Photon vetoes - Status report

Riccardo Fantechi (INFN Pisa)
for the Photon Veto Working Group

CERN, November 20th

The last report

- On May 3rd

  - Analysis of data from test beam in Frascati
  - Contacts with Protvino for scintillator
  - Status of Geant4 simulation
  - Simulation of the tagged photon beam for the run at CERN this summer
  - SAC prototype preparation

Where do we stand now?

- Large angle veto prototypes
- Simulation
- SAC prototype

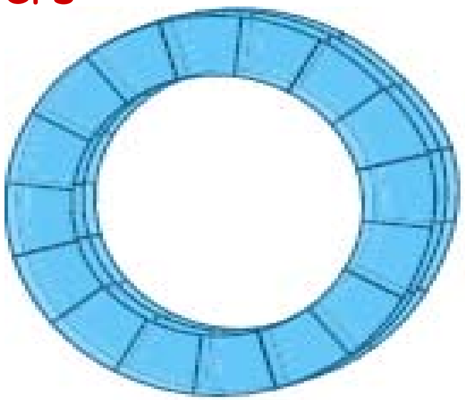
Large angle veto prototypes

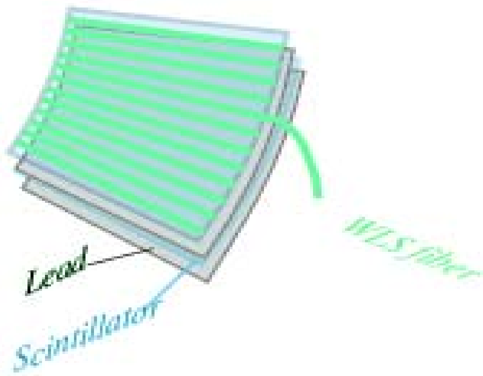
Large Angle Vetoes

- 12 counter rings, 4 different sizes, 28 m^2 surface
- Depth >17 X_0
- Have to operate in vacuum with extremely high efficiency
- Good time and energy resolution

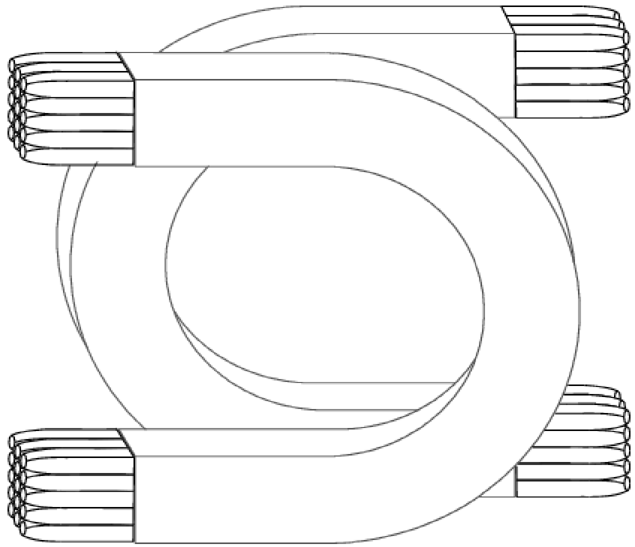
Still 2 technologies under study

16 modules/ring, structure with lead/scintillator tiles + WLS fibers

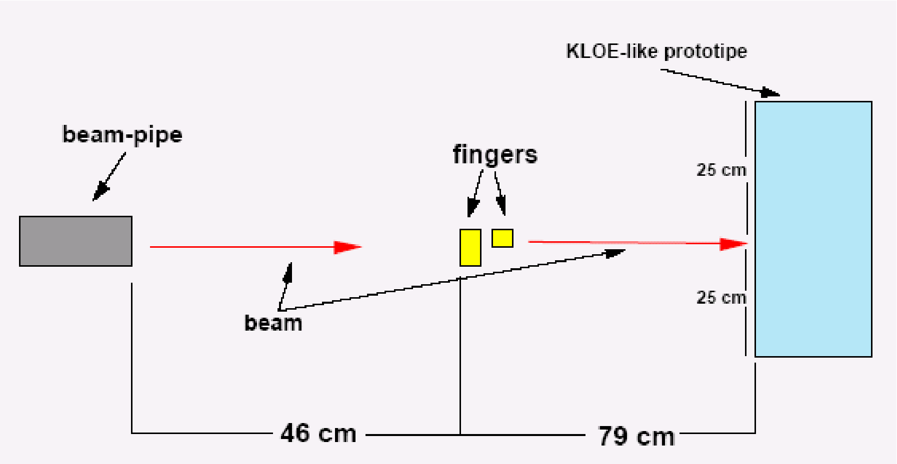




2 circular sectors/ring, structure with lead/scintillating fibers

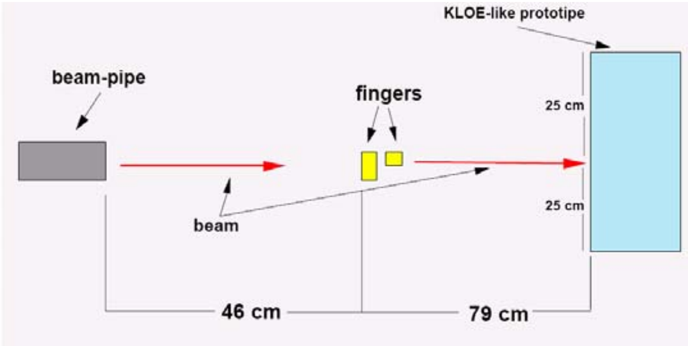


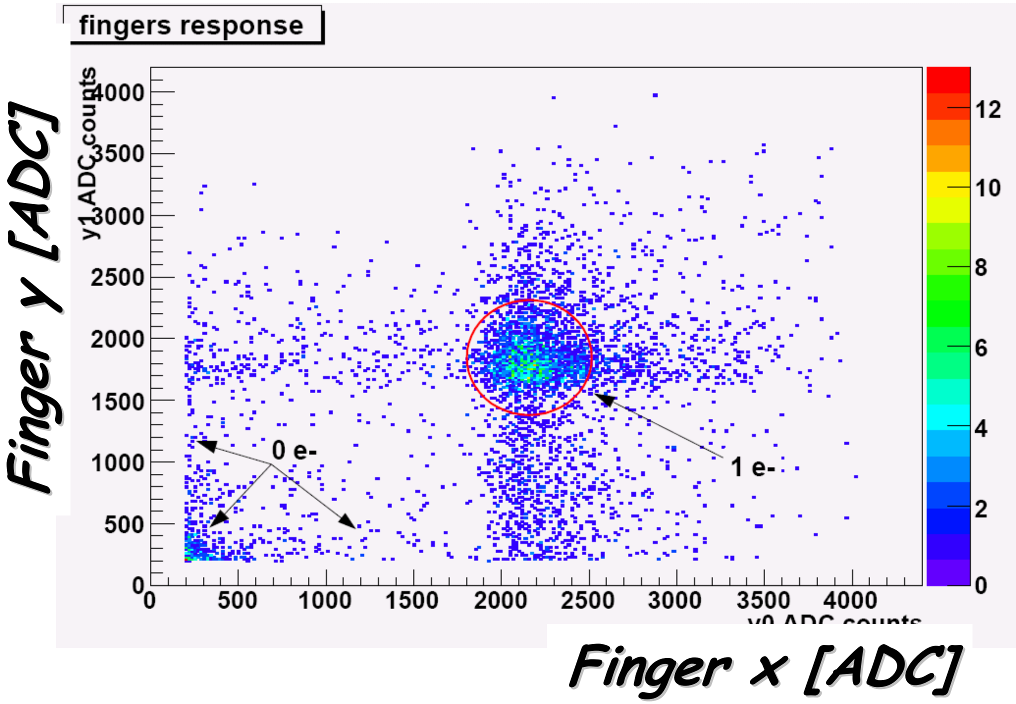
Efficiency with e^-

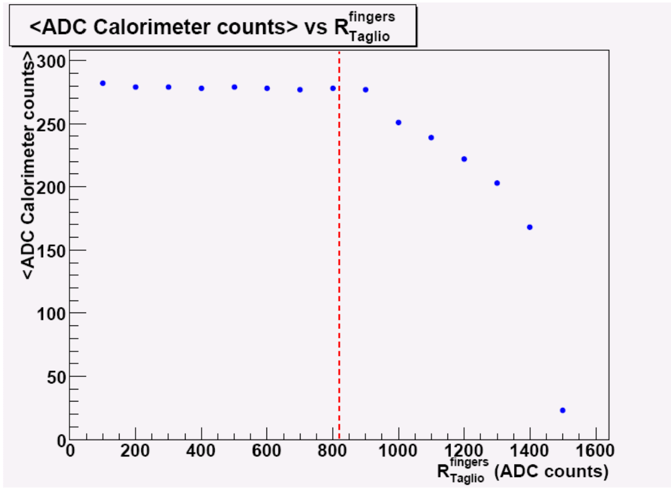


- Tag incoming electrons with 1 cm scintillator fingers
  - x and y
- Test in Jan./Feb. 2006:
  - test of tile [Protvino] and spaghetti [KLOE] prototypes
- Test in Jul. 2006:
  - devoted to γ-beam commissioning

Tagging incoming e^-





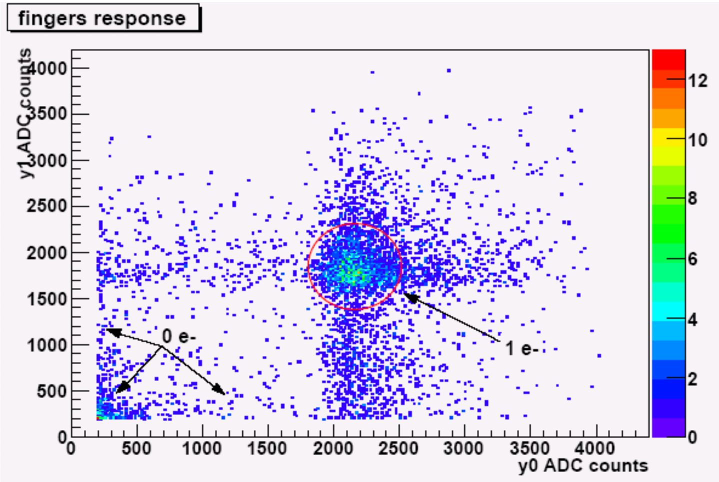


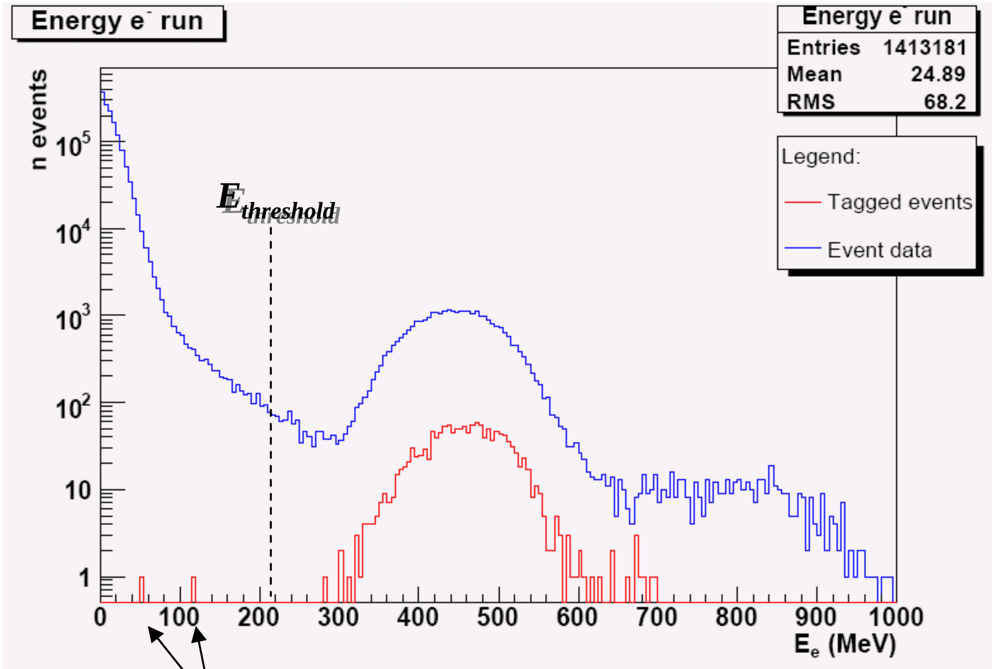
Evaluate **mistag** probability by changing radius of 1 e^- cut

KLOE prototype e⁻ inefficiency

E_e = 493 MeV

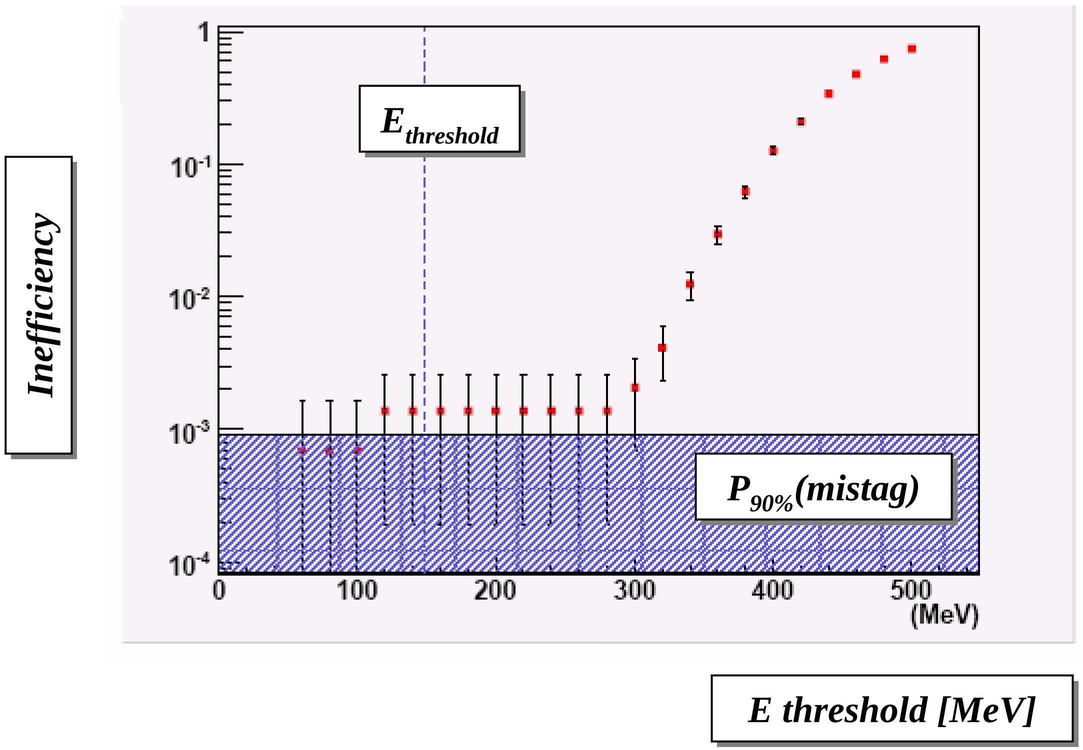
Tagged 1 e ⁻ events





Inefficient events

KLOE prototype e^- inefficiency

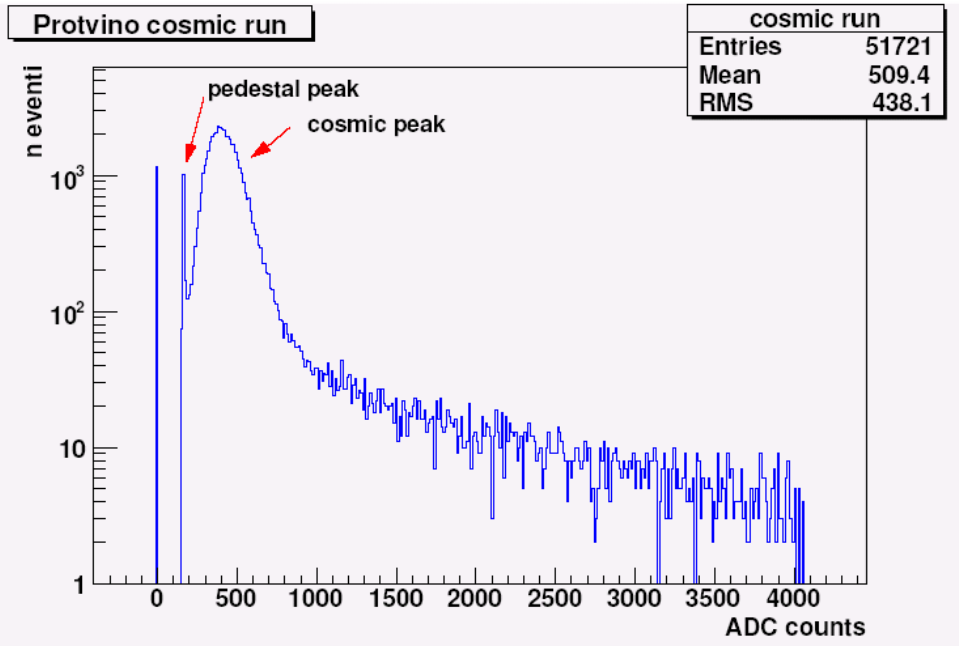


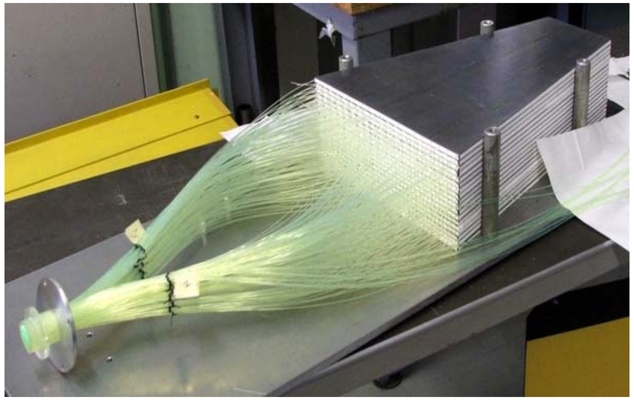
- Jan. '06 data confirm results of Jul.-Aug. '05 tests
- Inefficiency at the level of the mistag probability
- Hard to do better without "beam quality" improvements

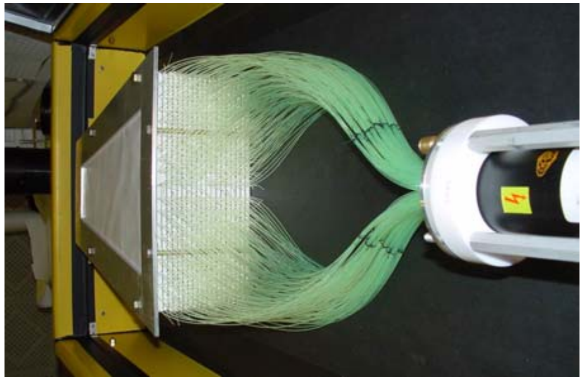
Tile prototype from Protvino

- Prototype with lead/scintillator tiles, read out by WLS fibers
- 20 layers: depth of » 3.8 X_0
- Read out: 1 green-extended PM

• Measurements with cosmic rays to obtain response map (validation of detailed MC simulation for the tile)



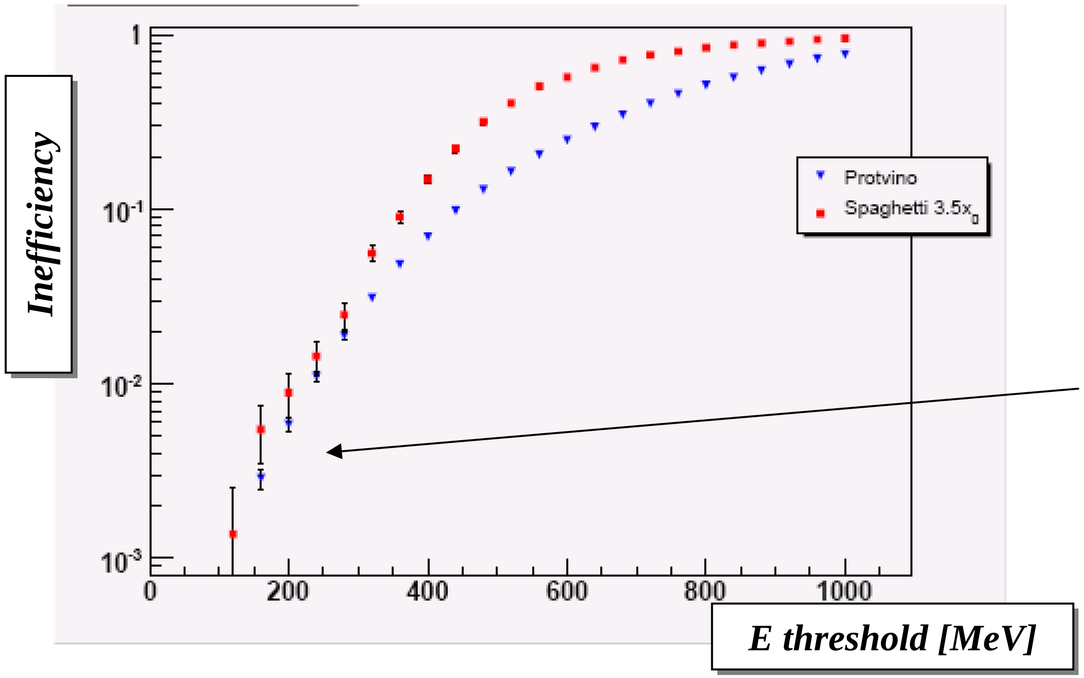




Tile inefficiency

- Only small Protvino prototype available, 3.8 X_0

- Try to compare to spaghetti, by looking only at the first cell of KLOE prototype [approximately same depth in X_0]

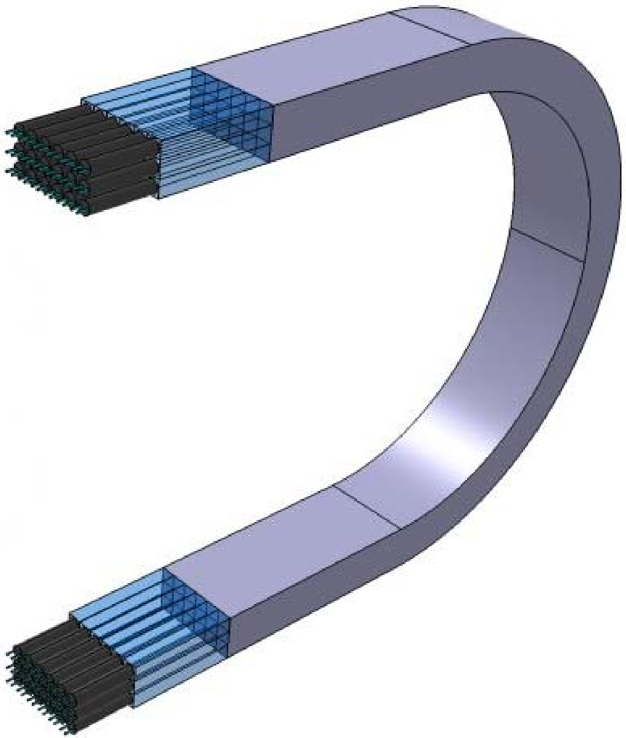


Difference is small in the low energy region

Prototypes

- Request to INFN to build a tile prototype in 2006
  - Suggestion by INFN referee to ask for the CKM prototype and to build in Italy a Kloe-like prototype
  - To be able to compare performances, mechanical details, understand costs and then choose a technology
- Start contacts with firms (Bicron, Kurarai) and collaborators (Protvino) to understand costs
  - For the spaghetti solution got offers for the total length (~6000 Km)
  - For the tile solution got an extrapolation from Bicron and a guess estimate from Protvino
  - Tiles are still the cheapest solution

Prototype characteristics: a reminder



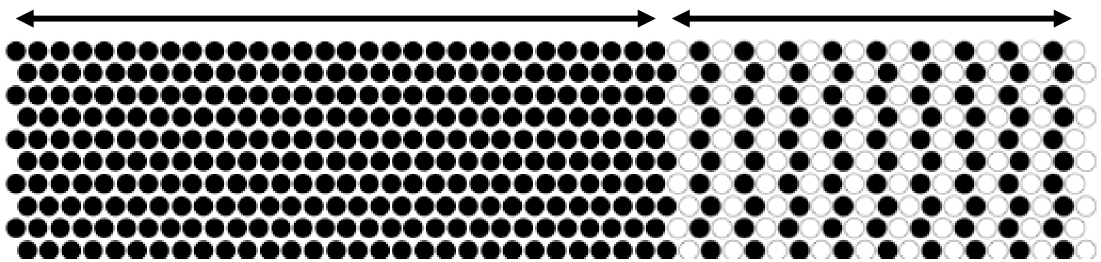
KLOE-type lead/scintillating fiber calorimeter

1-mm diameter scintillating fibers
0.5-mm thick lead foils

Inner/outer radius: 60 cm - 72.5 cm
Inner/outer length: 309.5 cm - 348.8 cm

Readout granularity: 18 cells, 4.2 x 4.2 cm2

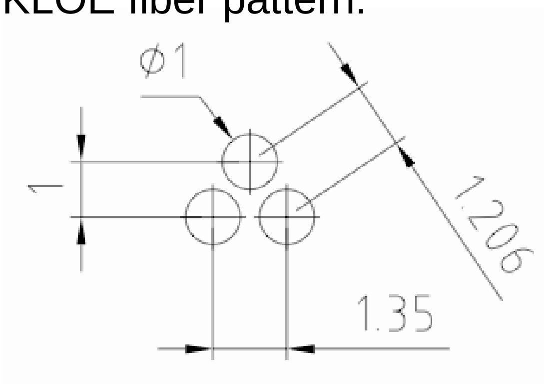
Depth: 25 cm, segmented



All fiber:
Same pattern as KLOE
~8 X_0

Fibers + 1-mm lead wires:
~9 X_0

KLOE fiber pattern:



Lead:fiber:glue = 42:48:10% vol.

Saddle and all equipment (e.g. rolling machine) moved to LNF AD machine shop

Organization for construction

Construction work requires at least 5 people

Morning: Assembly of planes

- Timeframe determined by pot-life of glue: approx. 2 hrs
- Max. planes in 2 hrs: about 6

Afternoon: Preparation of materials

- Ready for assembly following morning

Construction crew:

Antonella Antonelli (LNF)

Emilio Capitolo (LNF)

Luciano Iannotti (LNF)

Gianluca Lamanna (Pisa)

Matthew Moulson (LNF)

Vito Palladino (Napoli)

Tommaso Spadaro (LNF)

Paolo Valente (Roma1)

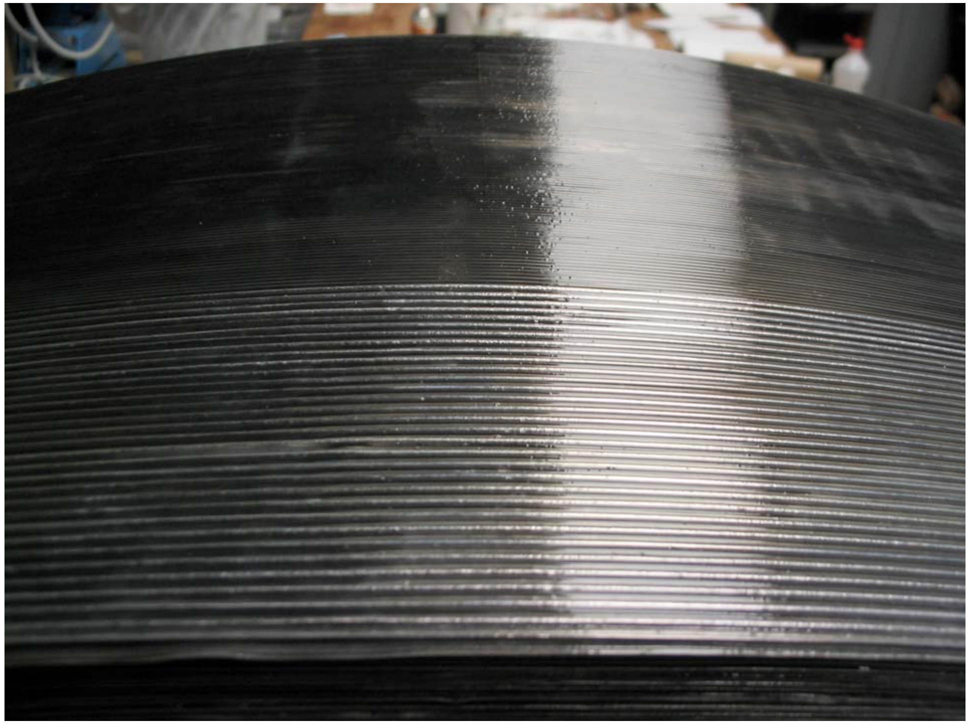
Construction steps

3. Place fibers on saddle and massage into place

- 120 fibers in fiber-only portion applied all at once
- 30 fibers in alternating region positioned one-by-one

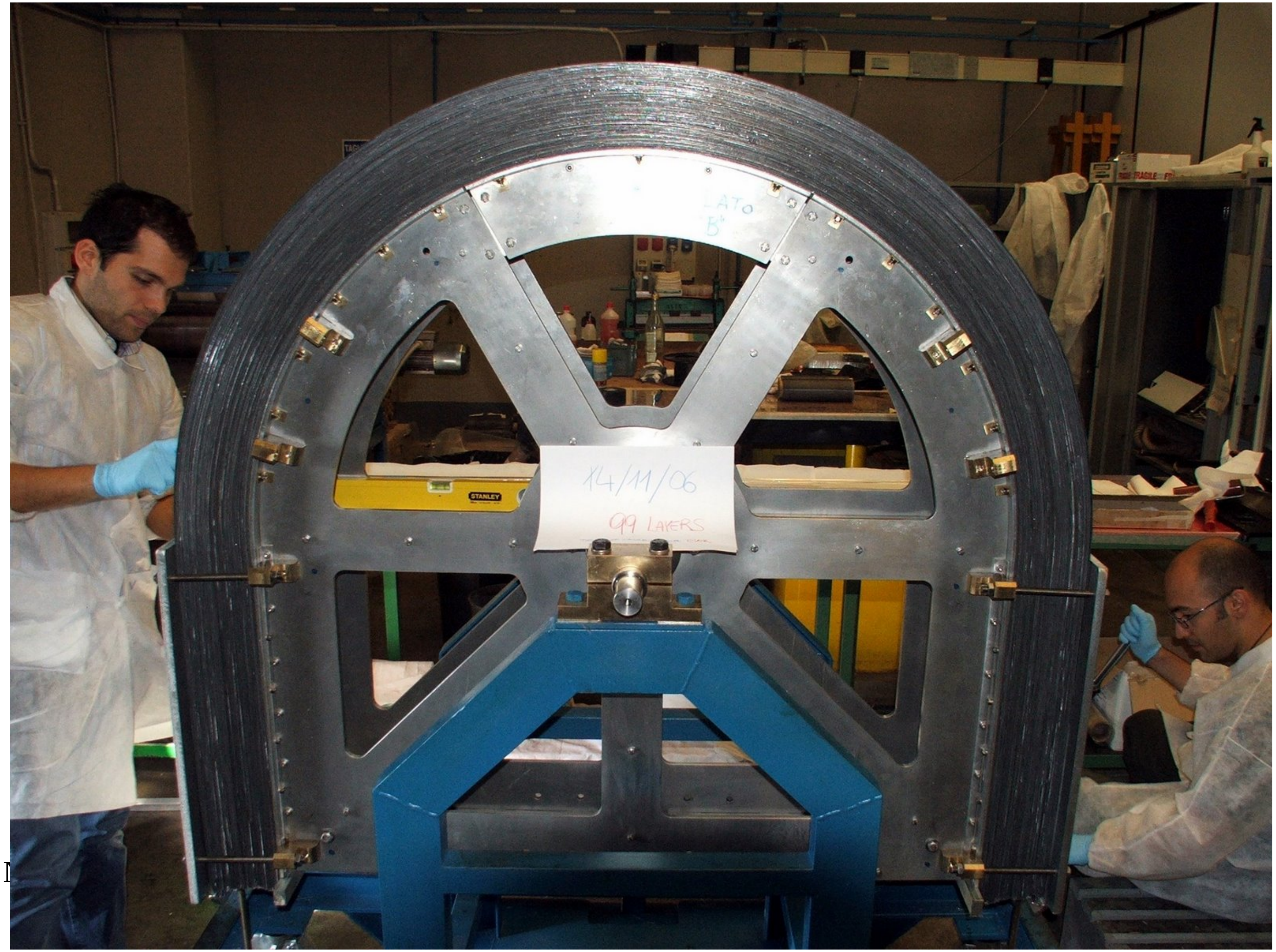
Construction steps

4. Fill gaps in alternating region with lead wires, one by one



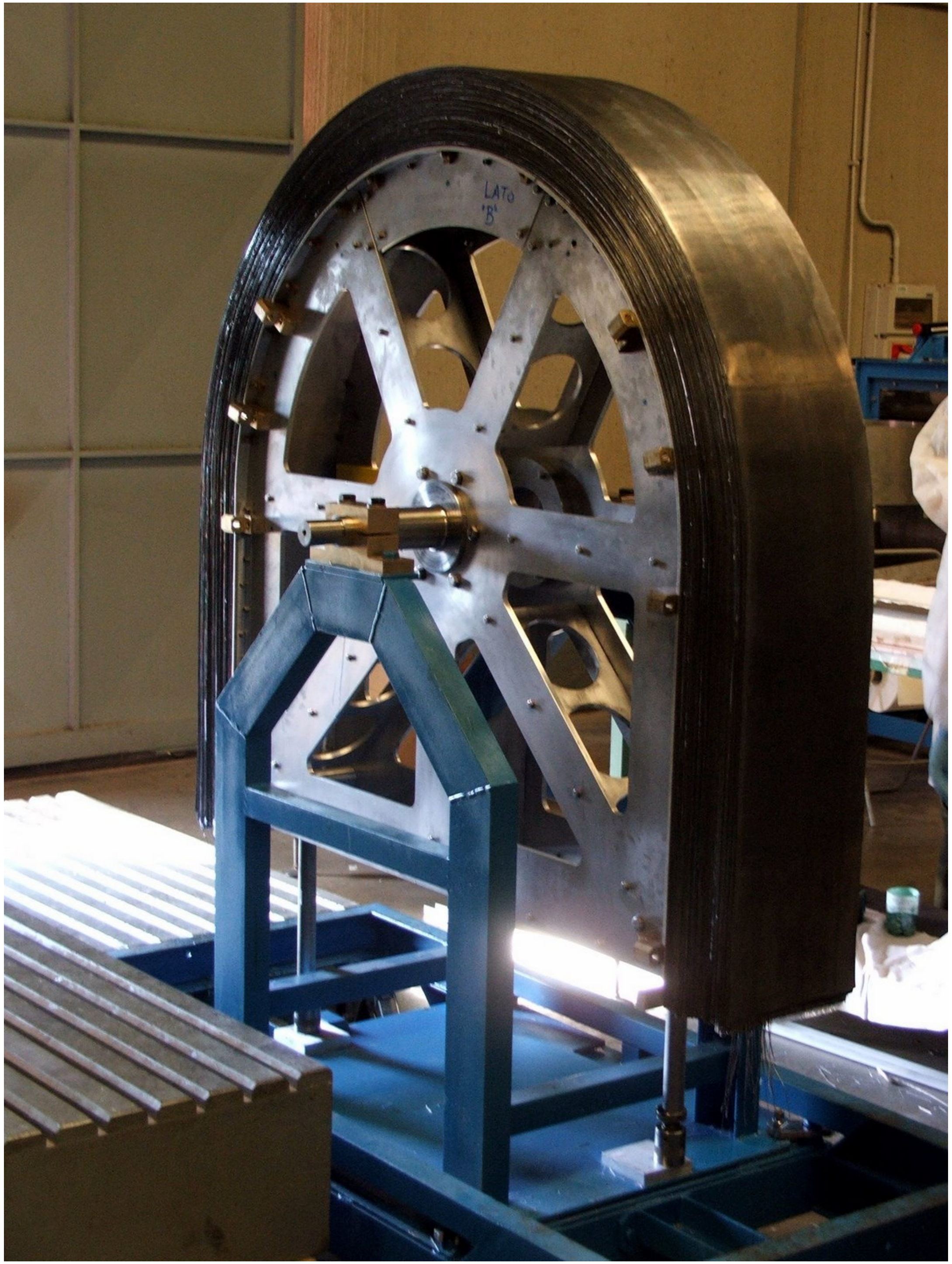
Lead wires are soft and crease easily: they cannot be smoothed into place many at a time

Current status



Prototype finished

Still to be milled



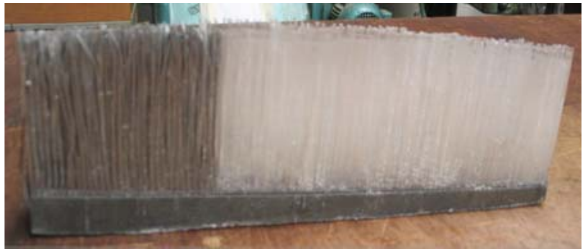
November 20th, 2006

Sample fill patterns

Examine fiber/wire filling patterns in pieces cut from ends of module

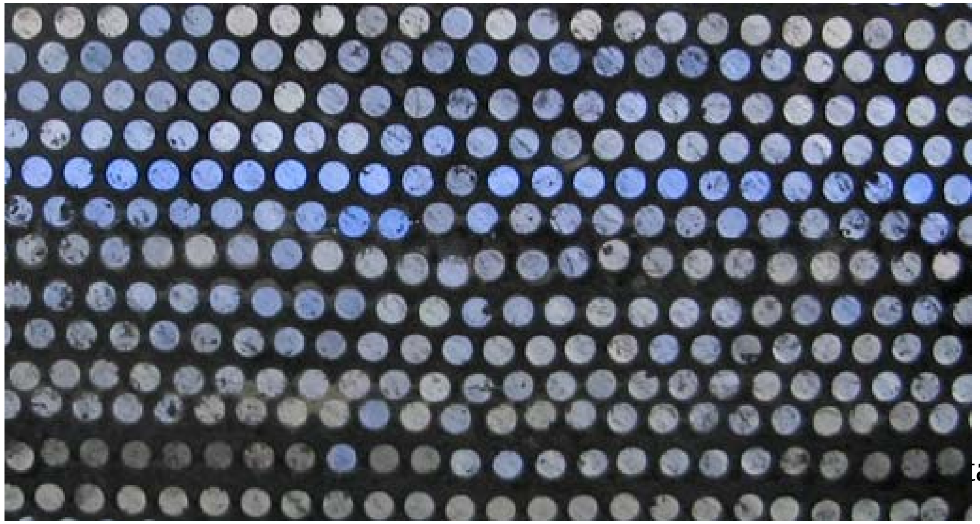
Interior of calorimeter is more regular:

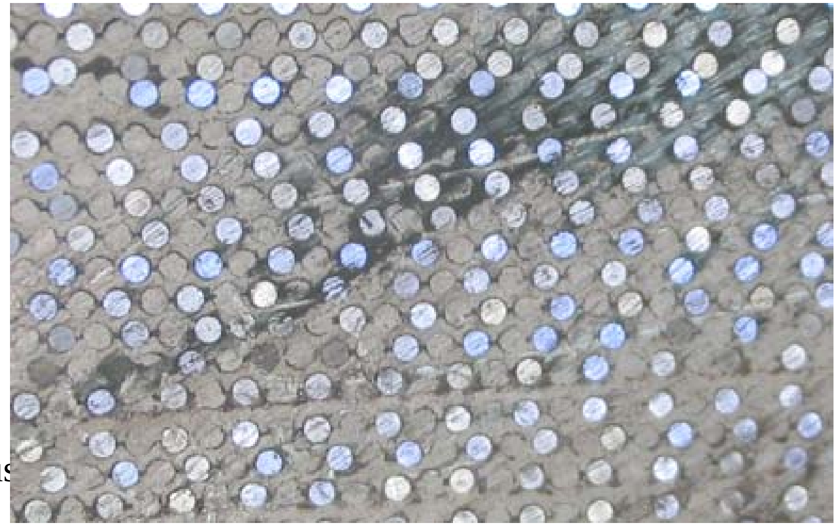
- Most misalignments at ends, grooves finish
- Excess at ends removed with rough saw
- No compression at very ends of module



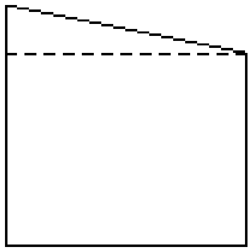
All-fiber region

Fibers + lead wires





Problems encountered

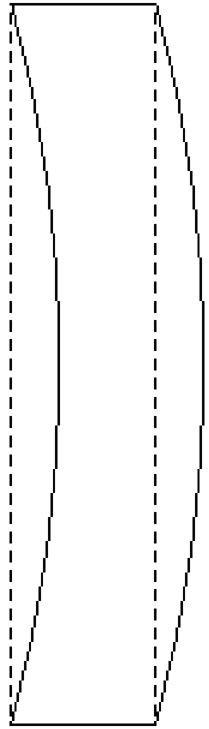


Layer thickness:

1.27 mm instead of nominal 1.16 → 99 planes instead of 108

Lead thickness after rolling differs by ~0.08 mm between edges

→ Alternate orientation of lead to absorb: net effect 2 mm/11 cm



Banana:

Foils exhibit banana as supplied!

- Not a result of rolling
- 1/3 of foils banana by ~2 cm
- Worst foils discarded

Causes misalignment of fibers and grooves:

- Correction applied by jumping grooves when placing lead foils

Banana effect can add coherently, at least locally (several planes):

- Inexact calorimeter geometry
- Surface unevenness at entering face

•"Partially solved pressing with force the foil while passing through the rolling machine

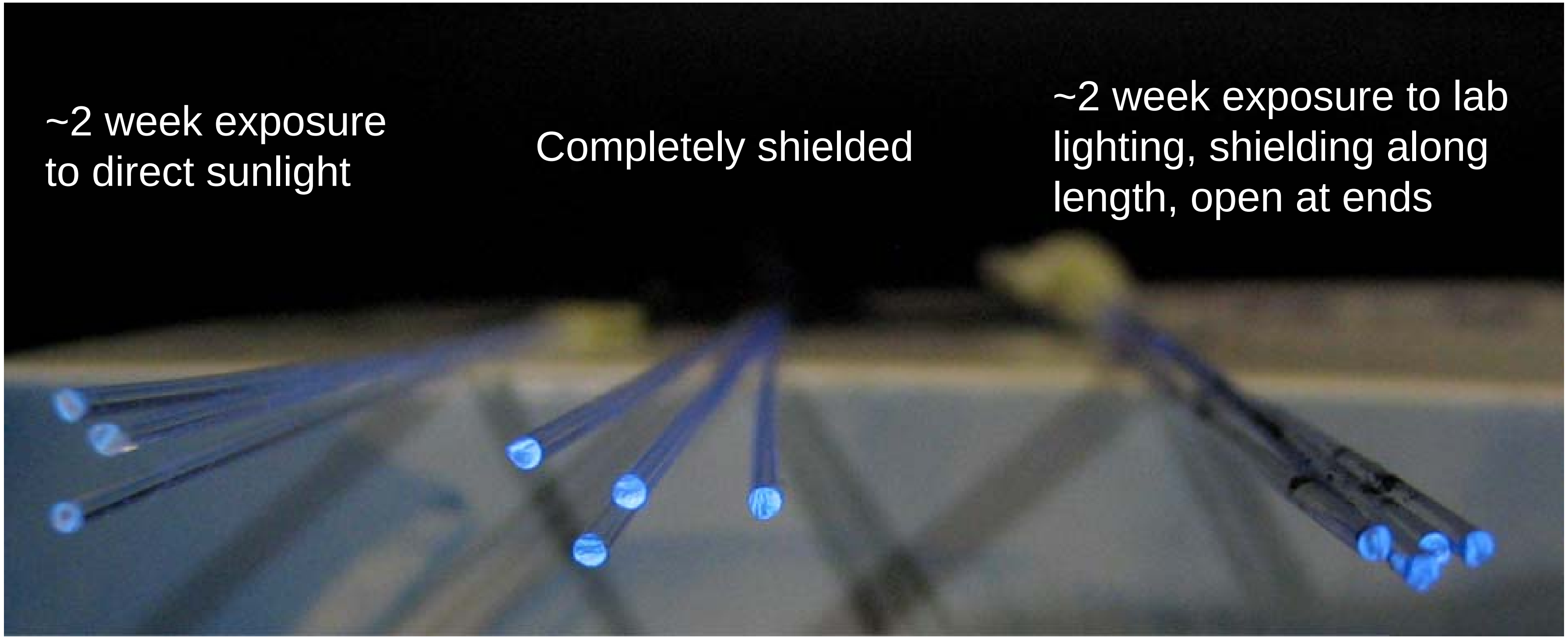
Are fibers damaged by light?

Some light damage observed in tests!

- Work with lights off
  Little fiber activity from natural light through windows
- Fibers and calorimeter covered with black neoprene blankets and boots
- Calorimeter spends most of the time in the dark anyway

NIM A482 364: KLOE calorimeter

Fluors and dyes are damaged by exposure to blue and near UV light. Kuraray fibers are particularly sensitive. A few days' exposure to daylight and industrial, i.e. mercury arc and similar light, severely reduces fiber quality [6]. Pol.Hi.Tech. fibers do not show similar losses of quality.



An open question: Surface milling?

Entering surface, face-on view

Photons incident on *edges* of lead foils

Surface is rather uneven

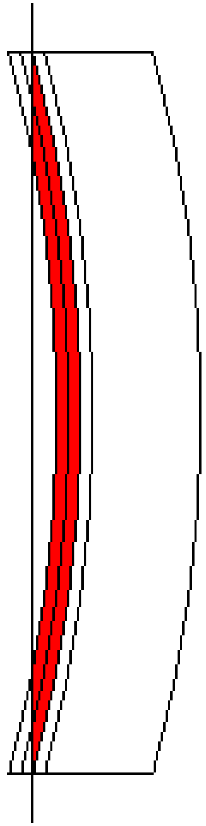
1st groove frequently unoccupied:
  → excess lead on front face

Try to remove by milling front face?

Because of banana problem, risk adding to dead material at center by cutting away ends of fibers near ends of module

We currently favor *not* milling front face

For production, milling faces could be a good idea if banana problem satisfactorily solved



Schedule and timescale

Construction	Finished
Milling	Can be done in 1 week Module returned by **end of November**
Light guides: preparation	Machining and polishing To be done at LNF while module is being milled Done by **end of November?**
Light guides: gluing	To be done at LNF, expect 1 week of work Done by **mid-December**
Mounting of PMTs	Need to make mounting hardware Depends on availability of machine shop Likely to complete by **early January**
Test beam	**To be scheduled**

CKM prototype

- Request to FNAL to have on loan the CKM prototype
  - 2 sectors
  - Sandwich 1mm Pb/5mm scintillator (Bicron)
  - Readout with Bicron WLS fibers and 8 PMs
- Official request September 2005
  - FNAL requested a Memorandum of Understanding
  - Sent by INFN to FNAL for signature in April 2006
- Long bureaucratic steps…
- As of now, it is packed in a box at FNAL
- Should be in Frascati at the beginning of 2007

Next test-beam

-Test the new spaghetti prototype

-Test the CKM prototype

- use electron and tagged photons
- compare response, inefficiency, time resolution,…

Improvements on the beam quality

- Greatly reduce e- mistag probability:
  - better charged halo veto or better tagging
- Use photon beam [with tagging!]

-Tuning to be done with beam-time during this and the next week

-Beam time soon scheduled for beginning of 2007

Next test-beam

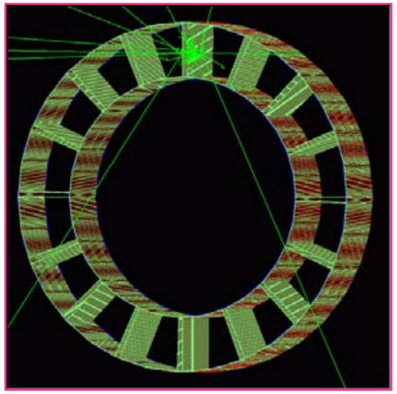
Radical modifications to BTF γ-tagging system completed (but not yet fully tested):

- improved mechanics
  - to reduce background from off-axis electrons
  - to reduce mistag
  - to improve tagging efficiency and resolution

- improved DAQ
  - no need of separate DAQ systems: reduce mis-match

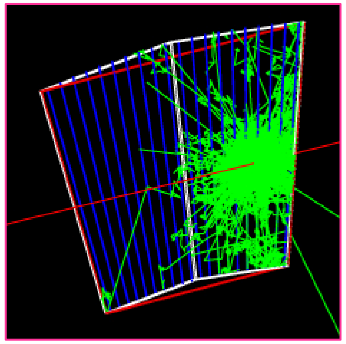
Simulation

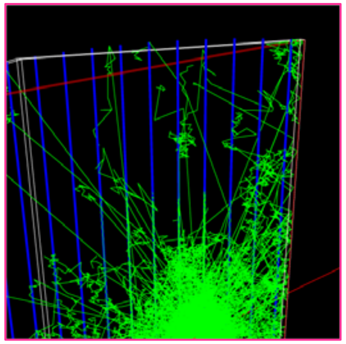
Simulations

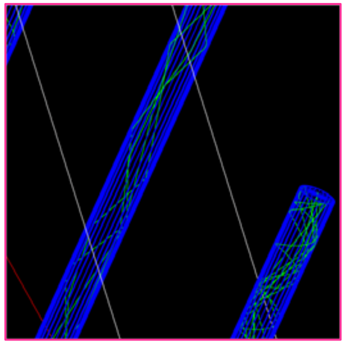


- G4 simulation of full Large angle veto
  - Full simulation of all veto rings, with **average photo-electron light-yield**

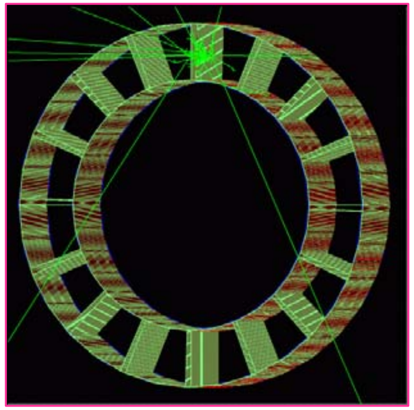
- G4 simulation of single tile
  - Detailed simulation of one single tile, including optical photon transport in scintillator and fibers, reflections on wrapping, photocathode Q.E., etc.
  - The goal is to have a matrix of response to be inserted in the full simulation as a parametrization





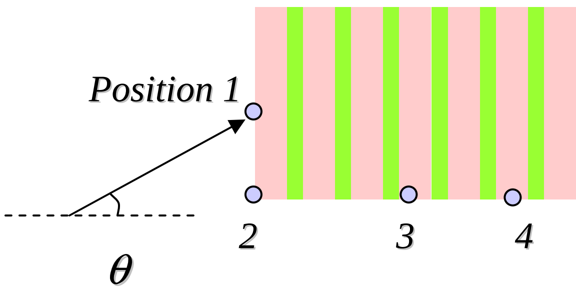


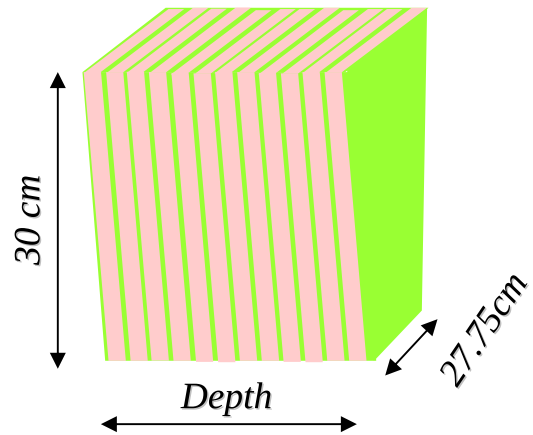
Simulations: full veto



3 different Scint/Pb sampling vs 2 depths

Config.	Depth [cm]		Sampling	Total X_0
	Scint.	Pb	$n_{Scint} \times d_{Scint} + n_{Pb} \times d_{Pb}$	
A1	42	8	80× 5 mm+80× 1mm	
A2	42	8	40× 10+40× 2	15.28
A3	42	8	160× 2.5+160× 0.5	
B1	47	9	90× 5+90× 1	
B2	47	9	45× 10+45× 2	17.18
B3	47	9	180× 2.5+180× 0.5	

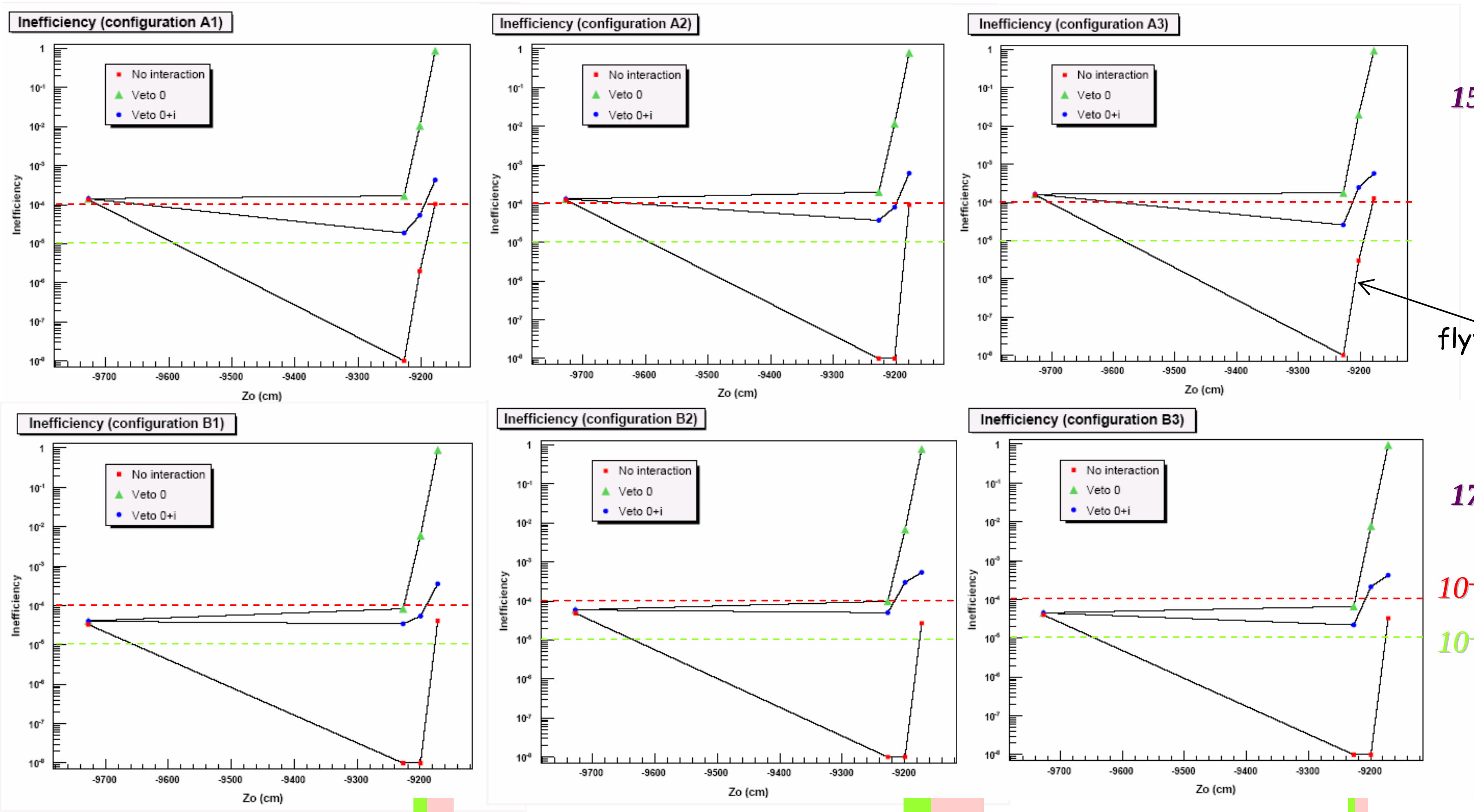




Inefficiency vs. depth

$\theta = 36$ mrad

$E_\gamma = 100$ MeV



$15.28\ X_0$

$17.18\ X_0$

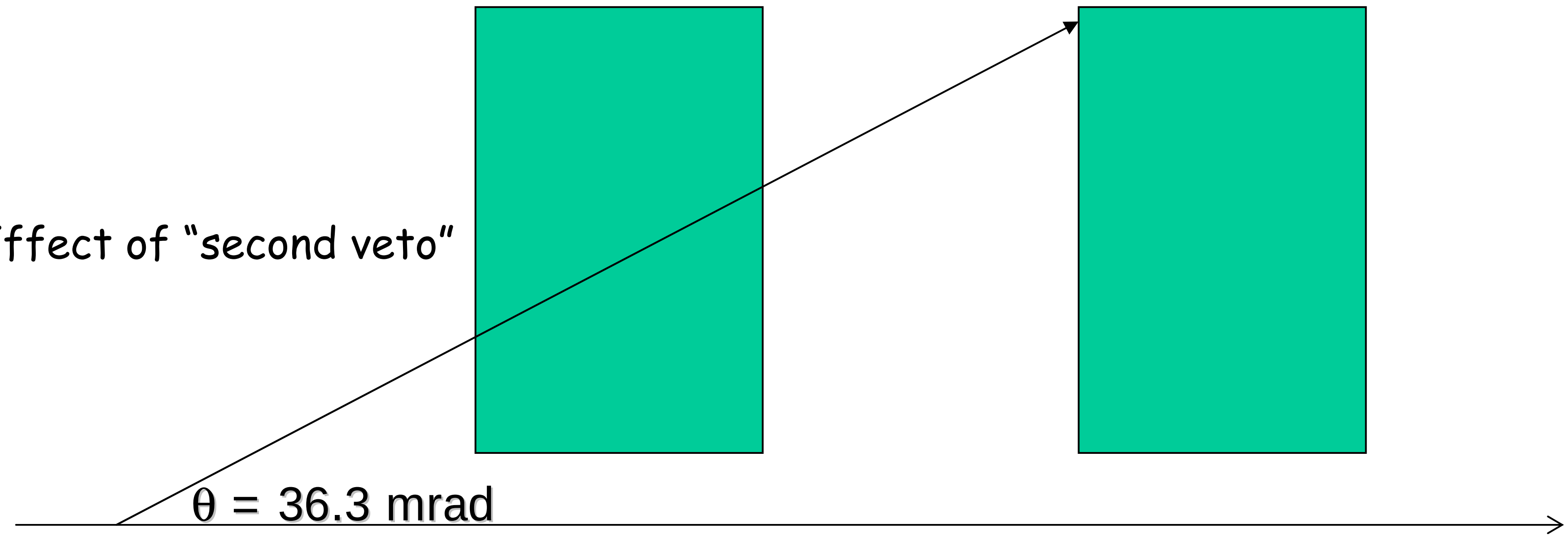
10^{-4}

10^{-5}

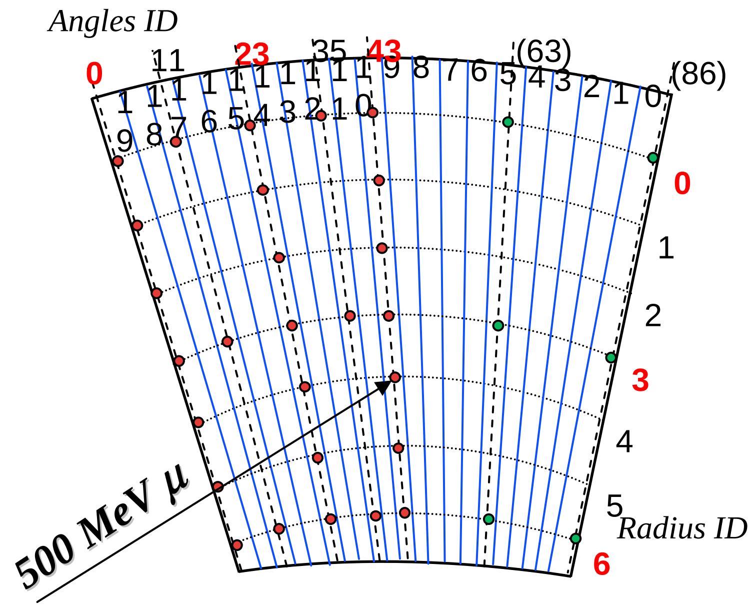
Inefficiency vs. depth (2)

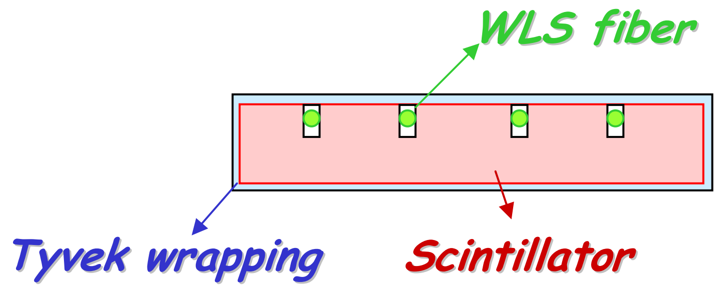
- I_{veto0}
  - Number of events where γ was not seen by first veto / Total events
- $I_{veto0+I}$
  - Number of events where γ was not seen by any veto / Total events
- $I_{nointeraction}$
  - Number of events where γ did not interact (flythrough) / Total events

Effect of "second veto"

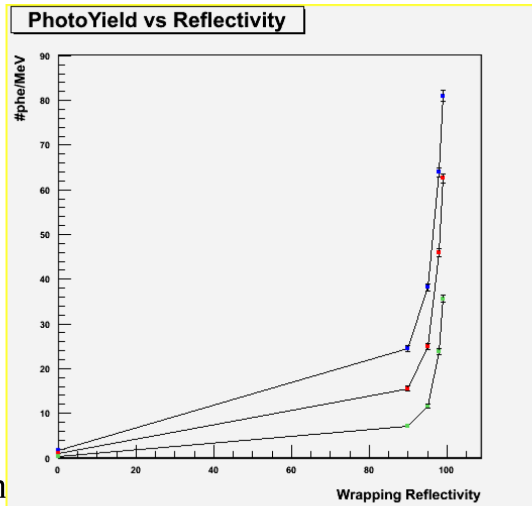


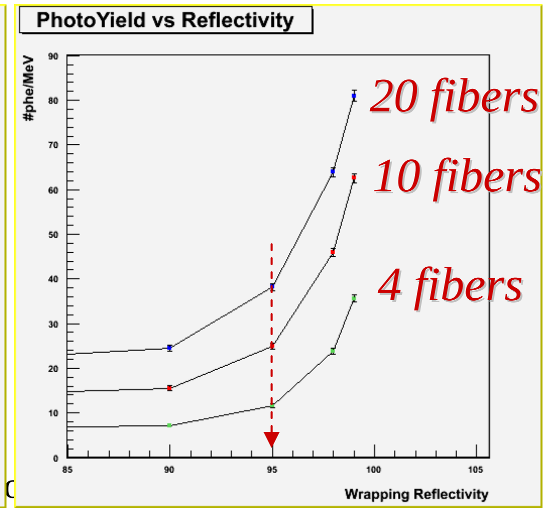
Tile simulation (1)





As one could expect, strong dependance of total light-yield on wrapping **reflectivity** and on **number** of readout WLS **fibers**

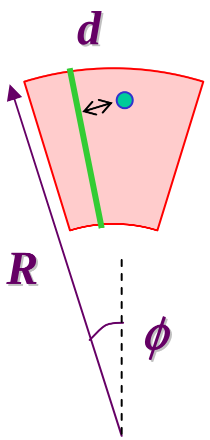




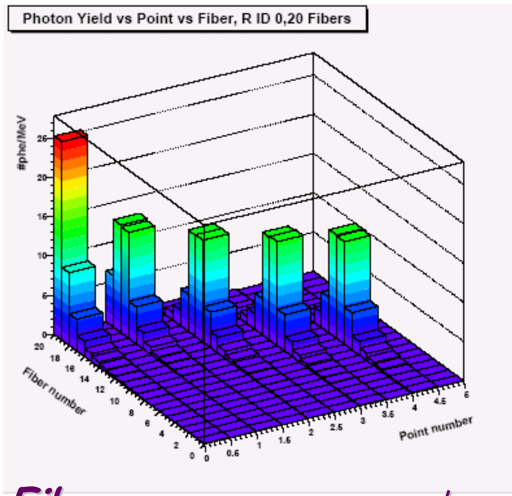
Y-axis is the number of ph.el./MeV collected at the PM

R=95% as reference

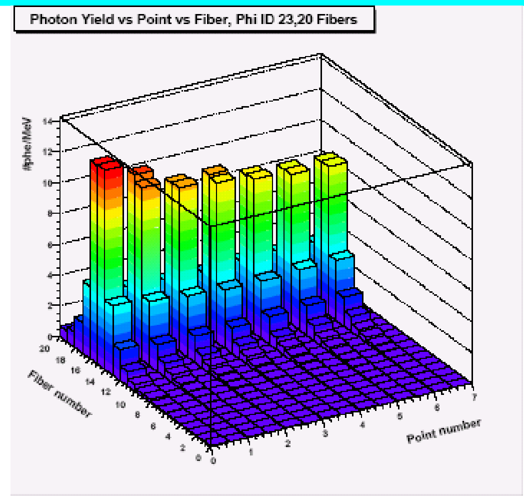
Tile simulation (2)



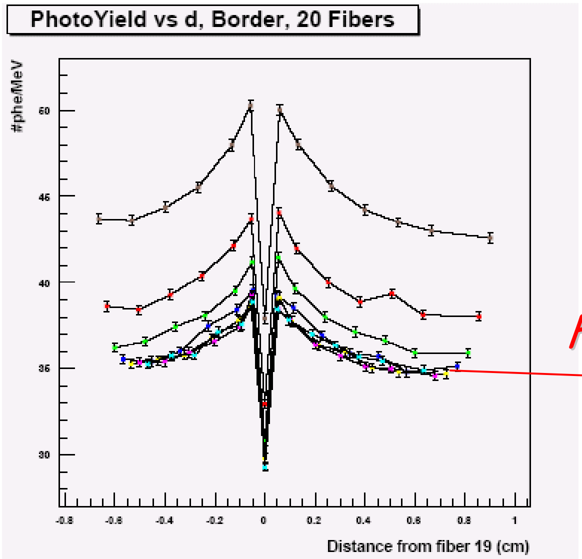
d = *distance from impact point*



Fibers response vs. ϕ

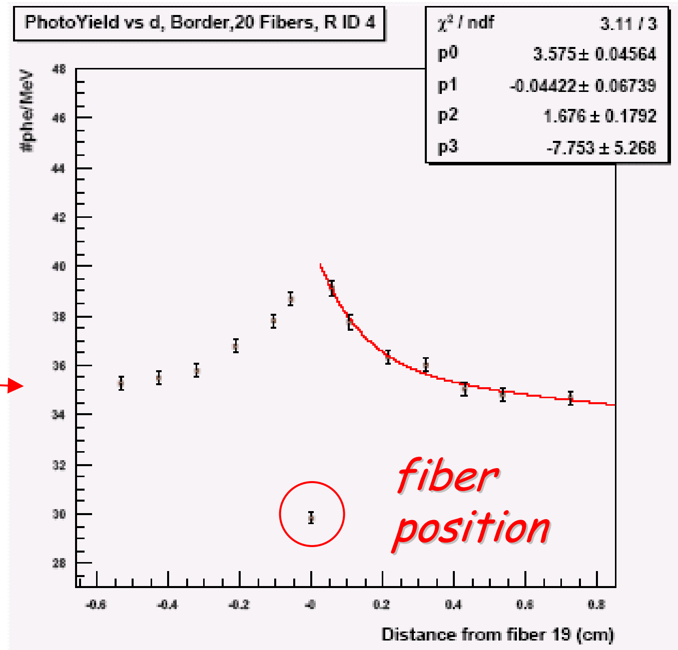


Fibers response vs. R

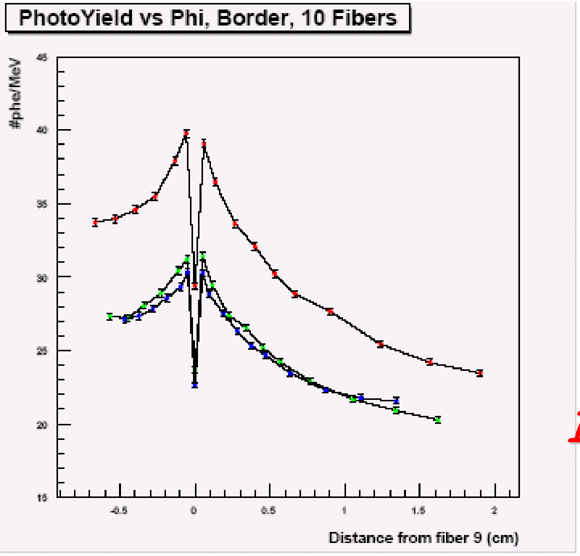


Fiber response vs. d [at different R]

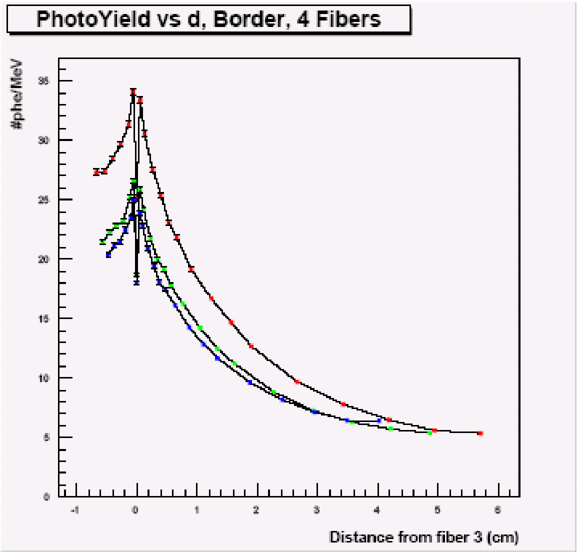
Fit of 1 curve



Tile simulation (3)



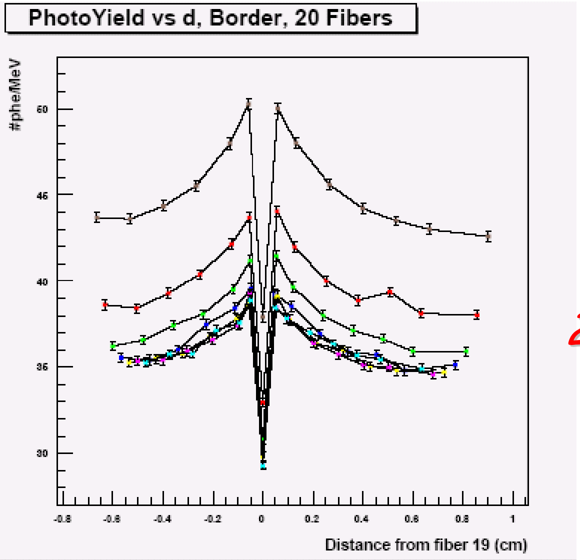
10 fibers



4 fibers

Fiber response vs. d

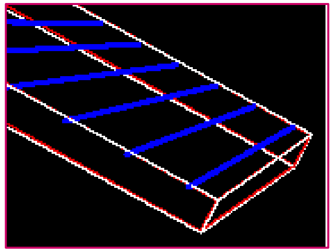
[at different R]

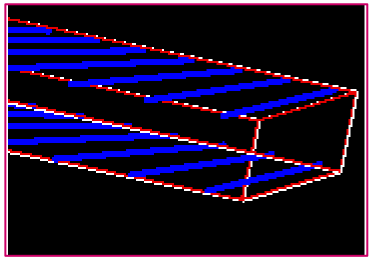


20 fibers

What's next?

- Change fiber layout
- Change scintillator depth

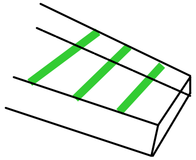




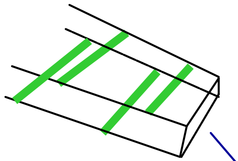
Tile yield

#phe/MeV

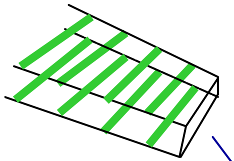
fibers on "1 side"



"2 sides staggered"



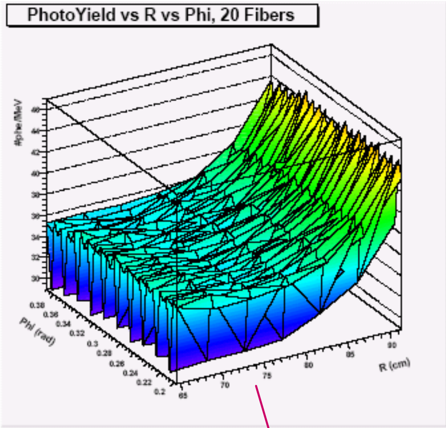
"2 sides"

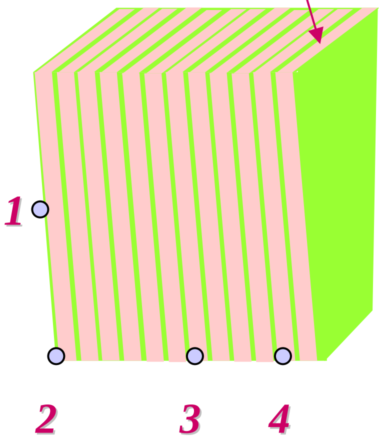


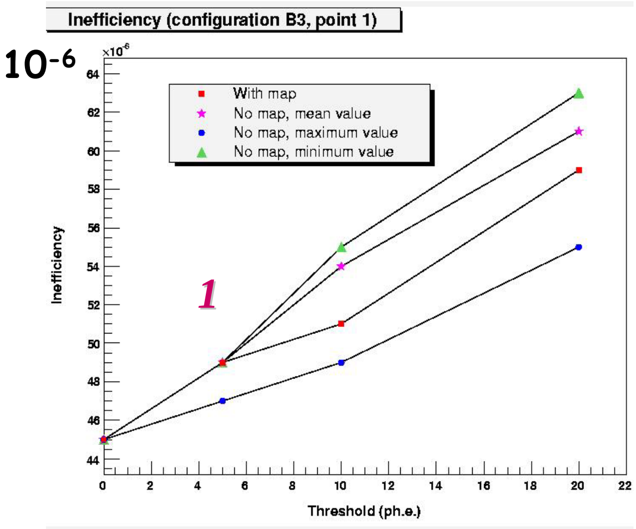
	2.5 mm	5 mm	10 mm	20 mm
4 fibre		27.3 ± 0.2, 6.8 ± 0.1, 4.7 ± 0.1 21.4 ± 0.2, 6.2 ± 0.1, 4.6 ± 0.1 20.4 ± 0.2, 7.3 ± 0.1, 5.6 ± 0.1		
10 fibre		33.7 ± 0.3, 27.6 ± 0.2, 21.9 ± 0.2 27.3 ± 0.2, 23.4 ± 0.2, 19.3 ± 0.2 27.1 ± 0.2, 23.6 ± 0.2, 20.5 ± 0.2		
20 fibre	34.3 ± 0.3, 31.8 ± 0.3, 31.8 ± 0.3 29.3 ± 0.2, 27.9 ± 0.2, 27.2 ± 0.2 30.3 ± 0.2, 29.2 ± 0.2, 29.0 ± 0.2	43.7 ± 0.3, 43.0 ± 0.3, 43.3 ± 0.3 35.6 ± 0.3, 35.8 ± 0.3, 35.7 ± 0.3 35.3 ± 0.3, 35.3 ± 0.3, 36.2 ± 0.3	44.6 ± 0.3, 44.9 ± 0.3, 45.3 ± 0.3 36.7 ± 0.3, 37.6 ± 0.3, 37.6 ± 0.3 36.1 ± 0.3, 36.9 ± 0.3, 37.2 ± 0.3	31.5 ± 0.3, 32.4 ± 0.3, 32.8 ± 0.3 26.6 ± 0.2, 27.4 ± 0.2, 27.3 ± 0.2 25.1 ± 0.2, 25.6 ± 0.6, 25.8 ± 0.2
19 fibre		43.0 ± 0.3, 43.3 ± 0.3, 37.3 ± 0.3 35.1 ± 0.3, 35.2 ± 0.3, 29.8 ± 0.2 35.2 ± 0.3, 35.1 ± 0.3, 28.9 ± 0.2	43.6 ± 0.3, 44.1 ± 0.3, 40.9 ± 0.3 36.3 ± 0.3, 36.3 ± 0.3, 34.0 ± 0.3 35.7 ± 0.3, 36.1 ± 0.3, 32.8 ± 0.3	39.7 ± 0.3, 39.8 ± 0.3, 39.2 ± 0.3 34.8 ± 0.3, 35.3 ± 0.3, 34.1 ± 0.3 33.2 ± 0.3, 34.0 ± 0.3, 32.6 ± 0.3
40 fibre		64.9 ± 0.4, 64.8 ± 0.4, 63.6 ± 0.4 50.0 ± 0.3, 50.1 ± 0.3, 50.2 ± 0.3 49.4 ± 0.3, 50.3 ± 0.3, 50.1 ± 0.3	67.7 ± 0.4, 68.4 ± 0.4, 68.6 ± 0.4 54.1 ± 0.3, 55.0 ± 0.3, 55.1 ± 0.3 51.7 ± 0.3, 52.5 ± 0.3, 53.6 ± 0.3	63.3 ± 0.4, 64.8 ± 0.4, 65.3 ± 0.4 53.3 ± 0.3, 54.7 ± 0.3, 54.8 ± 0.3 50.2 ± 0.3, 51.6 ± 0.3, 51.9 ± 0.3

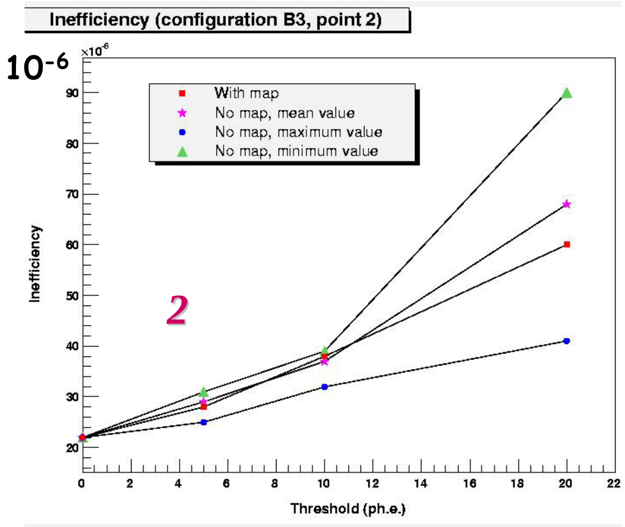
Veto Inefficiency with map

- Insert response map in veto simulation as light yield/released energy
- Evaluate veto inefficiency for E_γ=100 MeV and compare with average



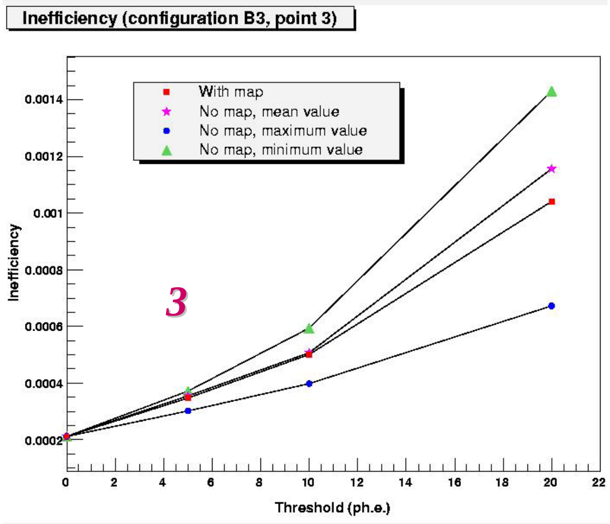


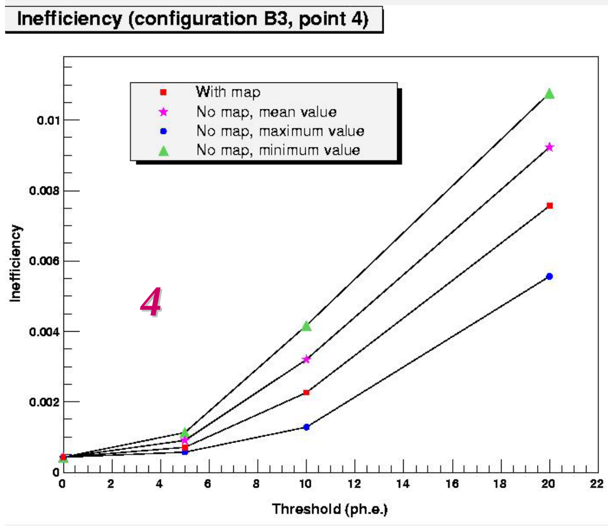




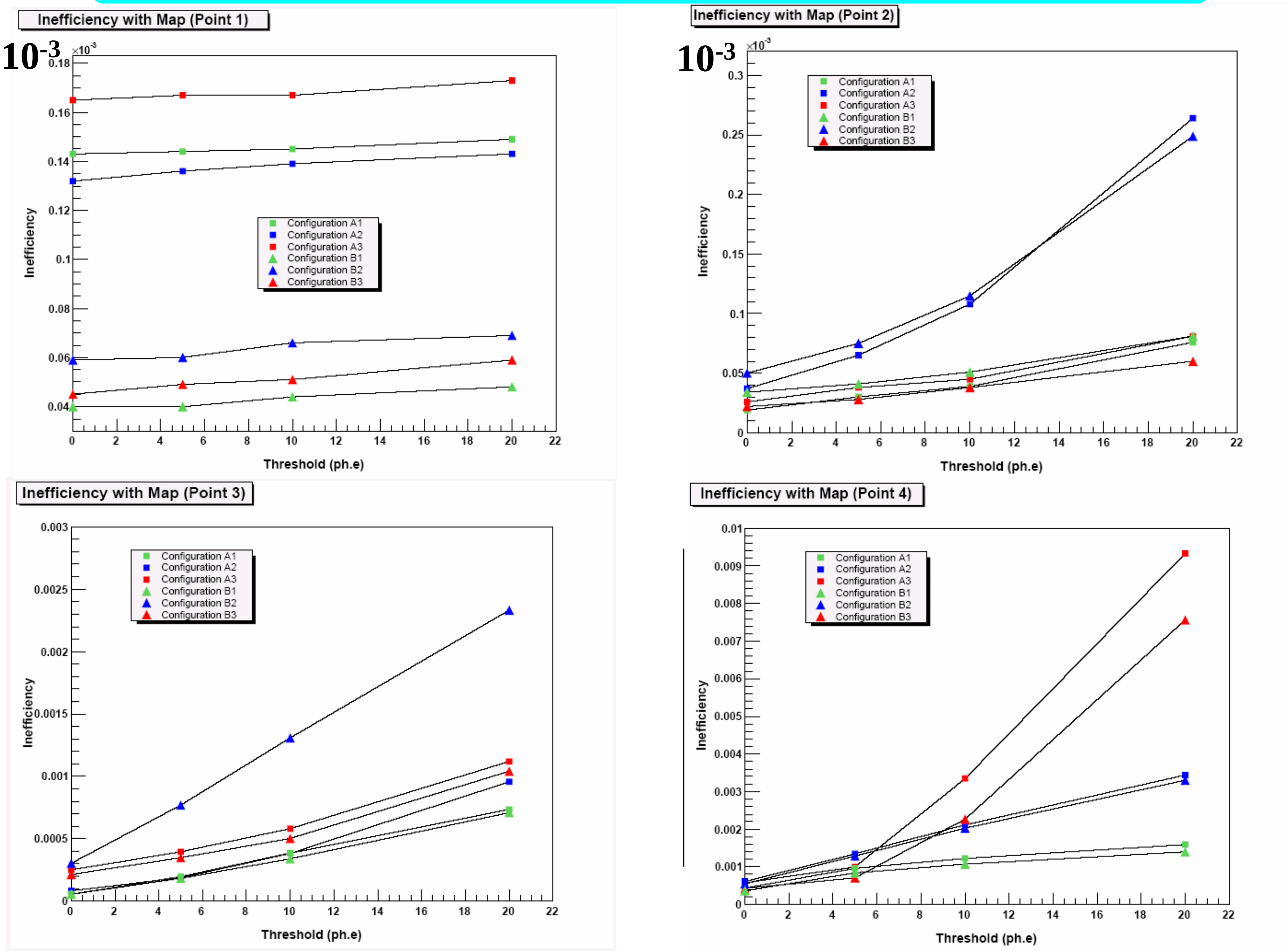
X_0 = 17.18

B3: 180×2.5 (Sci)+180×0.5 (Pb)





Inefficiency vs Sampling

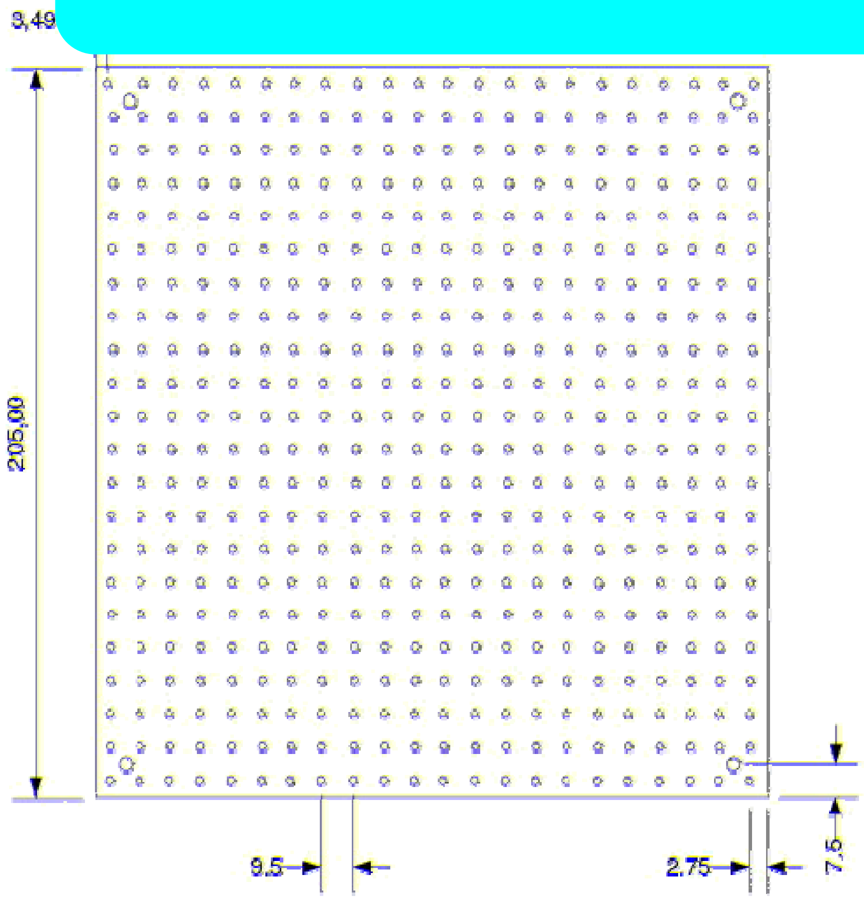


Small Angle Calorimeter prototype

SAC – Shashlyk type

- The idea is to construct a prototype of SAC as close as possible to the final design. Also "by product" to have identical approach for the IRC.
- Proposed structure and parameters:
  - SAC geometry:
    - active area 20x20cm2 + shower size~ 24-25 cm2
    - Depth of ~17 X0 to have "punch through" eff. less than 10^-5
    - Sampling layers of 1.5mm Sci +1.5mm Lead -> X_0 =12.5mm ,
    - R_m =27mm
  - WLS fibres : 1mm Y-11(250)MSJ (Kuraray)
  - Pitch between holes is 9.5 mm
  - Time response is defined by WLS fiber type: Y-11 decay time is 10nsec + signal shaping in the read-out.
  - Expected light yield estimate is ~9 photons/MeV.

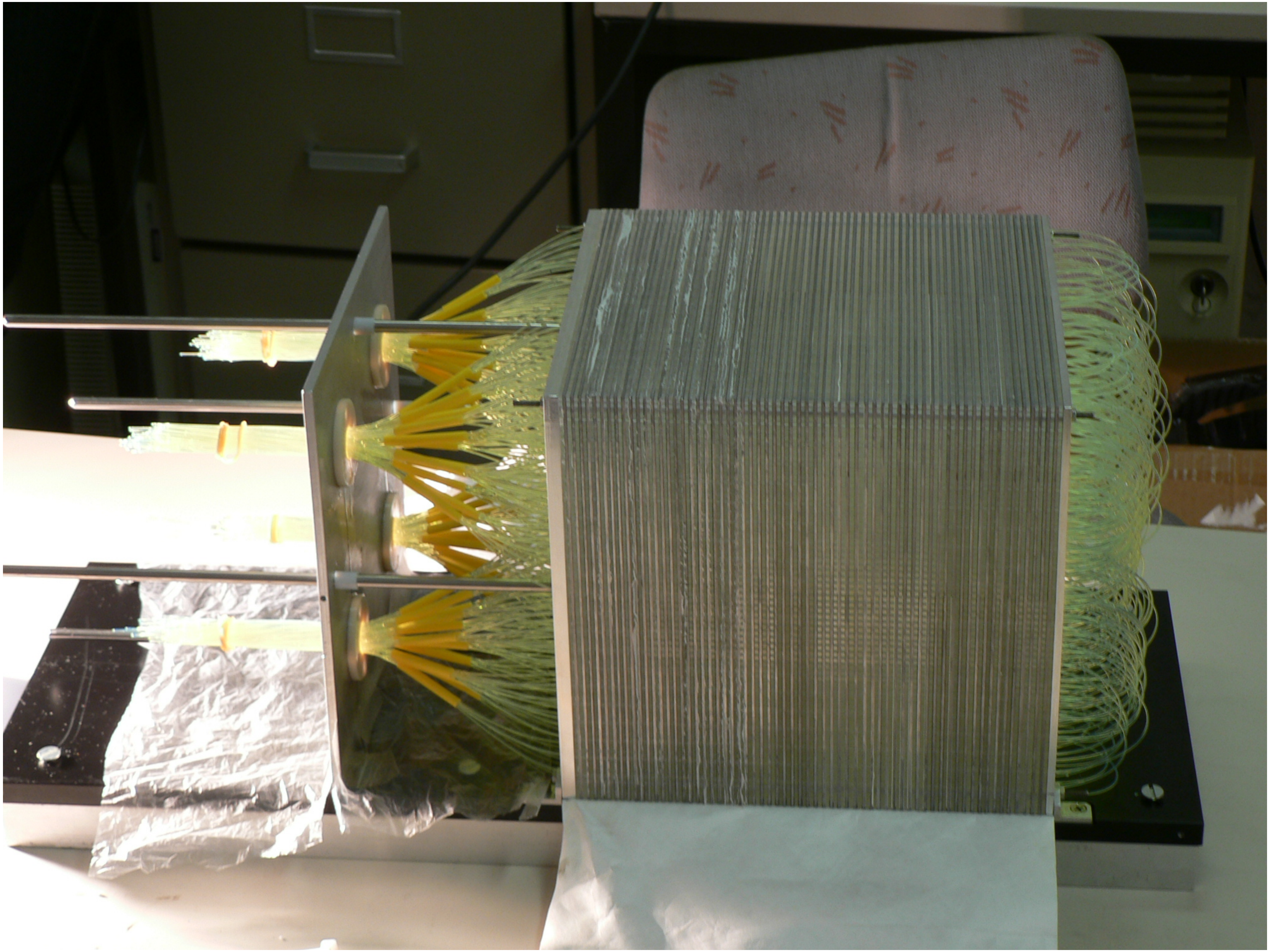
SAC design

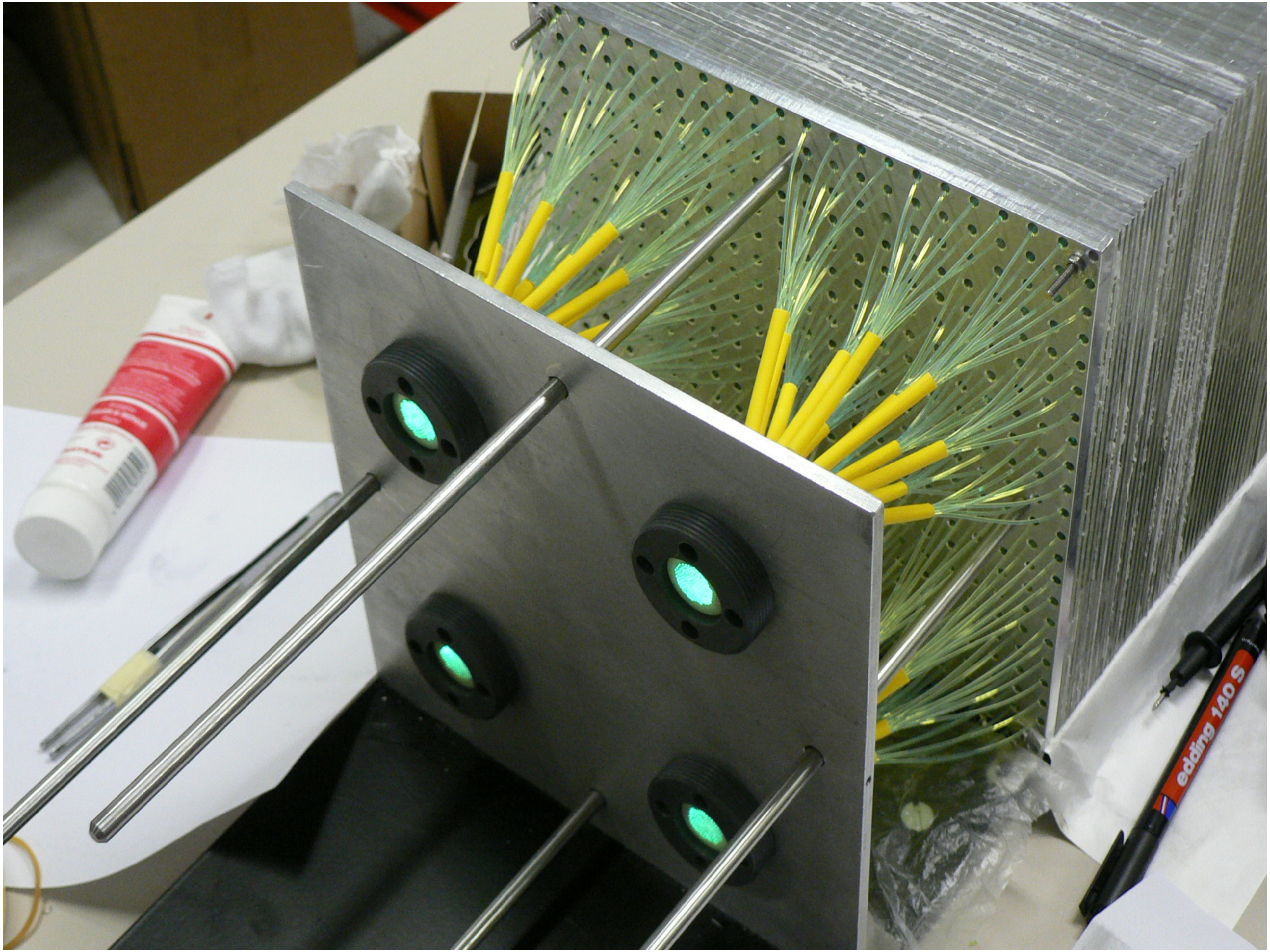


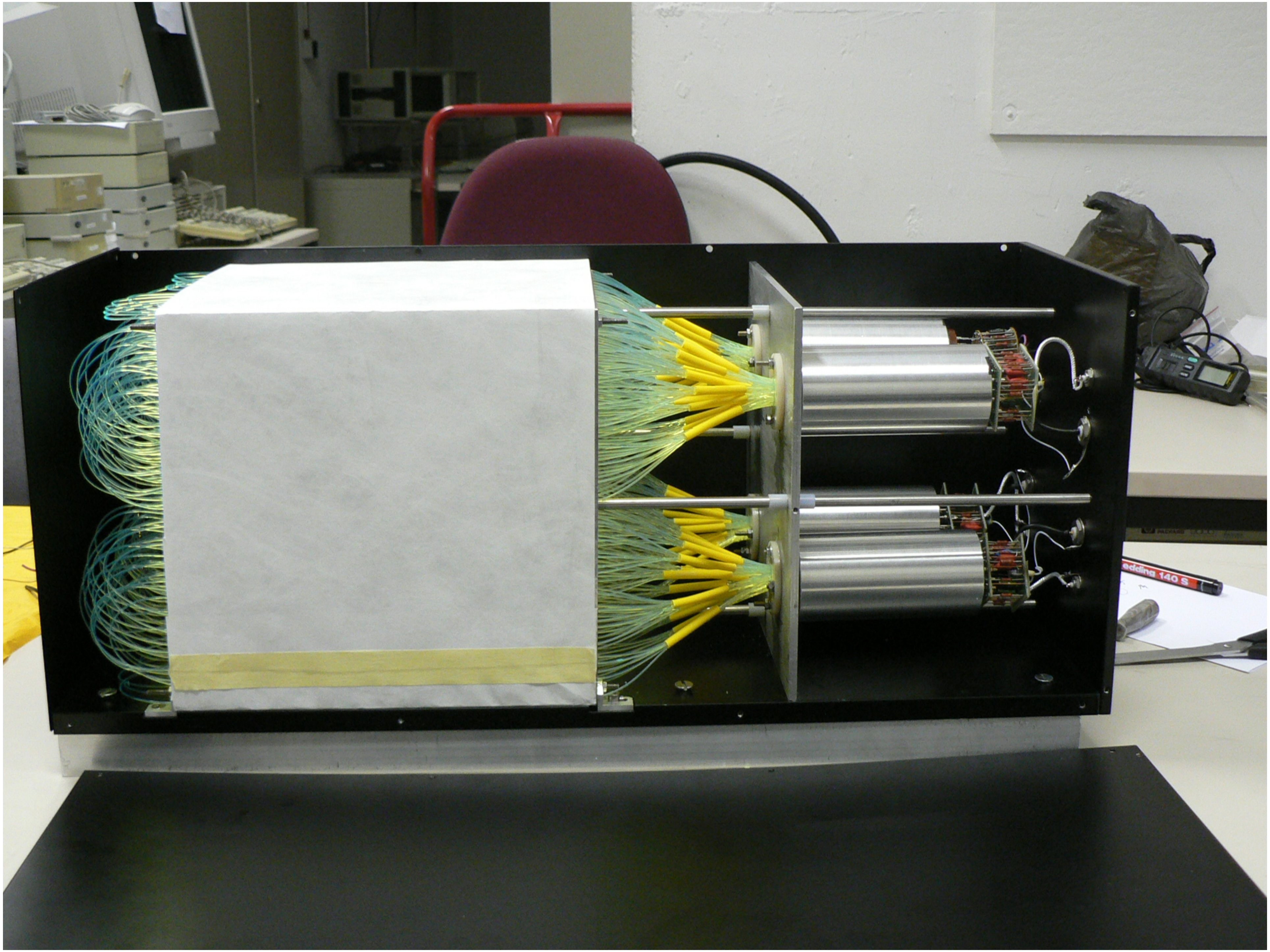
Scintillator dimensions:
size= 205 x 205, mm
holes: d=1.4 mm, pitch=9.5 mm

Lead dimensions:
size= 205 x 205, mm
holes: d=1.5 mm, pitch=9.5mm

Al front and back plates:
holes: d=3 mm
thickness front= 4 mm, back =8 mm



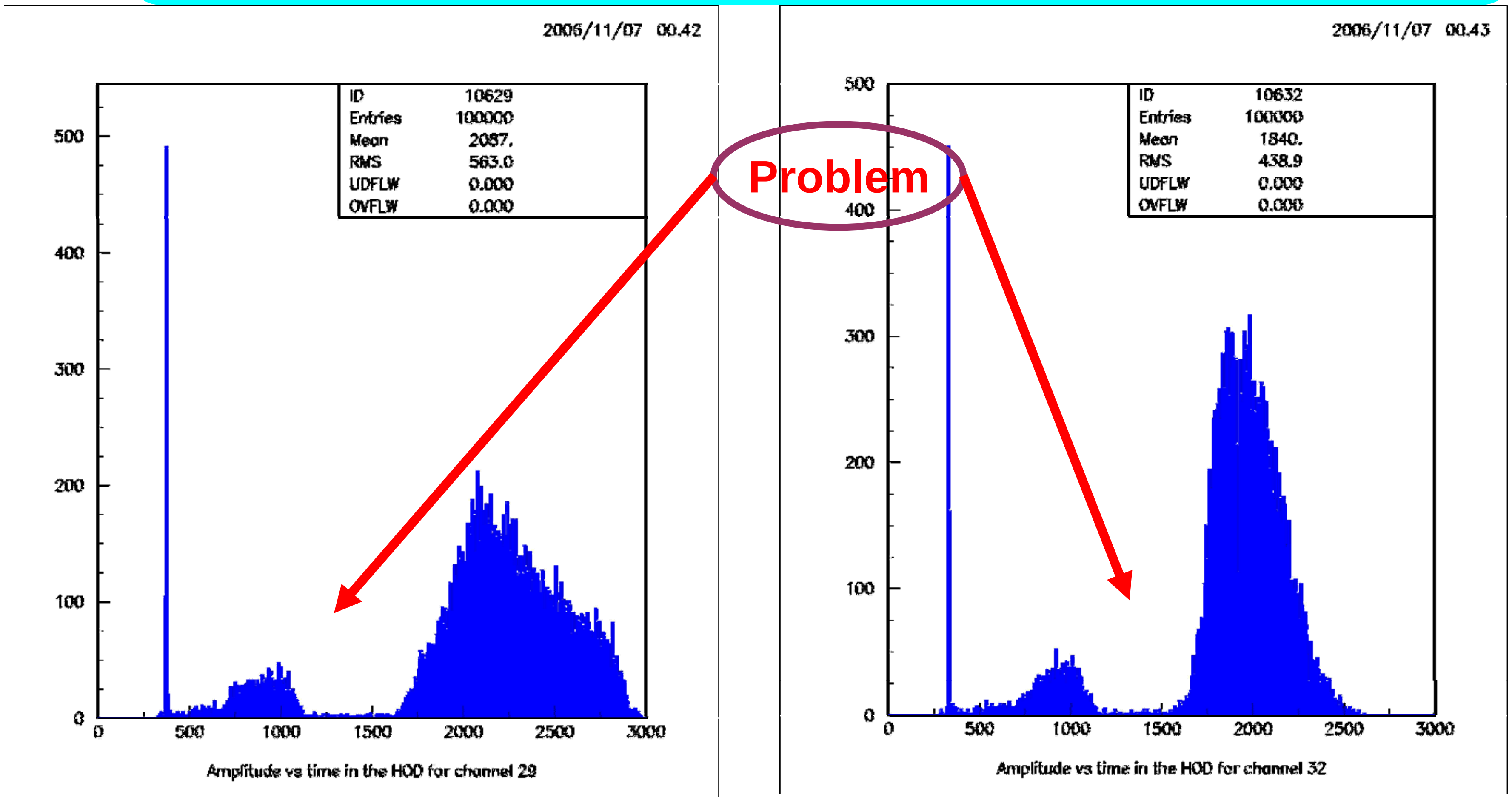

edding 140 S


edding 140 S

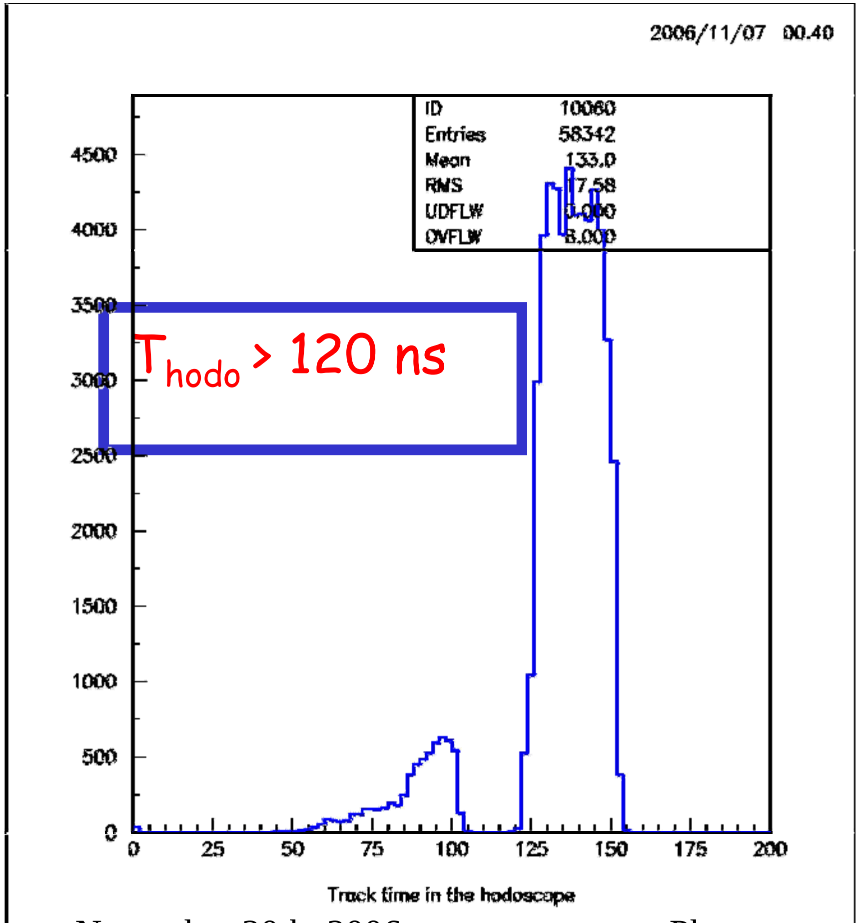
Installation and data collection

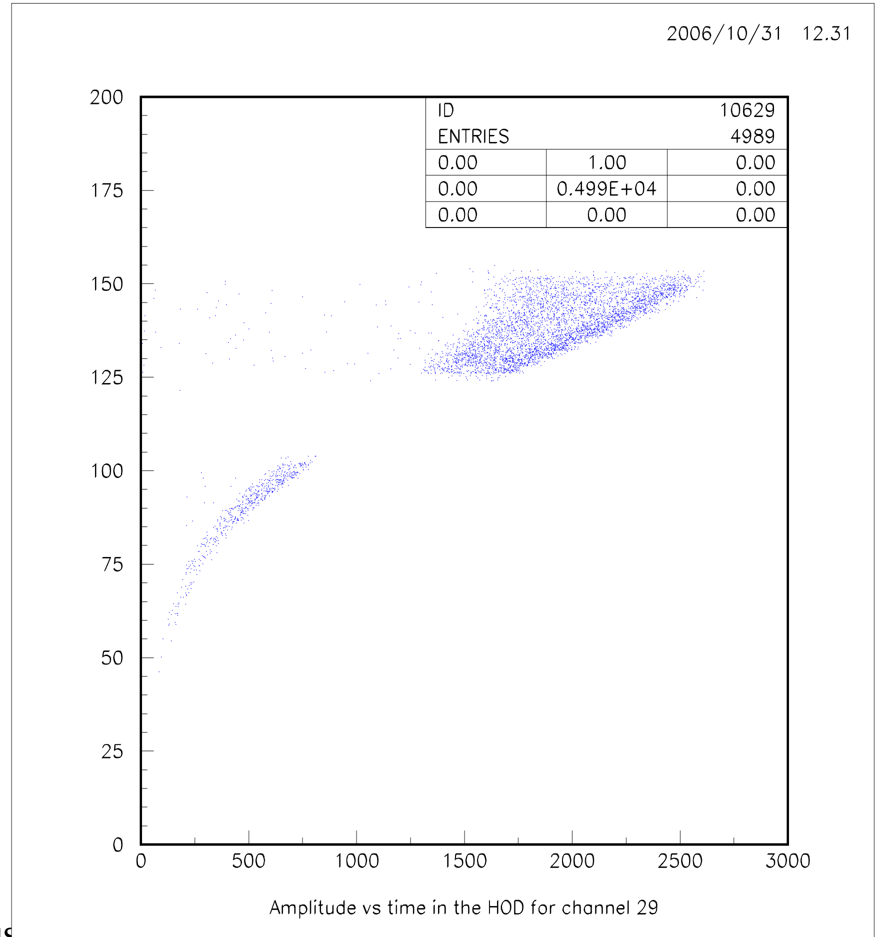
- In between the two layers of the hodoscope
- 22 < X < 42.5 cm
- -44.5 <Y< -22 cm
- SAC tilted to 3^0 with respect to Z-axis
- Use of the NMUV readout
- Four runs
- Scan on X with step 5 cm
- Totally 10 millions events
- Data analysis in progress
- Some results from 5 burst presented at the meeting

Signals

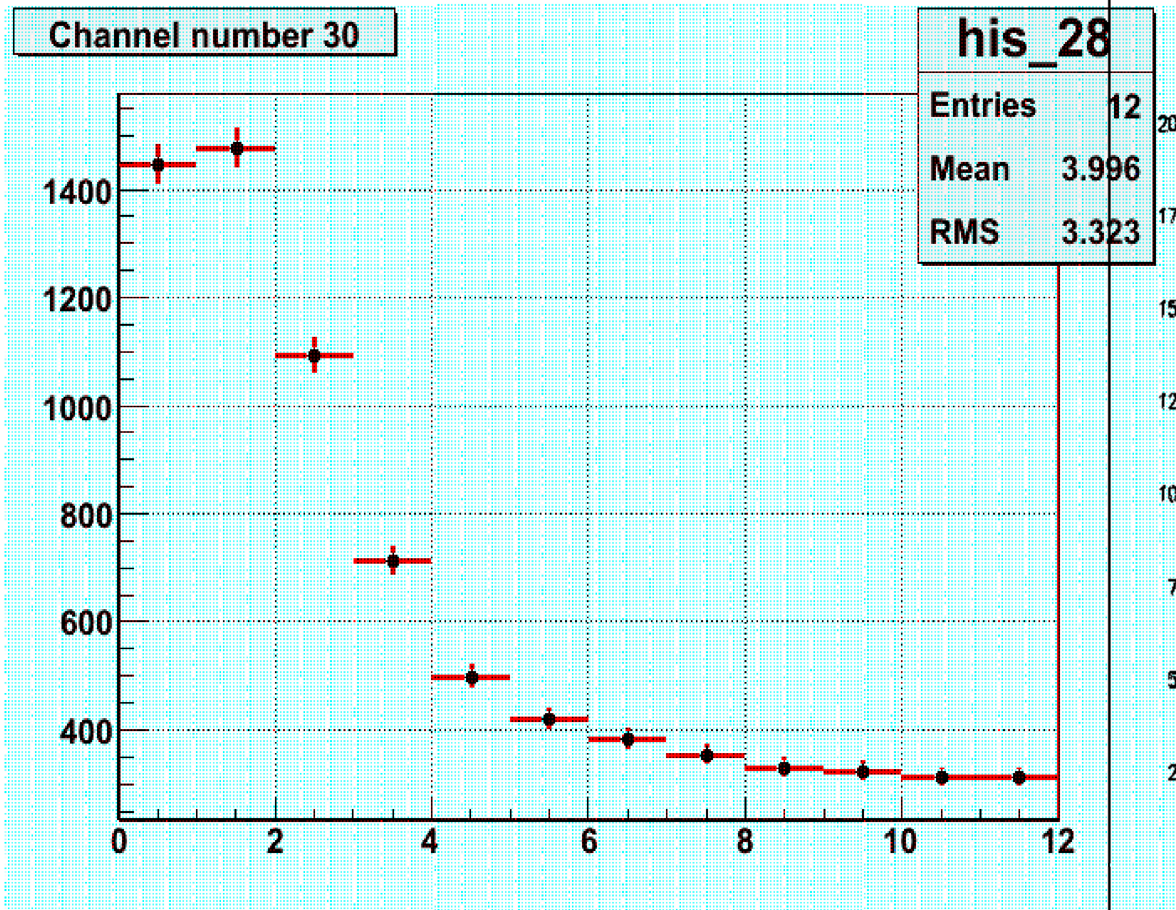

2006/11/07 00.42
ID 10629
Entries 100000
Mean 2087.
RMS 563.0
UDFLW 0.000
OVFLW 0.000
Amplitude vs time in the HOD for channel 29
Problem
2006/11/07 00.43
ID 10632
Entries 100000
Mean 1840.
RMS 438.9
UDFLW 0.000
OVFLW 0.000
Amplitude vs time in the HOD for channel 32

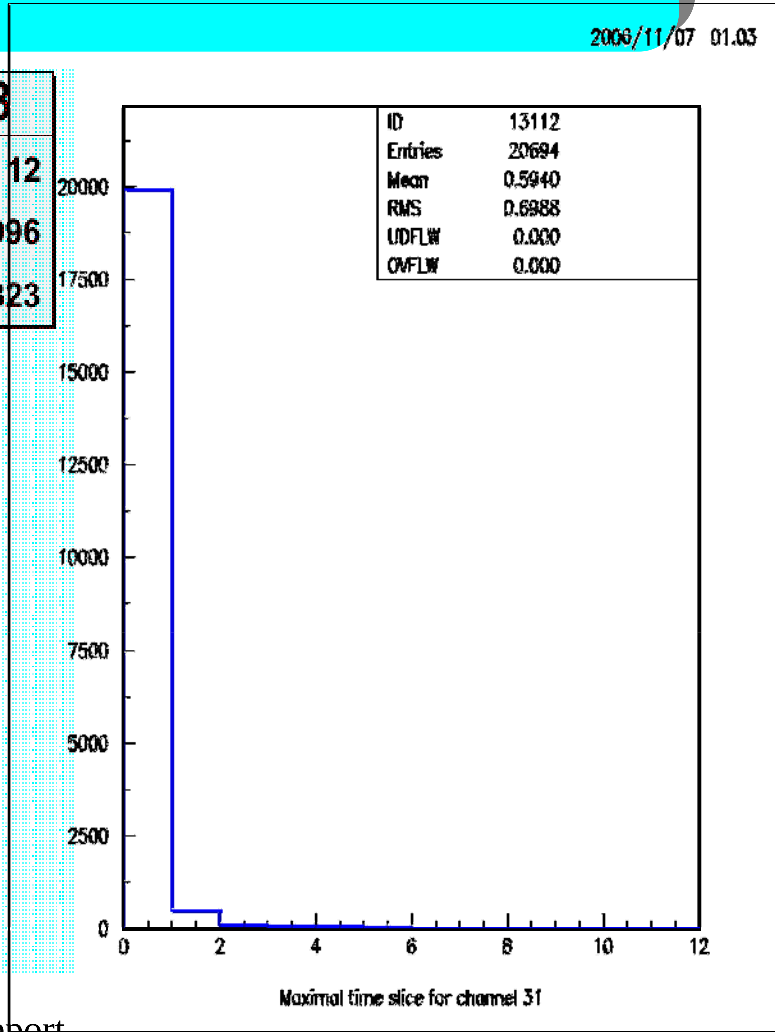
Trigger


2006/11/07 00.40
ID 10060
Entries 58342
Mean 133.0
RMS 17.58
UDFLW 0.000
OVFLW 8.000
T_{hodo} > 120 ns
Track time in the hodoscope

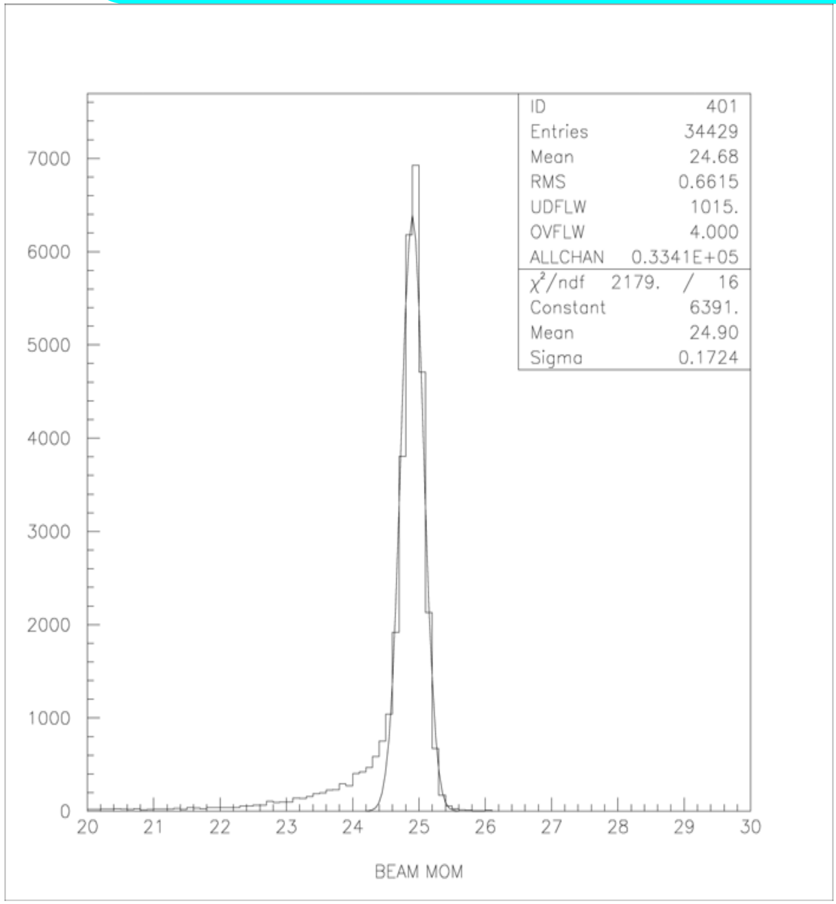

2006/10/31 12.31
ID 10629
ENTRIES 4989
0.00 1.00 0.00
0.00 0.499E+04 0.00
0.00 0.00 0.00
Amplitude vs time in the HOD for channel 29

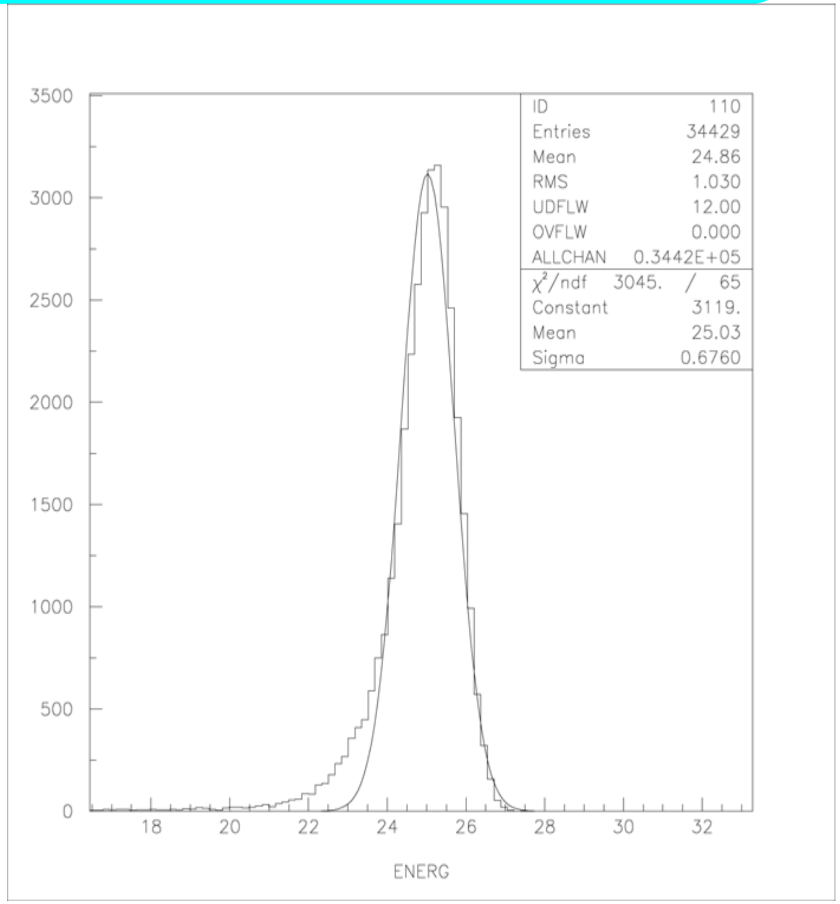
Time slices


Channel number 30
his_28
Entries 12
Mean 3.996
RMS 3.323
1400
1200
1000
800
600
400
0
2
4
6
8
10
12

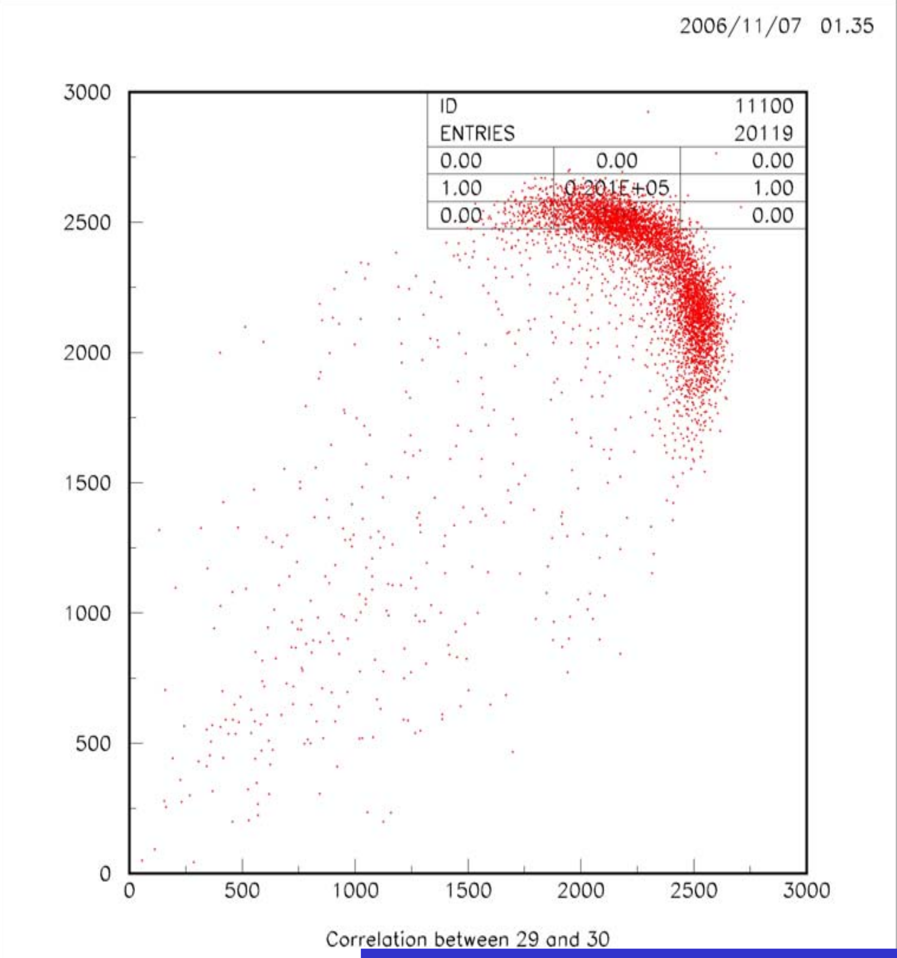

2006/11/07 01.03
ID 13112
Entries 20694
Mean 0.5940
RMS 0.6988
UDFLW 0.000
OVFLW 0.000
20000
17500
15000
12500
10000
7500
5000
2500
0
0
2
4
6
8
10
12
Maximal time slice for channel 31

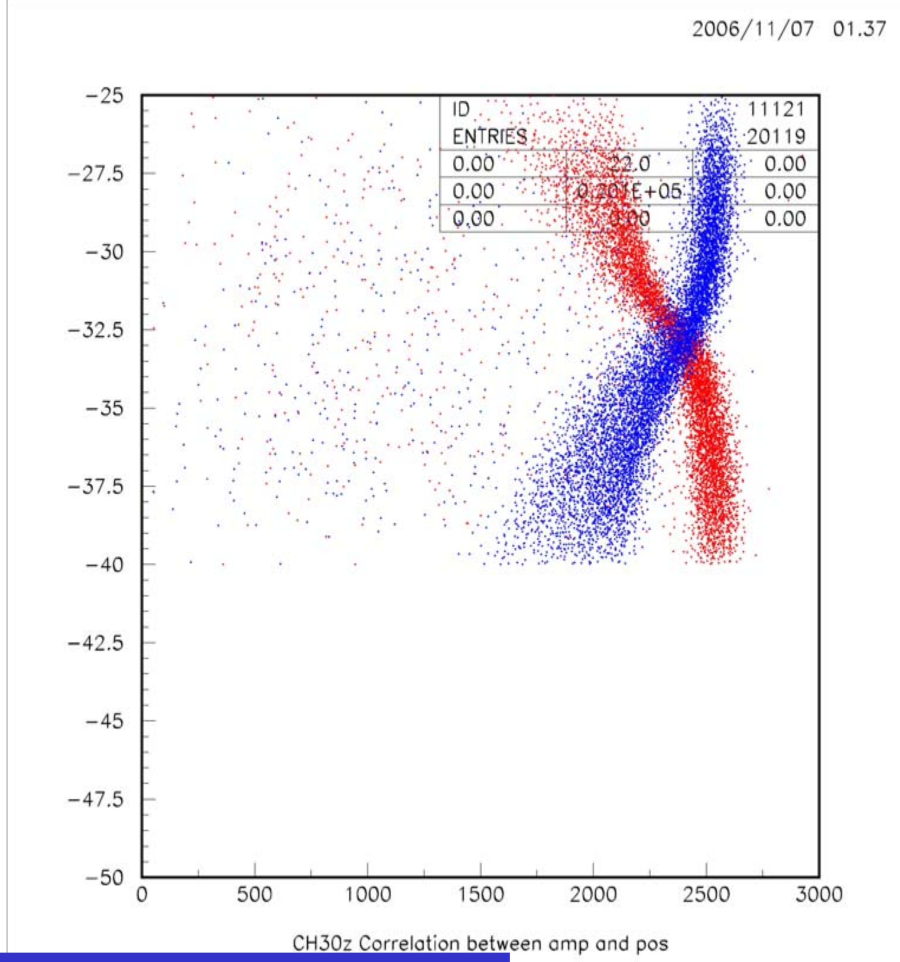
Energy resolution





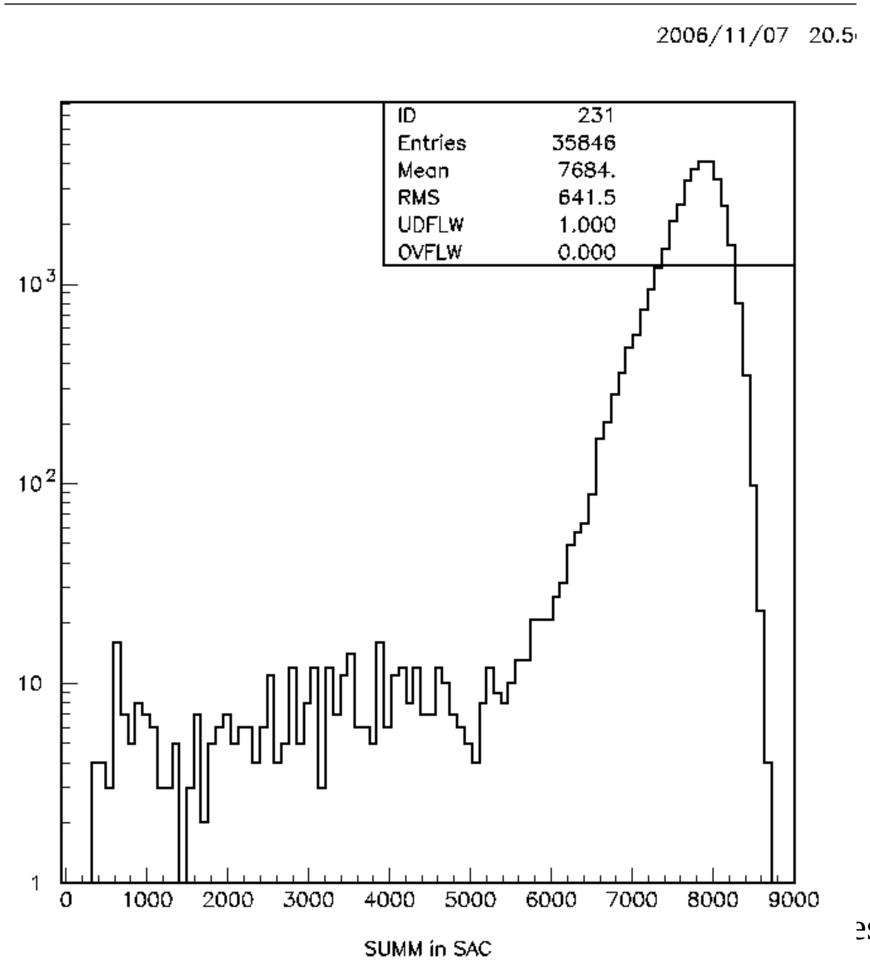
Correlations





X and Y dependence should be taken into account

Inefficiency



MIP signal around 300 counts

Estimated raw inefficiency of $6.4 \cdot 10^{-5}$

SAC test - Summary

- SAC prototype successfully constructed and installed in the beam
- PMT shifted – maximum signal in the first time slice
- Correction for the trigger time
- Strong dependence of the signal amplitude on X, Y position
- XY correction should be developed
- Good energy resolution
- Full analysis in progress

Prospects for 2007

- Prototype tests to be done beginning 2007
  - Performance comparison between tile and spaghetti solutions
- But also detailed comparison of costs
  - This would likely drive the choice
- Choice of the technology
  - Start the definition of the mechanics
    - *Way of avoiding cracks*
    - *Way of building the detector (modules vs all at the time)*
    - *Fiber routing*
    - *Optical feedthroughs*
    - *Support flanges*
    - *Need to understand the layout and the distribution of HV/signals for the IRCs*
  - Start the discussion of agreements between the various partners

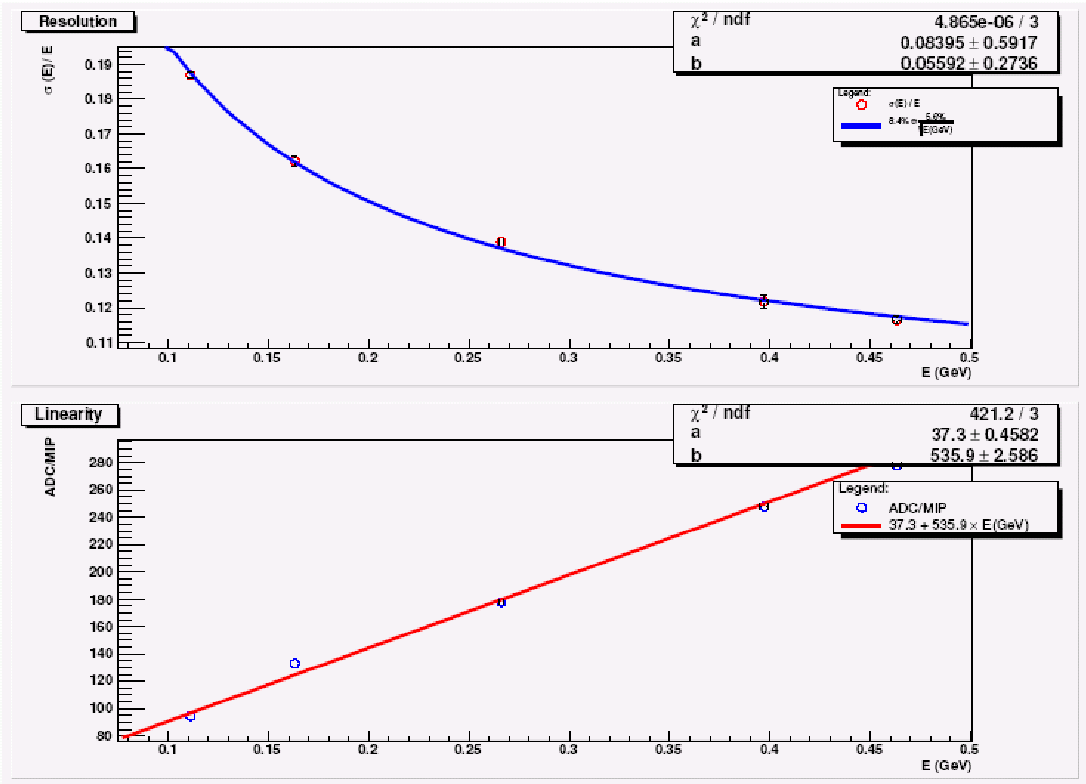
Prospects for 2007

- Definition of the specification for the electronics
  - Study time resolution using LAV prototypes
  - From this define the requirements of the electronics
    - *Dynamics, sampling rates, pileup*
  - LKr will need new digitizers
  - SAC and IRCs could have needs similar to antis
- It may be wise to check if there is a possibility for a common design
  - Availability of multiple sampling rates
  - Programmable shaping
  - Programmable dynamic ranges
  - A common format for digital output
- Continue software development

backup slides

Test of KLOE prototype

- Measure average response and resolution as a function of energy
- Results in agreement with expectation:
  - Good linearity
  - $\sigma_E/E \approx 9\%/\sqrt{E[GeV]}$ for each side $\rightarrow$ $6\%/\sqrt{E[GeV]}$ when response/side is averaged



Beam Energy (MeV)

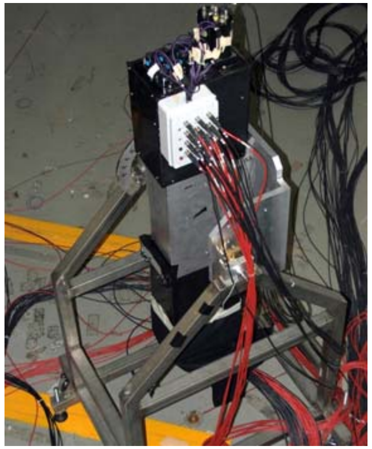
Prototype instrumentation/test

KLOE calorimeter prototype,

50-cm length

Both sides instrumented,
1+1/8" PM's

Read out granularity: 4.2×4.2 cm^2, 30 channels



Test using e$^{\pm}$ beams at LNF Beam Test Facility (BTF)

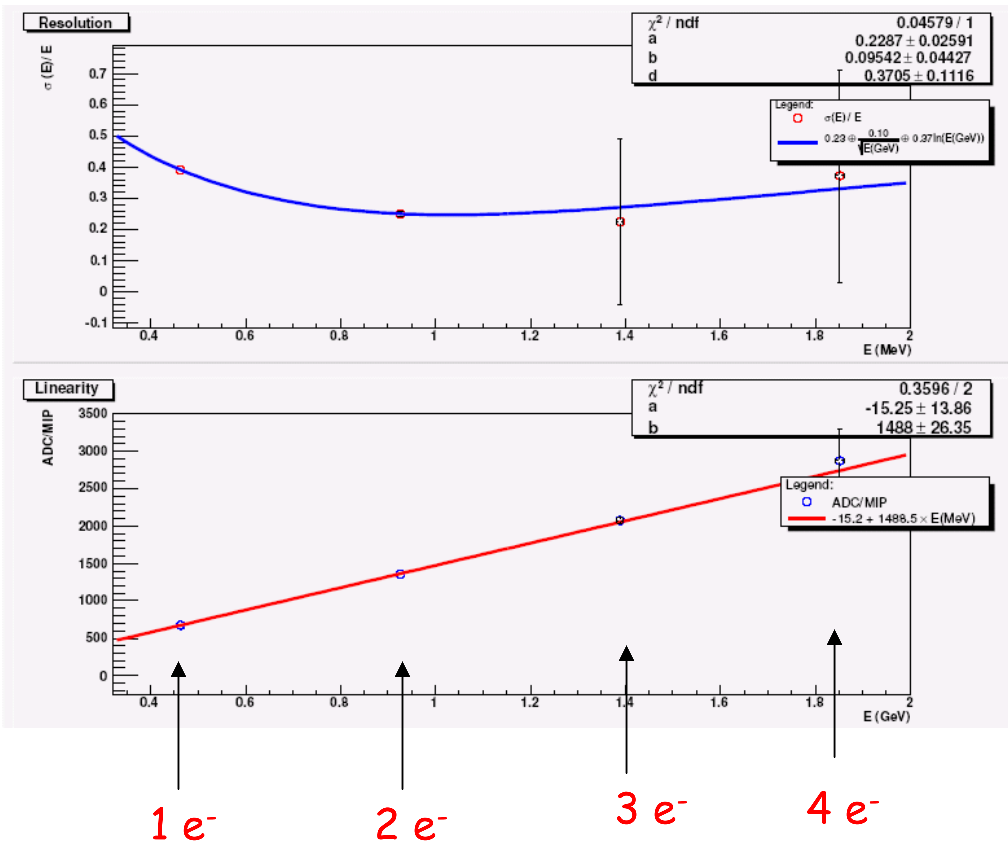
- Energy from 50 to 500 MeV
- from 1 to few tens of electrons/pulse
- 10 ns pulses / 49 pulse s^{-1}

Equalization via **cosmic-ray** runs

Absolute calibration by comparing with a **NaI** calorimeter

Tagged γ beam in preparation

Tile prototype from Protvino

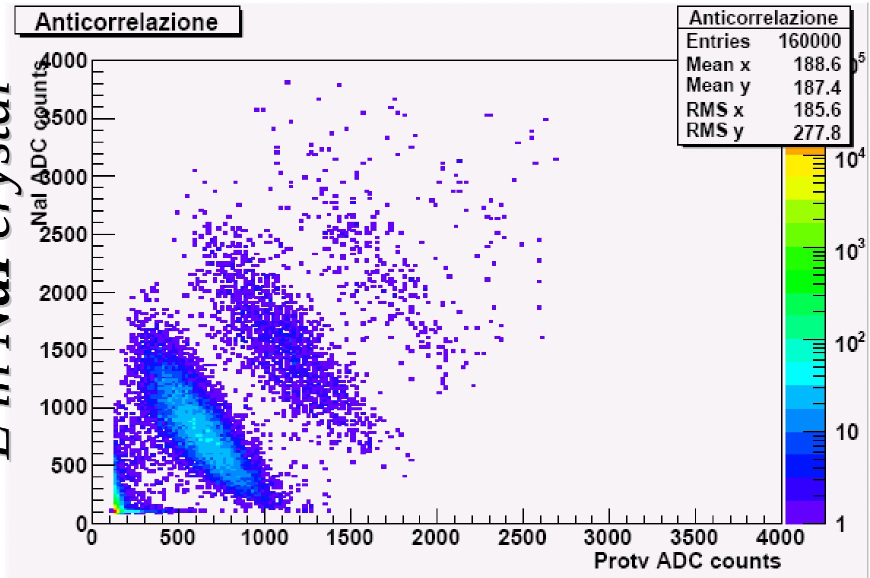


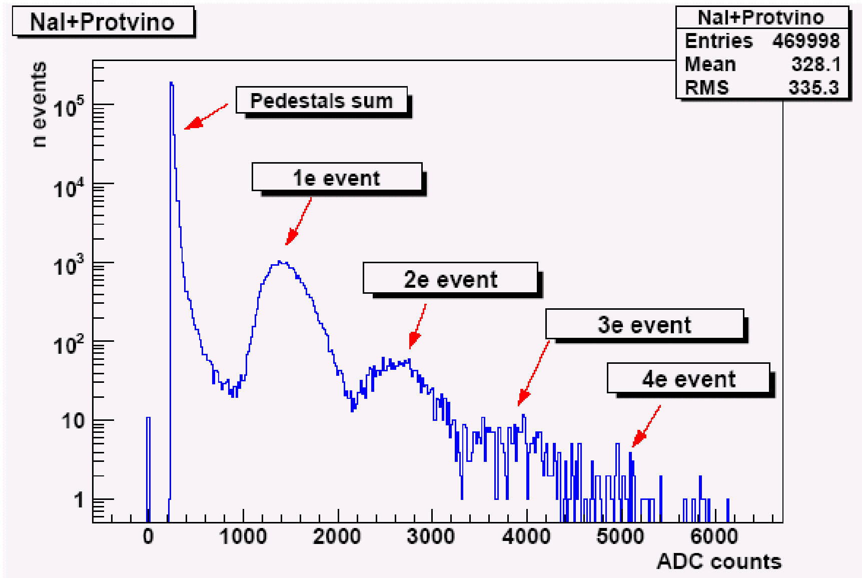
- Good linearity of energy response

- Resolution dominated by containment fluctuations

NaI as tail catcher, $E_{Protvino} = E_{beam} - E_{NaI}$

Tile vs. NaI



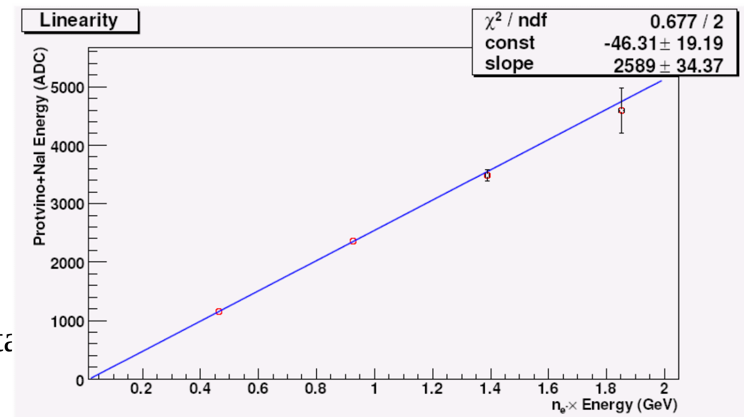


E in NaI crystal

*E in **Protvino** "mega-tile"*

*E in **NaI** + **Protvino** "mega-tile"*

***NaI + Protvino** linearity*



Tile yield

#phe/MeV

20 fibers

5 mm

43.7 ± 0.3	**43.0** ± 0.3	**43.3** ± 0.3
35.6 ± 0.3	**35.8** ± 0.3	**35.7** ± 0.3
35.3 ± 0.3	**35.3** ± 0.3	**36.2** ± 0.3

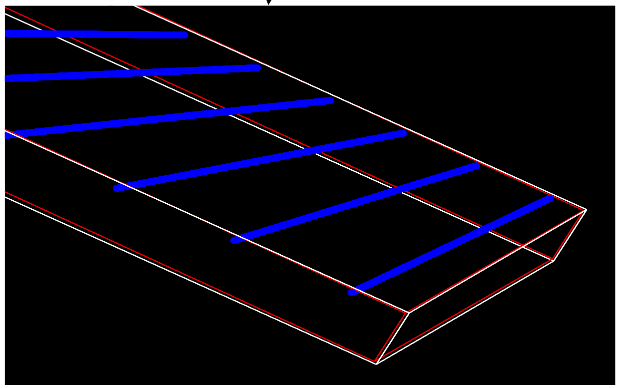
10 mm

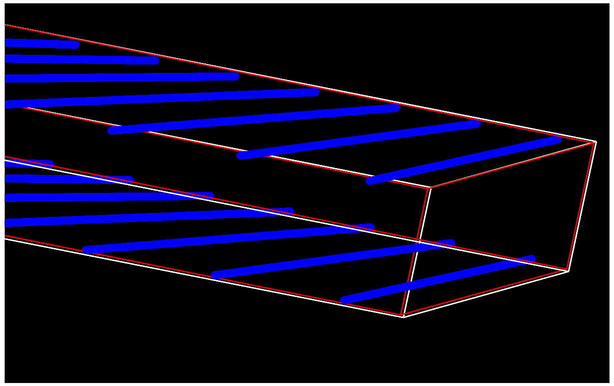
44.6 ± 0.3	**44.9** ± 0.3	**45.3** ± 0.3
36.7 ± 0.3	**37.6** ± 0.3	**37.6** ± 0.3
36.1 ± 0.3	**36.9** ± 0.3	**37.2** ± 0.3

40 fibers

2 cm

63.3 ± 0.4	**64.8** ± 0.4	**65.3** ± 0.4
53.3 ± 0.3	**54.7** ± 0.3	**54.8** ± 0.3
50.2 ± 0.3	**51.6** ± 0.3	**51.9** ± 0.3





Materials and equipment

Raw materials accumulating in Frascati since spring:

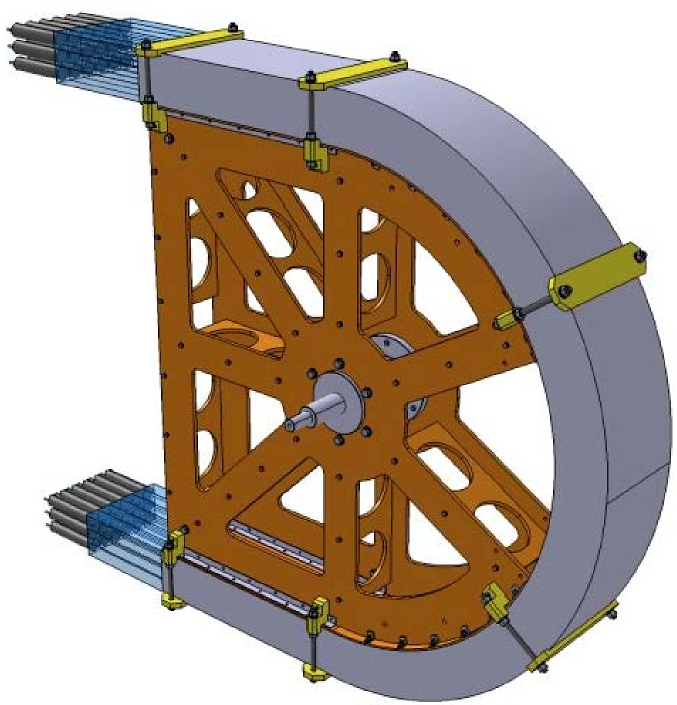
Fibers:	Kururay SCSF-81, 1 mm Ø × 3.5 m, 20000 pcs (Roma1 & Pisa)
Glue:	Bicron BC600, 19 kg (Pisa)
Lead foils:	Cofermetal, 3.5 m × 25 cm × 0.5 mm,m 130 + 50 pcs (Napoli)
Lead wire:	Cofermetal, 1 mm Ø, 12 km (Napoli)
PMTs:	Hamamatsu R6427 28mm, 37 pcs (LNF & Roma1)
Light guides:	Lucite Wilson-cone, from KLOE module 0

Construction saddle:

Support for gluing/construction and beam test

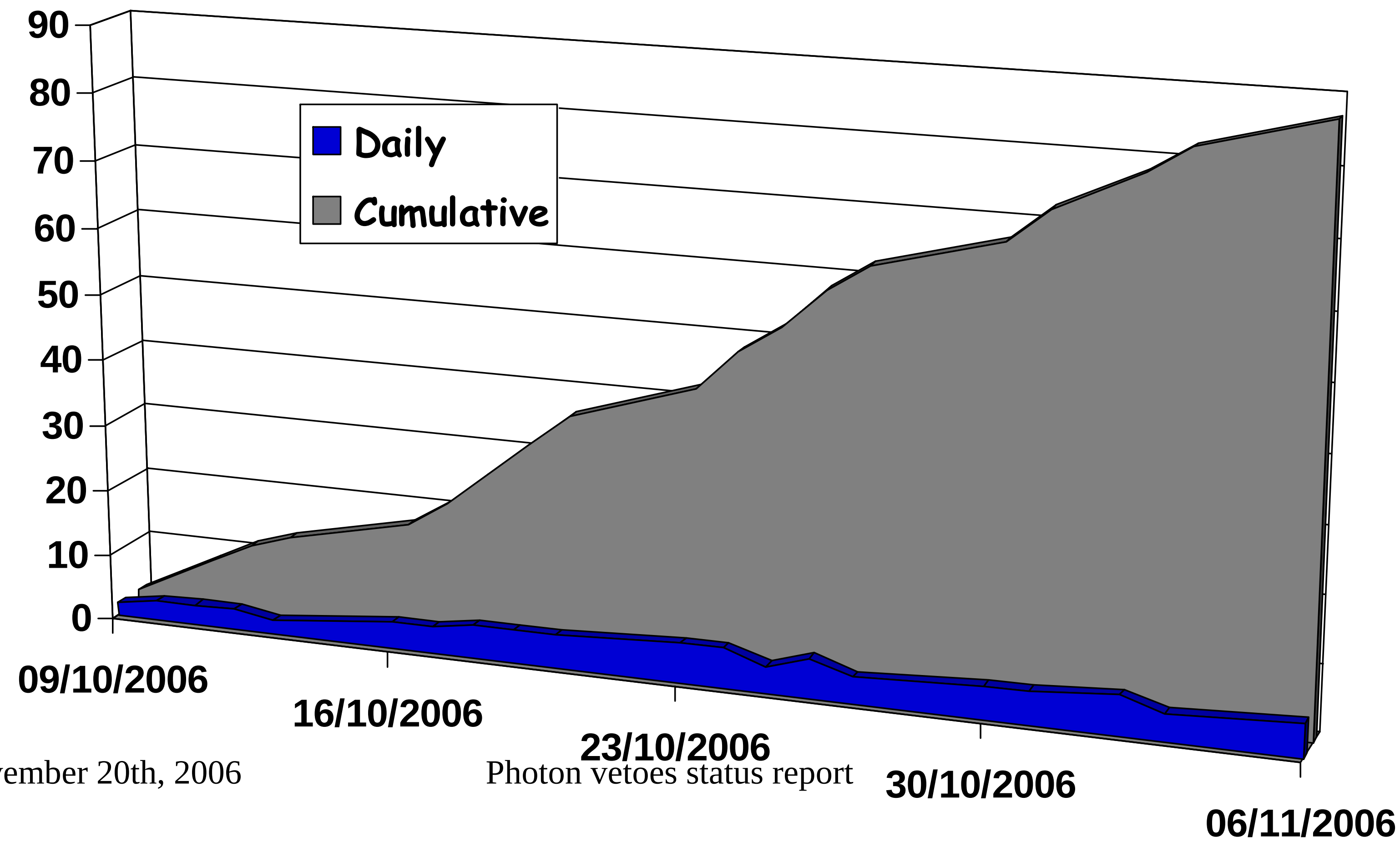
- Designed by S. Cerioni/LNF last spring
- Machining by OMCC (Ceccano)
- Carpentry and some assembly at LNF

Mounted on carriage and ready to use 29 Sep

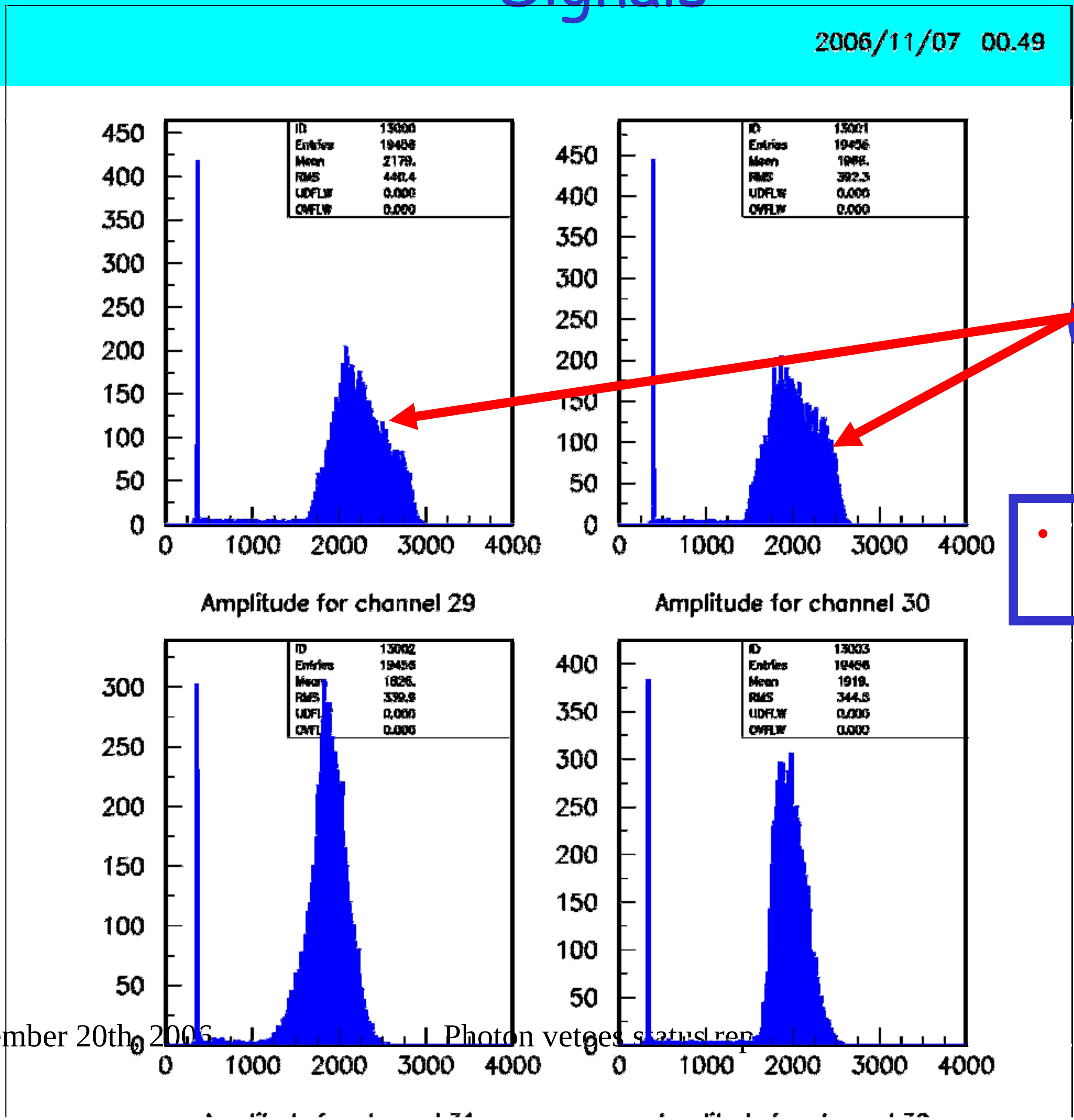


Day-to-day progress

20 working days - 87 planes done



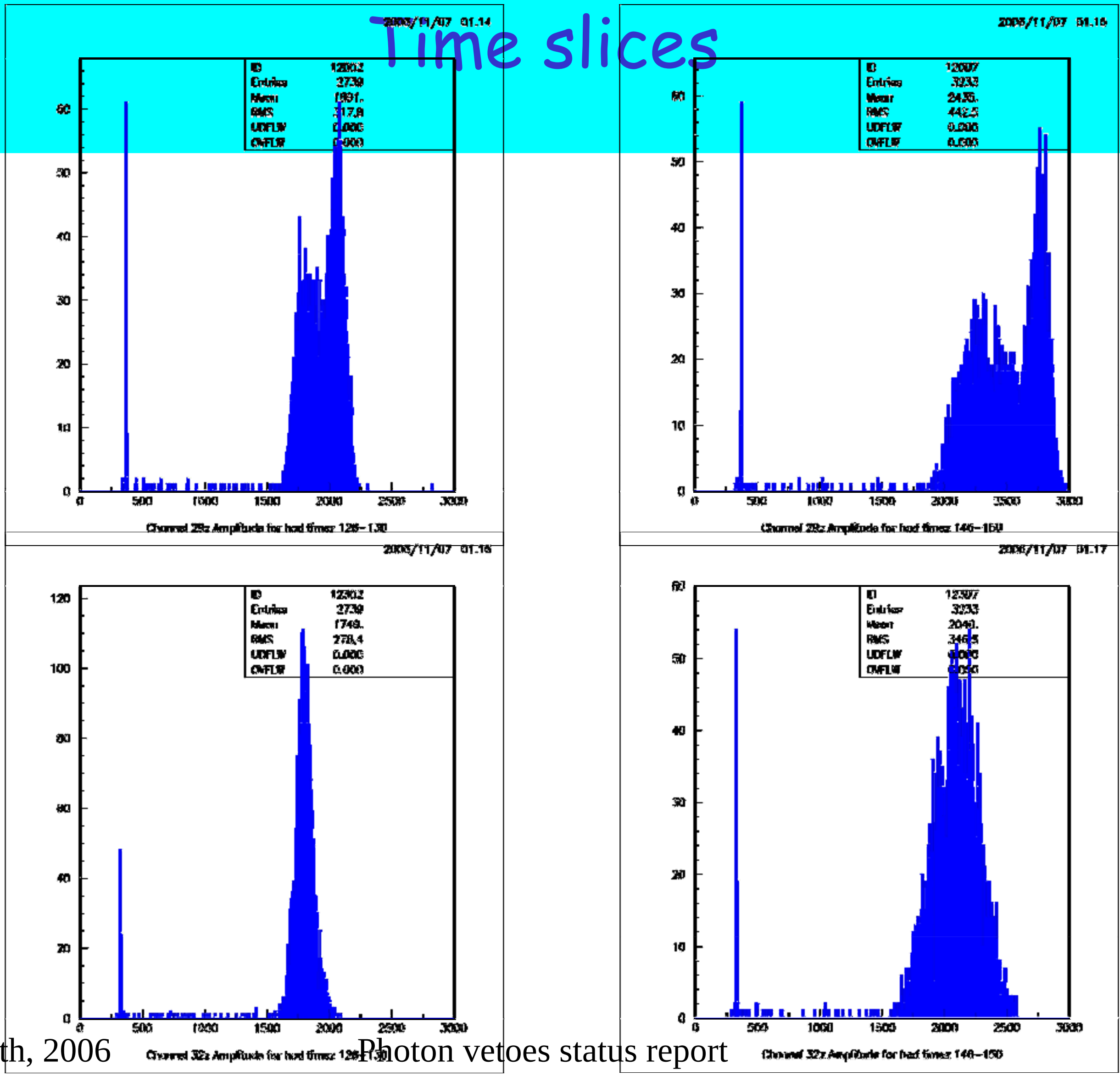
Signals



Wide peaks?

- Thodo > 120 ns

Time slices


Channel 29z Amplitude for hod times 126–130
Channel 29z Amplitude for hod times 146–150
Channel 32z Amplitude for hod times 126–130
Channel 32z Amplitude for hod times 146–150

Vacuum quality

- In January the Protvino prototype outgassing was measured at CERN
  - Outgassing for a single scintillator plate is ~$7*10^{-10}$ mbar*l/(sec*cm^2)
- After independent measurement of
  - 2 scintillator plates (Protvino molded scintillator)
  - 130*50 cm^2 lead plate
  - 100*80 cm^2 tyvek
- The result has been used to compute the total outgassing rate for all the 12 detectors
  - Taking into account number of plates, dimensions, etc.

Vacuum quality

- Results for outgassing (avg – worst case 2 times more)
  - Scintillator load $5.1*10^{-2}$ (mbar*l)/sec
  - Lead load $8.5*10^{-5}$ (mbar*l)/sec
  - Tyvek load $2.8*10^{-4}$ (mbar*l)/sec
  - Blue tube $1.0*10^{-2}$ (mbar*l)/sec
- So for 10^{-6} mbar vacuum we need $6*10^{4}$ l/s pumping power
- Tested also a small piece of Kloe structure
  - Kloe block load $1.3*10^{-1}$ (mbar*l)/sec
- Which combined with blue tube gives an expected pumping power of $1.4*10^{5}$, but should be checked again
  - This test will be done again with a bigger sample
- As soon as possible, mass spectrometer analysis
- It is planned to send at CERN an unused bigger old piece of the KLOE structure for outgassing measurements