ALFA Status Report

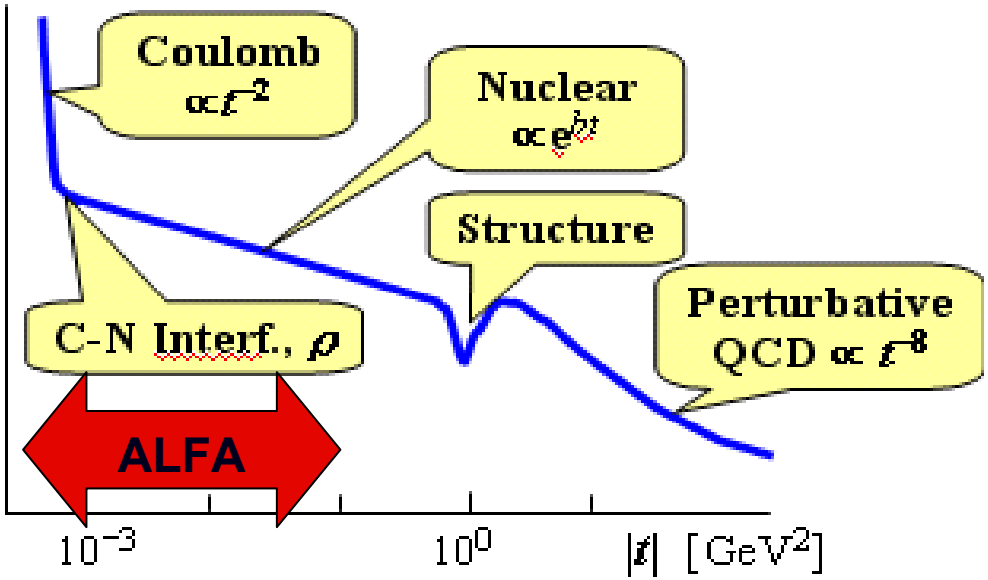
K.Hiller for the DESY ALFA group

DESY-ATLAS meeting, Zeuthen 22 May 2008

1) short introduction
2) status of main components
3) outlook

Luminosity from ALFA(1): Principle

Elastic scattering in the Coulomb-Nuclear interference region:



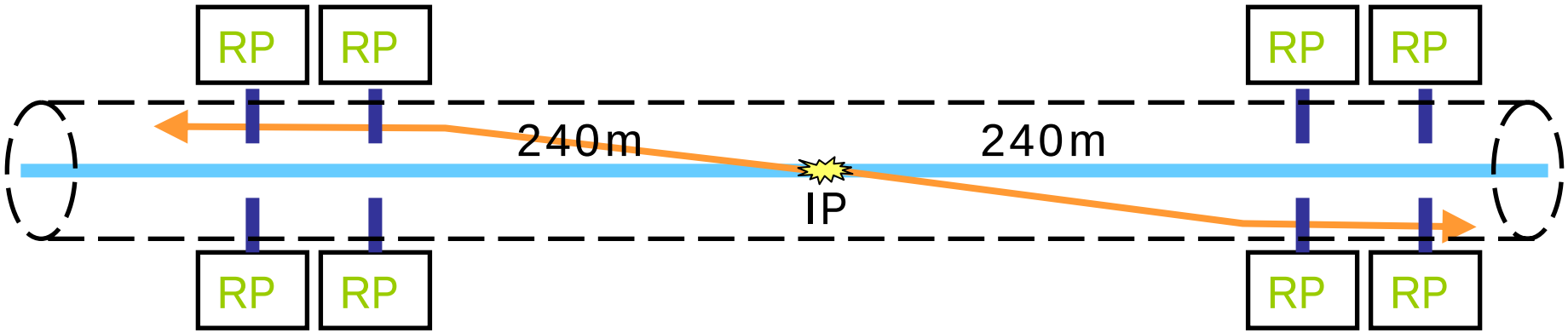
$$\frac{dN}{dt} \approx L\pi \left| -\frac{2\alpha}{|t|} + \frac{\sigma_{tot}}{4\pi}(i+\rho)\exp(-b|t|/2) \right|^2$$

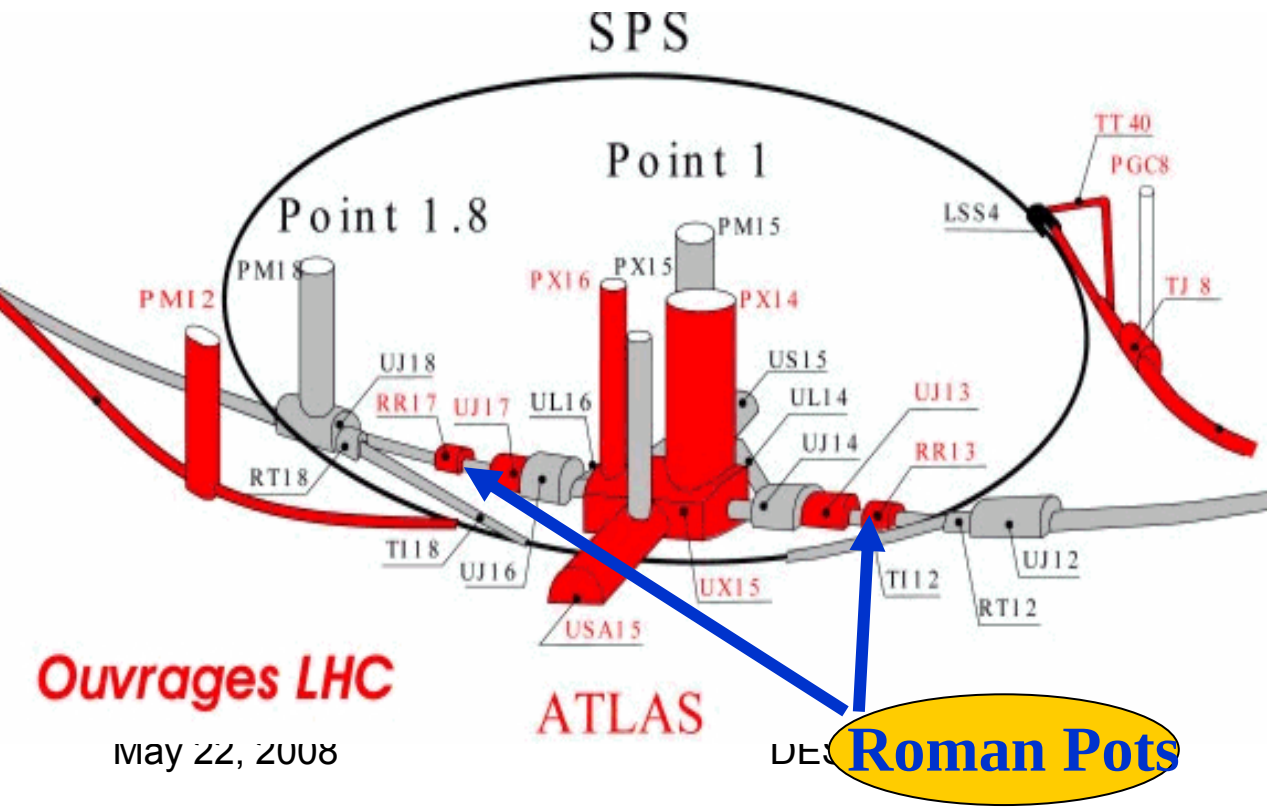
$L = \text{luminosity},\ \sigma_{tot} = \text{total cross section}$

$\rho = \text{Re } f_{el} / \text{Im } f_{el}(t=0),\ b = \text{nuclear slope}$

- Measure unbiased elastic rate
- Fit dN/dt
- To reach Coulomb region
  $|t| < 10^{-3}$ GeV^2
  needs tracking close to the beam
- Special request to:
  1) pot positions
  2) beam optics
  3) detectors …

Luminosity from ALFA(2): Roman Pots





Two RP stations at +- 240 m of ATLAS to cover smallest scattering angles

Luminosity from ALFA(3): Optics

Standard LHC optics impossible:

1) too large beam divergence

$$\sigma(x) = \sqrt{\varepsilon \cdot \beta^*} \qquad \sigma(x') = \sqrt{\varepsilon / \beta^*}$$

with : ε emmitance, β^* beta function

β*/m	σ(x)/μm	σ(x')/μrad	σ(t)/GeV²
11	74	6.7	0.002
2	32	16	0.012
0.5	16	32	0.050

Intrinsic beam divergence does not allow to measure beyond 0.001 GeV²

Optics solution: high β* = 2625 m
low **ε** = 1 μm rad

$$|t_{\min}| = p^2 \, n_\sigma \, \varepsilon / \beta^*$$

with p beam momentum,

n_σ distance to orbit in RMS

For n_σ=15 $|t|_{min}$ ~ 0.0004 GeV²

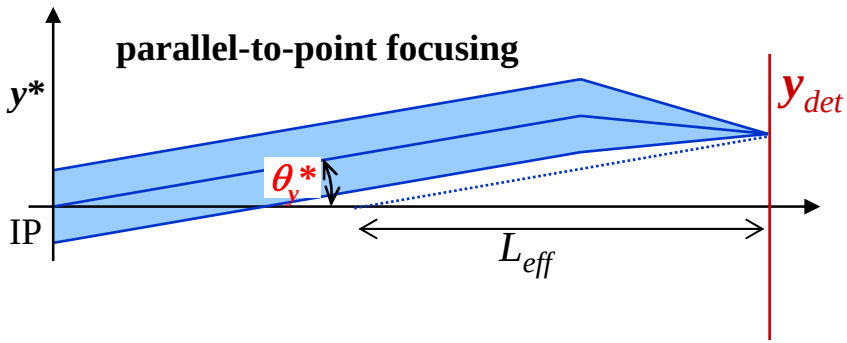
2) ALFA tracks depend from Θ* AND y*

$$y = \sqrt{\frac{\beta}{\beta^*}}\left(\cos\Psi + \alpha^* \sin\Psi\right) y^* + \sqrt{\beta\beta^*}\,\sin\Psi\,\theta_y^*$$

For unique relation between track in ALFA and momentum transfer phase advance

$\Psi = 90^0$

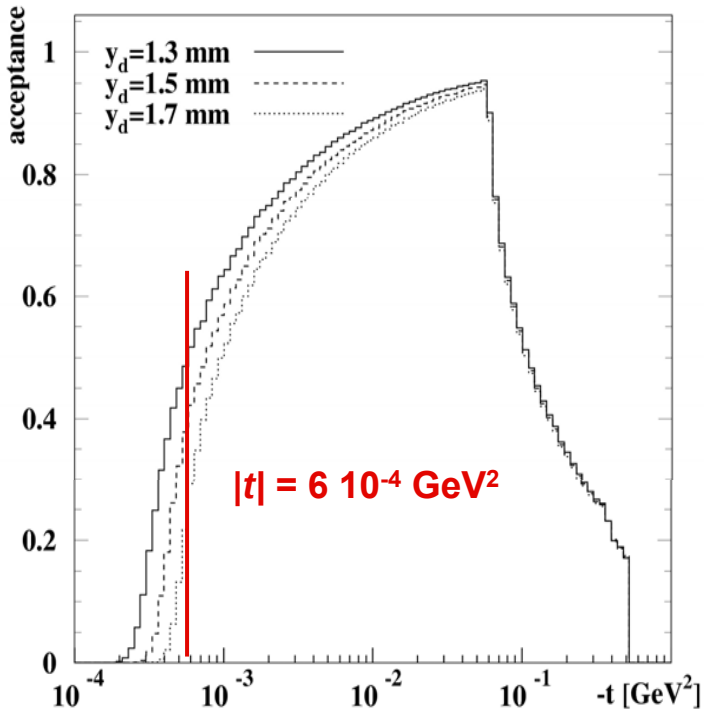
(α* ~ 0 at high β*)

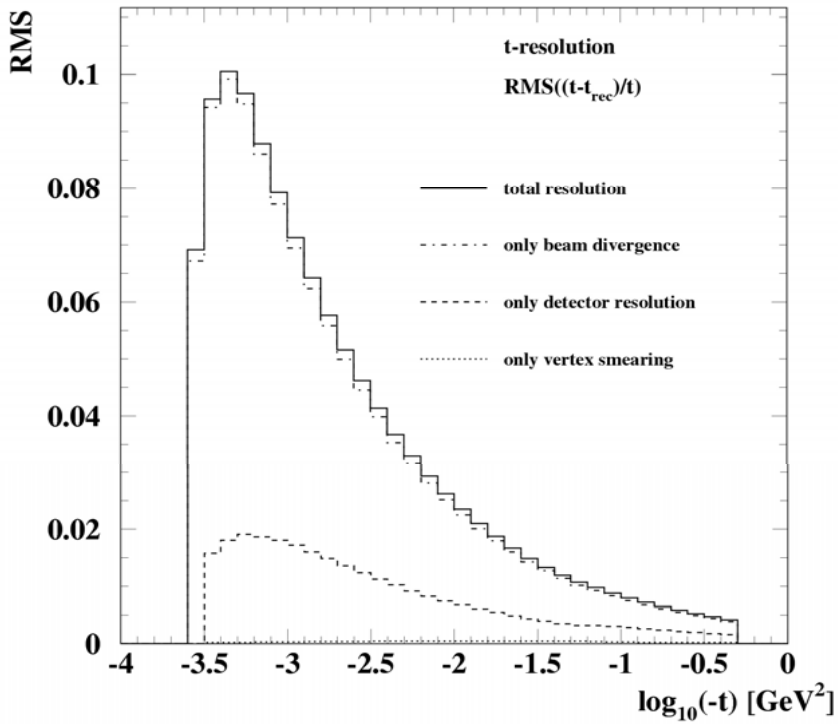


ALFA used in special runs with:
high β* , low ε , Ψ = 90⁰
→ L = 10 $^{27...28}$ cm^{-2}s^{-1}

Luminosity from ALFA(4): Acceptance

Detectors as close as possible to the beam to reach the Coulomb region





For y_d = 1.5 mm:
Integral acceptance = 67%

***t*-resolution < 10%**
dominated by beam divergence

The ALFA production sites

CERN
Design
Mechanics
Detectors
Electronics
Coordination
Installation

Orsay
Maroc 1/2/3
FGAs

Lisbon
Fiber coating

Lund
motherboard

DESY HH
Fiber metrology
MAPMTs, HV

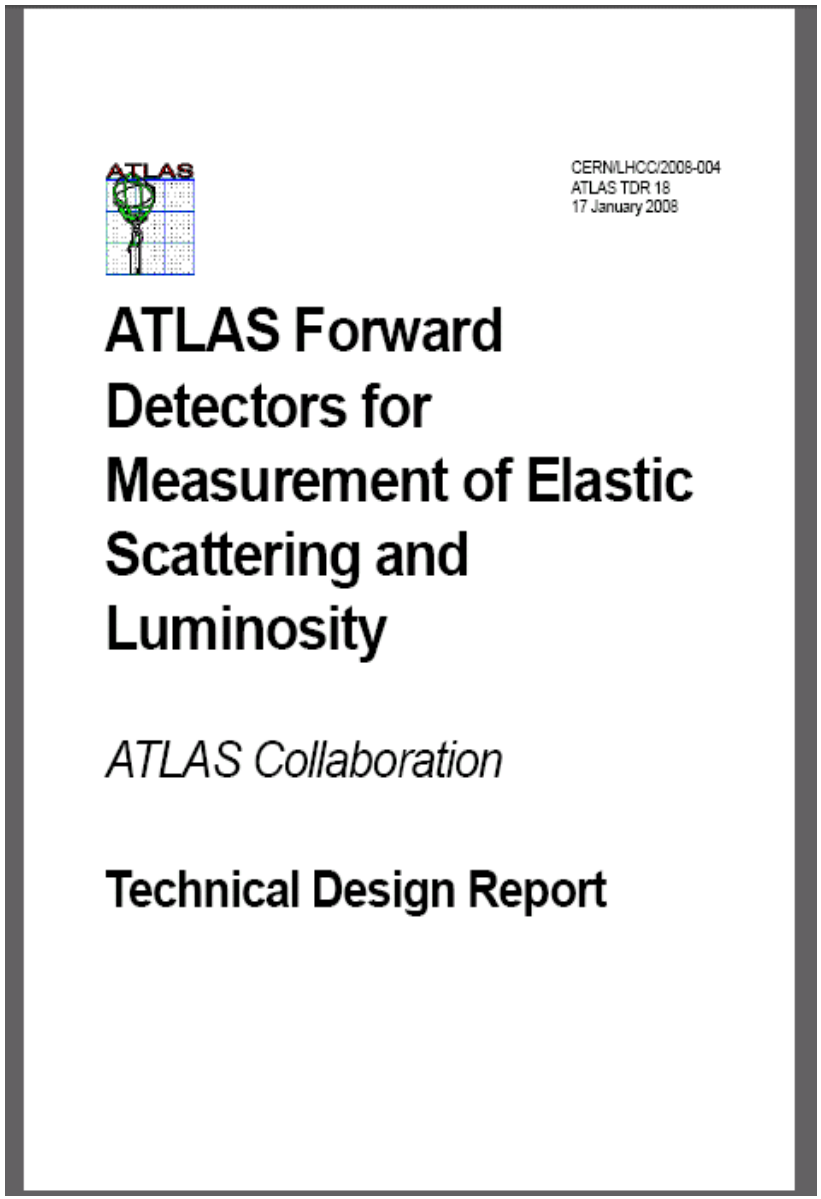
HU Berlin
Ti-substrates

DESY Z
Triggers

Giessen
Fiber detectors
Assembling software

Prague
mechanics
software

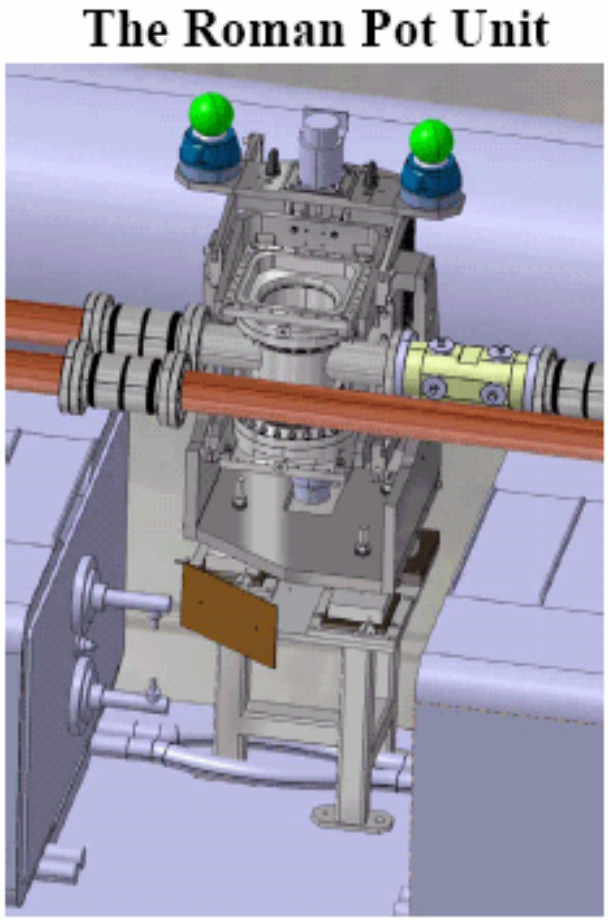
The ALFA TDR

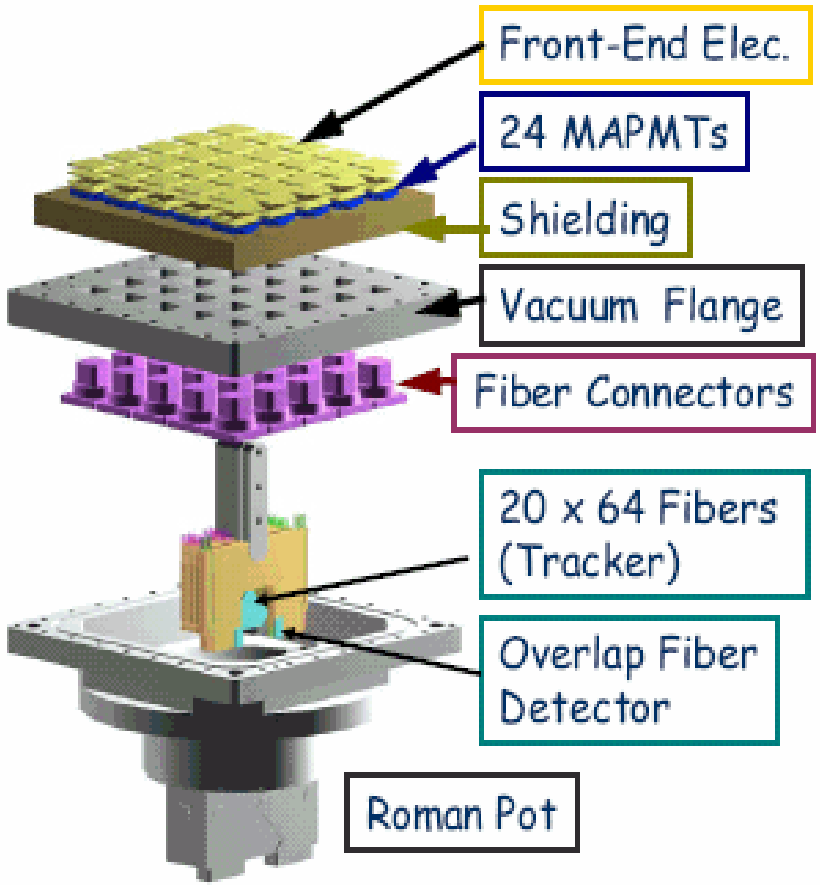


… an important formal step for any detector component

1) 3 internal ATLAS referees
2) LHCC open meeting 7th May 2008
3) LHCC referees are now looking at the TDR. Special session for next meeting in July

ALFA Detector: Scheme





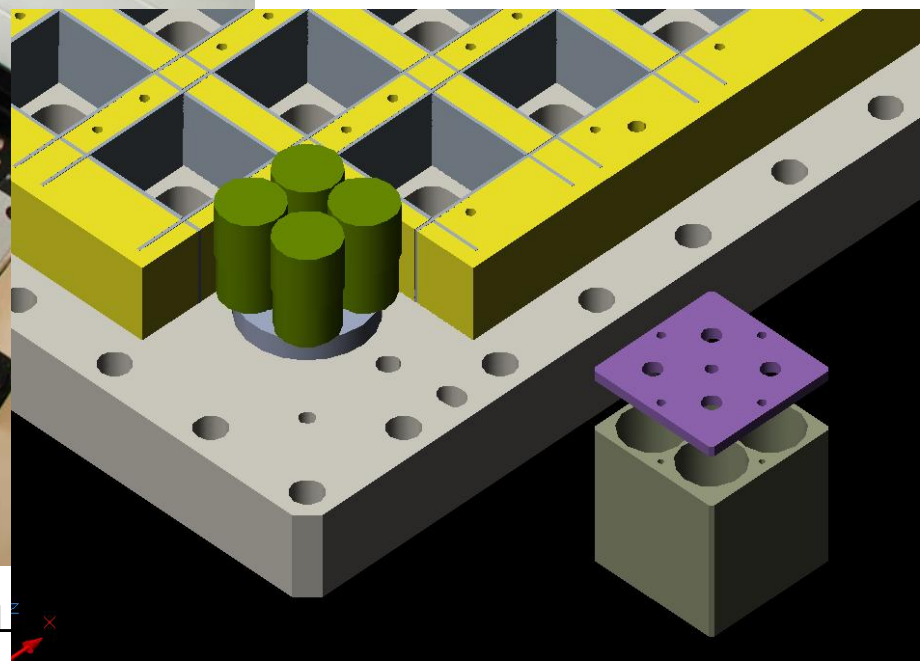
Prototype -1: test of installation

Giessen, March 2008:

- ❑ installation issues in a very tight environment
- ❑ decision of tile readout: bundles or light guides

R7400, R7401

R9880 SuperBialkali
Q.E. ~ 37%



Good news from Aluminization / CERN

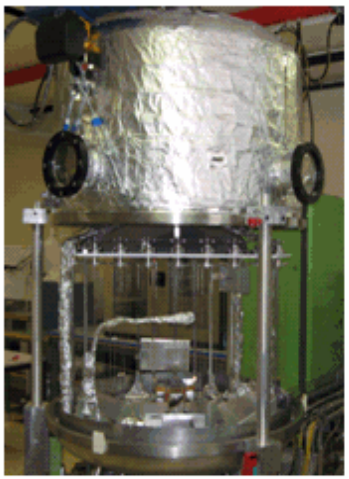
ATLAS
ALFA

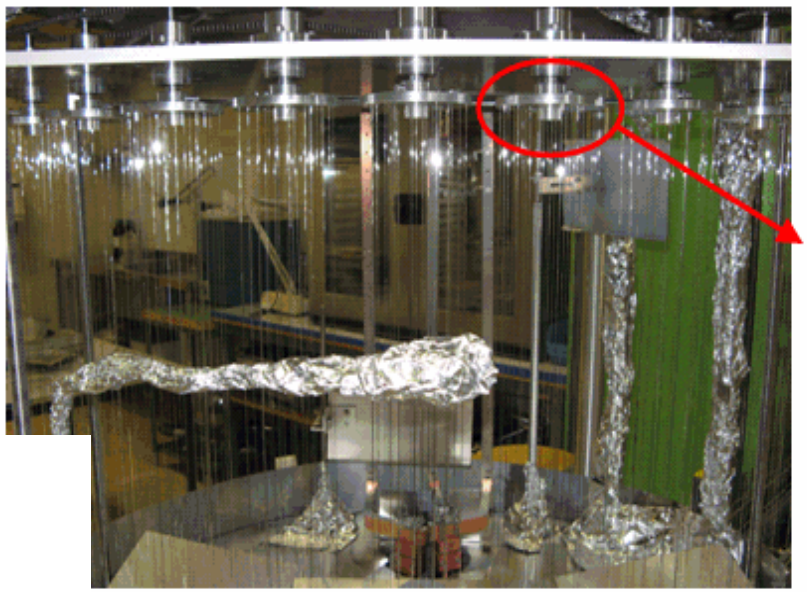
Status of fibers aluminization at CERN

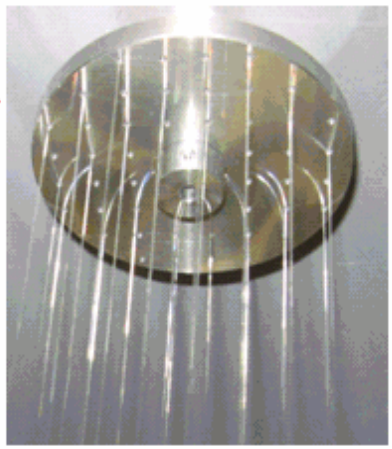
A fiber side coating system has been built at CERN

- Based on vacuum evaporation technology
- Implemented in our 1 meter evaporation plant, in building 108

Capability: 430 fibers / process







- ALFA detector meeting – Status of fiber aluminization at CERN - A.Braem , C.David

Summary of sides aluminizations for proto-2:

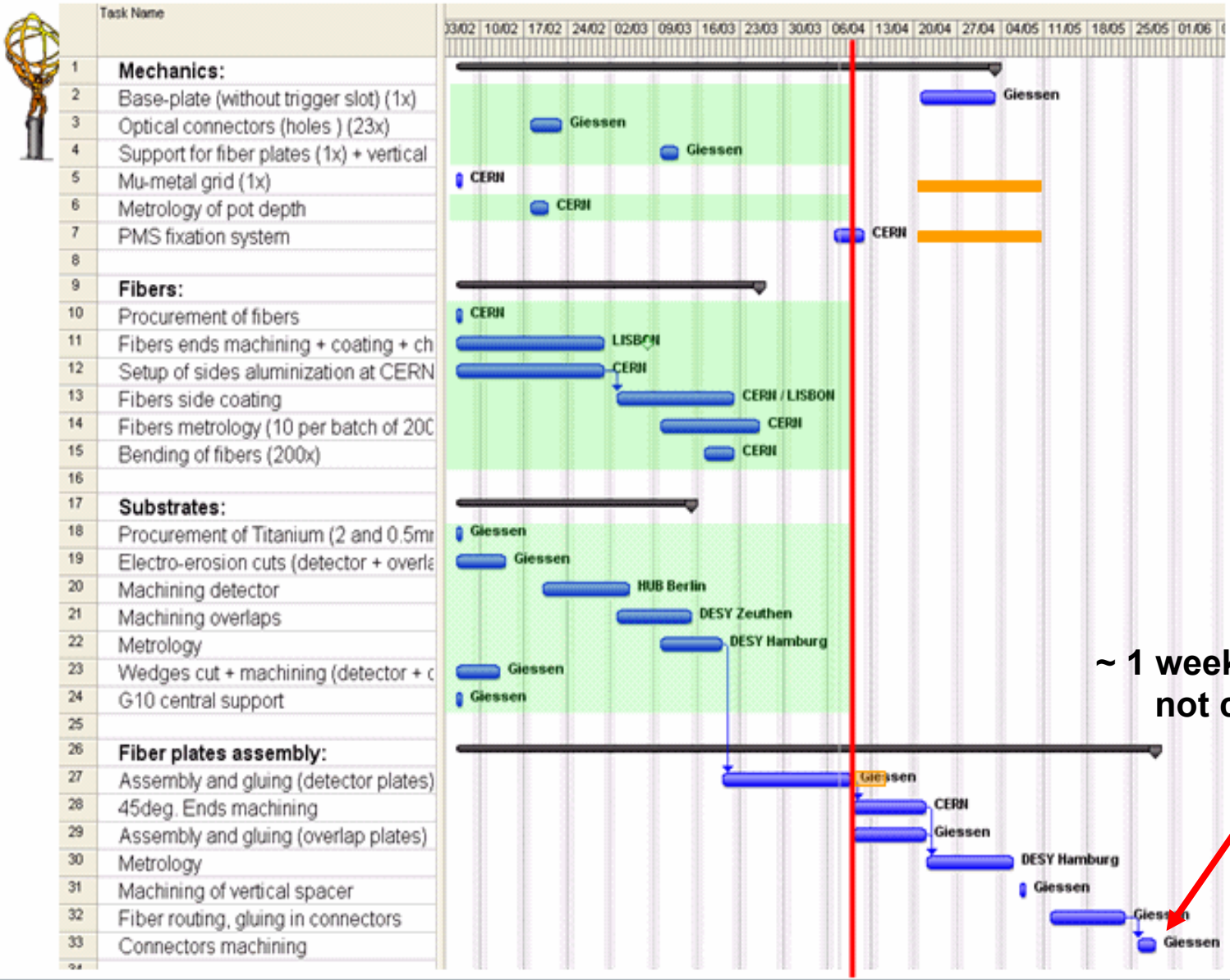
- 1650 fibers coated

  → 1600 fibers OK + 50 fibers rejected (bad adherence)

- 1300 fibers sent to Giessen for the assembly of the main detector fiber plates.
- 240 aluminized fibers bent for the overlap detector plates

Lisbon:
- problems with sputtering side coating
- but works fine for end coating of fibers

Good news: Prototype -2 (nearly) on schedule

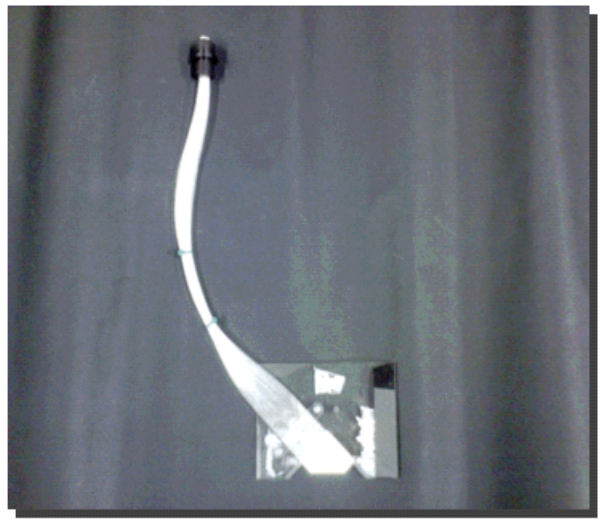


~ 1 week shifted, not critical

Trigger counters: bad news discharges, but …

Pros & Cons of both mini-PMT solutions

Parameter	PMT inside	PMT outside
Volume filling	possible	possible
Light yield	~ 50 P.E.	~ 40 P.E.
Vacuum	**discharges from 130 … 10-5 mbar**	leakage rate 3 x 10-6 mbar* l/sec
Handling	PMT exchange possible	PMT exchange simple
Personnel (technician leaves in November)	Proto_2 O.K., other pots unclear	Good chance to finish all trigger plates

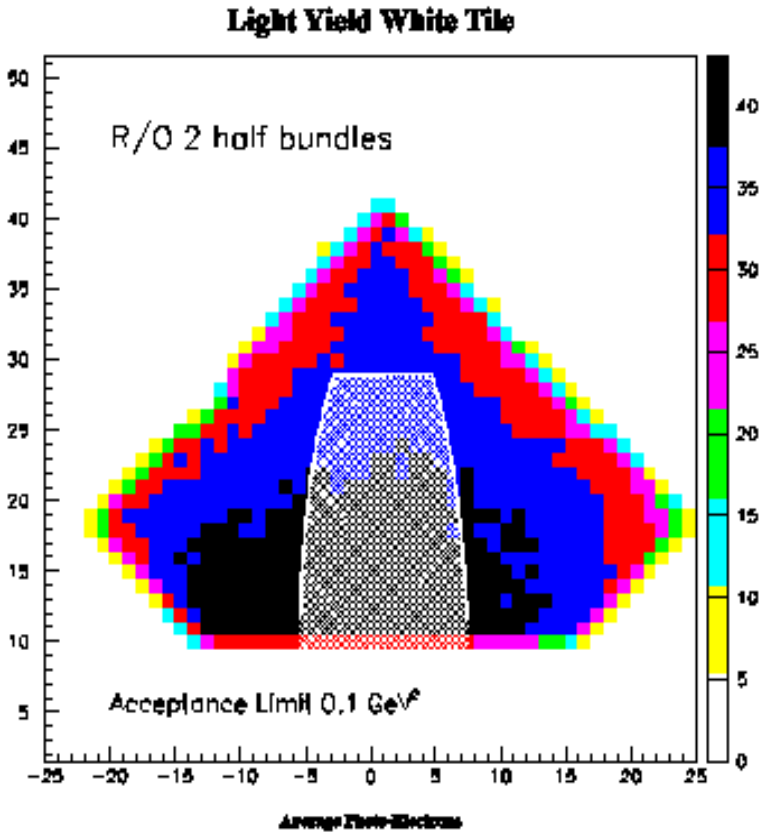


White full

4/9/2008 ALFA meeting CERN 4

Trigger counters: … fiber bundle R/O alive

Light yield estimation …



In the fiducial area one can expect 35 .. 40 P.E.

Ti-plates: good news and concerns

Schedule of Ti-production (M.Jablonski, HU Berlin)

week	activity
#11	order Ti grade 5 material
#14	delivery of material
<<<	3 weeks latency requested by workshop >>>
#18	start of electro-erosin
<<<	5 weeks production time >>>
#23	start of milling at HU Berlin and DESY Zeuthen
<<<	3 weeks final milling >>>
#26	optimistic date to have all ready

*** End of June ***

Continue with fiber gluing in Giessen and metrology in Hamburg

Precision of OD Ti-milling in Zeuthen

	<----- Zeuthen ---------> *)			<---- HH ---> **)	
Plate	A(ideal)	A(real)	differ	A(real)	differ
#1	136.333	136.298	+0.035	136.315	+0.018
				136.307	+0.026
#2	136.500	136.492	+0.008	136.495	+0.005
				136.478	+0.022
#3	136.667	136.648	+0.019	136.656	+0.011
				136.651	+0.016

*) J.Bienge
**) D.Petschull

Plate	B(ideal)	B(real)	differ	B(real)	differ
#1	128.533	128.500	+0.033	128.468	+0.065
				128.483	+0.050
#2	128.700	128.660	+0.040	128.687	+0.013
				128.631	+0.069
#3	128.867	128.833	+0.035	128.839	+0.028
				128.832	+0.035
<differences>			+0.028		+0.030
RMS			0.012		0.020

- global offset of ~ 30 micron
- staggering not so much influenced
- waiting for green light from management

OD milling in Zeuthen accepted

Roman Pot mechanics: good news from Prague

Prague February 2008

The four units

Stephane and the 4 units

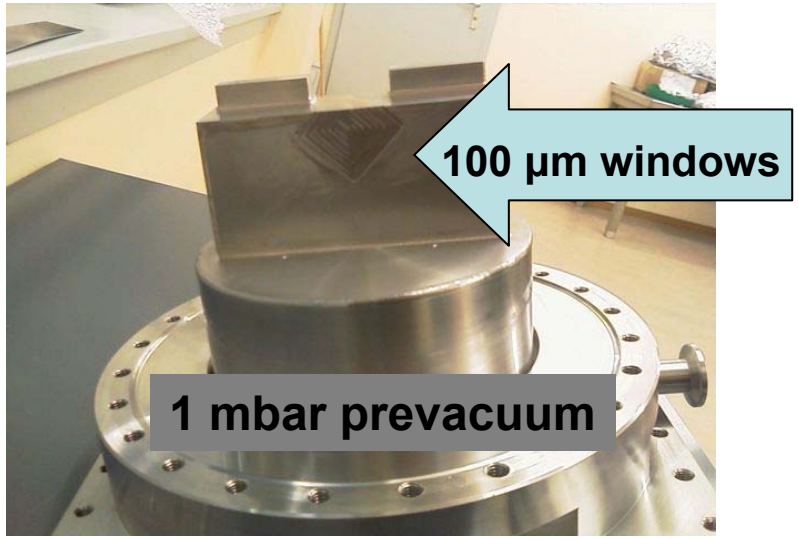
The vacuum chambers

Compensation system

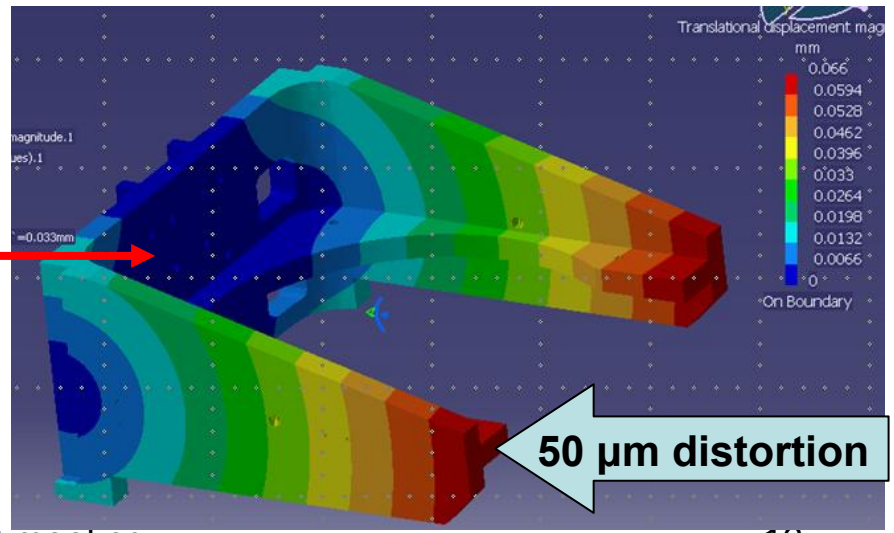
all vacuum elements

compensation system

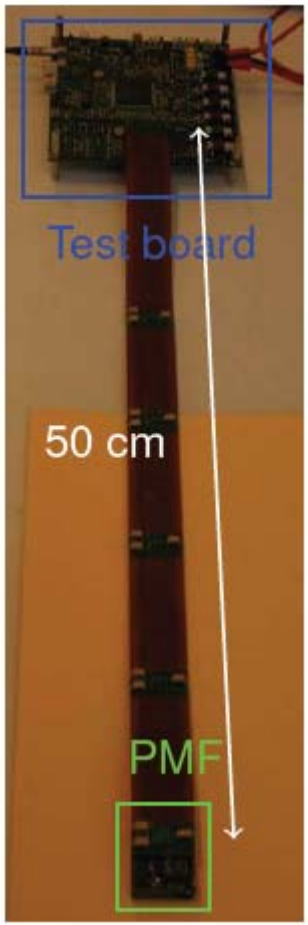
Roman Pots: difficult components



- 4 stations arrived at CERN
- Prague people working for stainless steel slides
- measurements of position reproducibility for each station

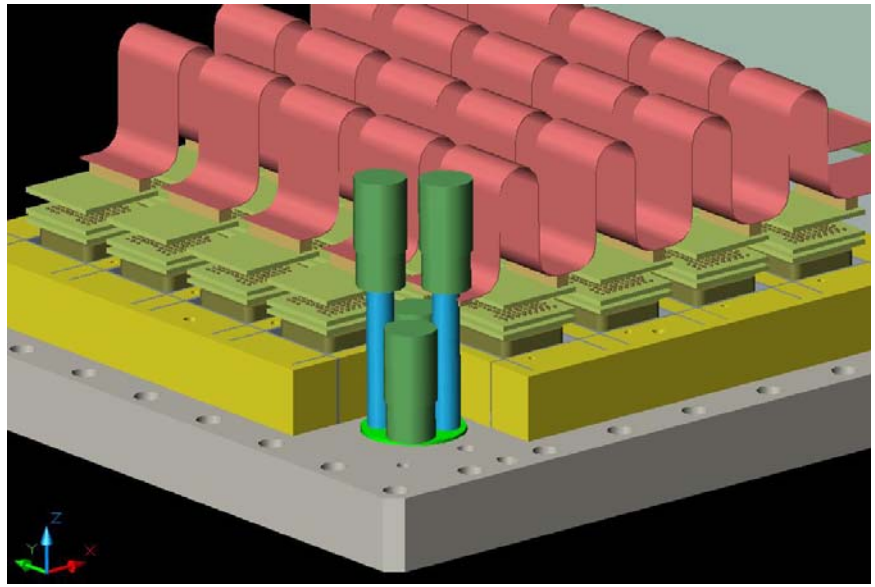


Electronics: R/O scheme



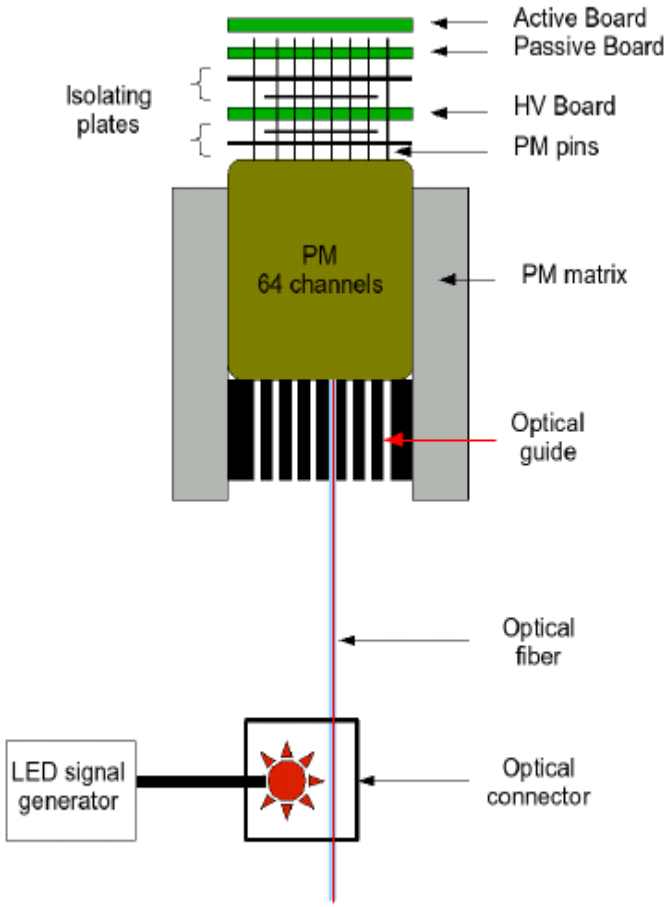
Orsay:
5 PMFs
on one kapton cable tested

→ production of 32 units
is going on

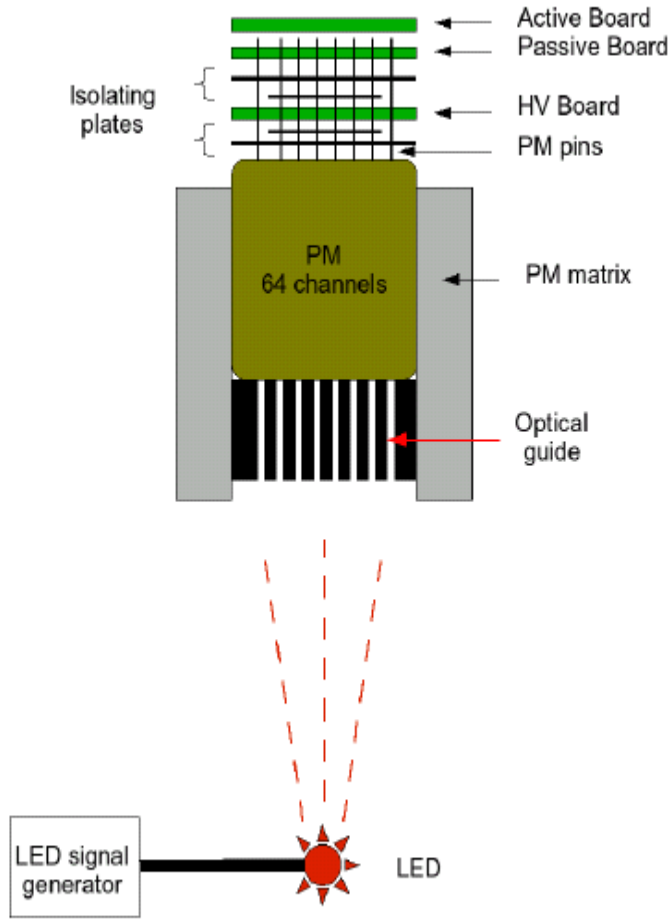


Lund:
mother board at CERN
Mid of May
→ completion
→ debugging

Electronics: 5 PMFs in Orsay tested

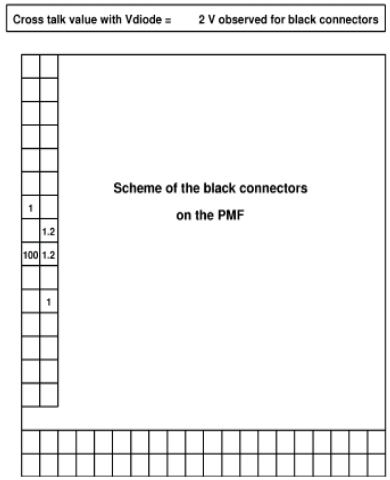


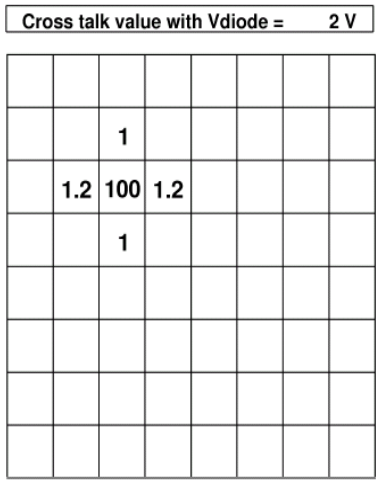
Set up used to illuminate one channel of the PM



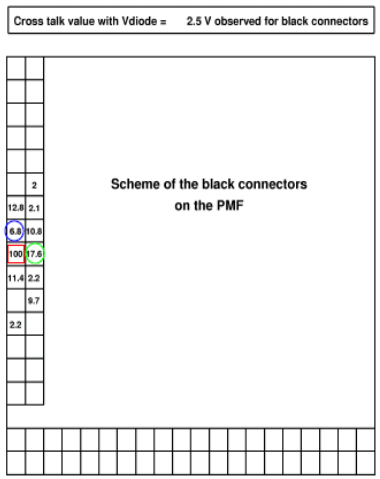
Set up used to illuminate all the PM

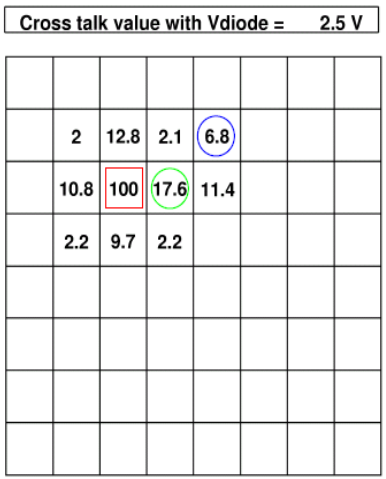
Electronics: Cross talk ...





Fiber light level:
X-talk at ~ 1%

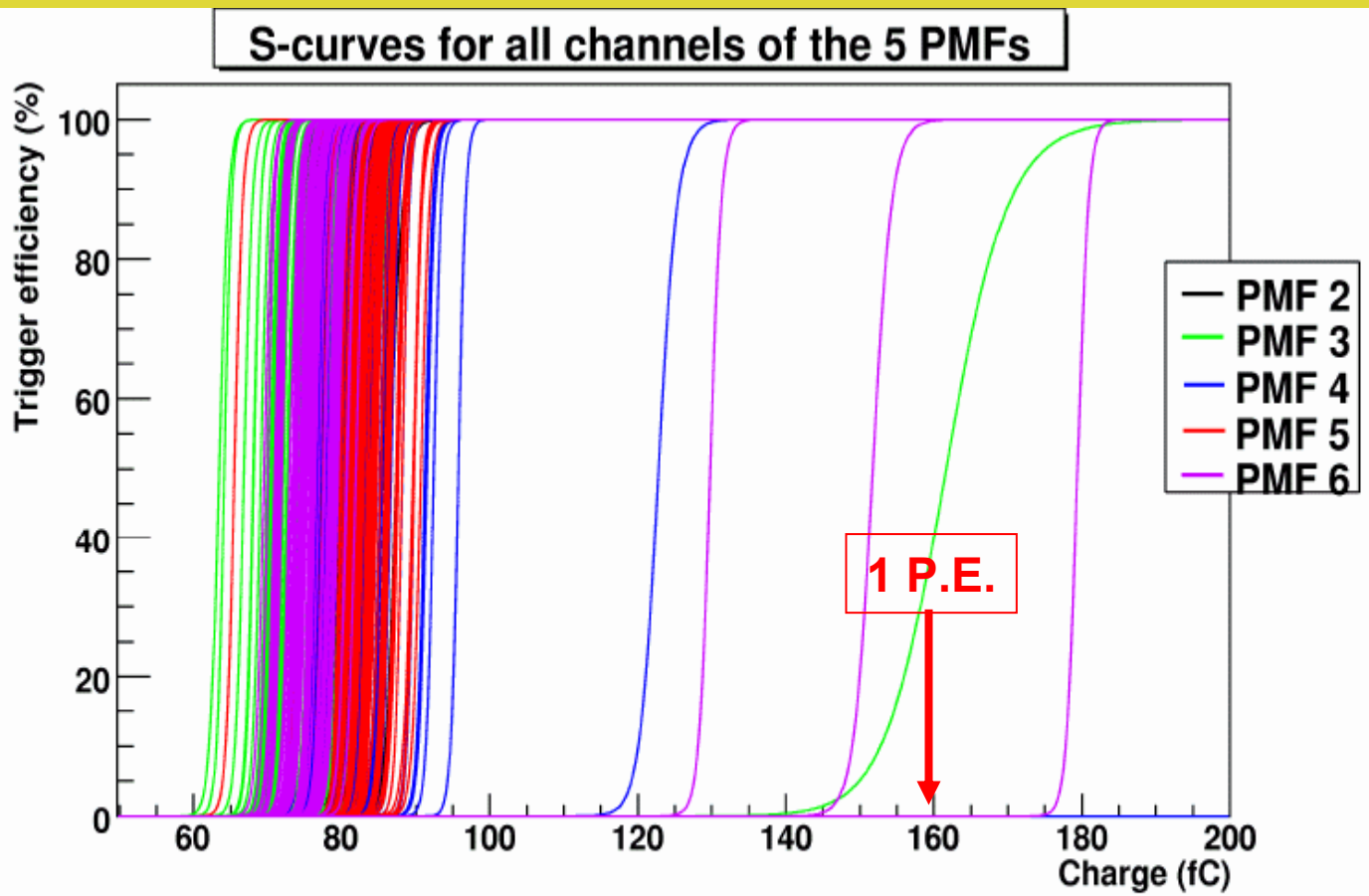




High light level:
Long distance
X-talk via connectors

Central channel 1st PM neighbour 2nd diagonal PM neighbour

Electronics: S-curves



Conclusions :

- Good homogeneity of the 314 channels out of 320.
- 6 channels out of 320 are shifted.

Electronics: motherboard – most critical

Lund: production → CERN for completion → debugging has started

A few modifications were added before the board submission :

- An ADC has been reinstalled on board. It will be able to read the MAROC analogue outputs (one output selected by demultiplexer)
- The ADC data outputs are connected to the MB FPGA, however the transfer of these data through the optical link and ROD are not defined
- A "trigger" input has been added (to allow readout without the TTC trigger)
- The output data rate from the GOL can be selected between 40Mbits/s or 50Mbits/s : 50Mbits/s is the data rate of the MROD-X hardware.

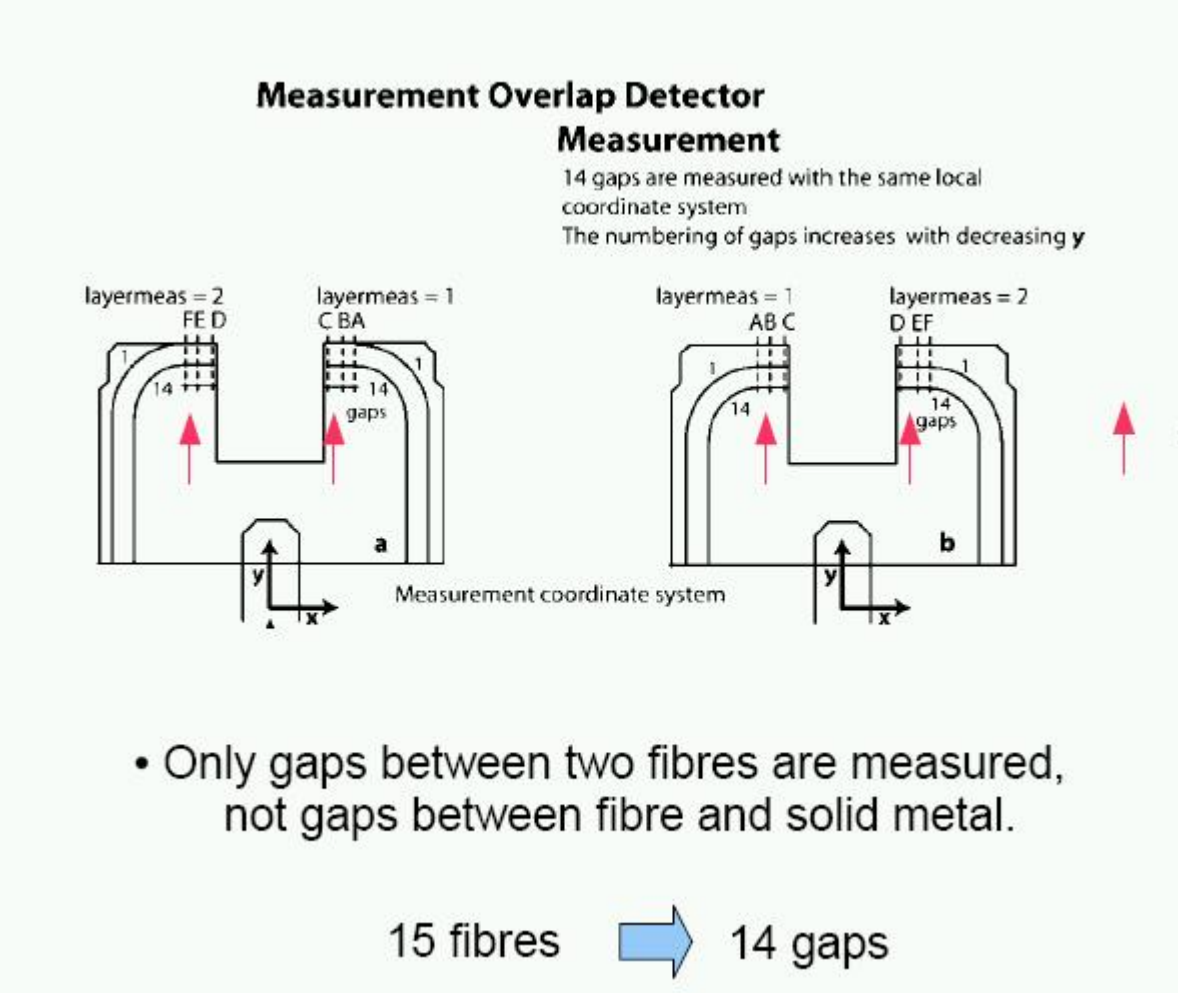
MB Status

Submission for fabrication has been done by Bjorn at Eastern

- Board with components expected at CERN ~ 15 May 2008
- Still a few components to mount at CERN
- Debug at CERN in building 251 (with PMF-2 units)

Malfunctioning motherboard can overrule the whole schedule

Metrology: overlap detectors

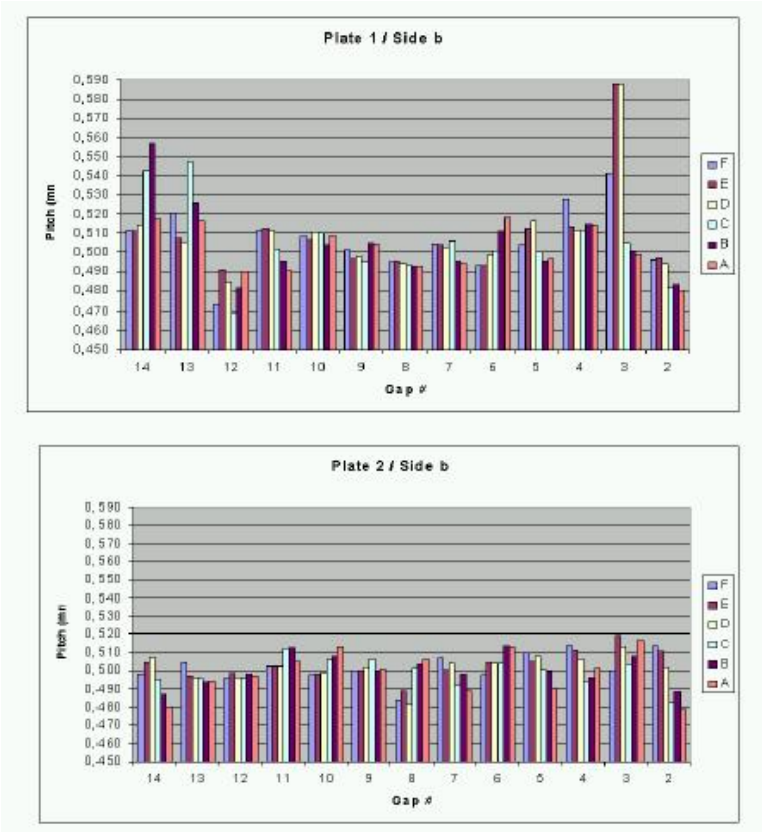


Resolution based on good knowledge of fiber position

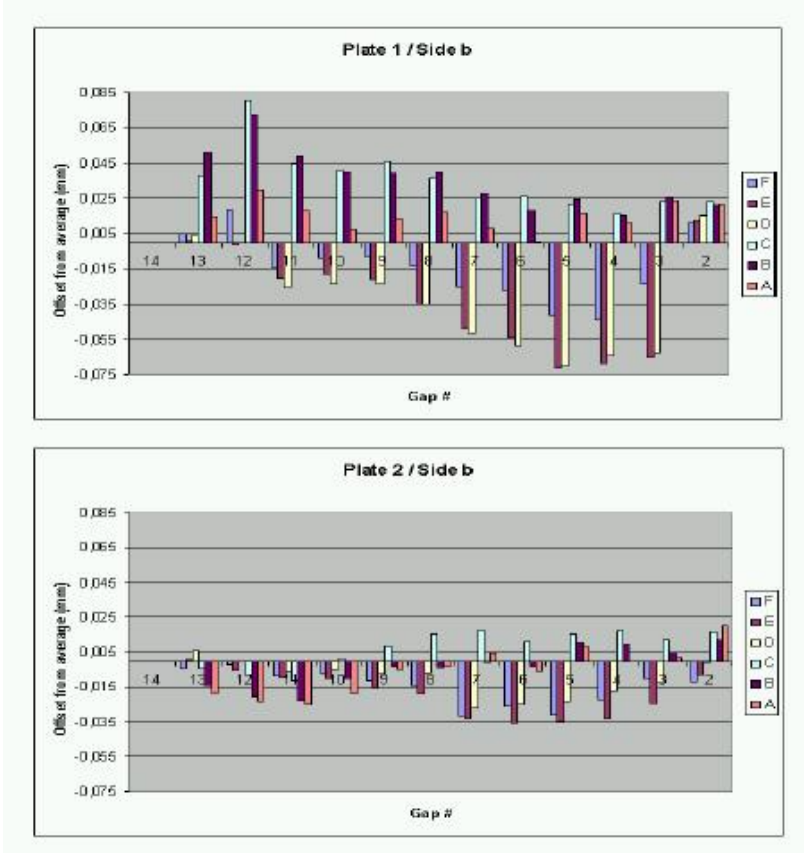
➔ metrology in Hamburg (D.Petschull)

Metrology: results

Pitch: gap-to-gap



Pitch – average

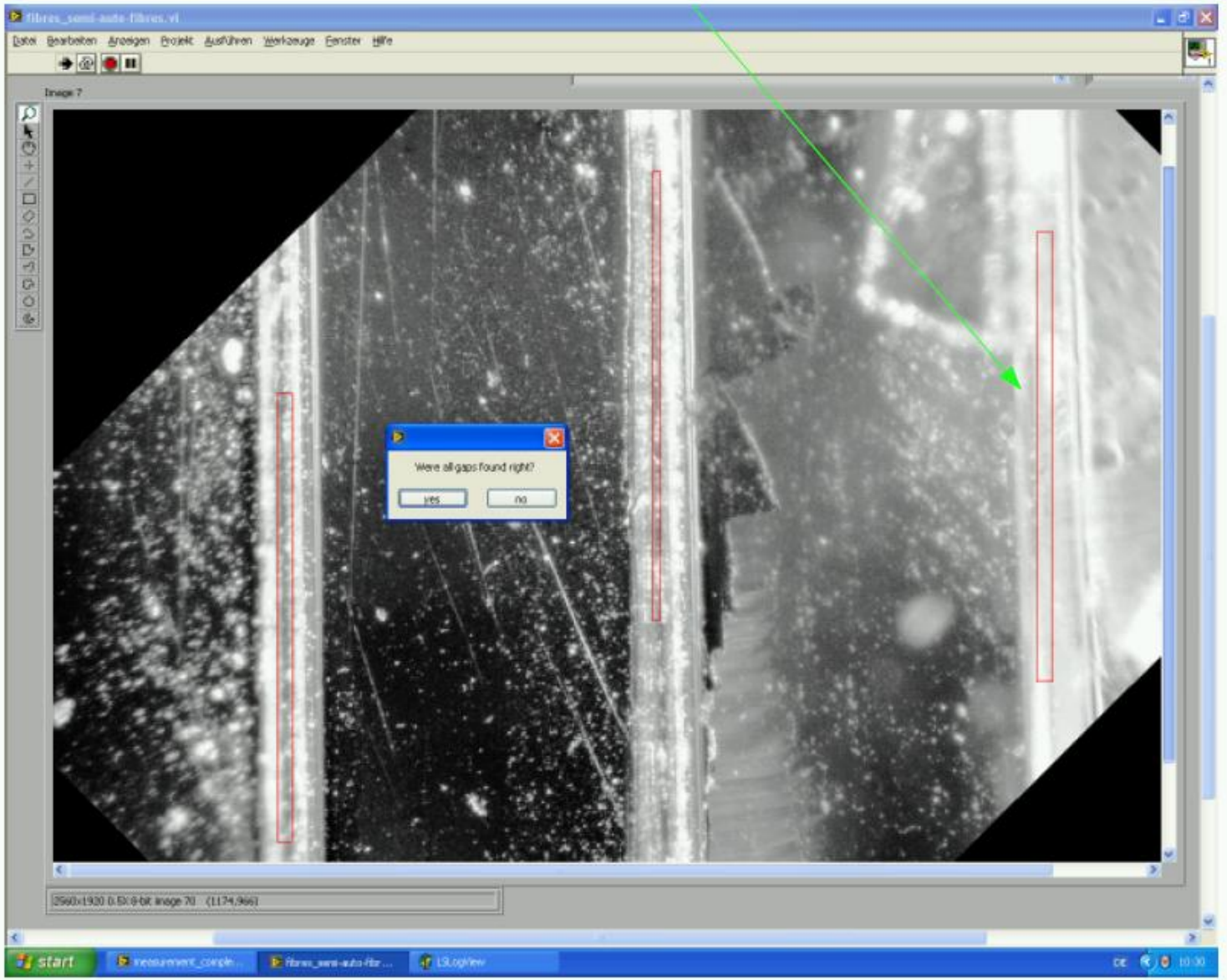


→ Resolution of OD due to large statistics of halo tracks

→ Less precision for individual tracks needed

Metrology: problems

- Excess of glue on fibre ⇨ Might misslead LabView in finding the gap



MAPMTs & HV: DESY contributions

HV-power for final setup

bids from companies

U. Koetz/Desy
8.5.2008

pmts in question

	base [MΩ]	U_{nom} (U_{max}) [V]	I_{nom} (I_{max}) [µA]	
R7600	2.2	800 (1000)	365 (455)	64 pixels
R7400	2.8	800 (1000)	285 (360)	trigger
R9880	3.5	1000 (1250)	285 (360)	trigger

Present choice →

→ DESY delivers HV for prototype-2
→ Patch panel for next test beam
(I.Gregor, U.Koetz)

offer from CAEN

1 SY 1527LC

8 + 1 A1535N and 2 A1535SN (24 ch/mod)

total sum 59.256 €

delivery time 90 to 120 days

offer from iseg

8 +1 EDS 20 130n_504 (32 ch/mod)

2 crates (left and right of IP)

fans, PCAN—PCI cards,....

total sum 41.200 €

delivery time 8 to 10 weeks

offer from iseg

14 +1 EDS 20 130n_504 (16 ch/mod)

2 crates

fans, PCAN-PCI cards,...

total sum 79.700 €

delivery time 8 to 10 weeks

Some more good – bad news …

Good:
- slow control well underway (S.Franz)
- all long cables in tunnel to USA15
- 8 CAEN power supplies ordered / 4 month
- DESY takes care for test beam HV
- some interest of the Krakow group to join ALFA

Bad:
- some short cables missing, many connector not yet ordered
- connection of ALFA to ATLAS interlock
- electronics for main/overlap detectors missing
- rack space in USA15 to check

…list certainly not complete.

Outlook

- The ALFA project is based on a vital group of institutions:
  Berlin, Cracow, CERN, Lisbon, Lund, Giessen, DESY, Manchester, Prague, Stony Brook, Orsay, Valencia

- Series of test beam measurements 2005, 2006, 2007 indicates that the design goal can be reached: resolution < 30 μm at 100% trigger efficiency 0(0.1%)

- Prototype_1: used for assembling tests
  Prototype_2: full pot with all final components presently in assembling
  4 potential weeks of **test beam measurements in July, August 2008**

- Mass production of 8 pot units plus 2 spares till end of 2008

- Installation of 8 Roman pots in shut down 2008/2009

- Insert sensitive detector components earliest spring 2009, (→ 2009/2010)

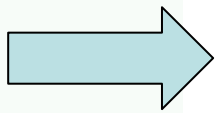
- ALFA stations are the test ground for physics upgrade projects RP220, FP420
  → installed probably not before long shut down 2013-2015

DESY responsibilities

1) MAPMTs: purchase, optical reception test, from marks to shims
2) detector metrology: measure central line of each fiber by microscope
3) trigger counters: precise 0(10μm) scintillator tiles + fiber bundles → Titanium

Table 11-2 ALFA detector cost (kCHF).

Items	Cost	Responsibilities
Prototypes 2005, 2006, 2007	68	CERN, Giessen
Fiber tracker	80	Giessen
Titanium plates	30	Humboldt
Aluminization	40	Lisbon
Trigger counters	40	DESY
MAPMTs	310	DESY (125), Prague (50) + 80 PMTs reused from Giessen
Total ALFA detector	**568**	
Total with contingency	**600**	



TDR, known to DESY directorate

Total DESY costs ~ 300 EURO
→ DESY project urgently needed