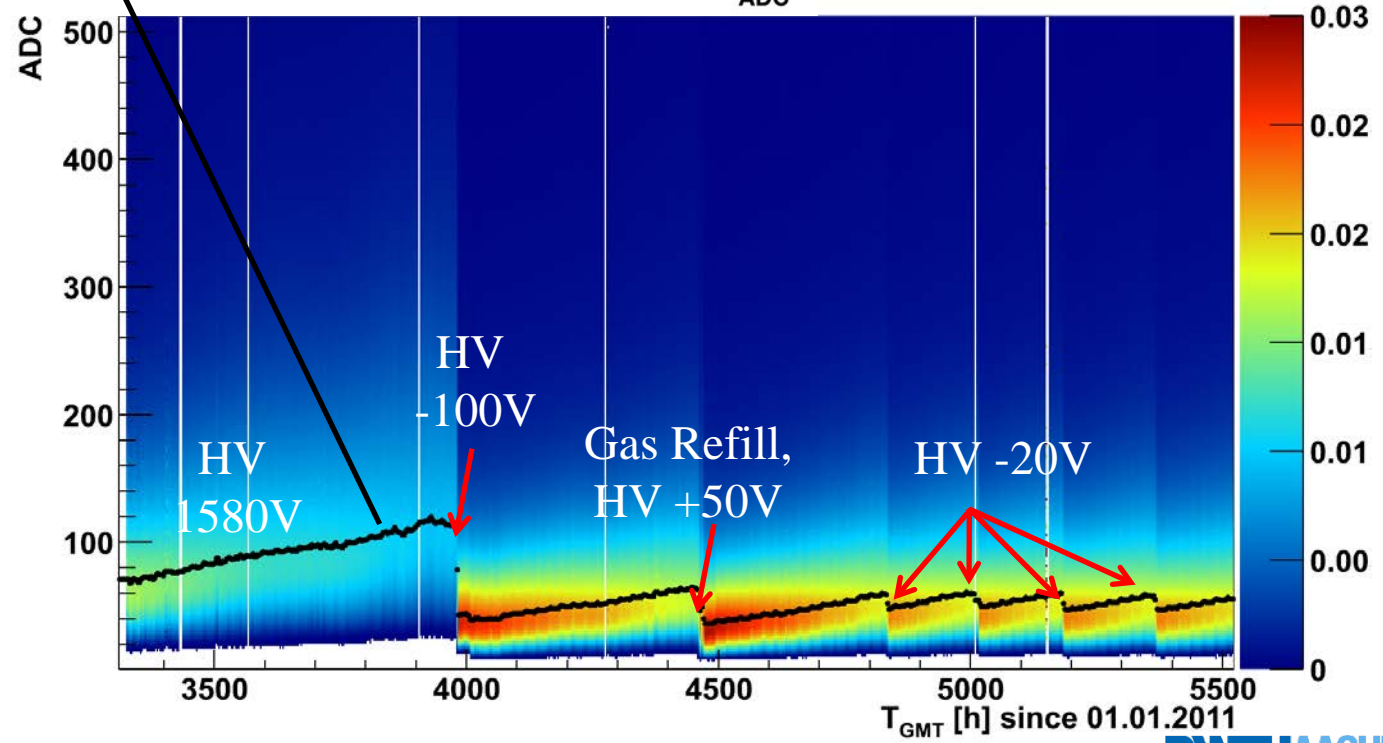
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AMS-02 TRD

AMS-02 TRD Raw Data, before 1st Calibration



Entries 6.145729e+08

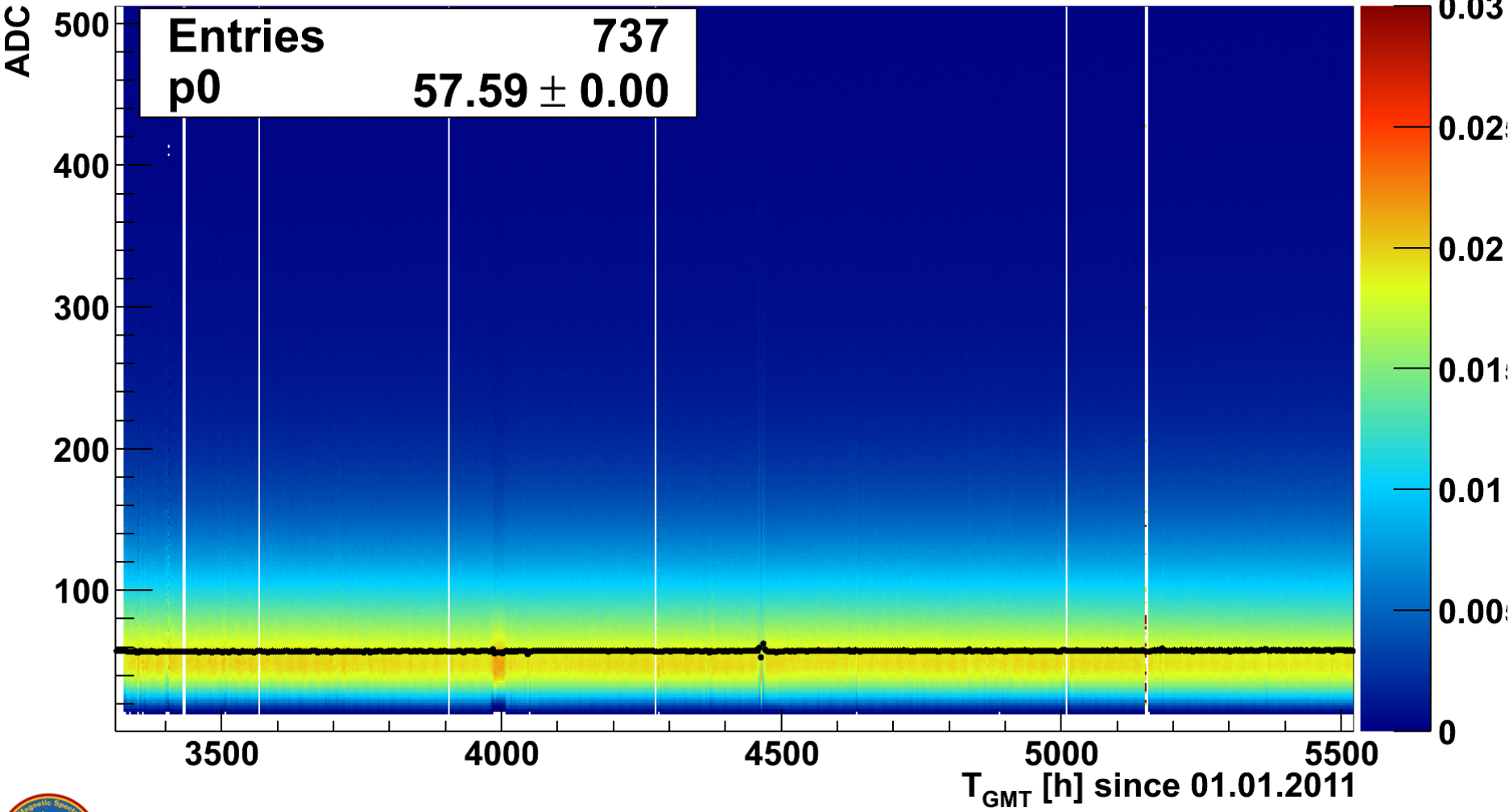


AMS-02 TRD



AMS-02 TRD after 1st Calibration

Entries 6.145729e+08

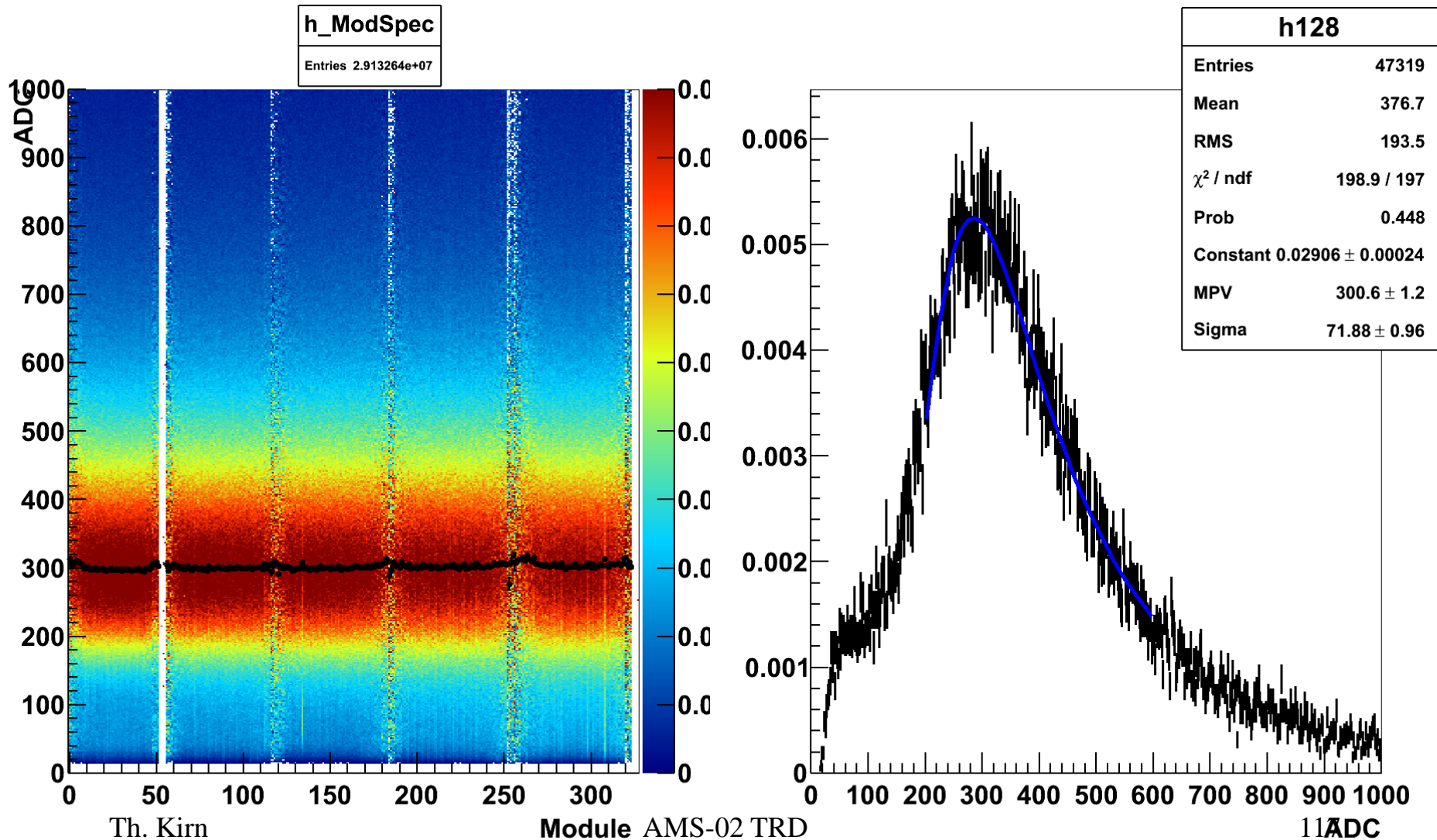


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AMS-02 TRD

AMS-02 TRD after 1st Calibration, He-Sample

Helium ($Z=+2$, $10.0 \text{ GeV}/c < P < 20 \text{ GeV}/c$) Day 138 - 220

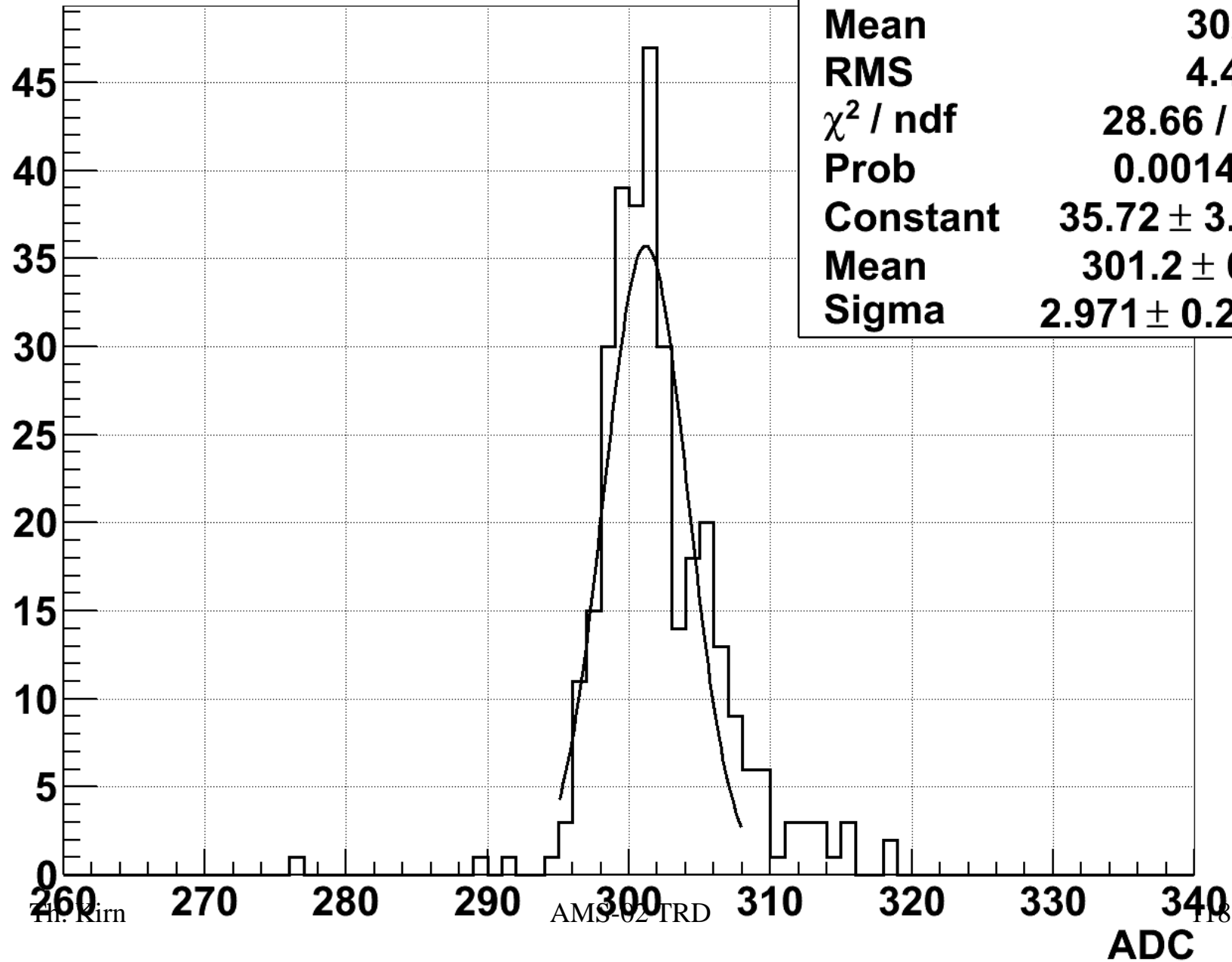


TRD Calibration Helium

hCalib

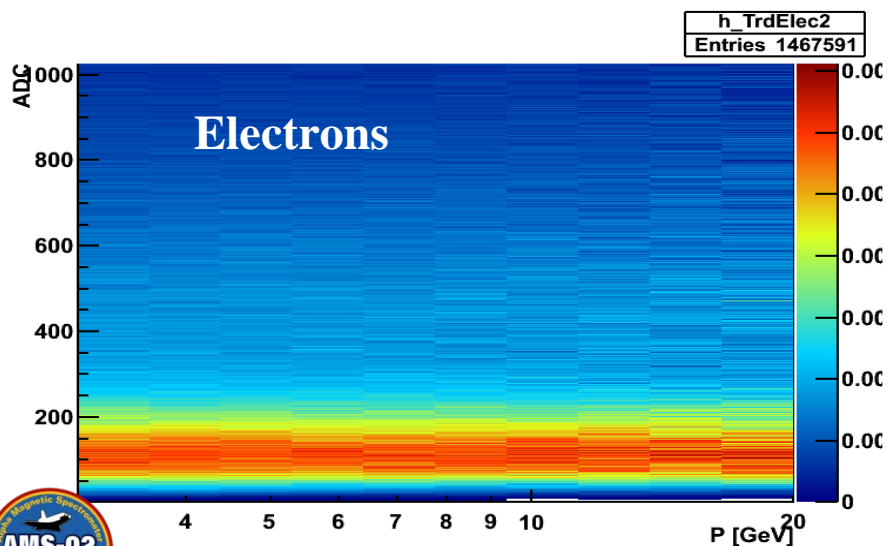
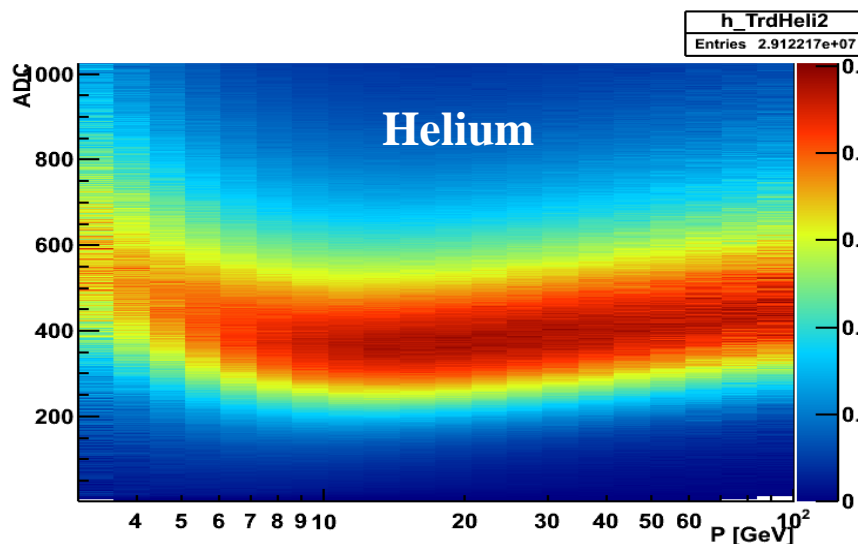
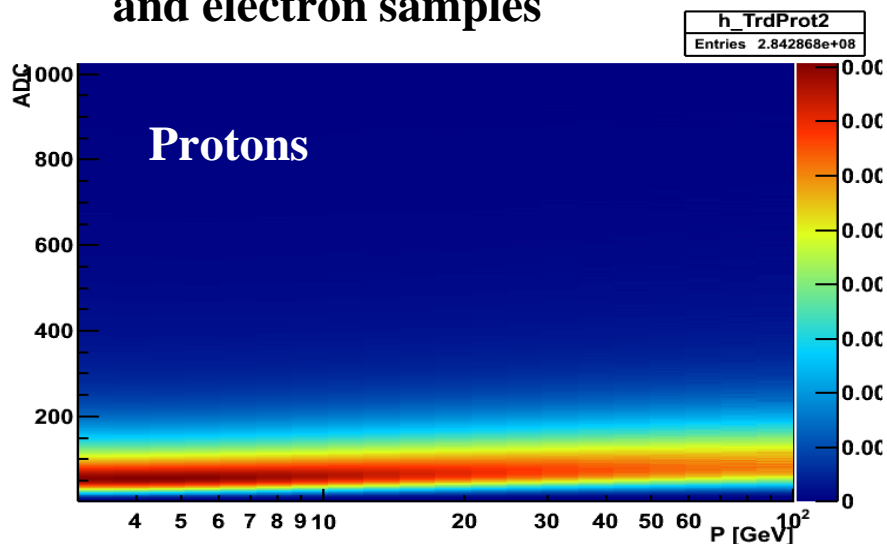
N/ADC

Entries	319
Mean	302.1
RMS	4.451
χ^2 / ndf	28.66 / 10
Prob	0.001413
Constant	35.72 ± 3.36
Mean	301.2 ± 0.3
Sigma	2.971 ± 0.248

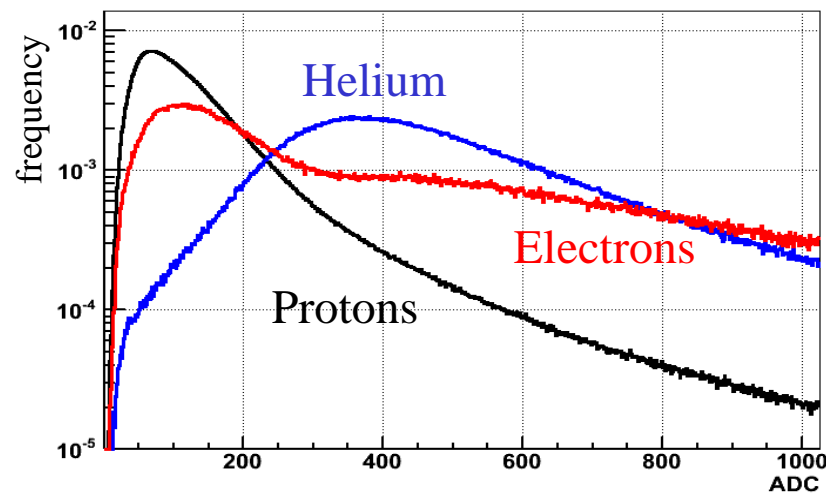


AMS-02 TRD Response to Protons, Helium, Electrons

- Use ToF, Tracker and ECAL to define clean single track proton, helium and electron samples



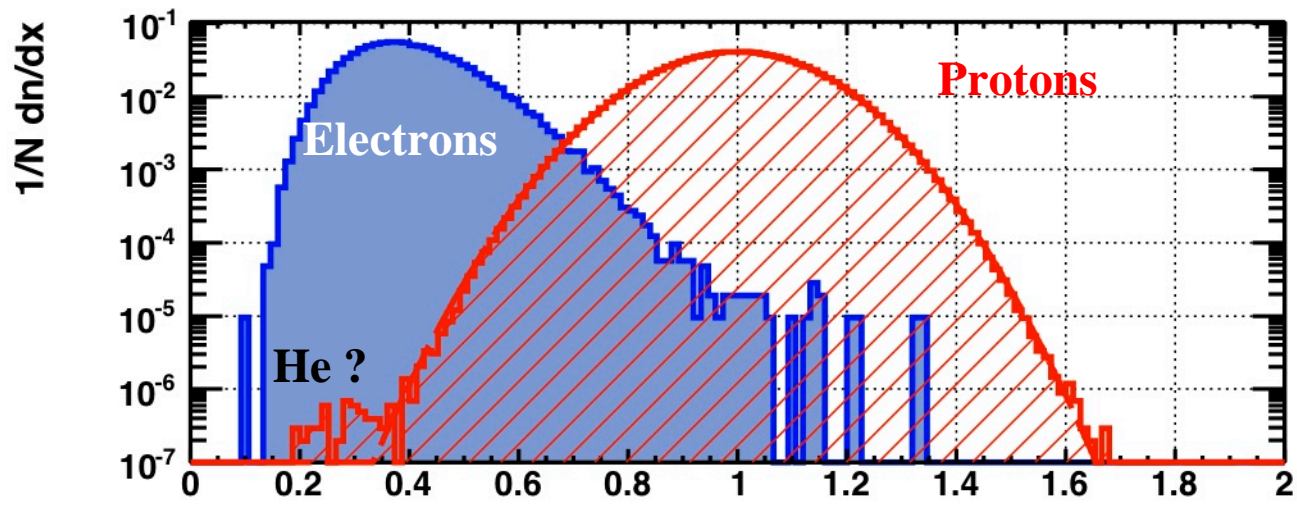
Single Straw Spectrum



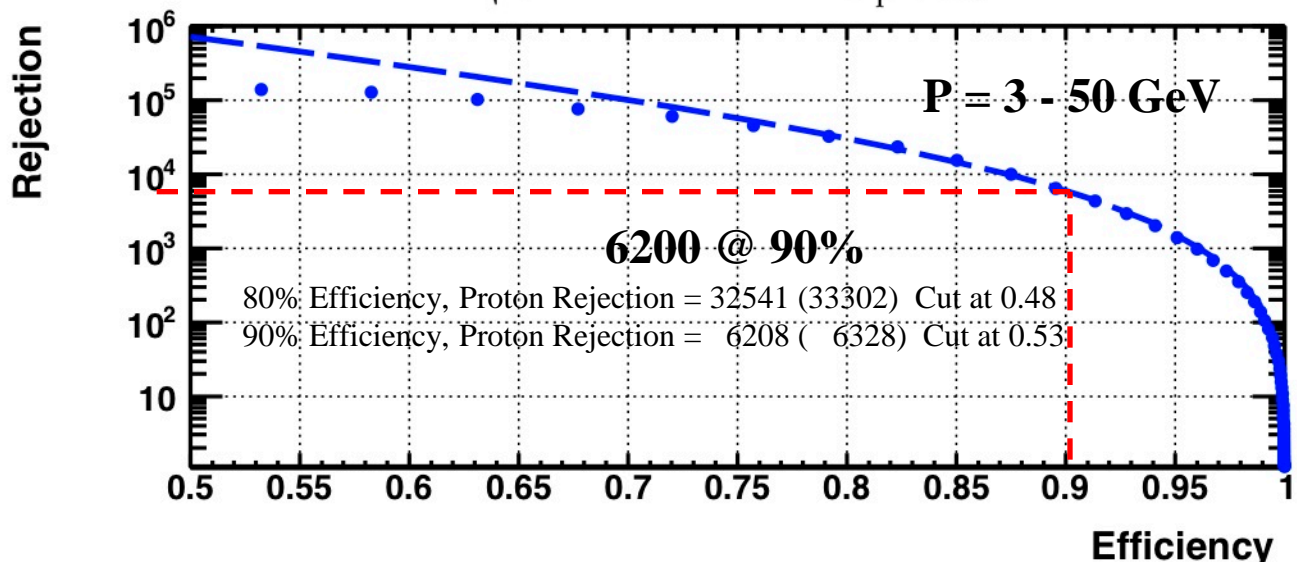
AMS-02 TRD



AMS-02 TRD Proton Rejection



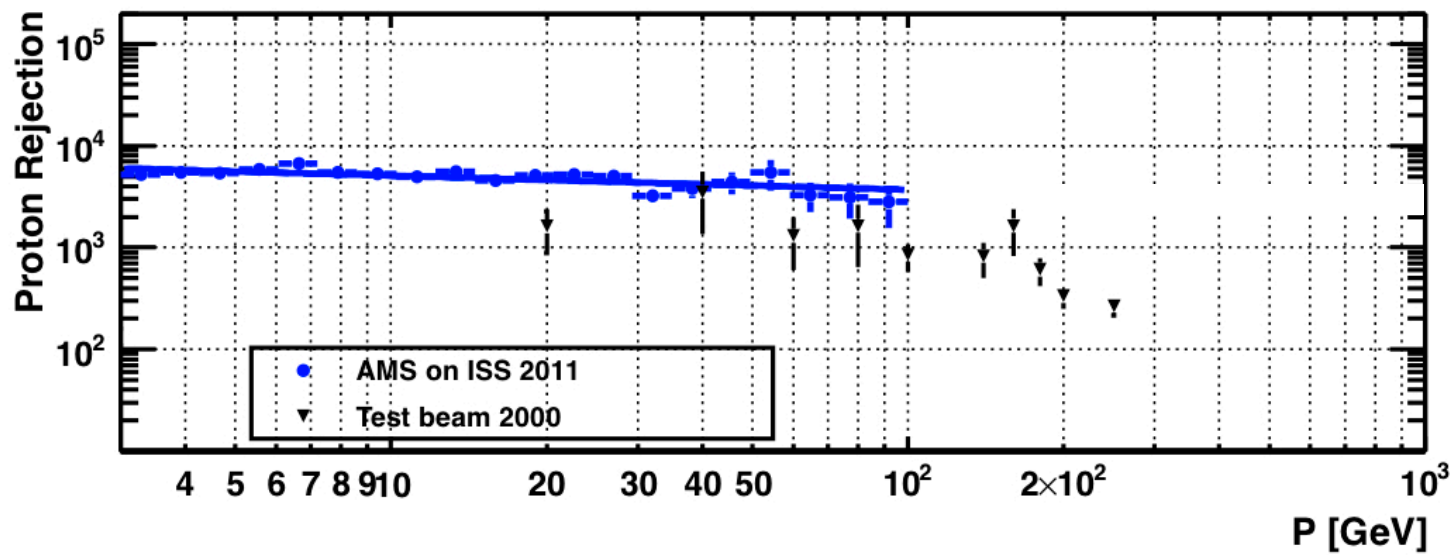
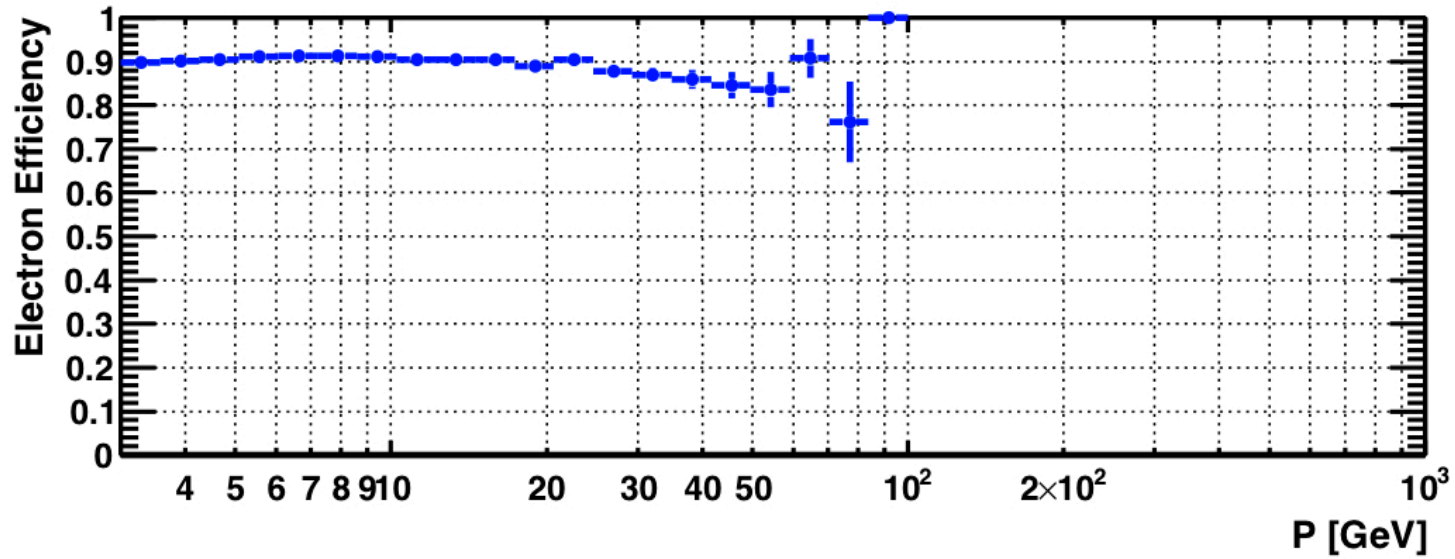
$$\bar{P}_{e/p} = \sqrt[n]{\prod_i P_{e/p}^{(i)}(E)} \quad L = \frac{\bar{P}_e}{\bar{P}_p + \bar{P}_e} \quad -\ln(L)$$



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AMS-02 TRD

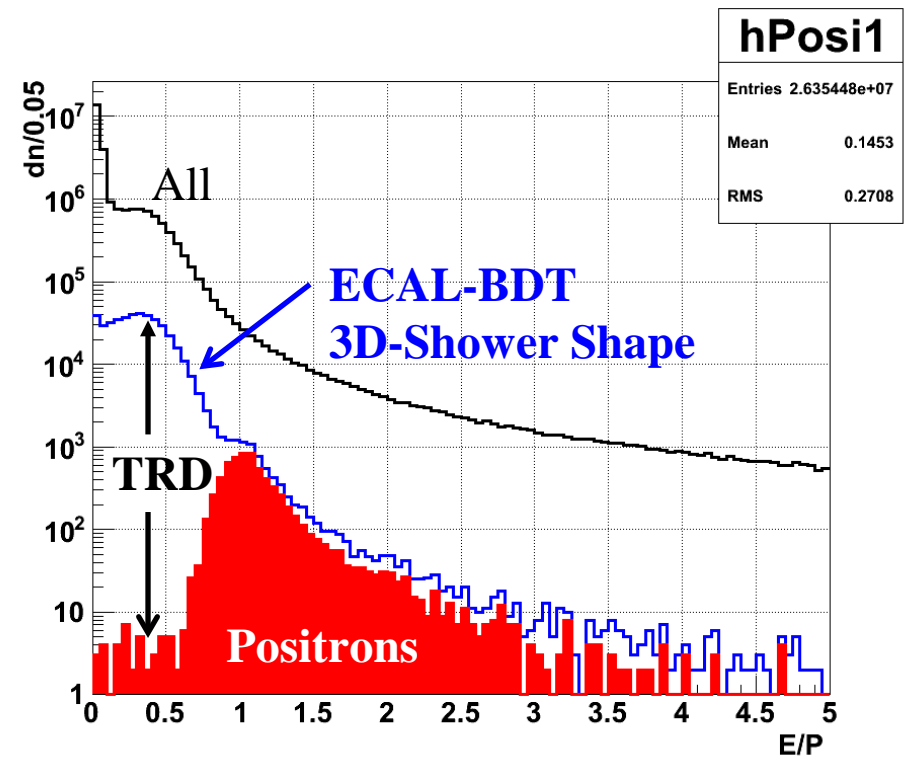
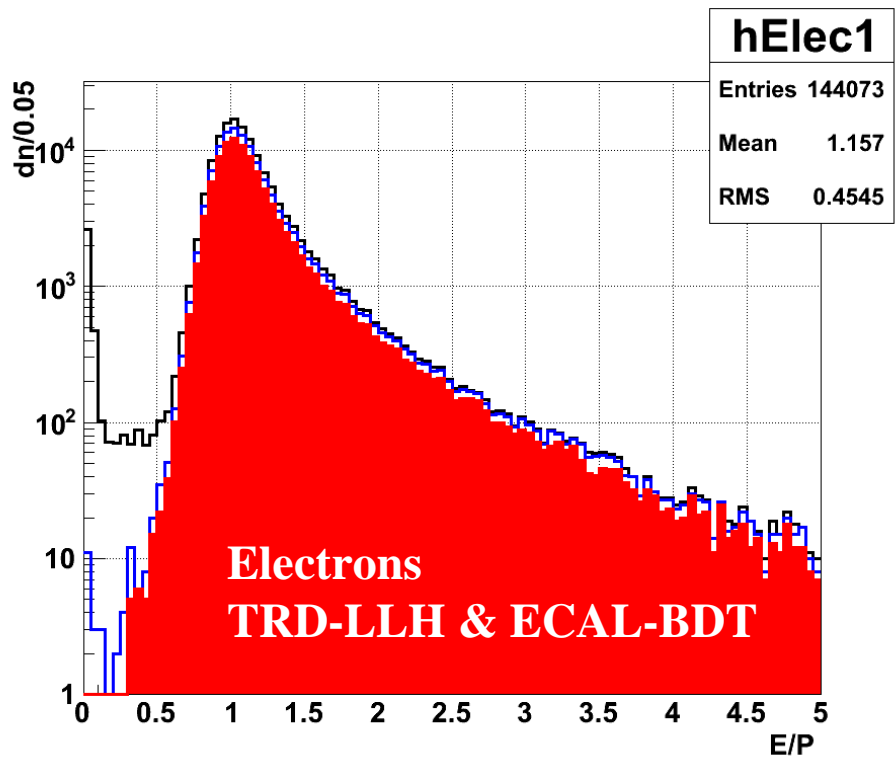
AMS-02 TRD Proton Rejection



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AMS-02 TRD

AMS-02 TRD Proton Rejection



AMS-02 TRD

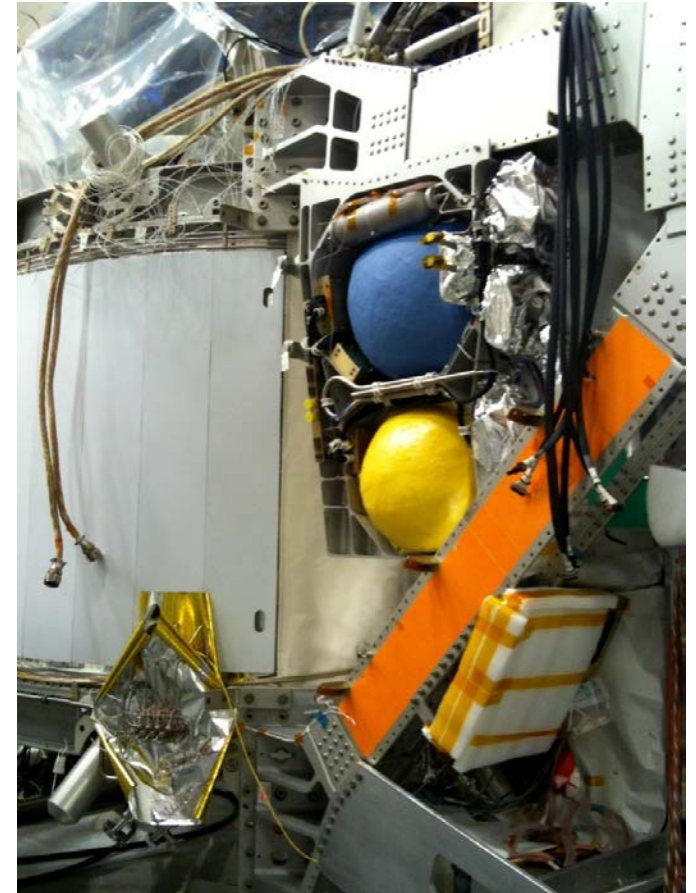
Slow Control and Data Monitoring



Th. Kirn

AMS-02 TRD

TRD/TRDGas-System Monitoring Programs



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TRD/ACC/TAS-Standard Shift



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AMS-02 TRD



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List of TRD/TRDGas Programs

Electronics Monitoring:

- TRD Status Monitor (TRD-S)
- Pedes_Canvas
- UDR_HK_Canvas
- Read_block_files
- UHV Status Monitor (UHV-S)

Gas Monitoring:

- TRDGAS Monitor (TRDGAS-M)
- TRDGAS Status Monitor (TRDGAS-S)
- TRD Pressure Monitor (Pressure Monitor)

Detector Monitoring:

- TRD Data Monitor (TRD-M)
- TRD-DTS Monitor (TRDDTS-M)
- TRD-GainMonitor (TRD-GainMonitor)



TRD-ACC-TAS SHIFTER: TRDGas Standard Monitoring Shift

Start-up of AMS-Activation:

AMS Power-Step-1 from CMD Post

- Initializes TRDGAS Crate (UG)
- Configures and starts UG CtrlTsk
- Activates UG Q-List items 7A/7B

HV ON: CMD asks if TRD Gas is ok

Standard Shift Activity:

- **No** TRDGAS commanding in standard shift
- **Adjust** TRD HV once per day by a 3V step (MOP-ADC value ≈ 60)
details see pages 131-133
- **Check: TRDGAS monitor data available**
All plots in TRDGAS-M update
- **Check: Pressures and Temperatures in range**
TRDGAS-S is updating regularly



TRD-ACC-TAS SHIFTER: TRD Gas Emergency Actions

Emergency Actions from TRD Post CALL EXPERT

- Xe/CO2 Vessel High Pressure (>175/100bar)
- Xe/CO2 Vessel High Temperature (>+60 C)
- Xe/CO2 Vessel Low Temperature (<-20 C)
- Xe/CO2 Vessel Low Temperature (<-40 C)
Requires UGPD-B powered and all DC/DC on
- Xe/CO2 Vessel Low Temperature (<-50 C)
- Mixing Vessel High Pressure (>13bar)
- Box-C High Pressure (>1500mbar)
- TRD High Pressure (>1300mbar)
- TRD Low Pressure (< 900mbar)

- TRD-SidePanel High Temperature (>+40 C)
Ask CMD to disable TRD 120V Heaters
- TRD-SidePanel High Temperature (>+50 C)
Option: ask CMD for AMS StandBy last Option:
- TRD-SidePanel Low Temperature (<+5 C)
Ask CMD to switch ON TRD 120V Heaters A & B
- TRD-SidePanel Low Temperature (<-20 C)

ASK for Commanding

- UG Heaters DISABLE
- UG Heaters DISABLE
- HEAT VESSELS (UG-A)
- HEAT VESSELS (UG-B)

- Turn AMS into sun
- VENT MIX
- VENT Box C
- Flipper Valves CLOSE
- Flipper Valves CLOSE
- ask CMD: TRD HV OFF
- Flipper Valves CLOSE
(PDS 120V Heater #3)
- ask CMD: TRD StandBy
- Turn TRD away from sun
- Flipper Valves CLOSE
(PDS 120V Heater #3)
- Turn AMS into sun



TRD-ACC-TAS SHIFTER: TRD Standard Monitoring Shift

- Check: TRD data monitor (TRD-M, Pedes_Canvas.ps, UDR_HK_Canvas)
- Check: TRD Temperatures in range (TRDGAS-S and TRD Sidepanels)

Emergency Actions from TRD Post CALL EXPERT
-TRD HV Trip!

ASK for Commanding
ASK Command to stop DAC
Go to [TRD-HV](#)

reset HV by pressing
button `HV On`



TRD-ACC-TAS SHIFT SETUP



Th. Kim

AMS-02 TRD

Screen 1 Left (TRD/GAS)

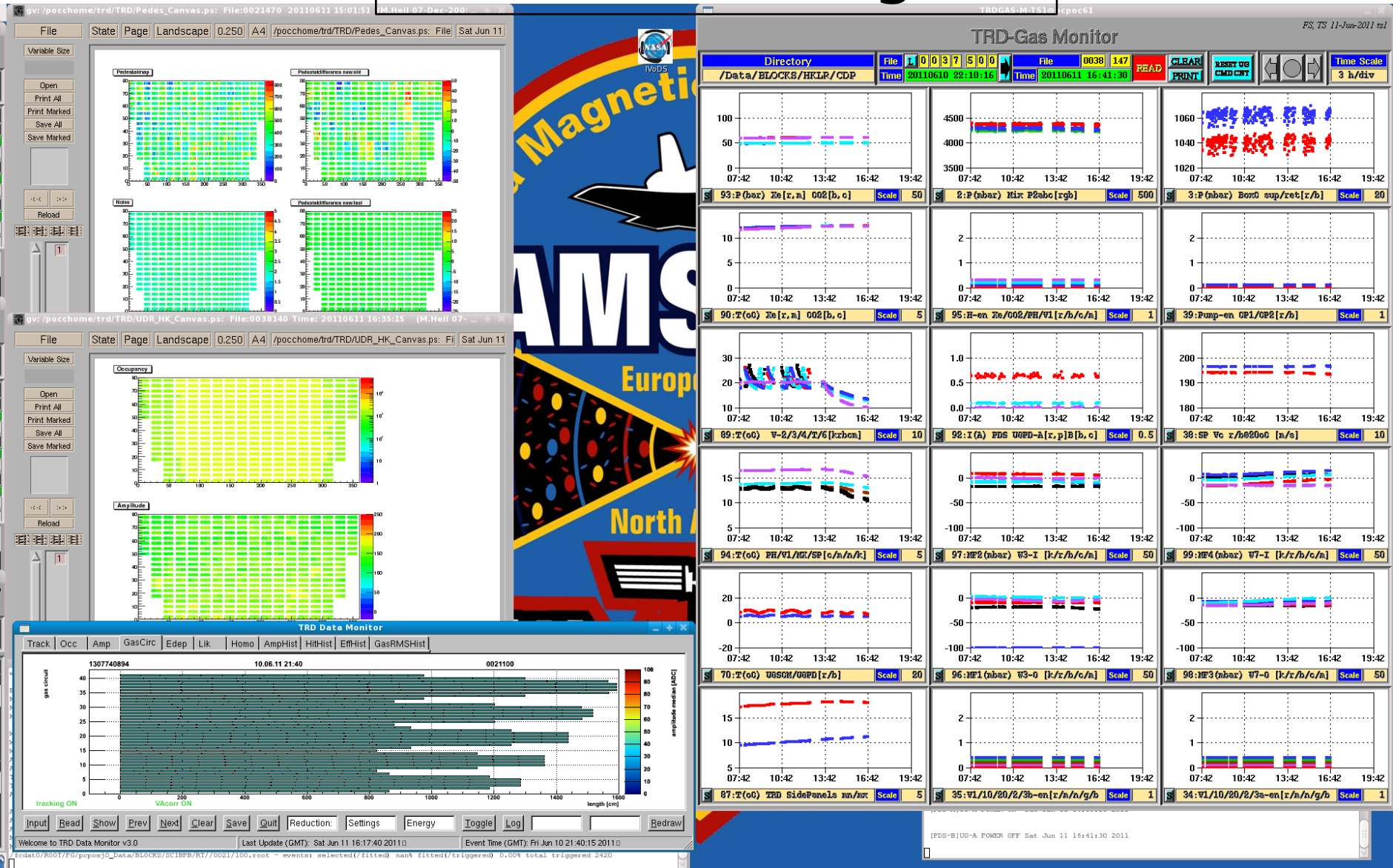
The screenshot displays a multi-panel control room interface for the AMS-02 TRD/GAS system. The interface is organized into several main sections:

- TRD Gas Status Monitor (Top Left):** Shows real-time status for TRD Gas Press, TRD Gas Temp, TRD Press, TRD Temp, and Leak. It includes a log of events such as "CET HP out of range" and "CET bad status sensor P1d".
- ACC Status Monitor (Middle Left):** Displays HV status, Temperature, and Scalers. It includes a log of calibration events.
- TAS Status Monitor (Bottom Left):** Shows Laser Current, Temperature, and Pulse Width. It includes a log of calibration events.
- TRD Status Monitor (Top Right):** Provides a detailed overview of the TRD system, including JINF & Crate Power, HV (1500 V), and UDR & DAQ. It includes a log of hits and event data.
- UHV Status Monitor (Bottom Right):** Displays UHV ADC Voltages and Alarms for U0 Side A and U1 Side B, with columns for voltage levels and alarm status.
- Configuration and Log (Center):** Shows system configuration details like "Use skin", "Last Detector", and "Page: None". It also includes a terminal window with system logs.

The interface features a top navigation bar with "Applications", "Places", and "System" menus. The bottom taskbar shows various application icons and the system tray.



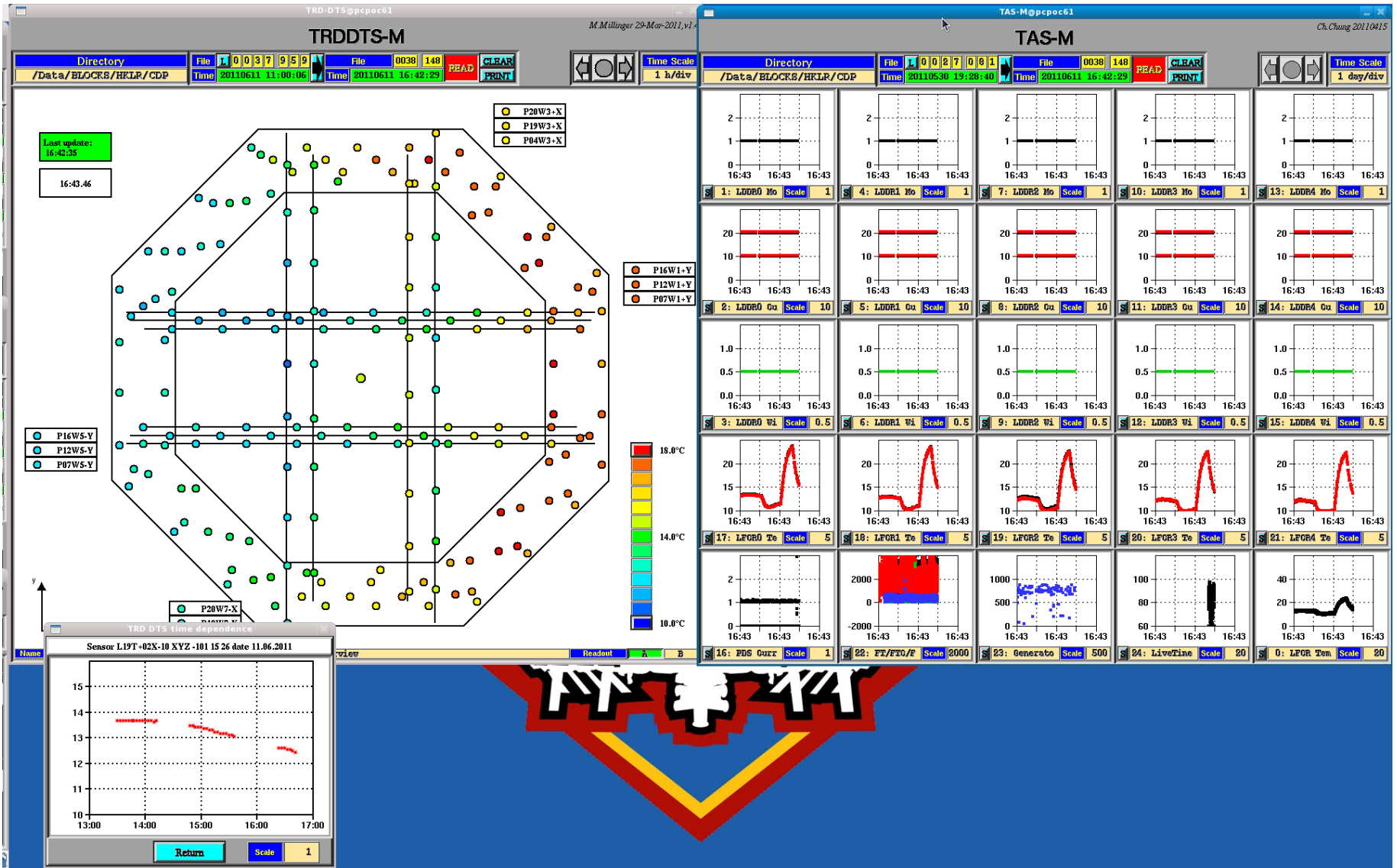
Screen 1 Right



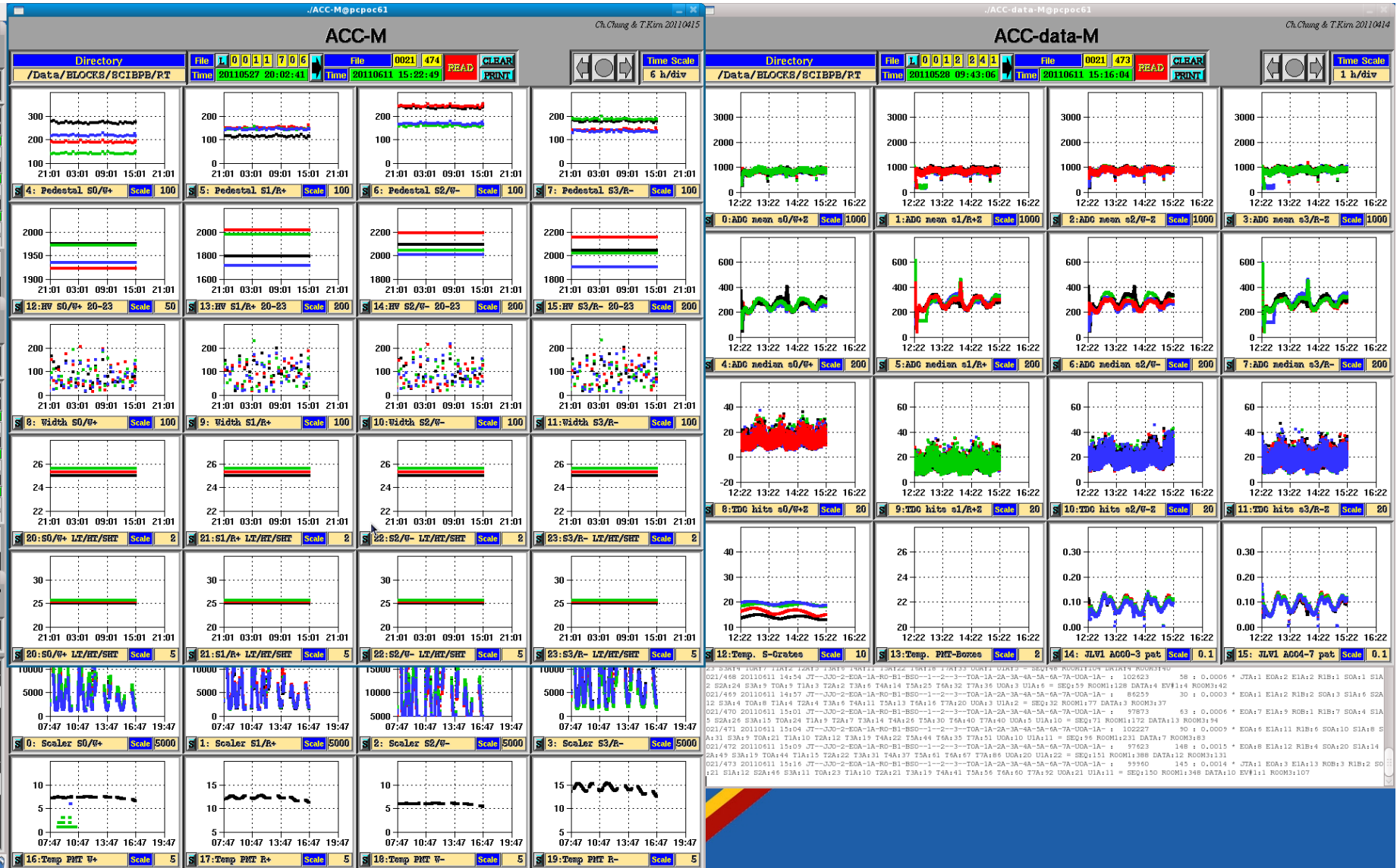
Th. Kirm

AMS-02 TRD

Screen 2 Right



Screen 3 Right!



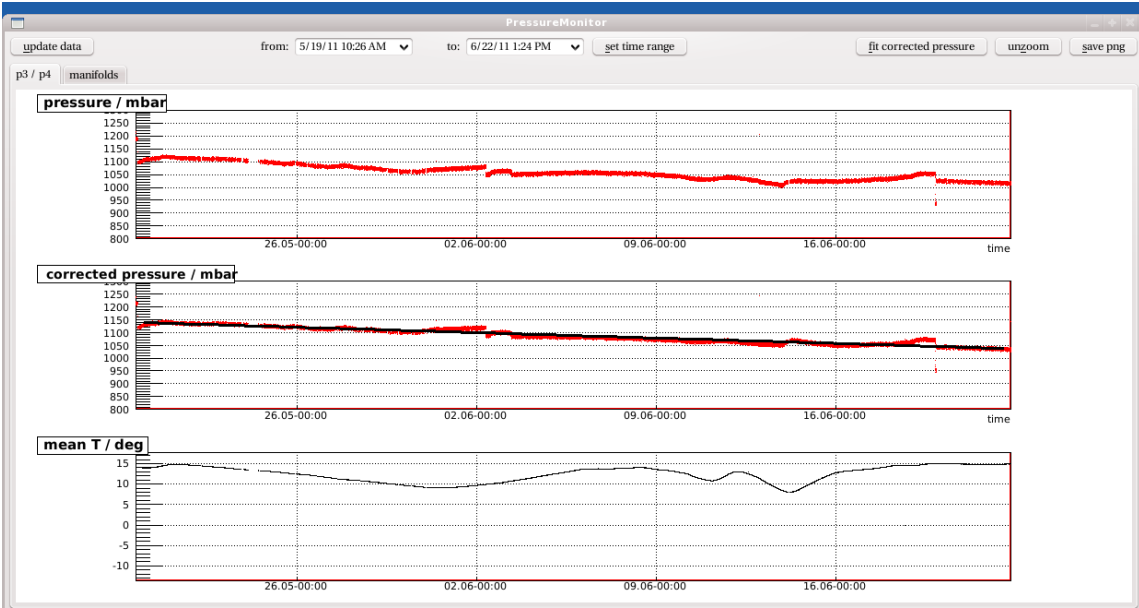
Th. Kirn

AMS-02 TRD



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Screen 4 Right!



TRD HV control panel. Buttons include PING, HV ON, HV OFF, and READ STATUS. The status display shows 'N/A' for two parameters. A message at the bottom states 'Command executed O.K.'

```

trd@pcpec61:~/RUN
trd@pcpec61 config$ ed
trd@pcpec61 -!$ ed RUN
trd@pcpec61 $N$ TRD-HV eas:hosc pcpecj0
Usage:
TRD-HV [(CAN|ANEM|1553|BRDL|EAS|(ECHO|CAN|1553|422|RS422|BRDL|HSC|ALC)) <Server>]
HOSC Server = pcpecj0
Fast = 61010
APID = 581(0x3D5)
New Peter's easserver will be used
HV ON: invalid 1. node address!
HV ON: invalid 2. node address!
HV ON: invalid 2. node address!
    
```

```

MessageLog
Timeout = 55.0 sec
Usage:
my-1 RW <Node> <DataType> [<Data>]
=<text string>, @<text file name>, @@<binary file name>, -<text string>, --text
exec: RQ W NA=14 DT=1 F0591 DC=878: 0F 7A 00 09 0F 54 00 00 11 84 C8 30
REQUEST: [0] RQ W NA=014 DT=1 F0591 DC=878 D=0F7A 0009 0F54 0000 11
REPLY: [0] RP W NA=00E DT=1 F0591 DC=0 Err=0000
    
```

TRD Gas Operation control panel. Includes sections for COMMAND PATH, FLIPPER VALVES (CLOSE, OPEN AC, OPEN BD), PUMP (OP2, Speed, START, STOP), HEAT (VESSELS, MIXING, OFF), VENT (MIX, Box-C, Xe, CO2), and MIX (1 SHOT Xe, 1 SHOT CO2, Transfer MIX, Disable MV).

```

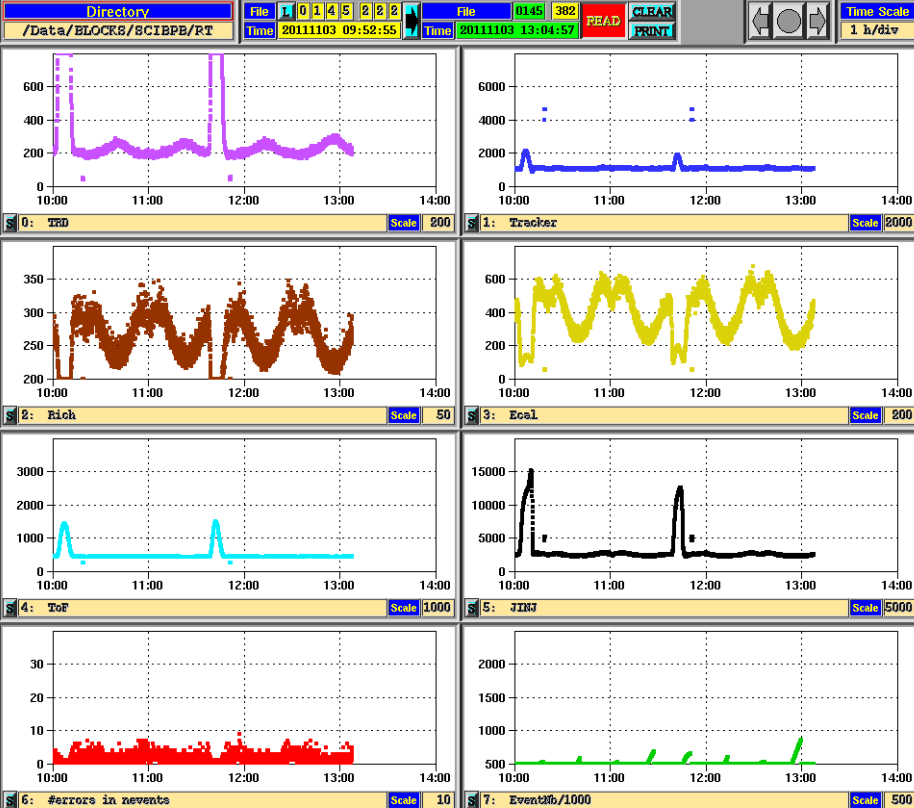
trd@pcpec61:~/COMMANDING/TRDGAS
usage:
TRDGAS-C <Interface> <Server> <Timeout>
f <Interface> <Server> not specified, those from ./command_path.
onf are used.
f <Timeout> not specified or invalid, Default is used.
ath [eas:hosc pcpecj0 Default] will be used
trd@pcpec61 TRDGAS$ === exe_commands cw = /poc/home/trd/ug/scripts/flight
=== exe_commands cw = /poc/home/trd/ug/scripts/flight_approved/Open_FV_AC
trd@pcpec61 TRDGAS$
    
```



Screen 5 Right!

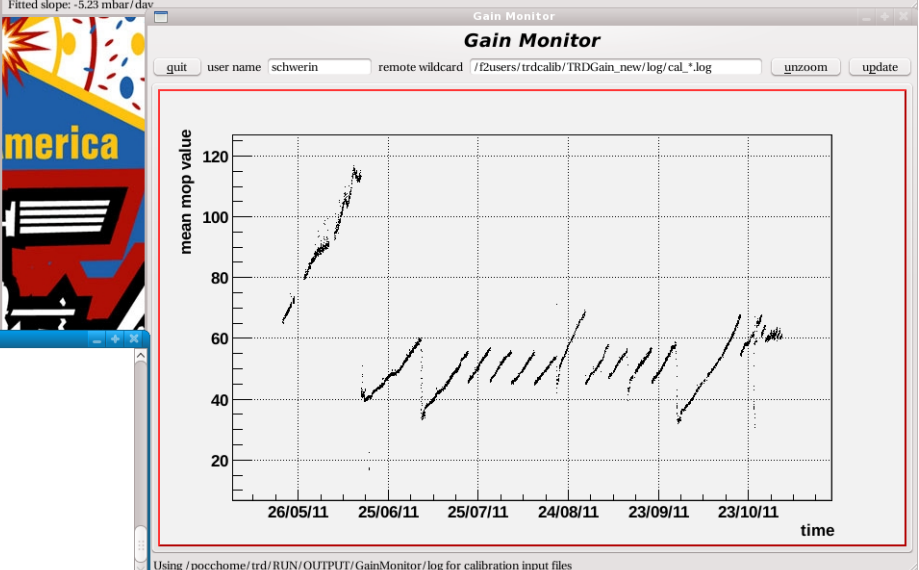
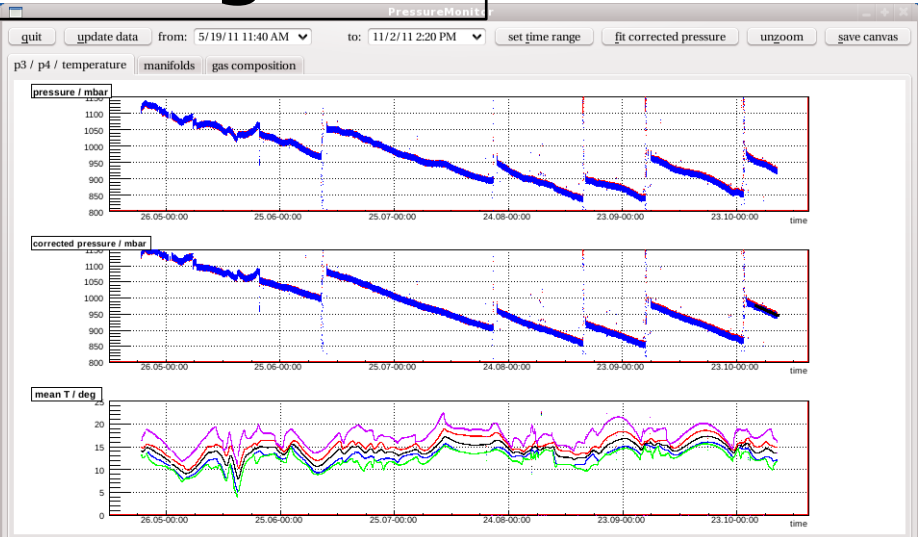
Event Size Monitor

Melanie Heil 16-Jun-2011



```

** $id: TGOt.cxx 3566 2010-09-21 20:34:17Z fine@BNL.GOV $ this=0xa2a5f70
Symbol font family found: "Standard Symbols L"
opening file: "/pocchome/trd/RUN/OUTPUT/GainMonitor/Log/mop.txt"
Font metric w = 133 h = 14 points= 9 pixels= 12 (Font["Arial,9,12,0,80,0,0,0,0,0"])
schwerin@ams.cern.ch's password:
receiving file list ...
36 files to consider
cal_1219564101.log 16815503 100% 7.71MB/s 0:00:02 (xfer#1, to-check=0/36)
sent 23460 bytes received 1502174 bytes 17435.82 bytes/sec
total size is 348736290 speedup is 228.58
opening file: "/pocchome/trd/RUN/OUTPUT/GainMonitor/Log/mop.txt"
    
```



TRD Monitoring:

- TRD Status Monitor ([TRD-S](#))
 - Pedes_Canvas
 - UDR_HK_Canvas
- Read_block_files
- TRD Data Monitor ([TRD-M](#))
- TRD-DTS Monitor ([TRDDTS-M](#))
- GainMonitor ([GainMonitor](#))



Configuration of TRD-S

Set X to 2

left-click ↑ number
right-click ↓ number

Find Last File
(left click)

Load for reading
(left click)

Read continuously
(right click)

Set Directory to
Data/BLOCKS/SCIBPB/RT
and
Data/BLOCKS/HKLR/CDP

Check:

- Every box green,
- HV value match the settings,
- browser for warnings/errors

The image displays two screenshots of the TRD Status Monitor web interface. The top screenshot is for the directory `/Data/BLOCKS/SCIBPB/RT` and the bottom screenshot is for `/Data/BLOCKS/HKLR/CDP`. Both screens show a grid of status boxes for 'JINF & Crate Power', 'HV', and 'UDR & DAQ' for two channels, U0 and U1. The status boxes are green, indicating 'OK'. The HV value is 1580 V. The 'READ' button is highlighted in red. The interface also shows a 'File' field with a sequence of numbers (1, 0, 0, 2, 1, 4, 5, 5) and a 'Time' field. The bottom screenshot shows a 'Common Mode (ADC)' value of 0.254 and an 'Amplitude' of 280.45. The status is 'OK' and the 'State Interval' is 'REVER'.



TRD-S

JMDC
QList



BLOCK
Files



Commands
from ground

DAQ and
SC Status



TRD Status Monitor (Top Screenshot):
 Directory: /Data/BLOCKS/SCIBPB/RT
 File: 0021 470
 Time: 20110611 15:01:42
 U0 Status: JINF & Crate Power (OK), HV (1580 V), UDR & DAQ (OK)
 U1 Status: JINF & Crate Power (OK), HV (1580 V), UDR & DAQ (OK)
 Hits/Event: 42, Common Mode (ADC): 0.254, Amplitude: 280.45, STATUS: OK

TRD Status Monitor (Bottom Screenshot):
 Directory: /Data/BLOCKS/HCLR/CDP
 File: 0038 147
 Time: 20110611 16:41:30
 U0 Status: JINF & Crate Power (OK), HV (1580 V), UDR & DAQ (OK)
 U1 Status: JINF & Crate Power (OK), HV (1580 V), UDR & DAQ (OK)
 Hits/Event: N/A, Common Mode (ADC): N/A, Amplitude: N/A, STATUS: OK

All information from TRD Readout is analyzed and summarized in overall status for shift taker



Screen-3: Additional Tools for TRD Experts

UHV Status Monitor:

Go to RUN directory and open programm:

```
cd ~/RUN
```

```
UHV-S &
```

UHV Status Monitor

State Interval: never

Directory: /Data/BLOCKS/HKLR/CDP

File: 0038 147

Time: 20110528 20:29:29

File: 20110611 16:41:30

READ CLEAR

PRINT

UHV ADC Voltages and Alarms

U0 Side A						U0 Side B						Age
-	-	-	-	-	-	1582	1581	1578	1581	1577	1577	1
-	-	-	-	-	-	1580	1582	1580	1579	1580	1579	min
-	-	-	-	-	-	1578	1576	1579	1580	1577	1578	
-	-	-	-	-	-	1579	1577	1579	1579	1583	1580	
-	-	-	-	-	-	1579	1579	1577	1578	1580	1579	
-	-	-	-	-	-	1580	1579	1581	1577	1580	1580	
-	-	-	-	-	-	1581	1578	1579	1578	1580	1577	
U1 Side A						U1 Side B						Age
-	-	-	-	-	-	1579	1577	1582	1578	1579	1579	7
-	-	-	-	-	-	-	1579	1579	-	1577	1582	min
-	-	-	-	-	-	1580	1576	1581	1579	1579	1581	
-	-	-	-	-	-	1579	1581	1579	1582	1580	1579	
-	-	-	-	-	-	1580	1577	1578	1579	1577	1579	
-	-	-	-	-	-	1581	1581	1578	1578	1579	1579	
-	-	-	-	-	-	1578	1578	1580	1580	1579	1580	

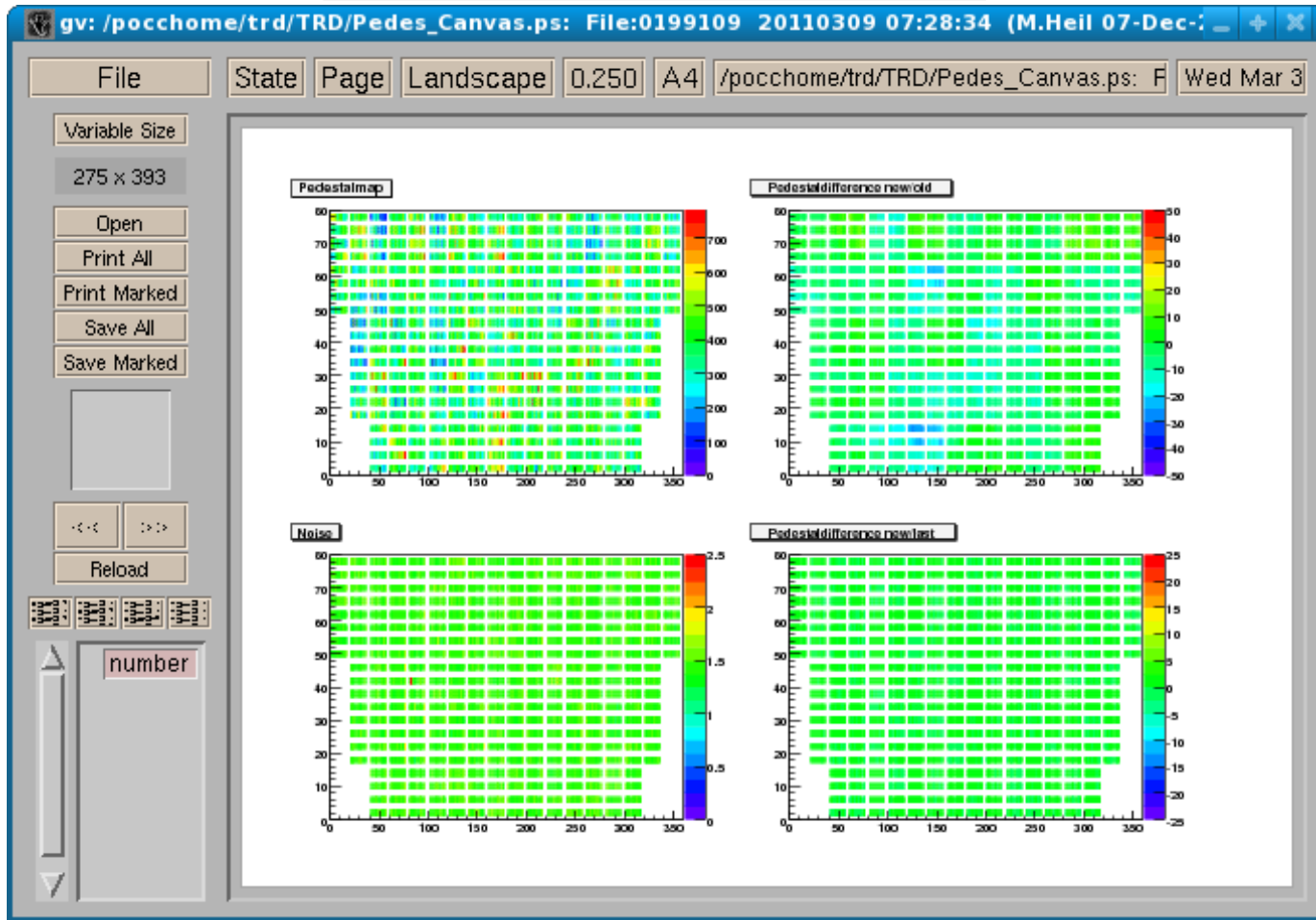
Set Directory to Data/BLOCKS/HKLR/CDP

Set to current directory and file

Use to check single channel HV values for A/B-Side



Pedes_Canvas.ps



Calibration of each of the 5248 Straw-Tubes

Upper left: Actual Pedestal values in ADC channels

Upper Right: Difference between actual and default Pedestal values

Lower Left: Actual Noise values in ADC channels

Lower Right: Difference between actual and last Pedestal values

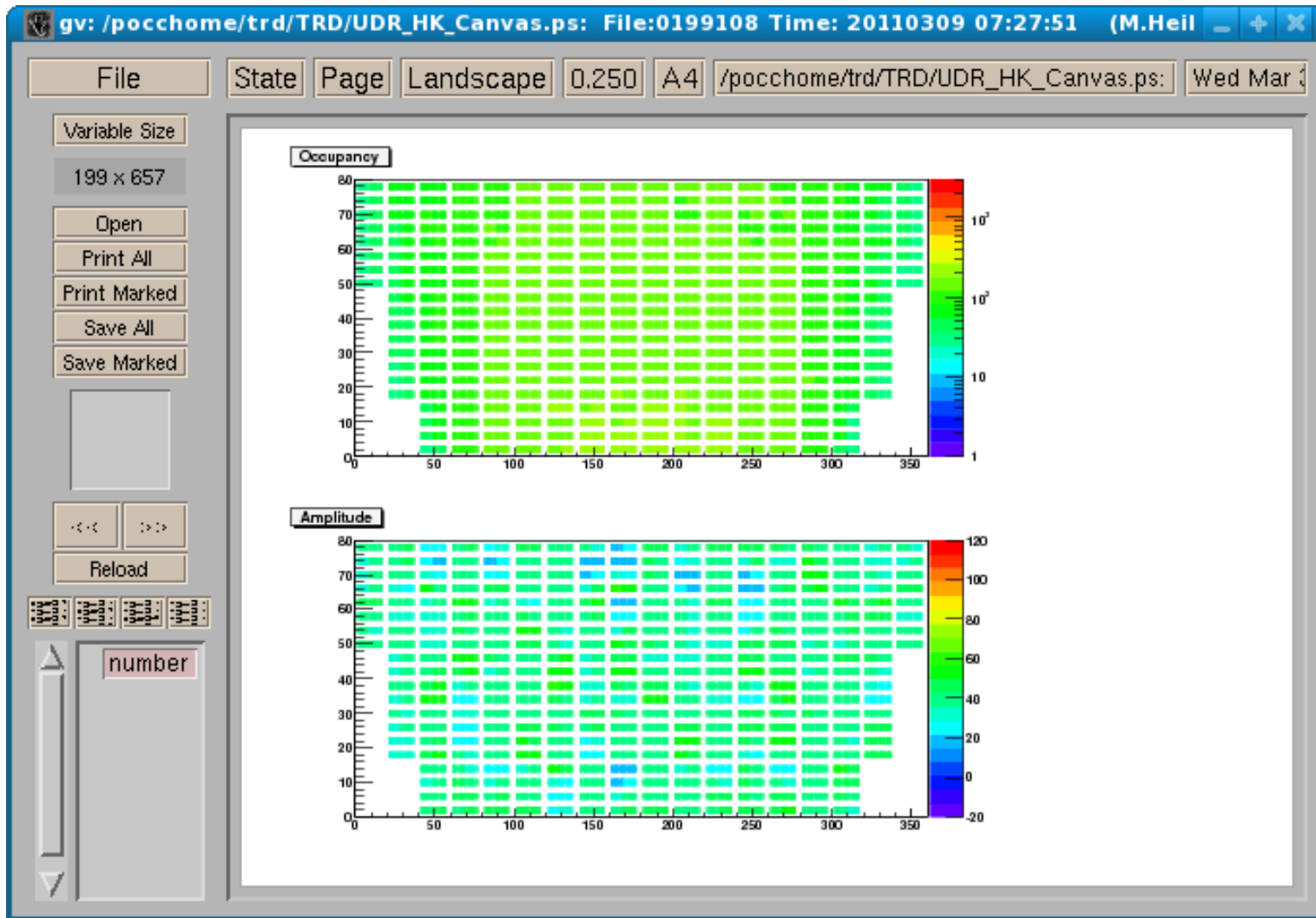


Th. Kim

Noise should show usual pattern
(all but 2 channels green for A-Side Power,
also slightly higher noises on end/front of segment for B-Side Power)

AMS-02 TRD

UDR_HK_Canvas.ps



Upper: Actual Occupancy (number of hits in each of the 5248 straws)

Lower: Actual Amplitude (Median, Pedestal corrected) values in ADC channels for each of the 5248 straws

Th. Kirin • Occupancy plot should not show any unusual high or low channels

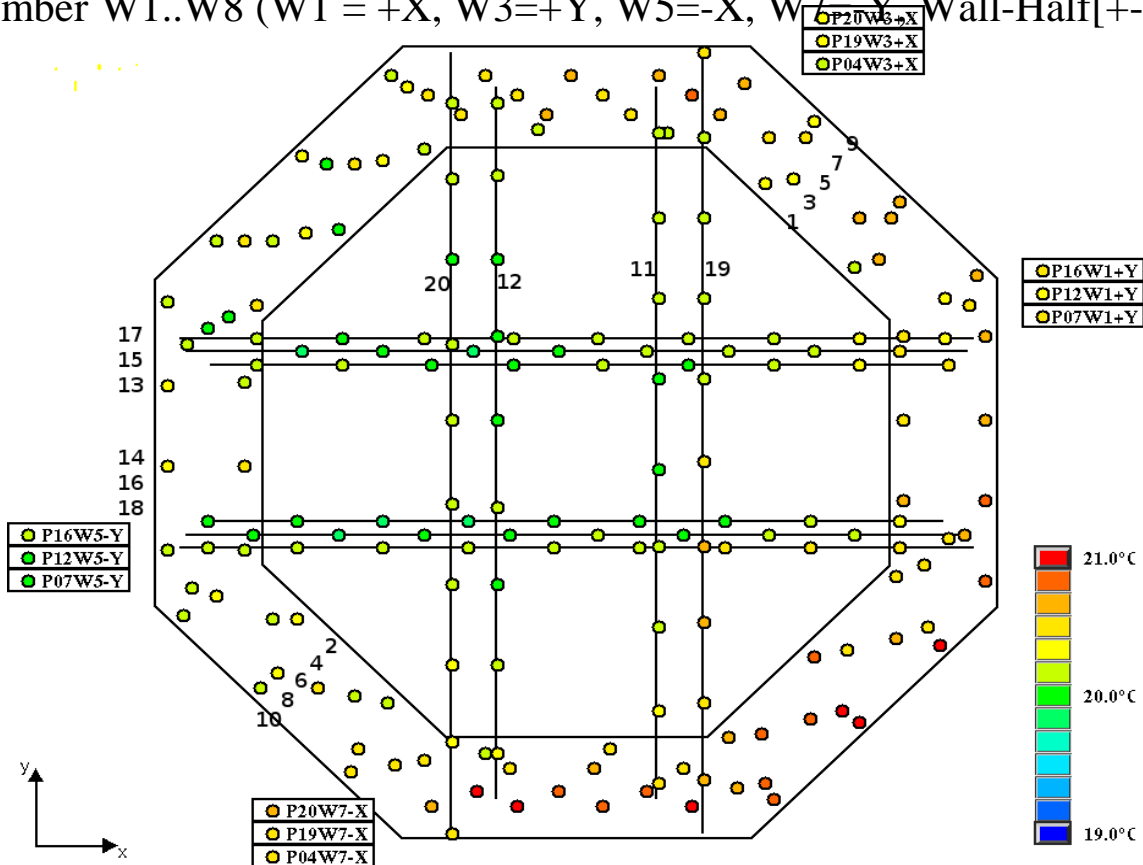
• Amplitudes should be fairly homogenous

AMS-02 TRD



TRD-DTS Monitor – TRDDTS-M

- A total of 404 Dallas Sensors on 40 strips are read out by USCM-UG-A/B (202 sensors – 20 strips – 7 busses respectively)
- The Label contains Layer-Number L01..L20, Tower-Number T-9..T+9 and position along chamber in decimeters [XY]-10..[XY]+10
- Some sensors on the strips are located outside of the octagon volume (near the connector patch-panel). For those sensors the naming scheme is as follows: Layer-Number P01..L20, Wall-Number W1..W8 (W1 = +X, W3=+Y, W5=-X, W7=-Y, Wall-Half[+-][XY])



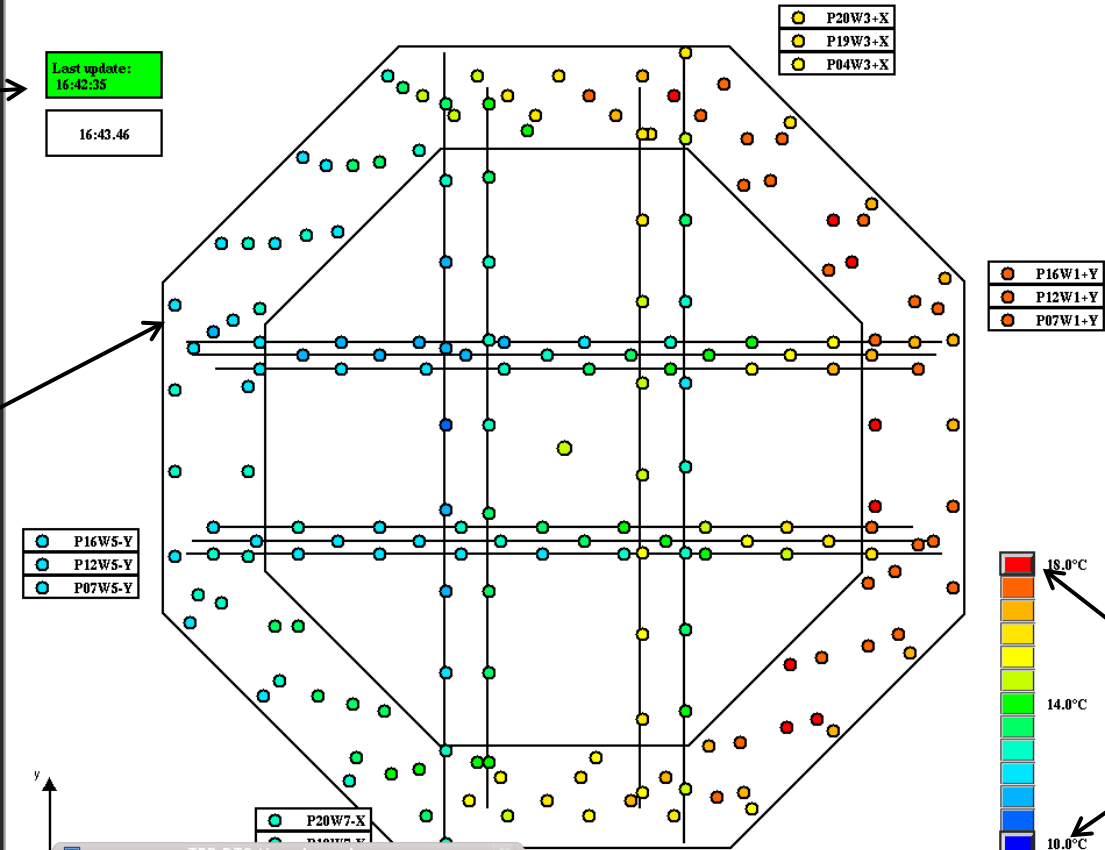
AMS-02 TRD



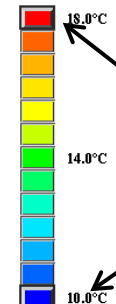
Directory: /Data/BLOCKS/HKLR/CDP
 File: 1 0 0 3 7 2 5 9
 Time: 20110611 11:00:06
 File: 0038 148
 Time: 20110611 16:42:29
 READ CLEAR
 PRINT

Time of last update

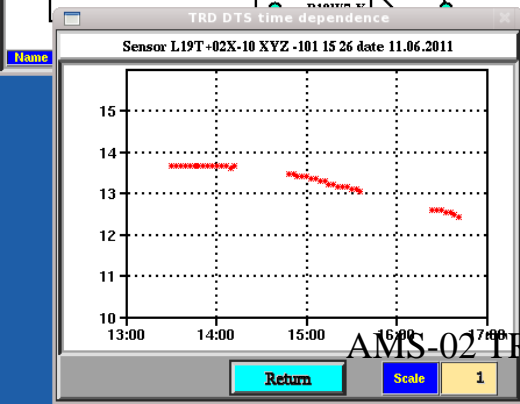
Last update:
 16:42:35
 16:43:46



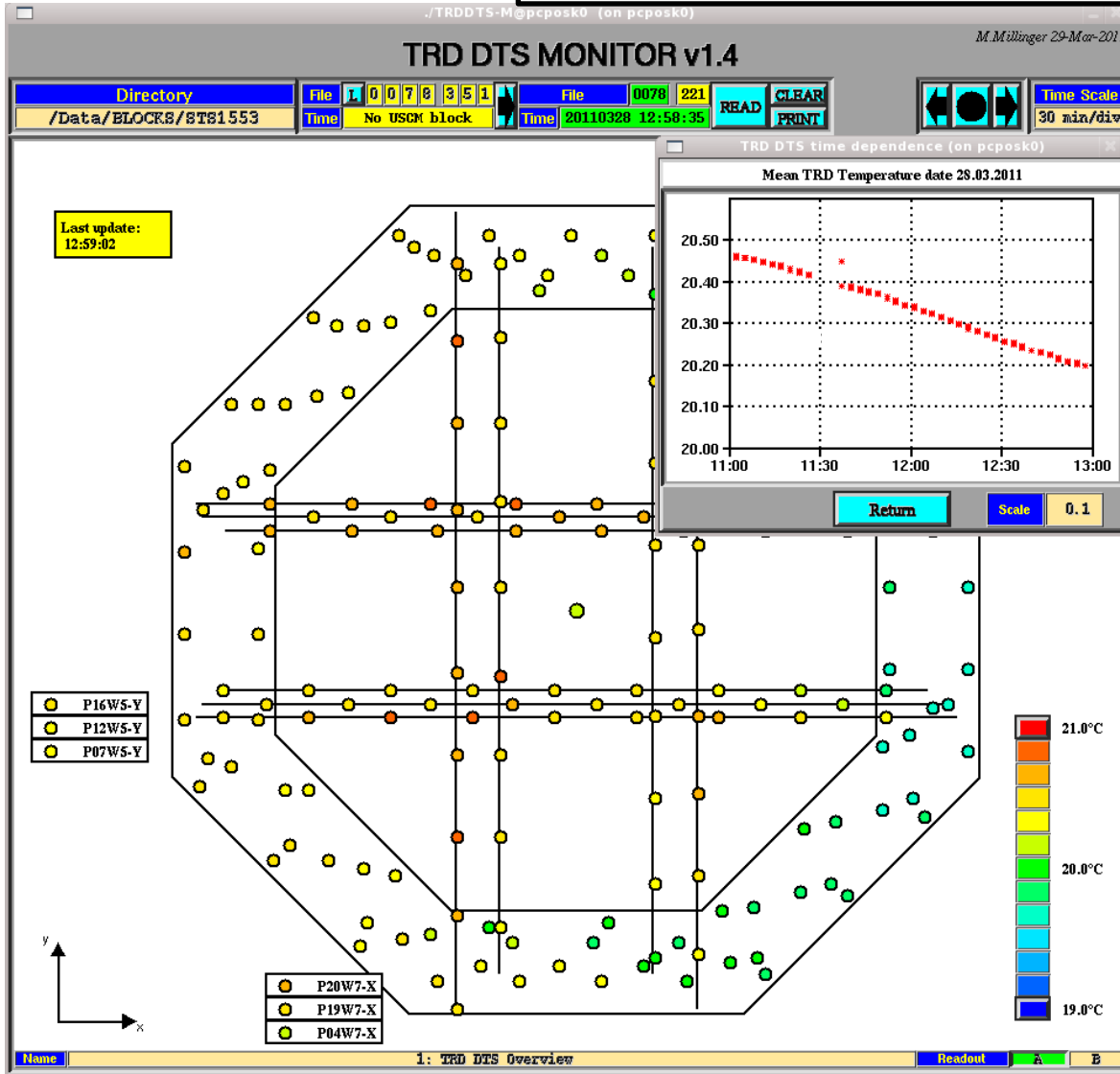
Change color range



On any sensor:
 Left click -> get sensor information
 Right click-> get histogram of sensor temperature (close histogram again using the 'Return' button!)



Usage: TRD-DTS Monitor– TRDDTS-M



- Each button represents the approx. location of 1A & 1B sensor
- A left-/right-click on a button shows detailed information/ Temp.history of the sensor
- ‘Last update’ supposed to stay green in ‘Read’-mode
- Color palette adjustable left-/right-click on max/or min button increases/decreases respective limit by 1
- On bottom right the active readout side is shown – in case both readouts are available one can select which one shall be displayed
- Different views available (click on ‘Name’ button on bottom)



Gain Monitor:

The HV of the TRD has to be adjusted every day to minimize the gas gain variations.

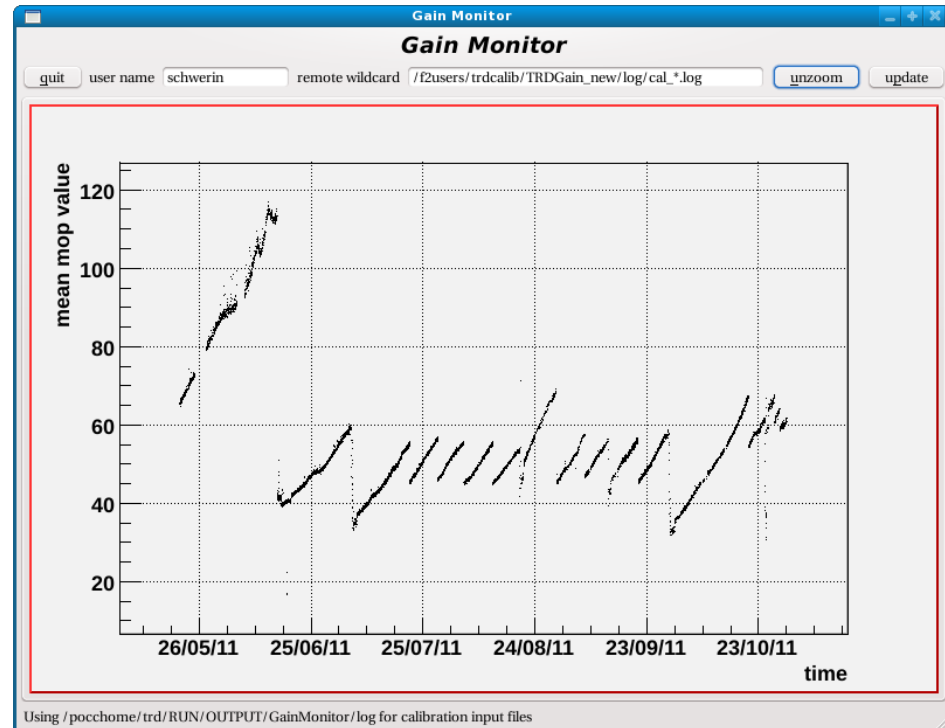
The MOP should be at about 60 ADC counts.

For checking the evolution of the TRD signal gain, open a terminal, go to RUN directory and open program:

```
cd ~/RUN
TRD-GainMonitor &
```

Take care that you do not hit any key afterwards (causes hang-up)

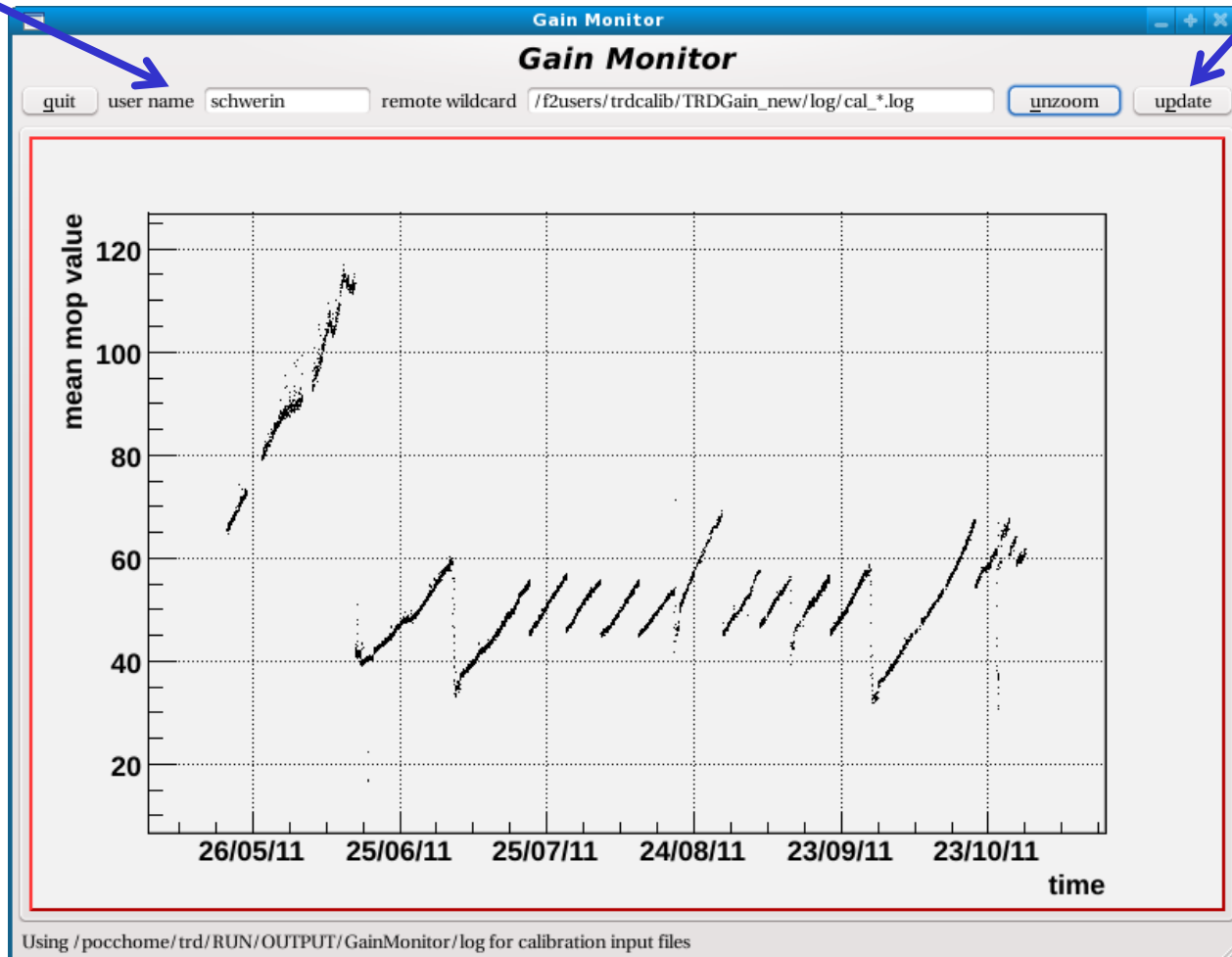
Be patient, especially when you ask for updating.



Type in your
CERN AFS user name

GainMonitor

Click on update



You are then prompted in the terminal window:

Your_user_name@ams.cern.ch password:

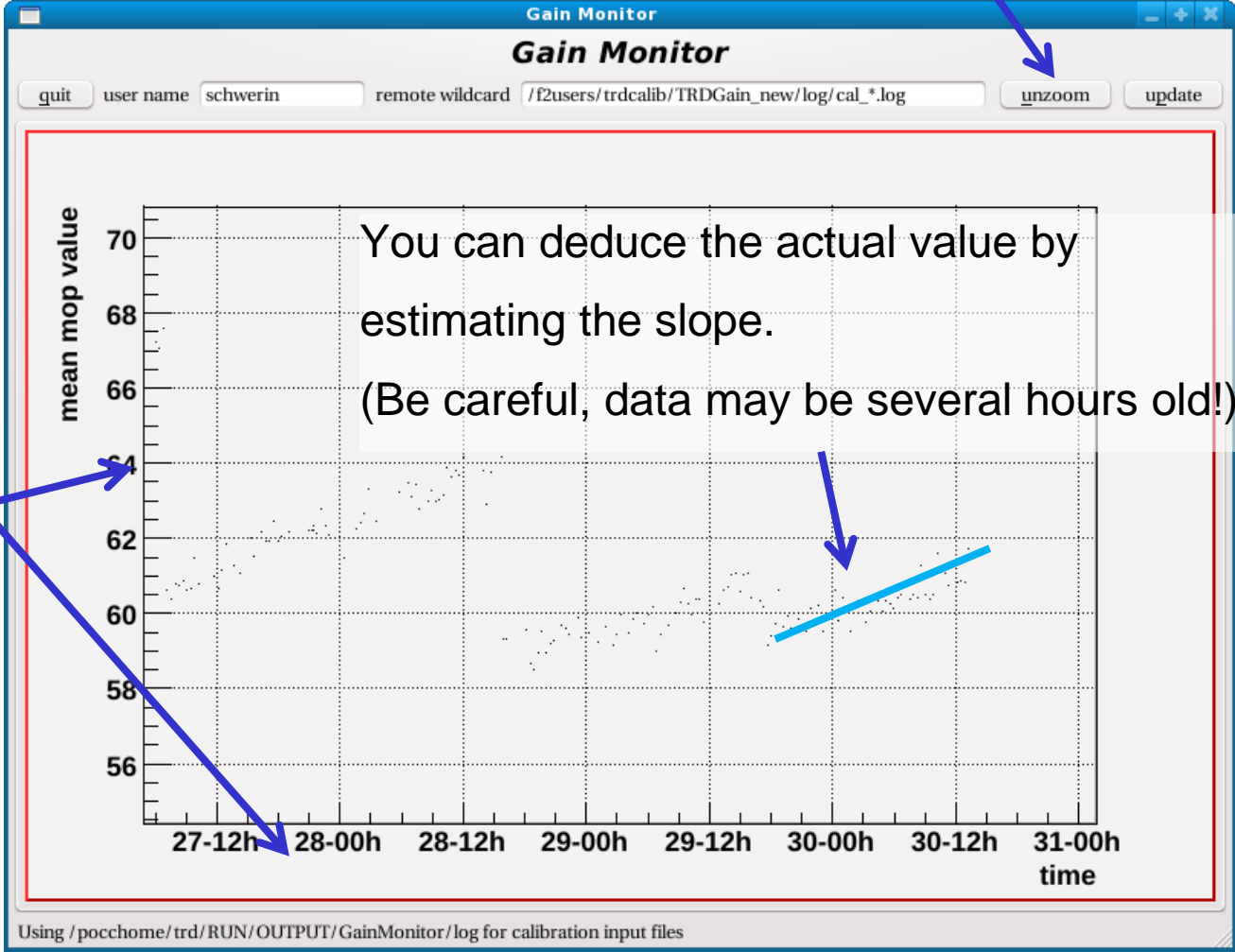
Th. Kirn

AMS-02 TRD



GainMonitor

Click on unzoom for returning to complete data set



You can enlarge the scale by selecting an interval on each axis

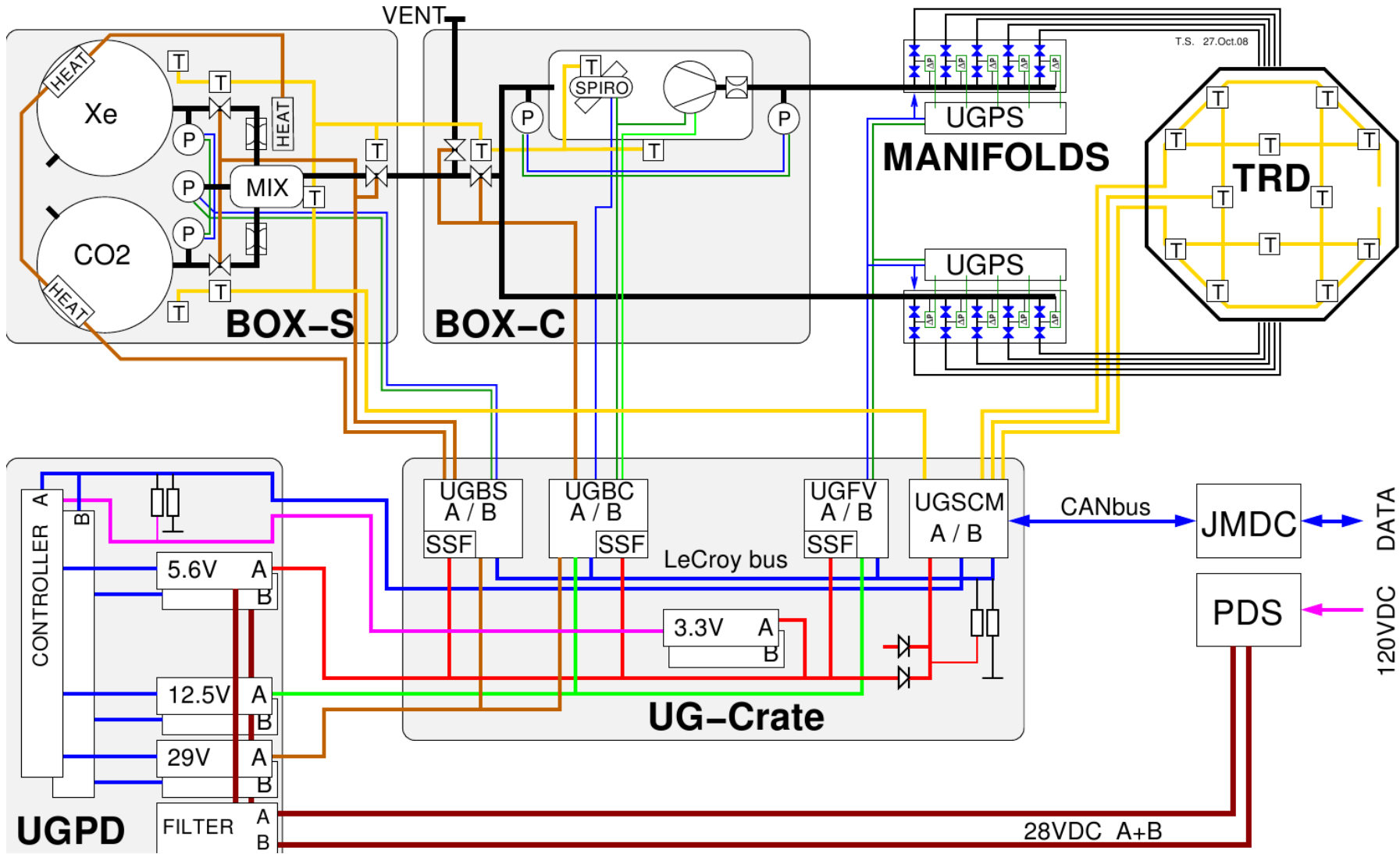


TRDGas Monitoring

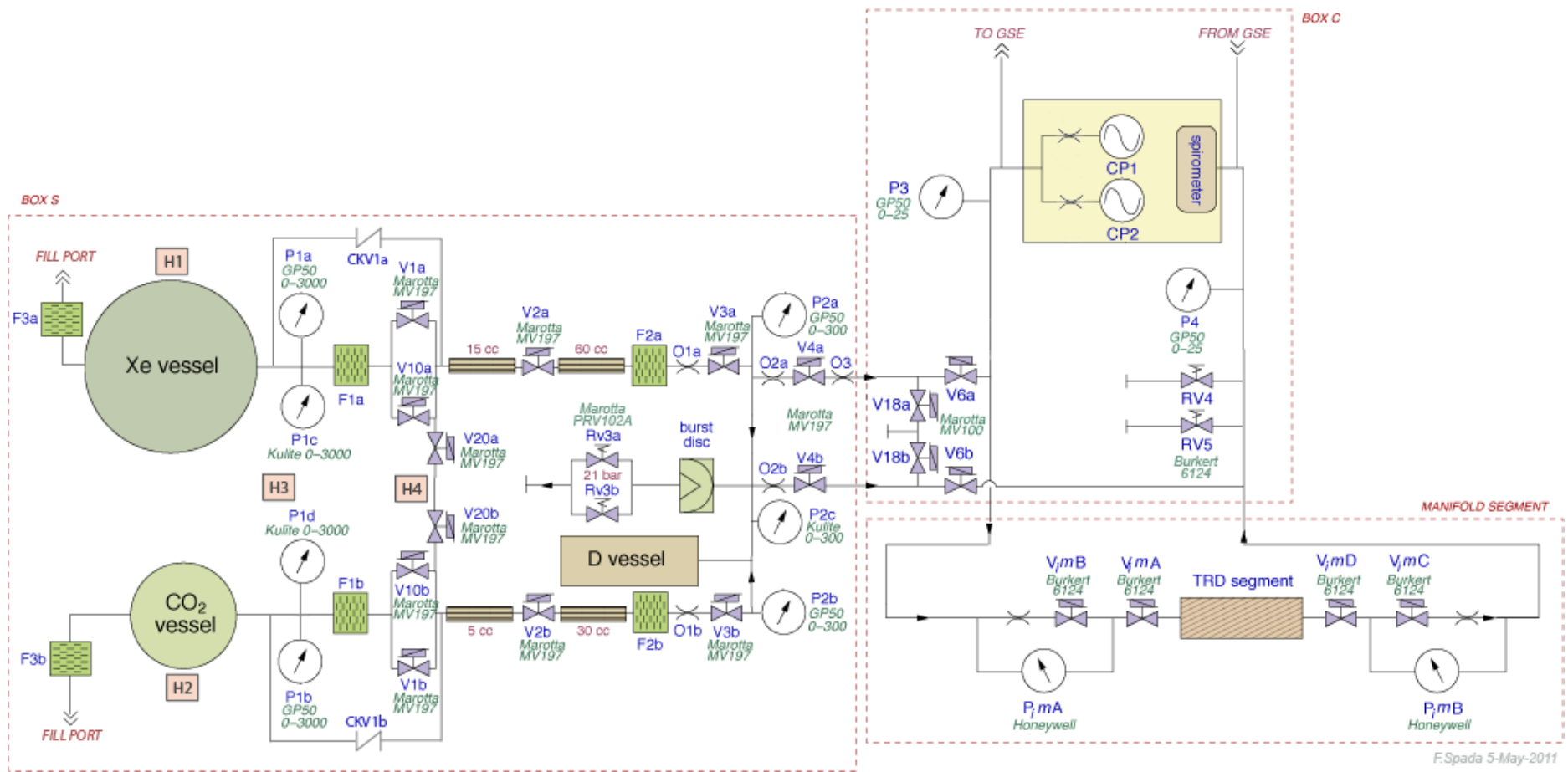
- TRDGAS Status Monitor (TRDGAS-S)
- UG CHD (Critical Health Data)
- TRDGAS Monitor (TRDGAS-M)
- Pressure Monitor (Pressure Monitor)



TRD/TRDGas-System

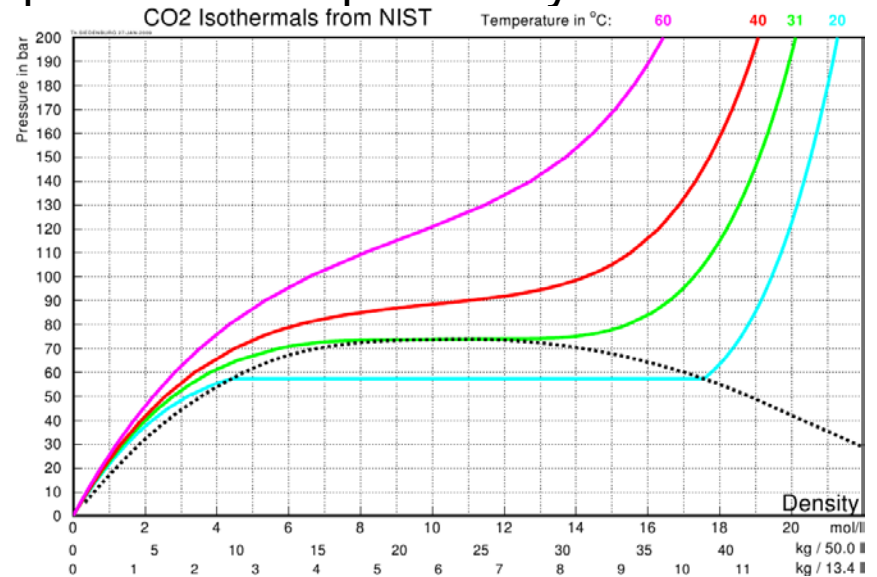
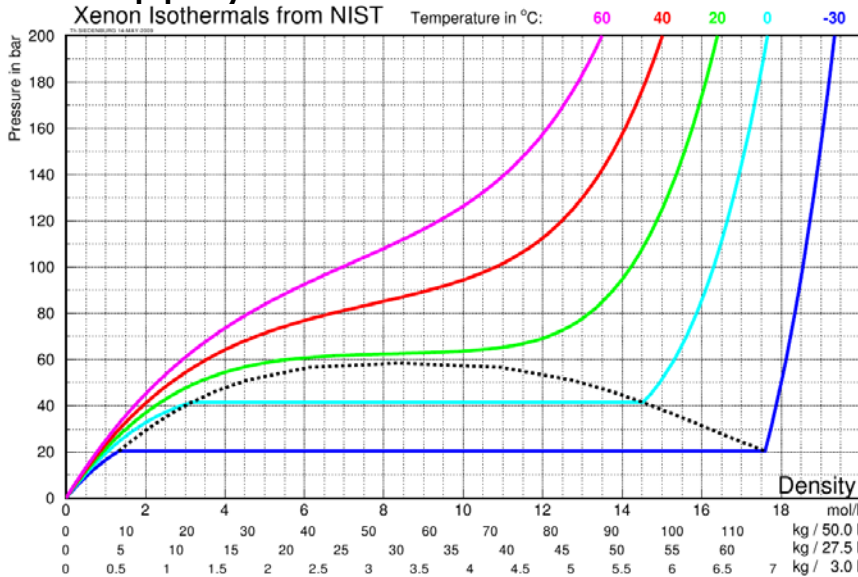


TRDGas-System



TRDGAS Supply Vessel Limits

Supply Vessels: Pressure-Temperature dependency



Vessel:	Xenon	CO2	MIX
100% Fill Level:	48kg	5kg	
Max.Op.Press.	175bar	100bar	14bar
Max.Des.Press.	207bar	220bar	20bar
Proof Press.	335Bar	330bar	40bar
Burst Press.	645Bar	440bar	80bar
Min.Des.Temp.	-70°C	-70°C	
Max.Des.Temp.	+65°C	+65°C	
Gas Freezing	-110°C	-55°C	



TRDGAS Sensor Value Limits

UG-Supply-Current [92] Monitoring: 0.6A
Pump HalfSpeed: +0.1A
Heat Vessels:
Heat for Mix: +1.0A
Marotta Valve: +1.2A

BoxC Canister Relief Valve at Inlet: 1.7bar

TRD Pressure: 900-1300 mbar
Pump HalfSpeed: Psup +320mbar Pret -320mbar

MfdP [96..99]: 0 +- 20 mbar

Temp [89/94]: -20°C .. +55°C
NO BOX-S/C Marotta-Valve Operations below 0 °C
NO Pump Operation below +5°C [94-SP blk]

Temp UGSCM/UGPD [70] -15°C .. +45°C



Configuration of TRDGAS-S

Set Directory to
Data/BLOCKS/HKLR/CDP

Find Last File
(left click)

Load for reading
(left click)

Read continuously
(right click)

Set X to 2

left-click ↑ number
right-click ↓ number

TRDGAS Status Monitor

Directory: /Data/BLOCKS/HKLR/CDP

File: L 0 0 2 4 4 2 5

File: 0038 147

Time: 20110527 21:31:59

Time: 20110611 16:41:30

TRDGas Press: OK

TRD Press: OK

TRDGas Temp: OK

TRD Temp: OK

Leak: OK

Log messages:

```

35990 [E] 20110609 04:06:40 CET DP out of range [CH 2 OUTLET] dp 387 [Pumps D D]
35990 [E] 20110609 04:06:38 CET DP out of range [CH 2 OUTLET] dp 387 [Pumps D D]
35455 [E] 20110608 12:07:46 CET Bad status sensor P1d
35455 [E] 20110608 12:07:46 CET Bad status sensor P1c
35455 [E] 20110608 12:07:46 CET Bad status sensor P1b
35455 [E] 20110608 12:07:46 CET Bad status sensor P1a
31208 [E] 20110604 02:35:44 CET TRD pressure(s) out of range
31208 [E] 20110604 02:35:44 CET p_TRD: 320 mbar [Pumps D D]
30786 [E] 20110603 15:17:19 CET TRD pressure(s) out of range
30786 [E] 20110603 15:17:19 CET p_TRD: 318 mbar [Pumps D D]
27877 [E] 20110531 13:53:25 CET Bad status sensor P1d
27877 [E] 20110531 13:53:25 CET Bad status sensor P1c
27877 [E] 20110531 13:53:25 CET Bad status sensor P1b
27877 [E] 20110531 13:53:25 CET Bad status sensor P1a
26638 [E] 20110530 08:10:08 CET TRD pressure(s) out of range
    
```

- Every box should be green,
- Temperature and Pressure values should be in the operating ranges,
- check the browser for warnings or errors

TRDGAS - S

TRDGAS-S@pcpoc61 FS 16-May-11

TRDGas Status Monitor

Directory /Data/BLOCKS/HKLR/CDP

File L 0 0 2 4 4 2 5 **File** 0038 147 **READ** **CLEAR**

Time 20110527 21:31:59 **Time** 20110611 16:41:30 **PRINT**

TRDGas Press	OK	TRD Press	OK	Leak	OK	CLEAR
TRDGas Temp	OK	TRD Temp	OK			

```

35990 [E] 20110609 04:06:40 CET DP out of range [CH 2 OUTLET] dp 387 [Pumps D D]
35990 [E] 20110609 04:06:38 CET DP out of range [CH 2 OUTLET] dp 387 [Pumps D D]
35455 [E] 20110608 12:07:46 CET Bad status sensor P1d
35455 [E] 20110608 12:07:46 CET Bad status sensor P1c
35455 [E] 20110608 12:07:46 CET Bad status sensor P1b
35455 [E] 20110608 12:07:46 CET Bad status sensor P1a
31208 [E] 20110604 02:35:44 CET TRD pressure(s) out of range
31208 [E] 20110604 02:35:44 CET p_TRD: 320 mbar [Pumps D D]
30786 [E] 20110603 15:17:19 CET TRD pressure(s) out of range
30786 [E] 20110603 15:17:19 CET p_TRD: 318 mbar [Pumps D D]
27877 [E] 20110531 13:53:25 CET Bad status sensor P1d
27877 [E] 20110531 13:53:25 CET Bad status sensor P1c
27877 [E] 20110531 13:53:25 CET Bad status sensor P1b
27877 [E] 20110531 13:53:25 CET Bad status sensor P1a
26638 [E] 20110530 08:10:08 CET TRD pressure(s) out of range
    
```

$$(dP_{(In)} - dP_{(out)}) / 2 = 0 \quad 50 \text{ mbar}$$

Temperatures:
All TRDGas
DTS-Sensors
Range:
-30 C to +50 C

Pressures TRDGas:
Xe/CO₂ / Mix. Vol.
Range:
Xe: <150 bar
CO₂: < 80 bar
Mix.Vol.: < 4.6 bar

Pressures TRD:
BoxC
Range:
Pump off: 900 to 1500 mbar
Pump on half speed:
P3: 1220 to 1820 mbar
P4: 580 to 1180 mbar

SidePanel DTS-
Sensors:
Ranges: +5 C to
+40 C



UG CHD (Critical Health Data)

Bit Definition:

AMS-02 CHD Time-Mux Data ID=14
TRD Gas Status

UG-CHD Bits from UG-CtrlTask

Monitor MultiCast Server:

```
$ TRDCHD-M -m MCC (Shuttle)
           -m HOSC (ISS)
```

Bit	7	6	5	4	3	2	1	0
6	P-TRD (1:low;2:high;3:inv)		P-Mix (1:low;2:high;3:inv)		P-CO2 (1:low;2:high;3:inv)		P-Xenon (1:low;2:high;3:inv)	
7	Pump off at over temperature	Valve disabled at over temperature	Heater off at over temperature	Gas closed by leak detection	Closed gas segment differing from P3-P4		Gas circulation drop wrong	Data Invalid
8	T-V1/2/3 (1:low;2:high;3:inv)		T-PH (1:low;2:high;3:inv)		T-CO2 (1:low;2:high;3:inv)		T-Xenon (1:low;2:high;3:inv)	
9	T-UG/PD (1:low;2:high;3:inv)		T-BP/Mix (1:low;2:high;3:inv)		T-Can (1:low;2:high;3:inv)		T-V4/6/18 (1:low;2:high;3:inv)	

STA INV – not updated
-> UG-Task running ?

```
XE P 20.. 175bar
CO2 R 10.. 100bar
MIX E 0.. 13bar
BXC S 800..1200mbar
DRP S Pin-Pout = 0 / 650mbar
    For CP off half
```

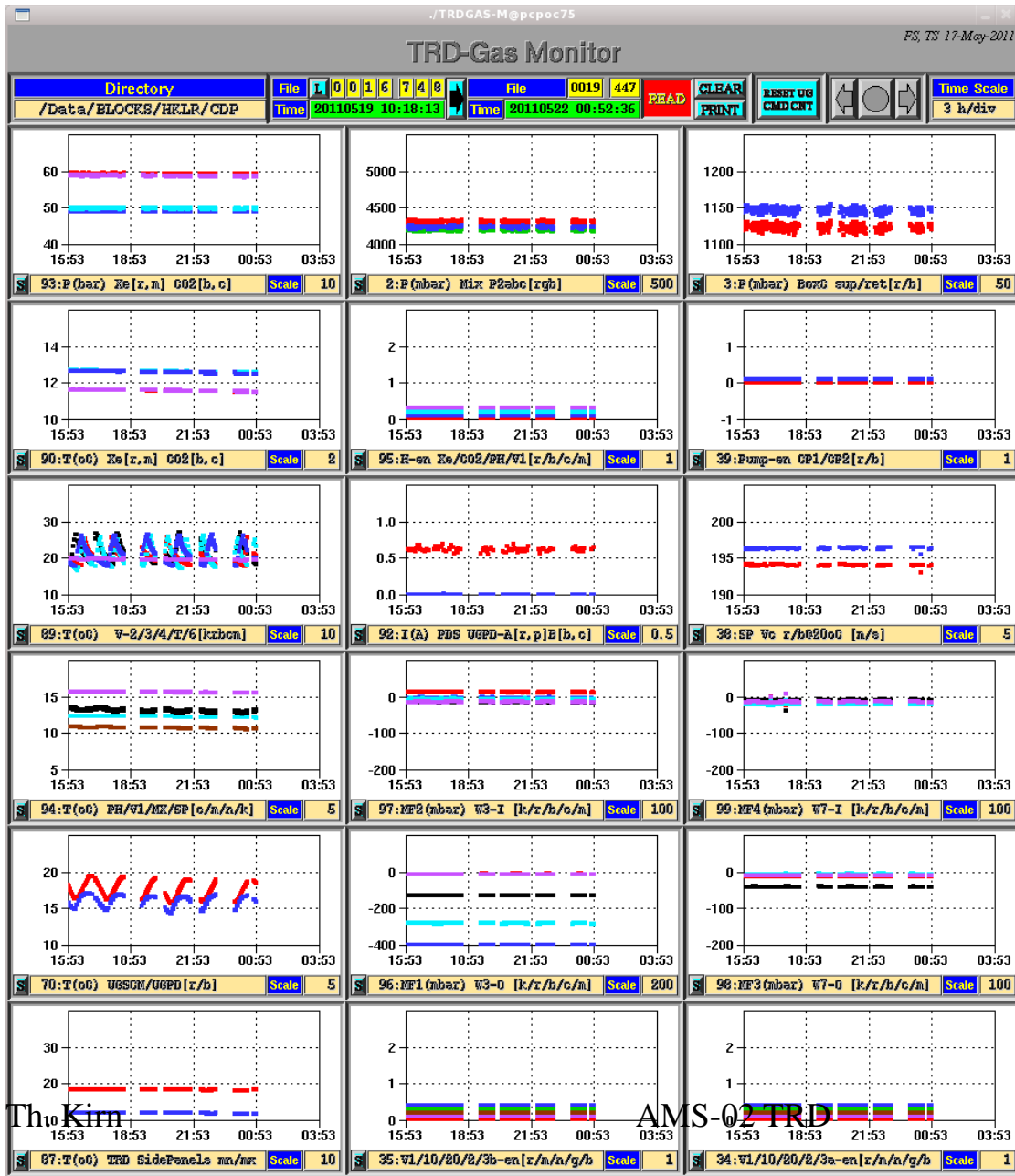
LEAK detected by UG-CtrlTask

```
XE T -30..+60degC
CO2 E -50..+60degC
PH M -15..+60degC
MVS P -15..+60degC
MVC E -15..+60degC
BXC R +5..+40degC
MIX T -15..+60degC
```

```
trd@pcposj0:~/COMMANDING/TRDGAS
File Edit View Terminal Help
[trd@pcposj0 TRDGAS]$
[trd@pcposj0 TRDGAS]$
[trd@pcposj0 TRDGAS]$ TRDCHD-M -m FS1553
MCastOpenFrom: IP: [224.0.0.24] PORT: [62022] IF: [eth0]
INV
INV
INV
INV
INV
INV
INV
INV
INV
INV
INV
OK Low OK OK HI BAD OK ??? ??? ??? ??? ??? ???
OK Low OK OK HI BAD OK ??? ??? ??? ??? ??? ???
OK Low OK OK HI BAD OK ??? ??? ??? ??? ??? ???
OK Low OK OK HI BAD OK ??? ??? ??? ??? ??? ???
OK Low OK OK HI BAD OK ??? ??? ??? ??? ??? ???
OK Low OK OK HI BAD OK ??? ??? ??? ??? ??? ???
OK Low OK OK HI BAD OK ??? ??? ??? ??? ??? ???
STA XE CO2 MIX BXC DRP LEAK XE CO2 PH MVS MVC BXC MIX
99 --- PRESSURES --- ----- TEMPERATURES -----
```



TRD-Gas Monitor Program: TRDGAS-M



Dir: selected interface
File: DDDD/NNN

right-click READ

PDS-UGPD current
from PDS

Other Data from UG
(1st DTsdata after 5min)

JMDC output in terminal



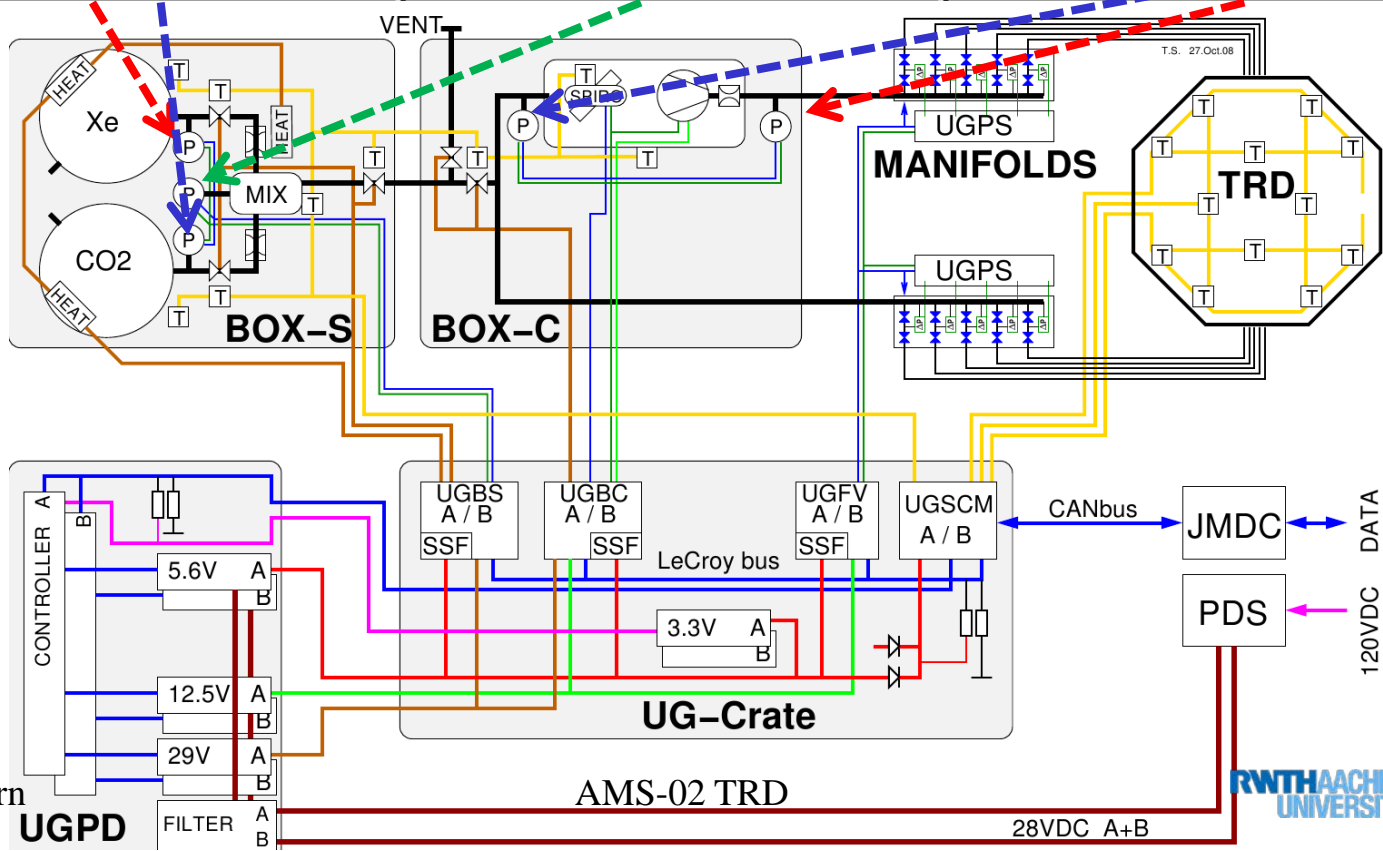
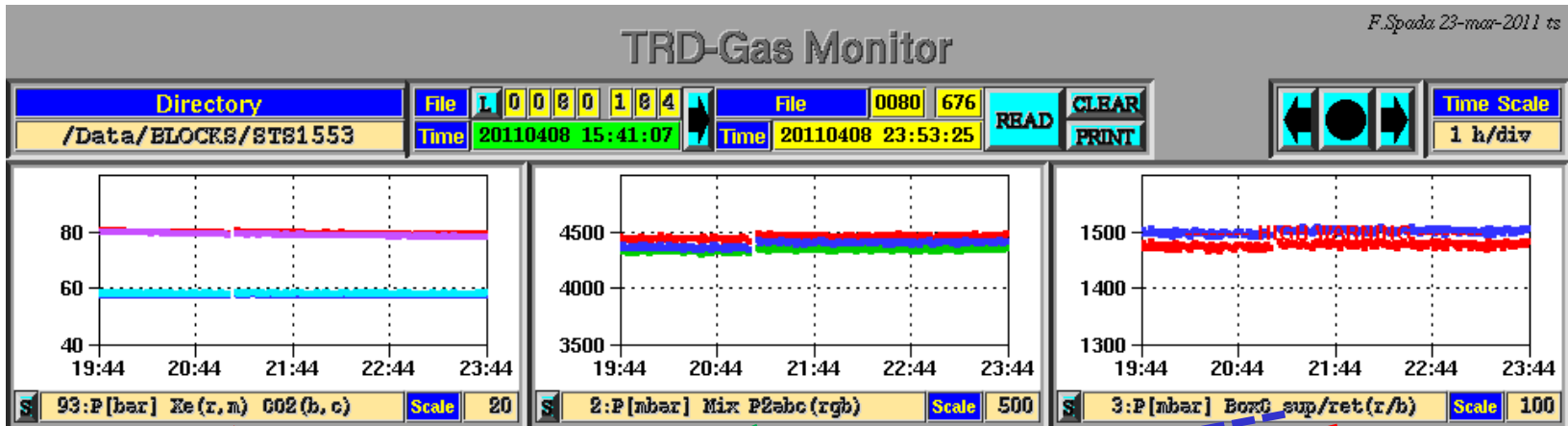
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AMS-02 TRD



TRD-Gas Monitor Program: TRDGAS-M

F.Spada 23-mar-2011 ts



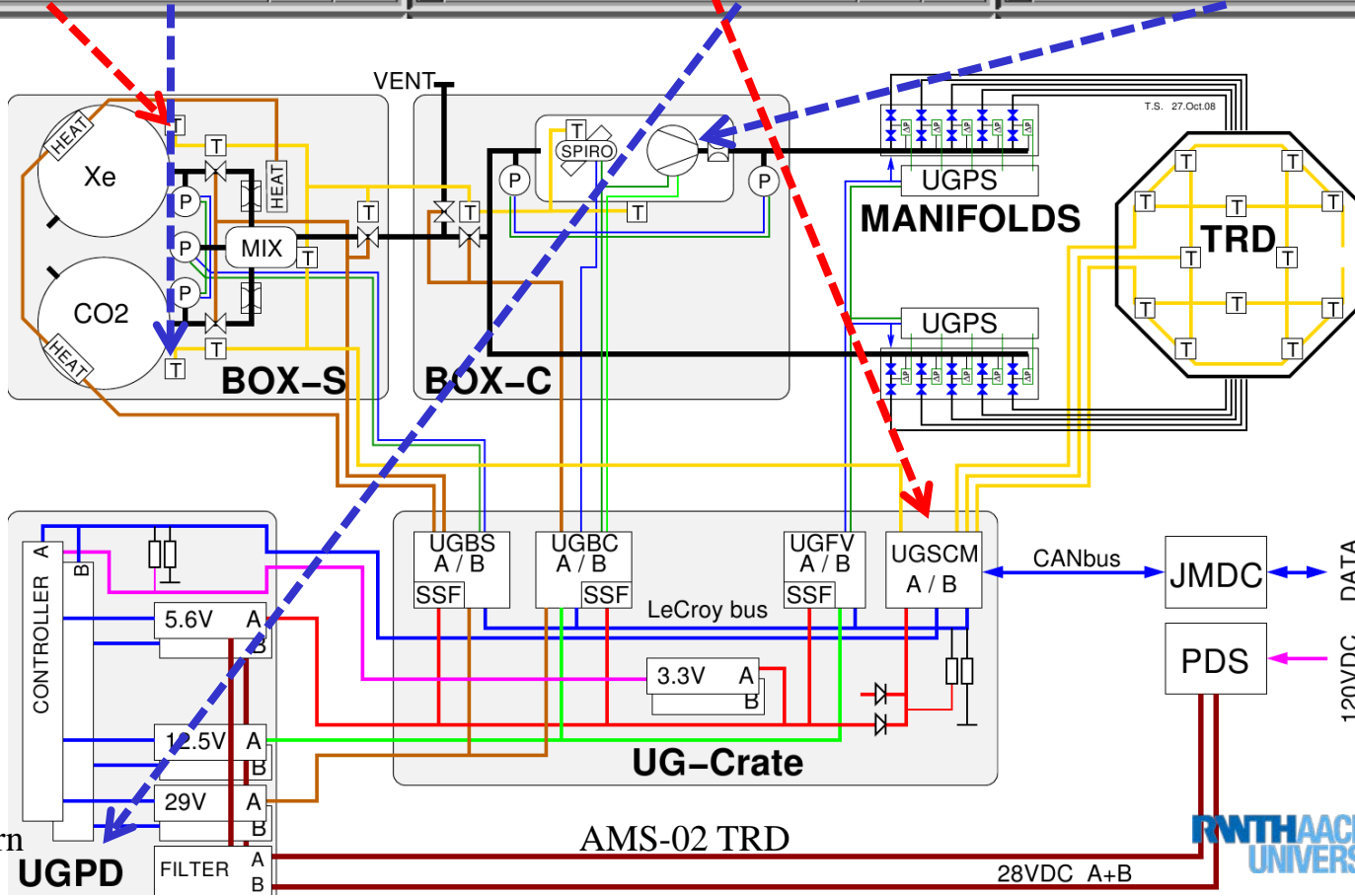
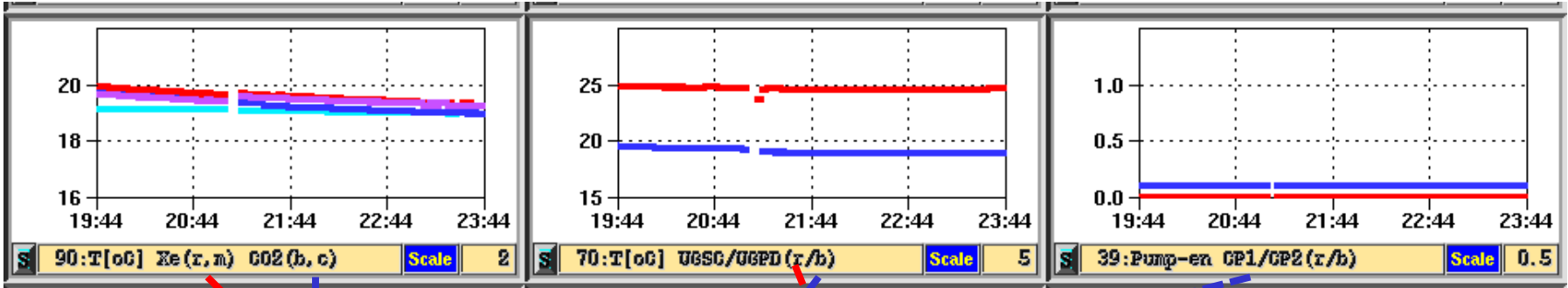
Th. Kirn

AMS-02 TRD

28VDC A+B



TRD-Gas Monitor Program: TRDGAS-M

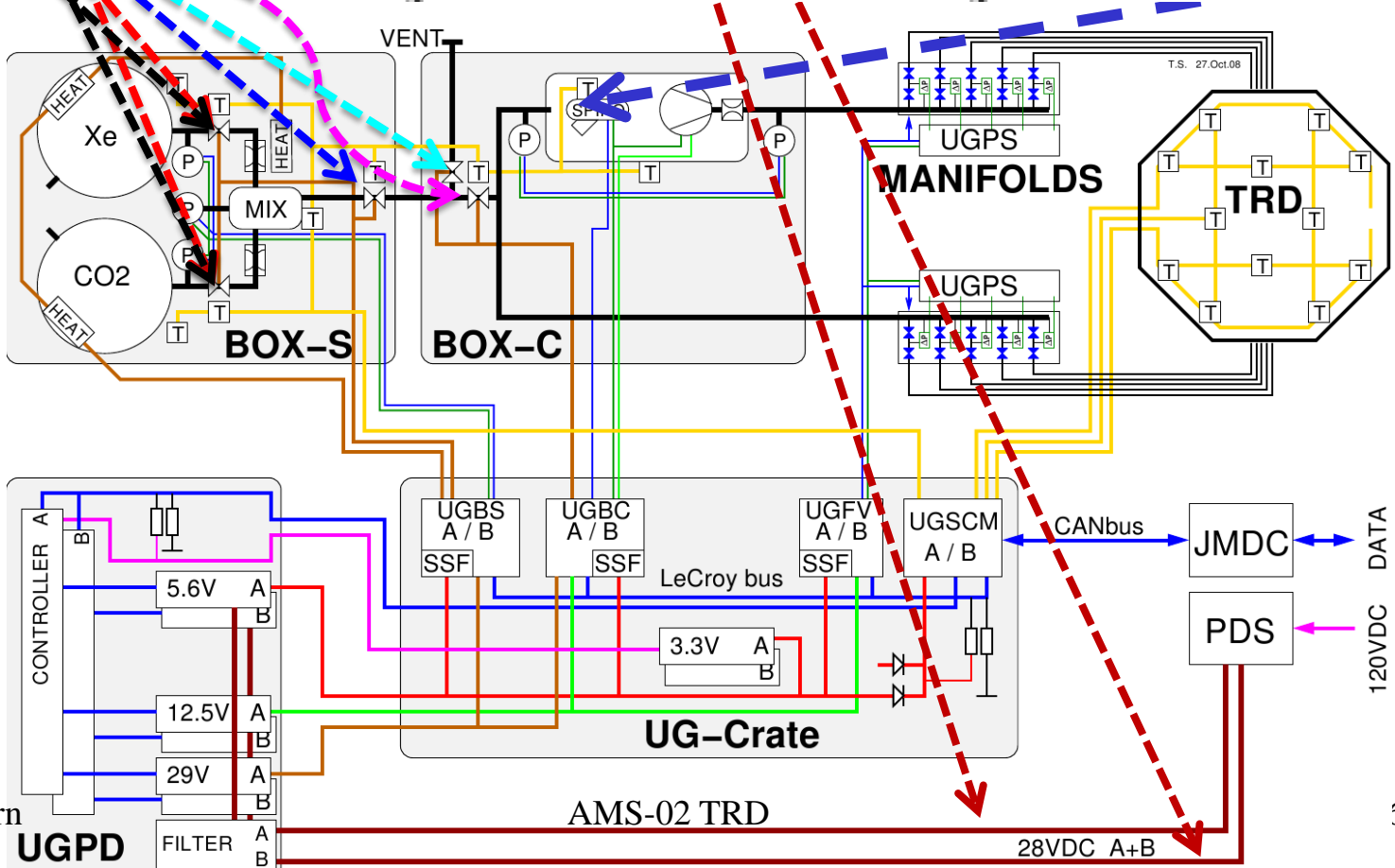
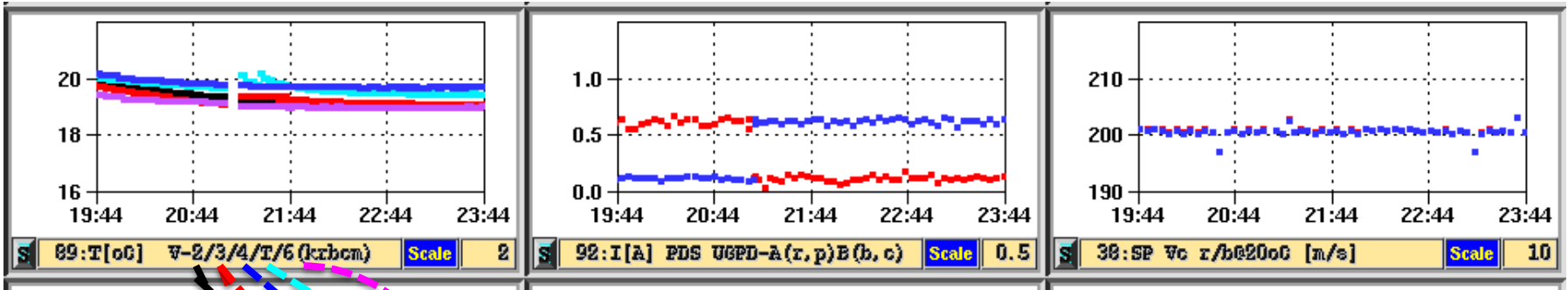


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AMS-02 TRD



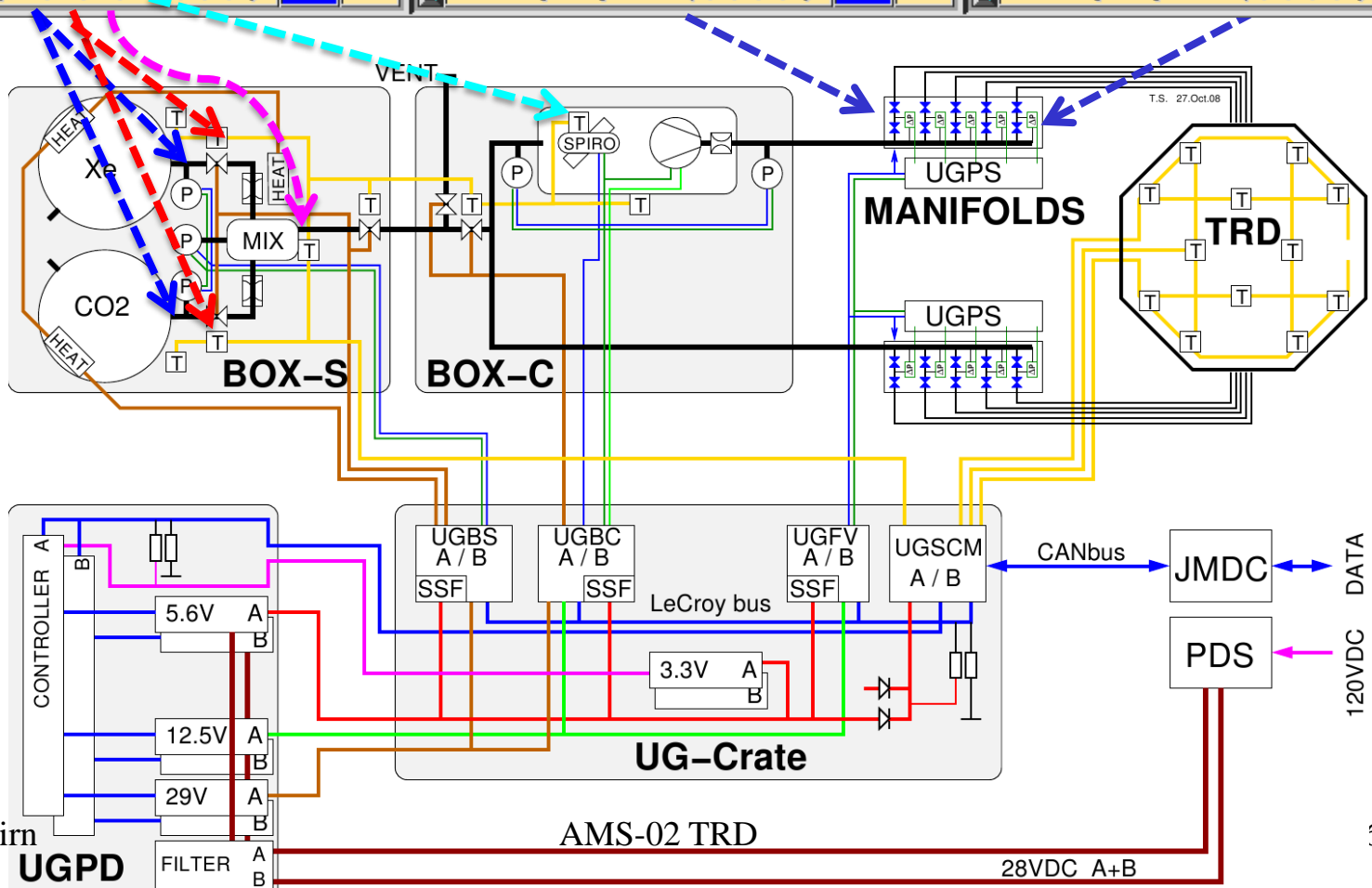
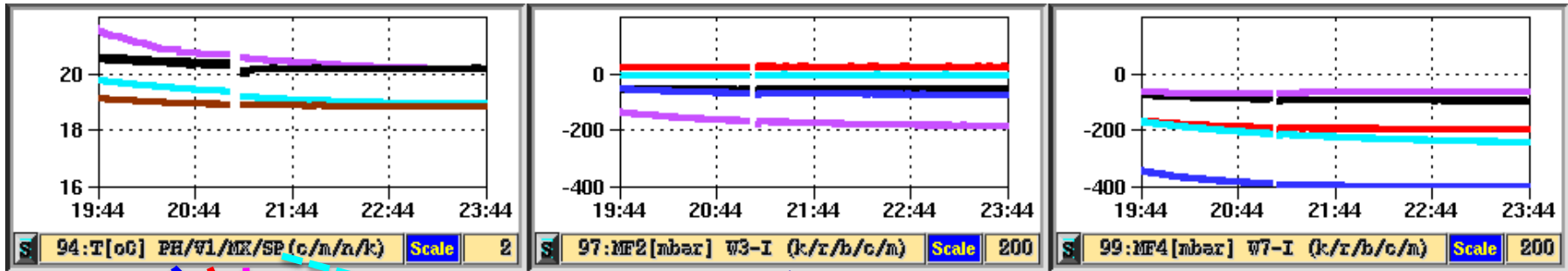
TRD-Gas Monitor Program: TRDGAS-M



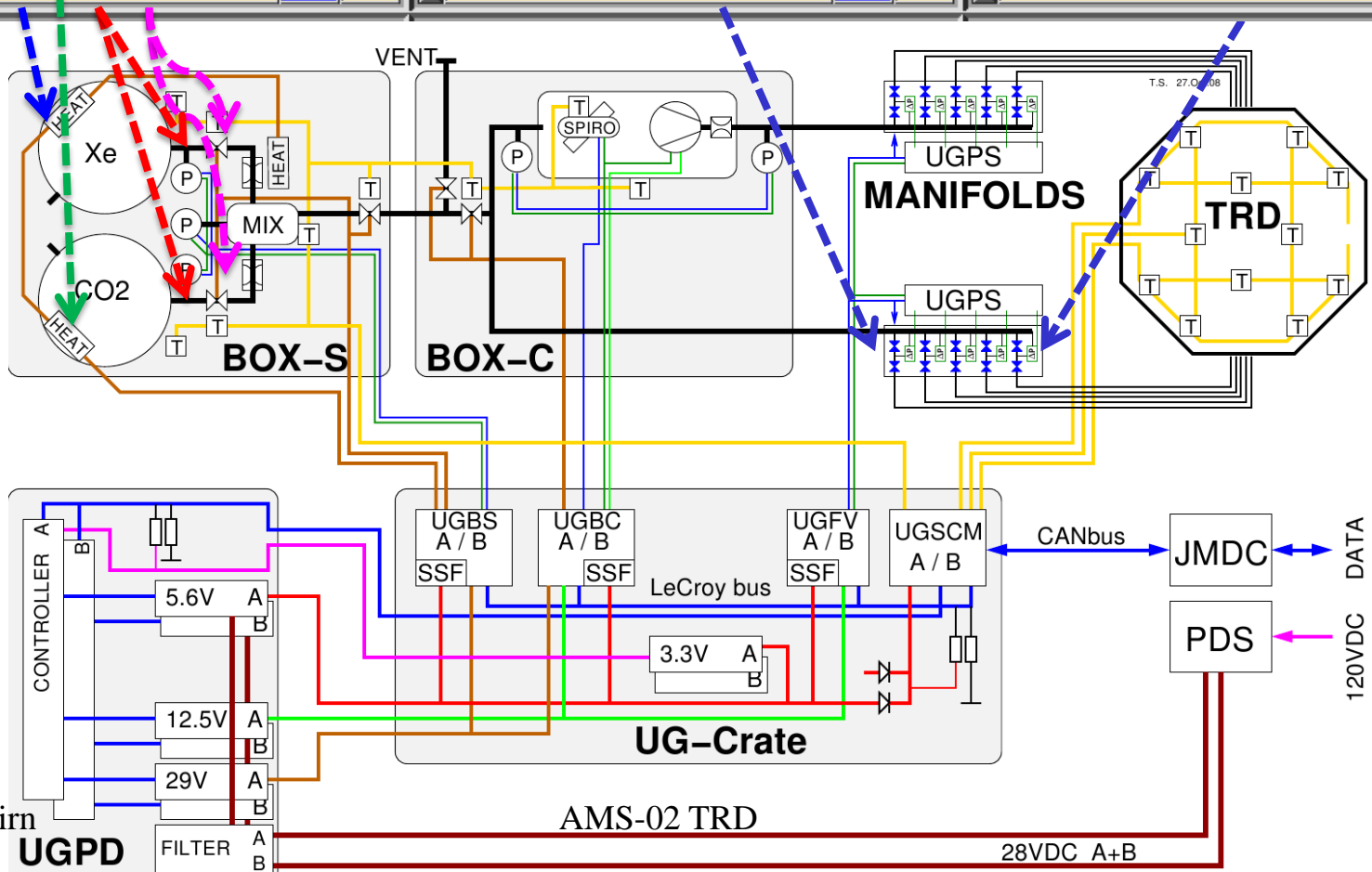
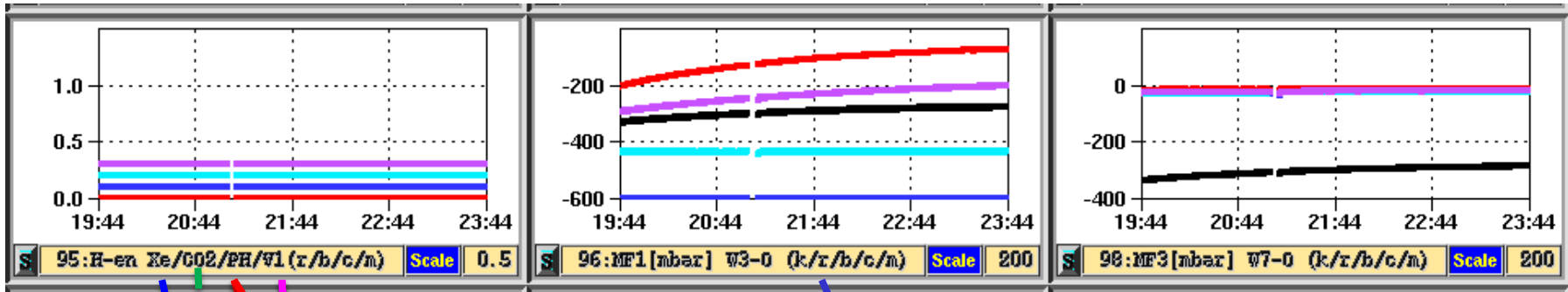
Th. Kirn

AMS-02 TRD

TRD-Gas Monitor Program: TRDGAS-M



TRD-Gas Monitor Program: TRDGAS-M



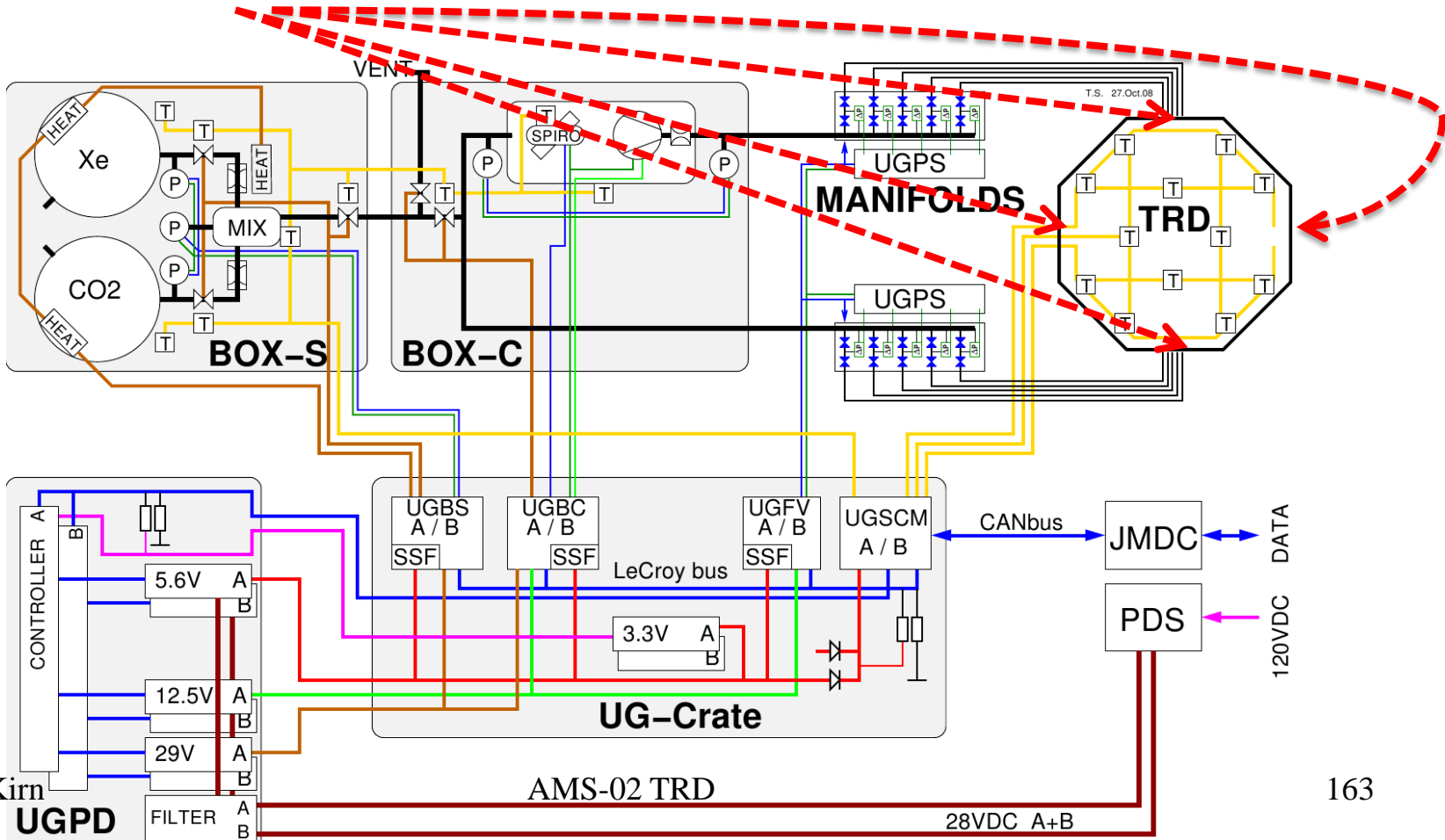
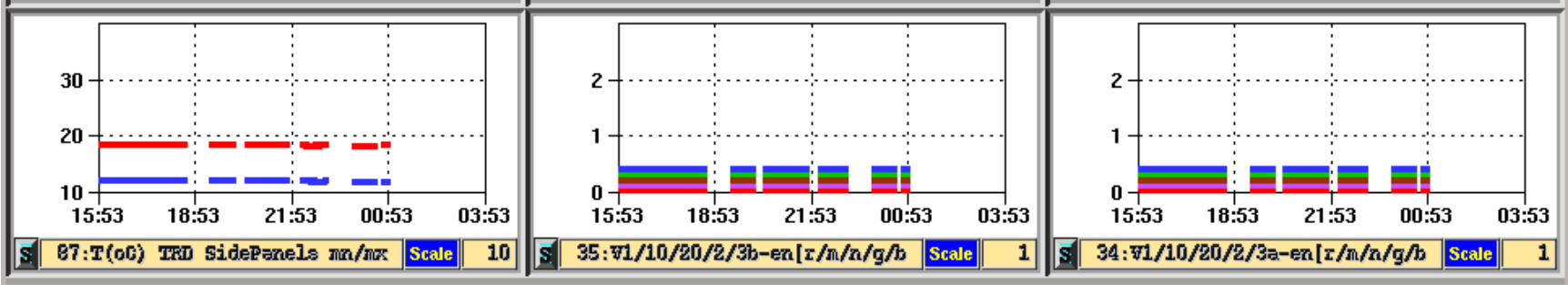
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AMS-02 TRD

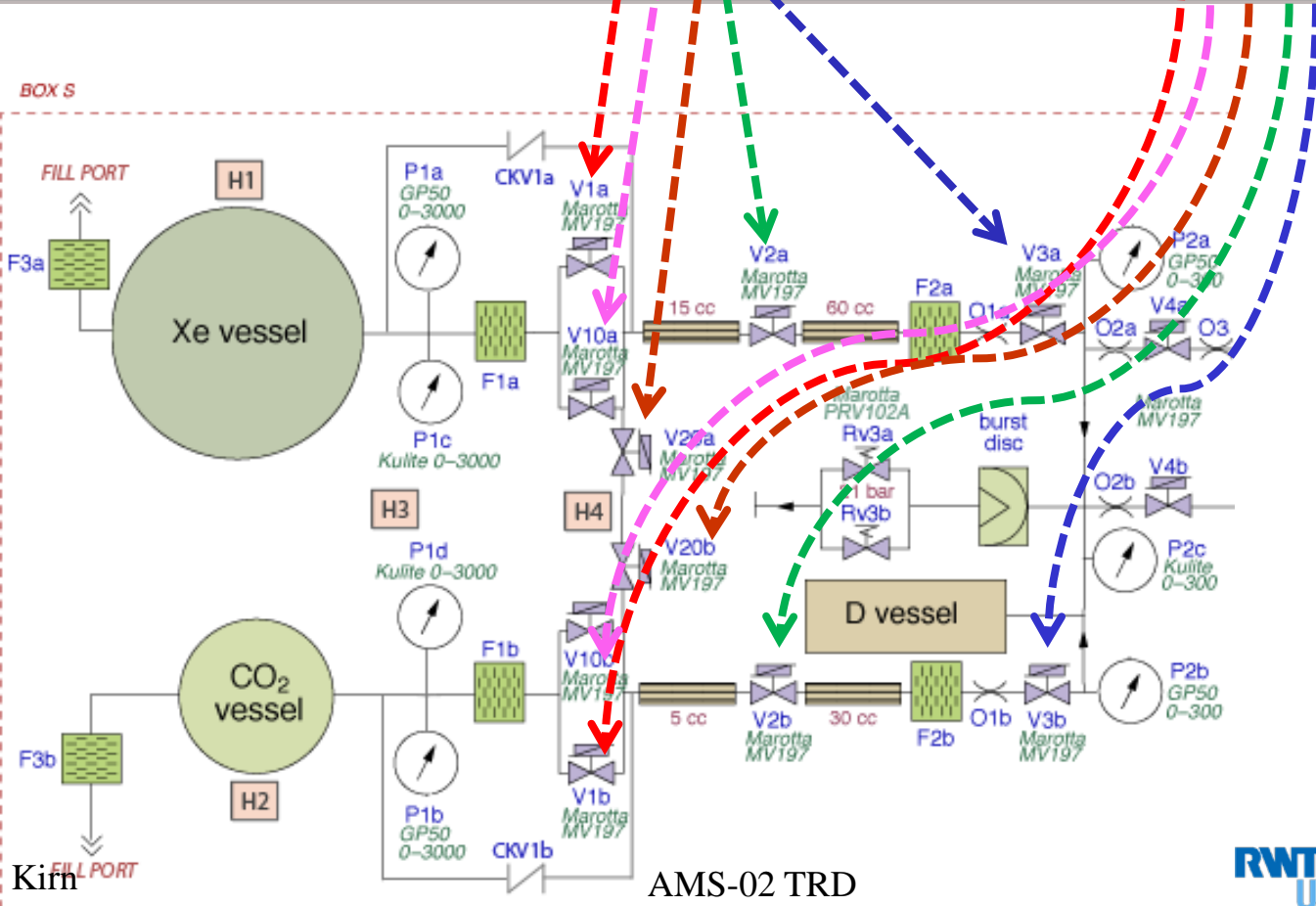
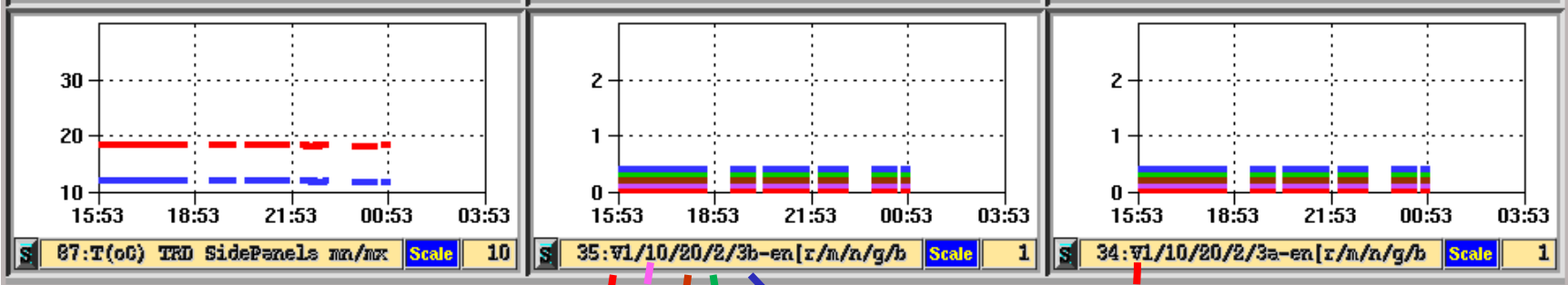
28VDC A+B



TRD-Gas Monitor Program: TRDGAS-M



TRD-Gas Monitor Program: TRDGAS-M



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AMS-02 TRD

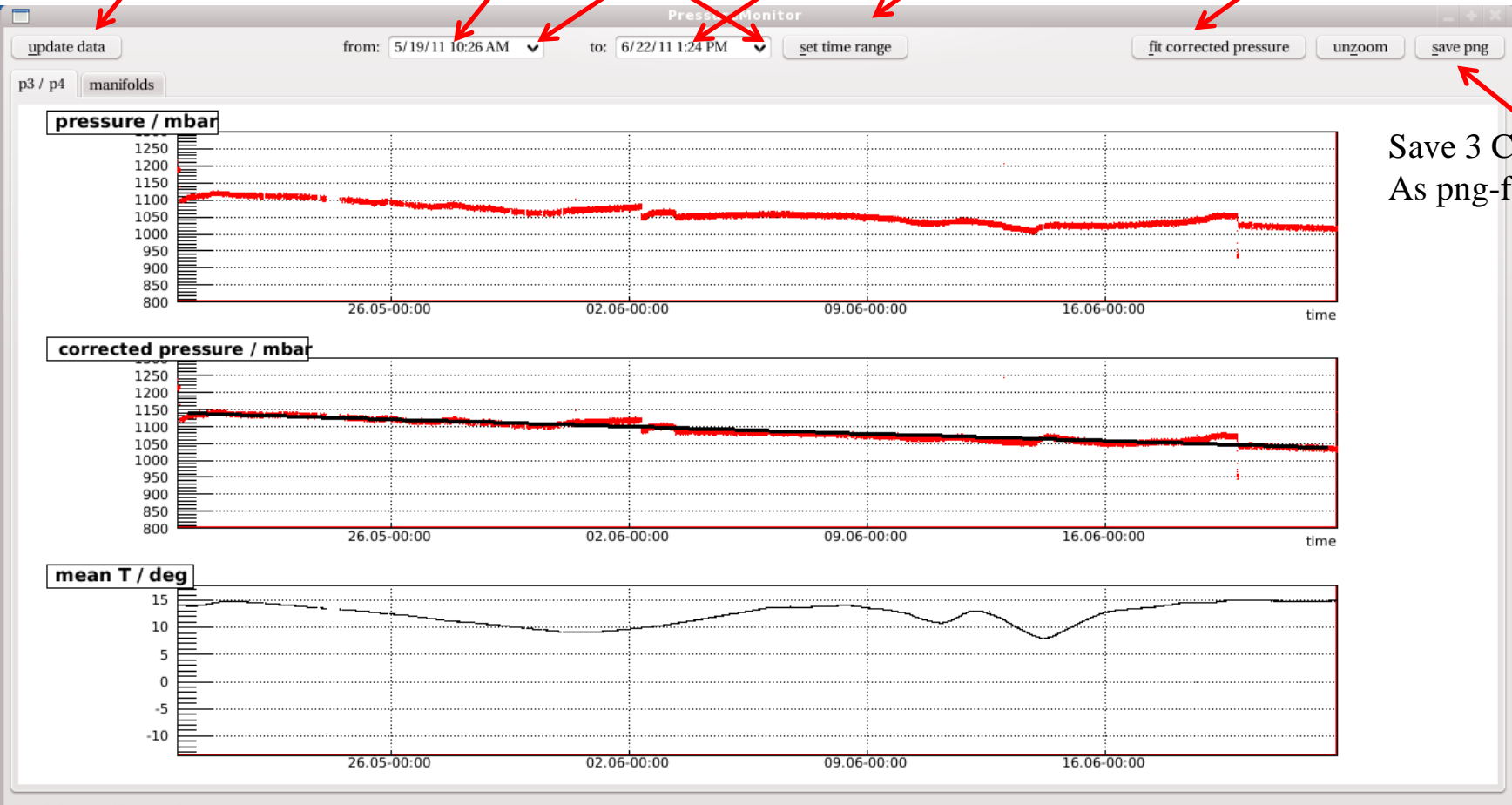
TRD-Gas Monitor Program: PressureMonitor

Actualize data

Chose Time Range,
Start (Calendar) End

Set chosen
time range

Fit to temperature
corrected pressure
in chosen time range



Save 3 Canvas
As png-file





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AMS-02 TRD