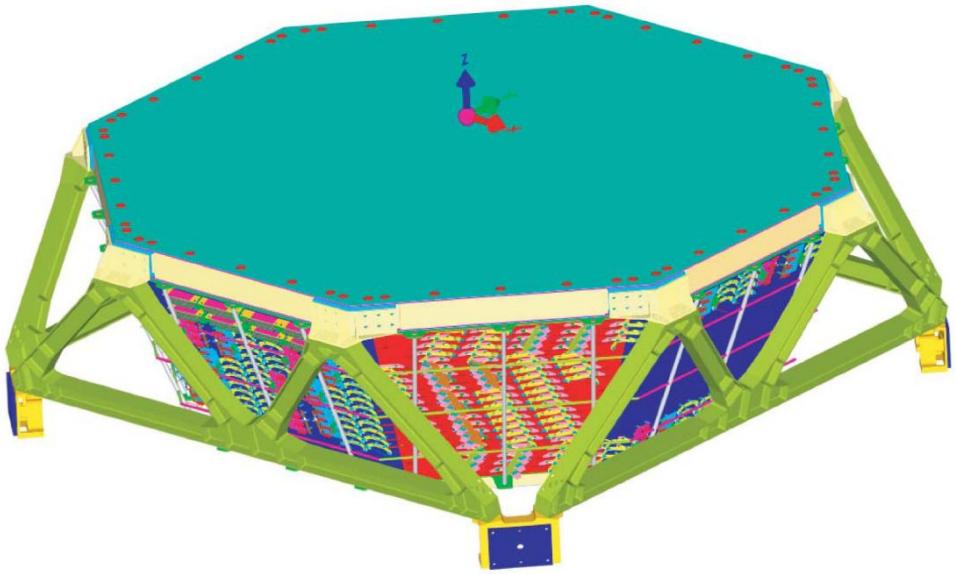
AMS TIM and General Meeting

Status of TRD Straw Modules



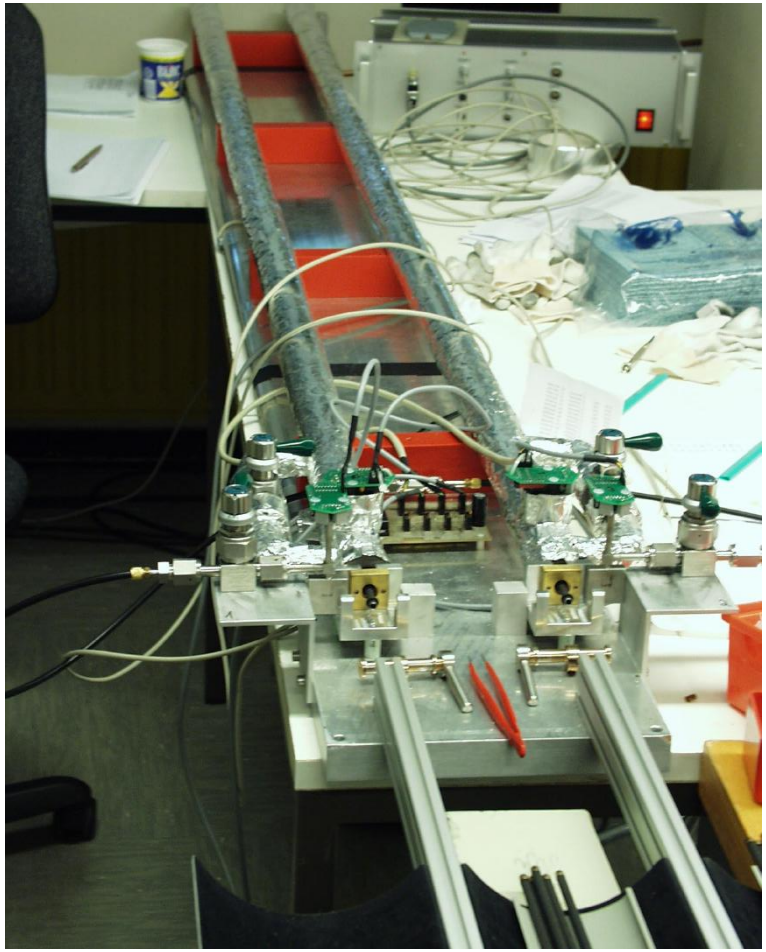
Th. Kirn
I. Phys. Institute B
RWTH Physics AC-I

CERN, 28th October 2003

Status TRD Straw Modules

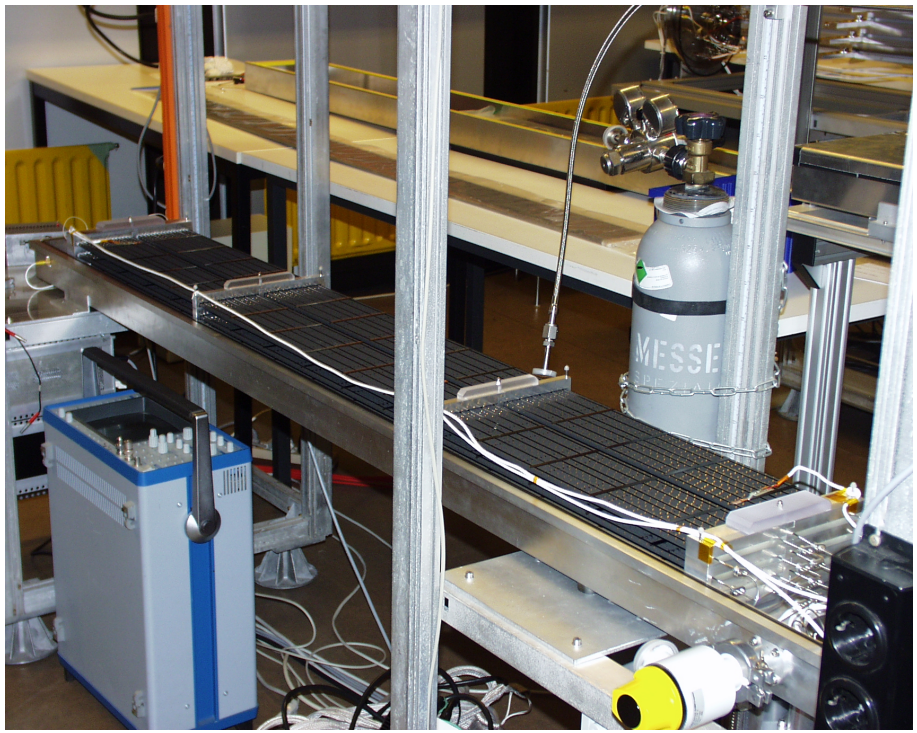
C.H. Chung, F. Dömmecke, S. Fopp, K. Lübelsmeyer, W. Karpinski, Th. Kirn,
S. Schael, G. Schwering, Th. Siedenburg, A. Schultz von Dratzig, M. Wlochal

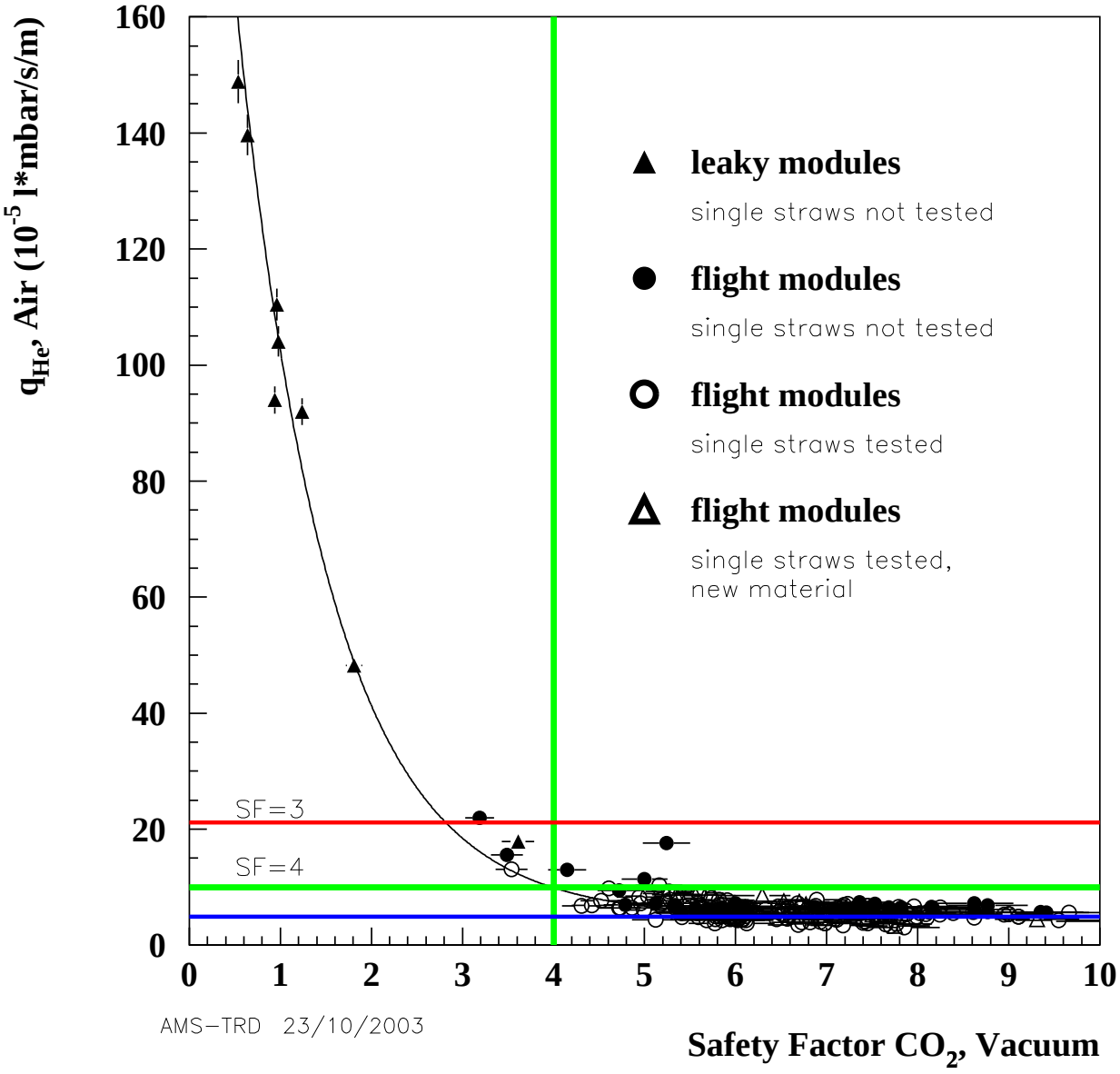
1.) Single Straw Test



2.) Module Production

3.) Longterm-Vacuum-Test

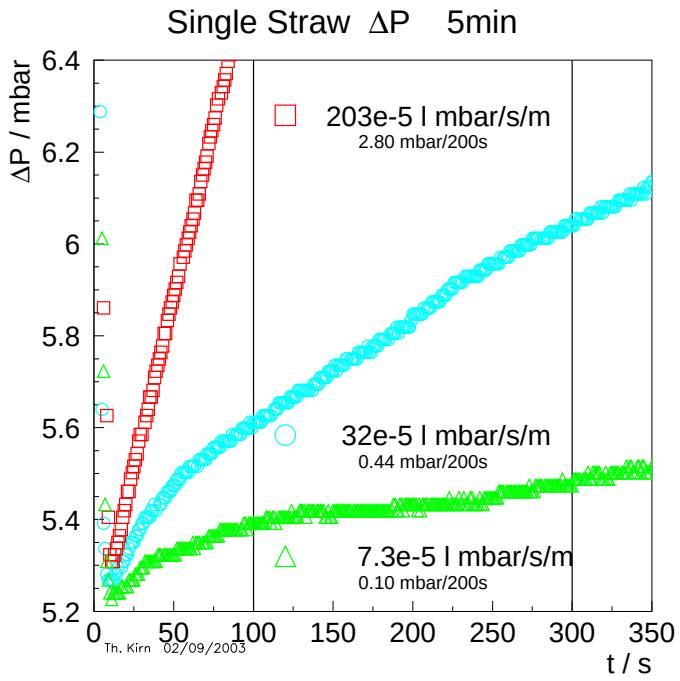


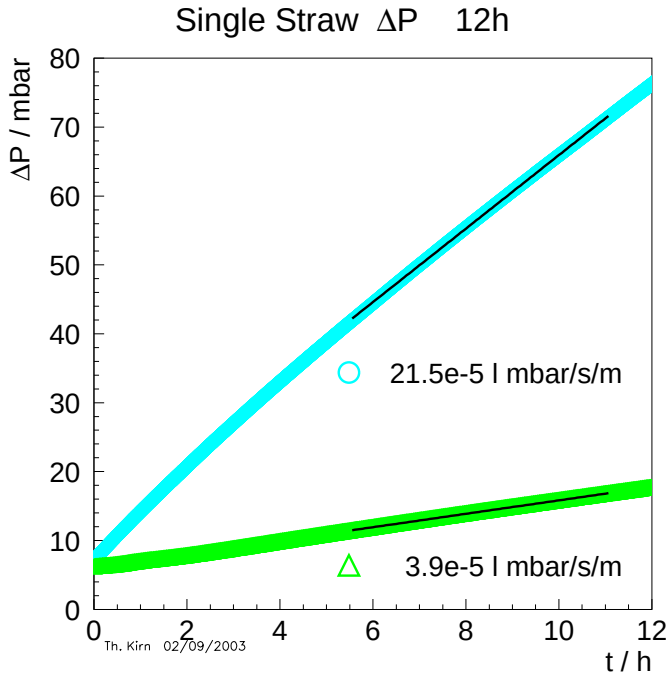


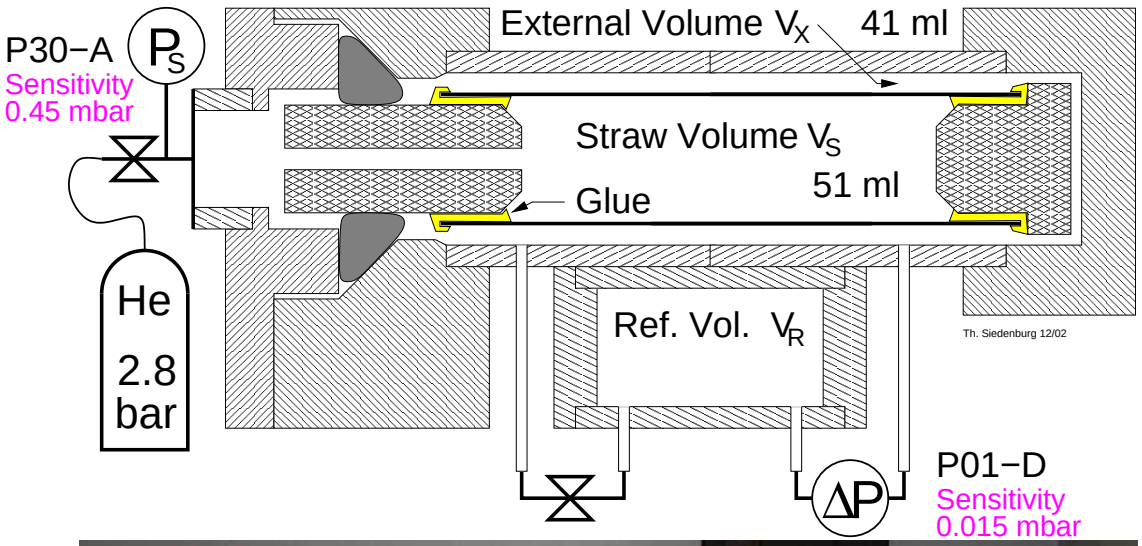
- Aim: Safety Factor of $> 4 \Leftrightarrow \ > 12$ years on ISS $\rightarrow$ He: $10 \cdot 10^{-5} l \cdot mbar/s/m$

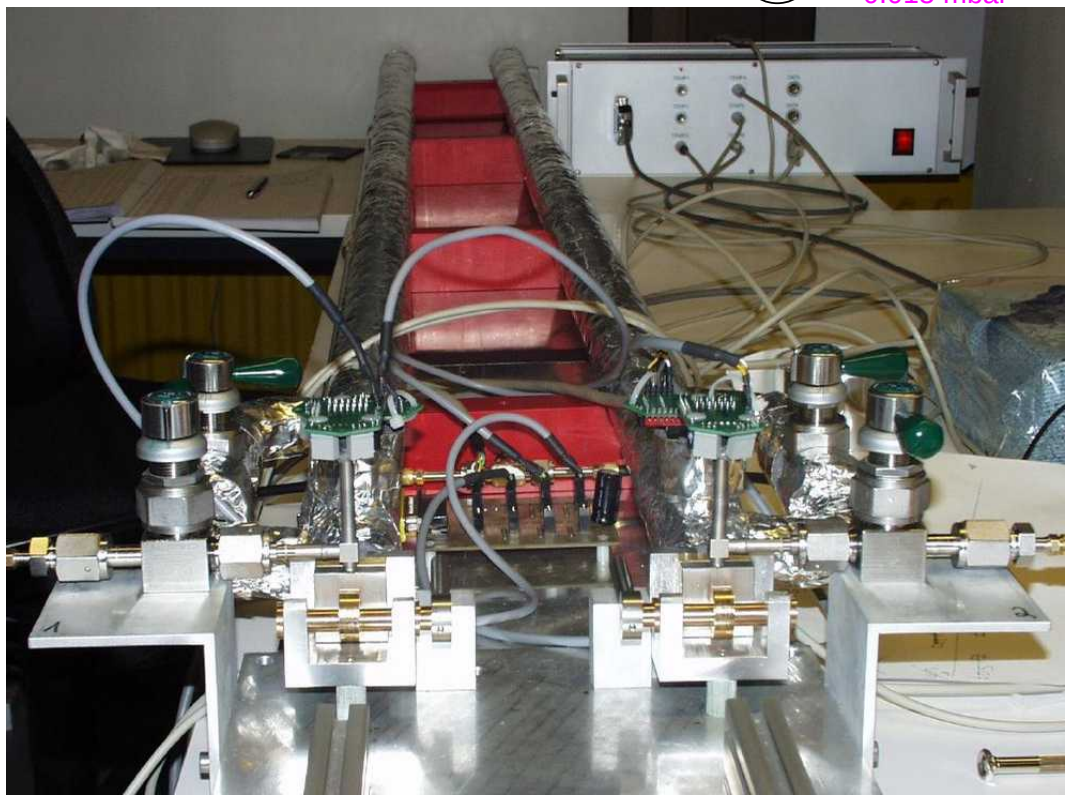
  $\Longrightarrow$ Need to test each of 5248 straws

Single Straw Test

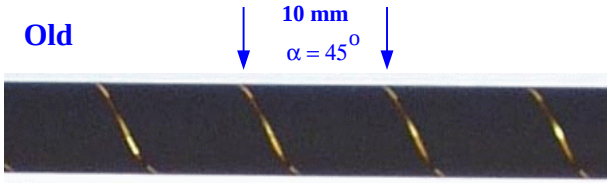


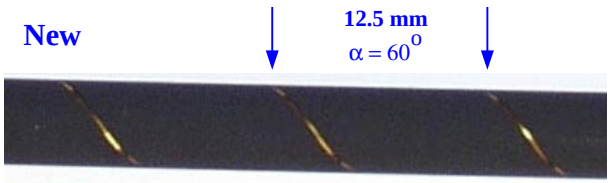






Single Straw Test: 16 Straws/Module × 328 Modules = 5248 Straws





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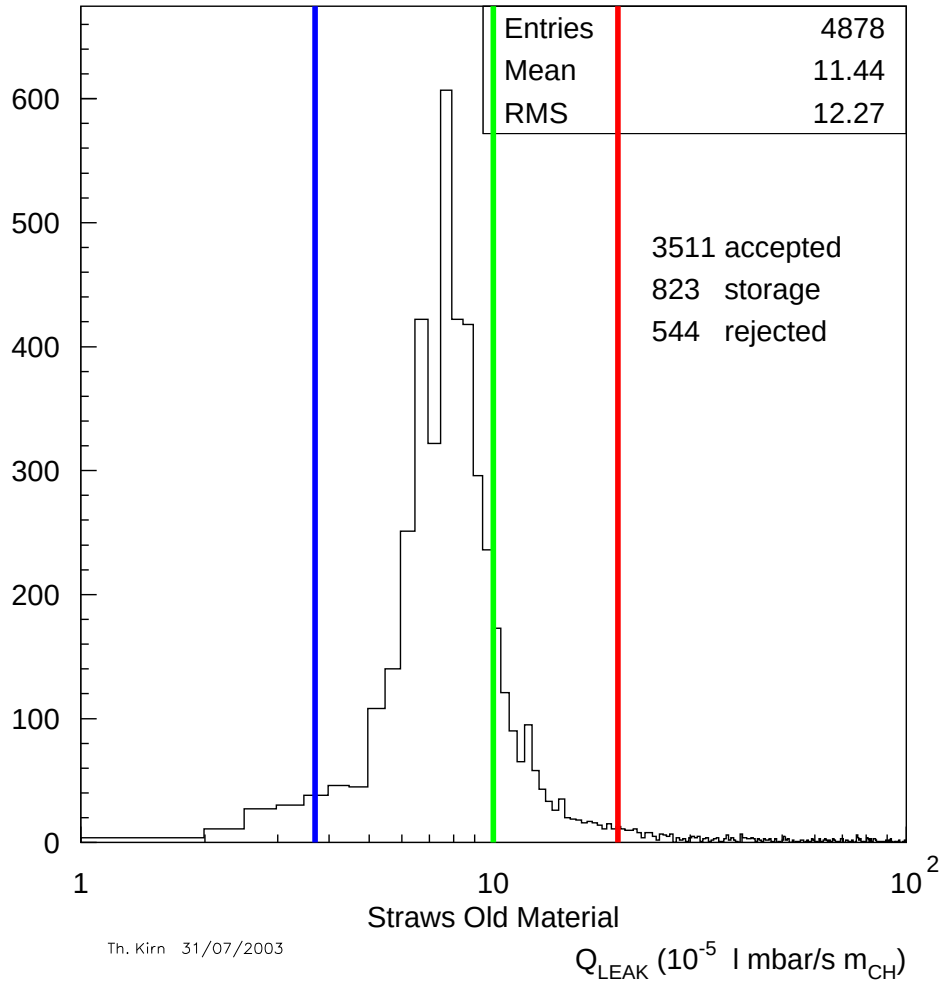
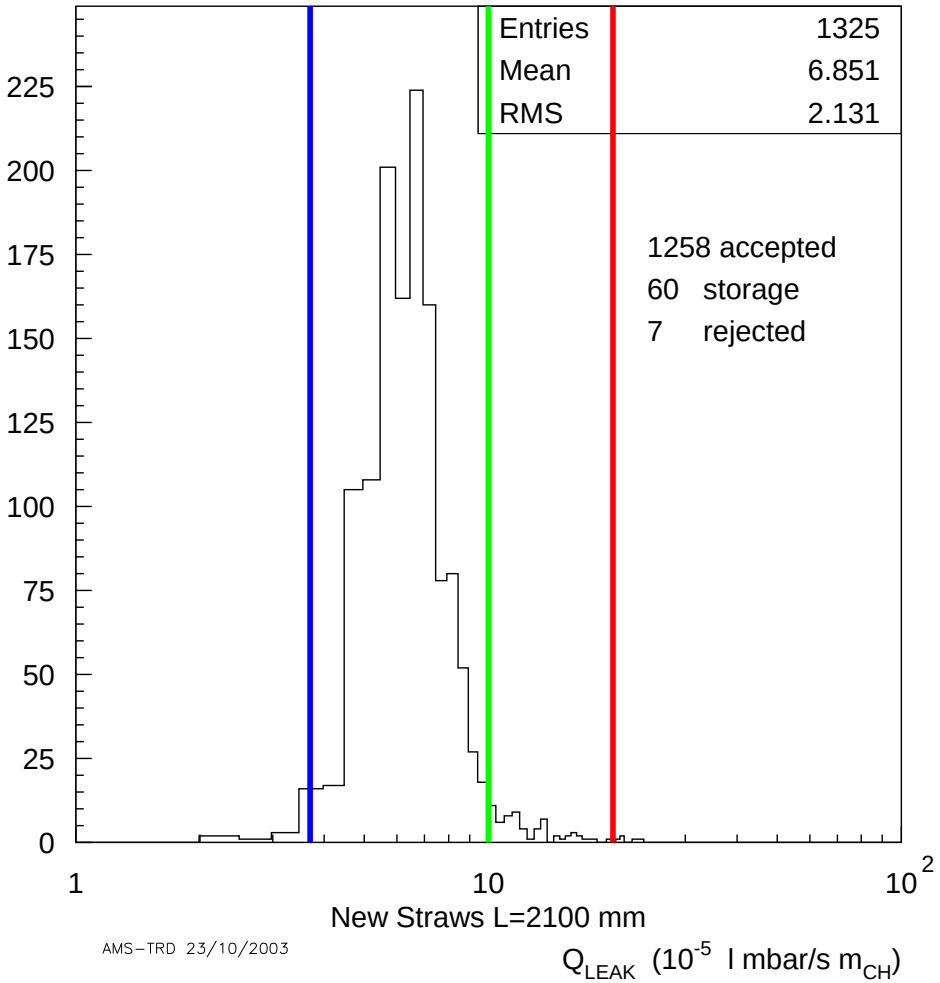
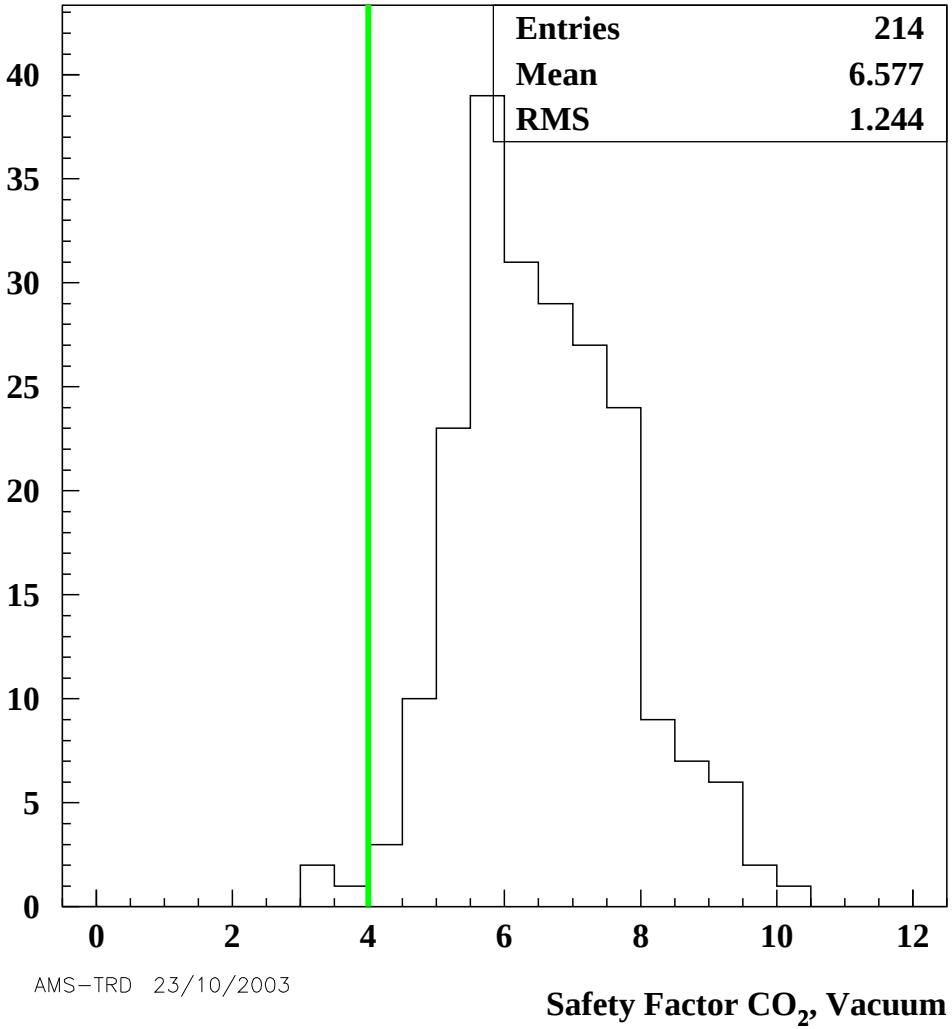


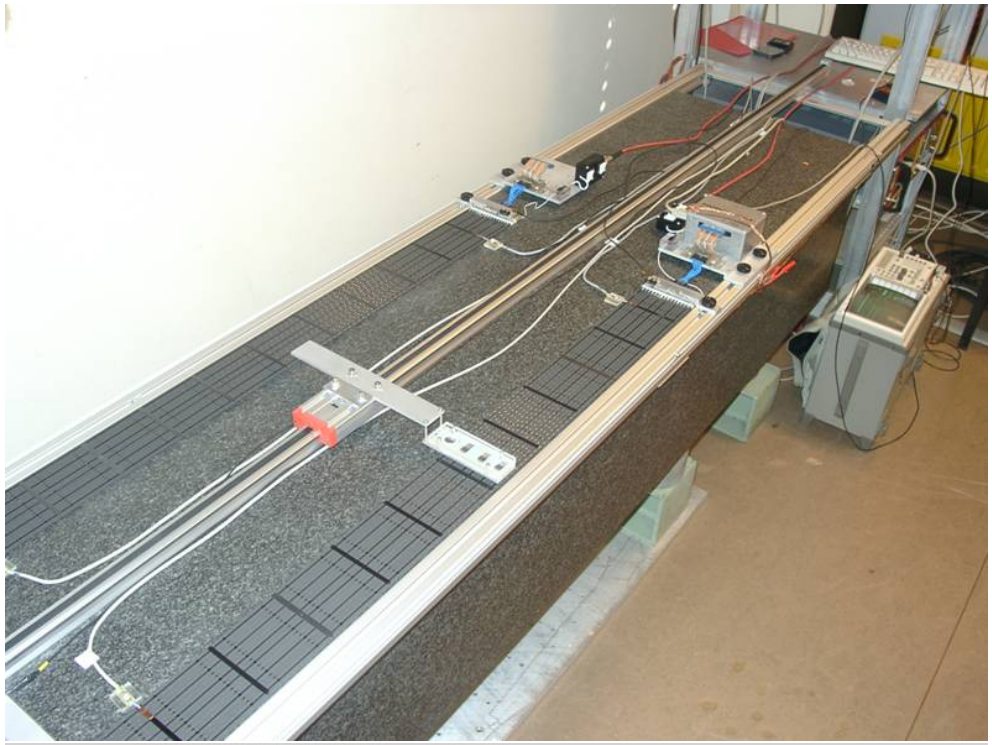


Straw Module Production



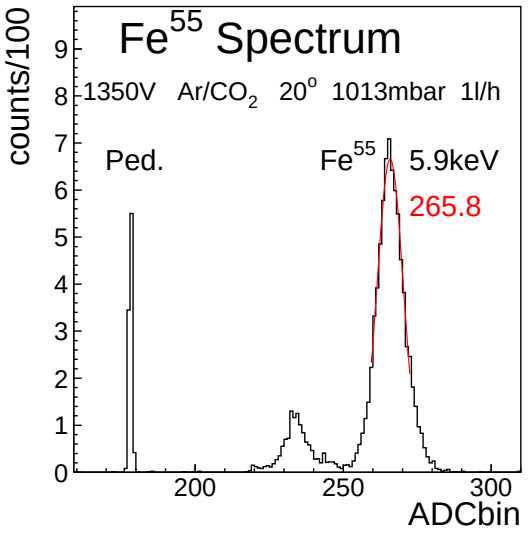
214 Straw Modules:
Safety Factor for TRD: ~ 6.6
6.6×3y ~ 20 years operation on ISS

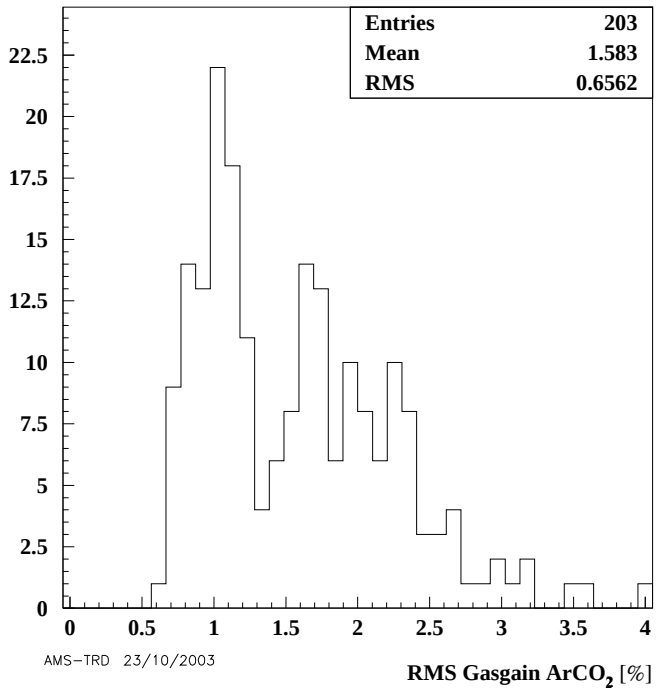
Measurement of Gas Gain with Fe^{55} source



Mean: 5720.69 RMS: 63.90
c:\ggdata\progs\027_3S.pas

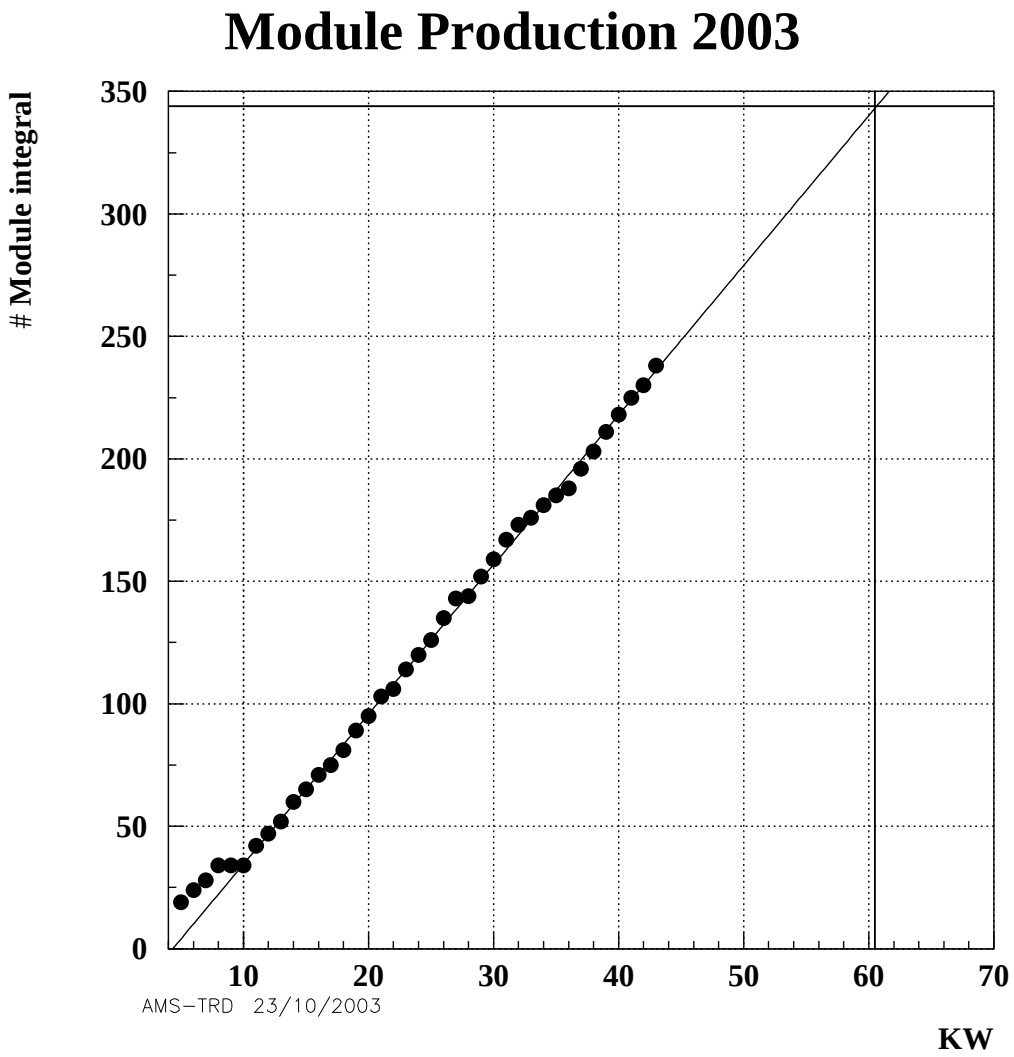
Straw										
1	2.1	1.6	-2.1	1.0	1.4	1.9	-0.3	0.5	1.6	0.5
2	-0.8	1.2	0.0	-0.7	1.2	1.0	1.7	-0.2	1.9	1.3
3	-0.4	-0.5	0.8	-1.3	-0.3	1.6	2.4	0.7	2.9	2.4
4	-0.4	-1.0	-0.7	-0.5	-1.6	-1.2	0.4	0.5	0.4	0.7
5	-0.3	0.2	-1.4	0.2	0.3	0.1	0.5	0.8	1.5	0.1
6	-0.4	0.7	-1.7	-0.1	0.4	-1.3	-0.2	1.4	-0.8	-1.2
7	-1.1	0.9	-1.9	-1.1	0.3	-0.3	-1.1	1.4	0.6	-0.0
8	-0.4	-0.1	-1.2	-0.8	-0.0	-2.0	0.4	1.4	-1.4	-1.2
9	-0.1	-0.3	-0.2	-0.7	-0.8	-1.4	0.2	1.4	-1.2	-0.2
10	-0.1	0.6	-2.5	-0.3	1.0	0.0	-0.5	0.6	1.2	-1.3
11	-1.7	-0.6	-1.1	-2.3	0.3	0.1	-0.6	-0.3	0.6	0.3
12	0.2	-0.9	-2.8	-0.7	-0.9	-0.5	-1.0	-0.5	-0.4	-1.3
13	-0.3	0.6	-2.3	-0.3	1.4	-0.5	-2.0	0.2	0.5	-1.1
14	-0.2	0.4	-0.3	0.2	0.3	0.6	-0.1	1.1	0.8	1.4
15	-2.2	-0.8	0.1	-0.6	-1.0	0.5	0.9	-0.8	2.0	1.9
16	0.8	1.3	-1.1	2.1	2.4	0.6	0.2	1.7	1.0	-1.2





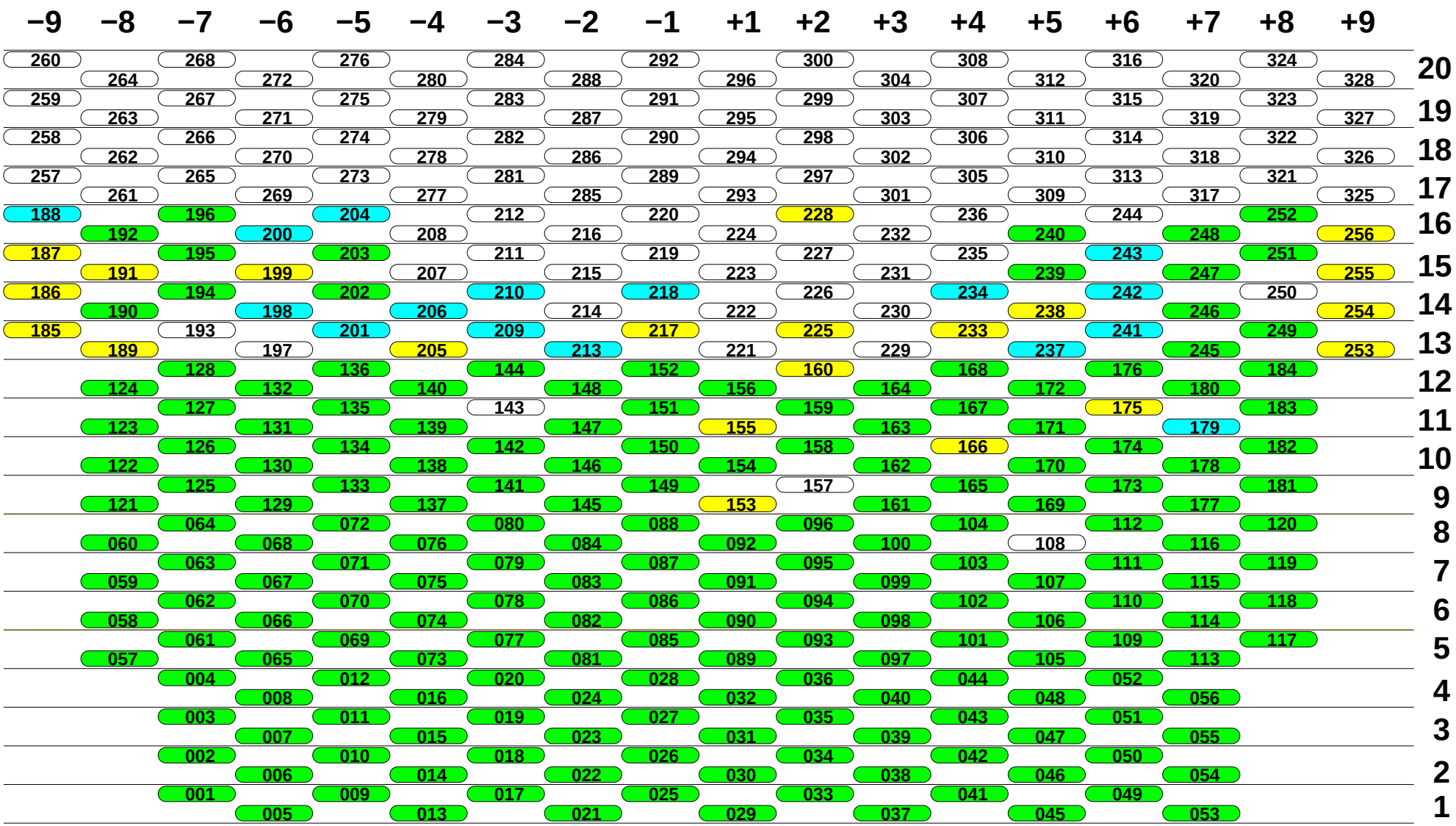
Average variation of gas gain: 1.6%

Straw Module Production Status

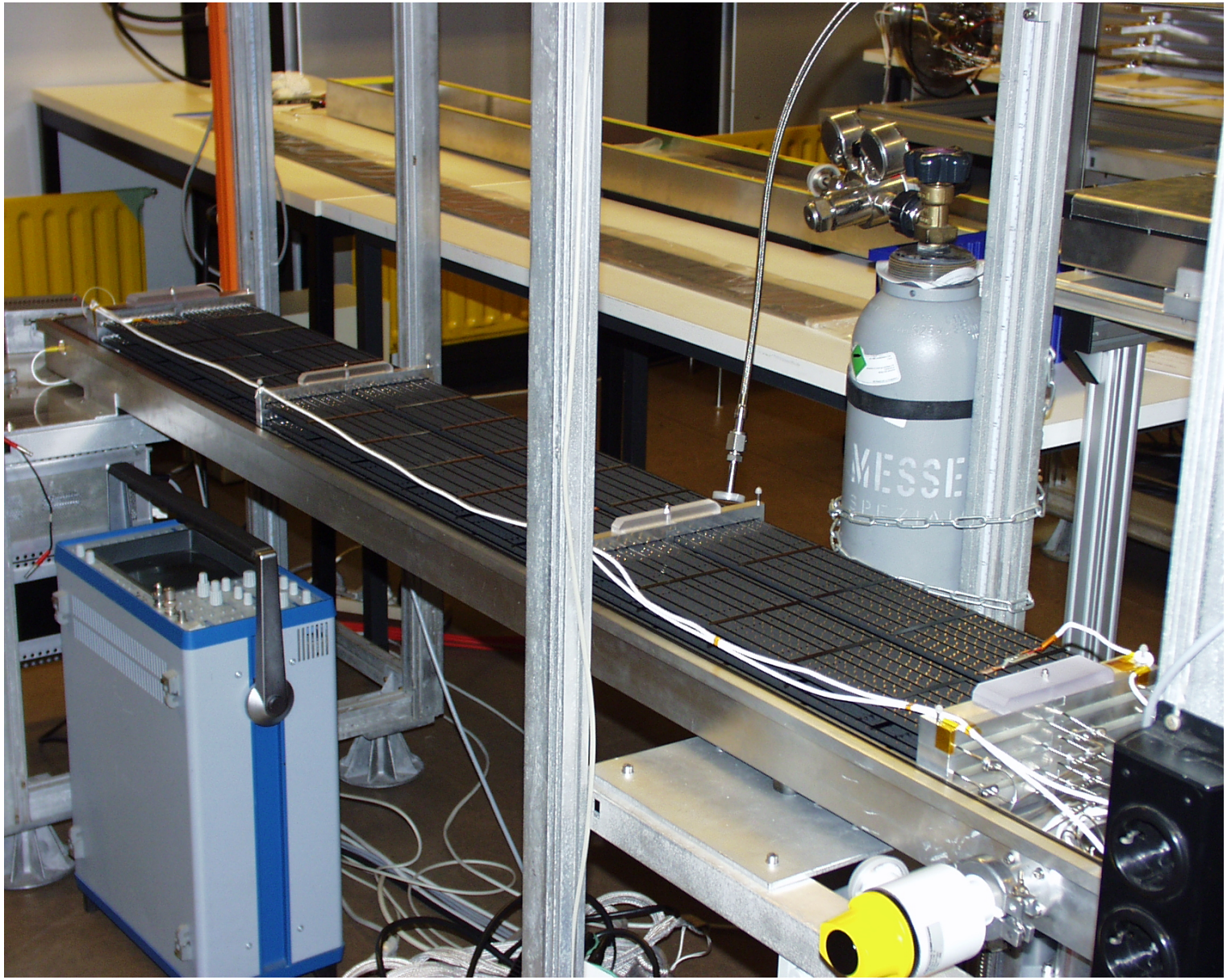


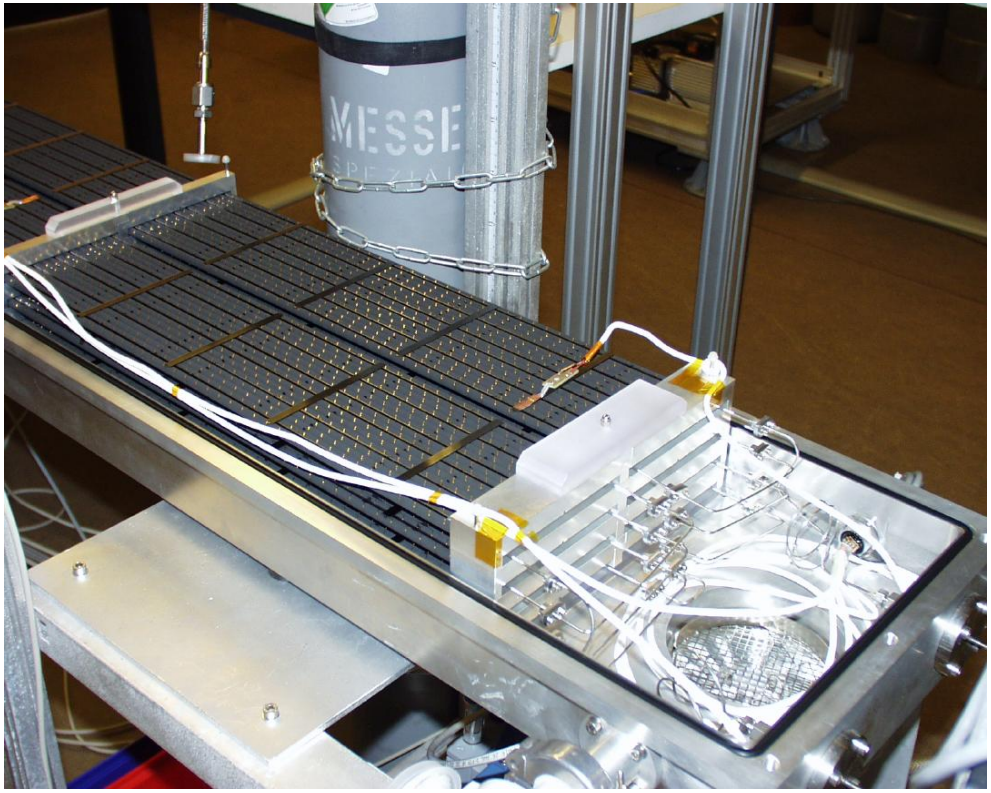
End of Module Production: March 2004

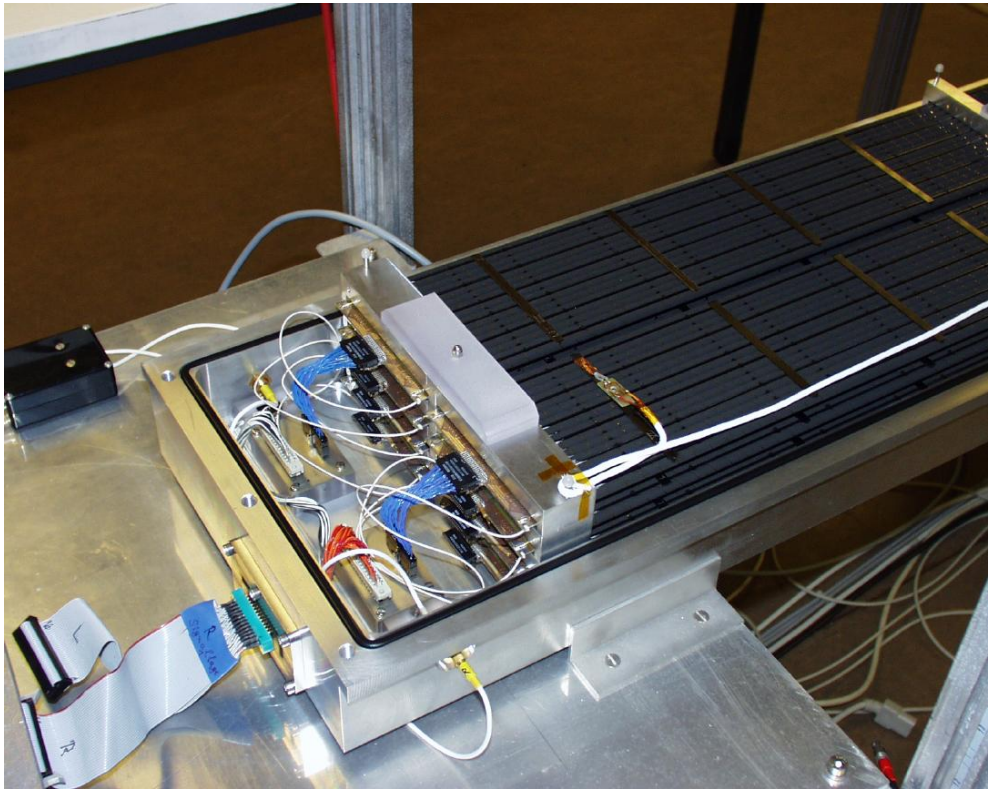
Straw Module Production Status



Longterm-Vacuum-Test:

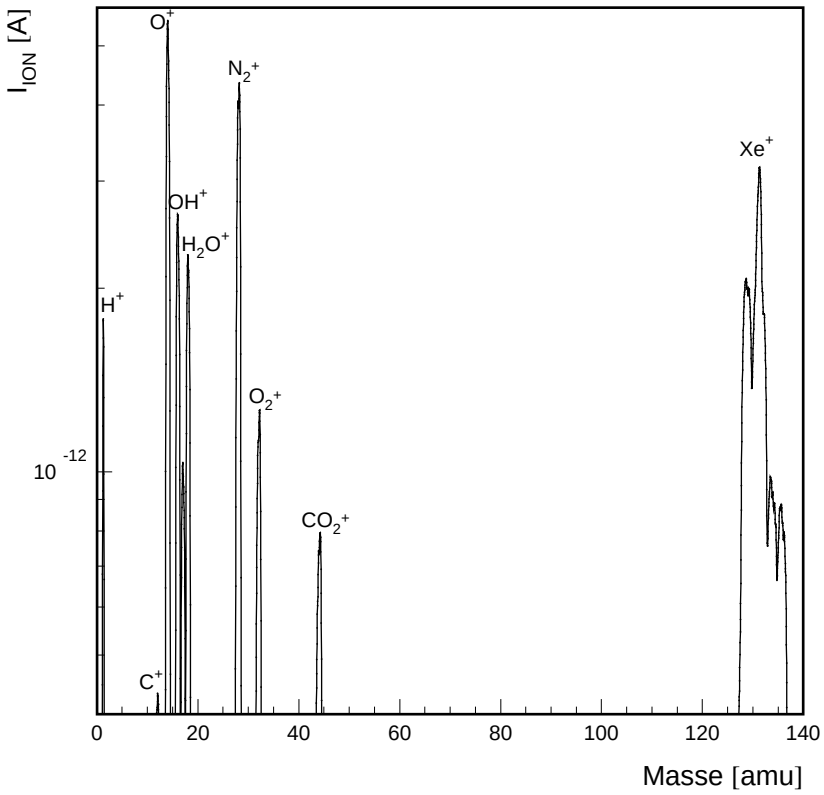




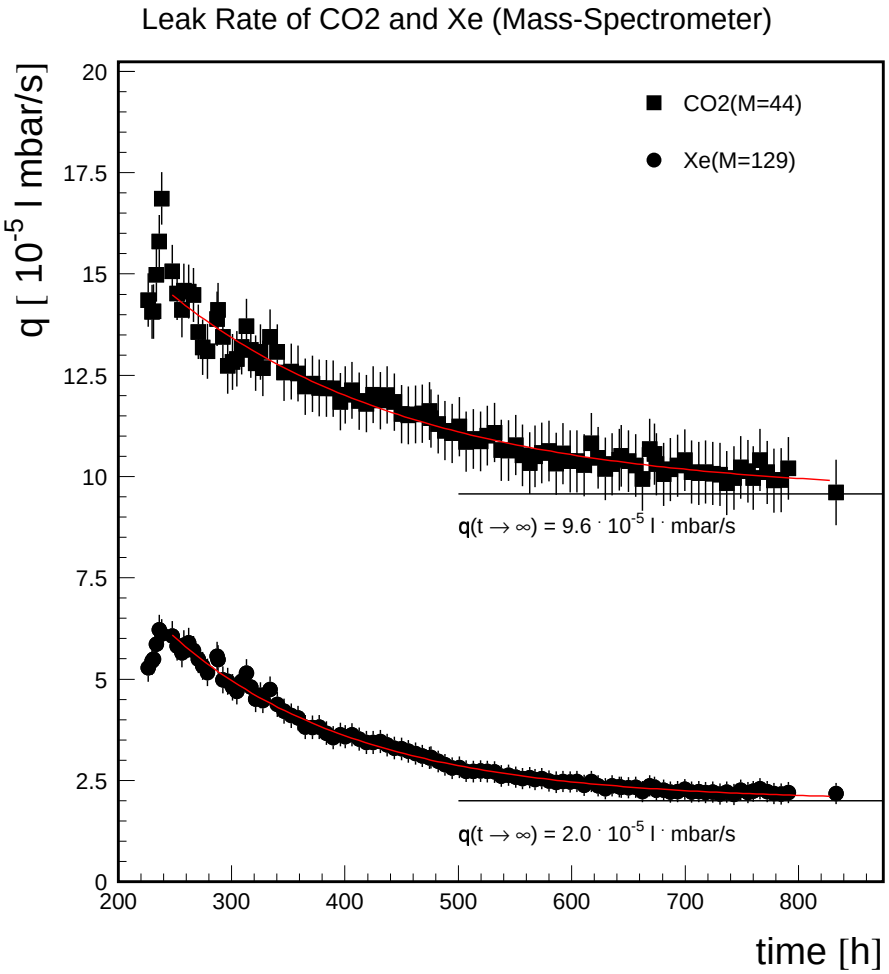


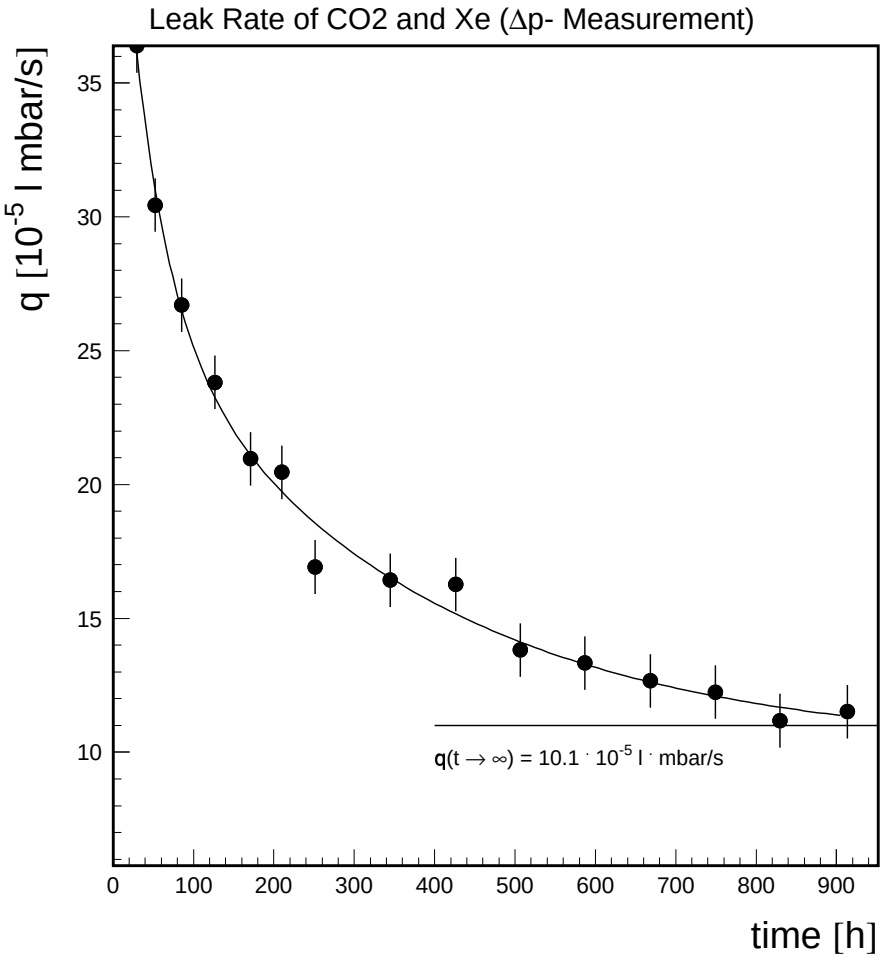
Mod. No.	Length [mm]	Air q_{He} $[10^{-5}\ \frac{l \cdot mbar}{s}]$	Vacuum Safety-Factor CO_2	Gas Gain $ArCO_2$ U = 1350V Mean	RMS [%]
LZT I	1534.61	6.0	7.40	6018.6	1.65
LZT II	1534.61	5.7	7.8	5922.2	1.82
LZT III	1534.61	5.2	7.2	5891.4	1.70
LZT IV	1534.61	5.8	7.5	5756.6	2.17
LZT V	1534.61	6.3	6.9	5902.3	1.64
LZT VI	1534.61	5.1	7.7	5737.9	1.11
LZT VII	1534.61	4.7	7.9	5906.7	1.99
LZT VIII	1534.61	5.5	7.7	5867.4	1.25

Longterm-Vacuum-Test:



Longterm-Vacuum-Test:

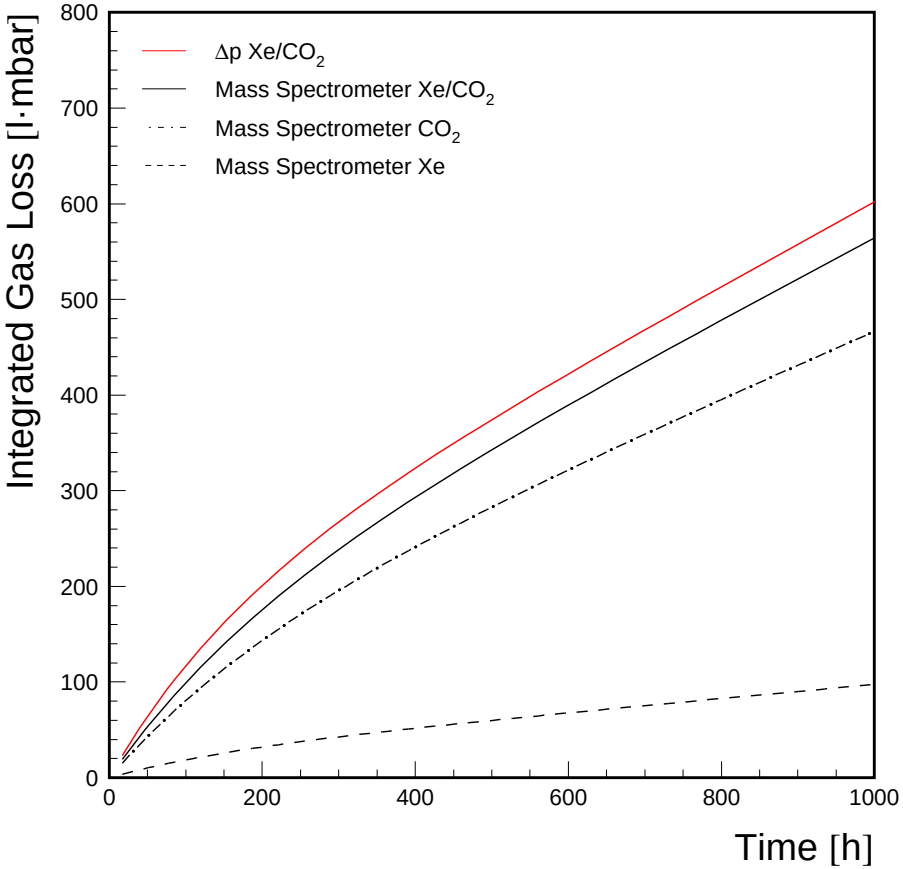


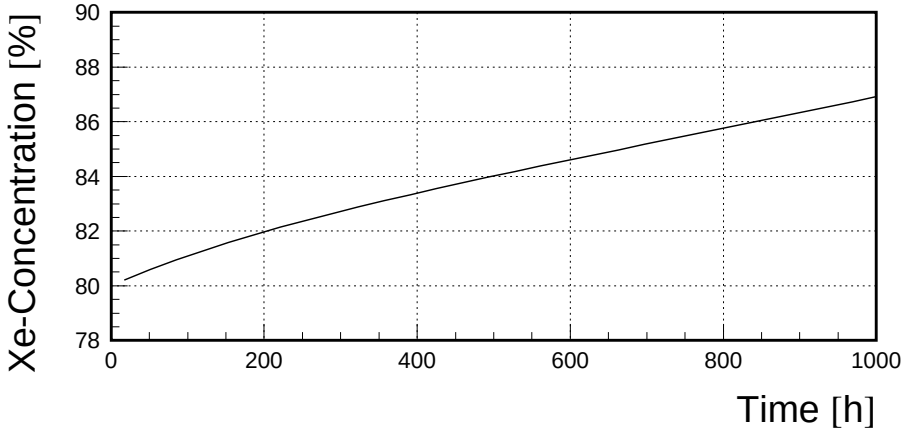


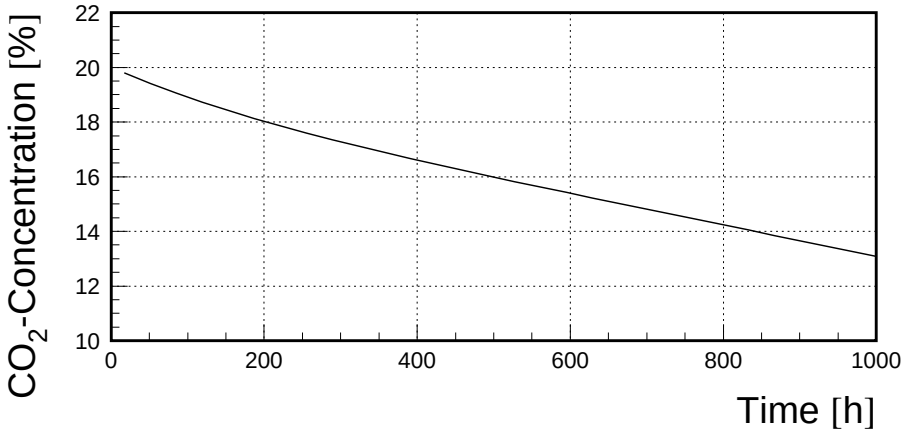
CO_2-Prediction:

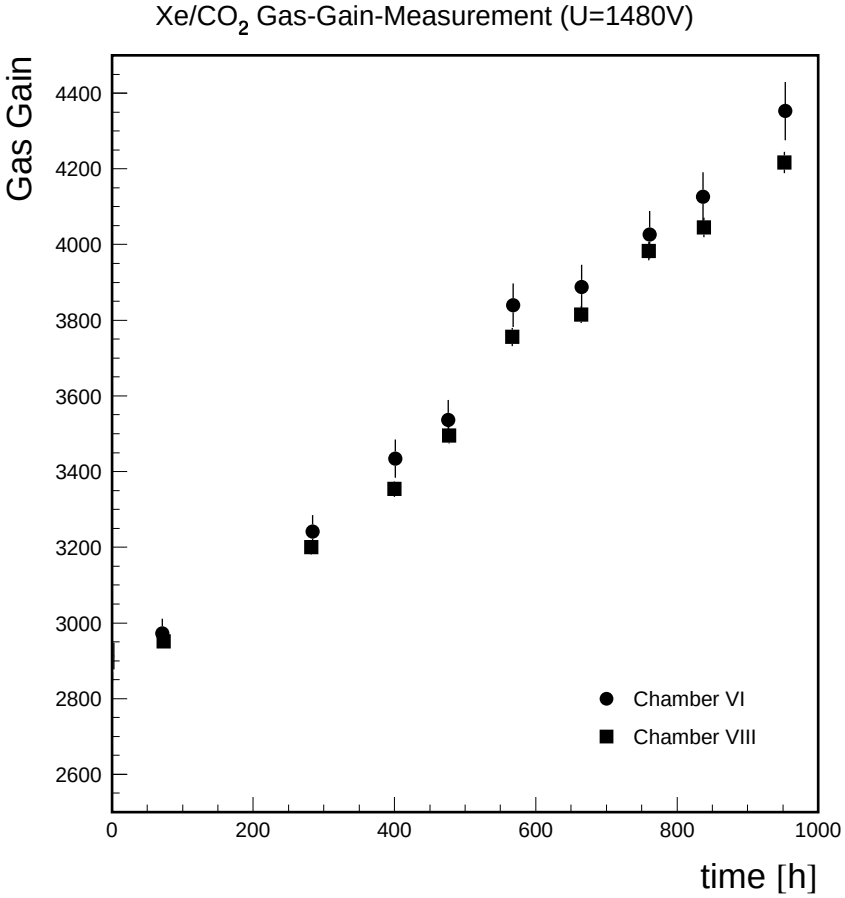
$$q_{\mathrm{Module}} = q_{\mathrm{straws}} + q_{\mathrm{endpieces}} = 4.5 \cdot 10^{-5}\frac{\mathrm{l\cdot mbar}}{\mathrm{s}} + 4.0 \cdot 10^{-5}\frac{\mathrm{l\cdot mbar}}{\mathrm{s}} = 8.5 \cdot 10^{-5}\frac{\mathrm{l\cdot mbar}}{\mathrm{s}}$$

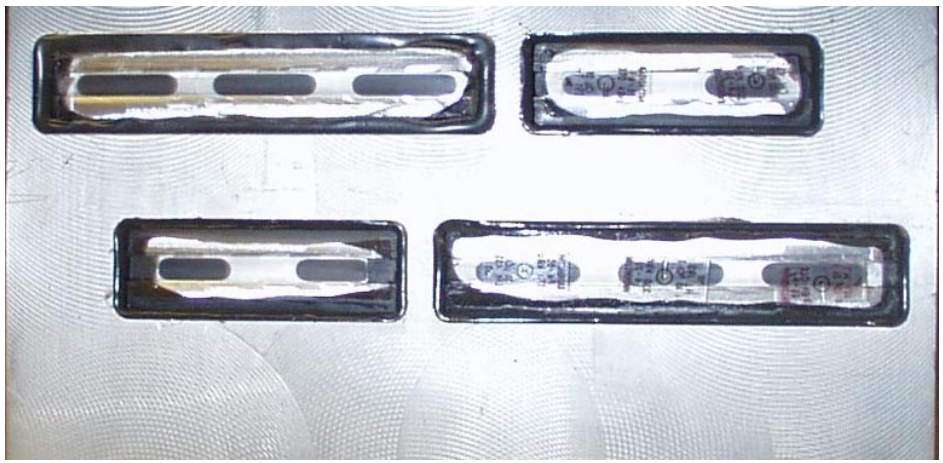
Longterm-Vacuum-Test:











$$\frac{dG}{G} = 53.6\%$$

$$df_{\mathrm{CO_2}} = 7\%$$

$$\frac{1}{G} \cdot \frac{dG}{df} = \frac{8\%}{1\% f_{\mathrm{CO_2}}}$$

Conclusion

TRD: 328 Flight Modules

- Flight Modules ready for installation: 191
- Flight Modules under test: 21
- Flight Modules in production: 16

$\rightarrow \sum \mathrm{FlightModules} = 228$

- Production ready March 2004

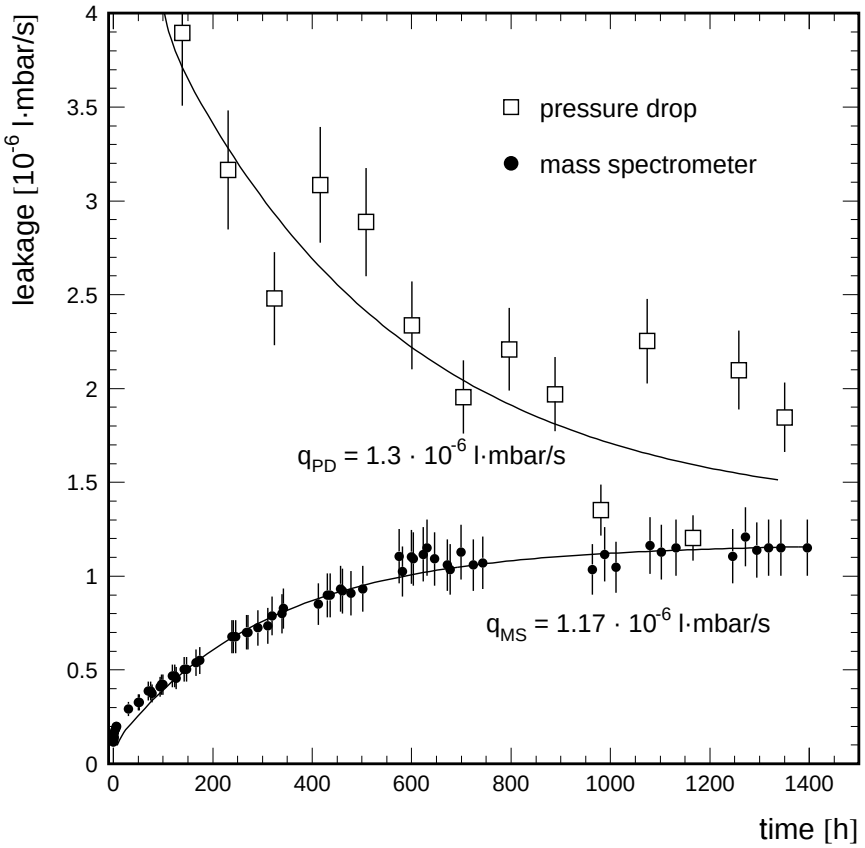
Longterm-Vacuum-Test:

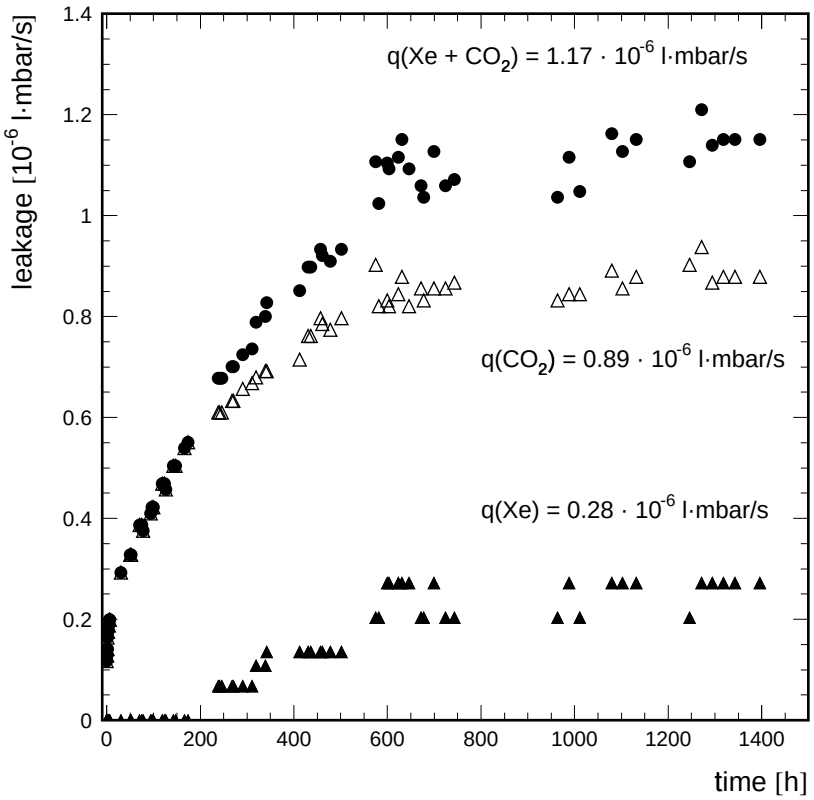
- 8 Straw Modules in series (1 loop) operating for 1000 h

  $\hookrightarrow$ $q_{\Delta p}$ and $q_{I_{ion}}$ in good agreement

  $\hookrightarrow$ Recirculating Gas System + Gas Analyzer


WENZEL





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

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

$$q_{Xe,max} = \frac{8100\ l \cdot 1013\ mbar}{1000 \cdot 86400\ s} \cdot \frac{1}{500\ m} = 19 \cdot 10^{-5}\ \frac{l \cdot mbar}{s \cdot m_{\text{Module}}} \quad \rightarrow \text{Safety factor :158}$$

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

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

AIM: CO_2 Safety Faktor: 4