Photon veto status report

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on behalf of the NA62 Photon Veto WG

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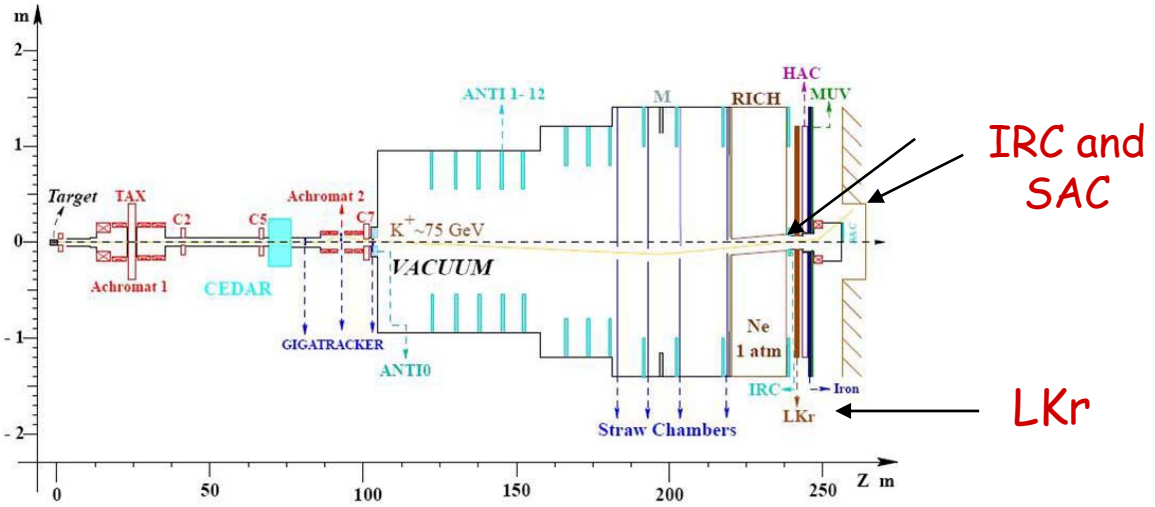
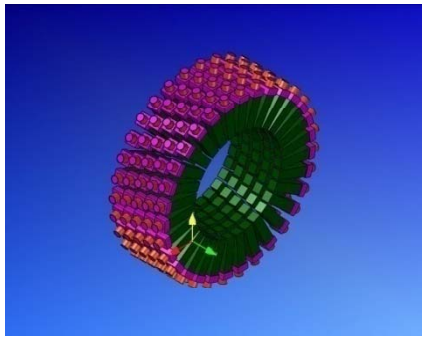
The photon veto system

- Ensure the almost hermetical coverage for photon detection (0-40 mrad)
- Aim for an average detection inefficiency of the π^0 of $O(10^{-8})$
- Three main components
  - Large angle photon vetoes to cover up to 40 mrad
  - The LKr calorimeter for intermediate angles
  - Small angle calorimeters to cover the beam pipe area and the forward direction



Operation in vacuum

- Preliminary mechanical design with PMs in air
  - One hole in the vacuum tube/each PM
  - Worries about the stresses due to pressure difference
- Check of the possibility of a design in vacuum
  - Verify operation of PMs in vacuum
  - Measure the outgassing of the components
- Extensive tests of PM in vacuum
  - On the divider alone an increase of up to 70^0 of the temperature of the resistors at 1500 V
  - Anyway reduced by the conduction through the PM pins



Outgassing

- Extensive measurement of the outgassing of the blocks
  - Carefully factorize the contribution of the various parts
  - It seems anyway that after long pumping the outgassing rate is small
  - The values obtained correspond to a total outgassing rate less than that coming from the straws
  - However care is being taken to avoid materials inside the structure which could give additional outgassing

Different conditions	Q (*mBar·l/s*)	Error	Pumping time
Full detector wrapped	$2.2 \cdot 10^{-5}$	$1.4 \cdot 10^{-5}$	2 weeks
Full detector unwrapped (*)	$2.0 \cdot 10^{-5}$	$1.3 \cdot 10^{-5}$	2 weeks
Wrapping only (*)	$1.0 \cdot 10^{-6}$	$5.1 \cdot 10^{-7}$	1 day
PMT and MuMetal only	$2.1 \cdot 10^{-7}$	$1.7 \cdot 10^{-7}$	1 day
Only crystal and Al	$2.0 \cdot 10^{-6}$	$2.9 \cdot 10^{-6}$	2 weeks

(*) after cleaning for the residuals of the exixting glue

The flood

- In April, because of heavy rain, dirty water flooded the storage area in BB5
  - Half of the lead glass blocks were immersed in the water for 3-5 cm
- CERN insurance is providing support for cleaning, recovery and validation of those blocks
  - They are about 1800, the cleaning rate is 30/week
  - They are cleaned, cabled and tested in a dark box with a LED pulser
  - Several damages has been found
    - Blocks with the glass broken at the interface with the steel – likely due to a sudden thermal shock
    - Blocks stained due to the attack of phosphate ions in the water – could be recovered by polishing
    - Blocks with a high discharge rate during the tests – most likely the effect of some water reaching inside the PMT wrapping

The flood

Broken 9%

To be polished 9%

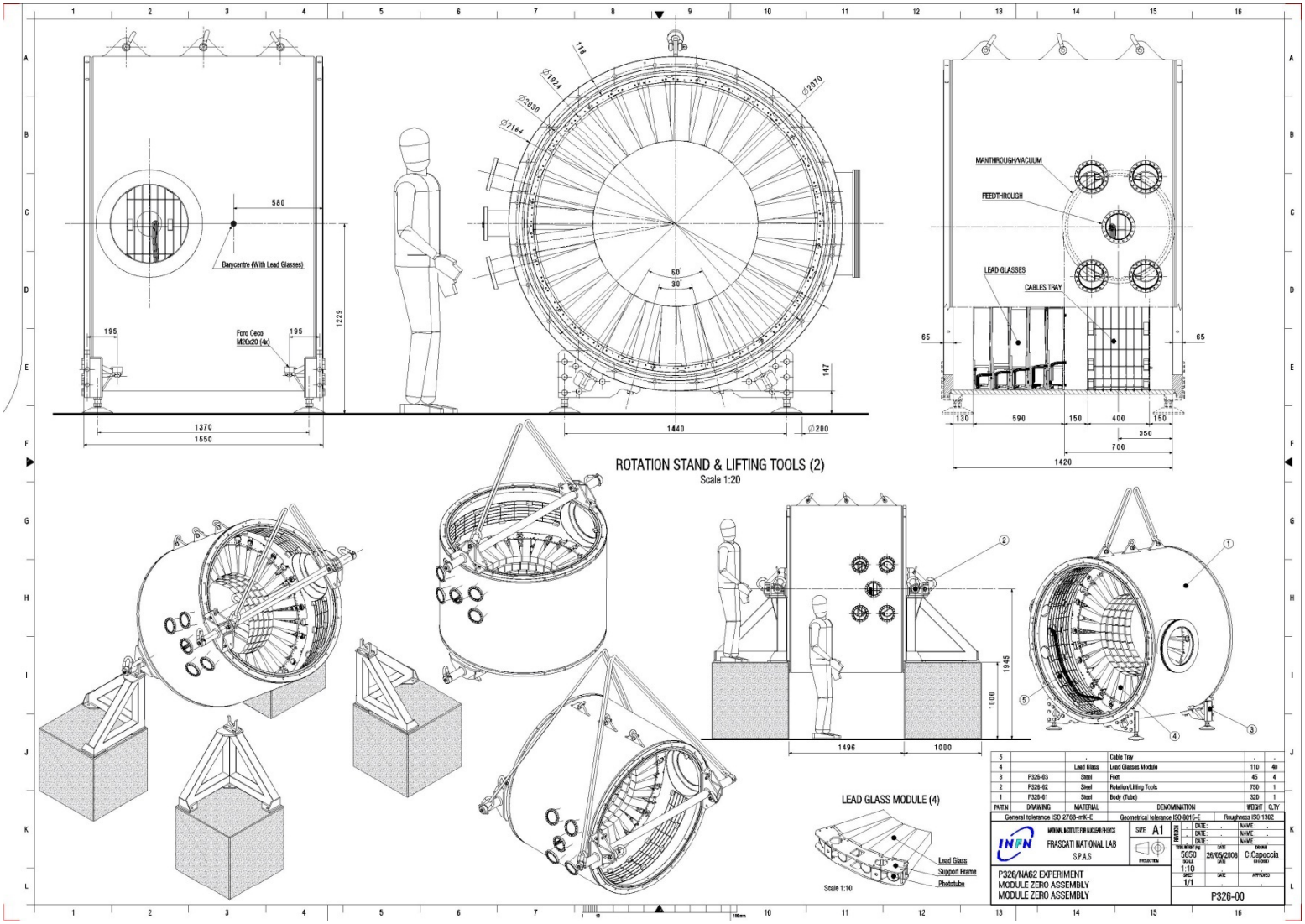
High rate 13%

Watch carefully these rates to be sure to have what we need (2496 blocks)

Mechanical design

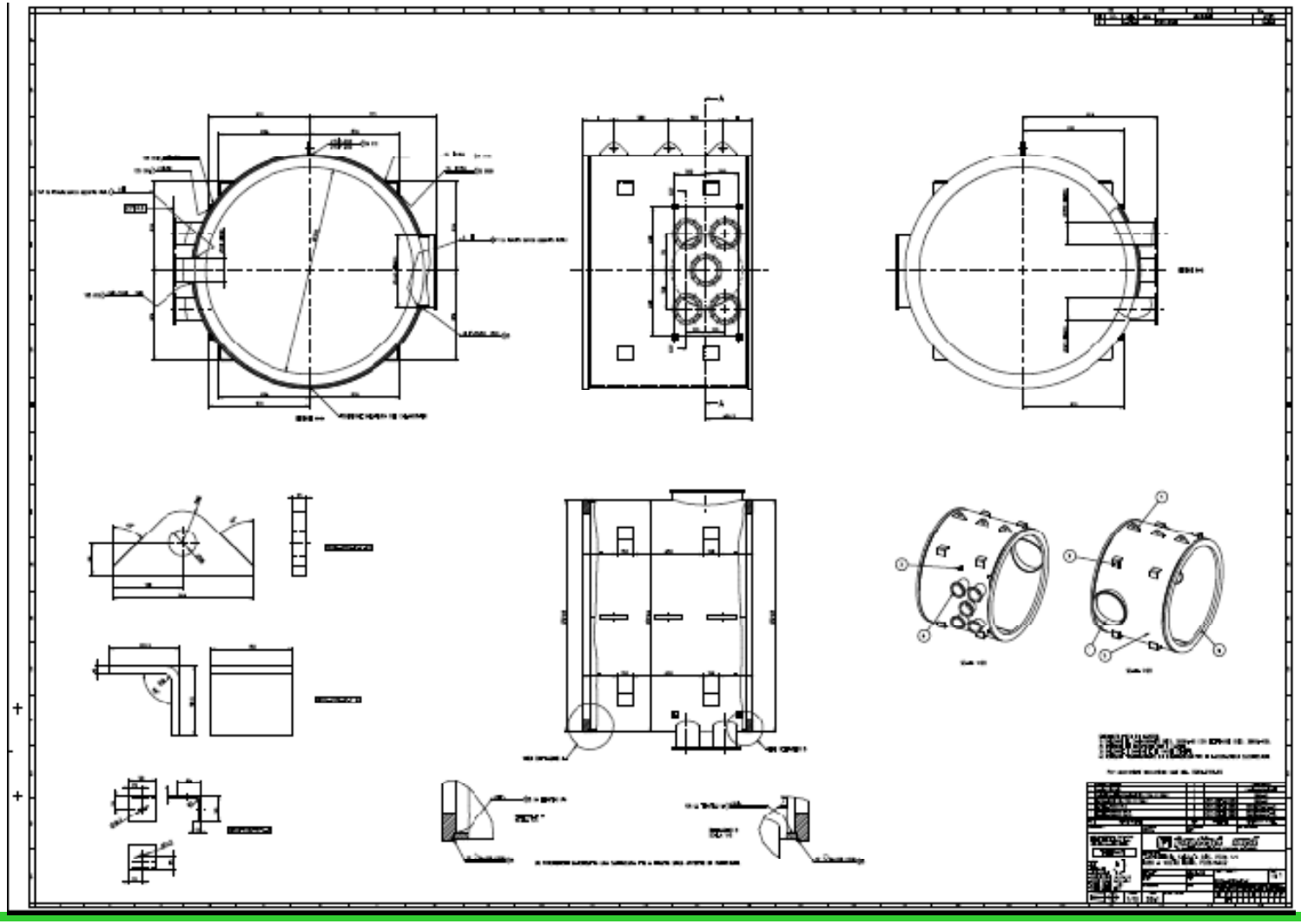
- Start to improve the preliminary design
  - Installation in vacuum
  - Only a single tube with the blocks and the service part
  - Add flanges for pumping and for signal/HV/light feedthroughs
  - Define the way of mounting the blocks
    - See later, tested in summer
  - Define a cabling structure
    - See later, tested in summer
  - Plan all the operations needed for the construction of a ring and for its installation on the beam
    - Design all the tools needed: feet, supports and bars to lift and to rotate it from the mounting position to the working one
- INFN has financed the construction in 2008 of the first ring
  - As an "operational prototype" to get all details fixed

Mechanical design



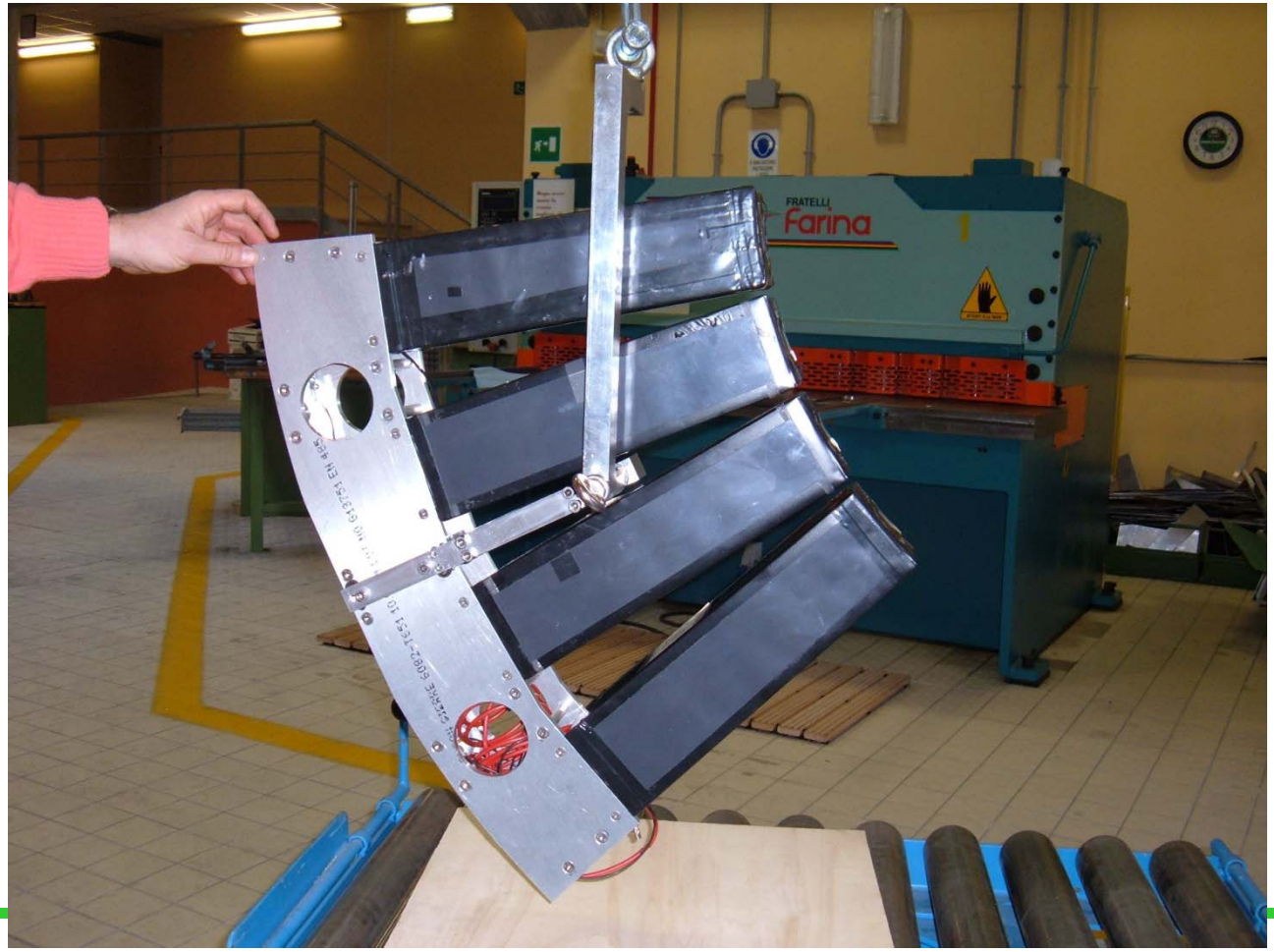
Mechanical design

The production drawings from the firm "Fantini Sud"- Anagni (Italy)



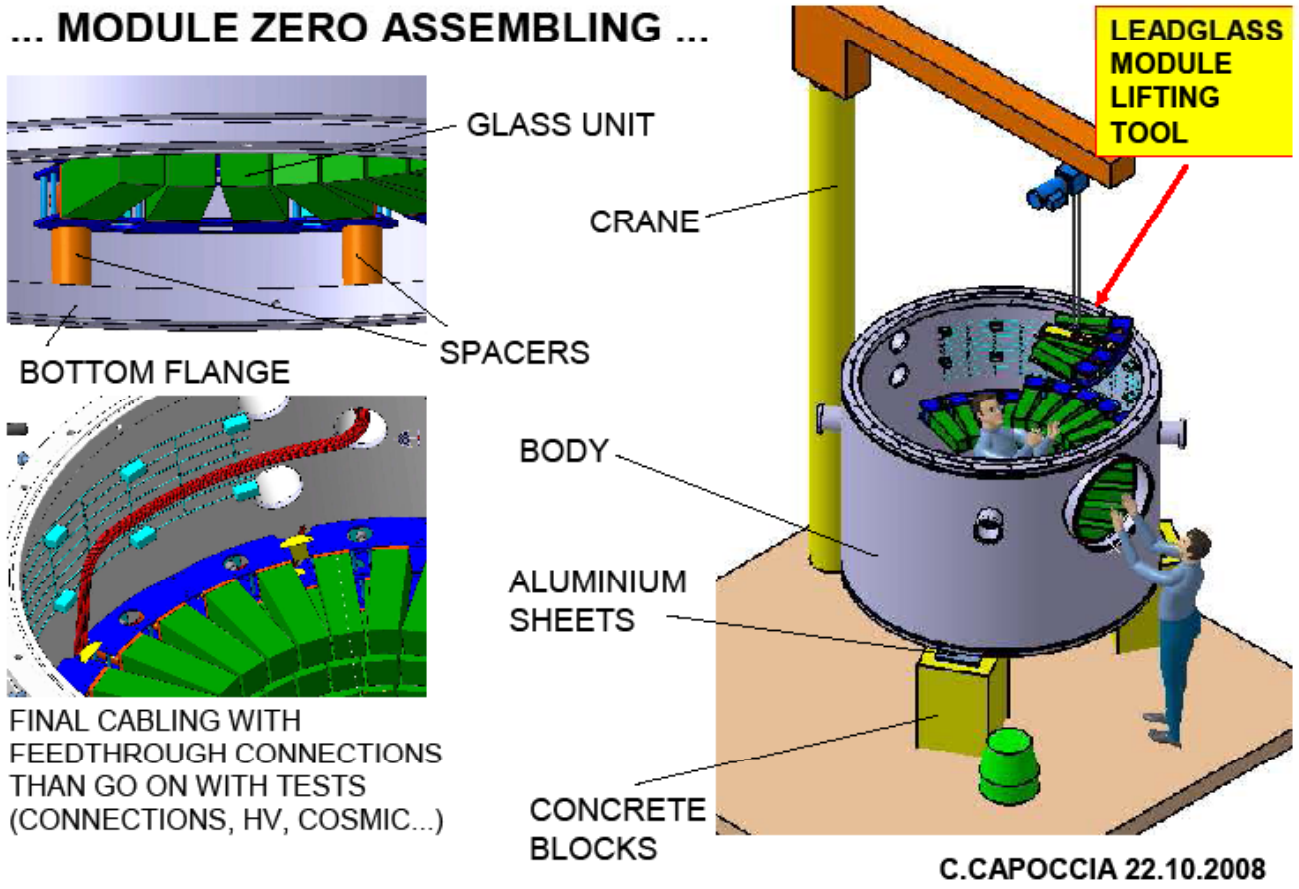
Support plates

Four blocks are mounted in one unit which is then bolted to the support tube



Design improved since the foto was taken

Blocks mounting



The working area in Frascati

To be done here:

Characterization

Mounting on the supports

Installation in the tube

Vacuum and electrical test

To be then shipped at CERN

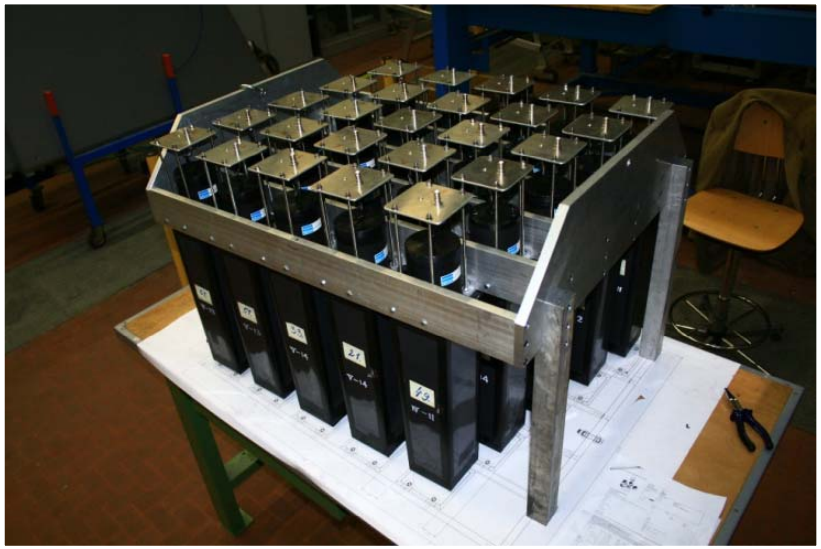
Cabling and connections

- The type of cabling has been defined and tested
  - Mini coaxial connector for signal
  - HV pin + 1K resistor in series to the HV ground
  - Teflon insulated RG 316/U cable with the proper length for each ring
  - Collected into round locking connectors (16 cables)
  - Adapter cables to mate feedthrough connector
    - 50 pin Sub D connectors for the signal (32 cables)
    - MIL C26482 round connectors for HV (32 cables)
- Early definition to help the procedure of block cleaning and cabling

Preparation work

- Tests of new wrapping for the blocks
  - To change the old one after the cleaning procedure
  - A lighter wrapping: either Al mylar or better Tyvek
  - Could be fastened to the block only with screws (no glue)
  - A preliminary version with Al mylar used in the 2008 proto at CERN
- Measuring station - ready
  - To characterize completely the blocks before the installation
  - Automatic measurement of the gain curve with a LED pulser
  - Automatic measurement of the photoelectron yield using cosmics
- Prototyping readout electronics
  - Adapter card to send the PM signal to multiple NINO + TDC channels with different attenuation factors
    - To have very good time measurement and the needed dynamical range for the amplitude measurement in a compact system
    - Prototypes being built now, to be tested in laboratory and at BTF before the end of the year

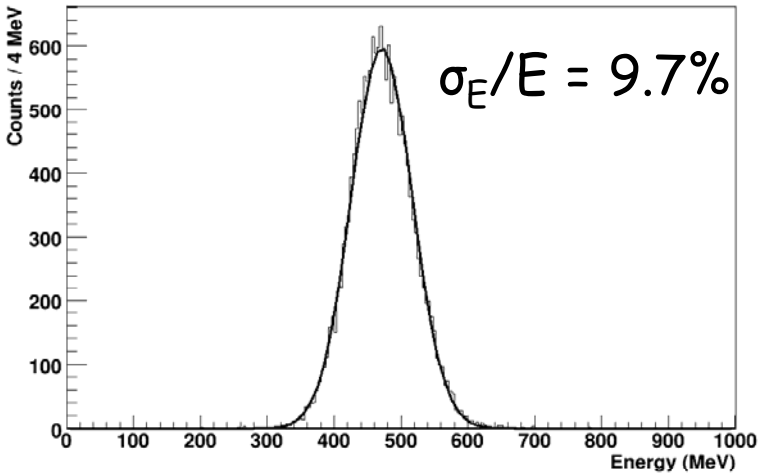
A prototype at the Beam Test Facility - Frascati



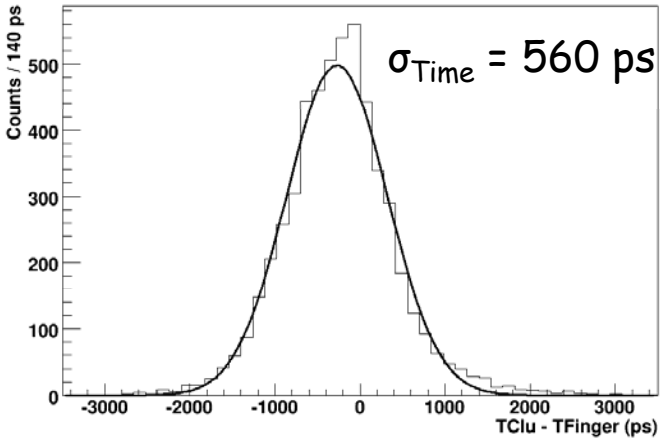
25 blocks

e^- 471 MeV

Energy Resolution

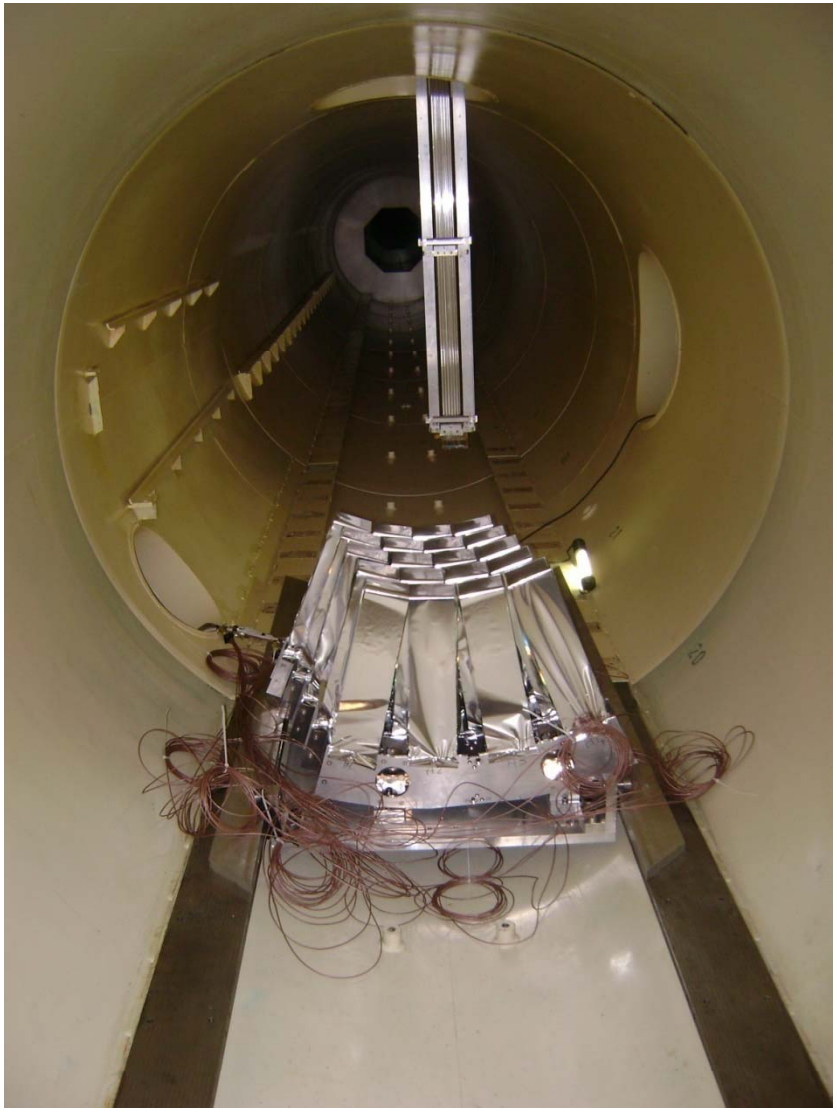


Cluster time Resolution



Beam Incidence	*Tagged Events*	*Inefficiency*
Central	22 703	$4.4^{+7.6}_{-2.8} \times 10^{-5}$
On edge	9 711	$1.03^{+1.75}_{-0.65} \times 10^{-4}$

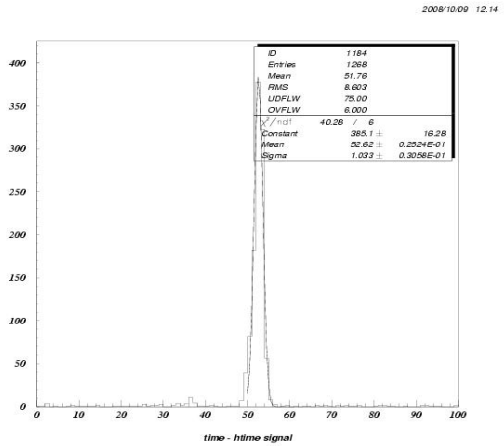
A prototype at CERN



20 blocks installed in the NA62 vacuum tube

Muons and kaons from 2/10 to 6/10

Validation of the operation in vacuum, cabling and support mechanics



Preliminary time resolution with kaons

σ_t = 1.02 ns

Conclusions

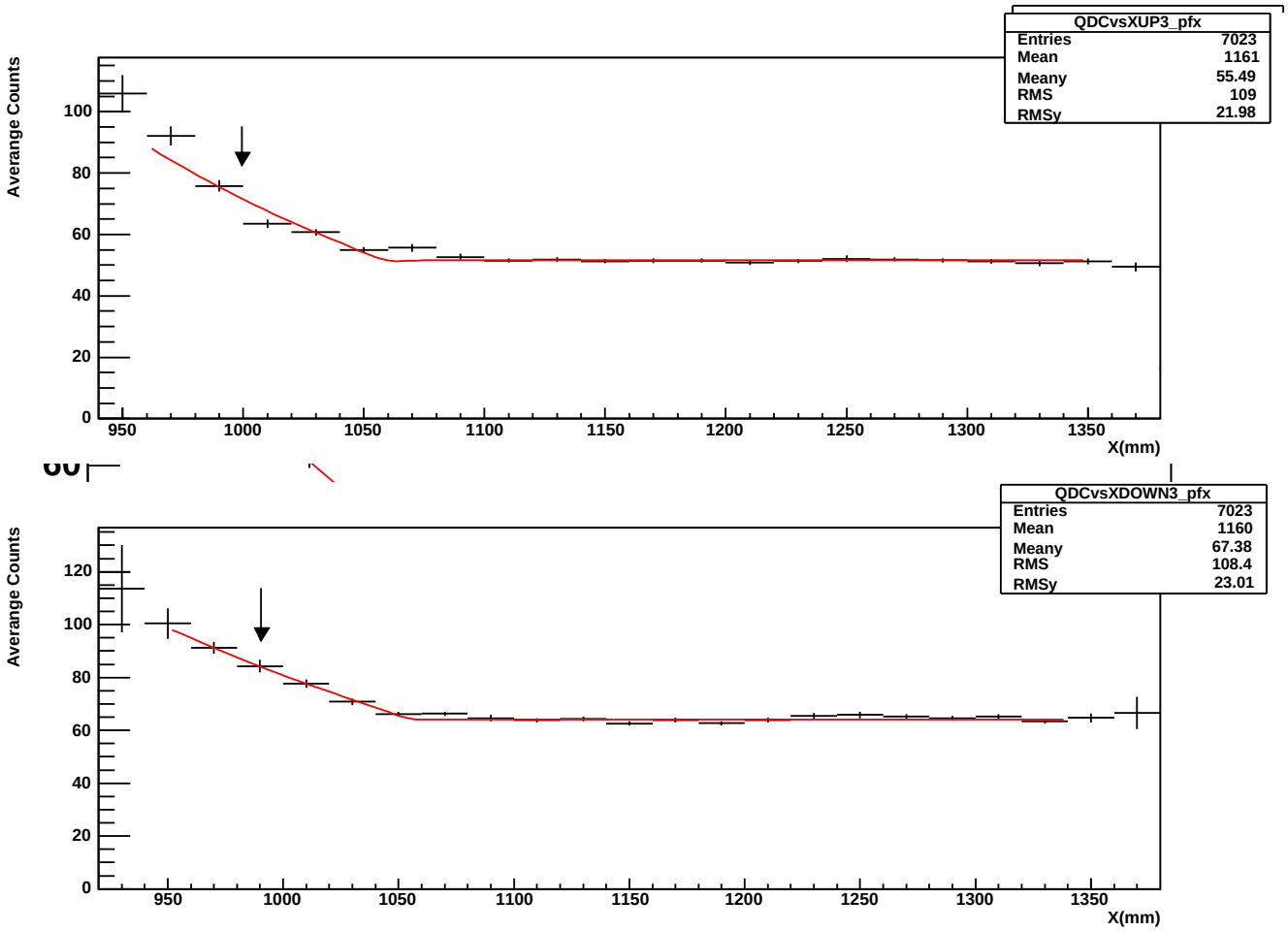
- The operation in vacuum has been validated
  - The mechanical design has been done
  - Production of the support is on going: completion expected by the end of the year
  - Assembly of the first 160 counters then will start
  - Expect to be able to install and test on the beam line (even with particles) end of summer 2009
- Work is going on for the definition of the readout electronics
  - Expect to have protoypes for few channels in November
- We are ready to proceed with the construction of the entire set of rings
  - Basic points defined, only adjustments needed to the design

Spares

Uniformity of response

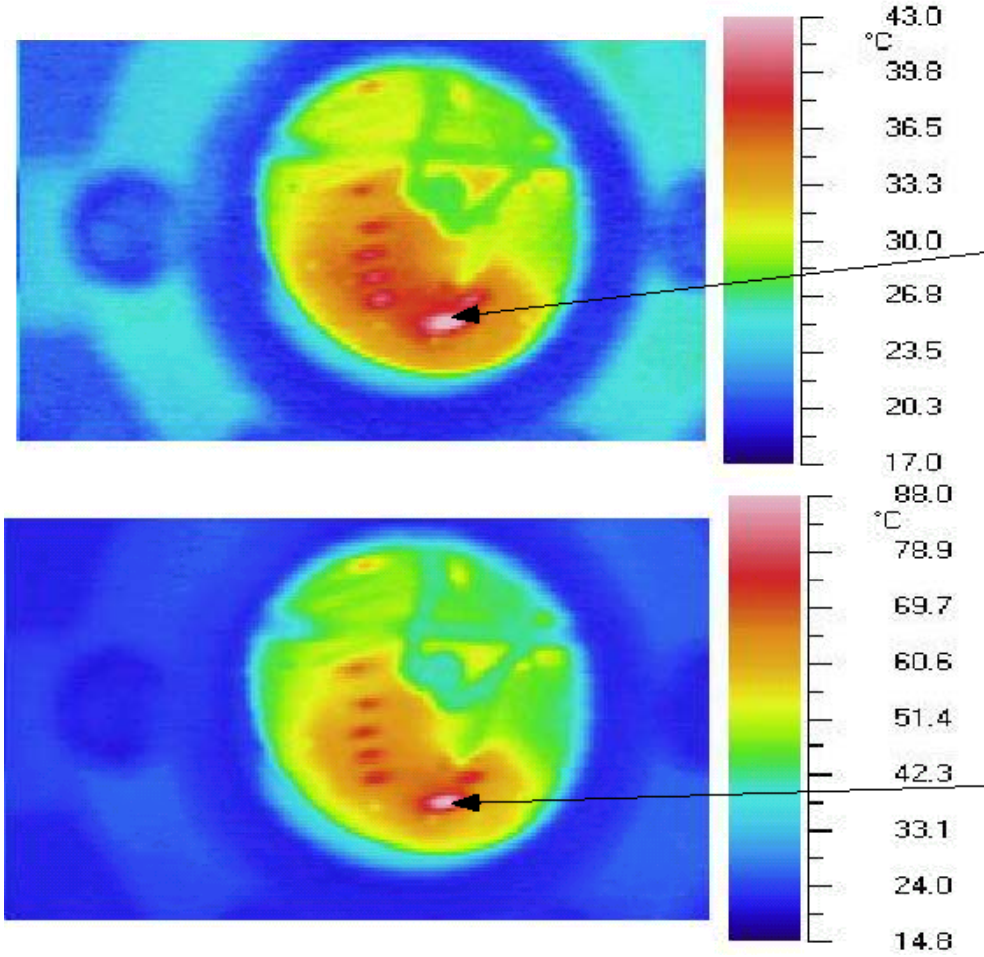
Cosmics telescope with drift chambers

The arrow indicates the start of the light guide



Operations in vacuum

PC board with a voltage divider with R1=480kΩ (one resistor) and R2, ..., R11 =240 kΩ in vacuum (3 10^{-2} mbar) observed with a Thermo-Camera (IR) trough a CaF_2 window



HV= 1500 V

Measured temperature of R1 ~ 45 °C corresponding to 70°C after calibration (correction due to the CaF_2 window. See next slide)

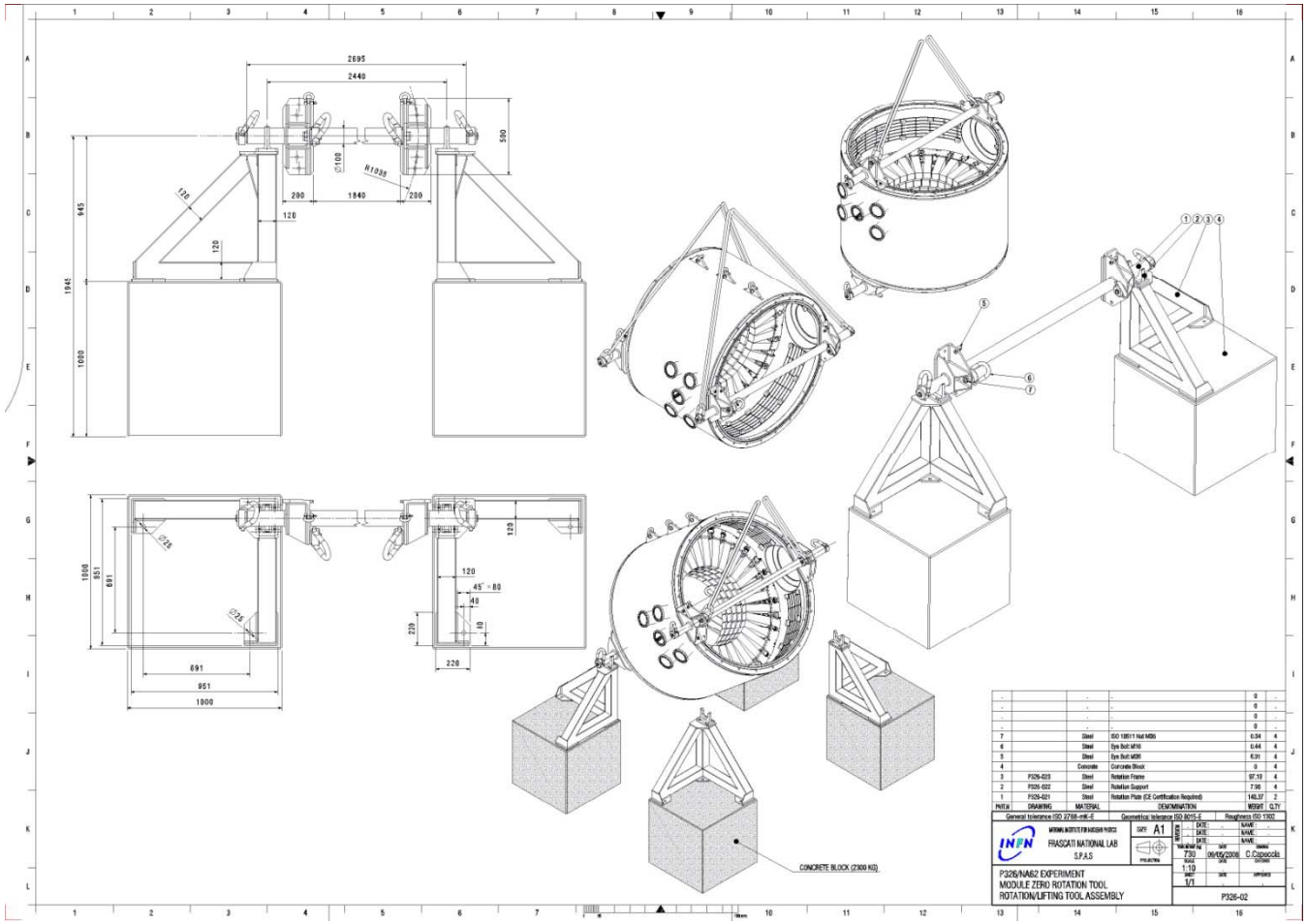
HV= 2500 V

T_{R1} ~ 130 °C (calibrated)

Highlights from 2007 status report

- Effect of the geometry on the inefficiency
  - Limit to the inefficiency due to dead space between the LAV
  - Inefficiency of the LKr is critical
- R&D for the large angle vetoes
  - Lead/scifi sandwich, lead/scint and old OPAL lead glass
  - All three tested, results are equivalent
  - Lead glass solution chosen
- Activity started for lead glass usage
  - Preliminary mechanical solutions
  - Measurement of the response to cosmics of a suitable sample (including uniformity of response vs impact point)
  - Setup of Geant4 simulation of lead glass blocks
- Results from analysis of data about the LKr inefficiency
  - Better than 10^{-5} above 10 GeV

Mechanical design



Tools to move and rotate the support

Block types and quantities

- Final accounting of the OPAL blocks
  - 3606 blocks (1798 good, 1808 flooded)
- Which types?
  - Type 11-16: mumetal length = 11 cm
  - Type 10: mumetal length = 11.5 cm
  - Type 9: mumetal length = 12.5 cm
  - Type 7-8: mumetal length = 14.5 cm
  - In origin, 640 block for each type, only 160 for type 16
  - Our design is tailored to types 11-16
- How many we need?
  - 1-5 : 5 layers, 32 blocks/layer 800 blocks
  - 6-8: 5 layers, 48 blocks/layer 720 blocks
  - 9-11: 4 layers, 60 blocks/layer 720 blocks
  - 12: 4 layers, 64 block/layer 256 blocks
  - Total 2946 blocks

Type	Good	Flooded	Total
7	81	79	160
8	156	164	320
9	155	163	318
10	166	152	318
11	152	158	310
12	147	163	310
13	231	230	461
14	309	310	619
15	321	311	632
16	80	78	160

Possible use of the counters

Ring	Type used	# needed	Existing A	Existing B	Left
1	15	160			
2	15	160			
3	15	160	321	311	152
4	14	160			
5	14	160			
6	14	240	309	310	59
7	4x13+1x16	192+48			
8	4x13+1x16	192+48	231+80	230+78	77+60
9	12	240	147	163	70
10	11	240	152	158	70
11	10	240	166	152	78
12	9	256	155	163	62

Existing A = not touched by the flood Existing B = touched by the flood

Basic schematics of the readout electronics