



The AMS-02 Transition Radiation Detector

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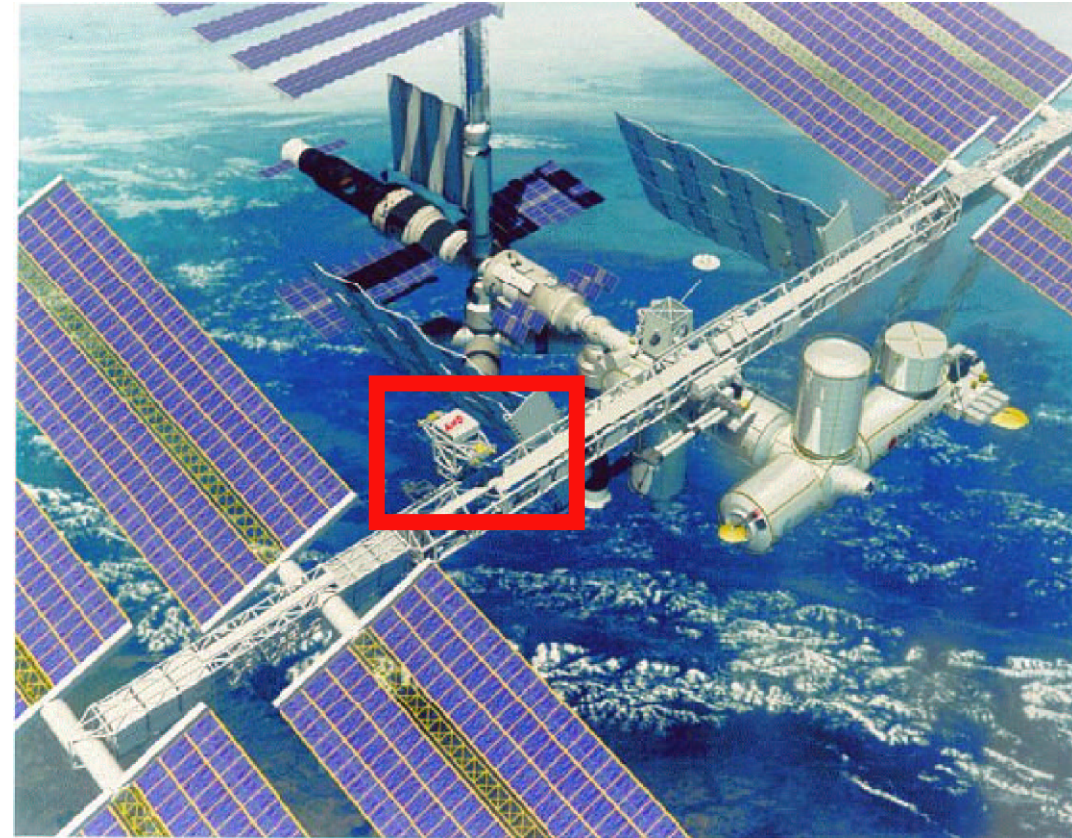
RWTH AACHEN
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Presenter: Thomas Kirn

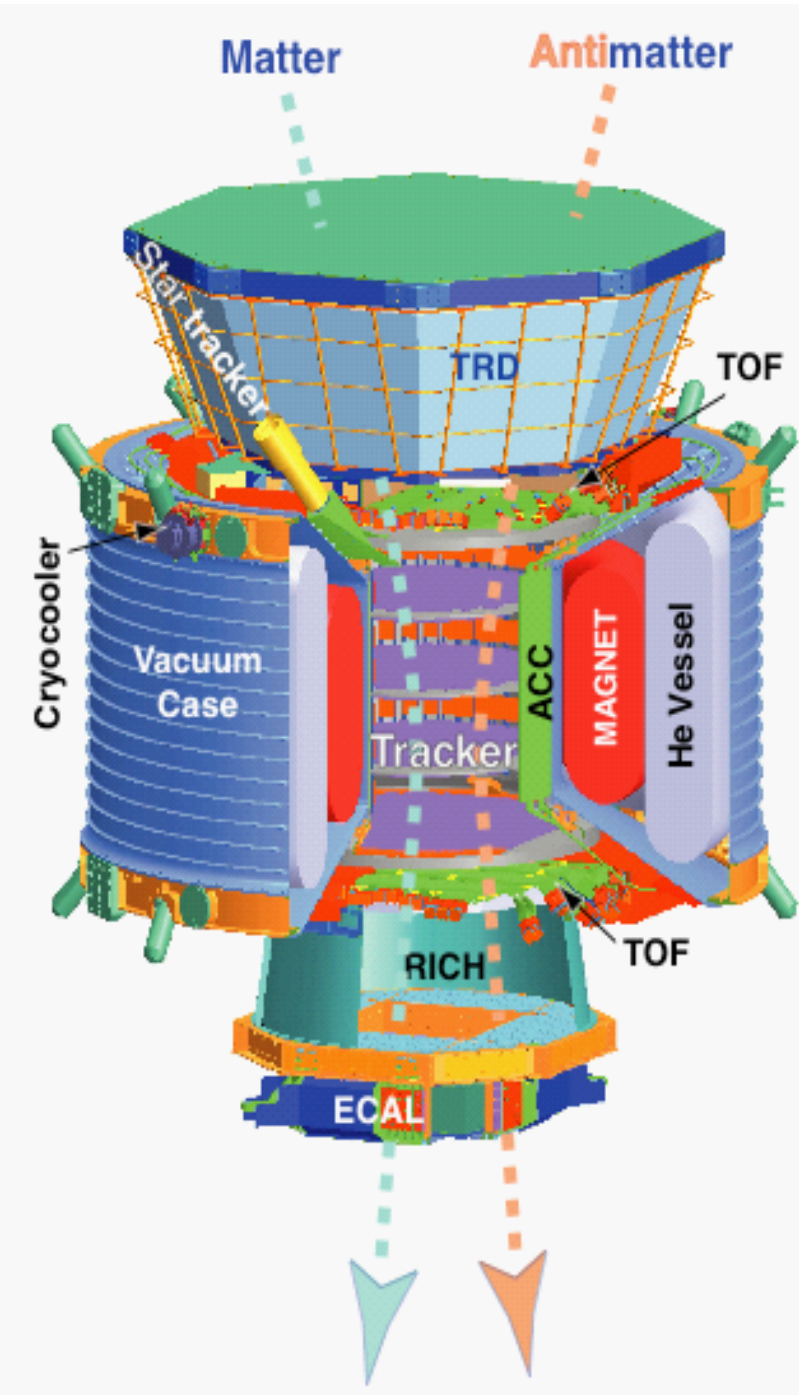
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AMS-02: A Particle Spectrometer for the ISS



Mean altitude 400 km
Mission > 3 years
Acceptance 0.5 m²sr
Power: 2500W
Weight: 6700kg
Dimension: 3.5x2.3x2.3 m³



TRD Particle ID & 3D tracking,
20 layers fleece + Xe/CO₂, 5248 channels 6mm straws
 p^+ rej. >10² 1-300 GeV 0.5m²sr

TOF 1.2 Trigger, $\sigma_t = 120$ ps; β dE/dX; Z;
Anticoincidence (Veto) counter,
Fine Mesh PMTs + plastic scintillators

Superconducting Magnet, B=0.9 T, BL² = 0.8 Tm²

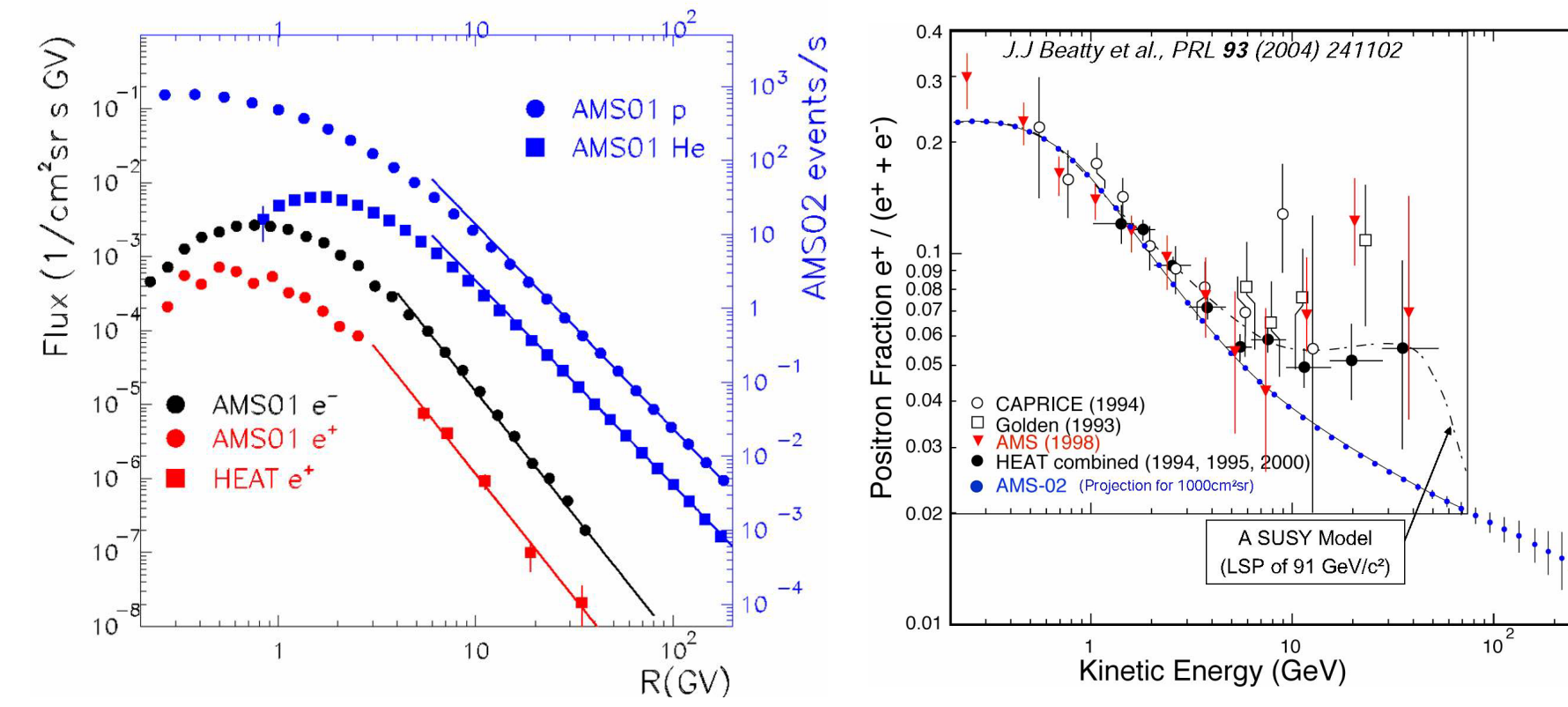
Silicon strip tracker (2·10⁵ Ch) with internal laser
alignment, 6 m² in 3 double+2 single xy layers,
1 σ charge separation up to 1TV, dE/dX; Z

TOF 3.4 Trigger, 1.3 m distance to TOF 1.2
 $p^+/e^+ > 3$

RICH Aerogel / NaF Radiator for A<27 and Z<28 separation
>3 σ from 1-12 GeV

ECAL 3D sampling lead/scint.-fibre, with p-E matching +
shower shape: h rej. >10⁴ 1-300 GeV 0.05m²sr

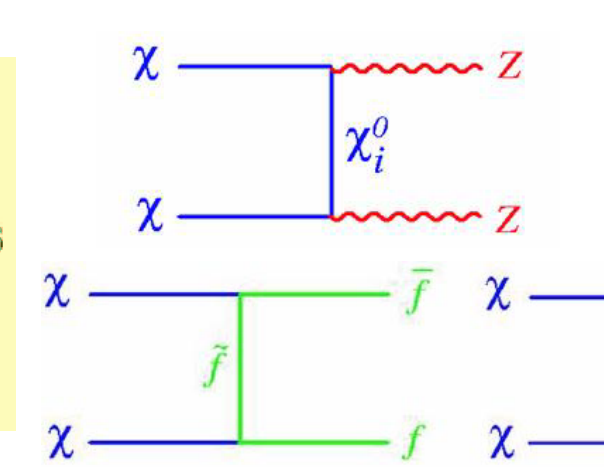
Cosmic Particle Spectroscopy: Indirect Dark Matter Search



flux ratio in orbit:
 $p^+/e^+ \approx 10^4$

p^+ -Contamination:
 $\leq 10^{-2}$

$\Rightarrow p^+$ -rejection > 10⁶



- Cosmic Ray Composition:
 - Protons 88 %
 - Helium 10 %
 - e⁻ 1 %
 - e⁺ 0.03 %
- e⁻ / p : 1 / 3000
- Primary Cosmic Rays:
(p, He, C, O, Fe)
 - Important for Secondary Production
- Secondary/Primary Nuclei:
(B/C, ¹⁰Be/⁹Be)
 - Constraints on CR Propagation & Diffusion Models
- γ -Ray Astrophysics
- Secondary Anti-Particles
 - CR nuclei + ISM → π^+ → μ^+ → e⁺
 - $\chi\chi \rightarrow b\bar{b}, W^+W^-, Z^0Z^0 \rightarrow e^+e^-$
 - Indirect Dark Matter Detection

AMS02 TRD Concept

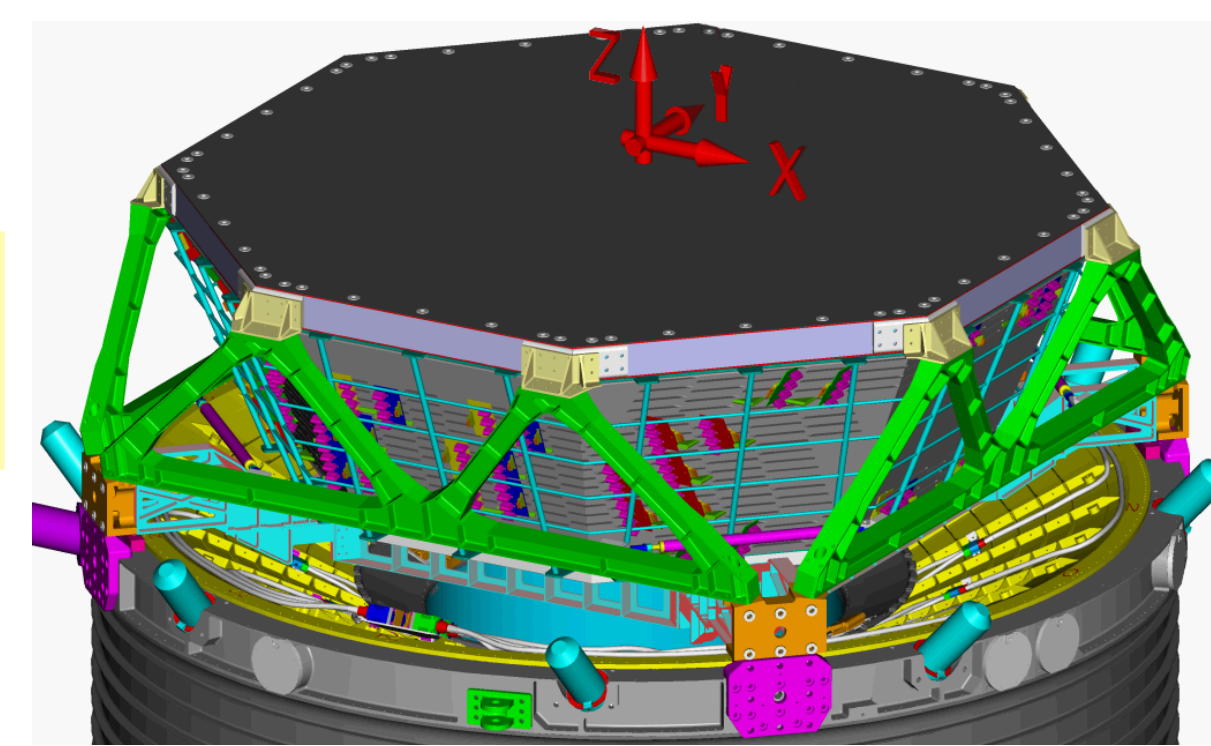
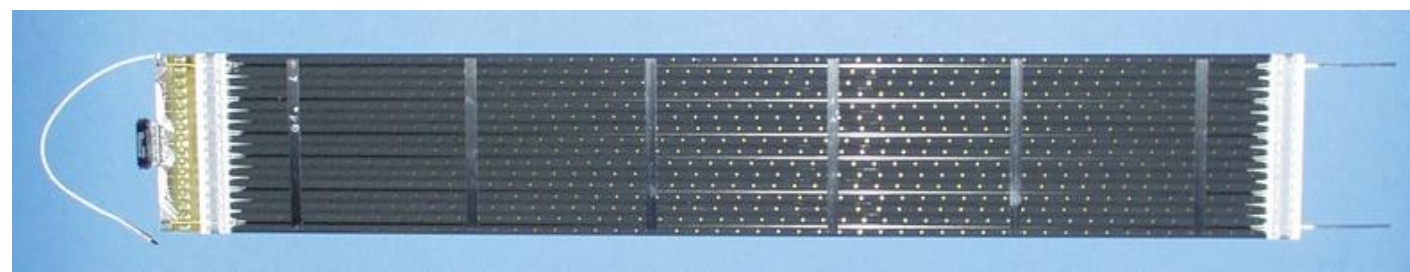
Chosen Configuration for 60cm height
20 Layers, each existing of radiator and proportional counter modules.

Radiator LRP 375BK (Freudenberg):
1 Layer thickness is 22mm, density = 0.06 g/cm³, 10 μ m polyethylene/
polypropylene fibers cleaned with Dichlormethane

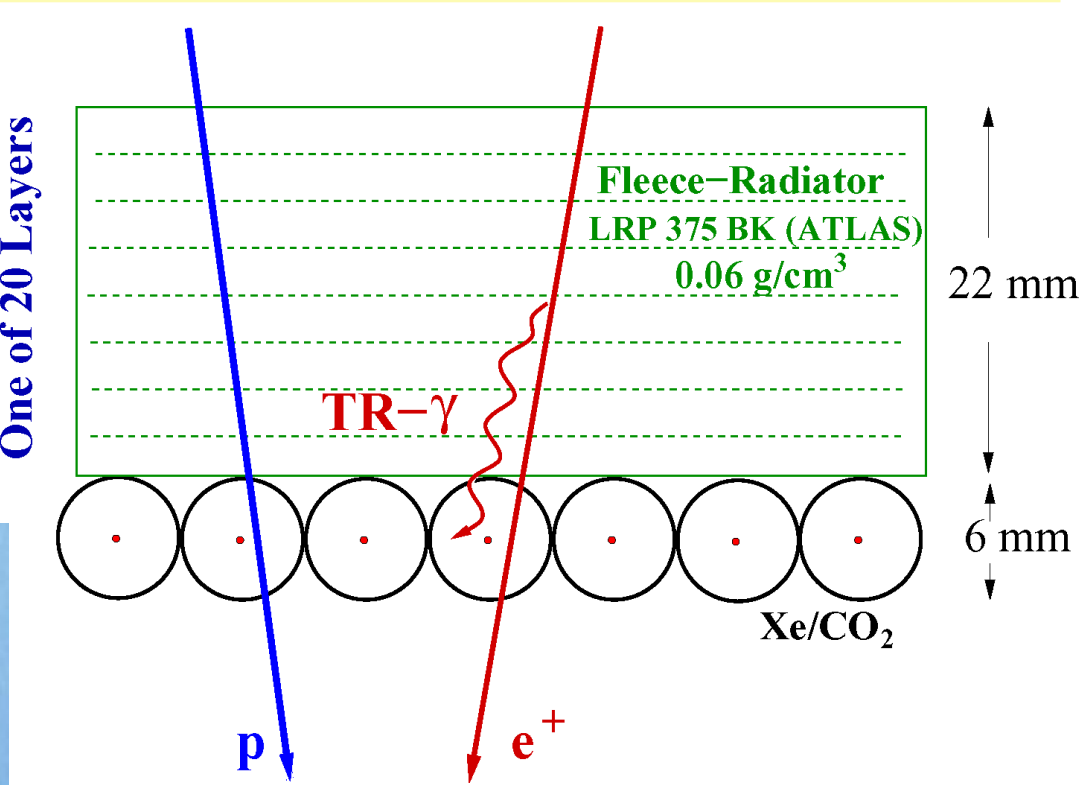
Straw tube proportional counter modules :
72 μ m multilayer aluminium kapton foil, $\varnothing$ 6mm, length: 0.8 - 2.0m,
tungsten wire ($\varnothing$ 30 μ m), gas mixture Xe/CO₂ (80/20), HV=1460V,
gasgain of 3000, 1 Module = 16 straws, 100 μ m mechanical accuracy,
Total 328 modules = 5248 straw tubes



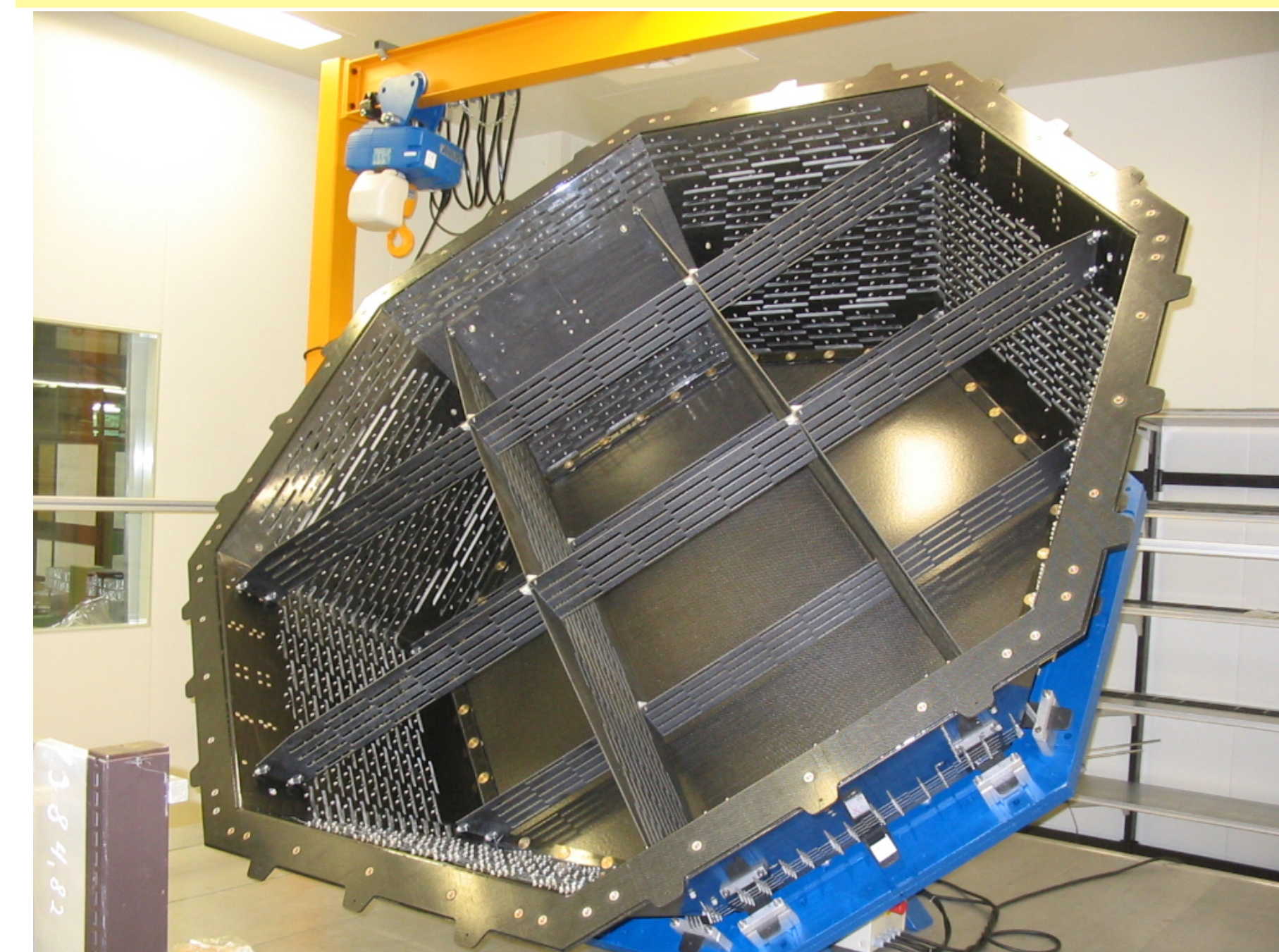
Straw module computer tomography
verifies mechanical accuracy



Size and Weight: 2.2m diameter, 0.67 height,
500kg total incl. DAQ and gas system

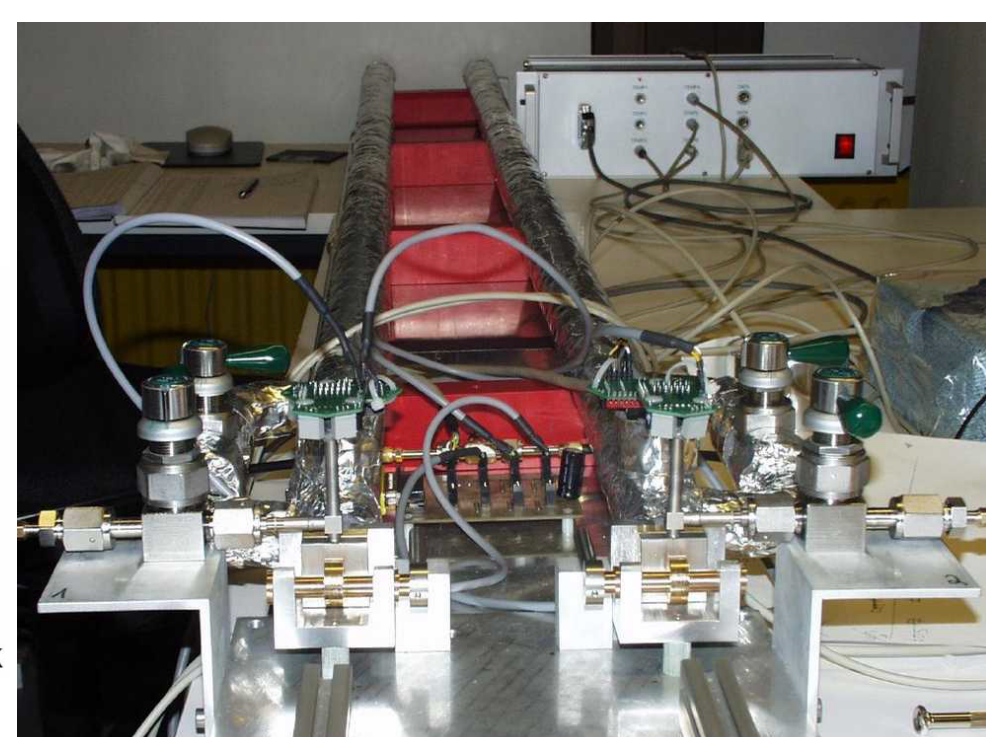
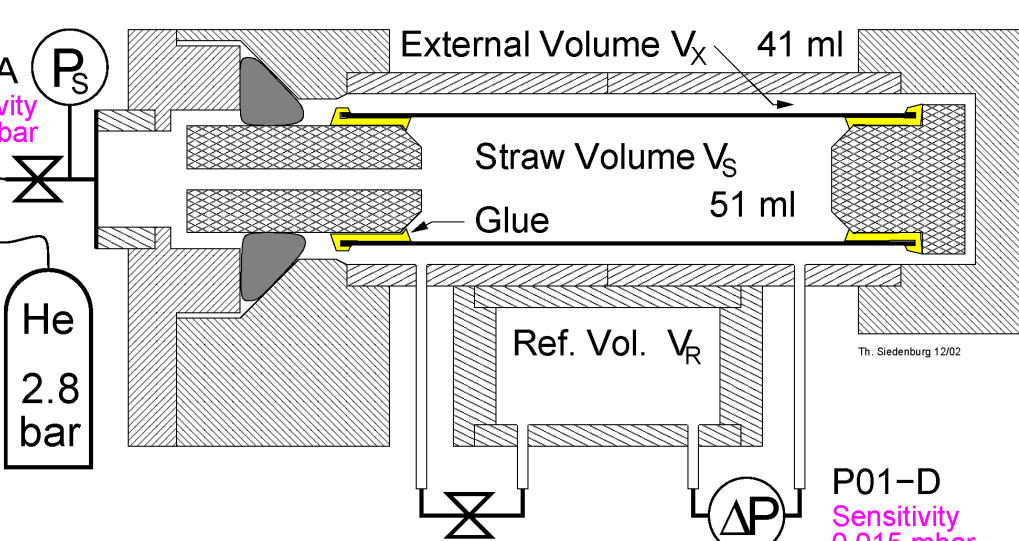
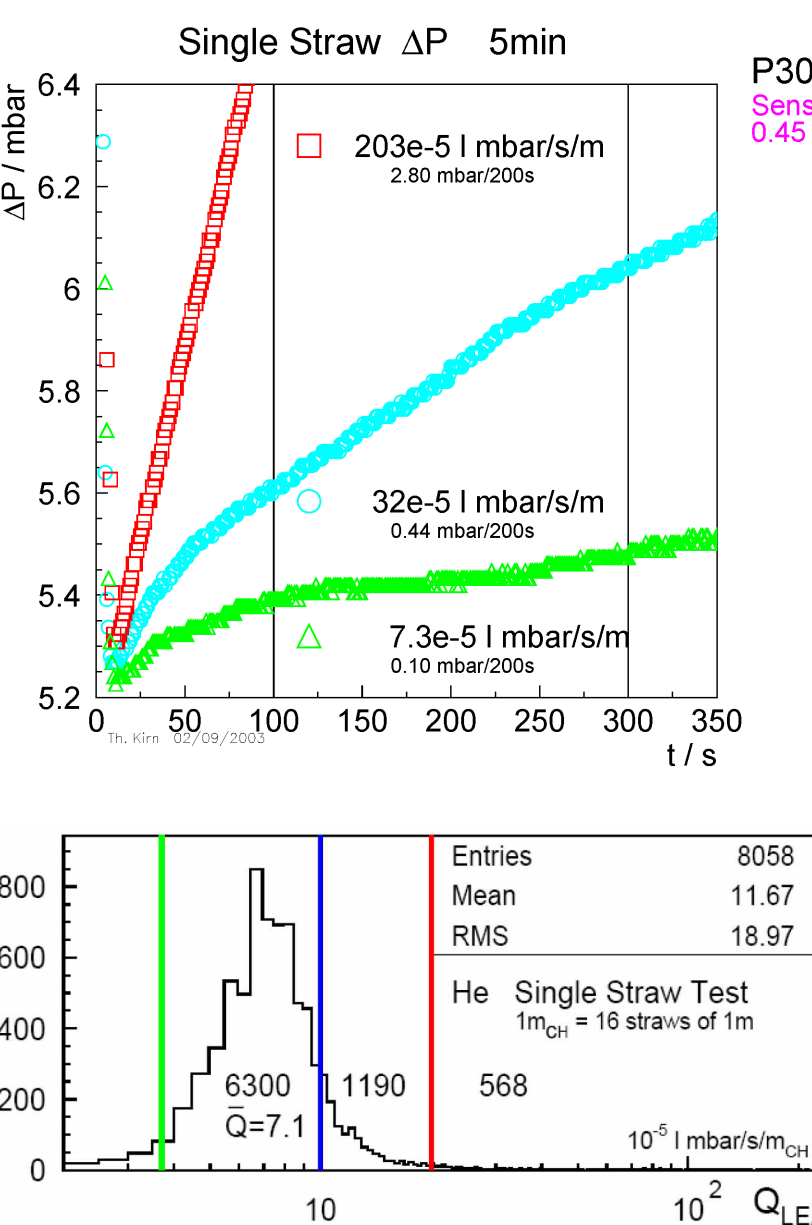


Octagon and Bulkheads support 328 Modules (5248 Straws,
L= 86 to 201 cm) with 100 μ m mechanical accuracy

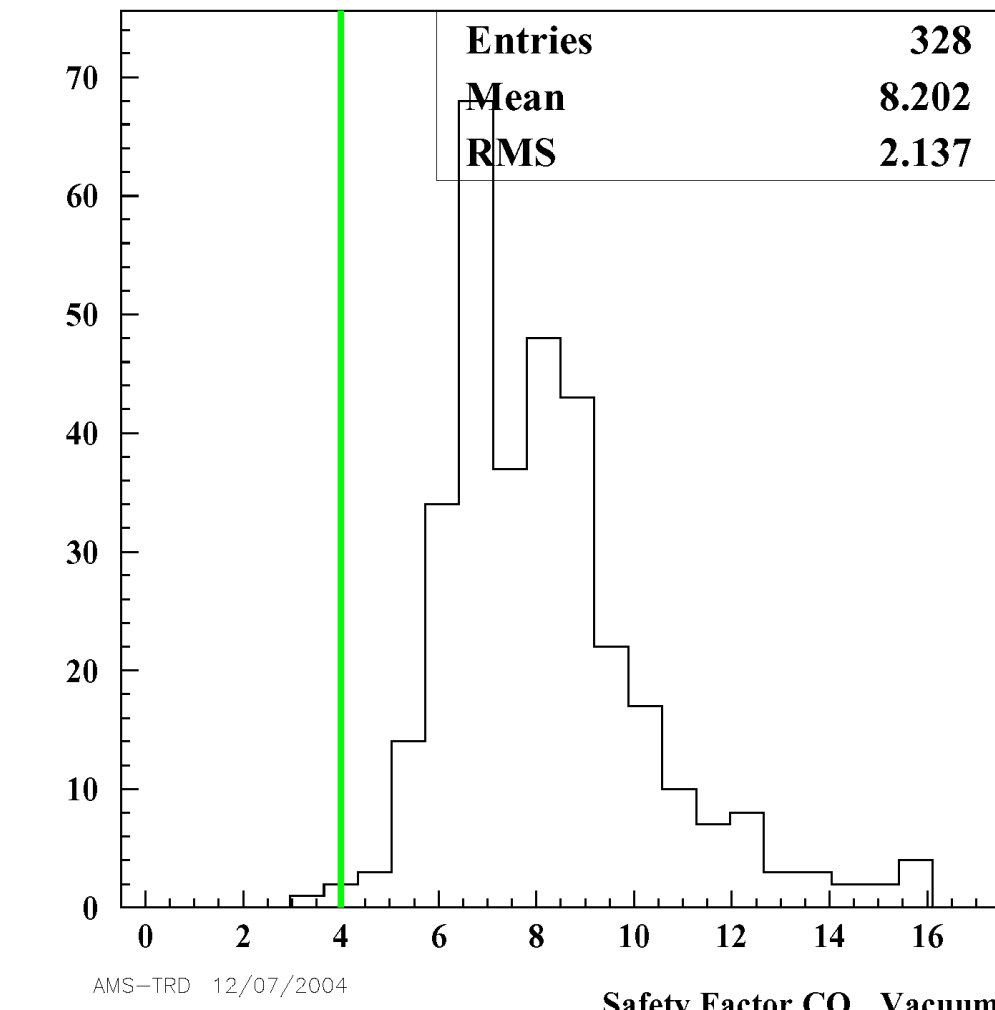


Upper/Lower 4 layers measure in bending plane
Middle 12 layers measure in perpendicular plane

Gastightness: Single Straws

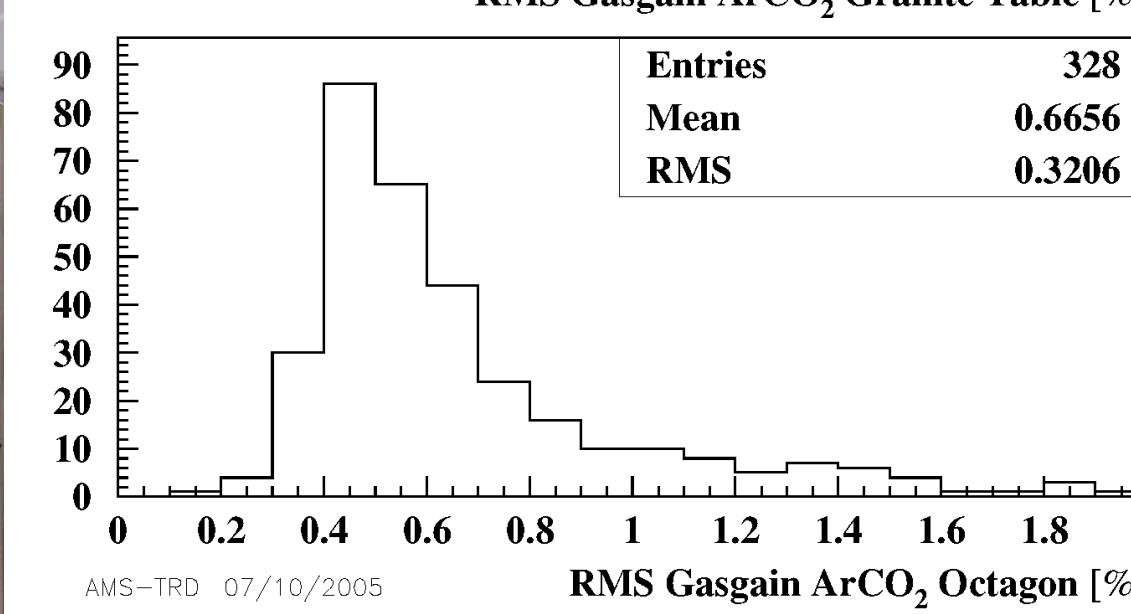
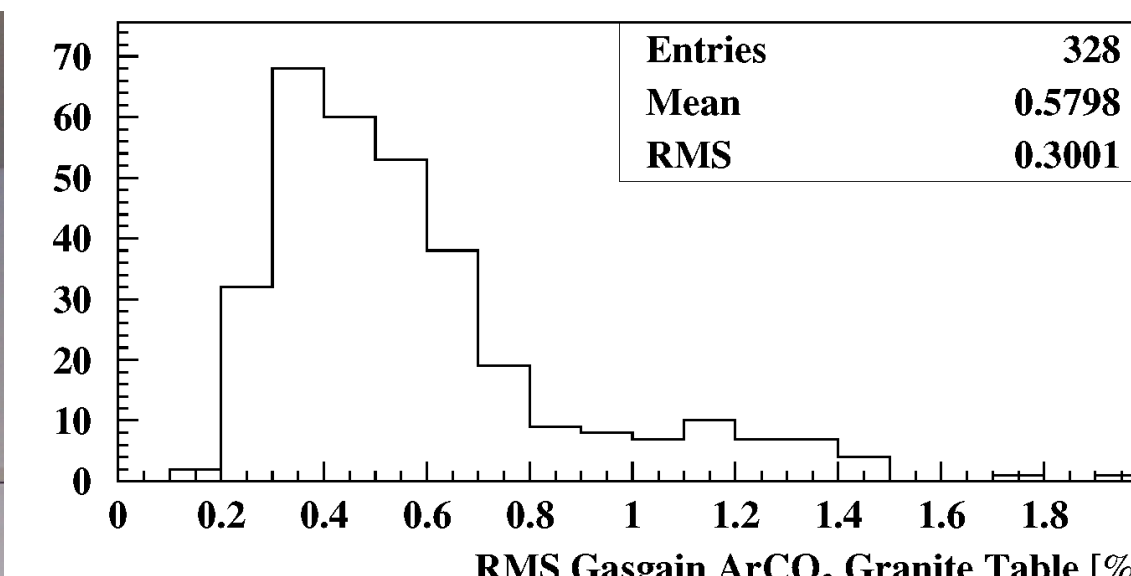


Straw Modules

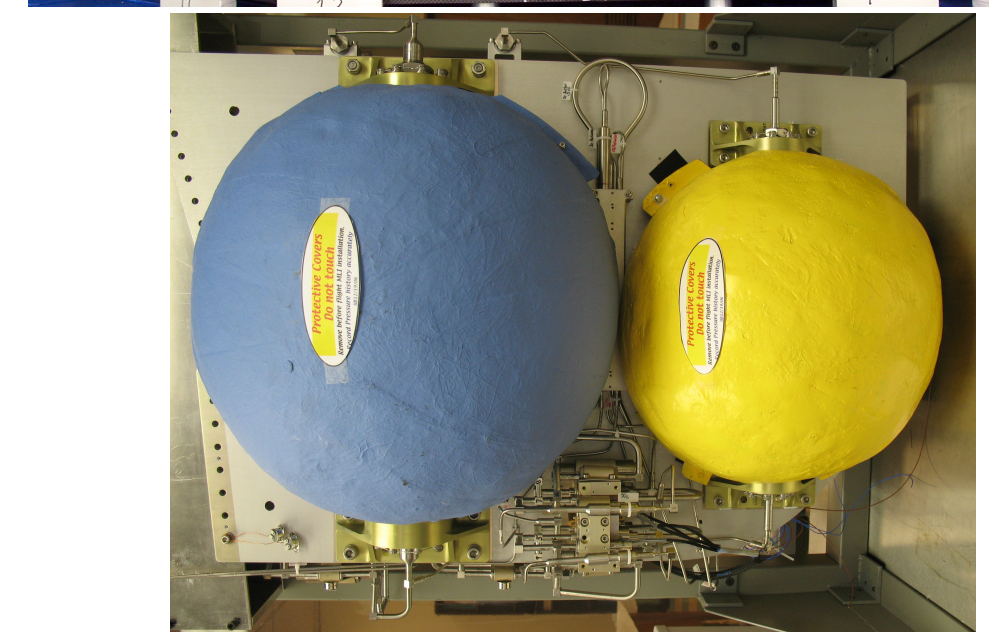


Gas Tightness is measured in
safety factors SF, module length 1m:
SF=1 -> 25.3*10⁻⁵ l mbar/s

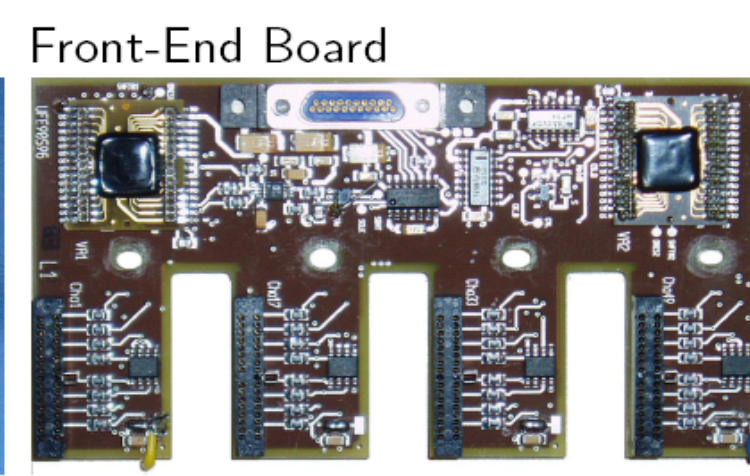
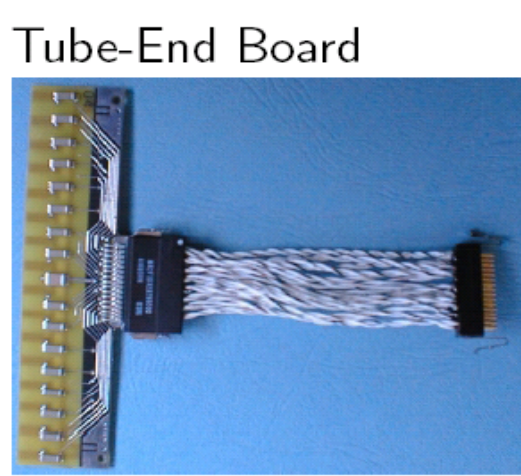
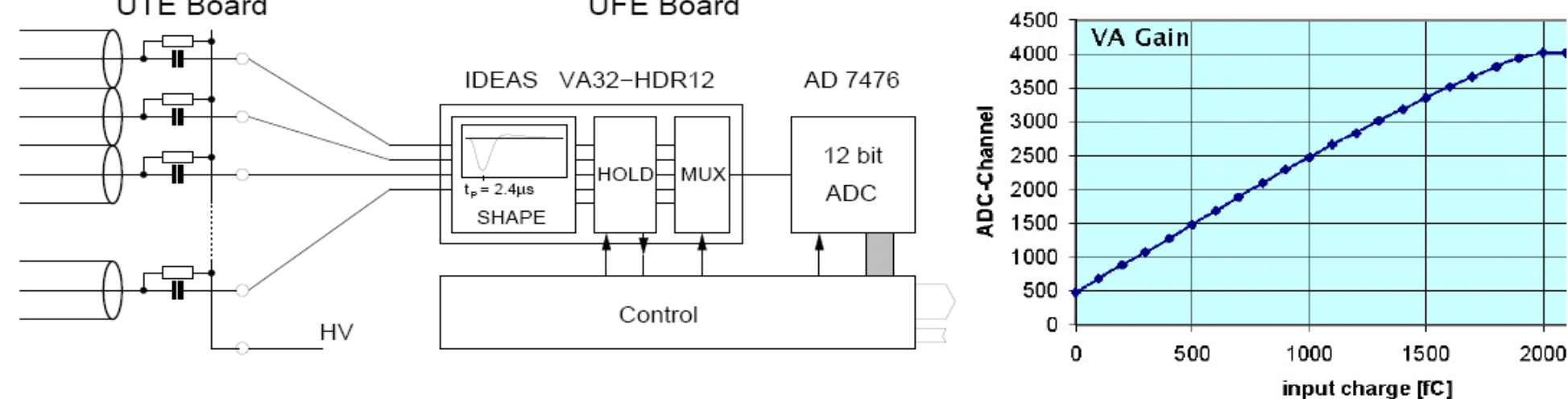
Gas Gain before & after integration of all 328 flight modules



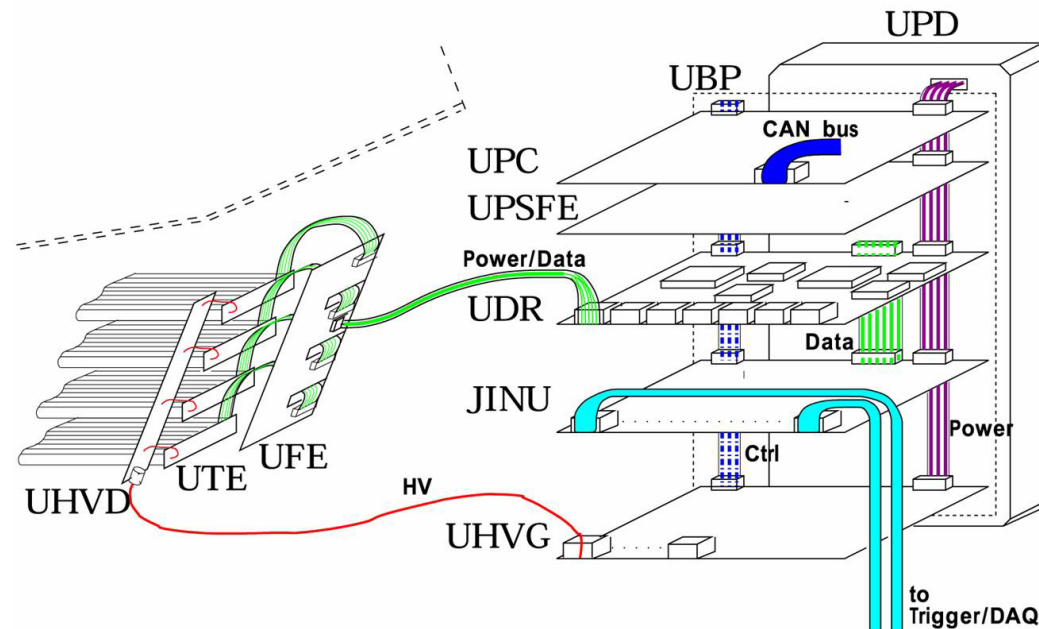
TRD Gassystem + Front End Electronics + DAQ



Total Straw Modul Length: 500m
TRD Volume: 230l @ 1bar
41 loops, each 8 modules in series
Xe: 49.5 kg, CO₂: 4.5 kg

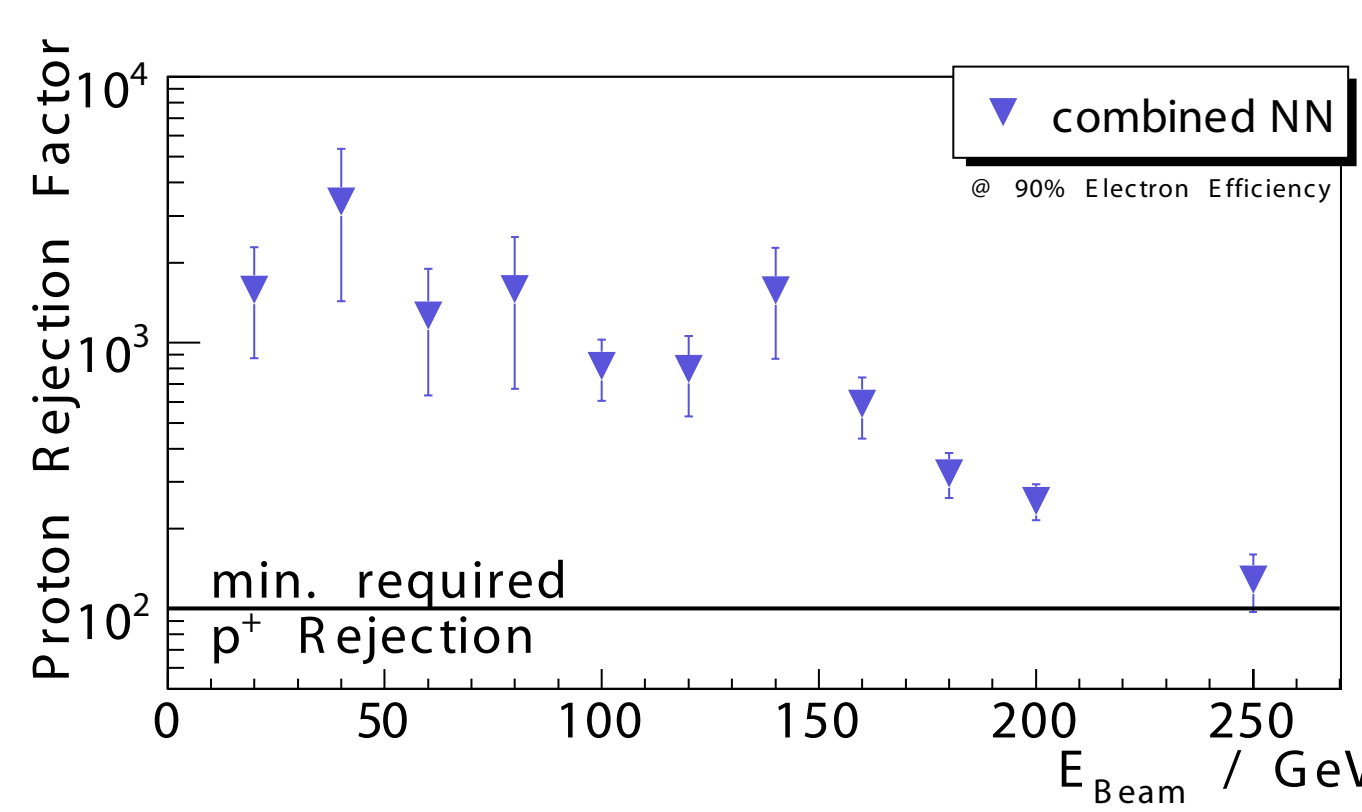
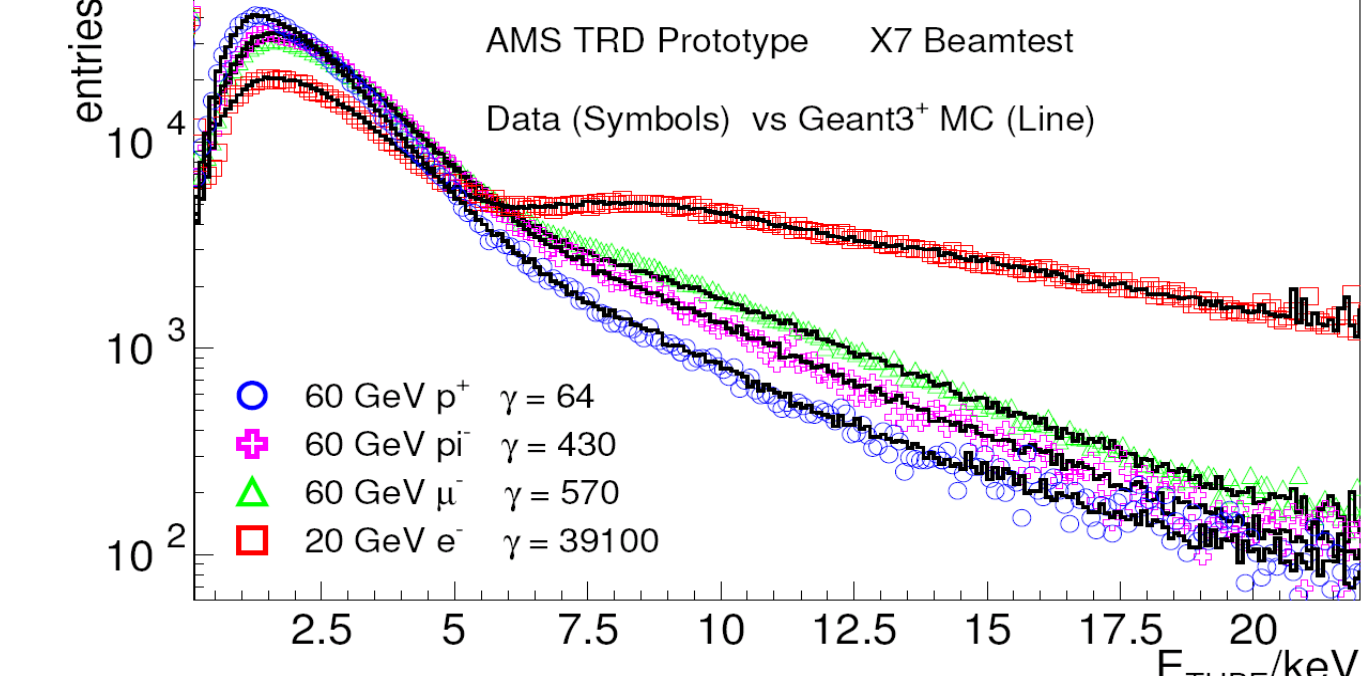
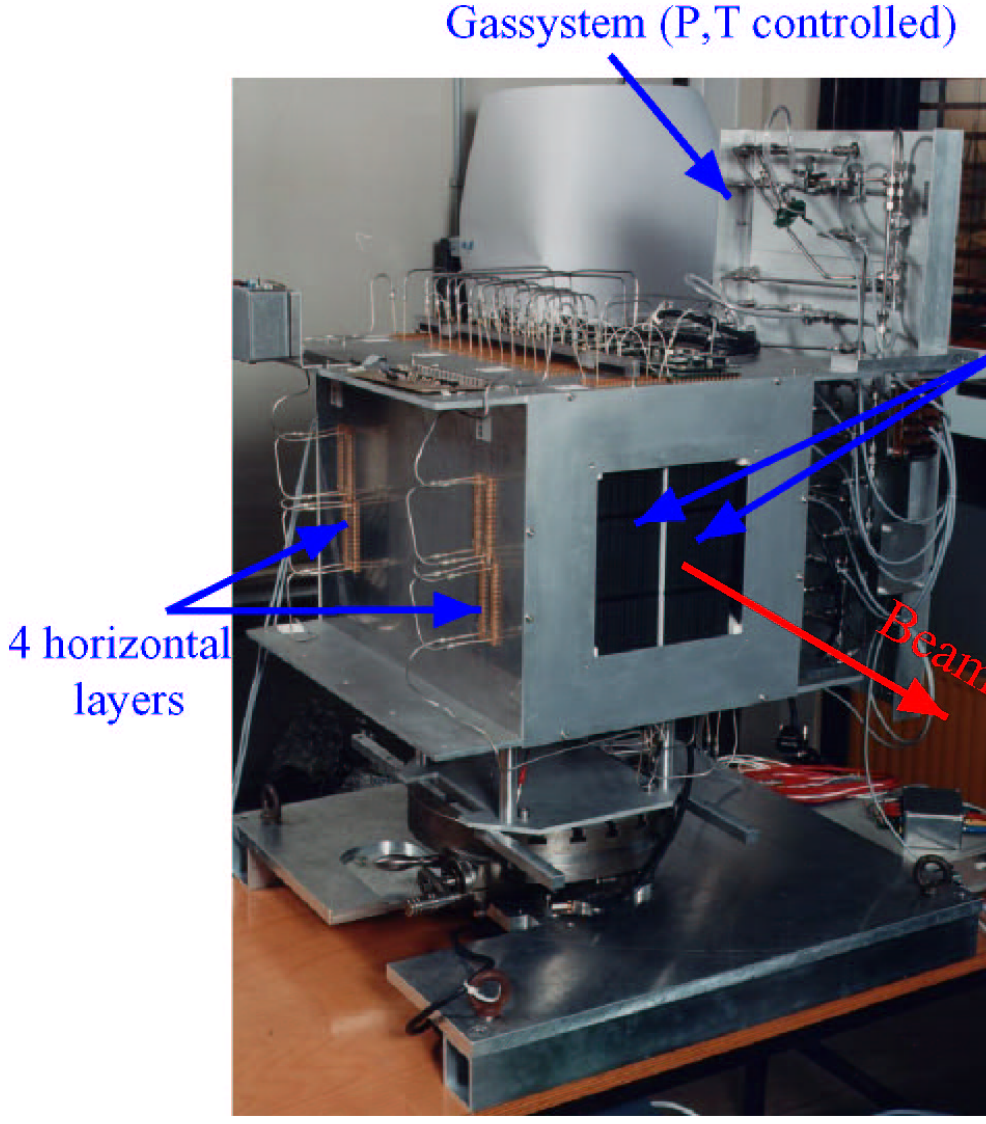


Power ~20 W/5248 Ch.
MIP MOP 30 fC
(G=3000) 60 bins
MIP S/N > 60/2
Range 60 MIPs

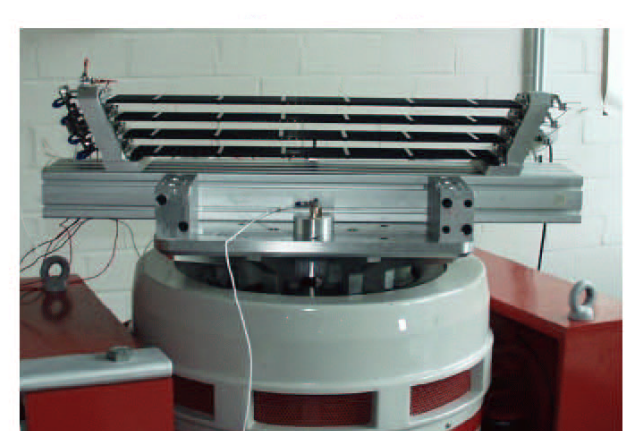
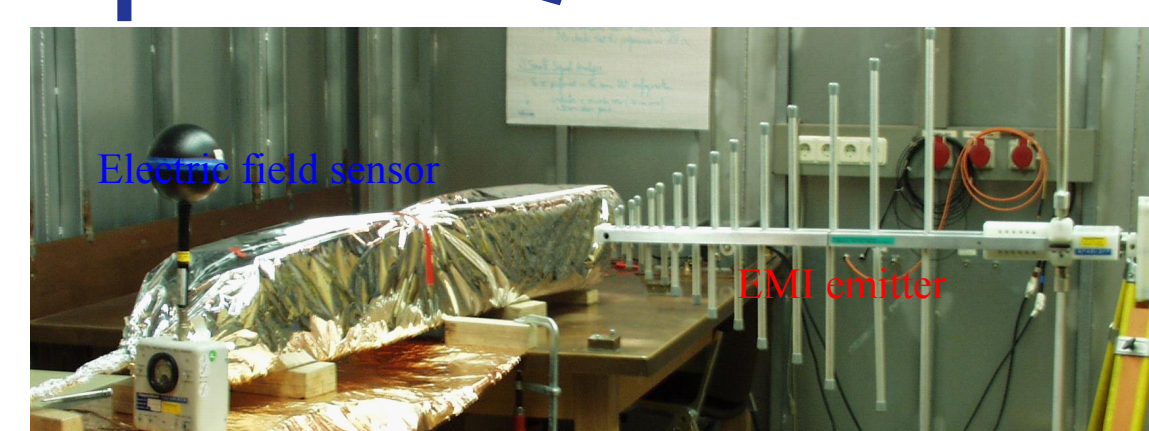


Power Consumption:
Front End Electronics 19.4 W
TRD Crate 71.4 W

TRD Performance:



Space Qualification: EMI + Vibration+ TVC



Vibration Test-Cycle
Sine Sweep 0.5 g (10-20000 Hz)
Random Spectrum aRMS = 6.8 g
Sine Sweep 0.5 g (10-20000 Hz)

