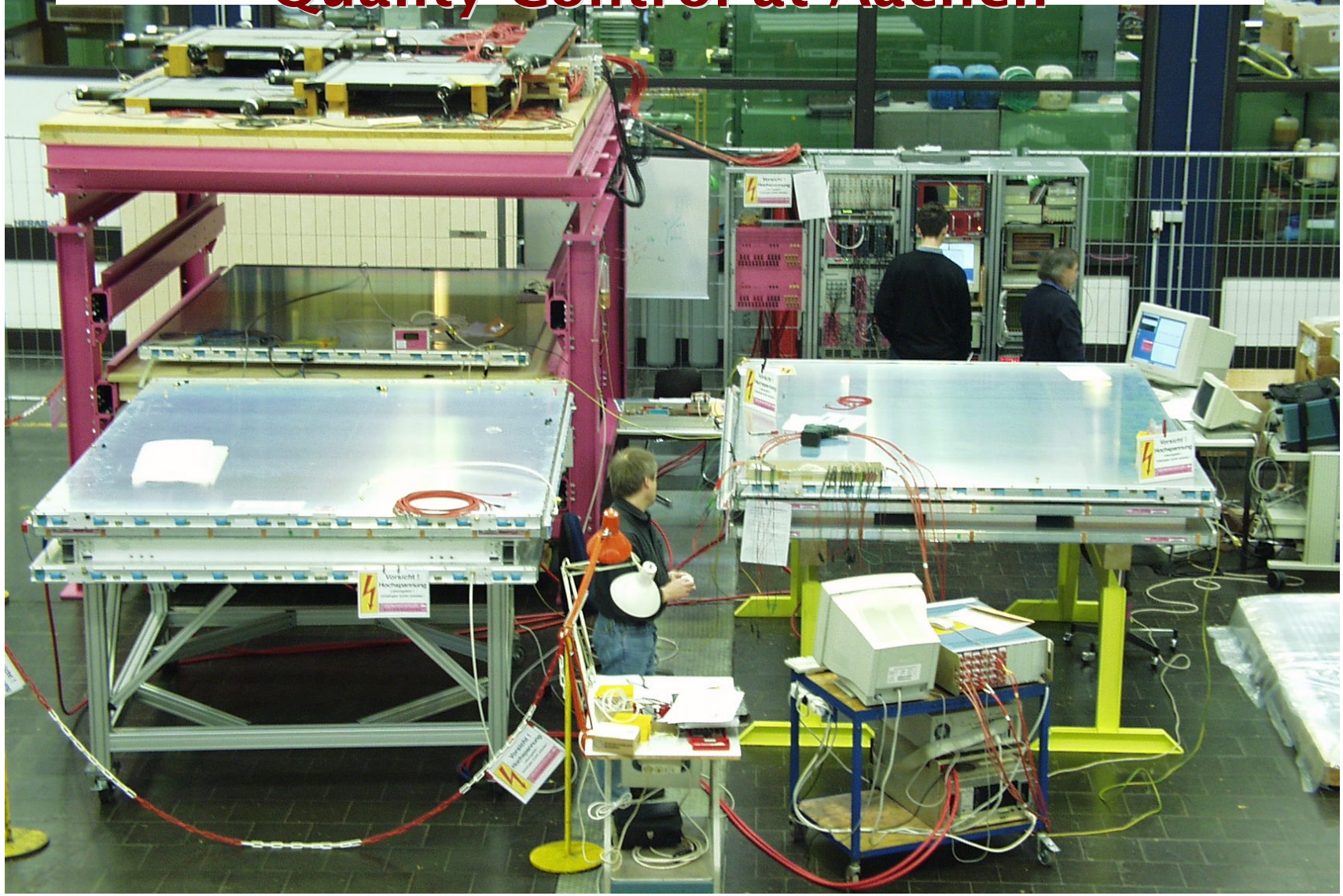
(Selected Items on)

Quality Control at Aachen



Quality Control

- QC of components (Al-plates, I-beams, HVB, HVC, FEB)
- QC during mechanical production (wire tension, position, corner block position, 1.strip/I-beam)
- QC after mechanical production/ during assembly with HV & FE (Gastightness, HV test in air & gas, noise, efficiency, mean time)
- Storage of QC data

Positions of wire, 1.strip & corner blocks

WIRE POSITION

QC requirement:

-Tolerance: nominal position $\pm$ 100 µm, measure FE & HV end

- Record in data base

QC @ Aachen:

Measure every wire position before closing layer, exchange till all positions are within limit

System calibrated with LED-system and reference bar

Output: final file with only positions within limits

POSITION OF 1.STRIP

QC requirement:

-Tolerance is 500 µm, nominal?

- Record in data base

- Correction?

QC @ Aachen:

Measured 3-4 times along strip

Output:

paper document [4]

CORNER BLOCK POSITION

QC requirement:

-Measure corner block w.r.t. closest wire before closing SL

- Record in data base

QC @ Aachen:

Measured

Output:

Paper document [4]

Non-straight strips ? More positions?

Recording without correction

Wire Tension

QC requirement:

measure individual wires before closing the layer, allowed range 230 – 325 gr, no recording

QC @ Aachen:

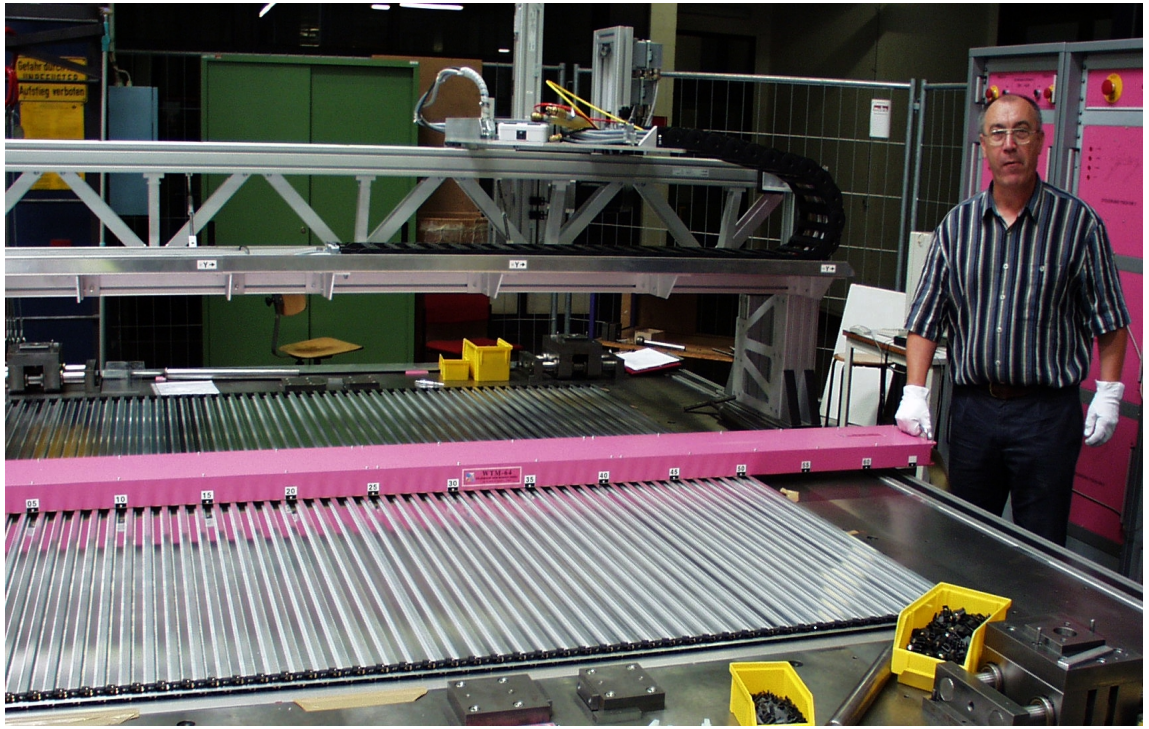
ALL wires are measured and stored in a local file

Frequency range phi 79.3 – 83.3 Hz, theta 90 – 98 Hz

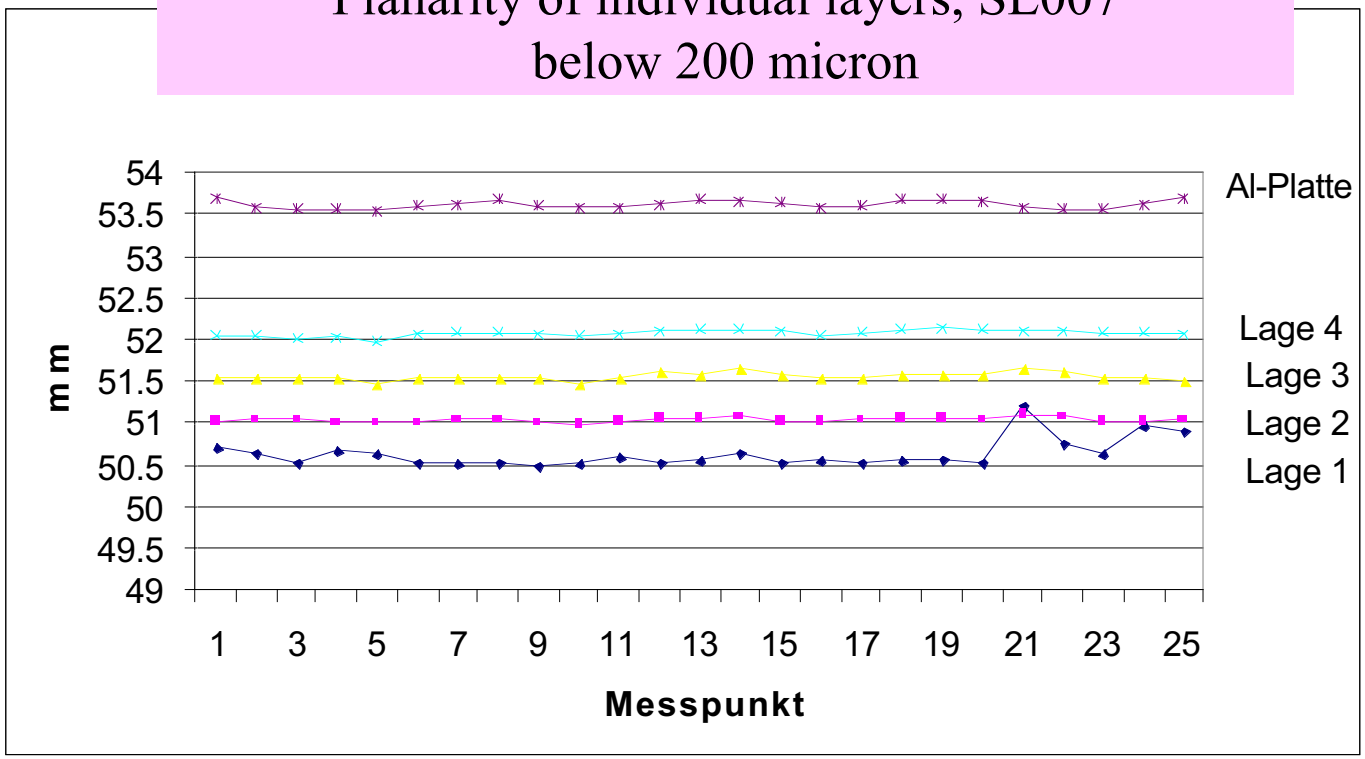
Wires with frequencies outside this range get replaced

Output:

file with all wire tensions, only within tolerances (ASCII-> root)



Planarity



SL Planarity,
for first 14 SL measured for every layer. Later just top layer + cover.

Output:

Excel-file per SL

Planarity of Honeycomb-panels

- **Measured at Aachen: Hight over flat table (several points per HC)** -> HR talk
- **Output: local file**

Quality Control

- QC of components (Al-plates, I-beams, HVB, HVC, FEB)
- QC during mechanical production (wire tension, position, corner block position, 1.strip/I-beam)
- QC after mechanical production/ during assembly with HV & FE (Gastightness, HV test in air & gas, noise, efficiency, mean time)
- Storage of QC data

Gas Tightness (7.3 + 7.4)

QC requirement: **2 methods (pressure drop, oxygen content)**

Record in DB

Pressure drop measurement is more relevant!

QC @ Aachen:

- **Pressure drop at 2 levels (2 HV-covers, FE+HV) for all SL**
- **→ excellent results**
- **Oxygen content just started recently**
- **Information to store: 1 time constant per SL with final settings,**
  Web accessible

Gas tightness is essential for operation of CMS Muon system. We should make an effort to have good gas tightness. Time constants around 1000 are feasible.

Results from Pressure Drop

QC requirement: τ >135 min

With two HV covers, time constant on average τ ~1500 min

In final conditions (FE+HV) τ = 1200 min

Pressure drop:

$$\tau = t / \ln\left(\frac{P_{i0} - P_a}{P_i - P_a}\right)$$

P_i = pressure at t=0

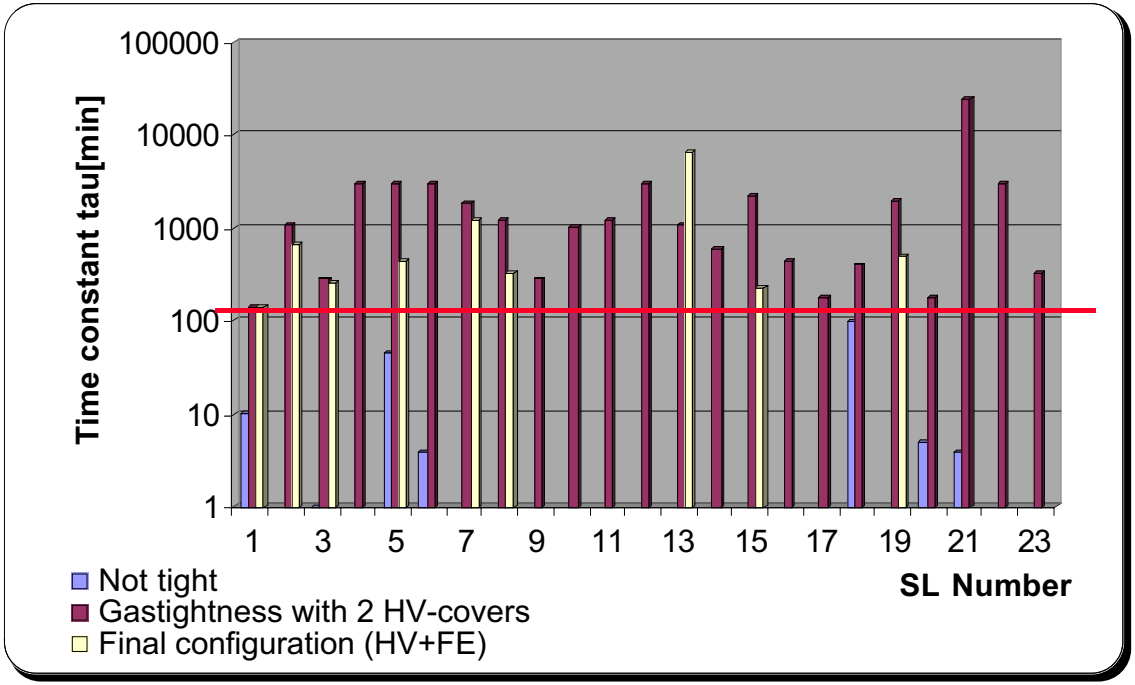
P_a = pressure after t>0

Our observations:

Recommended to first measure with two HV covers (check of FE-cover tightness during second measurement)

In case of leakage, τ<5 min

If additional sealing required, usual close to corner-blocks



HV Test in Air (7.2)

Aachen Method:

1. Ramp-up strips (2.5 kV) and cathodes (-2 kV) without HVB for 10 min, granularity: 16
2. Connect HVB and ramp-up to $V_{wire/strip/cath}$ = 3.9/1.9/1.6 kV
3. Monitor currents with a resolution of 10 nA.

   Require rest-currents ≤200 nA per HV channel

   Time dependance observed
   (increase by ~10 during days, then stable)

- Changes triggered by HV problems in gas:
- Increased HV-values in air, aiming at values for HV stability in gas:
- **Strips 1.8 kV (gas) -> 3.3 (air)**
- **3.8 kV**
- **Cathodes 1.4 (gas) -> 2.5 (air)**
- **3.1 kV**

for several hours. Over night run
arting with gas. Current fluctuations.

ith one SL.More statistics needed.

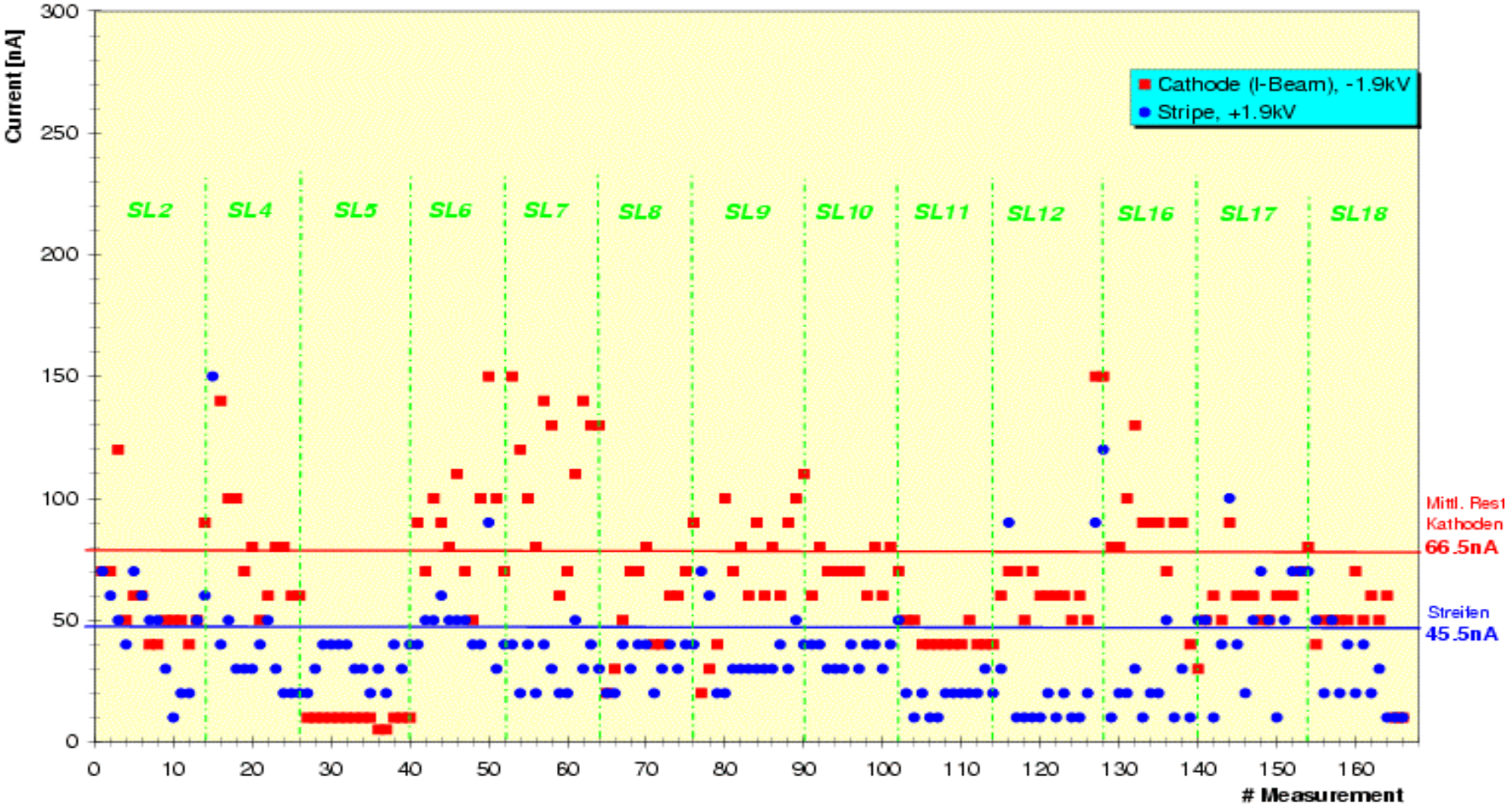
In QCD common current-limit. We observe $I_{wire/strip/cath}$~ 10 / 50 / 75 nA

In air mainly problems with strips.

Distribution of rest-currents for strips and cathodes

Rest currents after >10min in air ("Platinentest")

Time dependence (storage time, relaxation time of meas.)



Can we use rest-currents at this level as problem indicator?

HV Test in Gas (7.5)

QC requirement: „Conditioning is performed ramping up and down HV several times. This procedure stops if after N trials a channel is not stable... After several hours must be stable with ≤5% of disconnected channels and with a current per channel below 50 nA.“

Our observations:

- Ramping-speed is crucial.
- Rest-currents for strips & cathodes about 100 nA.
- Current fluctuations (limited by trip-limit 5 mA) stay for several days. Are they critical?
- Define stable running.

Aachen Procedure HV Training in Gas

- **Flush with gas for ~8 h (6 vol.exchanges).**
- **Ramp-up in steps:**

HV wire	HV strip	HV cathode	Δ HV
2000	1000	-800	1000
2500	1200	-900	1300
3000	1400	-1000	1600
3400	1600	-1100	1800
3600	1800	-1200	1800
Over	Night	~8-10 h	
3700	1800	-1300	1800
3700	1800	-1400	1800
Over	Night	~8-10 h	

Noticed: gas distribution inside SL very slow.

Total time: Good SL ~3 days

Incl.problem finding & repair (~1/3): .... 2-3 weeks

If problem, search for channel and disconnect (sometimes repair (glue, loose DC)). Very time consuming! Complicated by HV grouping.

No. of SL with HV problems in gas: 5/8 -> too high for MP

Results of HV Training in Gas

Netscape:

File Edit View Go Communicator

Bookmarks Netsite: http://www.physik.rwth-aachen.de/~hoepfner/Assembly/SL_Summary.html

HV Training in ArCO_2
Highest HV Settings
for longterm runs

SL #	Test in Air	Test in ArCO2
001	3600/1800/-1800	3600/1800/-1400
002	3600/1800/-1800	3595/1800/-1800
003	3600/1800/-1800	3600/1800/-1200
008	3700/3600/-3000	3500/1800/-1600
009	3600/1800/-1800	3600/1800/-1400
010	3800/3500/-2900	2100/1400/-1000
011	3700/1800/-1800	3700/1800/-1500
012	3700/1800/-1800	3700/1800/-1400 ?
013	3700/1800/-1800	3200/1400/-1000
014	3700/1800/-1800	3700/1800/-1500
015	3600/1800/-1800	3600/1800/-1600
016	3700/1800/-1800	2200/1200/-1000
019	3700/3600/3100	

02/04/2002 CA+OT+KH

Question: What to do with close-to-limit cases (e.g. 3595 V for wires, 1200 for cathodes, 1780 for strips?

Despite high voltage settings in air, problems in gas.

Fraction of disconnected channels < 1%

Except SL 005 (10), Sl 010 (4)

Longterm stability: 2 SL have been operating for ~4 weeks. Occasionally current over threshold, subsequent ramp-up smoothly.

Summary HV Remarks

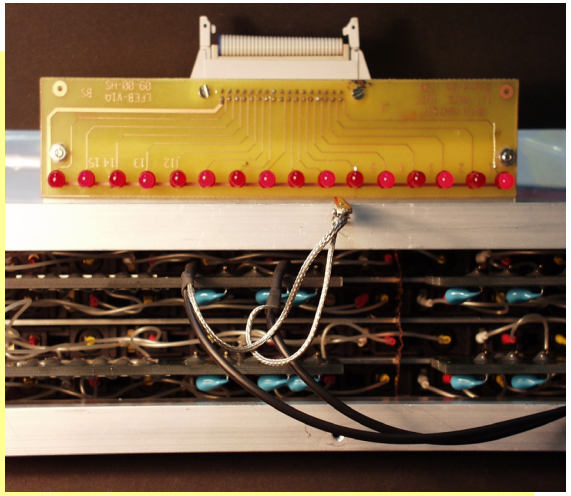
- The HV training is most critical/time consuming step in the commissioning phase.
- 50% cells which got cleaned in air, could not hold the HV in gas.
- Ramping speed seems critical (< 10/5/5 V/sec).
- What are typical rest-currents for strips and cathodes?
- Can we use rest-currents in air as a problem indicator? Could avoid opening of SL and time consuming repair after cable harness and connector installed.
- We need an agreement what to do with close-to-limit cases.
- It seems advicable to ramp-up in air to higher voltages to reduce problems in gas.
- Cathode voltages for test and operation.
- What to store from tests: on SL summary page (final settings, duration, number & cause of disconnected cells), Web accessible

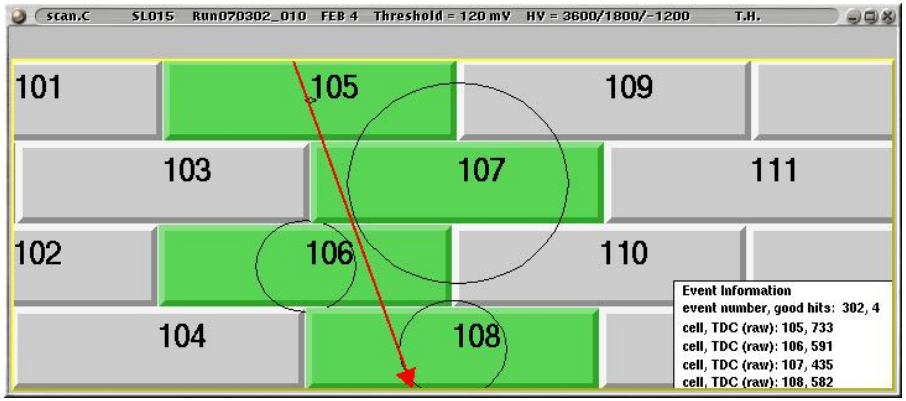
Front-end/Testpulse System

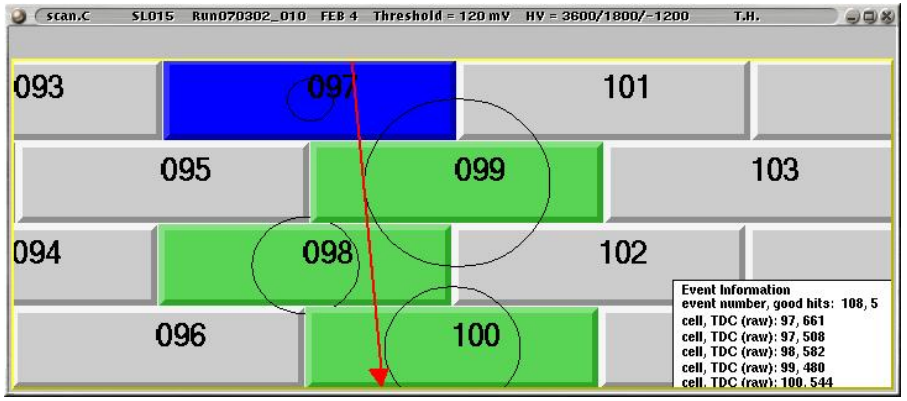
QC requirement: Rates

Tests done at Aachen:

1) Contact test, on average exchange 1 FEB per SL
2) Testpulses, check if all channel see testpulses of 2 V, threshold 15 mV
3) Cosmics data taking -> TH talk

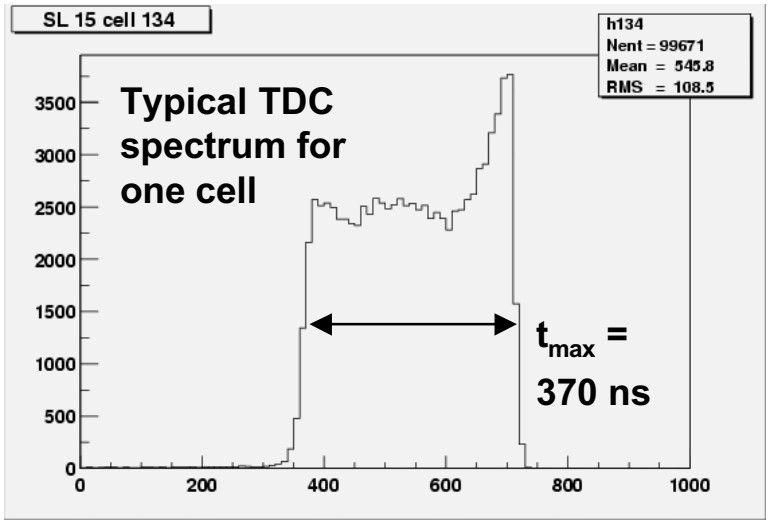


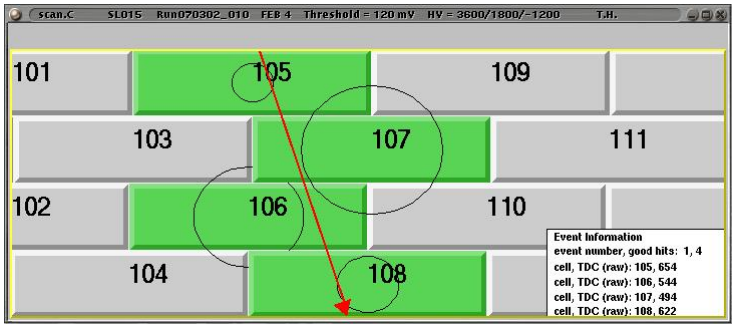




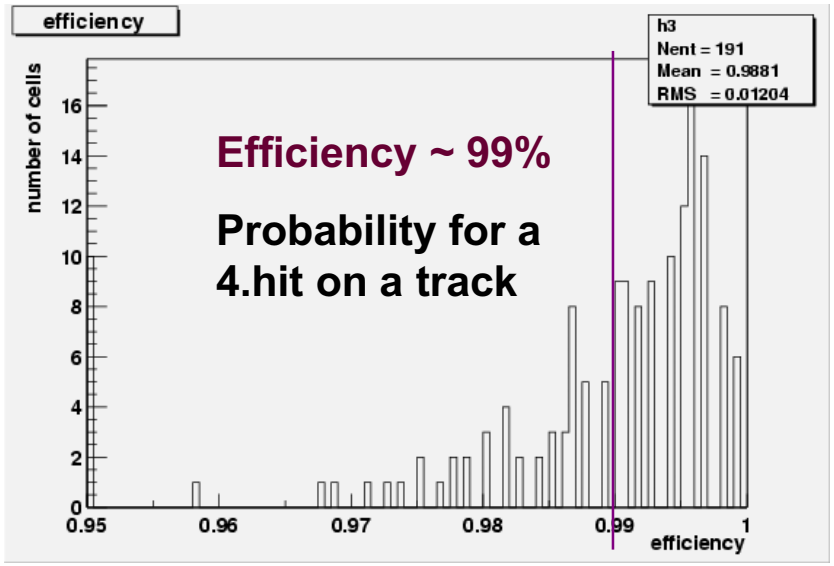
1 SL completely tested: SL 015 cells 41 (FEB3-9), 47 (FEB3-15), 119 (FEB8-7), 135 (FEB9-7), 170 (FEB11-10) <50% expected hits

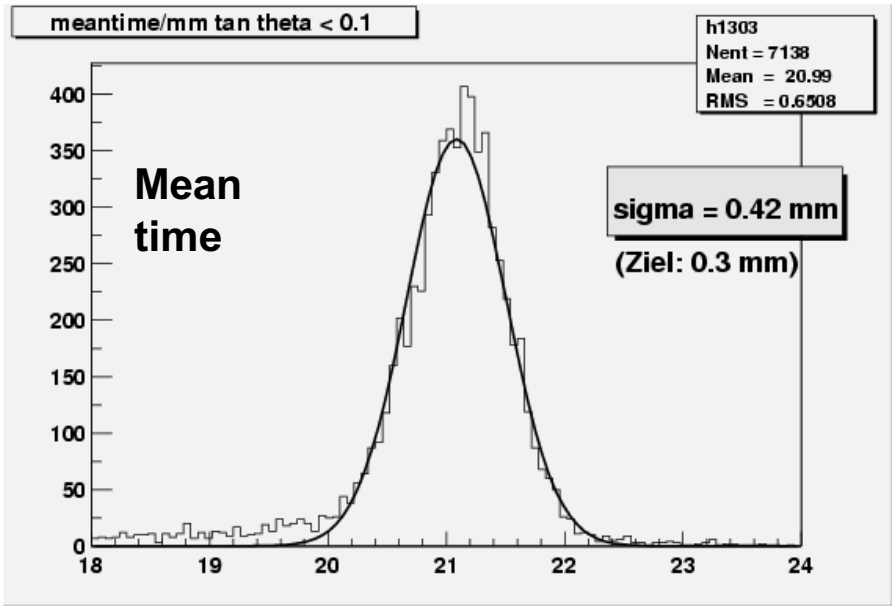
TDC spectrum and Mean time





$$\text{Meantime} = \frac{1}{2}\left[dist(1) + dist(3)\right] + dist(2)$$





A Typical Cosmics Output File (SL 15)

Noise ~ 30 Hz

Efficiency ~ 0.98

Afterpulse probability ~ 0.08

Meantime [mm] ~ 20

RMS [mm] ~1.2...1.6

Residual [mm] ~ 0.4

RMS [mm] ~ 0.6...2

2.line: Meantime left/right with RMS

1				0. +- 0.	0. +- 0.	0. +- 0.	0. +- 0.	
2	51.3 +- 3.4	0 +- 0	0.16 +- 0.02	20 +- 0.17	1.24 +- 0.12	0.784 +- 0.19	1.57 +- 0.13	
2	0 +- 0	0 +- 0	20 +- 0.17	1.24 +- 0.12				
3	224 +- 7.2	1 +- 0	0.11 +-0.016	20.2 +- 0.11	1.37 +- 0.08	0.348 +-0.087	1.06 +-0.062	
3	20.3 +- 0.21	1.42 +- 0.15	20.1 +- 0.13	1.34 +-0.095				
4	75.6 +- 4.2	1 +- 0	0.15 +-0.019	20.1 +- 0.13	1.33 +-0.094	0.205 +-0.056	0.681 +- 0.04	
4	20.3 +- 0.21	1.42 +- 0.15	20 +- 0.17	1.24 +- 0.12				
5	23 +- 2.3	0.986 +- 0.01	0.051 +-0.011	20.4 +- 0.18	1.76 +- 0.12	0.142 +-0.076	0.977 +-0.054	
5	20.5 +- 0.26	1.96 +- 0.18	20.2 +- 0.22	1.45 +- 0.15				
6	28.5 +- 2.6	1 +- 0	0.046 +-0.011	20.5 +- 0.11	1.61 +-0.079	0.204 +-0.079	1.03 +-0.056	
6	20.4 +- 0.17	1.75 +- 0.12	20.5 +- 0.14	1.47 +- 0.1				
7	65.9 +- 3.9	0.995 +-0.0054	0.044 +-0.0097	20.3 +- 0.11	1.64 +-0.079	0.42 +- 0.11	1.67 +-0.081	
7	20.3 +- 0.18	1.85 +- 0.13	20.4 +- 0.13	1.4 +-0.095				
8	47.8 +- 3.3	0.968 +- 0.013	0.11 +-0.015	20.3 +- 0.15	1.59 +- 0.11	0.147 +-0.059	0.877 +-0.041	
8	19.9 +- 0.23	1.64 +- 0.17	20.7 +- 0.19	1.46 +- 0.13				
9	33.4 +- 2.8	0.991 +-0.0064	0.11 +-0.014	20.2 +- 0.12	1.33 +-0.084	0.187 +-0.081	1.31 +-0.058	
9	20.4 +- 0.16	1.37 +- 0.11	20 +- 0.17	1.2 +- 0.12				
10	35.7 +- 2.9	0.996 +-0.0043	0.061 +-0.011	20.2 +- 0.09	1.41 +-0.064	0.423 +- 0.1	1.65 +-0.072	
10	20.2 +- 0.13	1.5 +-0.095	20.3 +- 0.12	1.3 +-0.084				
11	40.6 +- 3.1	0.996 +-0.0037	0.043 +-0.0085	20.4 +-0.085	1.47 +- 0.06	0.413 +-0.089	1.6 +-0.063	
11	20.4 +- 0.12	1.5 +-0.086	20.5 +- 0.12	1.44 +-0.084				
12	36.9 +- 2.9	0.989 +-0.0064	0.063 +- 0.01	20.4 +- 0.12	1.48 +-0.087	0.0745 +-0.052	0.922 +-0.037	
12	20.4 +- 0.19	1.61 +- 0.13	20.4 +- 0.16	1.33 +- 0.11				
13	28.5 +- 2.6	0.979 +-0.0077	0.053 +-0.0091	20.6 +- 0.13	1.7 +- 0.09	0.26 +-0.064	1.25 +-0.045	
13	20.6 +- 0.18	1.81 +- 0.13	20.5 +- 0.18	1.54 +- 0.13				
14	33.2 +- 2.8	0.994 +-0.0043	0.08 +-0.011	20.5 +-0.083	1.59 +-0.059	0.387 +-0.078	1.54 +-0.055	
14	20.5 +- 0.13	1.73 +-0.092	20.6 +- 0.11	1.44 +-0.074				
15	52.2 +- 3.5	0.988 +-0.0082	0.037 +-0.0076	20.6 +- 0.11	1.6 +-0.077	0.536 +- 0.13	2.01 +-0.095	
15	20.6 +- 0.18	1.81 +- 0.13	20.6 +- 0.13	1.36 +-0.091				
16	36.9 +- 2.9	0.987 +-0.0089	0.07 +-0.0099	20.6 +- 0.13	1.36 +-0.091	0.097 +-0.052	0.769 +-0.037	
16	0 +- 0	0 +- 0	20.6 +- 0.13	1.36 +-0.091				
17	26.6 +- 2.5	0.987 +-0.0091	0.067 +- 0.01	20.3 +- 0.19	1.78 +- 0.13	0.238 +- 0.09	1.26 +-0.064	
17	20.3 +- 0.19	1.78 +- 0.13	0 +- 0	0 +- 0				

Summary of SL Status

Netscape:

File Edit View Go Communicator H

Bookmarks Netsite: http://www.physik.rwth-aachen.de/~hoepfner/QualityControl/SL-Summary/sl-qc.html What's Related

SL SUMMARY
Results from gas tightness, HV and FE Tests

SL Number and SL type	Time constant Gas tightness HV + FE cover	Part of chamber No.	Status HV Test in gas	Total No. of dead channels	Cell No. Component	Dead FE-channel, Cell No.	SL Flyer (link to PS-file)
SL 001 - phi	140	1	OK	0		1	link to PS file
SL 002 - theta	670	1	OK	0		0	
SL 003 - phi	260	1	OK	0		1	
SL 004 - phi		2	air				
SL 005 - theta	440	2	air	10	12, 22, 24, 18, 56, 178, 182, 204, 208 = Strips 144 Cathode		
SL 006 - phi		2	air	1	166 Strip		
SL 007 - phi	1200	exploded SL	OK	2	102 Strip 18 ???		
SL 008 - phi(l)	320		repair	1	.... Wire		
SL 009 - theta			ongoing	1	141 Cathode left		
SL 010 - phi			repair				
SL 011 - phi(l)			OK	0			
SL 012 - theta			OK	1	210 Strip		
SL 013 - phi	6600		repair	3	66, 91, 76 Strips		
SL 014 - theta			ongoing	1	69 Strip		
SL 015 - phi(l)	230		OK	0		5	SL Flyer Cosmics
SL 016 - phi			air				
SL 017 - theta			air				
SL 018 - phi(l)							
SL 019 - phi	500						
SL 020 - theta							
SL 021-phi(l)							
SL 022-phi							
SL 023-theta							

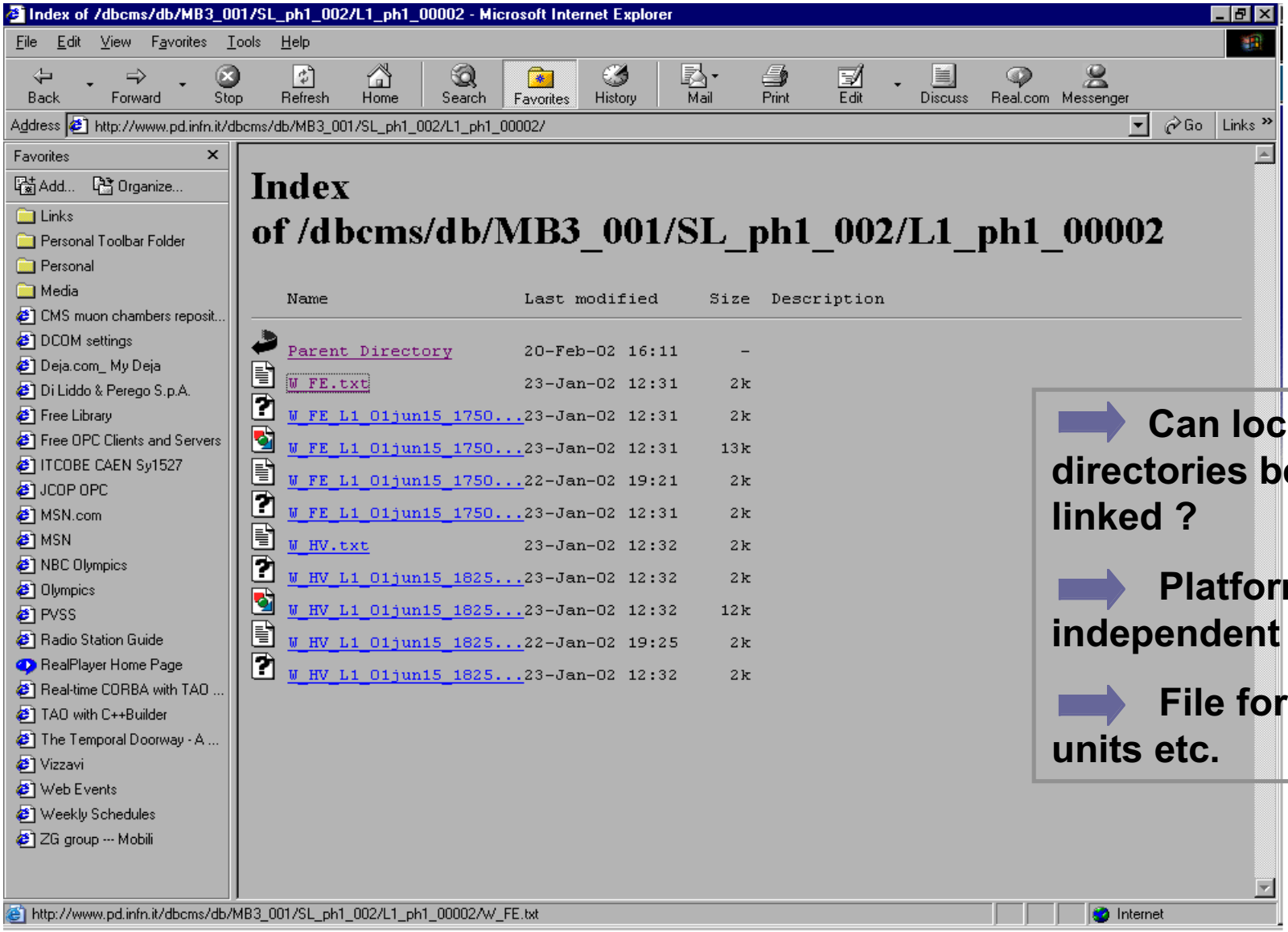
SL Summary Sheet

SL Summary Sheet:

SL#	015			
HV in $ArCO_2$ [V]	wires	strips	i-beams	date
	3600	1800	-1600	10.01.02
Training duration	~ 18 h			
Gastightness	2600 min (2 HV cover)			
Dead cells	#	type		
Kanal 9	41	FE		
Kanal 15	47	FE		
Kanal 7	119	FE		
Kanal 7	135	FE		
Kanal 10	170	FE		

File from cosmics data taking

Marinas Proposal from last CMS week



- Can local directories be linked ?
- Platform independent tools
- File format, units etc.

Relevance of QC Information for future Data Analysis

Some data are very relevant for muon reconstruction, like corner block position needed for alignment. Other data, like wire tension, are not essential for data analysis but for chamber operation.

QC during production has different meaning (monitoring <-> correction). Divide QC data in 2 groups [app.no. of data per SL]:

Values just noted but no correction

- 1.strip position [4]
- Gastightness [1]
- No.of dead channels [0-10]
- Corner block position [4]
- O_2-content [1]
- Noise [200]
- Efficiency [200]
- Mean time [6 x 200]
- Planarity [50]
- HV settings [3]

QC until values are within limits

- Wire position [200]
- Wire tension [200]
- Rest-currents [25]

Presently accessible via www

QC Data Storage

QC during production

Store QC data
Controlling
For public access
For future reconstruction

DB

HTML based

Others

Use of information for muon reconstruction

Get started:

- Place priorities! Which data most urgently needed for public access (operation of chambers at ISR, alignment testbench, etc).

Gastightness, O_2-content
HV settings
No.of dead channels
Corner block position
1.strip position
Noise
Efficiency
Mean time

- Aim of data storage.
- Schedule.

  I'd estimate ~4 weeks for this amount of data in Aachen.