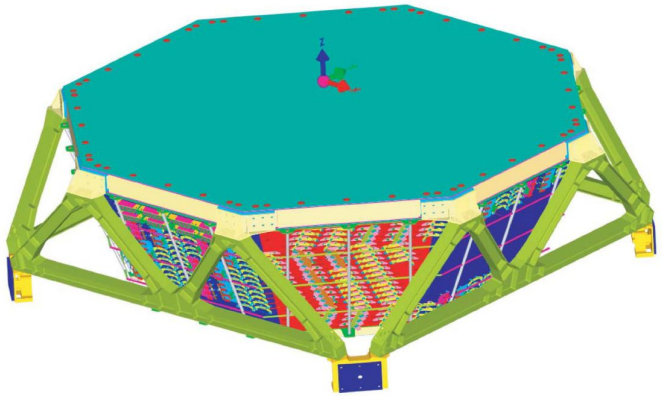
AMS TIM and General Meeting

Status of AMS TRD



Th. Kirn
I. Phys. Institute B
RWTH Physics AC-I

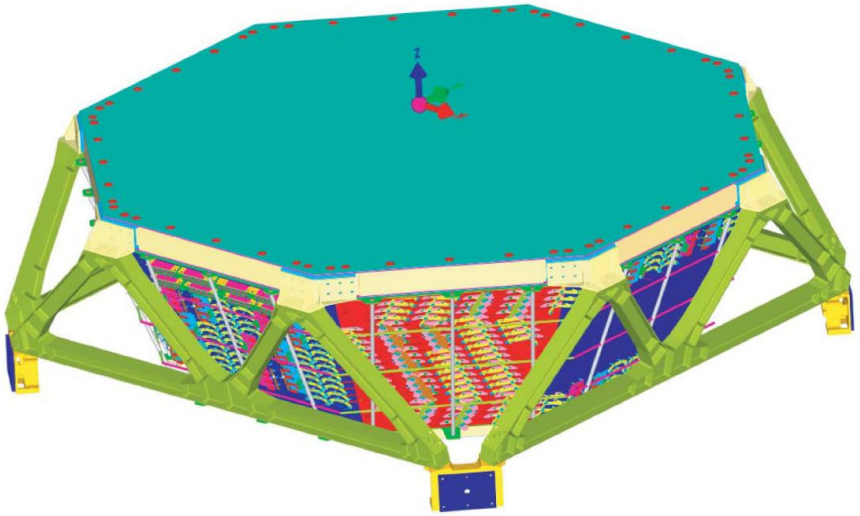
Houston JSC, 30th October 2002

1.)	TRD Production & Testbeam	Th. Kirn	50 min
2.)	TRD Electronics & Testbeam	W. deBoer	20 min
3.)	TRD Box S	R. Becker	15 min
4.)	TRD Box C	P. Fischer	15 min
5.)	TRD Manifolds	J. Burger	15 min

TRD Production Status

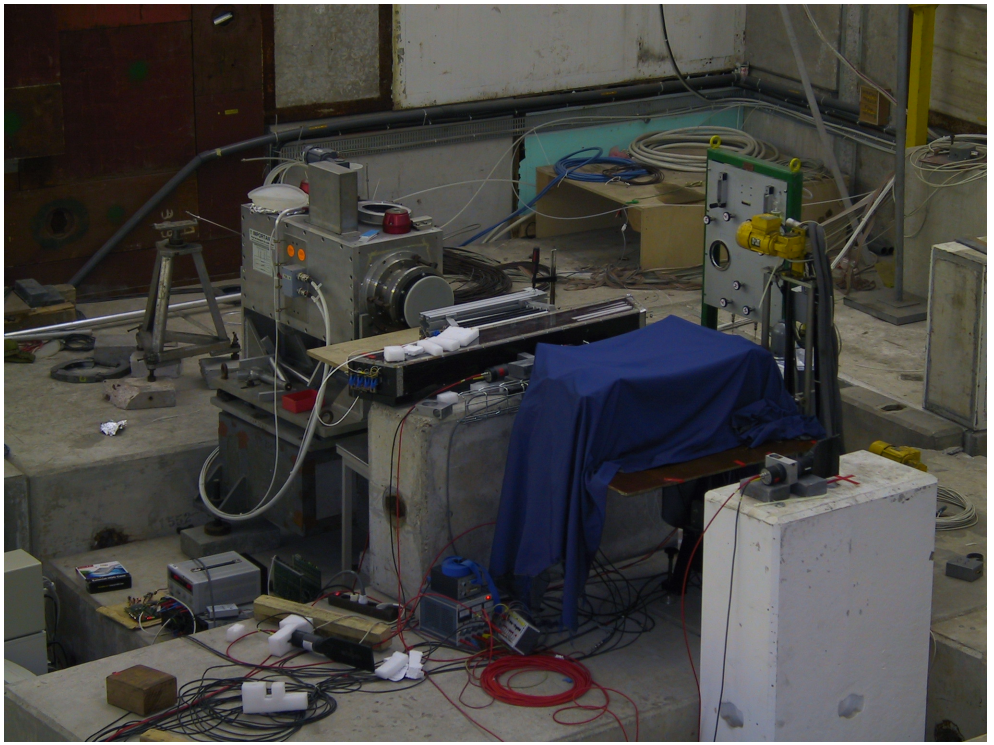
S. Fopp, K. Lübelsmeyer, W. Karpinski, Th. Kirn, S. Schael
G. Schwering, Th. Siedenburg, R. Siedling, A. Schultz von Dratzig

1.) Support Structure

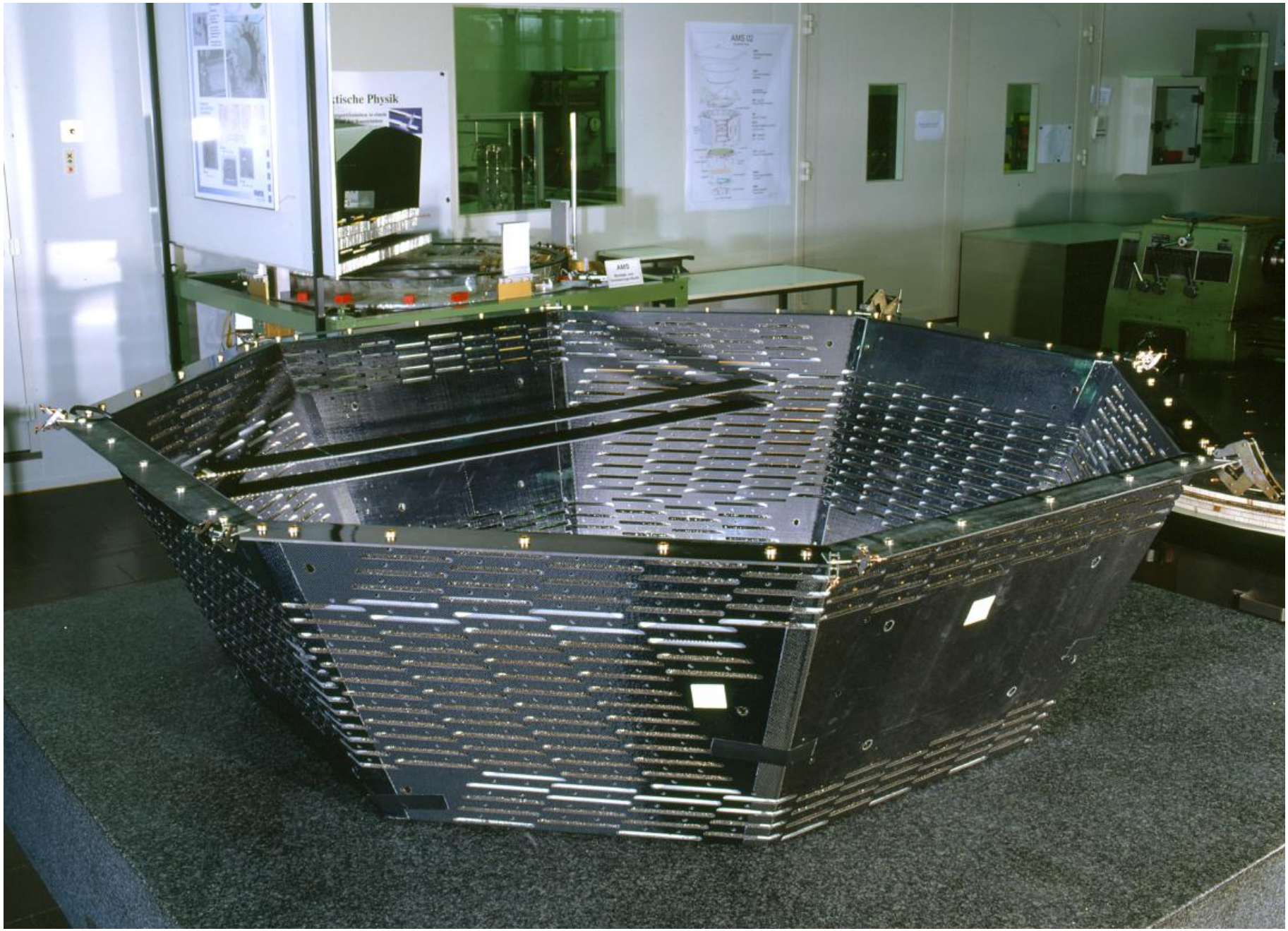


2.) Straw Module Status

3.) Testbeam



TRD Support Structure



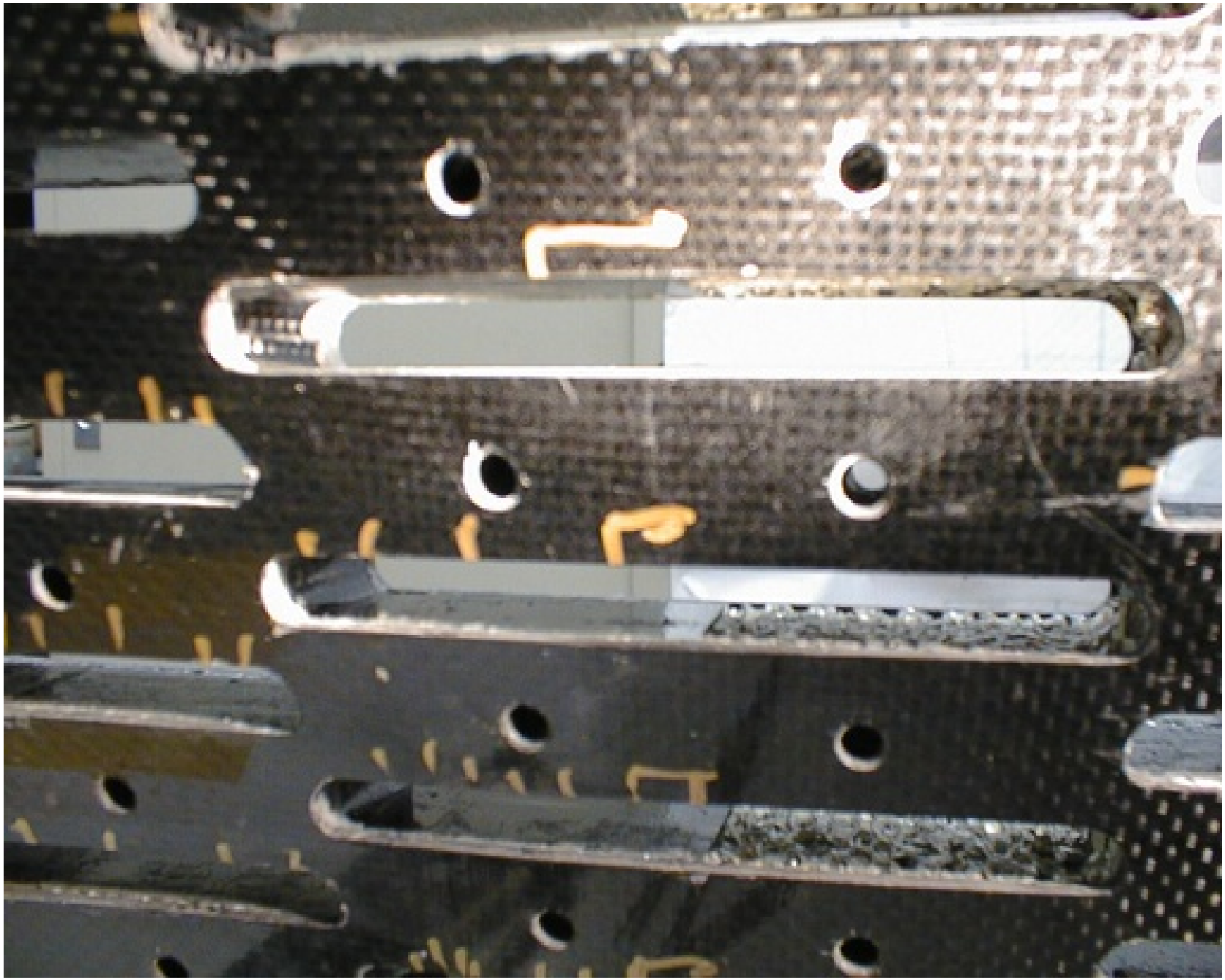
TRD Support Structure

Octagon panels:

Slit cladding:
CFC Inserts to protect Straw Modules

90° panels ready
45° panels to be done

TRD Support Structure

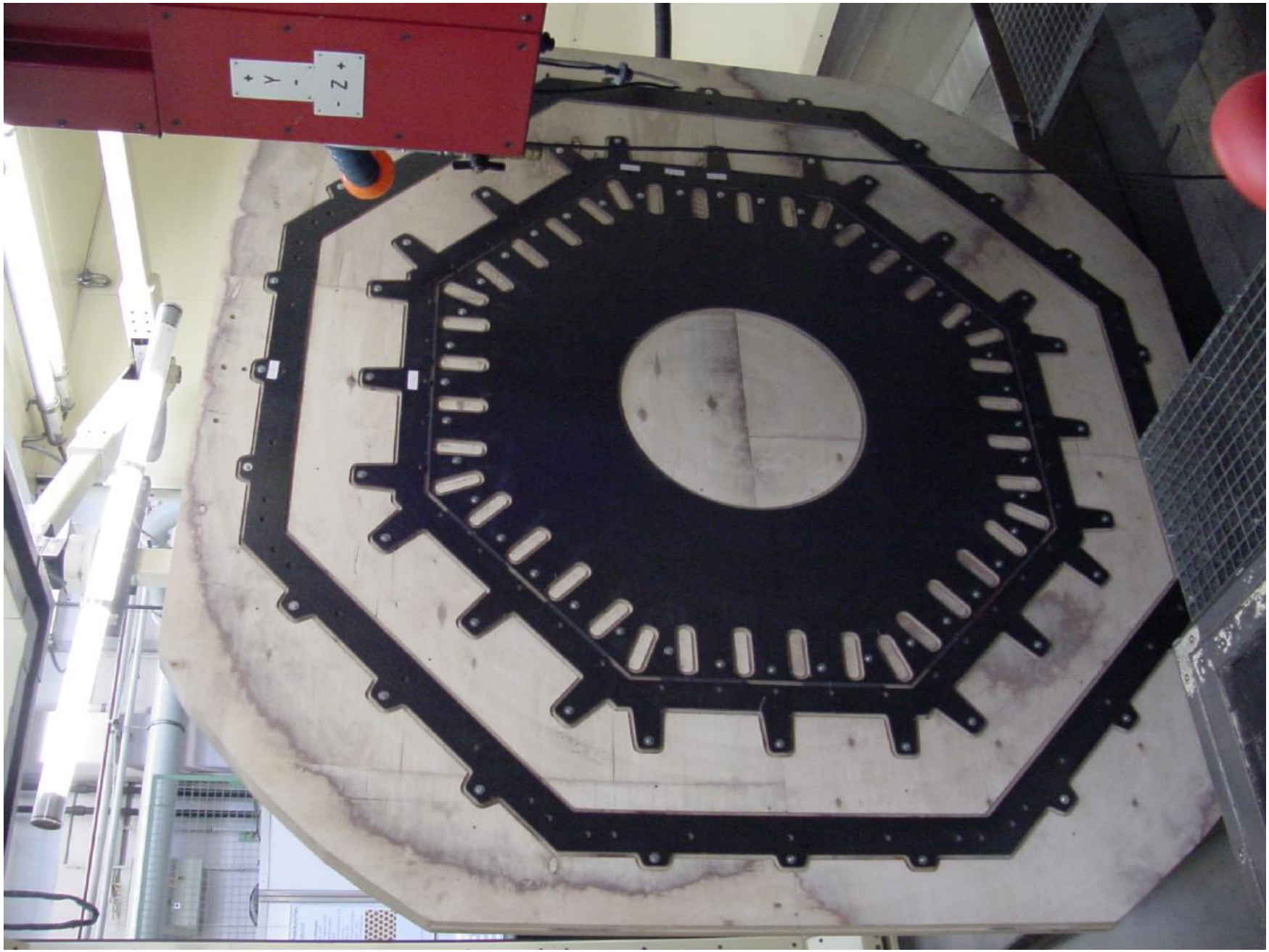


TRD Support Structure

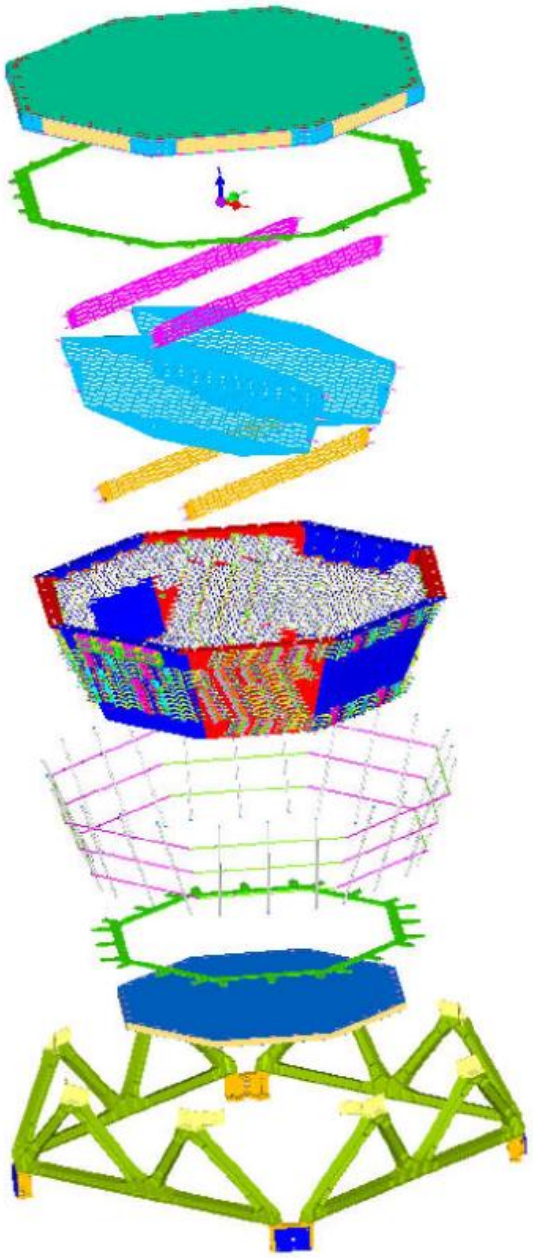
Lower HC Plate

TRD Support Structure

Reinforcement Rings, Milling @ IPT

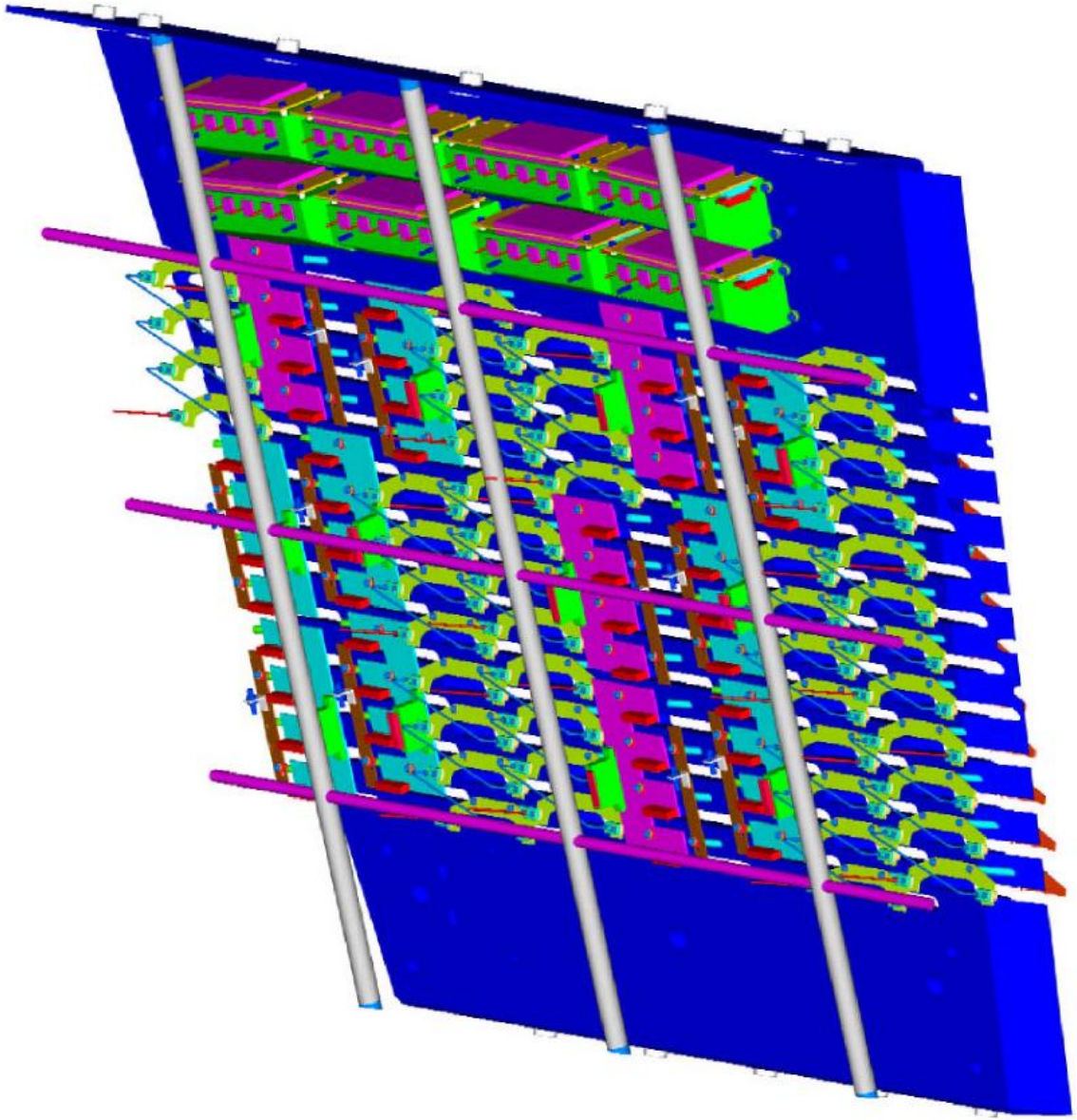


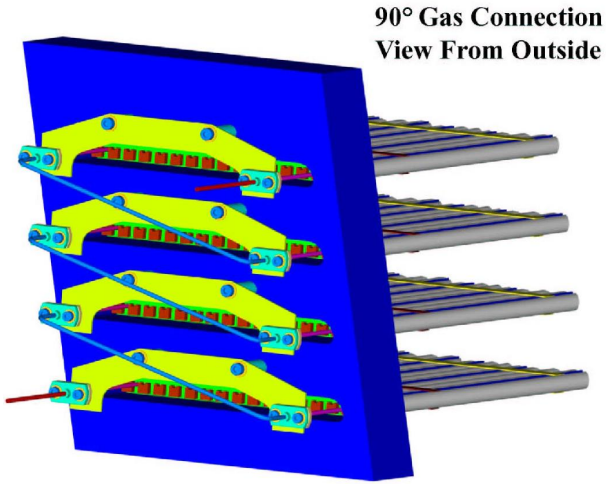
TRD Support Structure



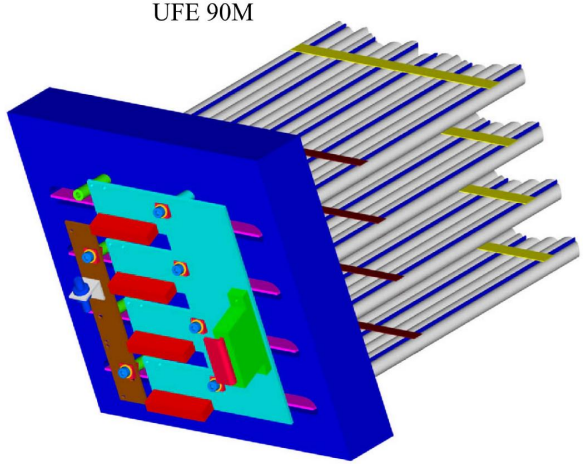
- Upper Support Plate
- Upper Reinforcement Ring $\surd$
- Bulkheads
- Octagon panels $\surd$
- Grid (Cable & Tube Support)
- Lower Reinforcement Ring $\surd$
- Lower Support Plate $\surd$
- M-Structure

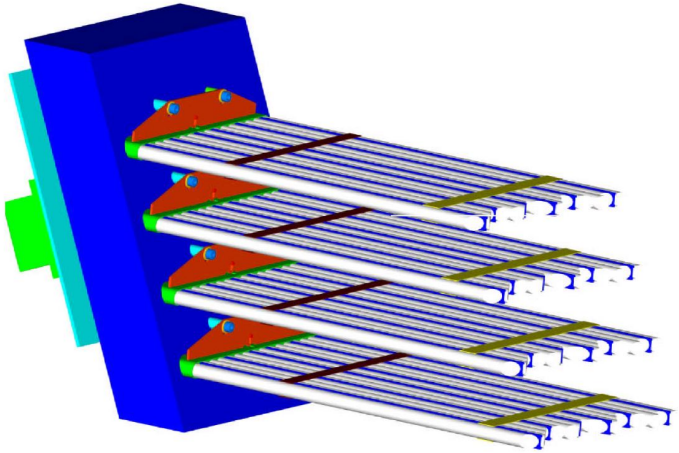
TRD Support Structure



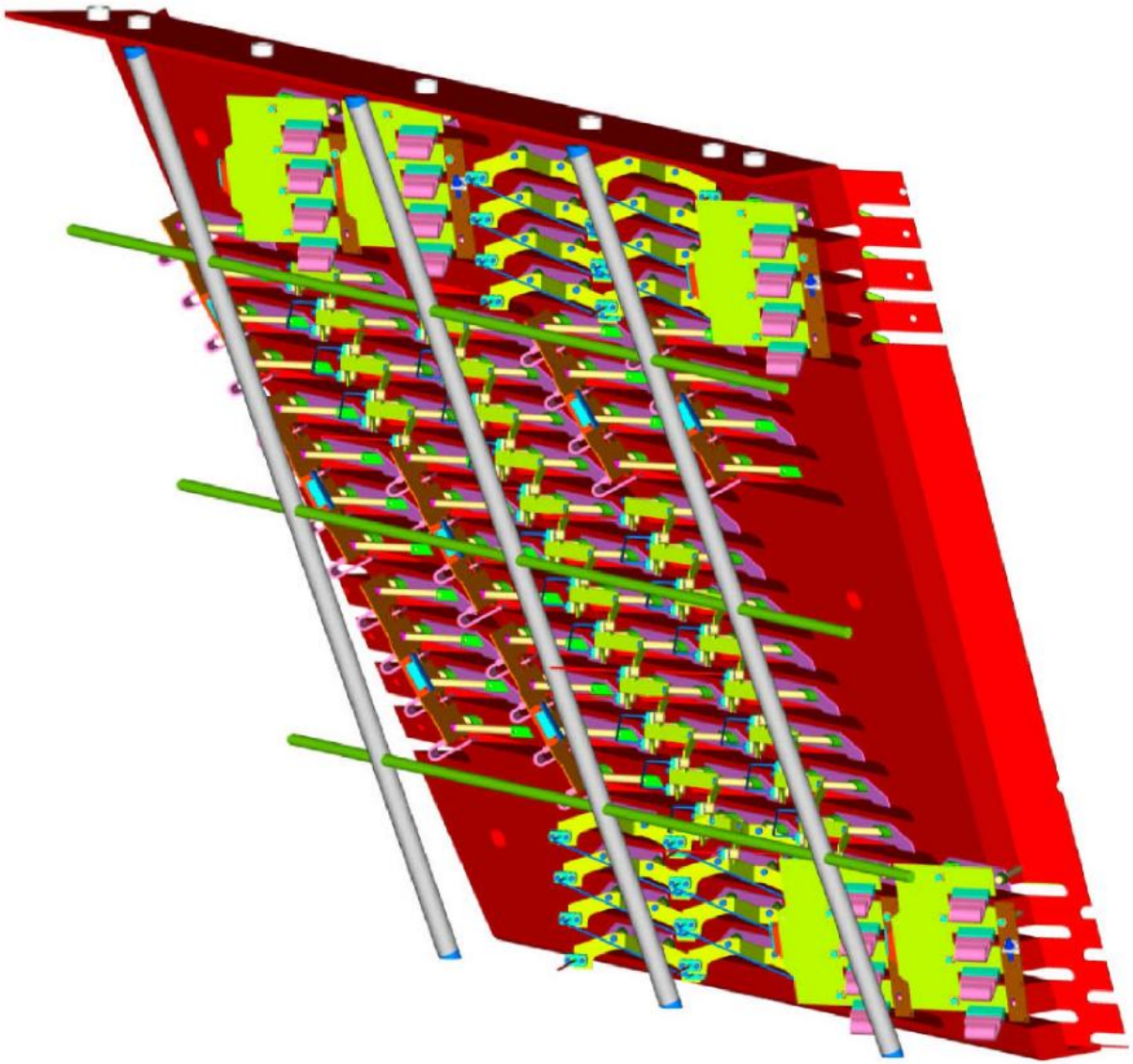


UFE 90M

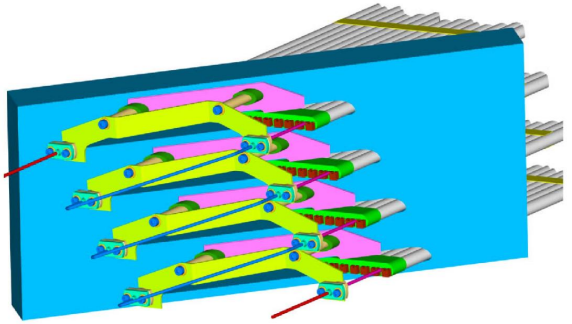




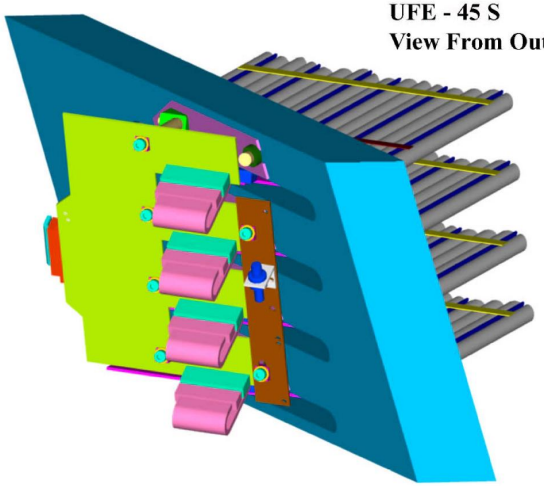
TRD Support Structure



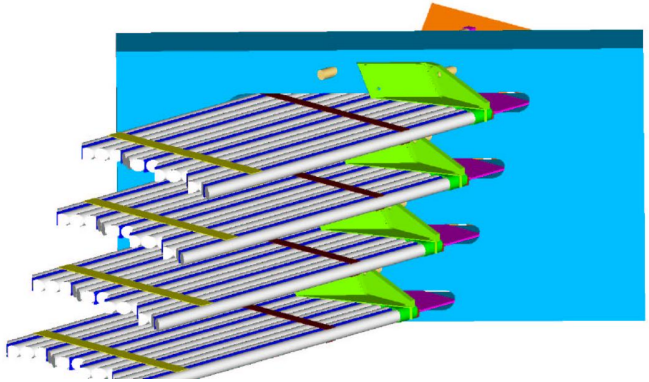
45° Gas Connection
With Chamber Fixation
View From Outside



UFE - 45 S
View From Outside



45° Chamber Fixation
View From Inside



TRD Straw Module Status

TRD Modules Production Status

1. **8 modules for long term test stand produced**

2. **4 modules for space qualification produced**
   will be tested next week

3. **4/328 modules for AMS-02 TRD produced**
   will be tested next week
   continuous production has started

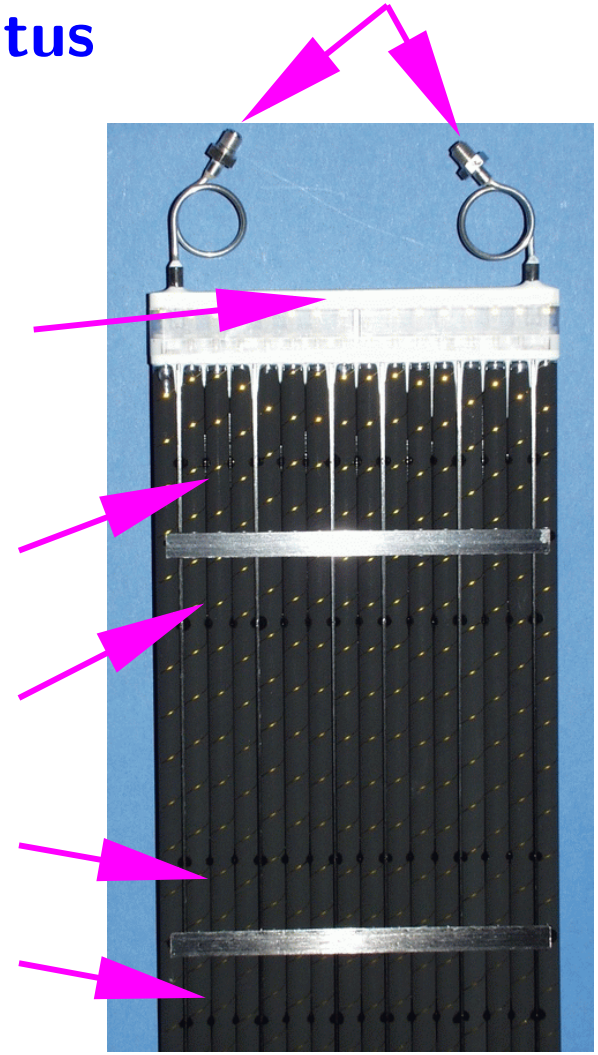
Measurements		
Wire Tension (g)	Leak Rate q (He) $10^{-4}\ \frac{mbar}{s}$	Gasgain Ar/CO_2 HV: 1350 V Flow: 1 l/h
100.68 ± 1.53	2.4	5503 ± 64
99.69 ± 1.89	2.1	5336 ± 53
99.49 ± 1.24	2.0	—
99.71 ± 1.23	2.3	5344 ± 76
101.38 ± 1.18	2.2	—
100.74 ± 1.66	2.0	5541 ± 76
100.53 ± 1.62	2.6	—
100.03 ± 1.00	2.0	5531 ± 117

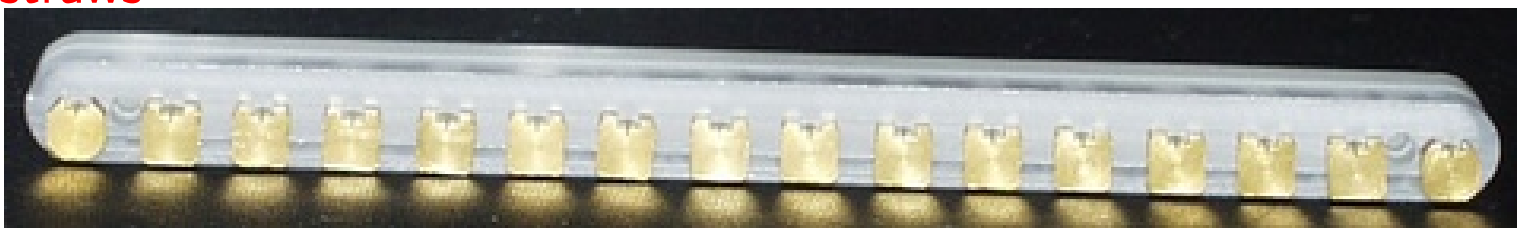
Straw Module Status

- 8 Longterm Straw Modules L=1549 mm,
  ($q \approx 2 \cdot 10^{-4} \frac{\mathrm{mbar}}{\mathrm{s}}$ (He))
  - Leaky gas connectors

- 4 Space Qualification Straw Modules
  L=1258, 1282, 1306, 1330 mm
  ($q \approx 2 - 5 \cdot 10^{-4} \frac{\mathrm{mbar}}{\mathrm{s}}$ (He))
  - Leaky gas connectors
  - Leaks at underside of endpieces
  - Leaks along straws

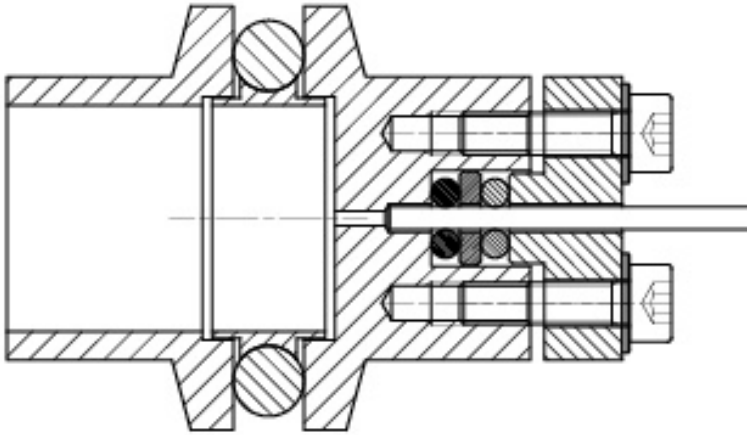
- 3 TRD Flight Straw Modules
  L=1540, 1564, 1588 mm
  ($q \approx 1 \cdot 10^{-4} \frac{\mathrm{mbar}}{\mathrm{s}}$ (He) $<$ diffusion rate)
  - Leaky gas connectors
  - Leaks at underside of endpieces
  - Leaks along straws

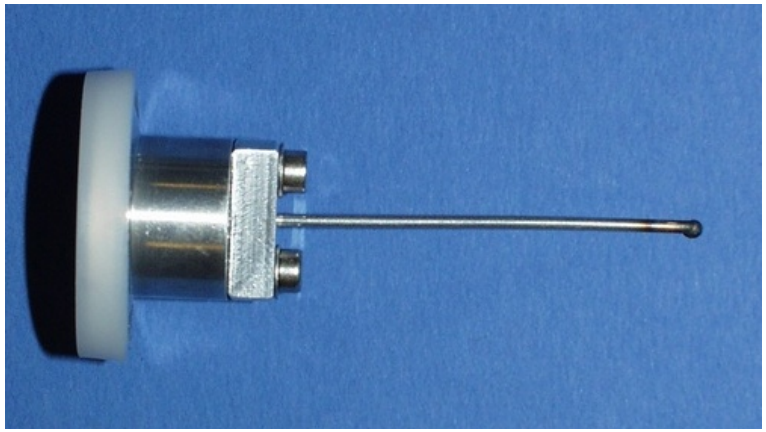




Gas Connectors

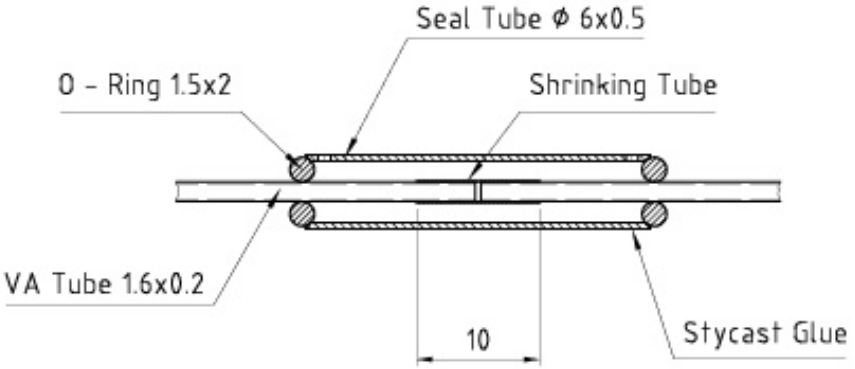
Double-O-Ring connector

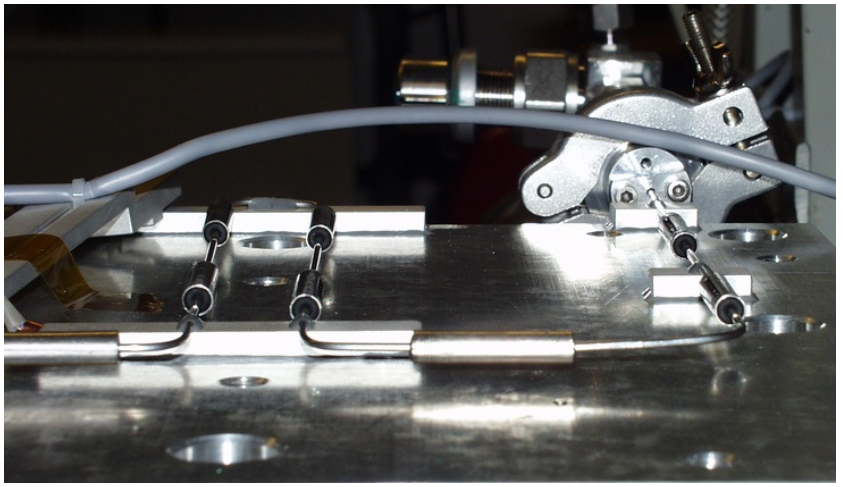




Leak rate: $q = 1 \cdot 10^{-6} \frac{l \cdot mbar}{s}$ (He)

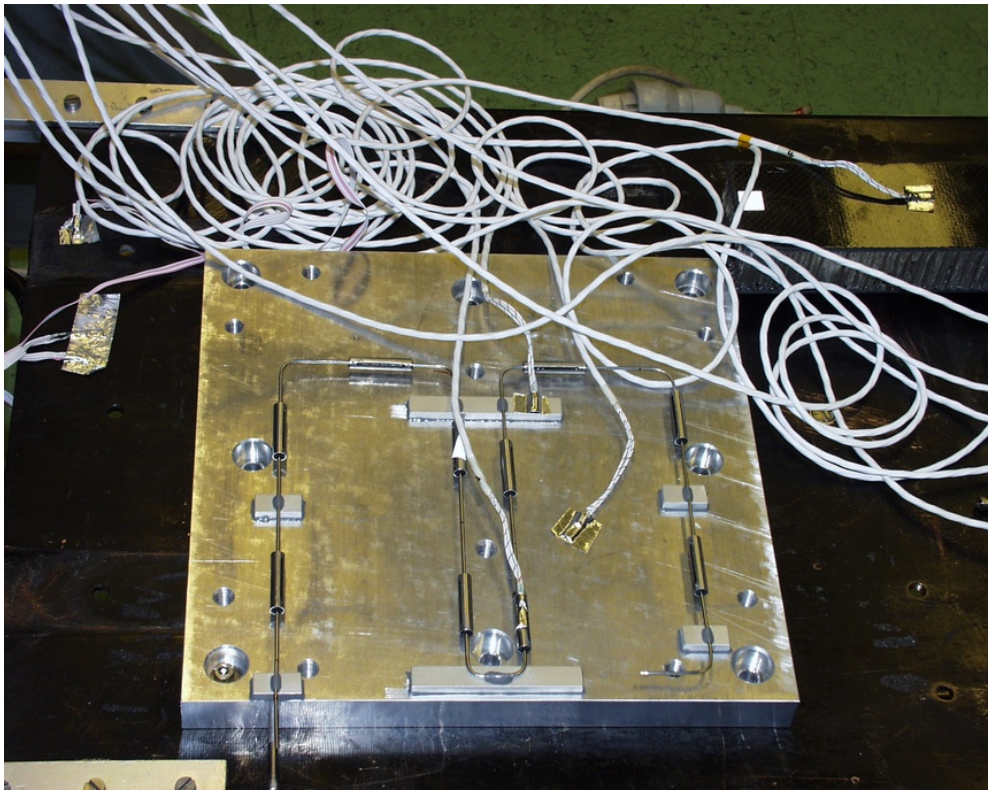
Stainless Steel Tube Fitting

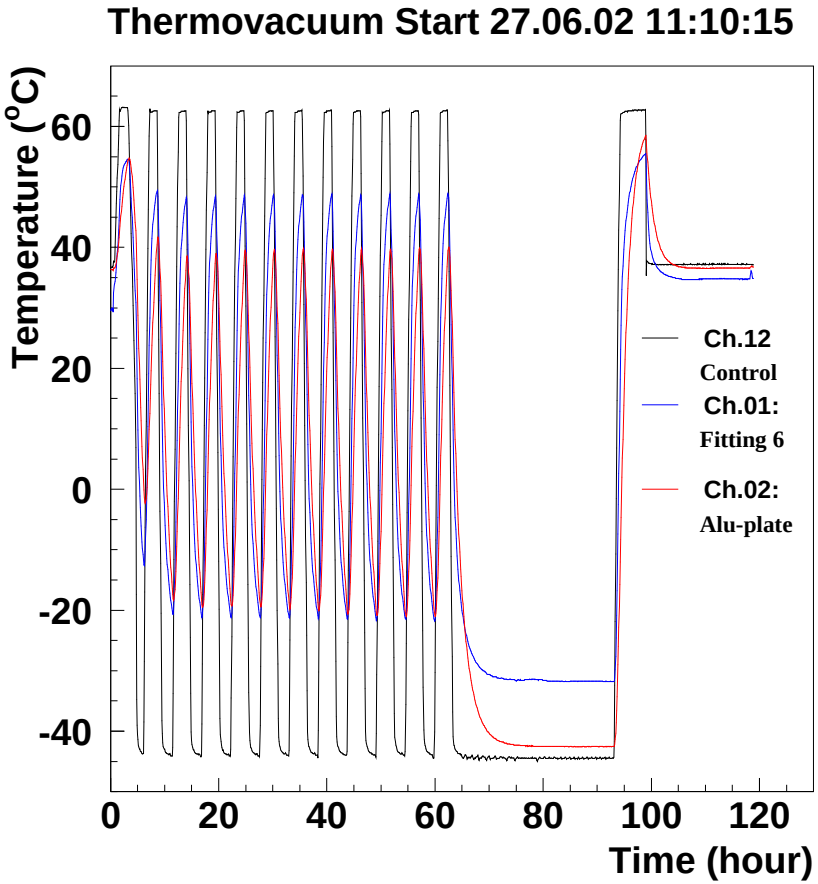




Leak rate: $q = 1 \cdot 10^{-6} \frac{l \cdot mbar}{s}$ (He)

Gas Connectors, Stainless Steel Tube Fitting
Vibration Test I + Thermo Vacuum Test + Vibration Test II

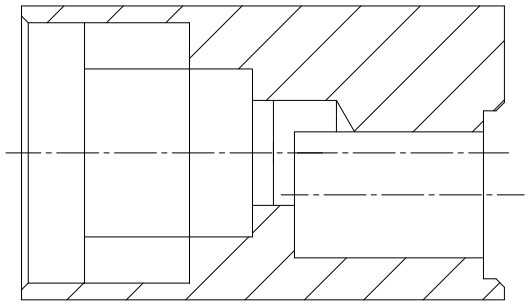




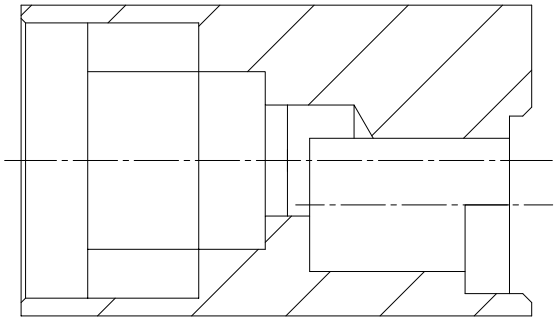
Leak rate before + after: $q = 1 \cdot 10^{-6} \frac{l \cdot mbar}{s}$ (He) $\Rightarrow$ Test with Straw Modules

Straw Module Endpieces

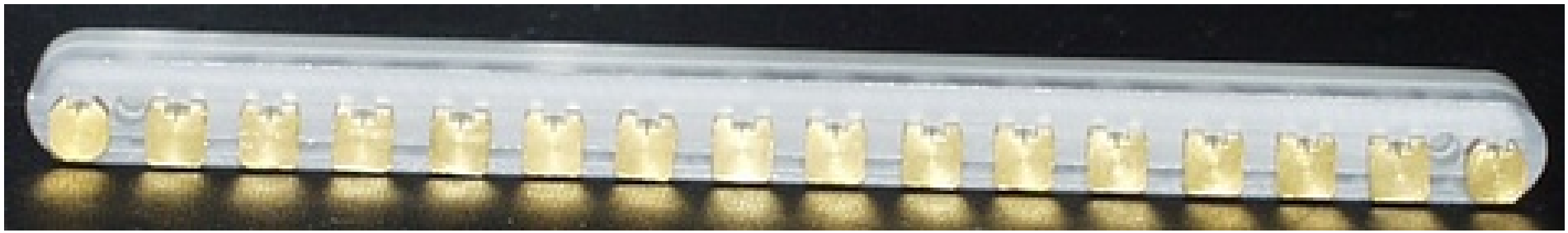
Old Design:



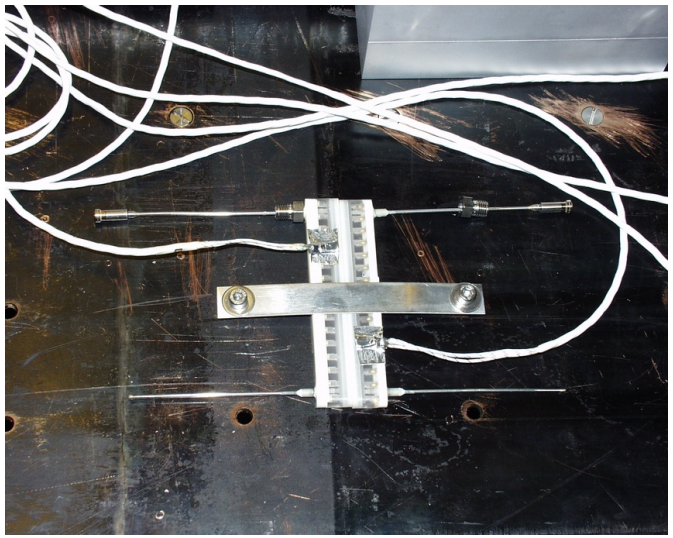
New Design:

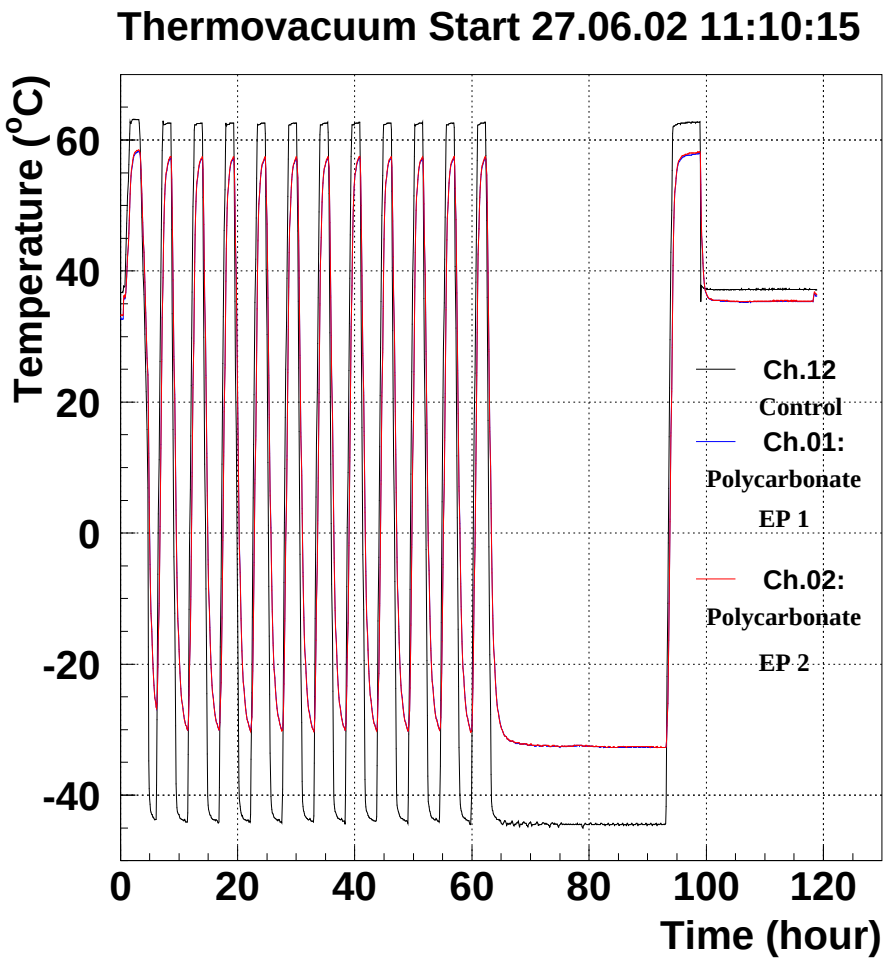


Leak rate: $q = 3 \cdot 10^{-5} \frac{l \cdot mbar}{s}$ (He)
Space qualified? $\Rightarrow$ Thermo Vacuum Test



Straw Module Endpieces
Thermo Vacuum Test





Leak rate before + after: $q = 3 \cdot 10^{-5} \frac{l \cdot mbar}{s}$

$\Rightarrow$ Test Straw Module

Space Qualification

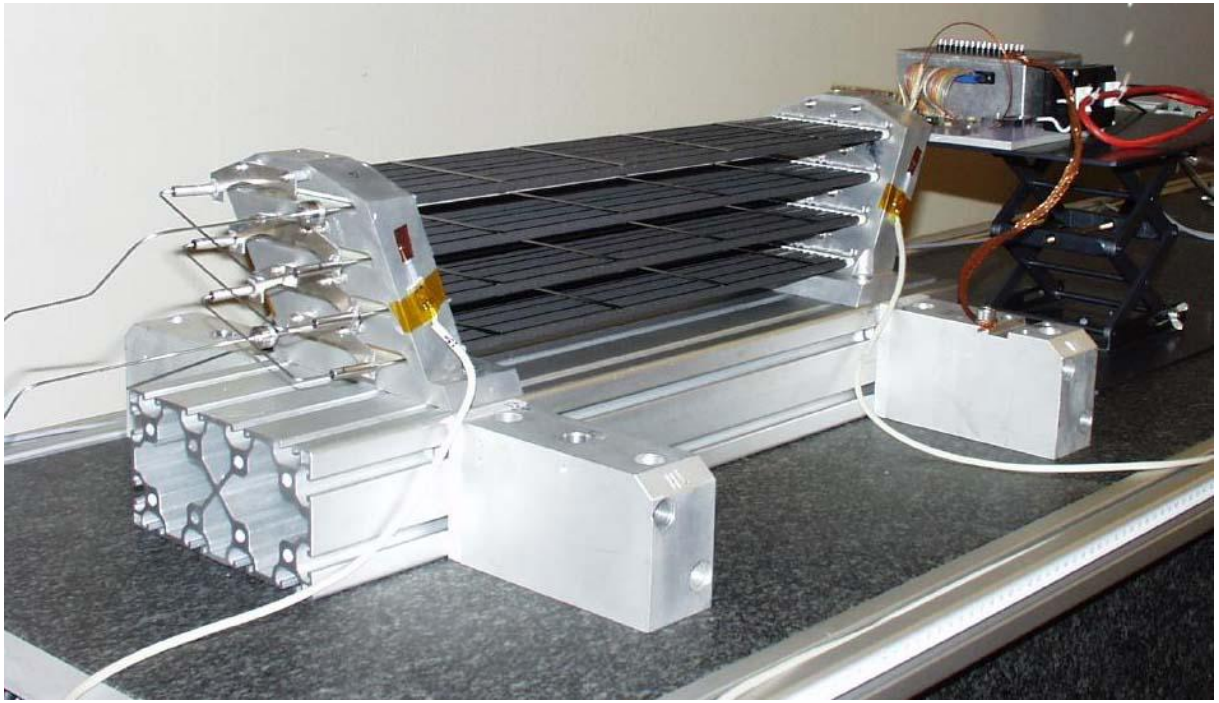
- 5 Straw Modules → Leaks along straws
  L=376, 400, 400, 424, 448mm

Test programm:

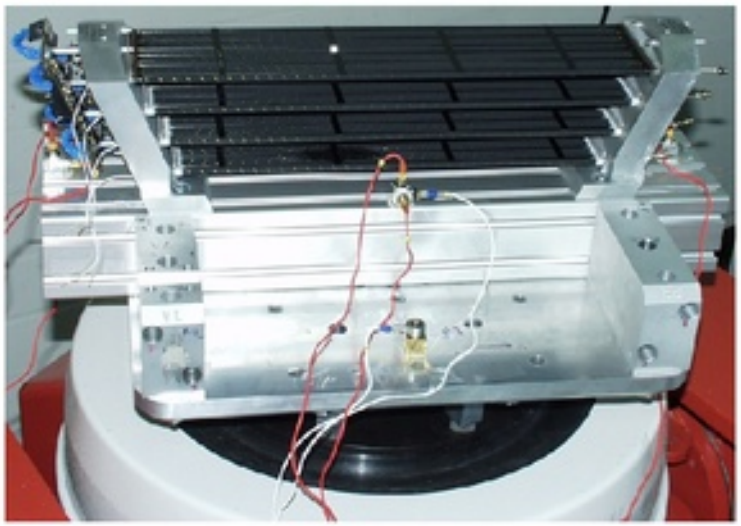
Vibration test, Thermo vacuum test

→ Eigenfrequencies, Leak rate, gas gain

Mod. No.	q_{He} $10^{-5}\ \frac{l \cdot mbar}{s}$	$q_{He,diff}$ $10^{-5}\ \frac{l \cdot mbar}{s}$
376	2.90	2.58
400	13.3	2.68
400	5.08	2.68
424	3.04	2.77
448	3.11	2.85

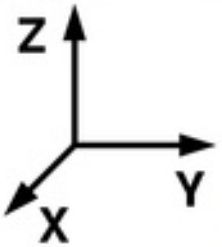


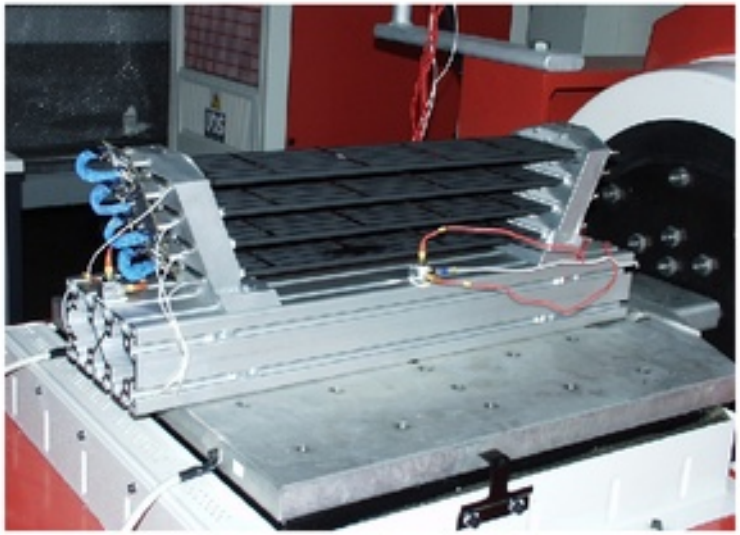
Space Qualification, Vibration Test

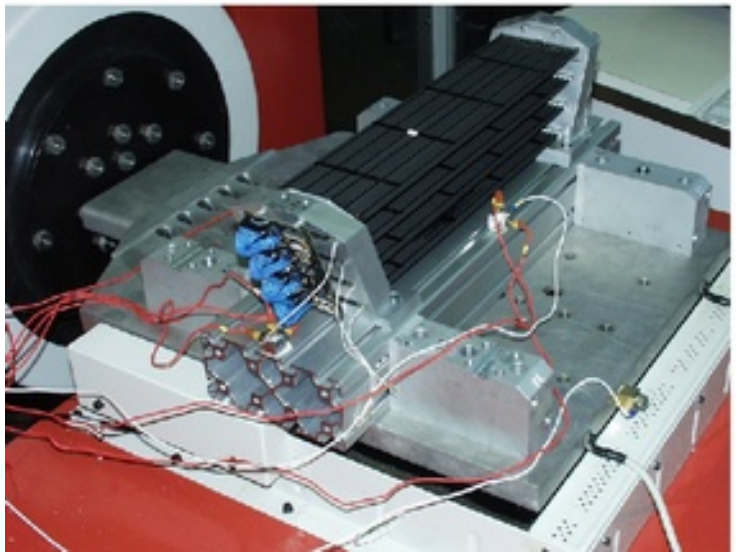


Vibration-Test-Cycle:

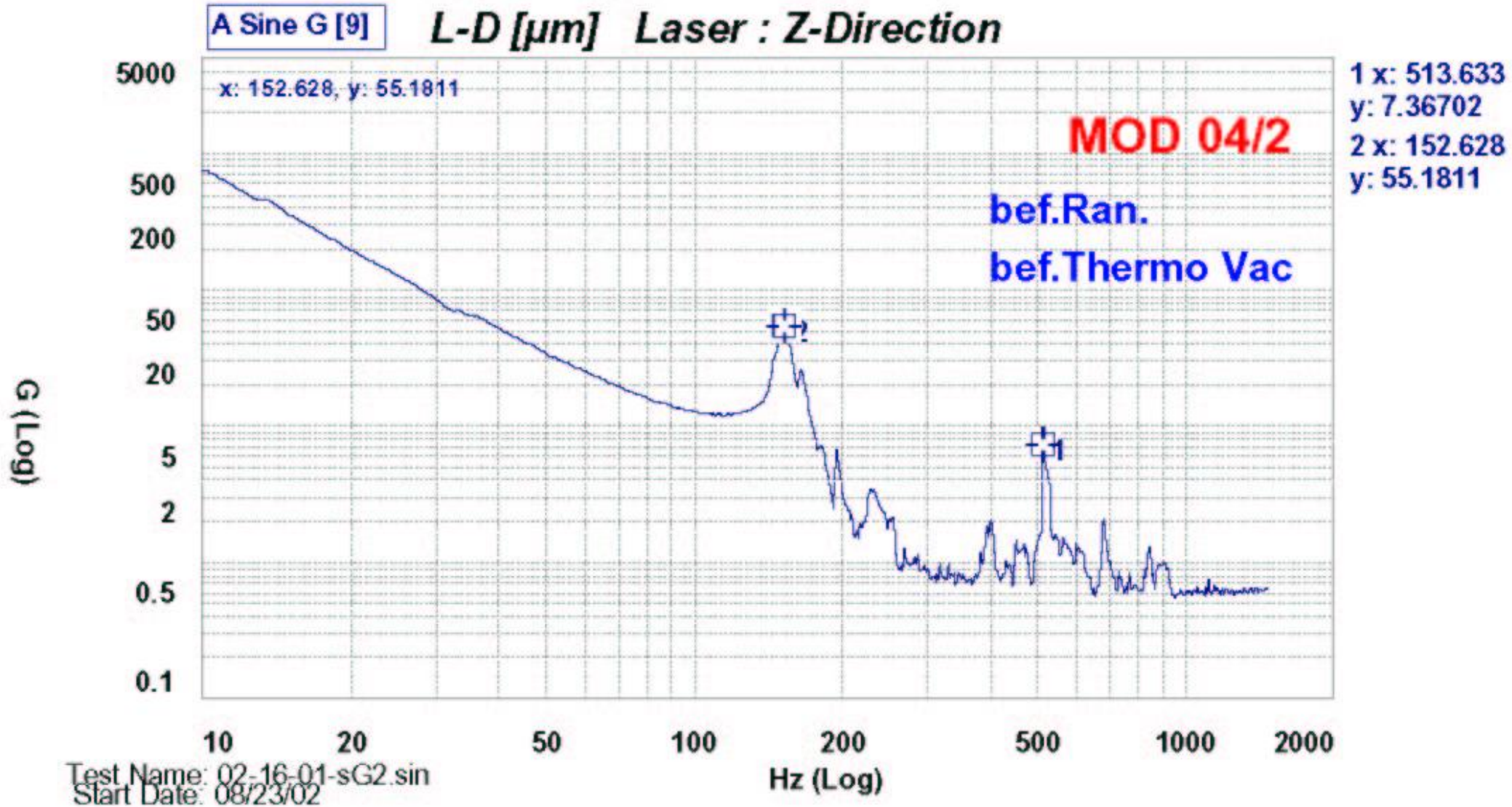
- Sine Sweep 0.5g (10-2000Hz)
- Random Spectrum $a_{\mathrm{RMS}} = 6.8g$
- Sine Sweep 0.5g (10-2000Hz)

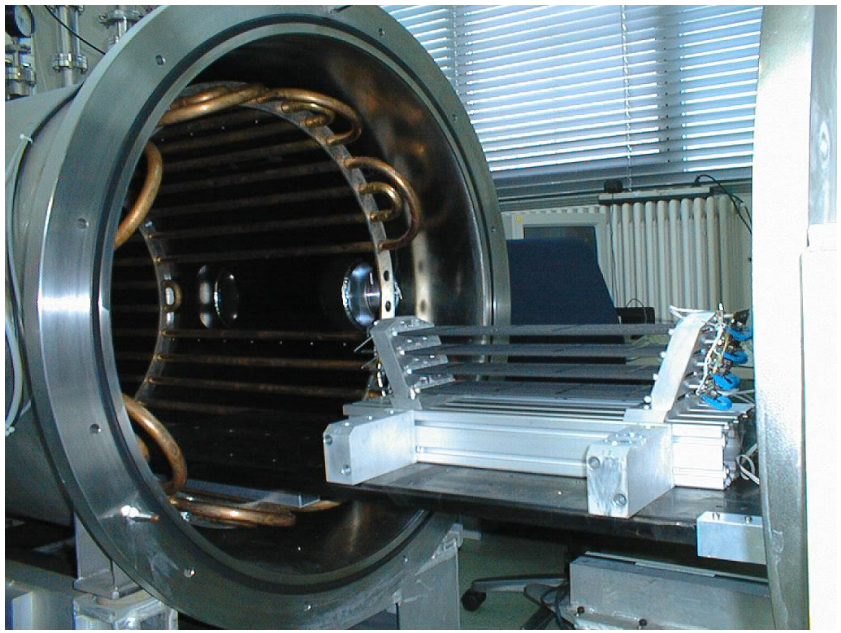




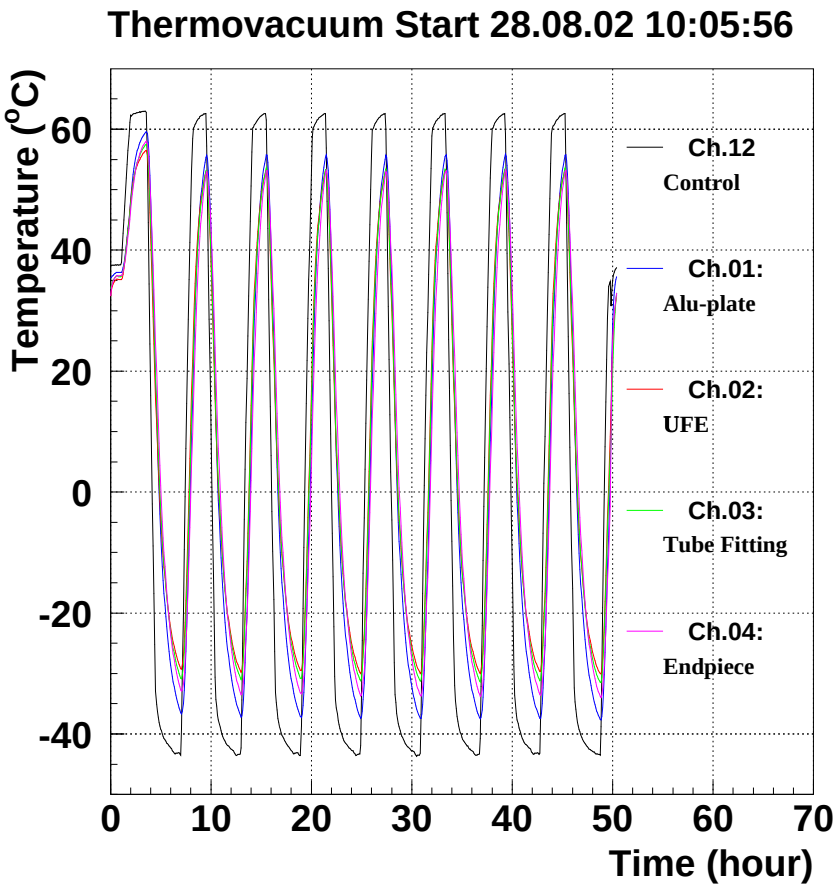


Space Qualification, Vibration Test





Space Qualification, Thermo Vacuum Test



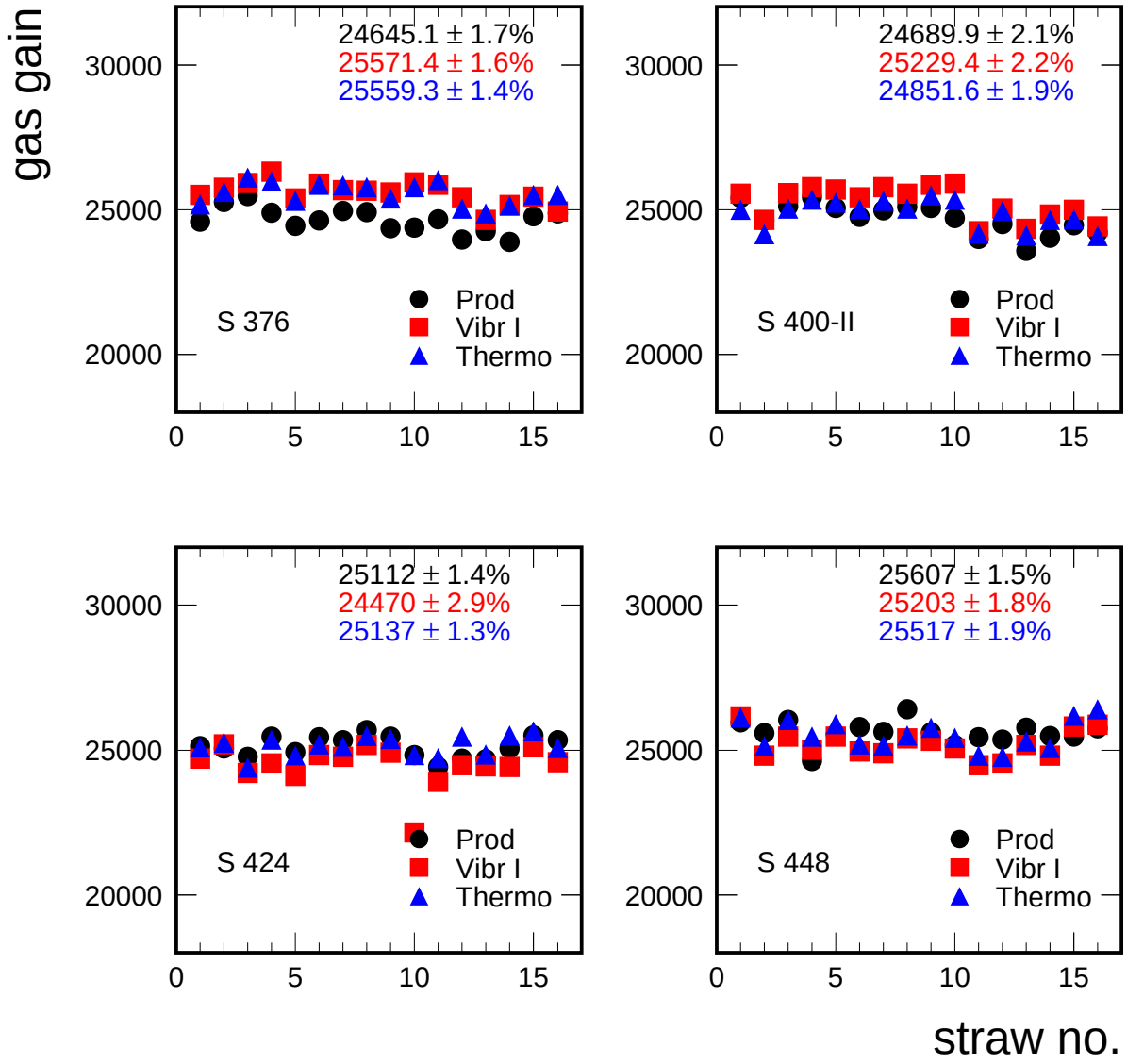
⇓

All Stainless Steel Tube Fittings leaky!

→ Double-O-Ring connector the choice!

Space Qualification

Gas Gain Measurement in $ArCO_2$ (Mod4/02)



Space Qualification, Gastightness

L=376, 400, 424, 448mm

Mod. No.	q_{He} $10^{-5}\ \frac{l \cdot mbar}{s}$ before	q_{He} $10^{-5}\ \frac{l \cdot mbar}{s}$ after	$q_{He,diff}$ $10^{-5}\ \frac{l \cdot mbar}{s}$
376	2.90	3.83	2.58
400	5.08	4.89	2.68
424	3.04	3.57	2.77
448	3.11	3.83	2.85

Leaks along Straws, Parylene-C Coating @ Astrium

L=376, 400, 424, 448mm with $9\ \mu m$ Parylene-C

80 cm tank $\rightarrow$ extension up to 2 m

Parylene-C Coating, Gastightness

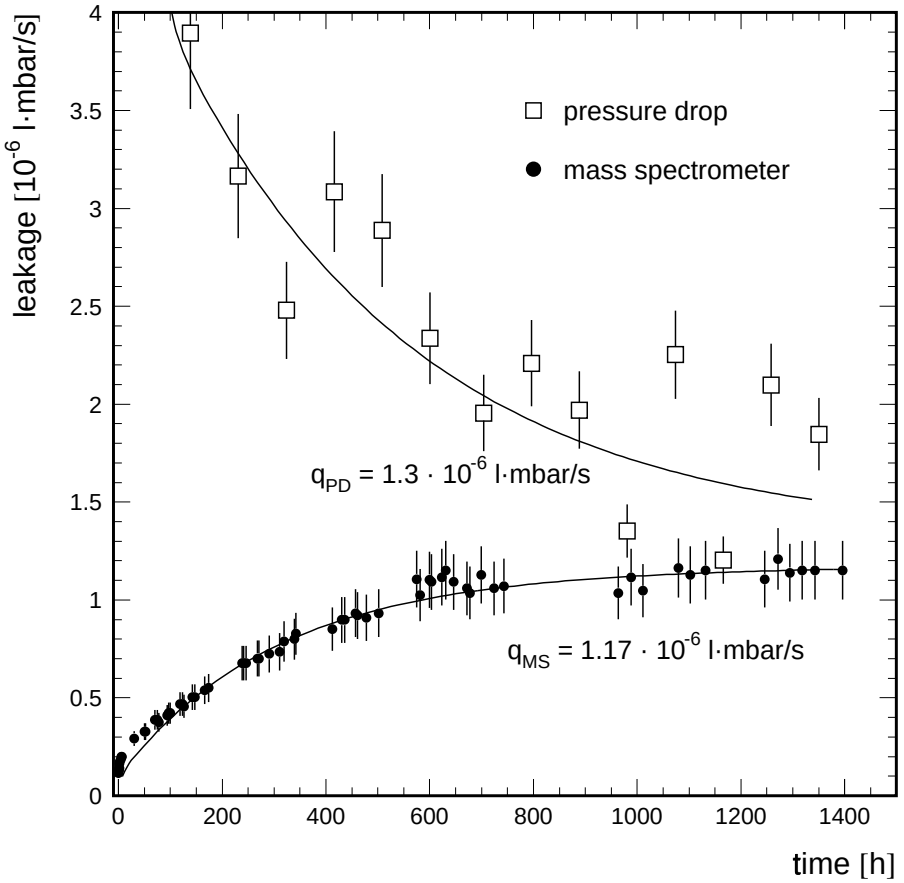
$$V_{CO_2,CF_4} = 2000\ \mathrm{l} \rightarrow q_{CO_2,CF_4,max} = \frac{2000\ \mathrm{l \cdot 1013\ mbar}}{1000 \cdot 86400\ \mathrm{s}} \cdot \frac{5}{500\ \mathrm{m}} = 23.5 \cdot 10^{-5} \frac{\mathrm{l \cdot mbar}}{\mathrm{s \cdot m_{Module}}}$$

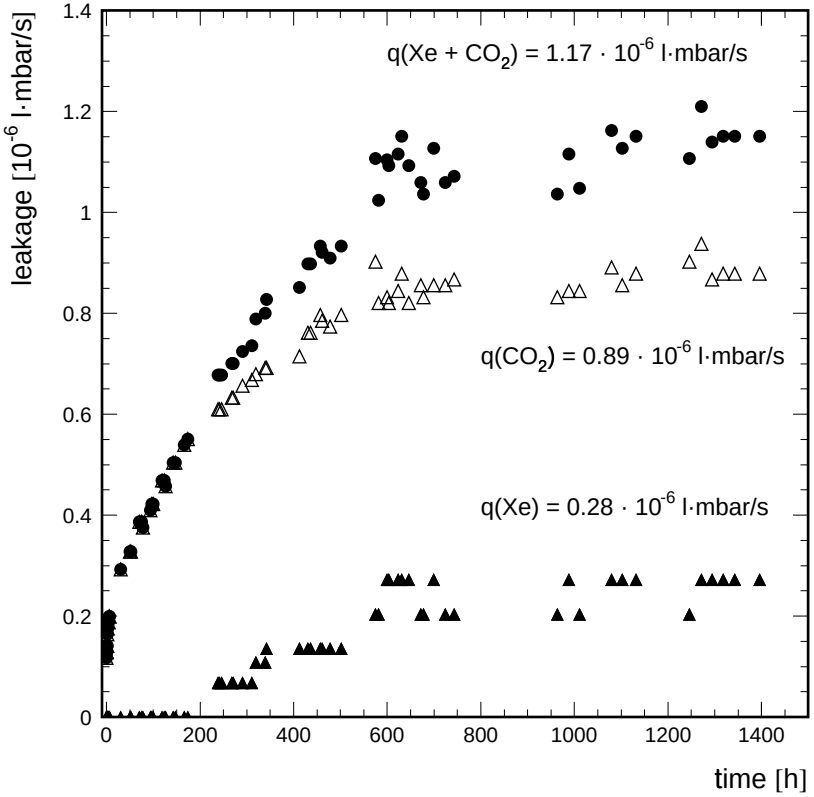
$$\text{Safety factor} = \frac{q_{CO_2,CF_4,max} \cdot L_{\mathrm{Module}}}{q_{CO_2}} \cdot f_{\infty}$$

Mod. No.	q_{He} $10^{-5}\ \frac{l \cdot mbar}{s}$	q_{CO_2} $10^{-5}\ \frac{l \cdot mbar}{s}$ 208 h	$q_{CO_2,diff}$ $10^{-5}\ \frac{l \cdot mbar}{s}$ 1400 h	Safety-factor CO_2	
376	2.90	-	-	-	before S.Q.
	3.83	-	-	-	after S.Q.
	-	4.0	0.70	2.9	$9\ \mu m$ P.-C
400	5.08	-	-	-	before S.Q.
	4.89	-	-	-	after S.Q.
	4.38	4.5	0.74	2.8	$9\ \mu m$ P.-C
424	3.04	-	-	-	before S.Q.
	3.57	-	-	-	after S.Q.
	-	4.0	0.78	3.3	$9\ \mu m$
448	3.11	-	-	-	before S.Q.
	3.83	-	-	-	after S.Q.
	3.88	4.5	0.83	3.1	$9\ \mu m$ P.-C

Straw Module Gastightness

- Xe/CO_2 (80/20) Leak rate 3 single Straw Tubes L=1.3 m





$$q_{CO_2}(20\%, 16\text{straws}) = 0.37 \cdot 10^{-5} \frac{l \cdot mbar}{s \cdot m_{\text{Module}}},$$

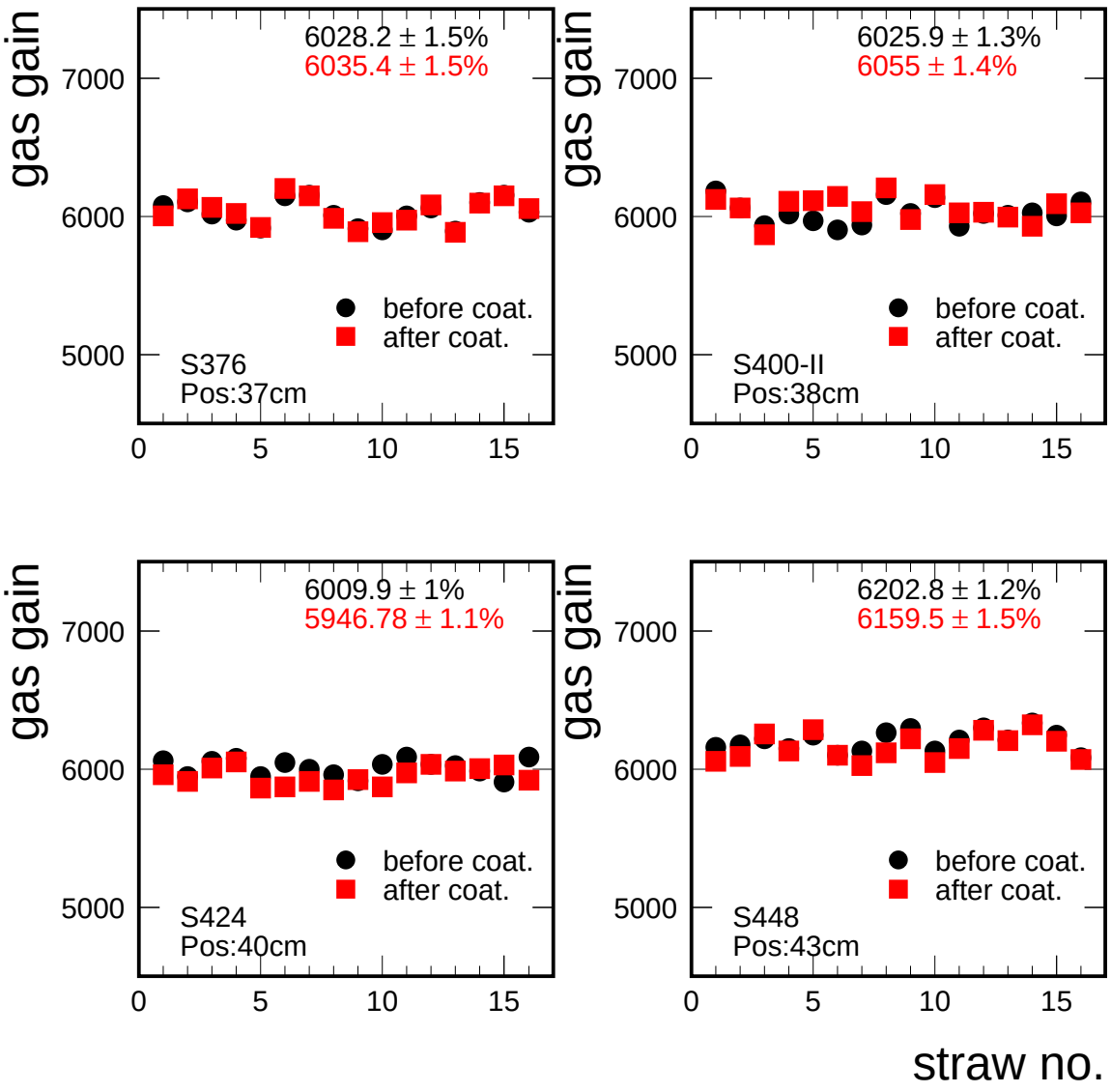
$$q_{CO_2,max} = \frac{2000\ l \cdot 1013\ mbar}{1000 \cdot 86400\ s} \cdot \frac{1}{500\ m} = 4.7 \cdot 10^{-5}\ \frac{l \cdot mbar}{s \cdot m_{\text{Module}}} \quad \rightarrow \text{Safety factor :12.7}$$

$$q_{Xe}(80\%, 16\text{straws}) = 0.12 \cdot 10^{-5} \frac{l \cdot mbar}{s \cdot m_{\text{Module}}},$$

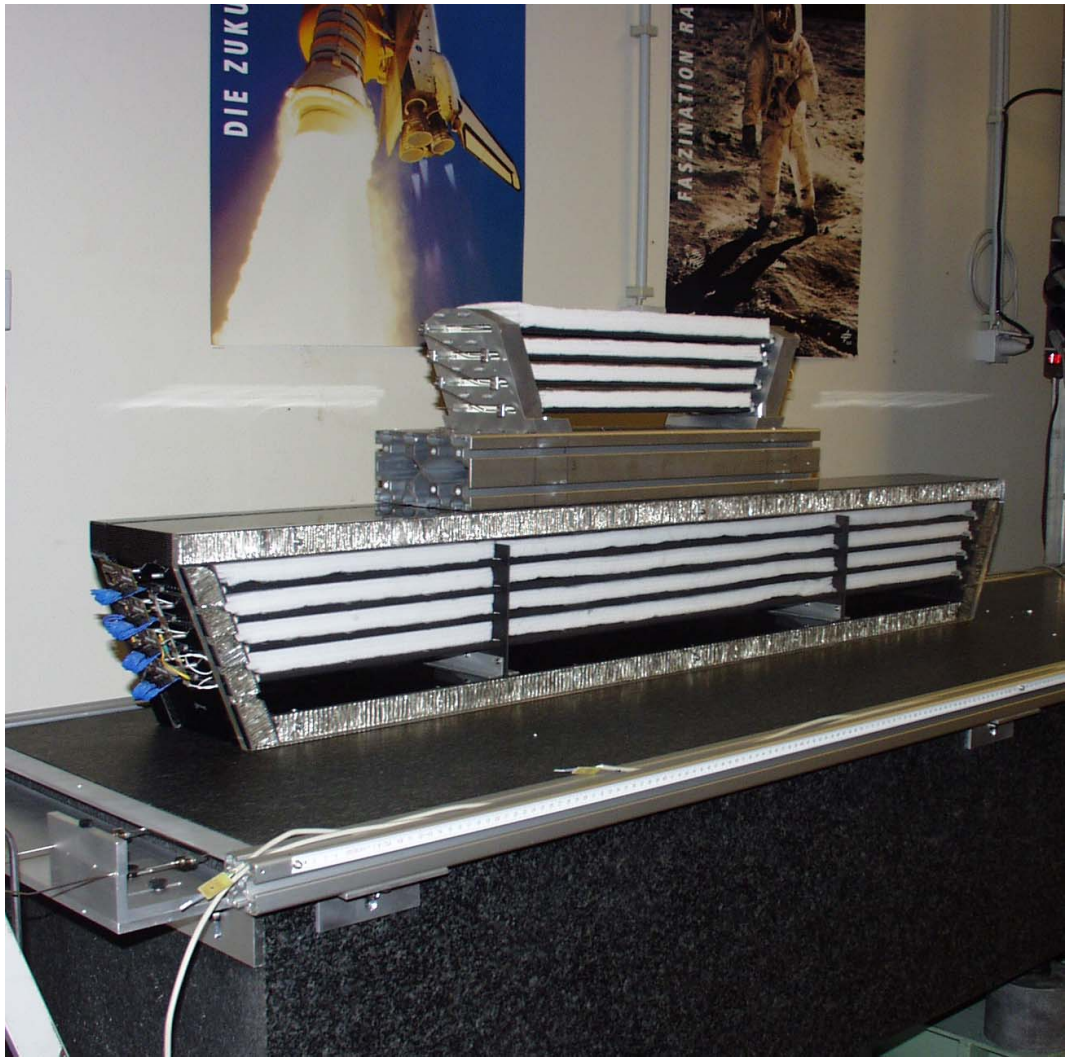
$$q_{Xe,max} = \frac{8000\ l \cdot 1013\ mbar}{1000 \cdot 86400\ s} \cdot \frac{1}{500\ m} = 18.7 \cdot 10^{-5}\ \frac{l \cdot mbar}{s \cdot m_{\text{Module}}} \quad \rightarrow \text{Safety factor :155.8}$$

Parylene-C Coating, Gasgain

Gas Gain Measurement in $ArCO_2$ (effect of Parylene C -Coating)



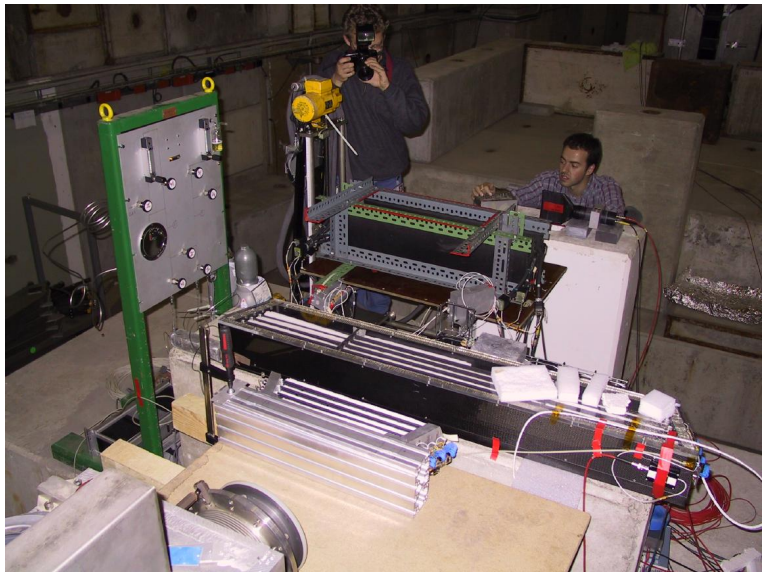
Testbeam

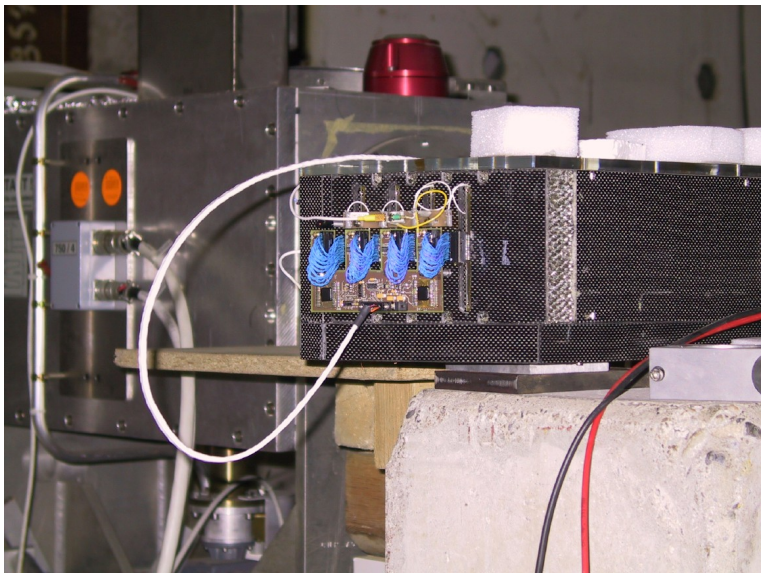


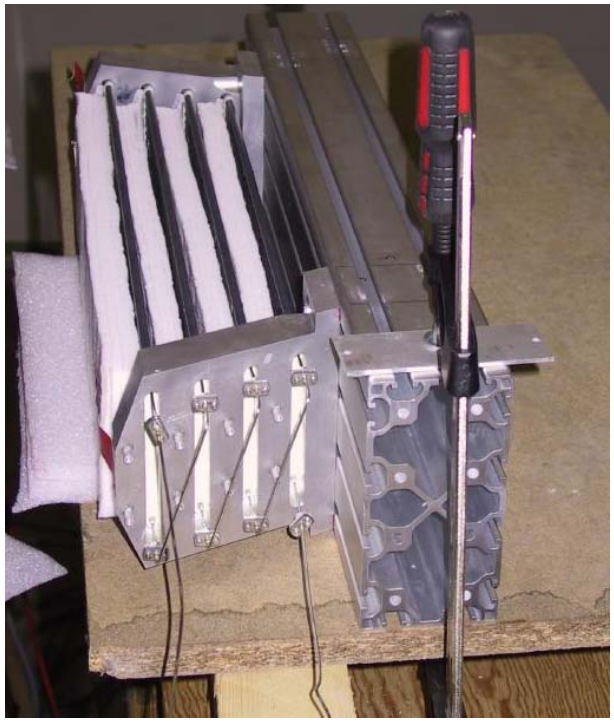
Upper Jigg $\rightarrow$ Space qualification jigg, Modules coated with $9\ \mu m$ Parylene-C

Lower Jigg $\rightarrow$ EMI-Jigg, Old long space qualification modules non coated

Testbeam T9-Area

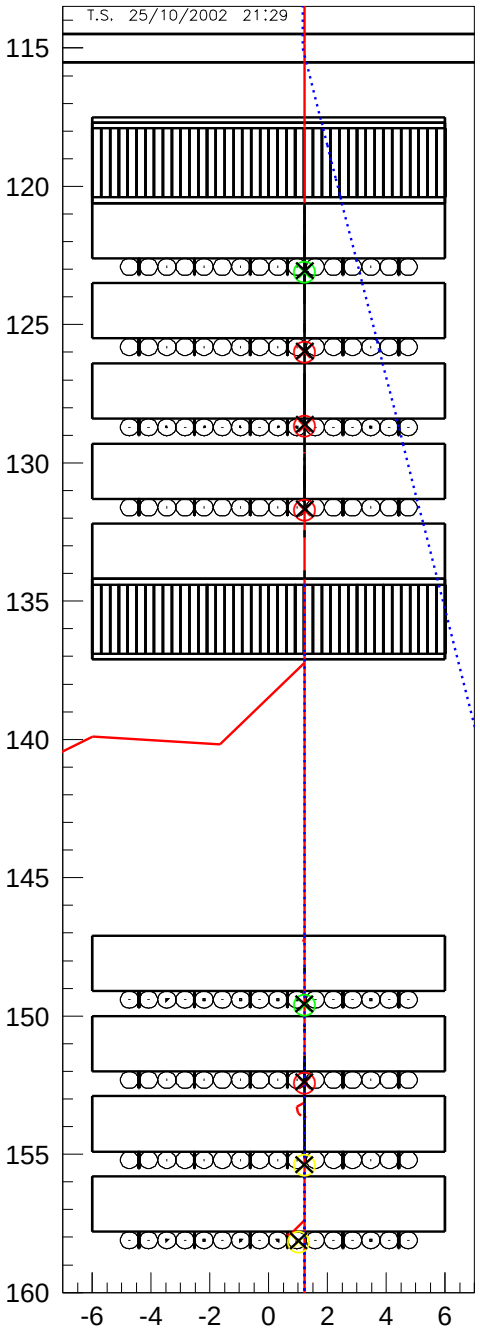


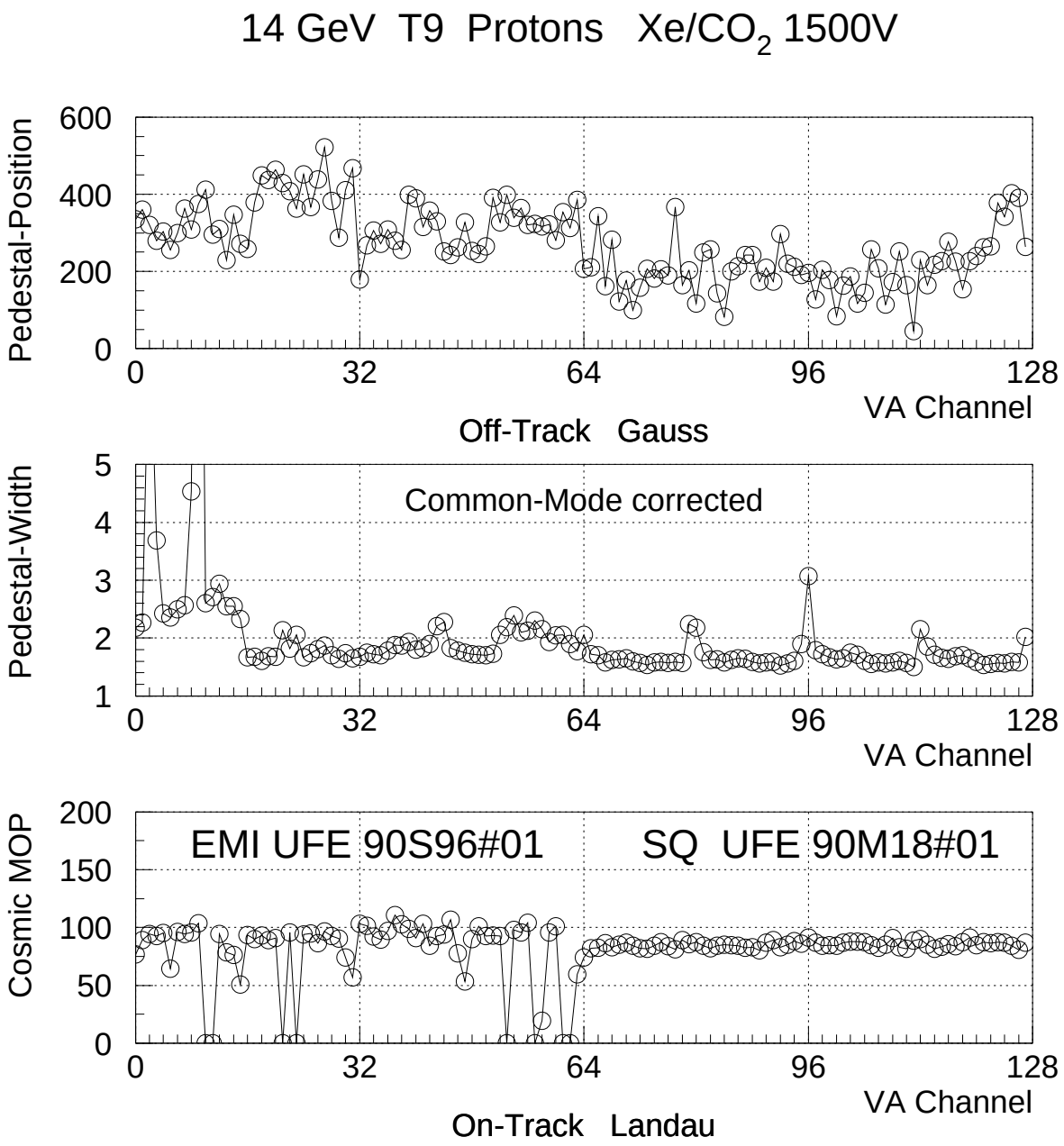




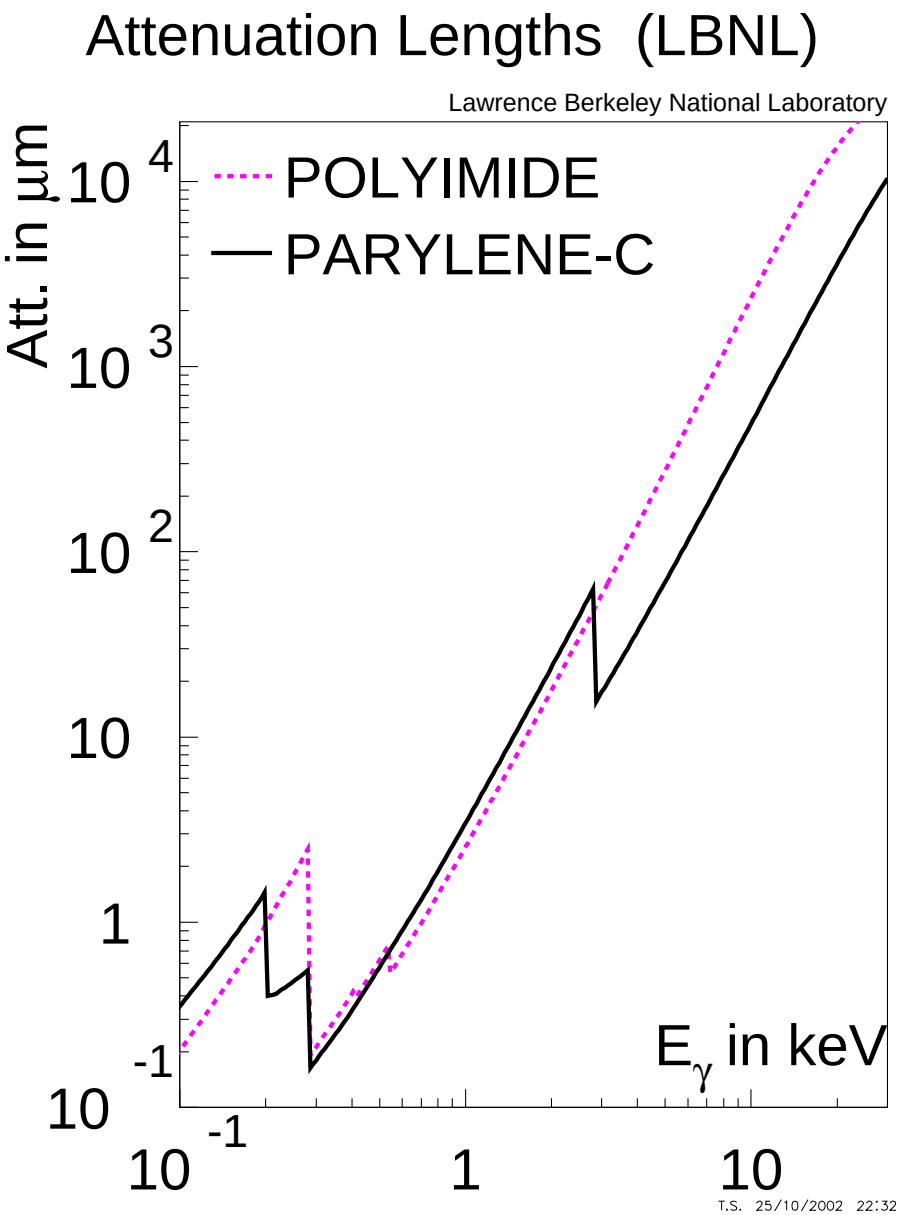
→ talk W. deBoer

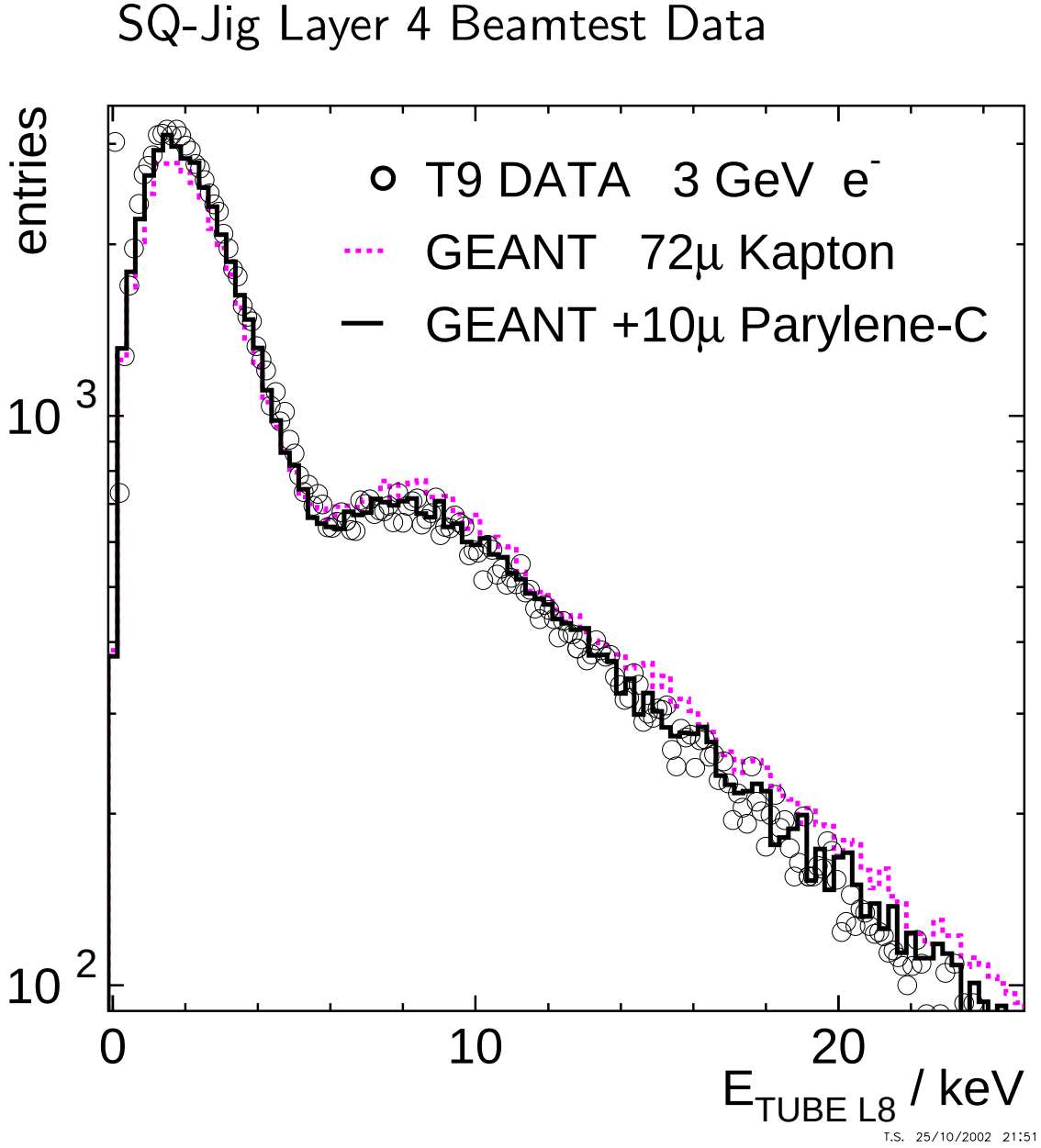
Beamtest Setup / UFE Intercalibration



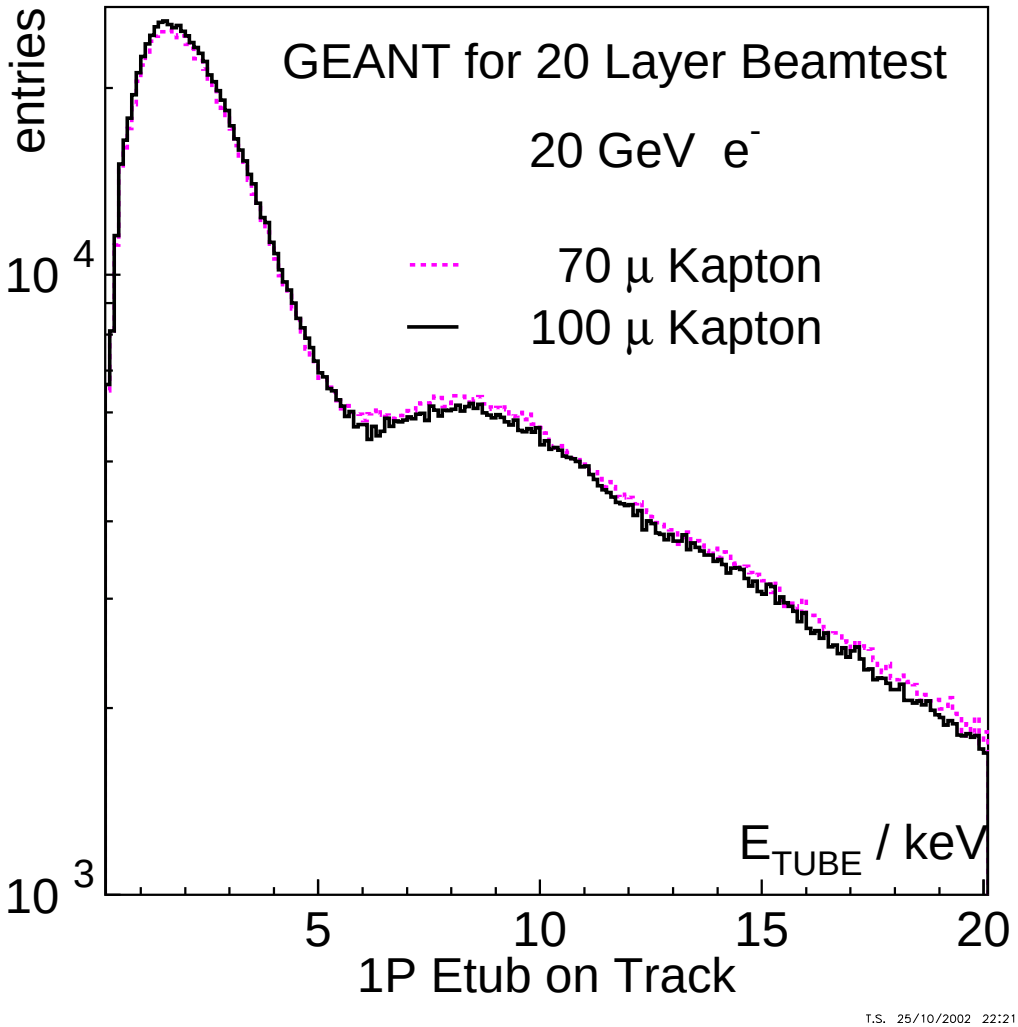


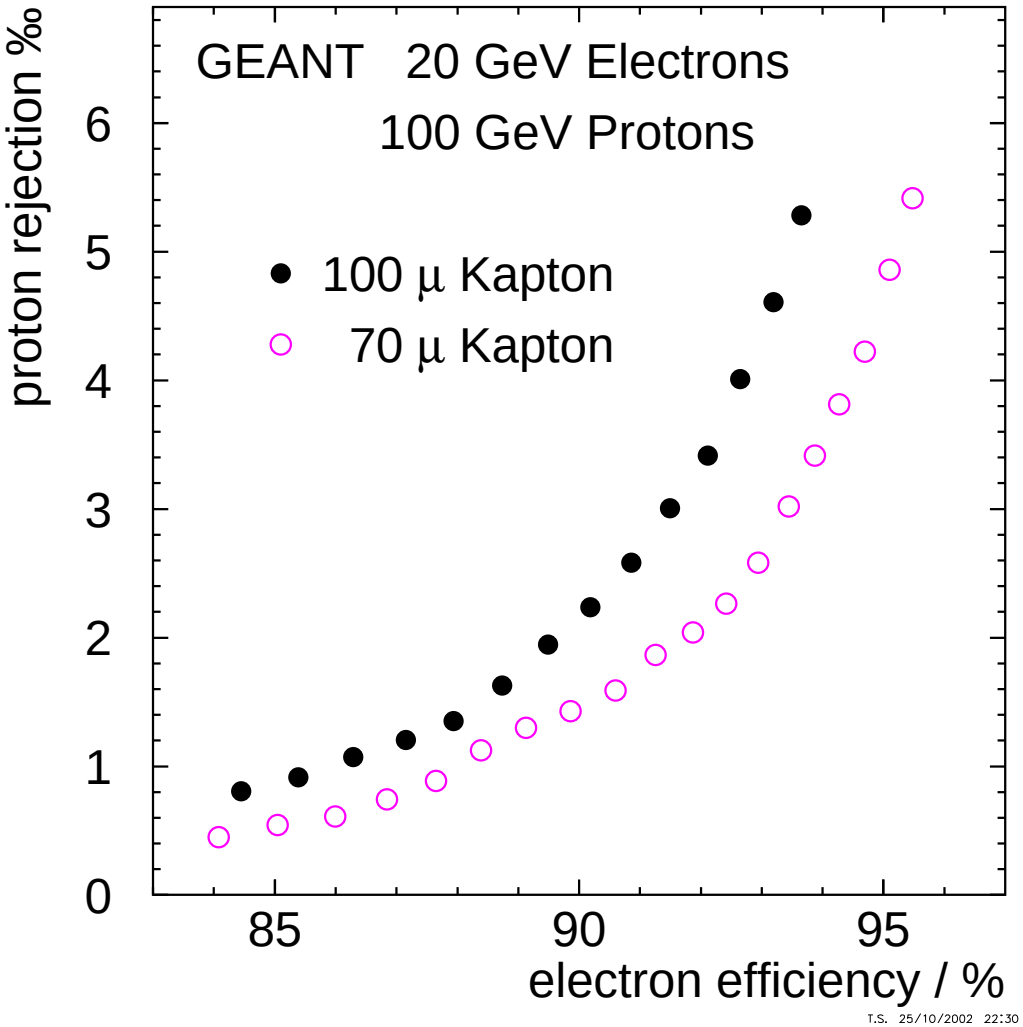
Electron Spectrum DATA vs MC with Parylene-C





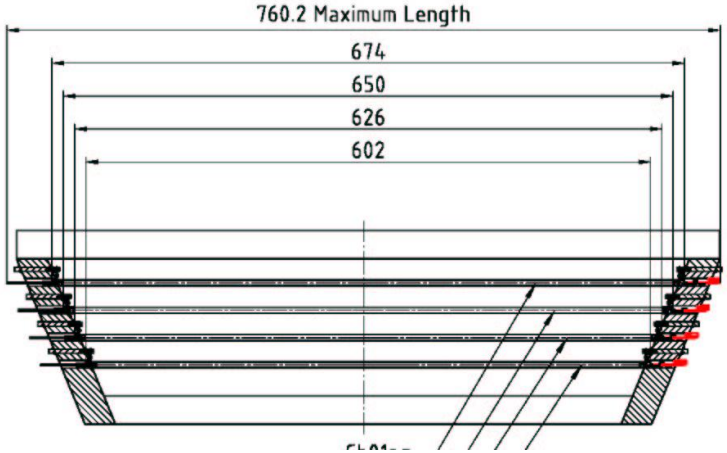
AMS-TRD GEANT Proton Rejection vs Electron Efficiency





Space Qualification with $9\ \mu m$ Parylene-C coated Modules

L=587, 611, 635, 659, 635 mm



before Parylene-C coating (november)

Mod. No.	q_{He} $10^{-5}\ \frac{l \cdot mbar}{s}$	$q_{He,diff}$ $10^{-5}\ \frac{l \cdot mbar}{s}$	q_{CO_2} $10^{-5}\ \frac{l \cdot mbar}{s}$ 110 h	$q_{CO_2,diff}$ $10^{-5}\ \frac{l \cdot mbar}{s}$ 1400 h	Safety-factor CO_2
587	4.17	3.37	5.5	1.08	4.2
611	4.18	3.46	5.5	1.12	4.4
635	4.23	3.54	5.5	1.17	4.6
659	5.21	3.63	7.5	1.21	3.5

Straw Module Gastightness, Alternative

• 4 +7 Longterm Straw Modules L=1549 mm, → Leaks along straws
($V_{CO_2,CF_4} = 2000\ l \rightarrow q_{CO_2,CF_4,max} = \frac{2000\ l \cdot 1013\ mbar}{1000 \cdot 86400\ s} \cdot \frac{5}{500\ m} = 23.5 \cdot 10^{-5} \frac{l \cdot mbar}{s \cdot m_{\mathrm{Module}}}$)

Mod. No.	q_{He} $10^{-5}\ \frac{l \cdot mbar}{s}$	q_{CO_2} $10^{-5}\ \frac{l \cdot mbar}{s}$ 240 h	Safety-factor CO_2	q_{CF_4} $10^{-5}\ \frac{l \cdot mbar}{s}$	Safety-factor CF_4
I	-	-	-	-	-
II	27	15.2	3.1	-	-
III	147	73.0	0.7	0.21	172
IV	56.8	31.1	1.6	0.82	44
1	21.6	-	-	9.72	3.7
2	15.3	-	-	0.53	68
3	13.4	-	-	0.10	361
4	14.8	-	-	0.10	361
5	14.3	-	-	0.60	60
6	14.2	-	-	0.56	64
7	13.2	-	-	0.52	69
diff.	6.9	2.82	12.7	0.17	212

AMS TRD GAS CF_4 vs. CO_2

ATLAS TRT	10 μA/straw	CF_4 + O_2, H_2O → F & HF etching & Si deposition
AMS TRD	20 pA/straw 150 Hz G 3000	none in space

Mixture	Xe/CO_2	Xe/CF_4
80/20 Volume	40/4 Kg	40/8 Kg
Diff. loss / 1000 d	300/300 g	300/26 g
$\frac{\Delta G}{G}/\Delta U$	1.0%/V	2.0%/V
HV @ 1000 mbar	1500 V	1585 V
HV @ 1250 mbar	1570 V	1620 V

Straw Module Production Status

Continous production has started

- TRD: 328 Flight Modules
- Flight Modules produced: 12 (2/d)
- Module chambers produced @ FVT: 48 (2/d)

TRD Status

- Thermovacuum stand @ Aachen I.b

- EMI test @ CAE Electronics GmbH

TRD Time Schedule