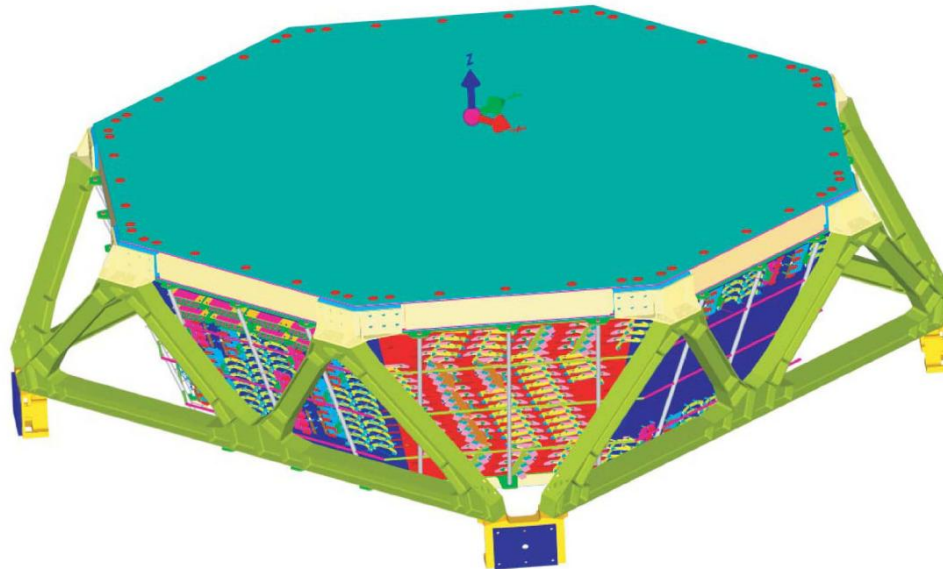


AMS TIM and General Meeting

Status of TRD Straw Modules



Th. Kirn
I. Phys. Institute B

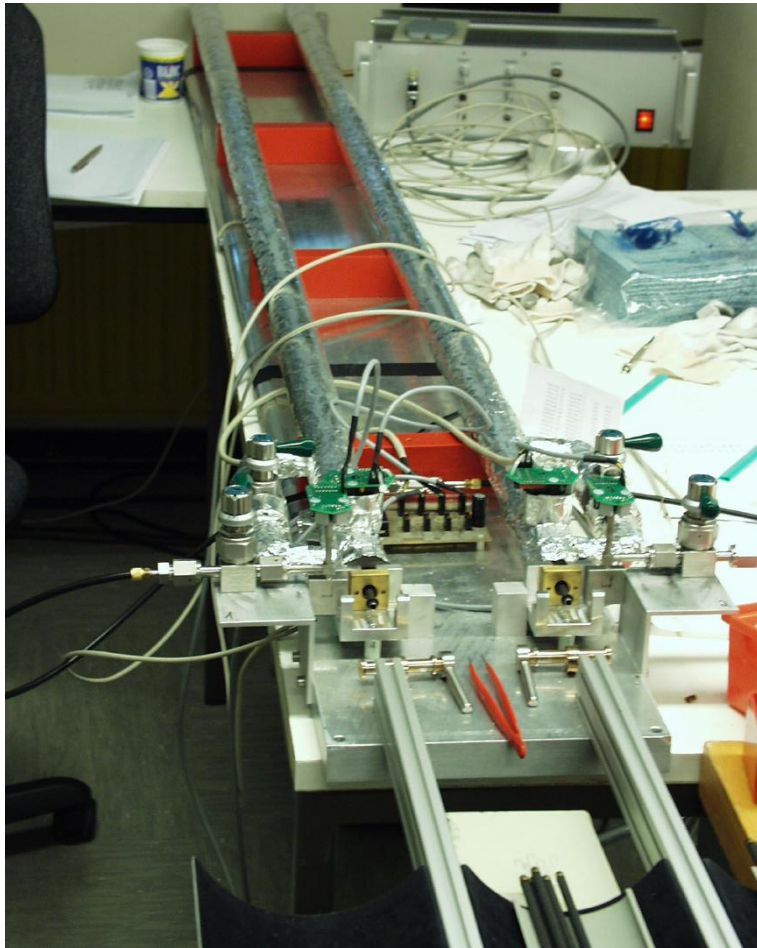
RWTH
Physics AC-I

CERN, 28th July 2003

Status TRD Straw Modules

C.H. Chung, S. Fopp, K. Lübelmeyer, W. Karpinski, Th. Kirn, S. Schael
G. Schwering, Th. Siedenburger, R. Siedling, A. Schultz von Dratzig, M. Wlochal

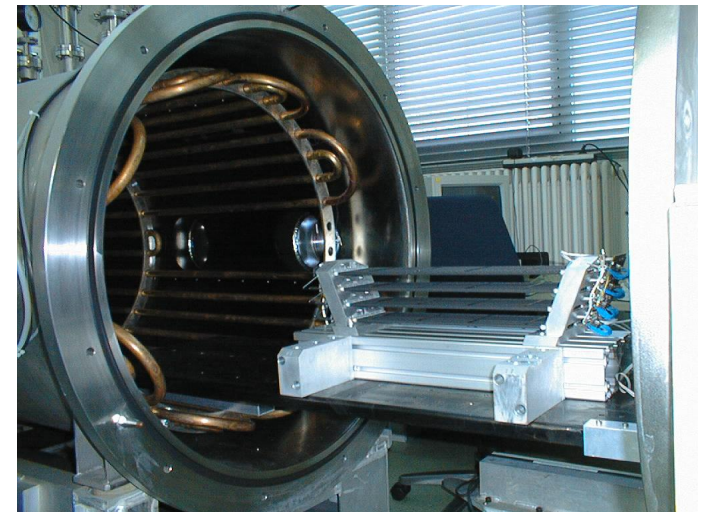
1.) Single Straw Test



2.) Module Production

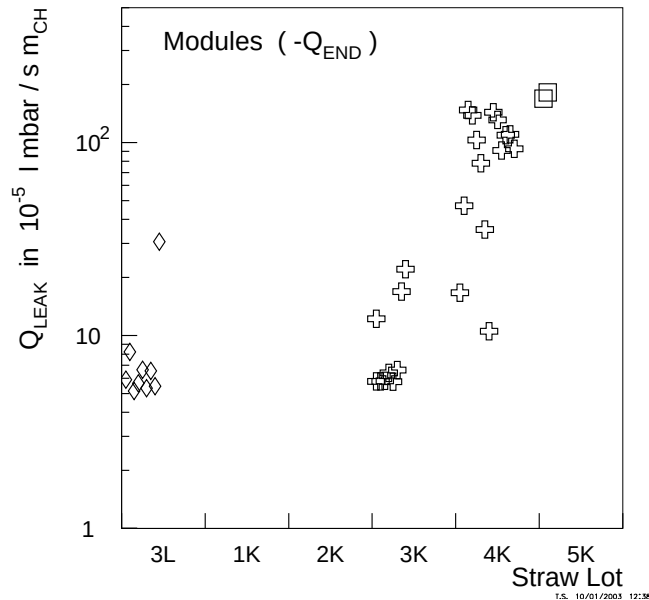


3.) Space Qualification

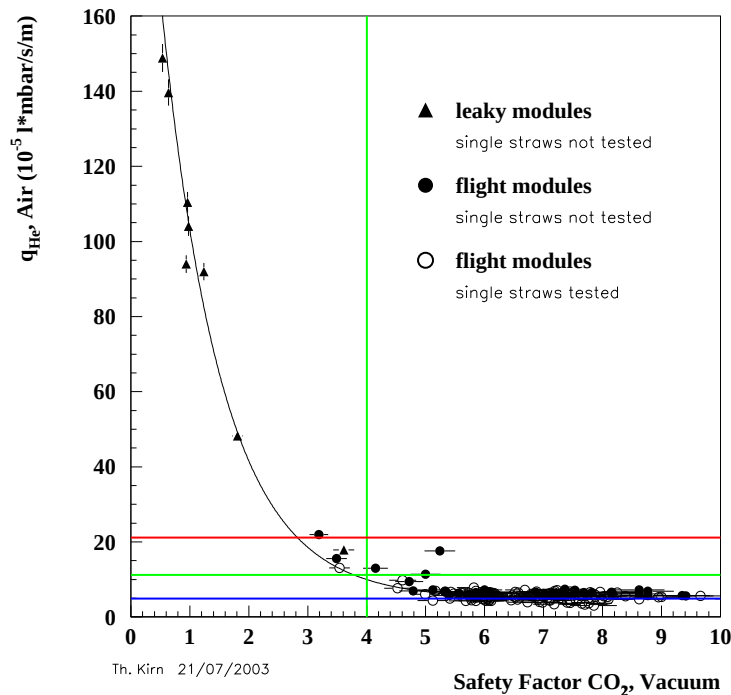
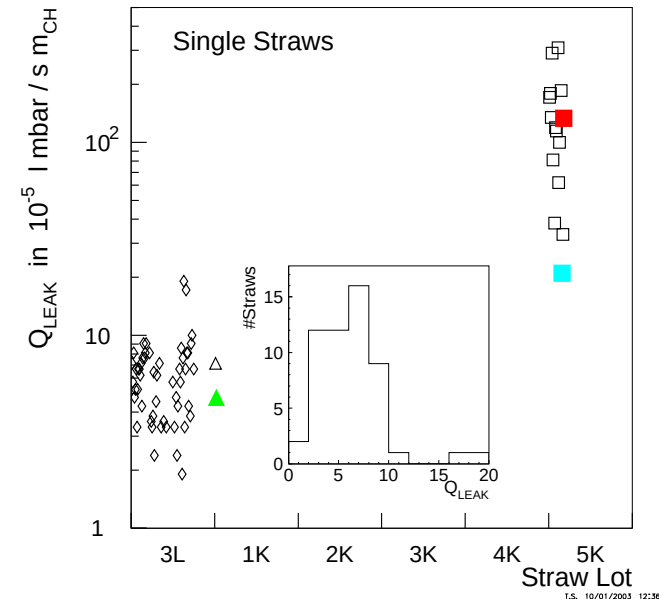


Single Straw Test

Module-Production Lot-Statistics

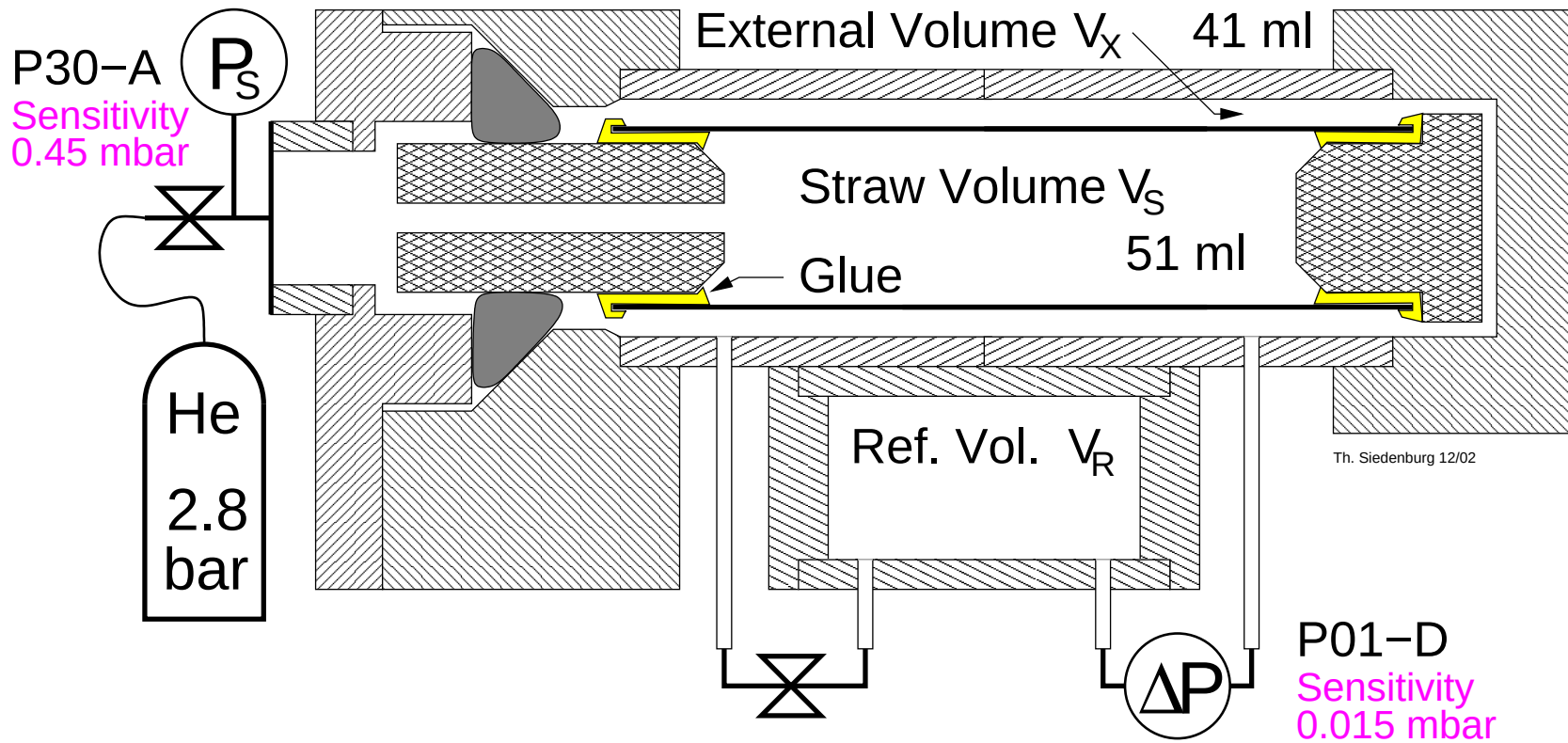


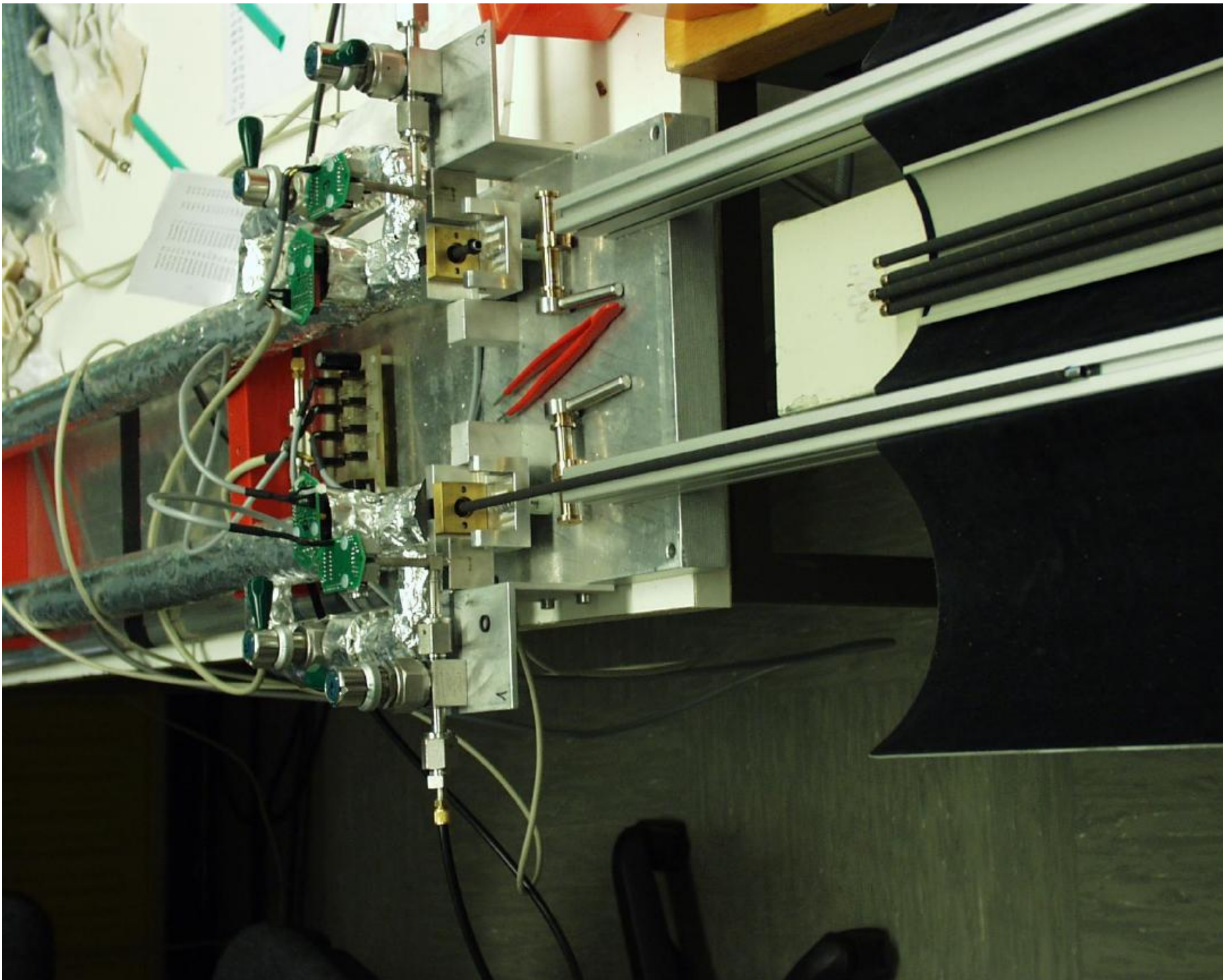
Straw-Production Lot-Statistics

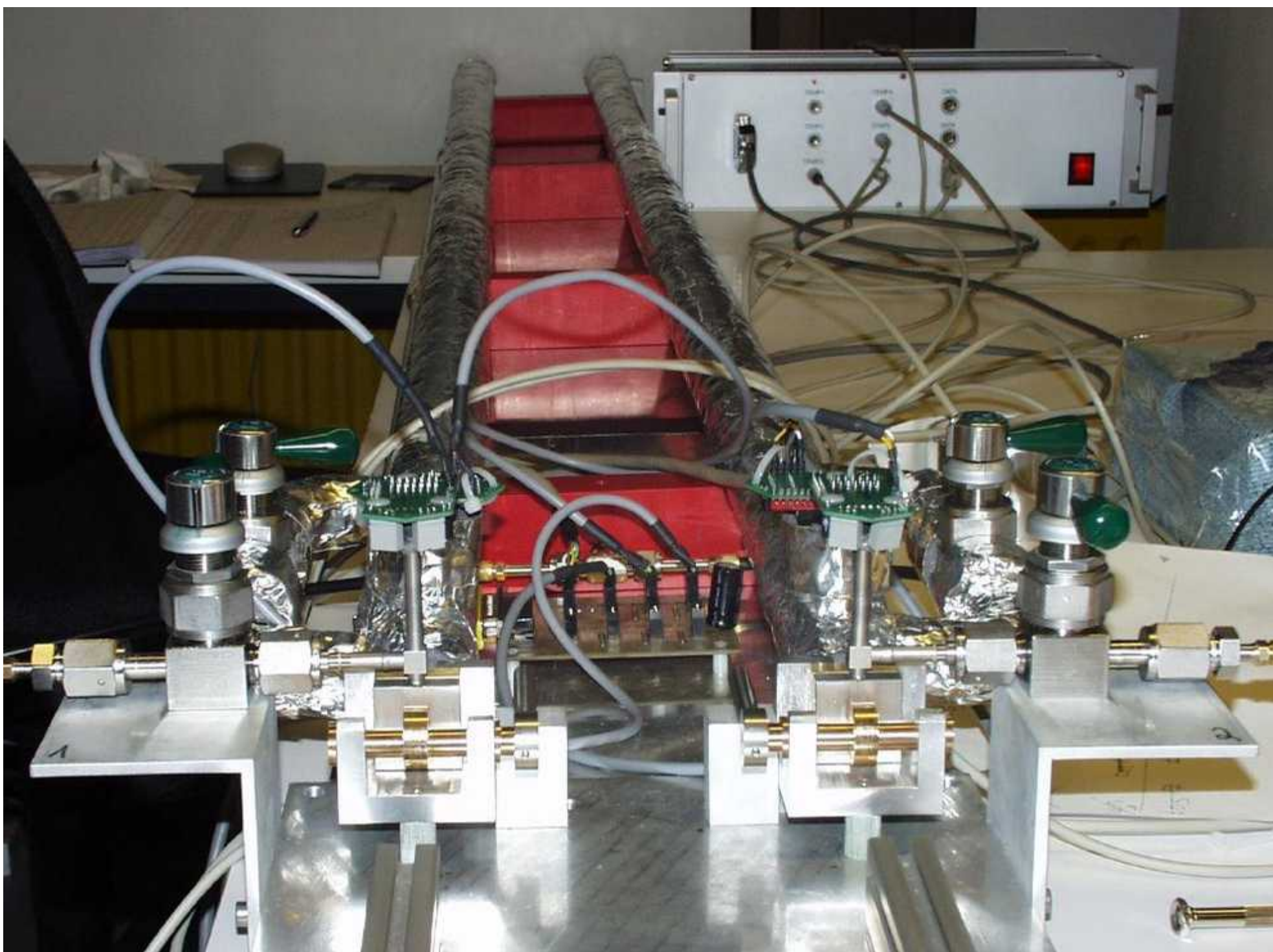


- Bad straws vs bad modules → perfect correlation
- He vs CO₂ good correlation,
Advantage: He measurements much faster
- Aim: Safety Factor of $> 4 \Leftrightarrow > 12$ years on ISS
 $\hookrightarrow$ He leak rate $11 \cdot 10^{-5} \text{ l} \cdot \text{mbar} / \text{s} / \text{m}$
 $\Rightarrow$ Need to test each of 5248 straws

Single Straw Test

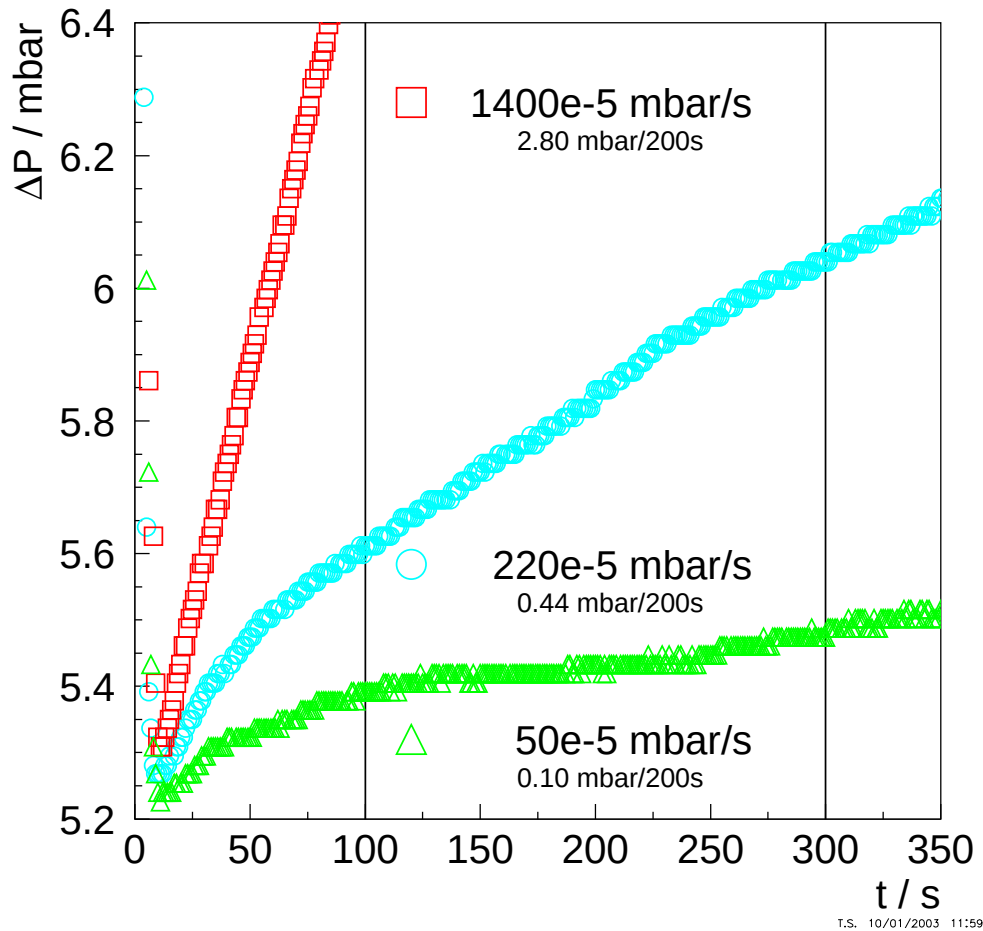




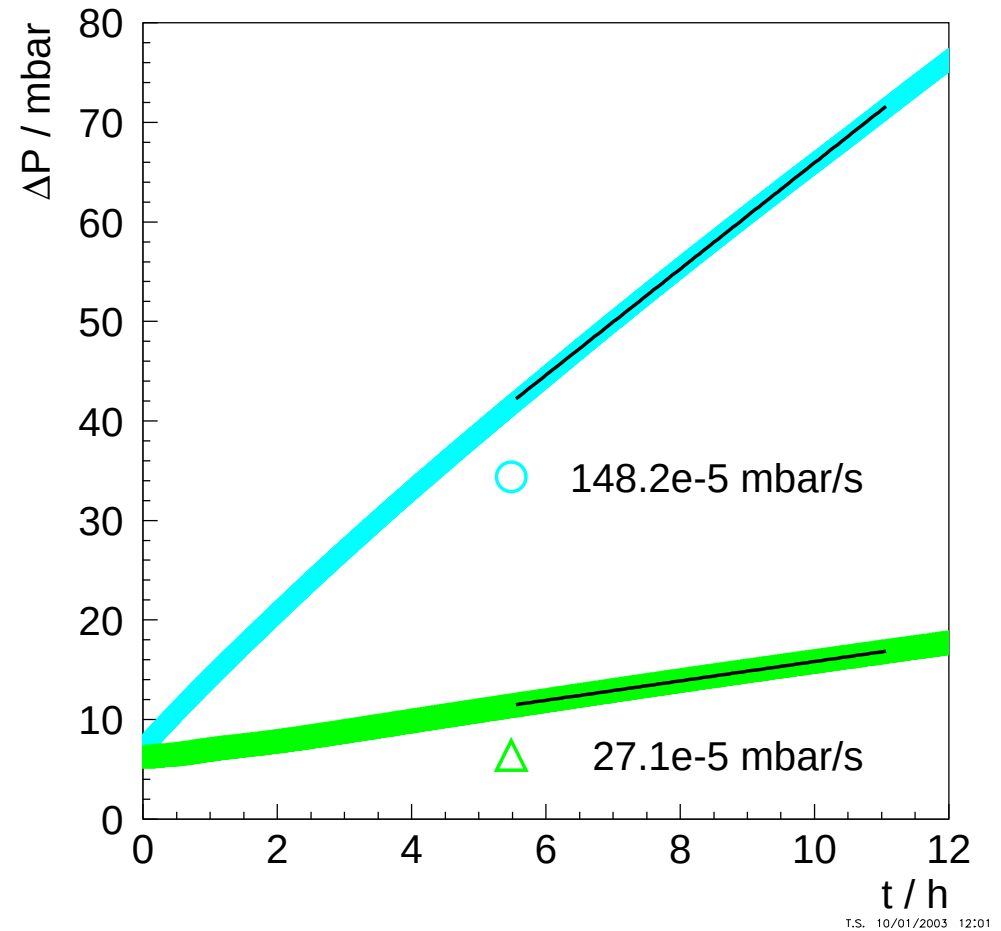


Single Straw Test

Single Straw ΔP 5min



Single Straw ΔP 12h

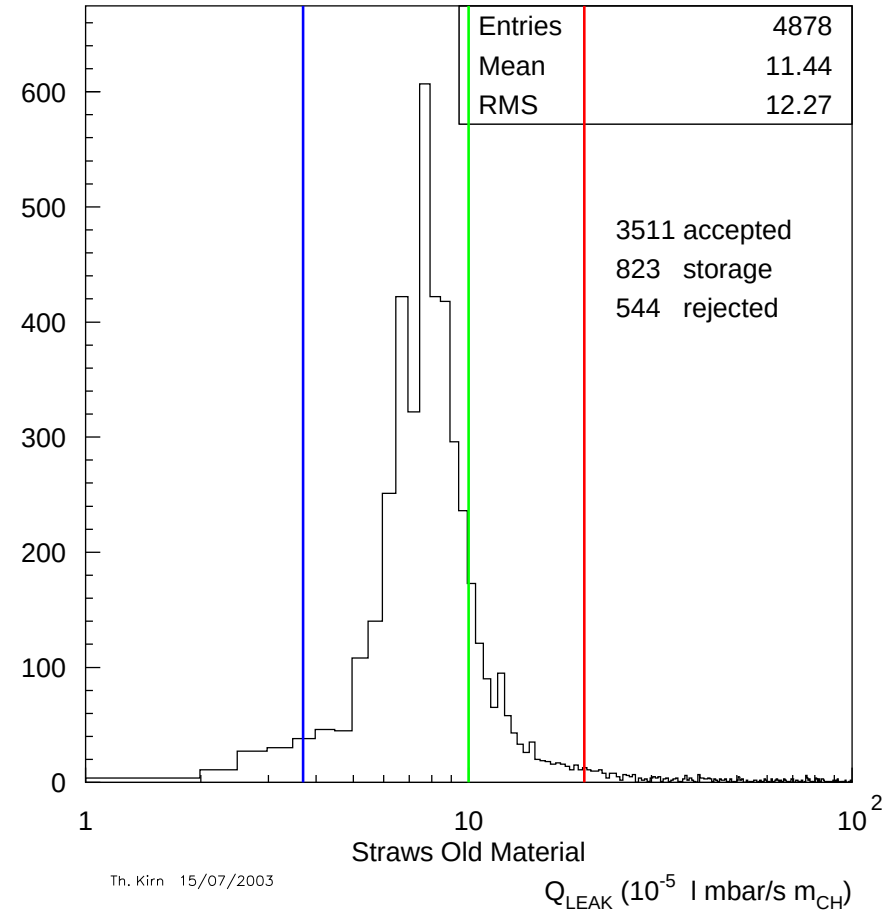
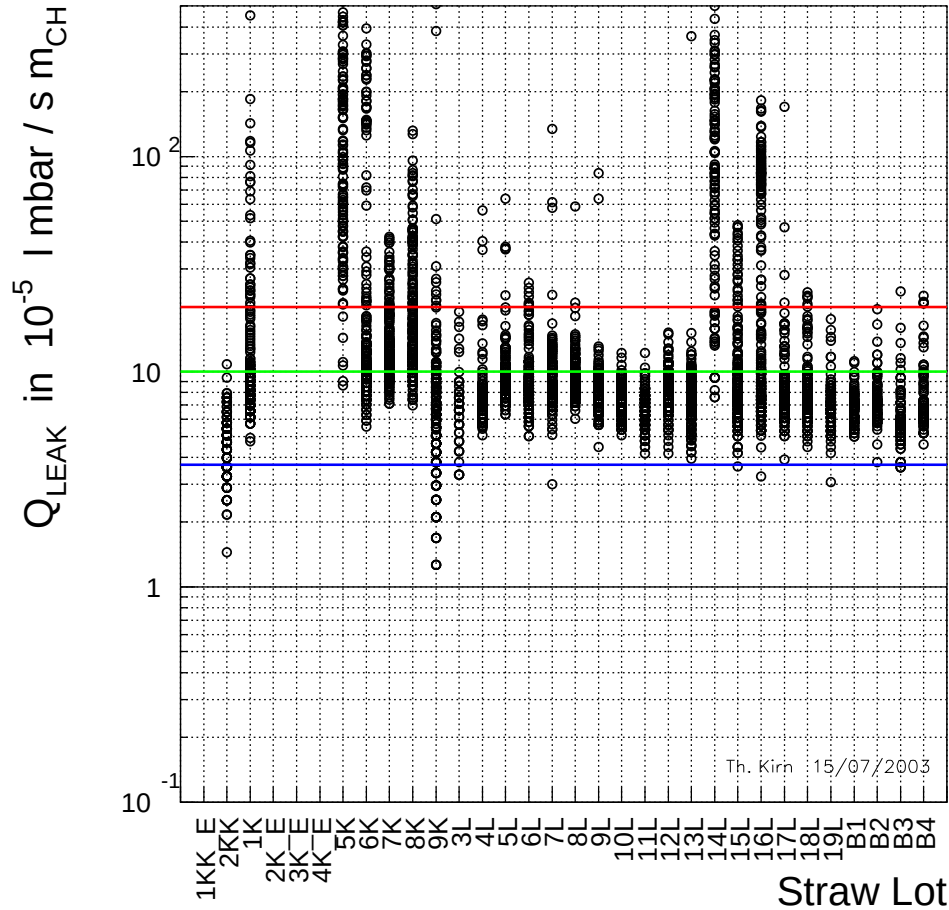


- 12h reference measurement over night

→ Δp -increase

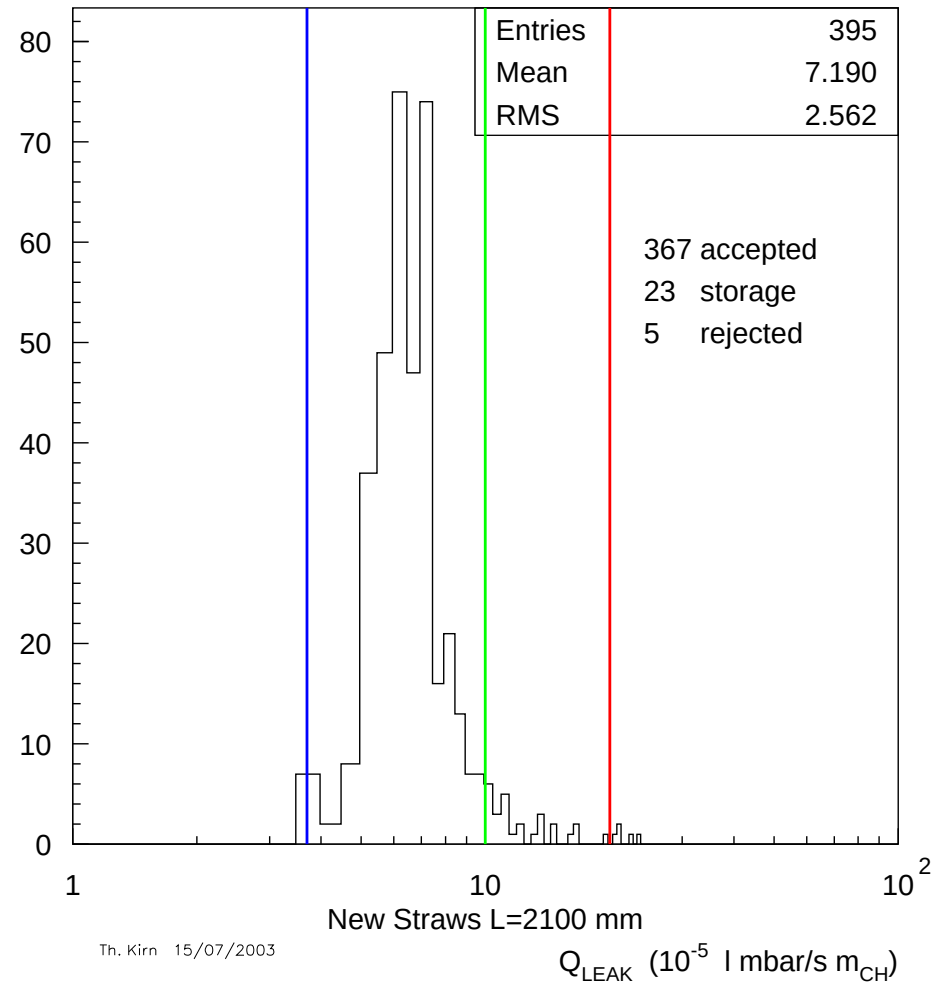
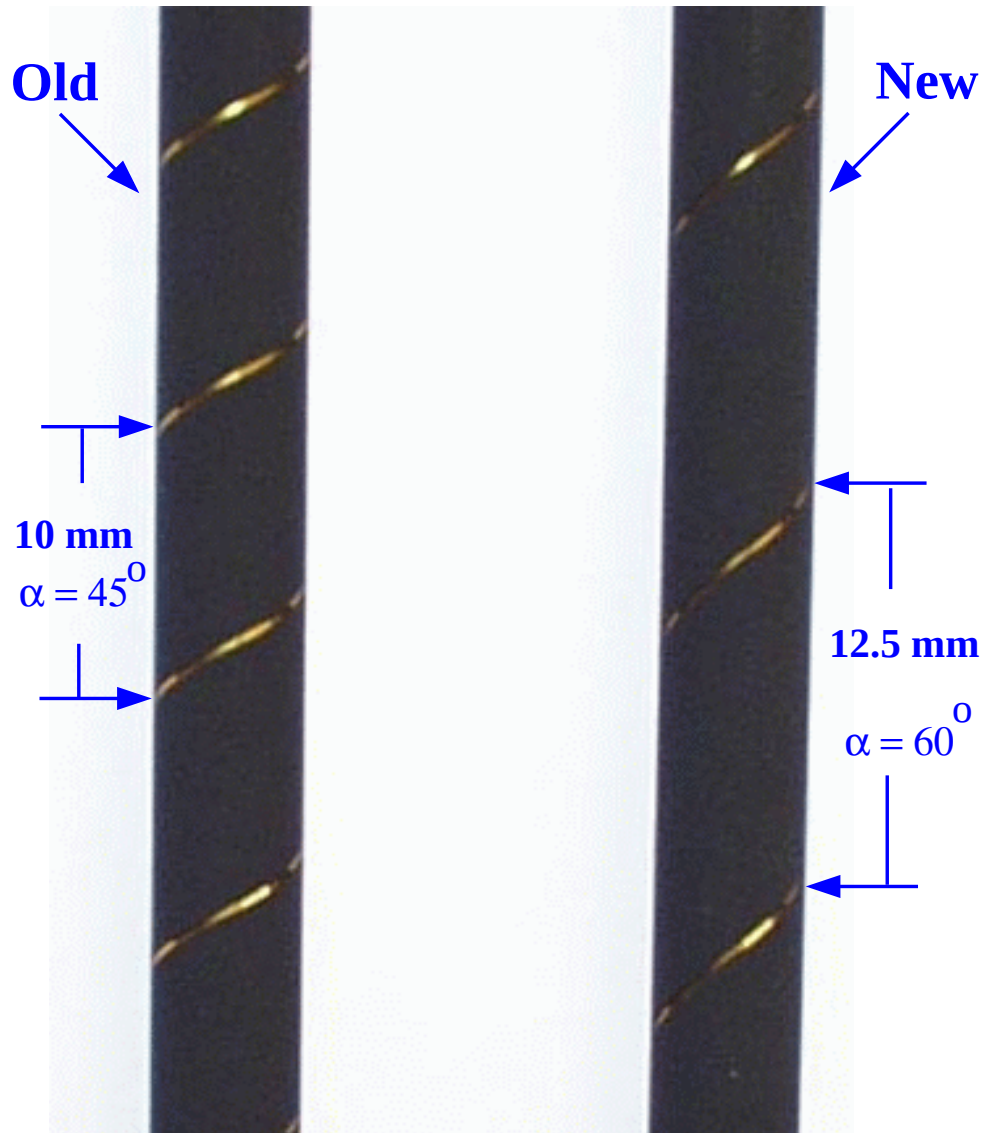
Single Straw Test

Straw-Production Lot-Statistics



16 Straws/Module $\times$ 328 Modules = 5248 Straws $\longrightarrow$ 1737 Straws missing
 $\longrightarrow$ New Straws needed

Single Straw Test

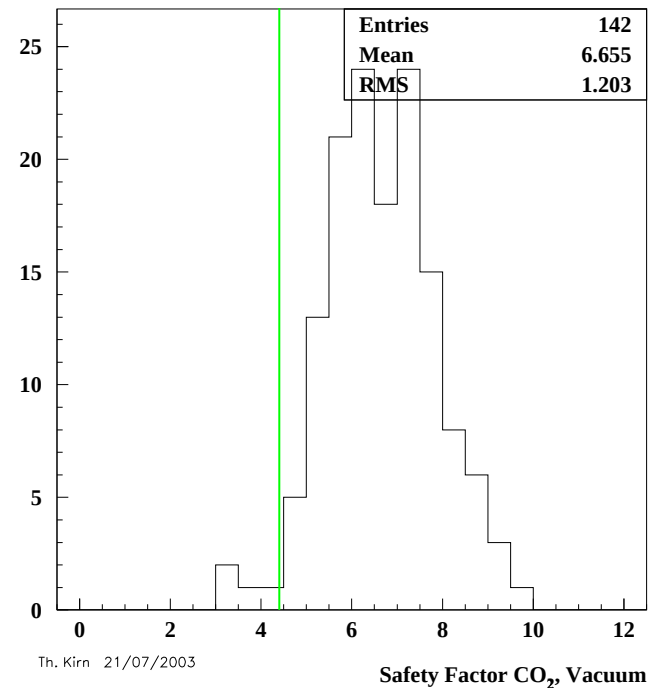
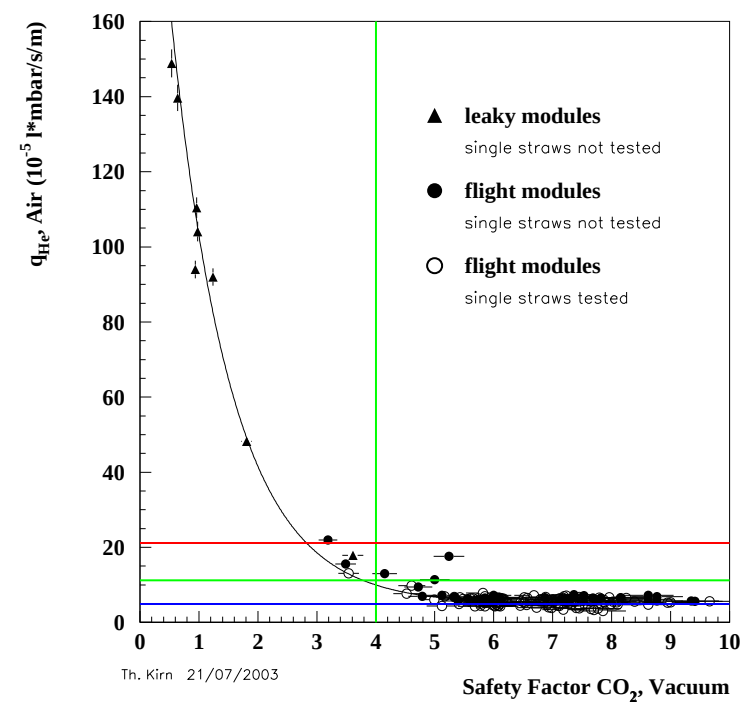


→ 1800 new straws ordered

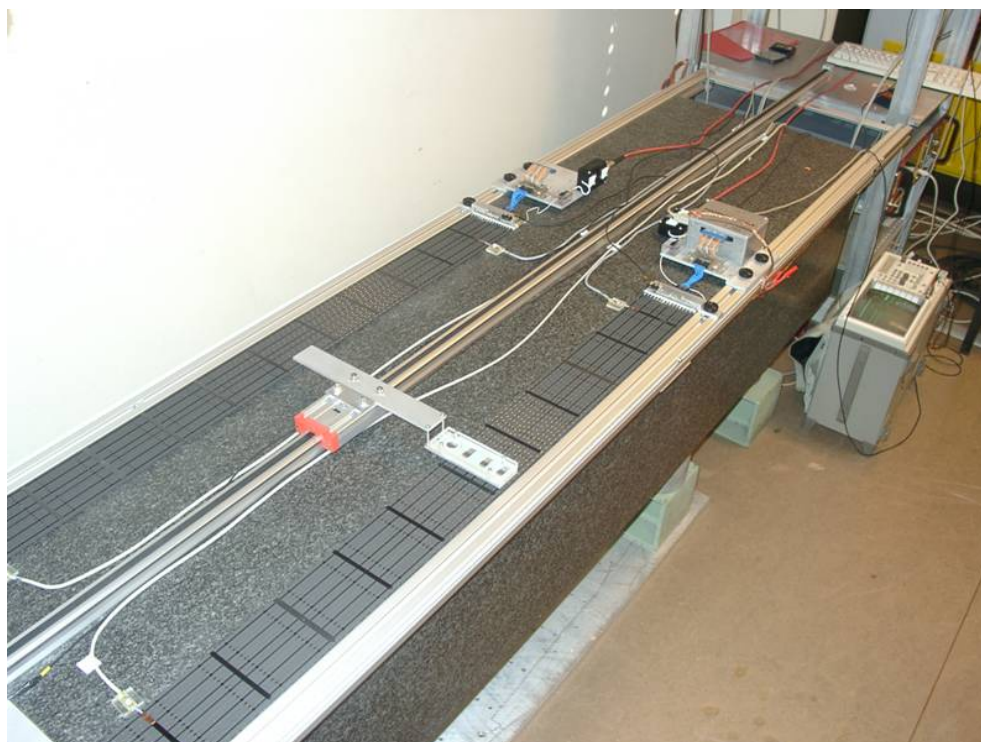
Module Production



142 Straw Modules:
Safety Factor for TRD: ~ 6.7
 $6.7 \times 3y = 20$ years operation on ISS

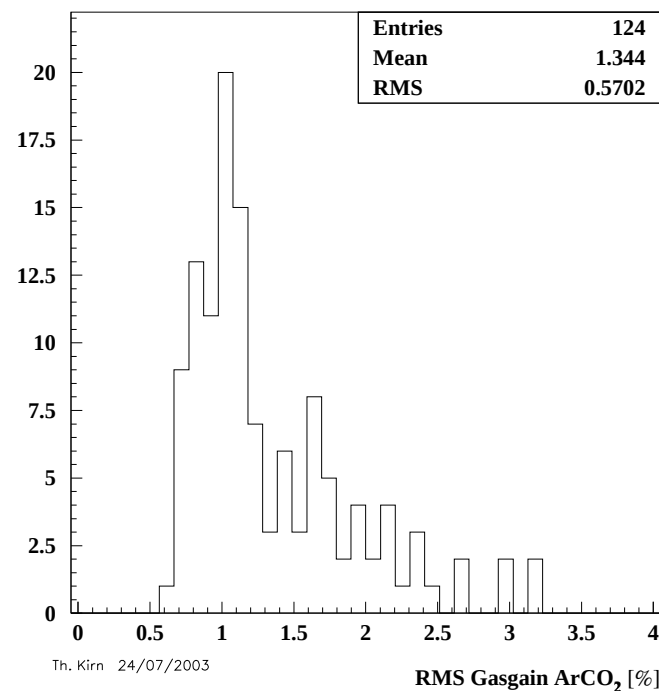
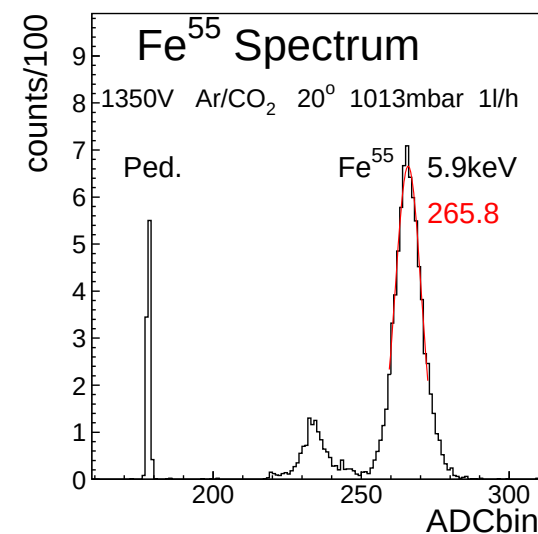


Measurement of Gas Gain with Fe^{55} source



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

Straw	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
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						

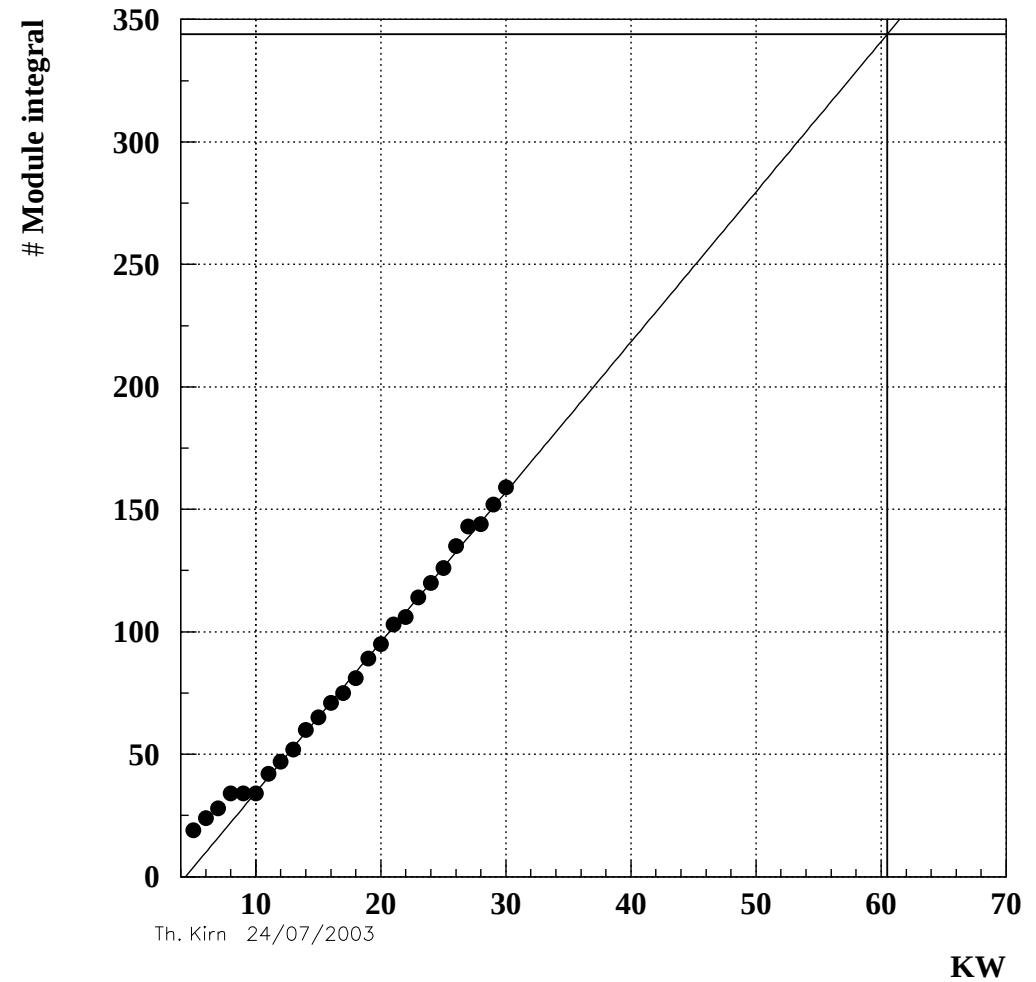


Average variation of gas gain: 1.3%

Module Production Status



Module Production 2003



End of Module Production: March 2004

Module Production Status

-9	-8	-7	-6	-5	-4	-3	-2	-1	+1	+2	+3	+4	+5	+6	+7	+8	+9	
260		268		276		284		292		300		308		316		324		20
	264		272		280		288		296		304		312		320		328	
259		267		275		283		291		299		307		315		323		19
	263		271		279		287		295		303		311		319		327	
258		266		274		282		290		298		306		314		322		18
	262		270		278		286		294		302		310		318		326	
257		265		273		281		289		297		305		313		321		17
	261		269		277		285		293		301		309		317		325	
188		196		204		212		220		228		236		244		252		16
	192		200		208		216		224		232		240		248		256	
187		195		203		211		219		227		235		243		251		15
	191		199		207		215		223		231		239		247		255	
186		194		202		210		218		226		234		242		250		14
	190		198		206		214		222		230		238		246		254	
185		193		201		209		217		225		233		241		249		13
	189		197		205		213		221		229		237		245		253	
		128		136		144		152		160		168		176		184		12
	124		132		140		148		156		164		172		180			
		127		135		143		151		159		167		175		183		11
	123		131		139		147		155		163		171		179			
		126		134		142		150		158		166		174		182		10
	122		130		138		146		154		162		170		178			
		125		133		141		149		157		165		173		181		9
	121		129		137		145		153		161		169		177			
		064		072		080		088		096		104		112		120		8
	060		068		076		084		092		100		108		116			
		063		071		079		087		095		103		111		119		7
	059		067		075		083		091		099		107		115			
		062		070		078		086		094		102		110		118		6
	058		066		074		082		090		098		106		114			
		061		069		077		085		093		101		109		117		5
	057		065		073		081		089		097		105		113			
		004		012		020		028		036		044		052				4
			008		016		024		032		040		048		056			
		003		011		019		027		035		043		051				3
			007		015		023		031		039		047		055			
		002		010		018		026		034		042		050				2
			006		014		022		030		038		046		054			
		001		009		017		025		033		041		049				1
			005		013		021		029		037		045		053			

BODY

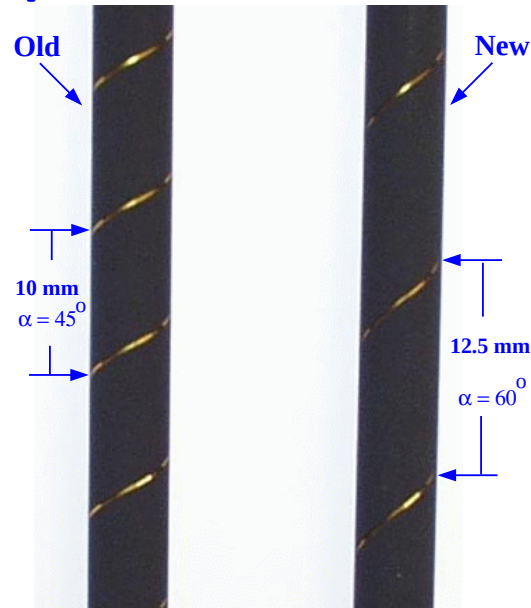
produced

MODULE

under test

ok

Space Qualification

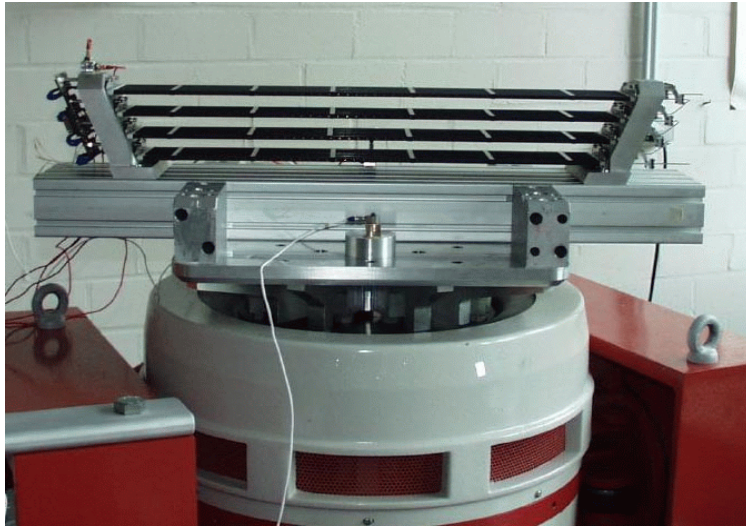


MOD 06 Length <i>mm</i>	Air q_{He} $10^{-5} \frac{l \cdot mbar}{s}$	Vacuum Safety Factor CO ₂
587	5.7	4.1
611	7.0	4.2
635	4.5	5.6
659	3.8	5.9
Σ	20.9	

MOD 07 Length <i>mm</i>	Air q_{He} $10^{-5} \frac{l \cdot mbar}{s}$	Vacuum Safety Factor CO ₂
587	2.6	5.1
611	2.7	5.8
635	8.3	3.5
659	4.0	5.0
Σ	17.6	

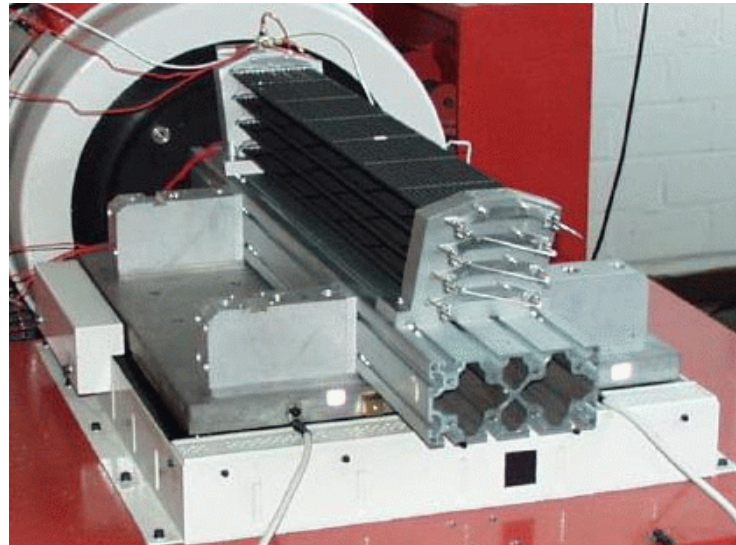
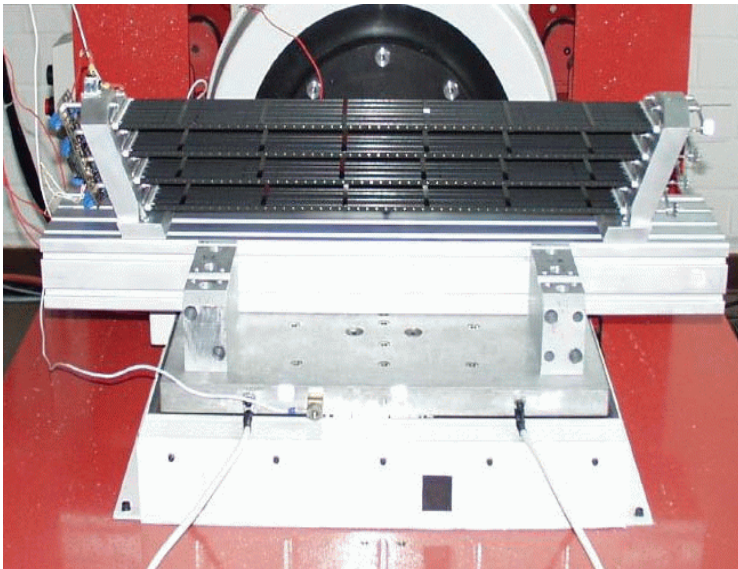
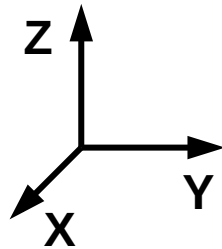
Vibration test, Thermo vacuum test → Eigenfrequencies, Leak Rate, Gas Gain

Space Qualification, Vibration Test I+II



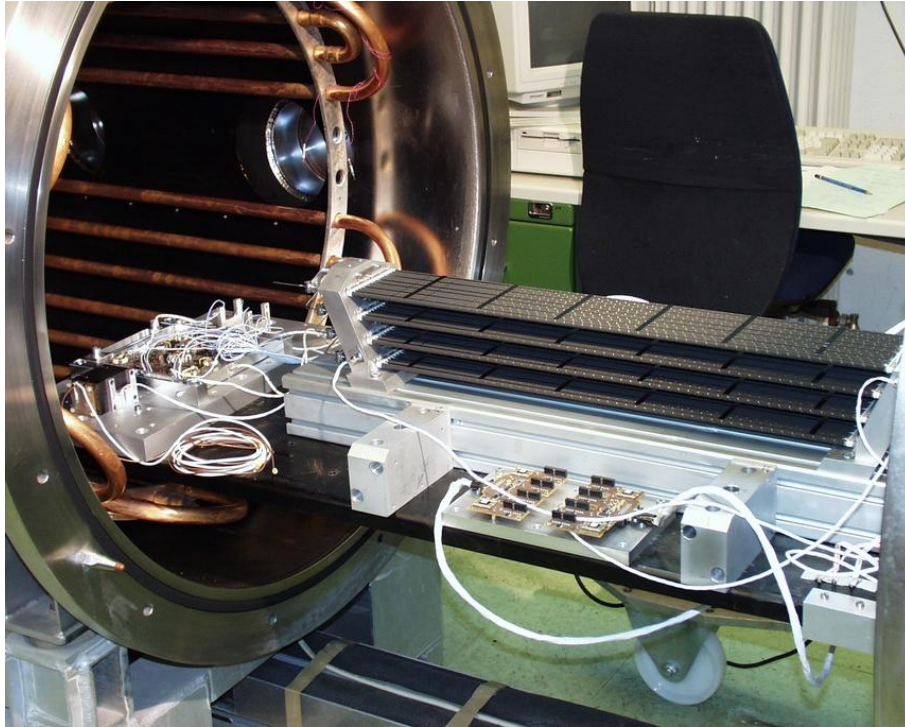
Vibration-Test-Cycle:

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

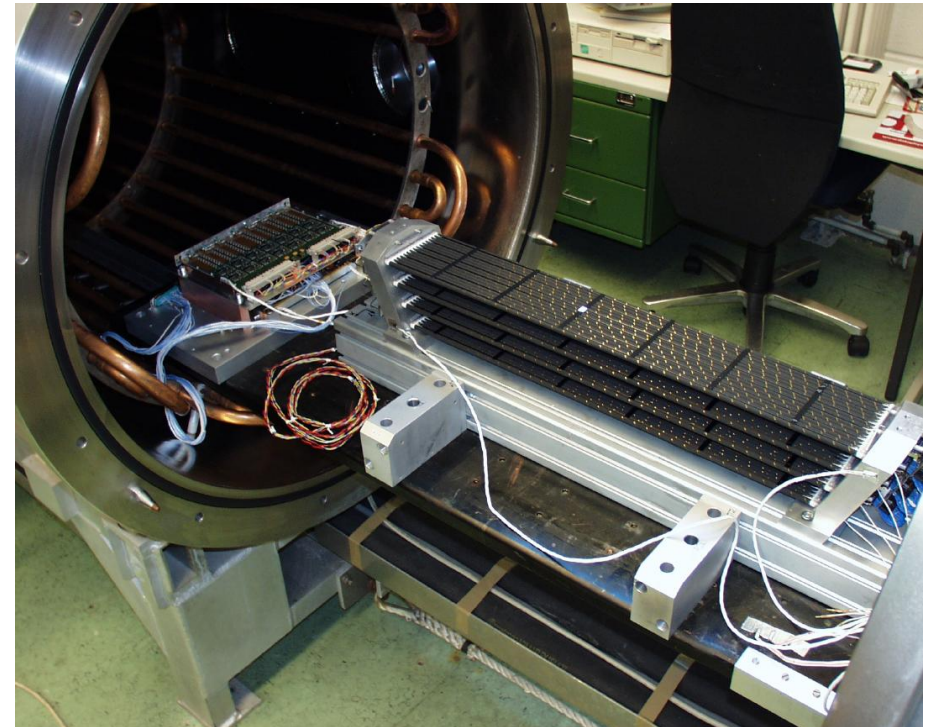


Space Qualification, Thermo Vacuum Test

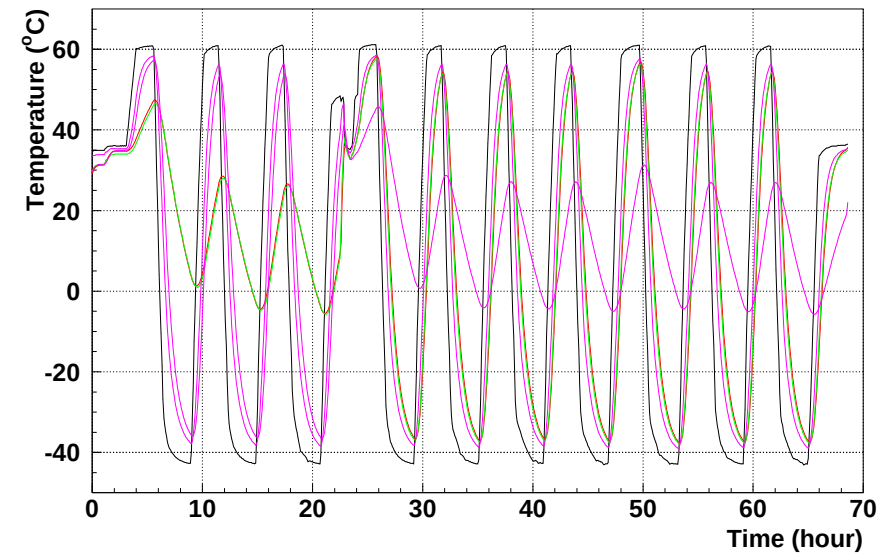
MOD06



MOD07



Thermovacuum Start 14.07.03 12:29:56



Space Qualification, Leak Rate

Mod. No.	$q_{He,Air}$ $10^{-5} \frac{l \cdot mbar}{s}$			
	before SQ	Vib I	TVT	Vib II

MOD06: Old Straw Material

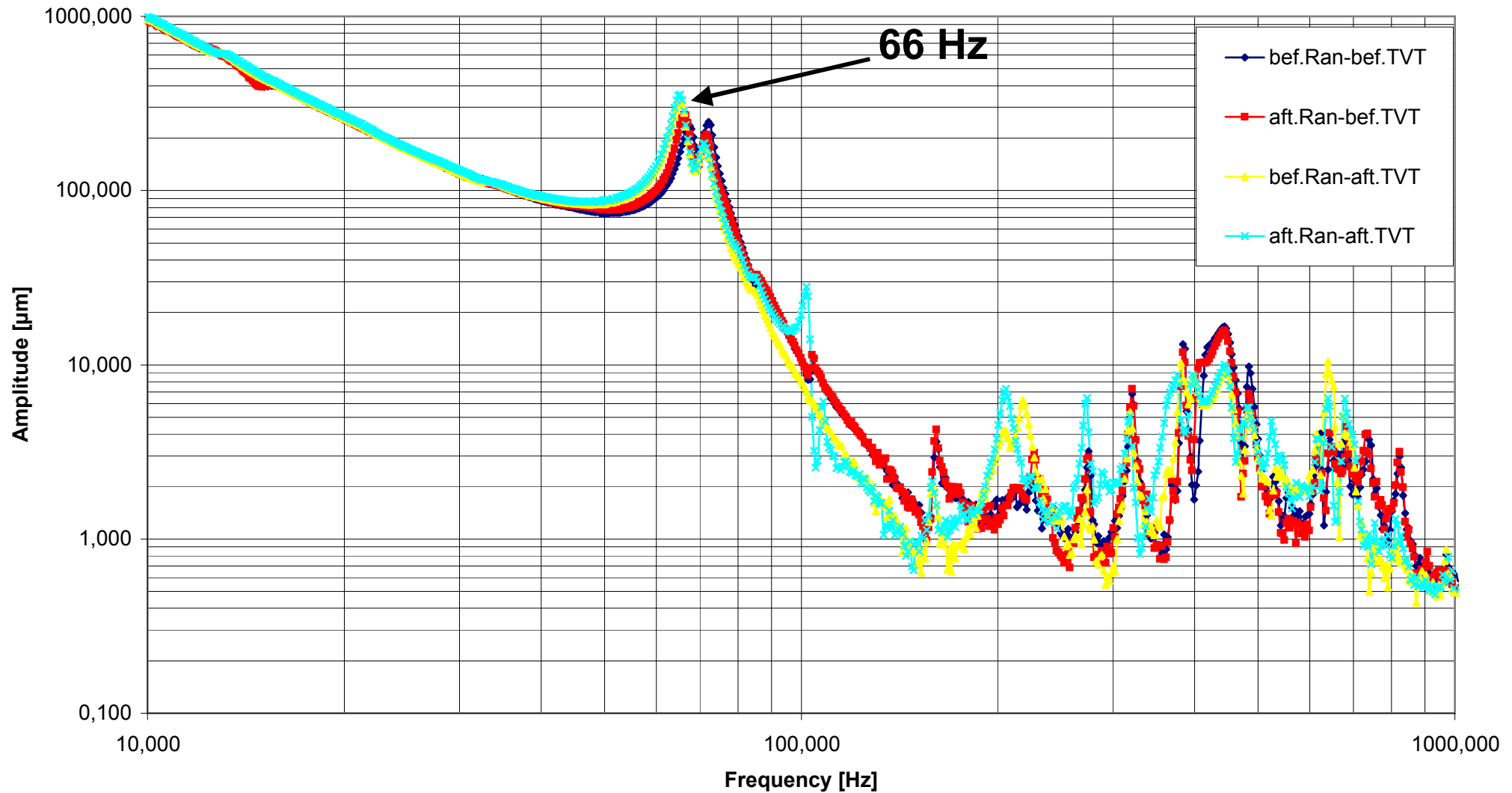
587	5.7			5.2
611	7.0			6.1
635	4.5			3.7
659	3.8			3.5
Jigg06	21.5	19.9	22.4	19.4

MOD07: New Straw Material

587	2.6			
611	2.7			
635	8.3			
659	4.0			
Jigg07	13.5	12.7	18.4	14.0

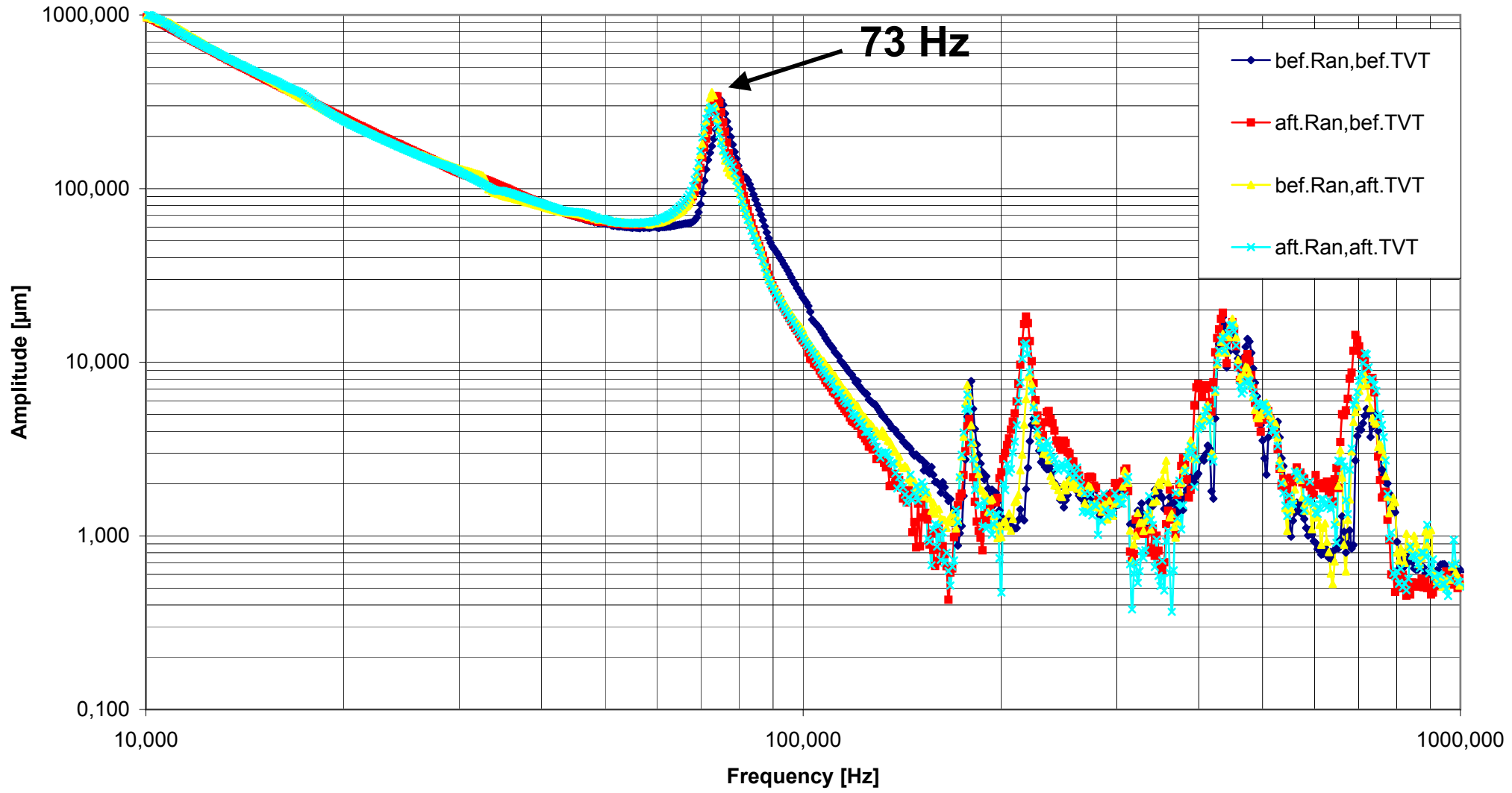
Space Qualification, Eigenfrequencies

AMS-02 TRD MOD-06



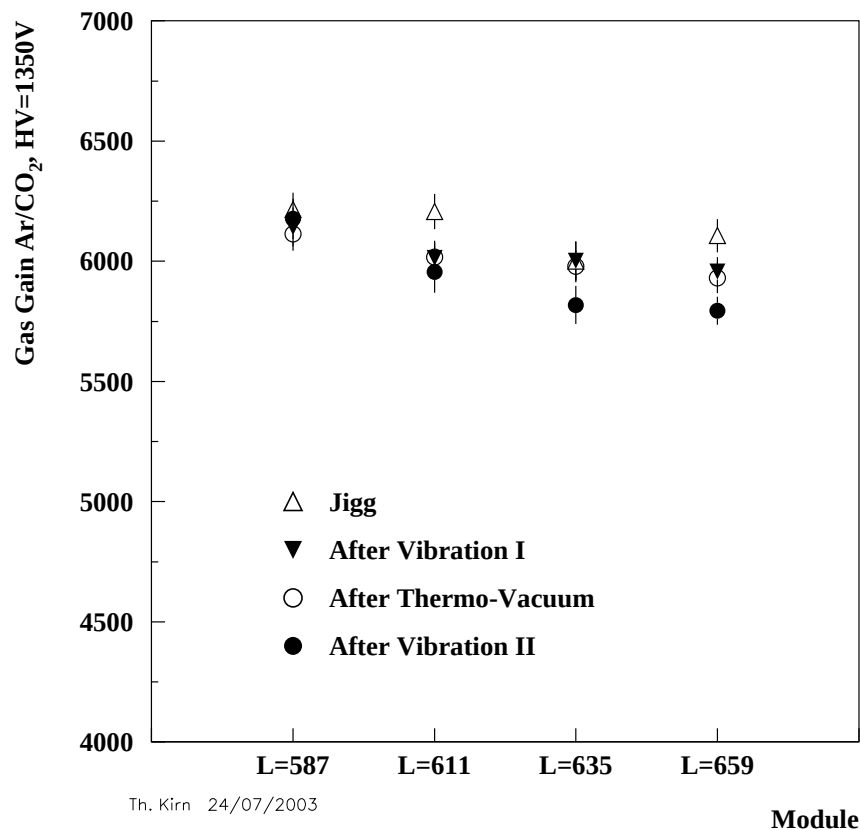
Space Qualification, Eigenfrequencies

AMS-02 TRD MOD-07

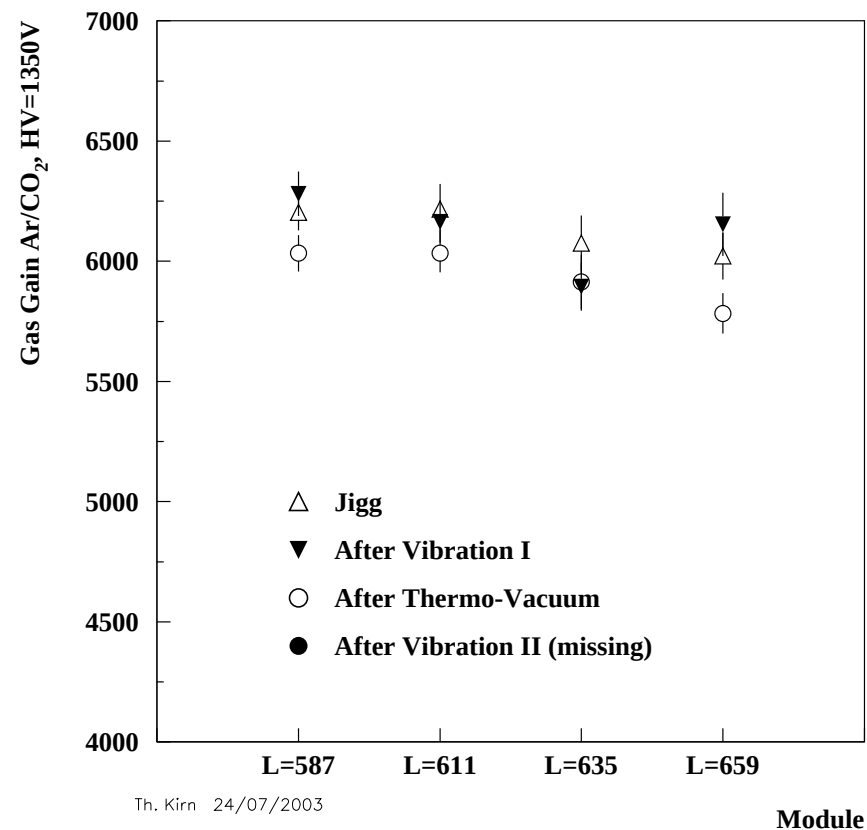


Space Qualification, Gas Gain

MOD 06



MOD 07

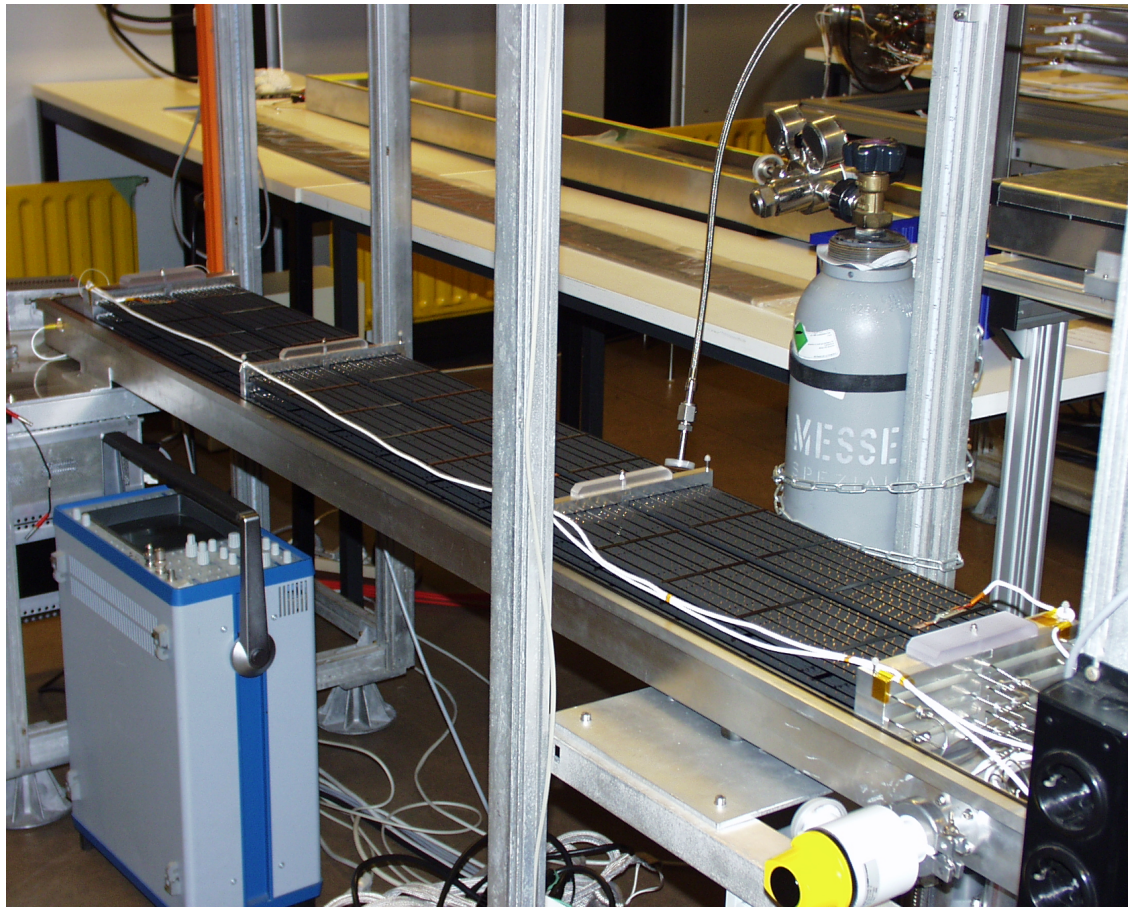


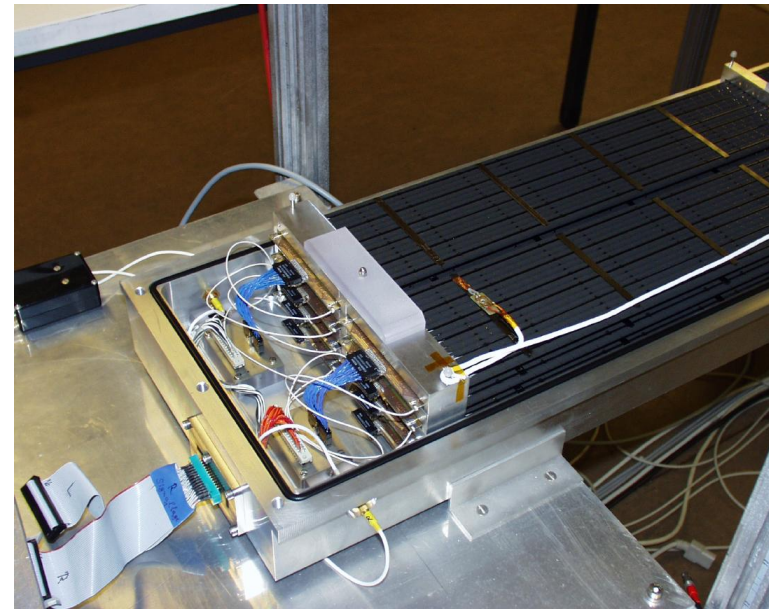
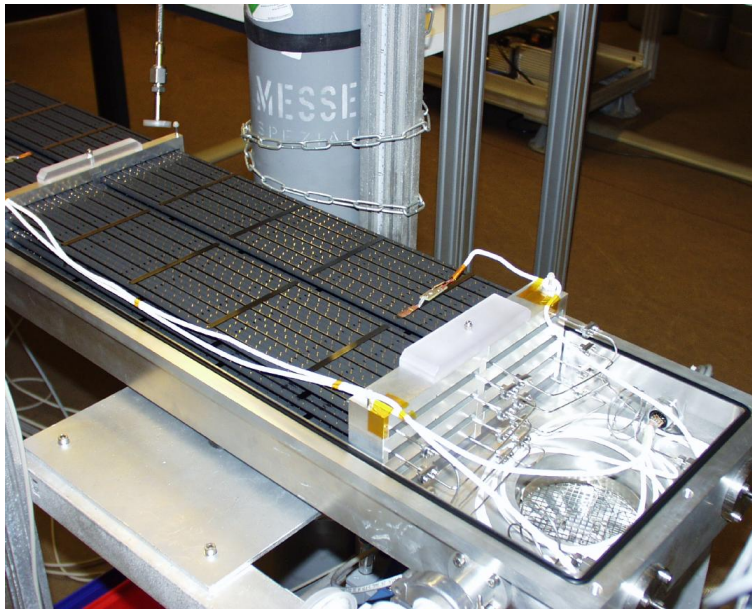
Straw Module Production Status

TRD: 328 Flight Modules

- Flight Modules ready for installation: 124
- Flight Modules produced: 160
- Production ready March 2004
- Space Qualification successful

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