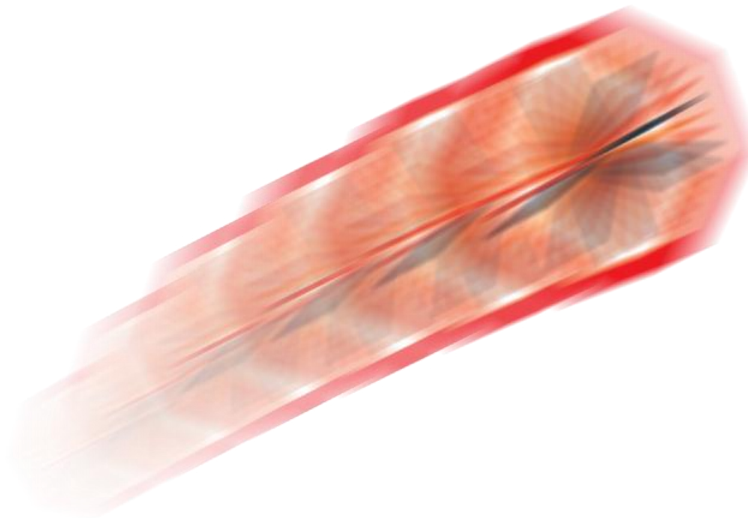
# Fast Interaction Trigger (FIT)

**X. Y.**
*on behalf of FIT Collaboration*

March 2014

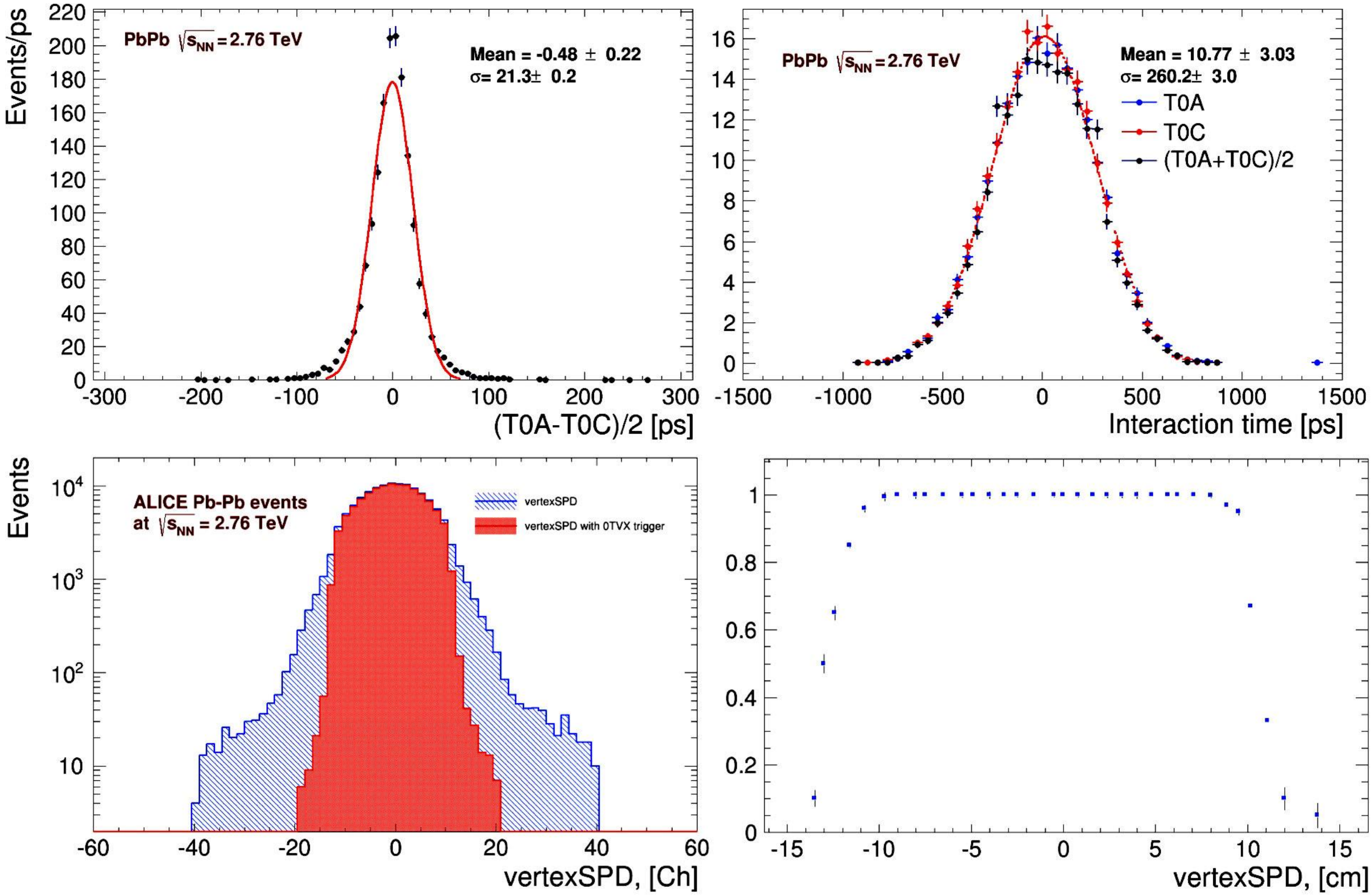
# Outline



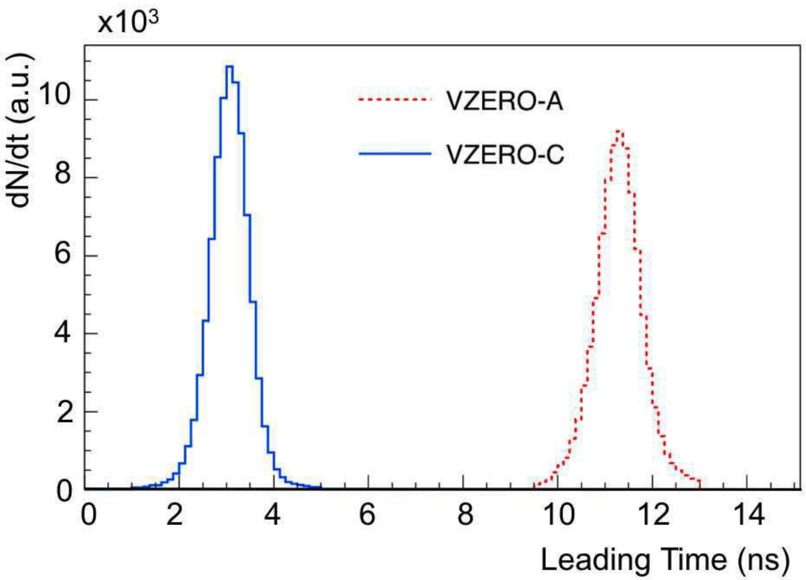
# Required functionality for FIT @ Run3

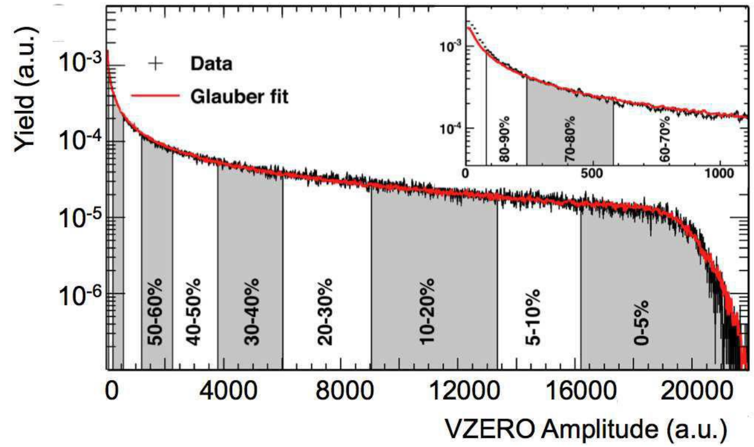
- Minimum Bias trigger for pp collisions with efficiency comparable to the current V0: 83 % for vertex (A&C) and 93% for the OR signal (A|C).
- Event Multiplicity determination capable of selecting and triggering on central as well as on semi-central collisions. The centrality selection should match the performance of the present V0.
- Vertex location with a performance comparable to the present T0 system.
- Evaluation and rejection of beam-induced background and in particular beam gas event sensitivity on the level of the current V0 detector.
- Time resolution better than 50 ps for pp collisions, as in the present T0 system.
- Determination of collision time for TOF with resolution better than 50 ps.
- Event plane determination with a precision similar to the present V0 system.
- Minimal ageing over the ALICE operation period.
- No after pulses or other spurious signals.
- Direct feedback to LHC on luminosity and beam conditions.

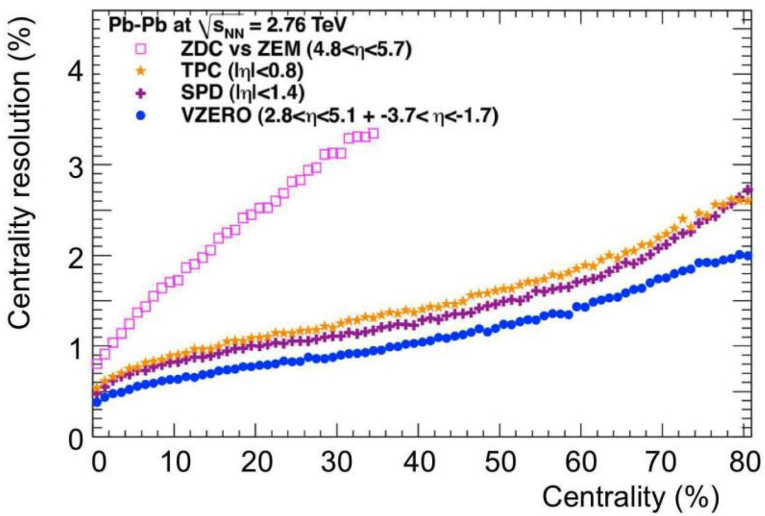
# T0 performance during Run1

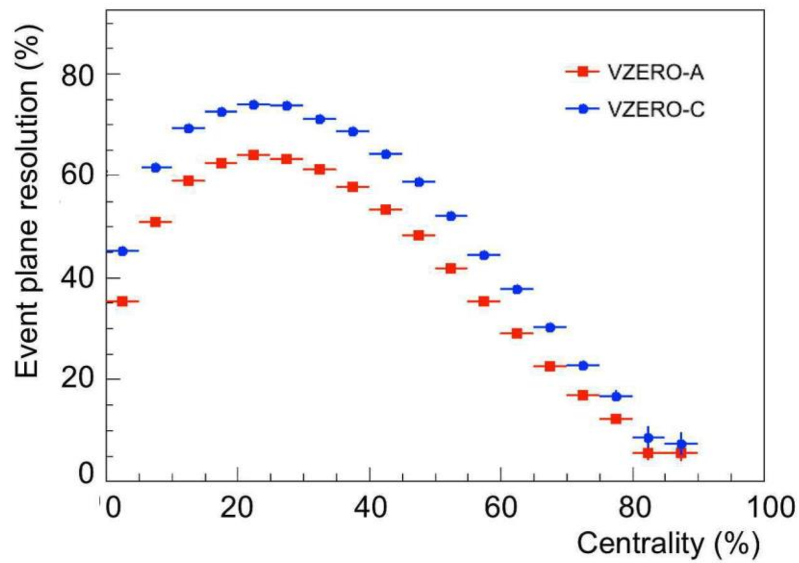


# V0 performance during Run1



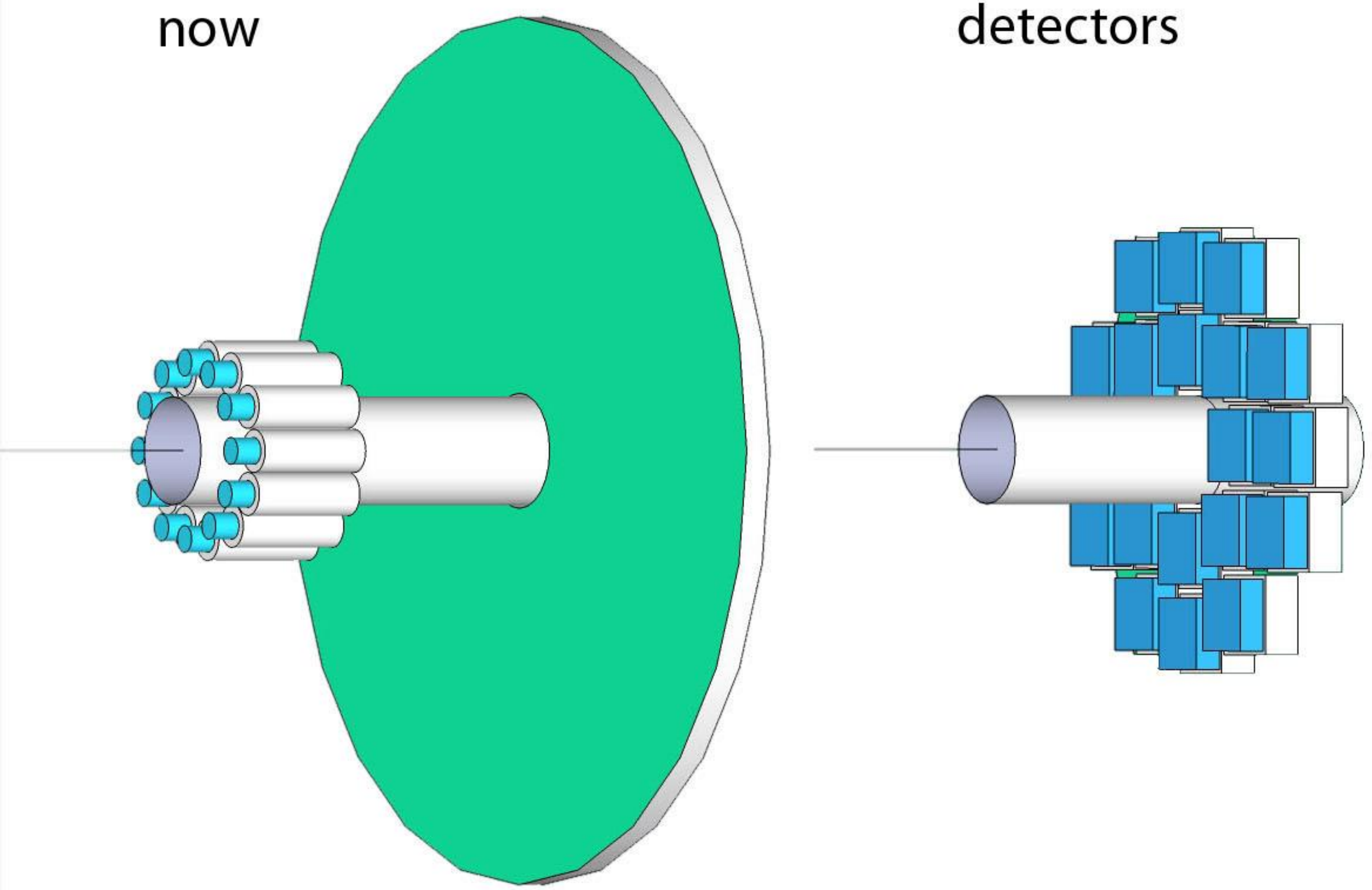



# T0 & V0 → FIT (T0+)

T0 and V0 now

Upgraded detectors



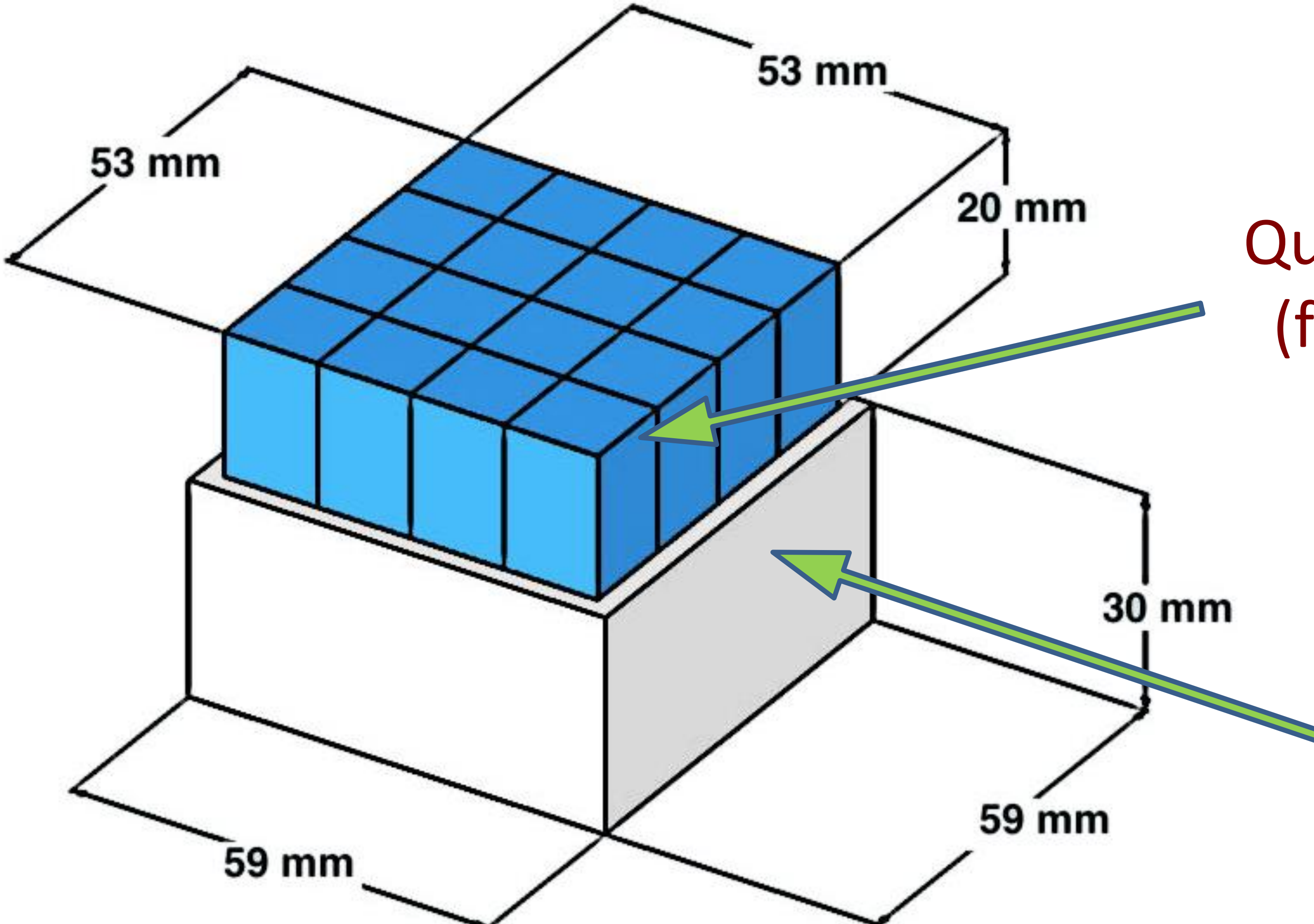
# Efficiency comparison

| | A | C | A&C | A\|C |
|---|---|---|---|---|
| pp @ 14 TeV | | | | |
| **V0***  | 0.88 | 0.88 | 0.83 | 0.93 |
| **T0-Plus*** $R_{min}$=50 mm | 0.89 | 0.89 | 0.84 | 0.94 |
| **T0-Plus*** $R_{min}$=60 mm | 0.88 | 0.88 | 0.83 | 0.93 |
| **T0-Plus** Detailed geometry $R_{min}$=60 mm | 0.88 | 0.86 | 0.80 | 0.93 |
| PbPb @ 5.5 TeV (b>13 fm; 70-100% centrality) | | | | |
| **T0-Plus** Detailed geometry $R_{min}$=60 mm | 0.97 | 0.98 | 0.95 | 0.996 |

**Table 10.1:** Efficiency comparison between the current V0 and the proposed T0-Plus. Asterisks indicates that the simulations were done using a simplified geometry.

# T0-Plus detector unit

(shown dimensions are without the protective housing nor cabling)

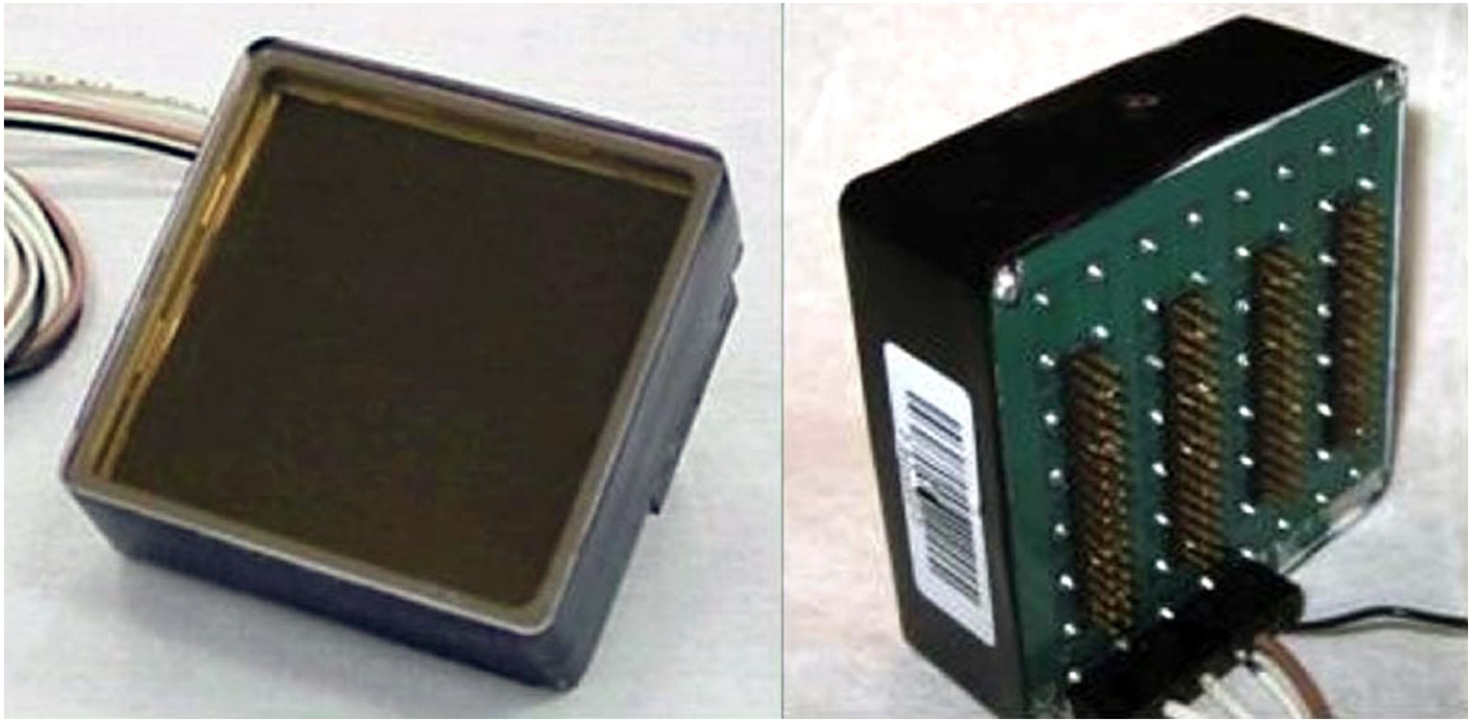



Quartz radiator (fragmented) ~125 g

MCP – PMT ~130g

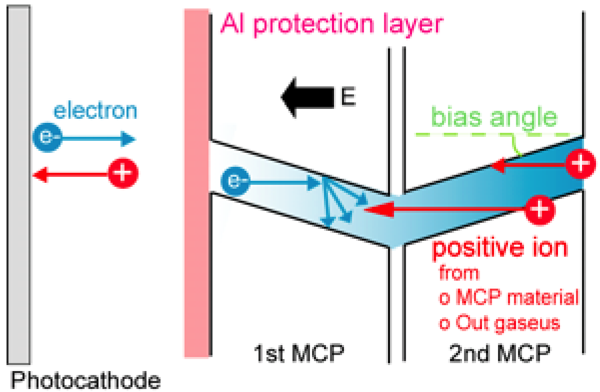
**Weight with electronics 400 – 500 g**

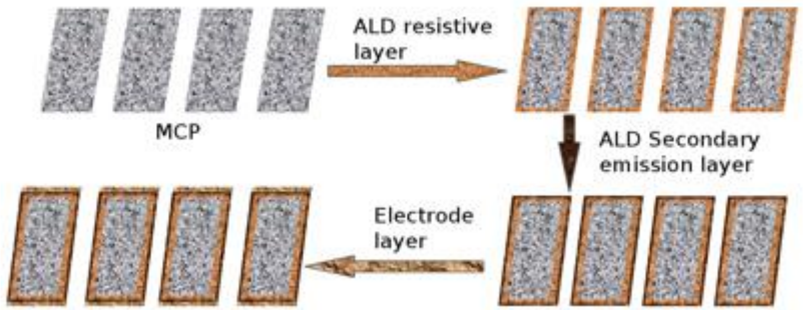
# Photonis PLANACON®
# XP85012 or XP85112



# Big progress in MCP technology
## (since the initial R&D for ALICE)

- Appearance of commercially available MCP-PMTs (Hamamatsu, Photonis USA, BINP)
- Significant and ongoing improvement in lifetime:
  - Atomic Layer Deposition technology [NIM A639 (2011) 148]

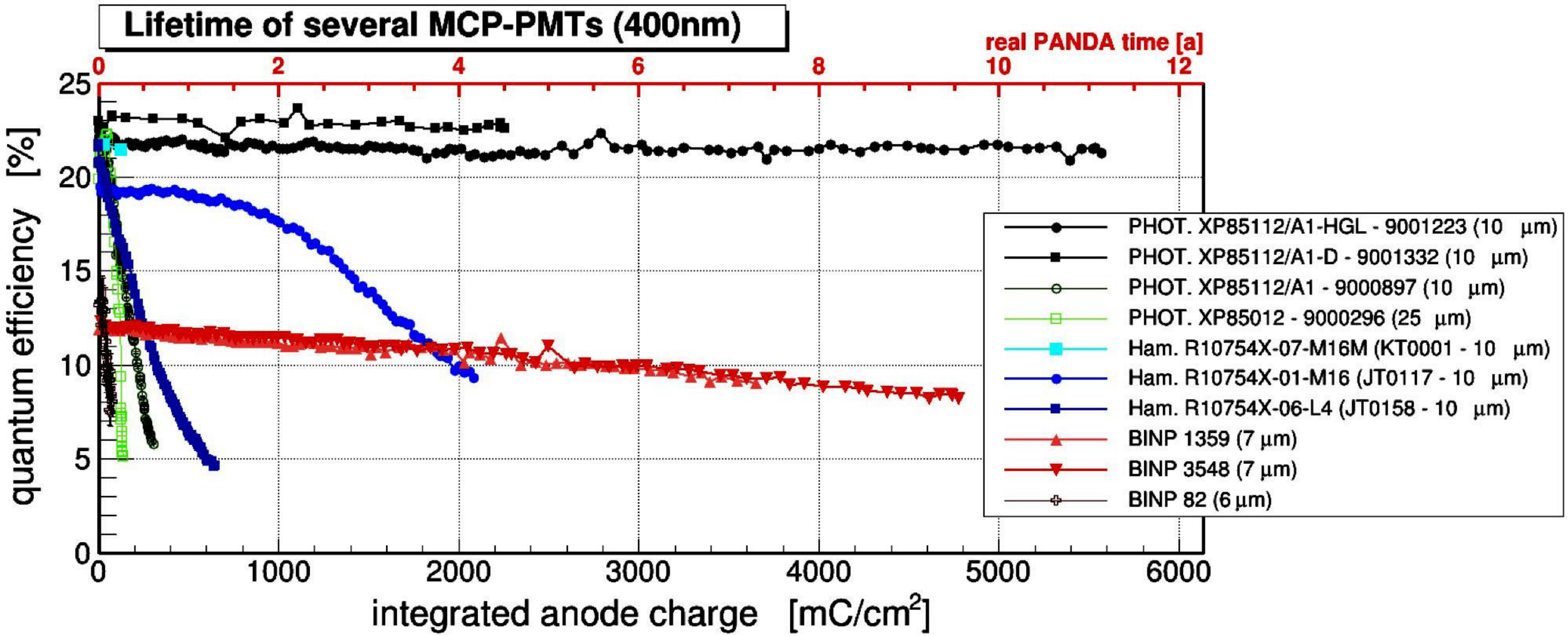



  - Modified photocathodes [JINST 6 C12026 (2011)]
  - Reduced outgassing (borosilicate glass)

**For more information**: Albert Lehmann, $12^{th}$ Pisa Meeting on Advanced Detectors, May 2012

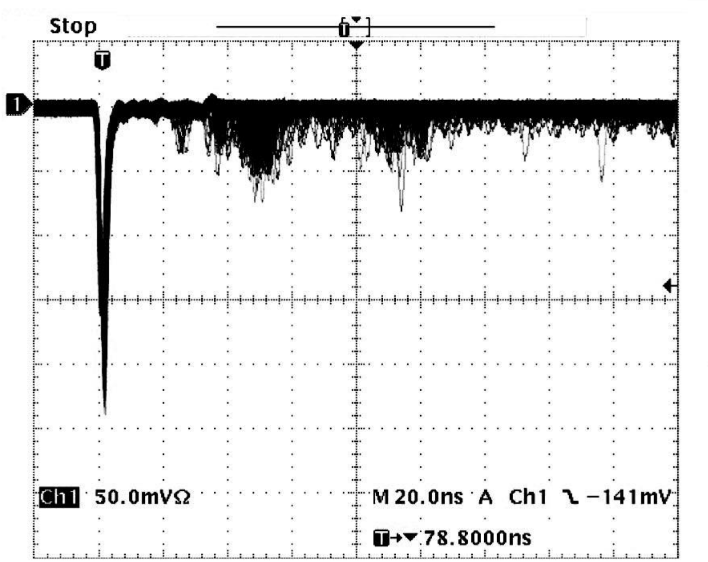
# Reliability and lifetime

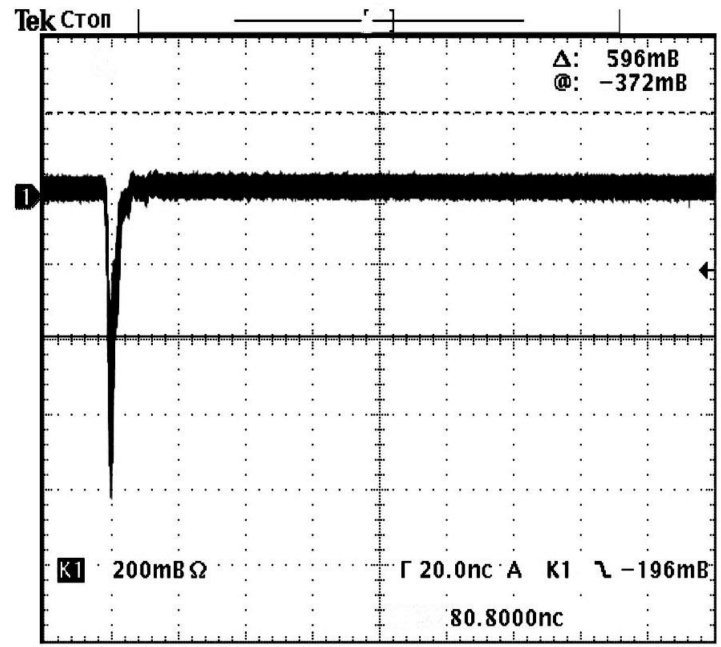



Dependence of the Quantum Efficiency on the Integrated Anode Charge for a variety of MCP-PMT sensors measured by PANDA collaboration. The performance of the ALD treated samples from Photonis USA is shown by the top curves.

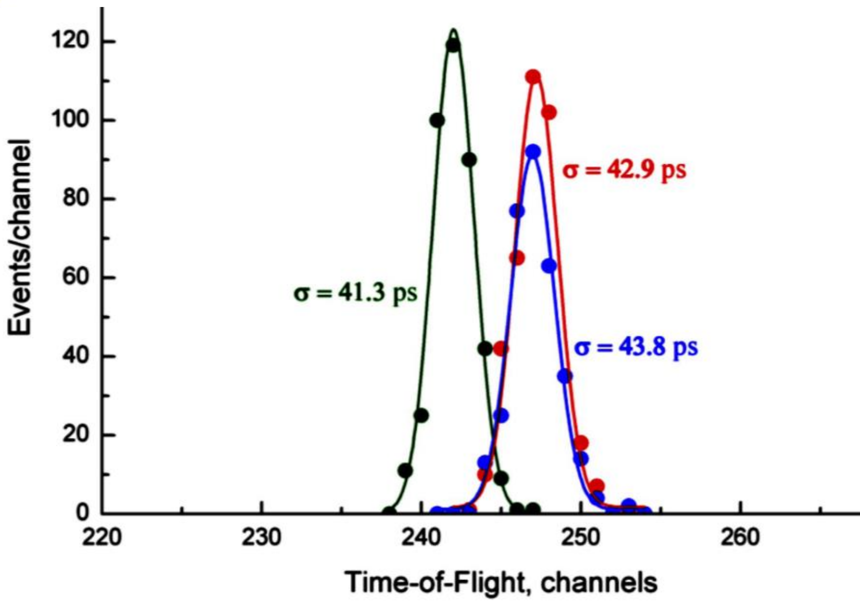
*A. Lehmann. Lifetime measurements of MCP-PMTs. DIRC2013: Workshop on fast Cherenkov detectors, Giessen Sept 4, 2013.*

# PMT (T0) vs. MCP-PMT (T0-Plus)

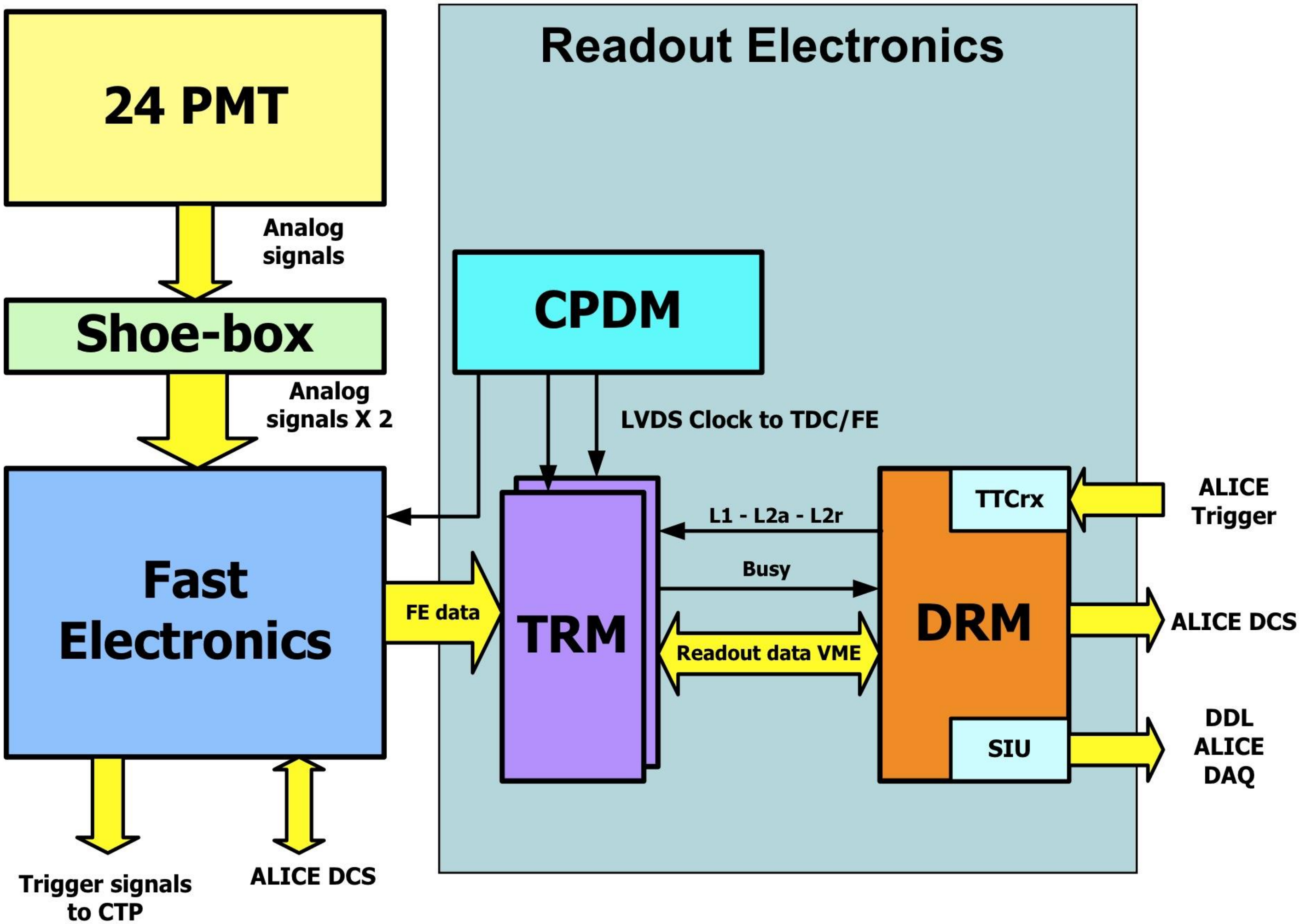


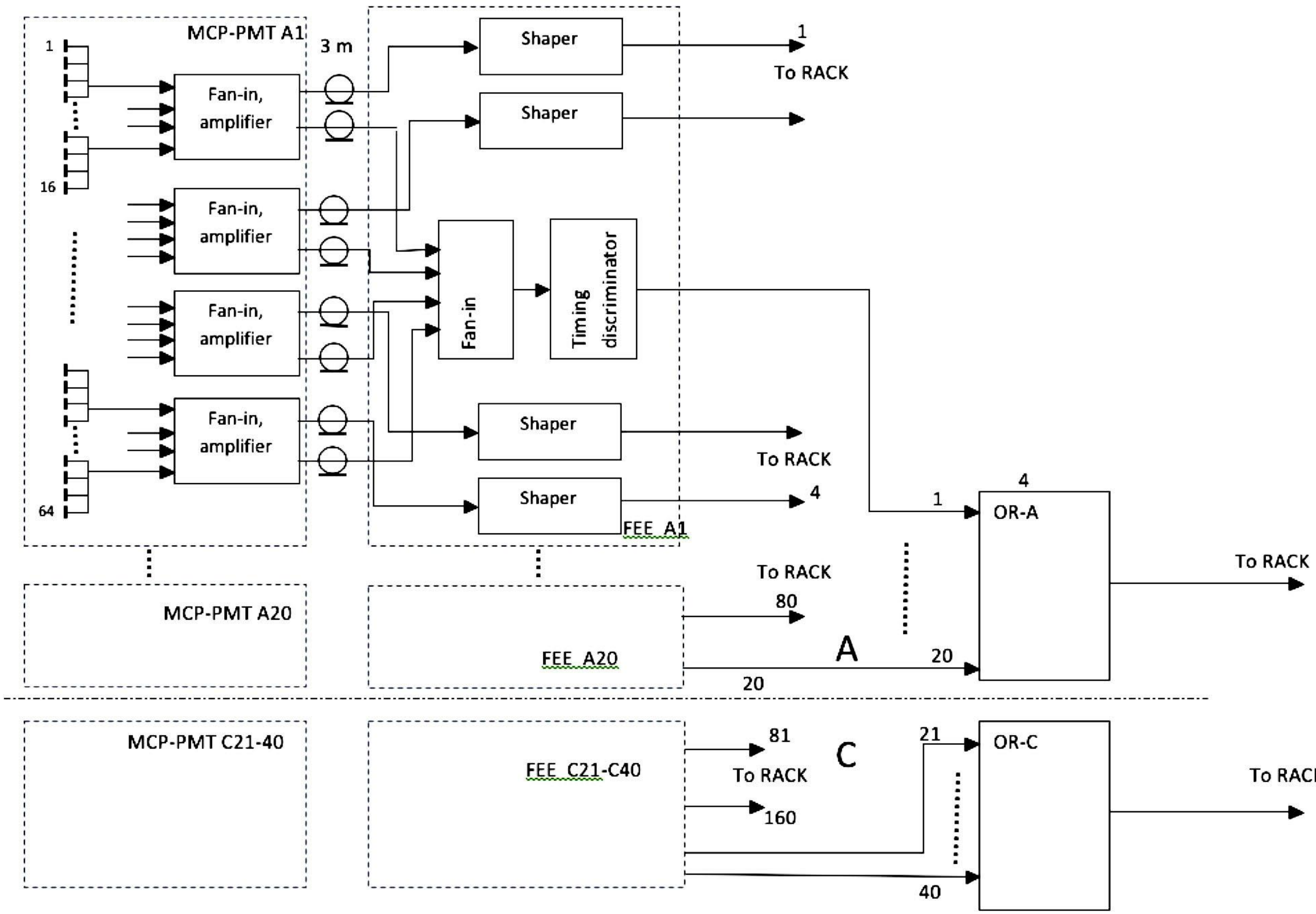
# Prototype of MCP-PMT based detector module (NIKA)



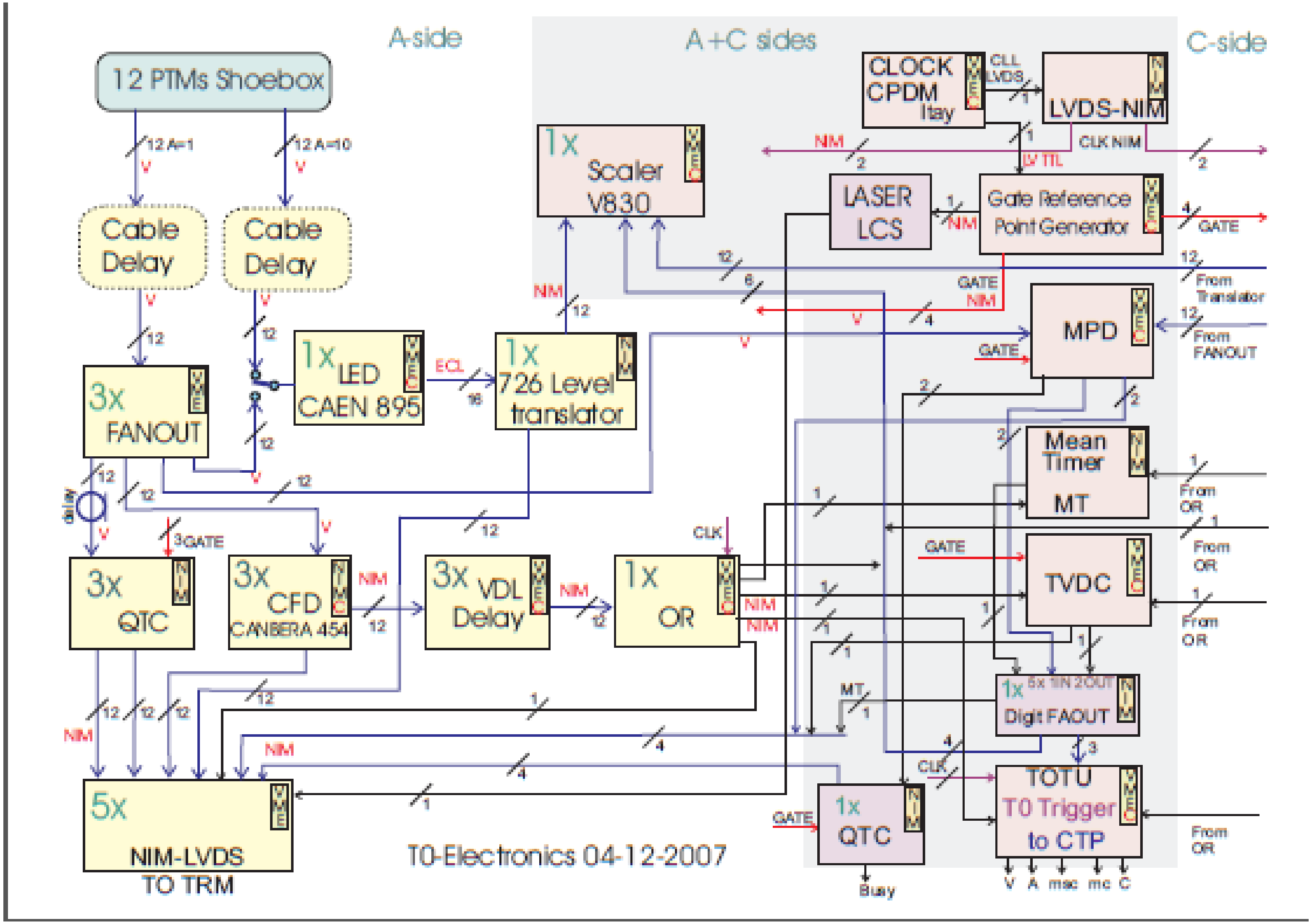
# FIT electronics and readout will follow the T0/TOF solution



# First draft of shoebox/preamp stage for FIT



# T0/FIT fast electronics



# FIT cost

| T0-Plus | [kCHF] |
|---|---|
| MCP-PMT | 500 |
| Readout electronics | 480 |
| Services and Mechanics | 40 |
| T0-PlusTotal | 1020 |

# FIT Institutes

1. Chicago State University, Chicago, United States
2. Helsinki Institute of Physics (HIP) and University of Jyväskylä, Jyväskylä, Finland
3. Institute for Nuclear Research / Academy of Sciences, Moscow, Russia
4. Moscow Engineering Physics Institute, Moscow, Russia
5. Niels Bohr Institute, University of Copenhagen, Copenhagen, Denmark
6. Russian Research Centre Kurchatov Institute, Moscow, Russia

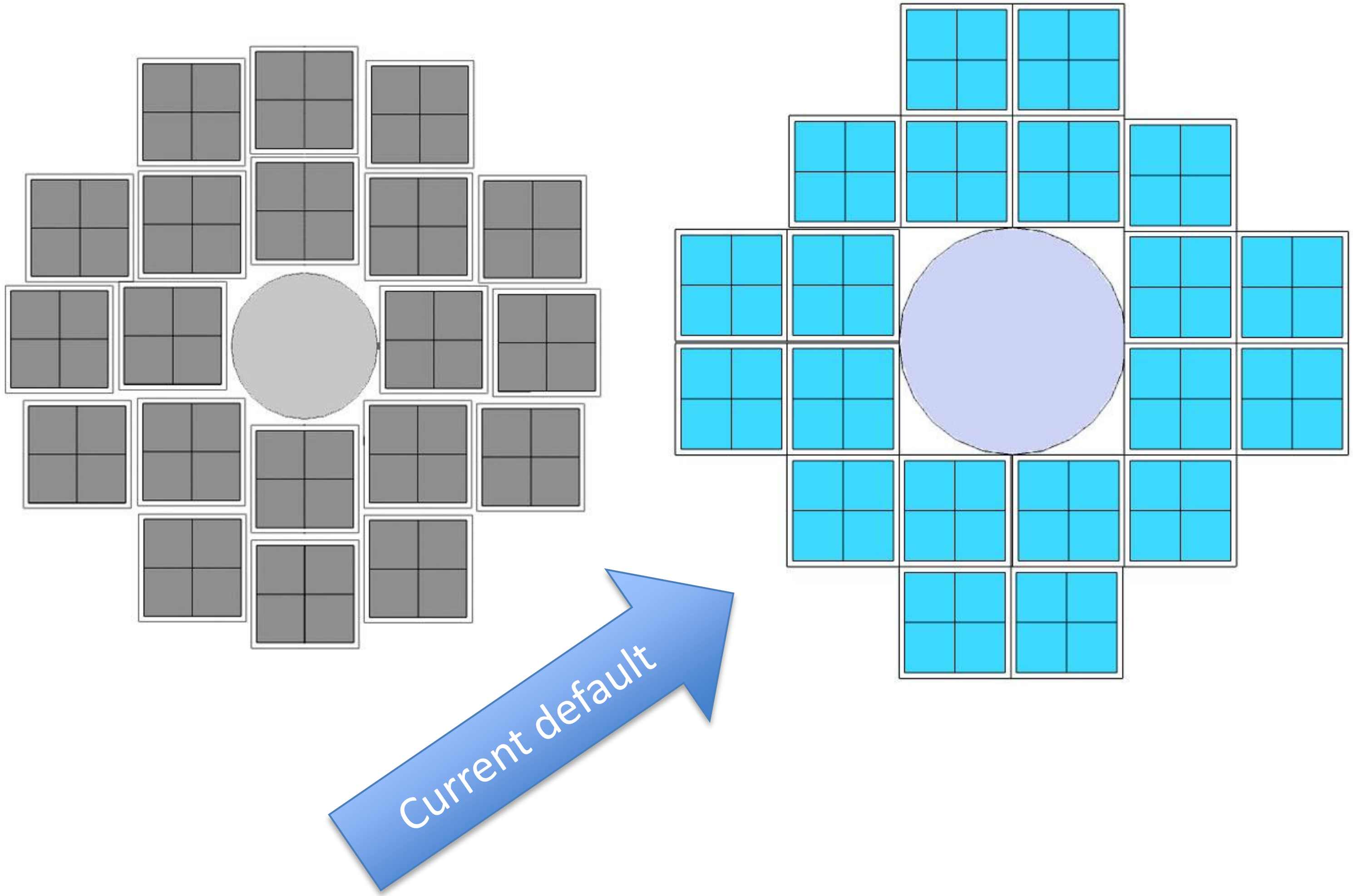
# FIT schedule

- **2013-2016** prototyping of detector modules and electronics; in-beam tests
- **2017** Purchase of MCP-PMT sensors and assembly of detector modules and electronics
- **2018** FIT installation

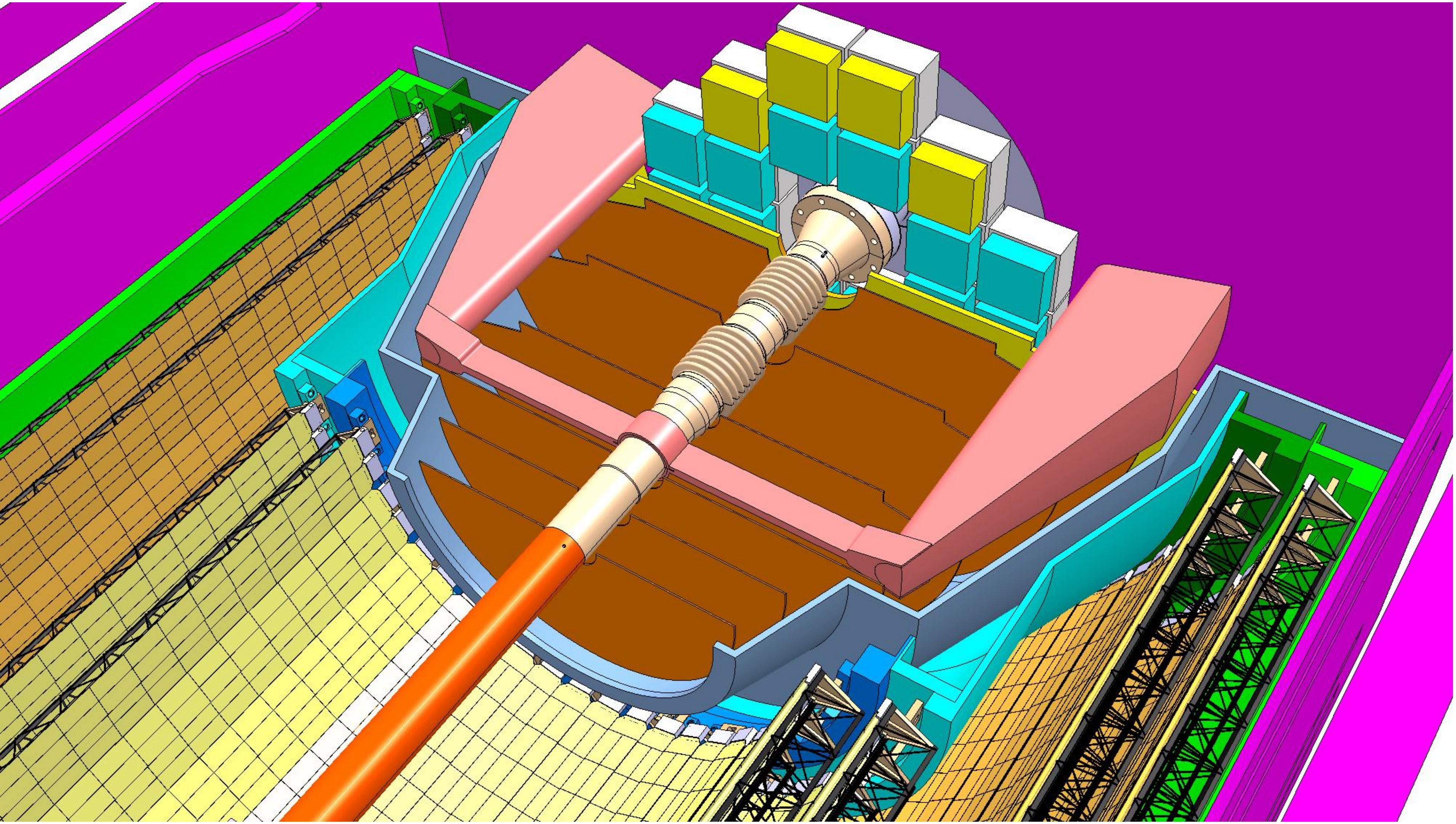
# Considered configurations on the C-side

$R_{MIN} \cong 5$ cm vs. $R_{MIN} \cong 6$ cm

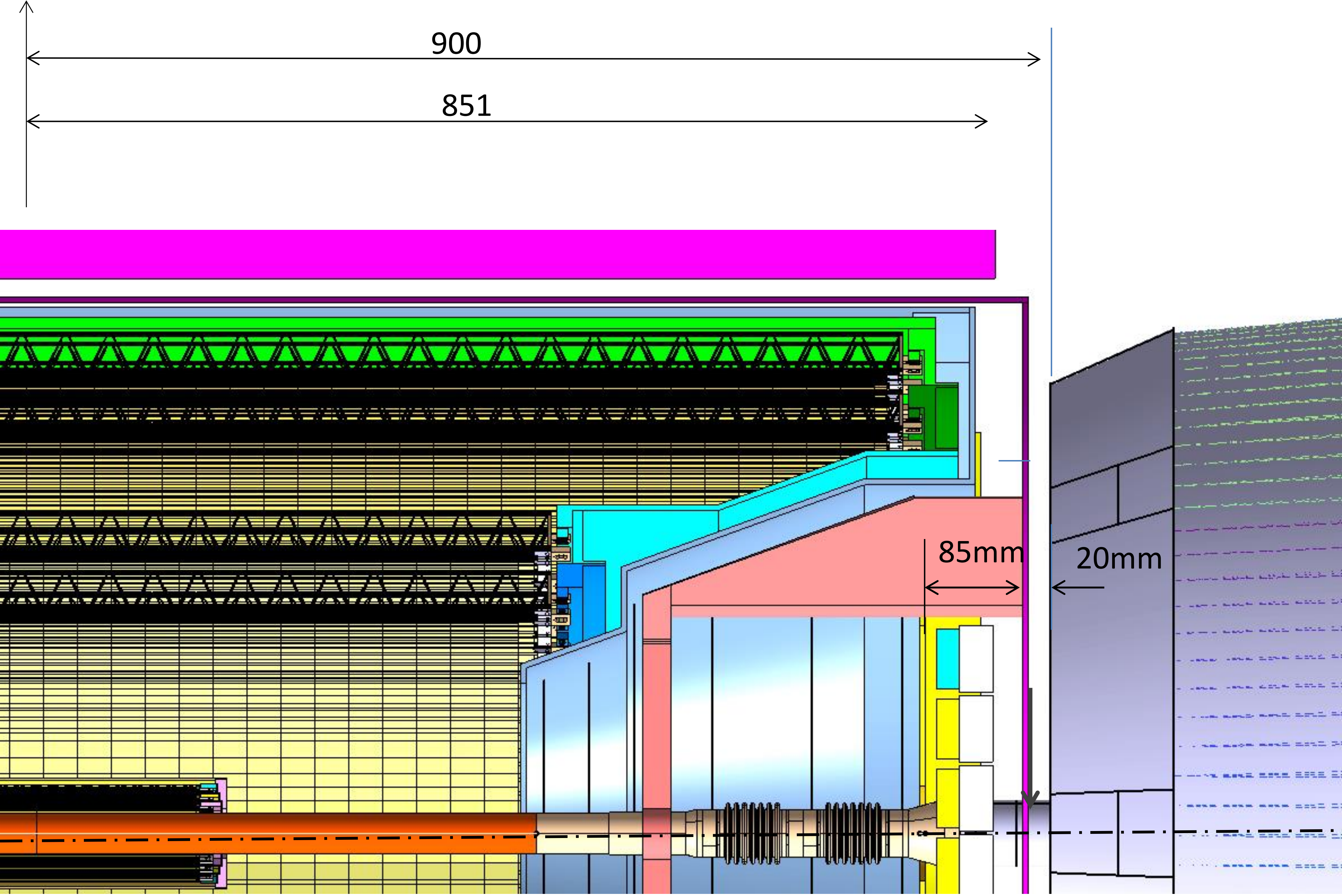
(20 detector modules)



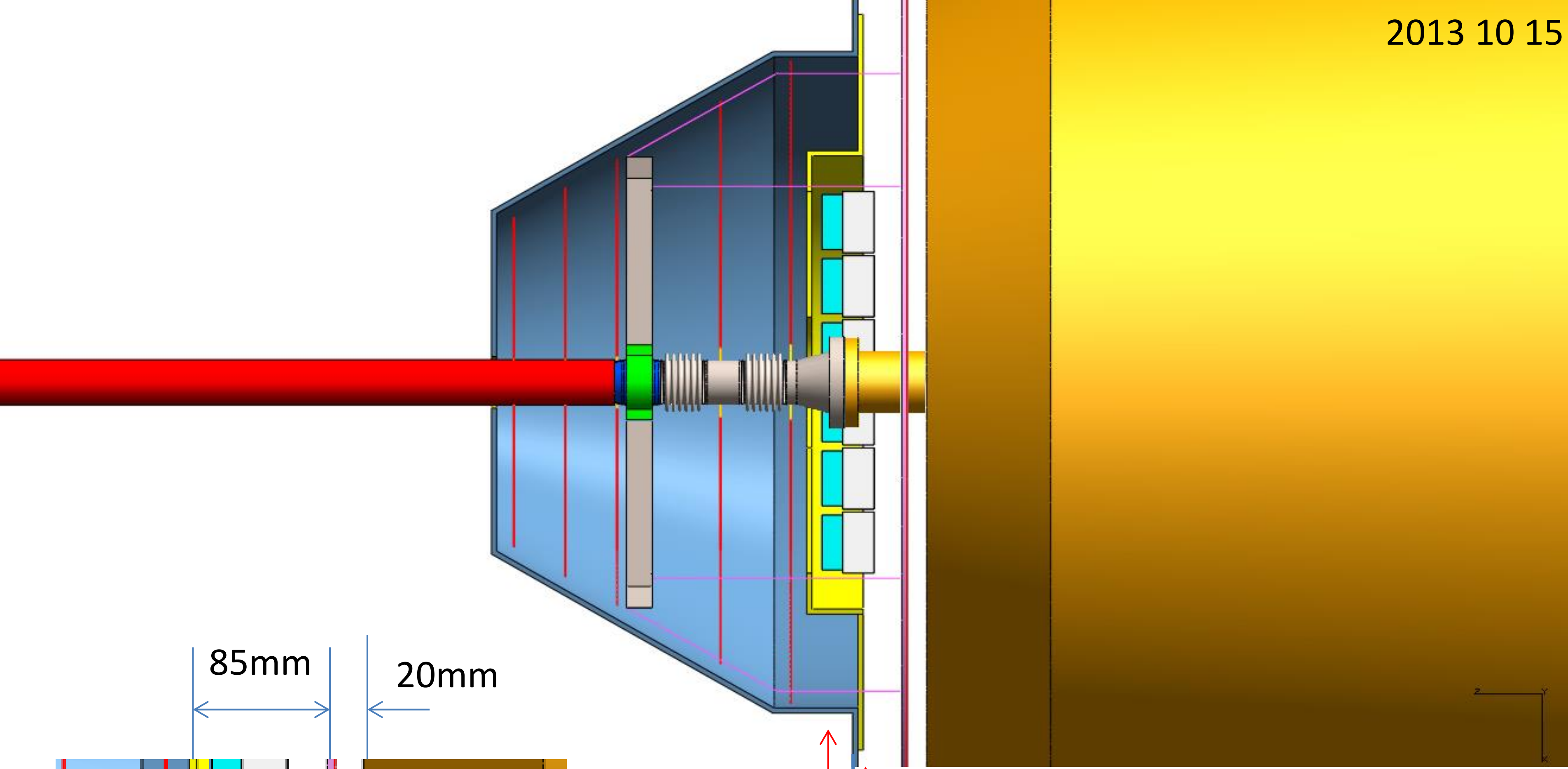
# Integration on the C-side (ITS, MFT, FIT)

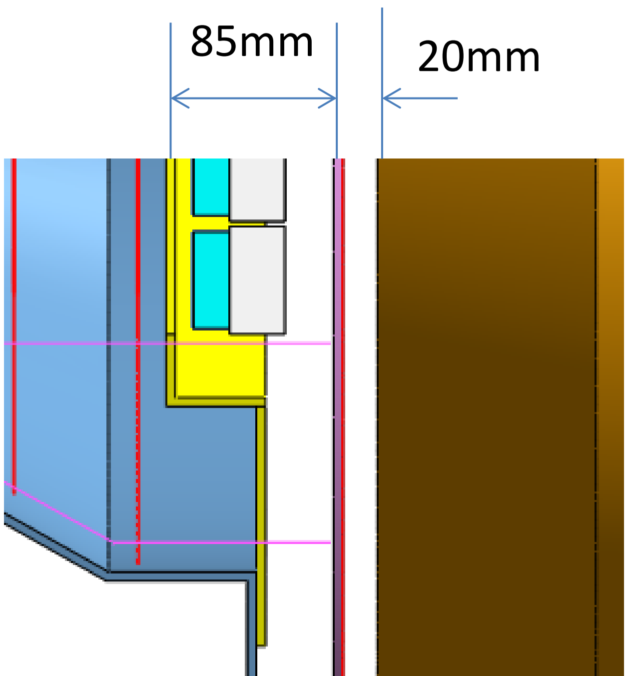


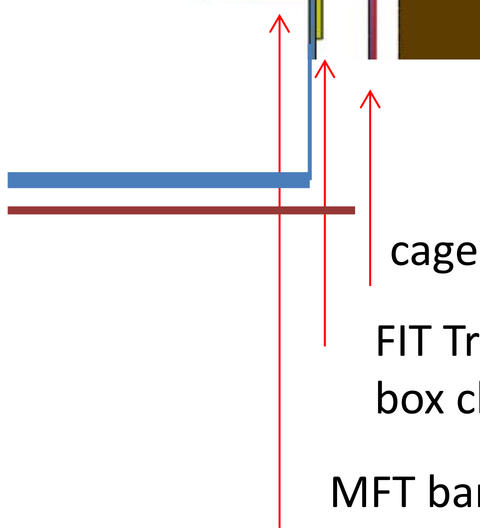
Corrado Gargiulo




Corrado Gargiulo

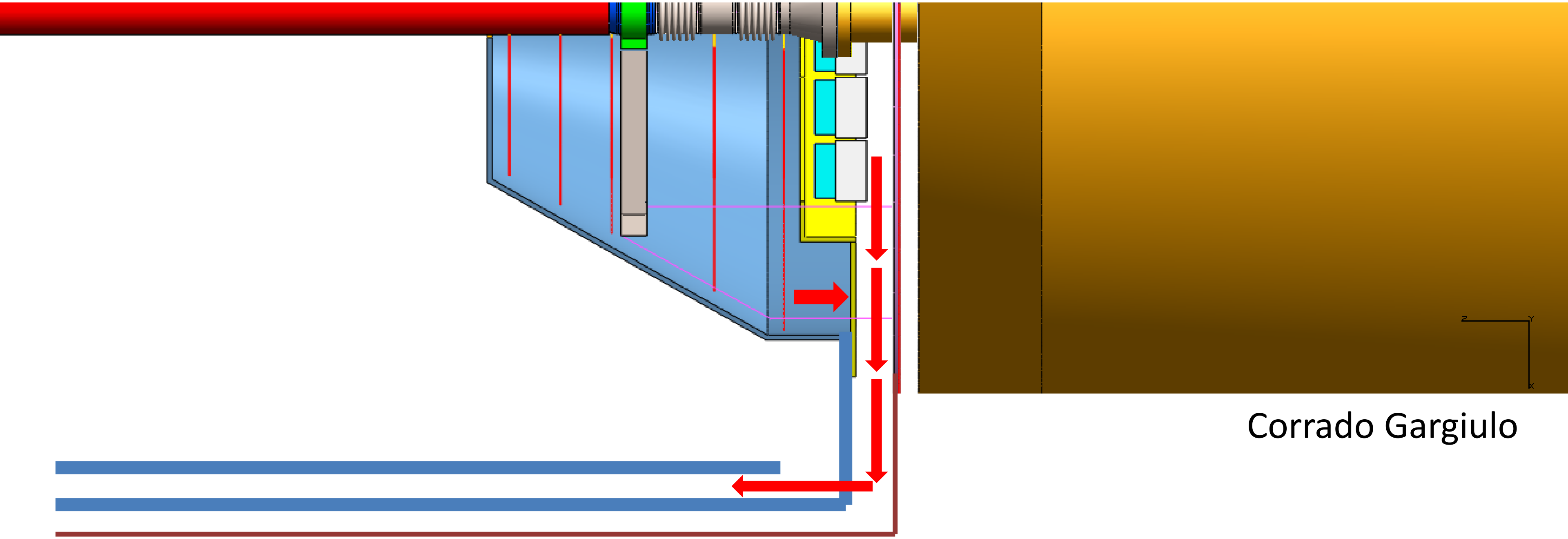




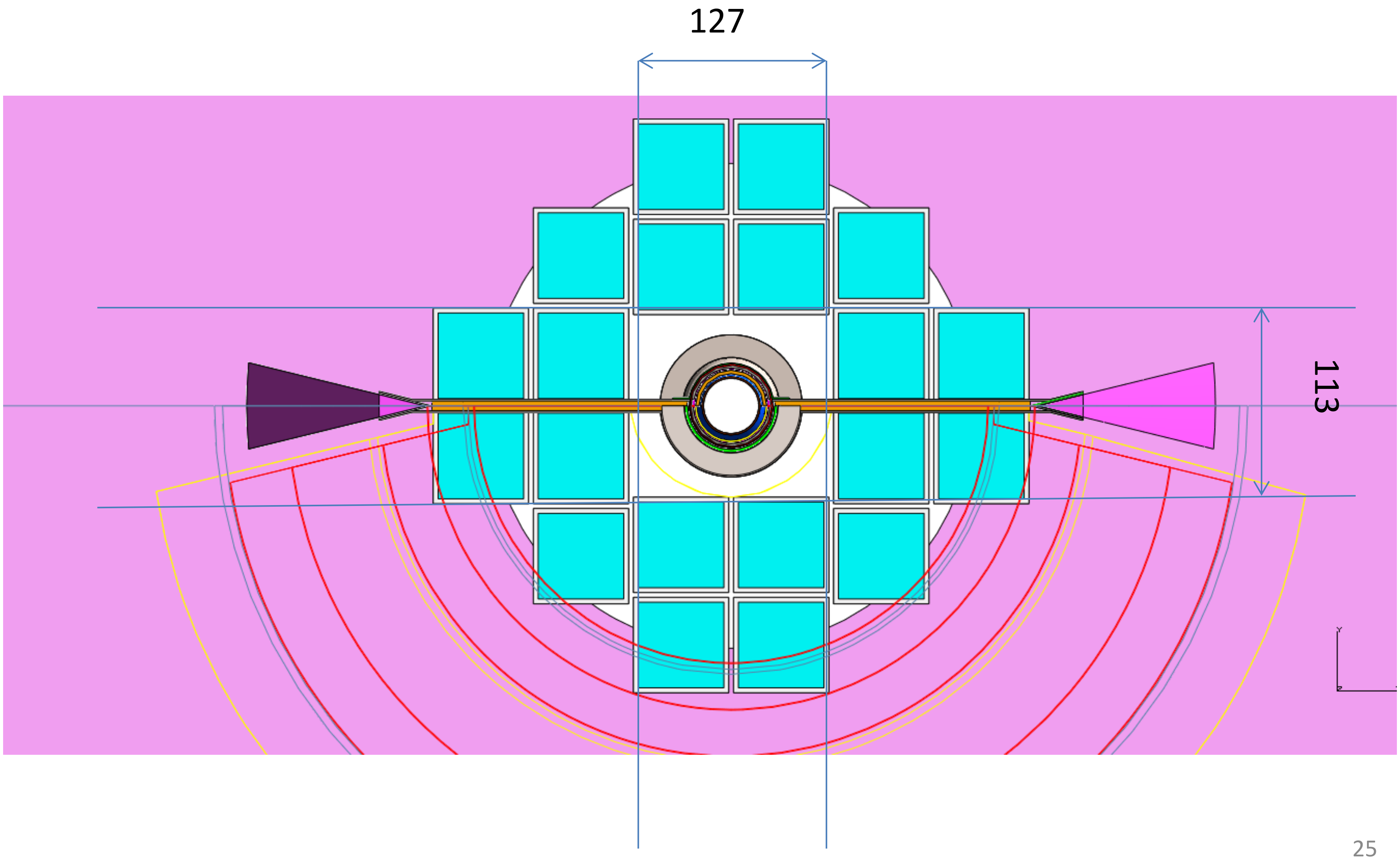

Corrado Gargiulo

# FIT-C services would go to A-side

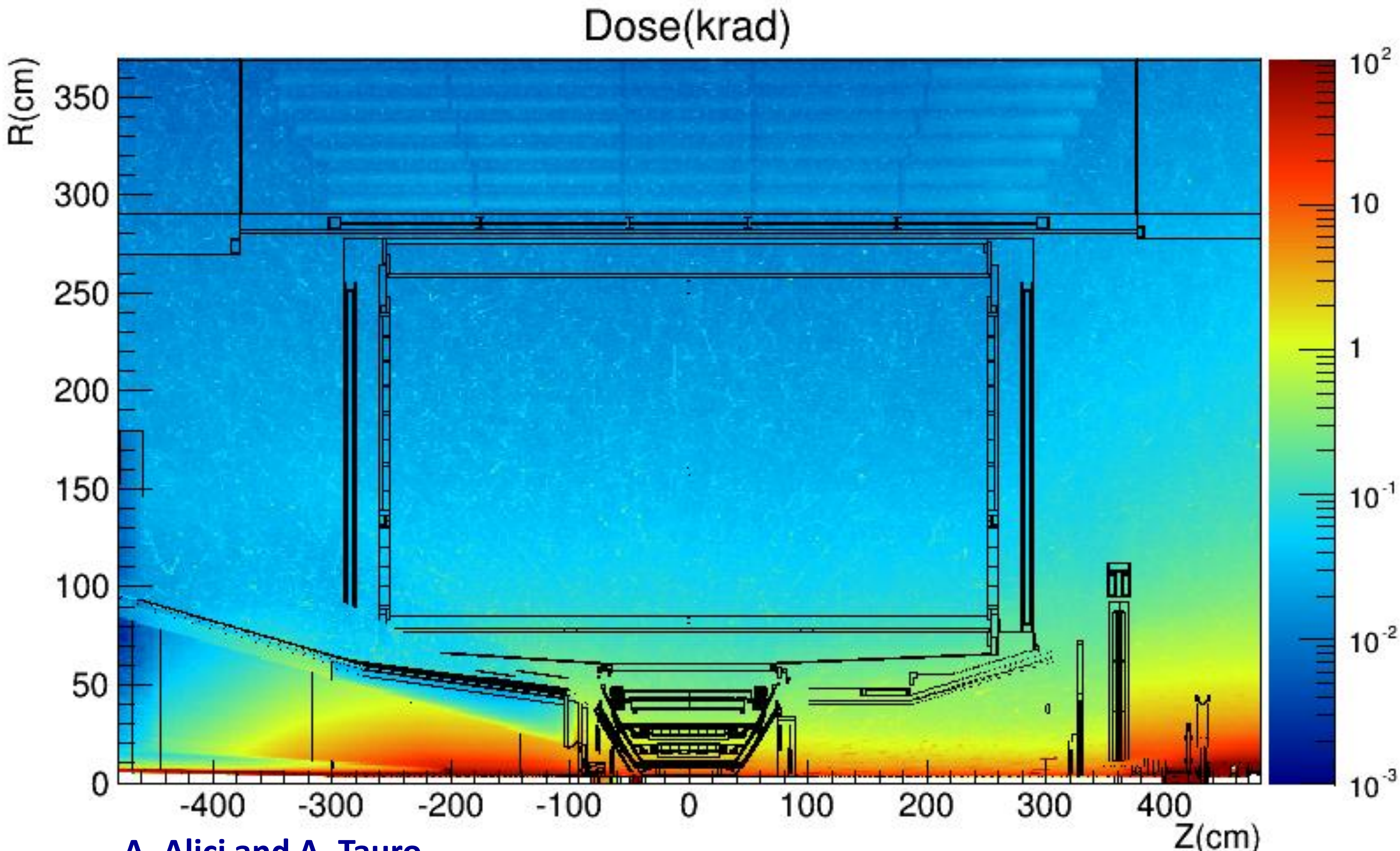


Corrado Gargiulo

# Current default configuration
## (imposed by MFT boundary conditions)

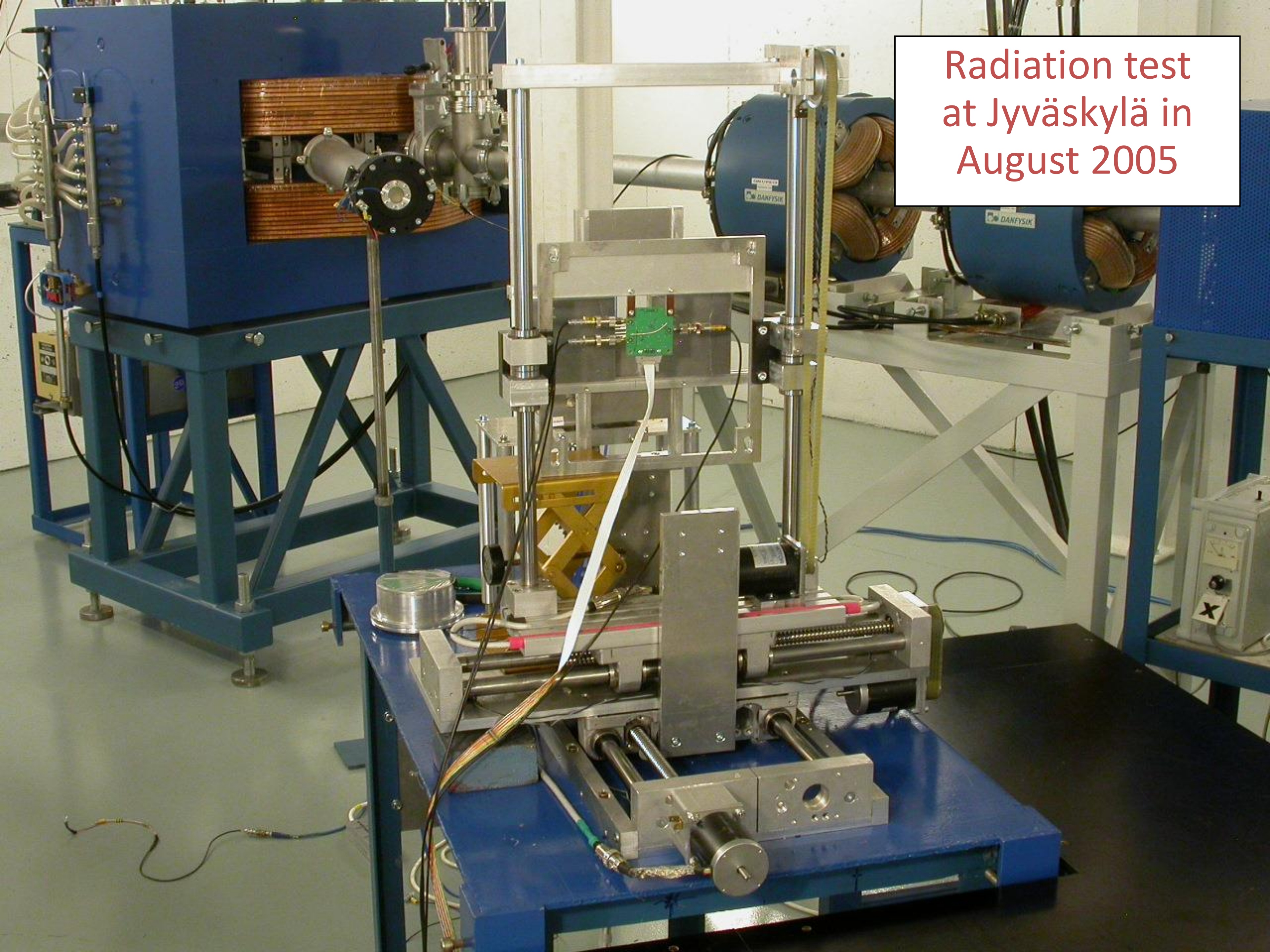


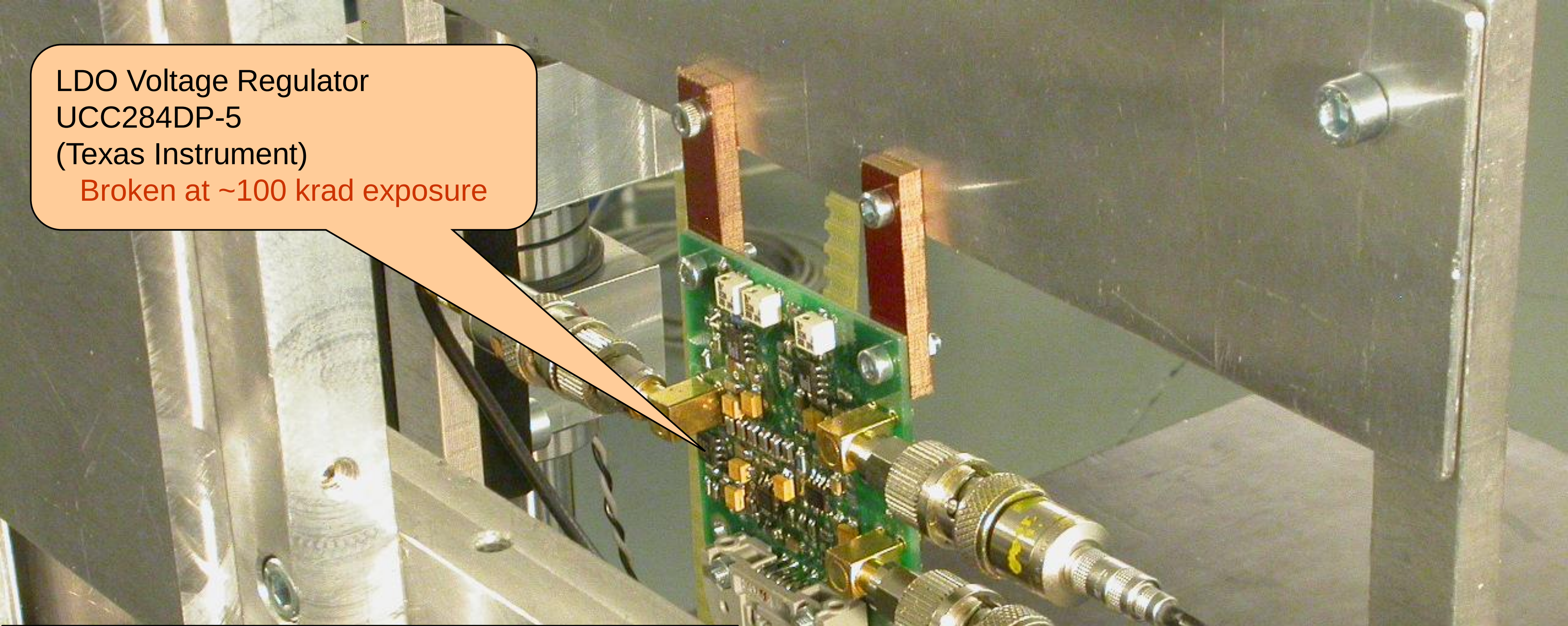
# Expected dose during Run3

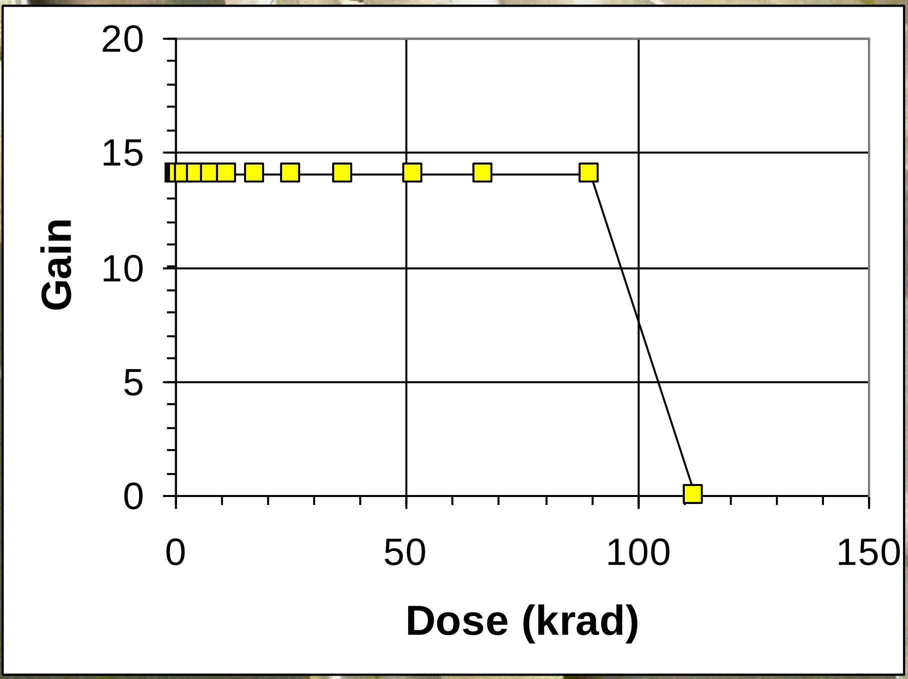


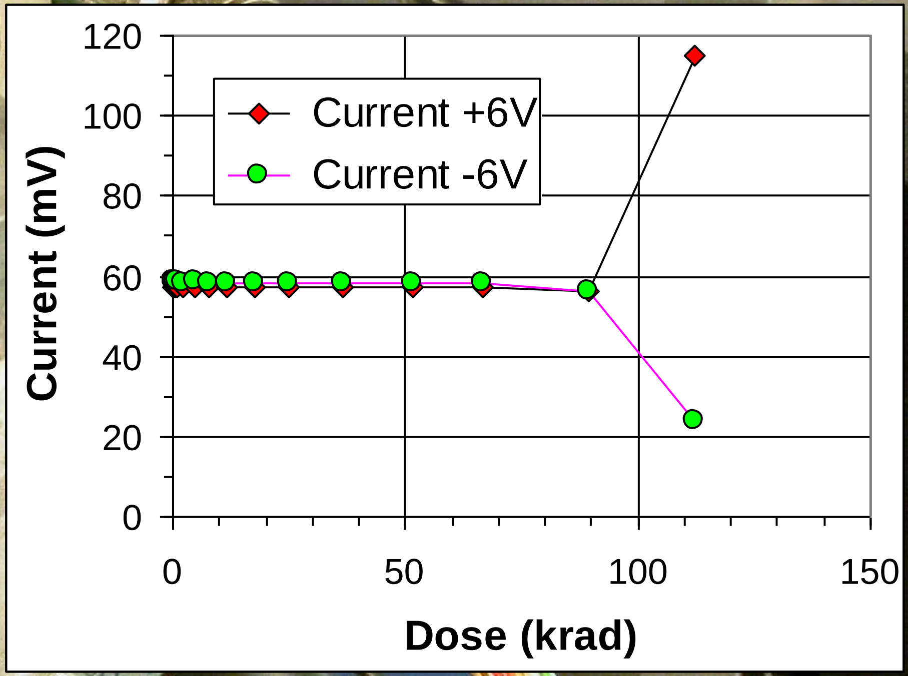

**A. Alici and A. Tauro**

Radiation test at Jyväskylä in August 2005

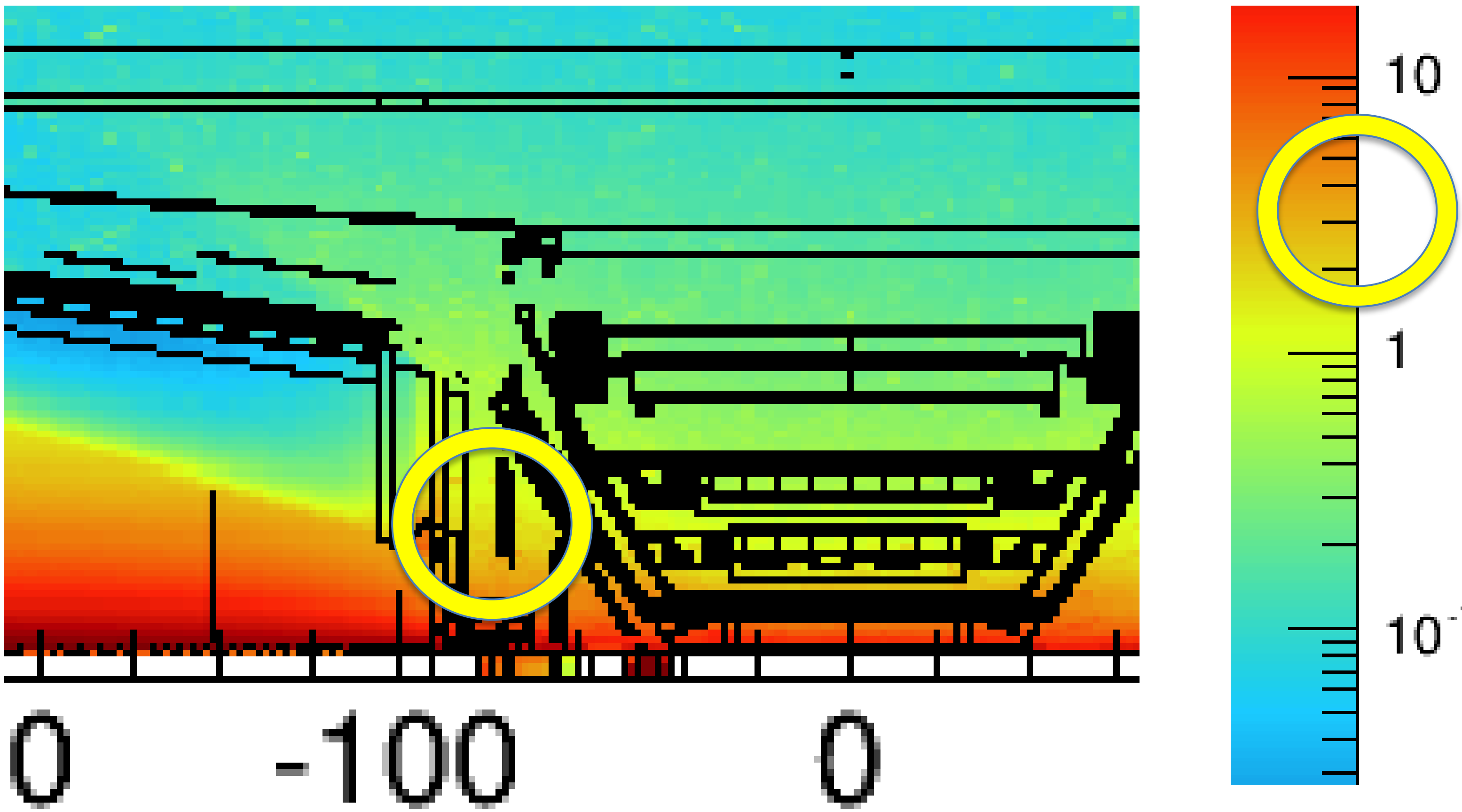



LDO Voltage Regulator
UCC284DP-5
(Texas Instrument)
Broken at ~100 krad exposure


20
15
10
5
0
Gain
0
50
100
150
Dose (krad)


120
100
80
60
40
20
0
Current (mV)
Current +6V
Current -6V
0
50
100
150
Dose (krad)

# Expected Run3 dose in the sensor region is < 10 krad



# Bandwidth calculations

| Detector & Collision type/Event type | Hits/event | TRM x crate | Word x TRM | HPTDC readout (µs) | Maximum rate due to HPDTC (kHz) | Crate payload (bytes) | Input Trigger Rate (kHz) | DDL Bandwidth (MB/s) | VME Bandwidth (MB/s) |
|---|---|---|---|---|---|---|---|---|---|
| Empty | 0 | 10 | 6 | 3.8 | 263 | 296 | 200 | 59.2 | 48 |
| Empty | 0 | 10 | 2 | 3.8 | 263 | 136 | 200 | 27.2 | 16 |
| TOF HM PbPb | 10000 | 10 | 36 | 6.8 | 147 | 1496 | 50 | 74.8 | 72 |
| TOF MB PbPb | 2000 | 10 | 12 | 4.4 | 227 | 536 | 50 | 26.8 | 24 |
| TOF MB pp | 100 | 10 | 7 | 3.9 | 256 | 336 | 200 | 67.2 | 56 |
| FIT HM PbPb | 160 | 8 | 66 | 9.8 | 102 | 2168 | 50 | 108.4 | 105.6 |
| FIT MB PbPb (0-80% centrality) | 160 | 8 | 66 | 9.8 | 102 | 2168 | 50 | 108.4 | 105.6 |
| FIT MB pp | 25 | 8 | 16 | 4.8 | 208 | 568 | 200 | 113.6 | 102.4 |

**Pietro Antonioli**

| | |
|---|---|
| TRM Empty readout [µs] | 3.8 |
| DRM words (CDH + TOF) | 14 |
| Single hit readout [µs] | 0.1 |

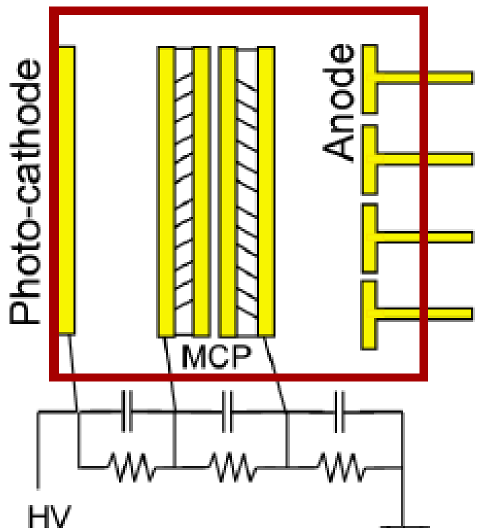
T0-Plus (40 modules; 160 segments) is already <u>close to the bandwidth limit</u> of one create readout system! Increasing of the segmentation or adding of the second detector (V0-Plus) would require the second crate (brute force approach) or a new/clever way of processing the input data.

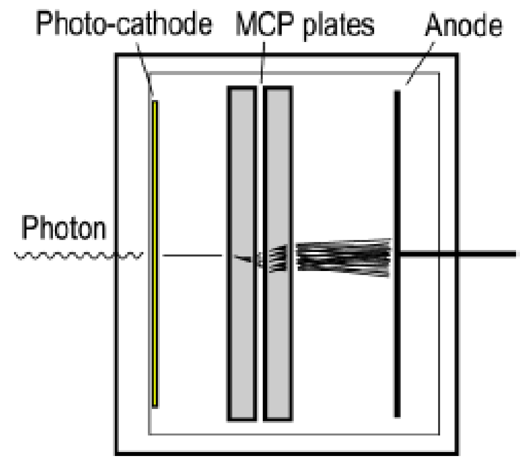
Thank you for your attention!

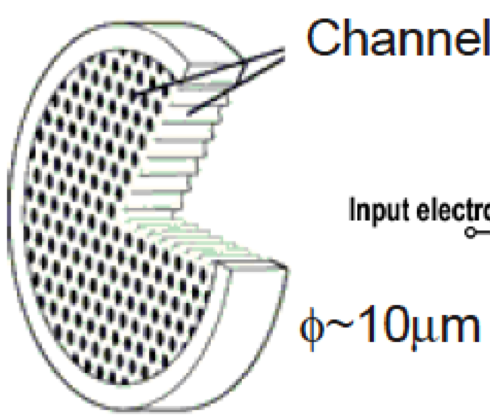
Fast Interaction Trigger

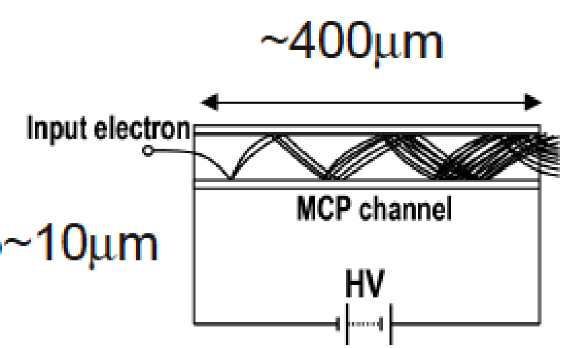
# BACK UP SLIDES

# Microchannel-Plate PMT



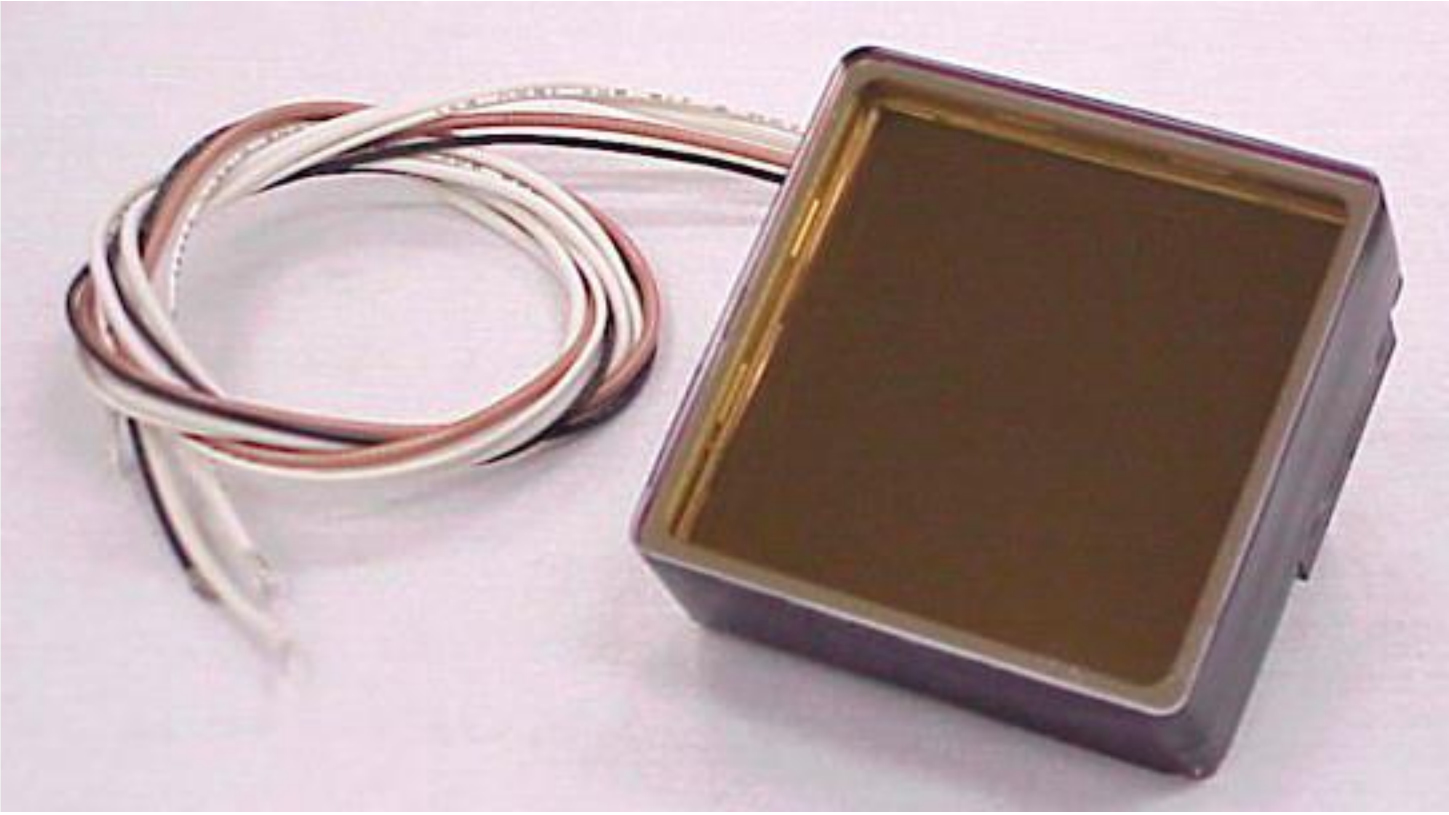



# Photonis PLANACON®

# **XP85012** or XP85112



Cost (2012):

**XP85012/A1-Q - $8,830**
XP85112/A1-Q - $14,900

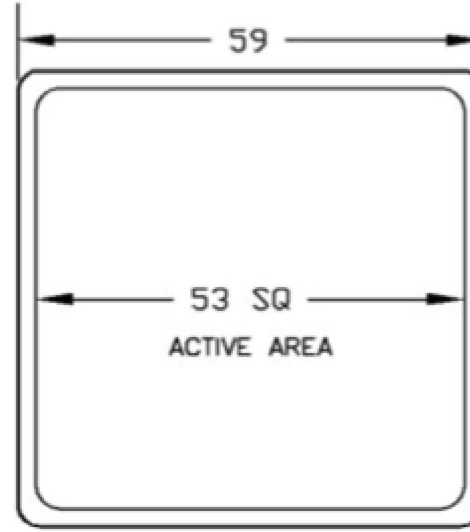
Datasheet available at:
http://www.photonis.com/attachment.php?id_attachment=40

# XP85012

# PLANACON®

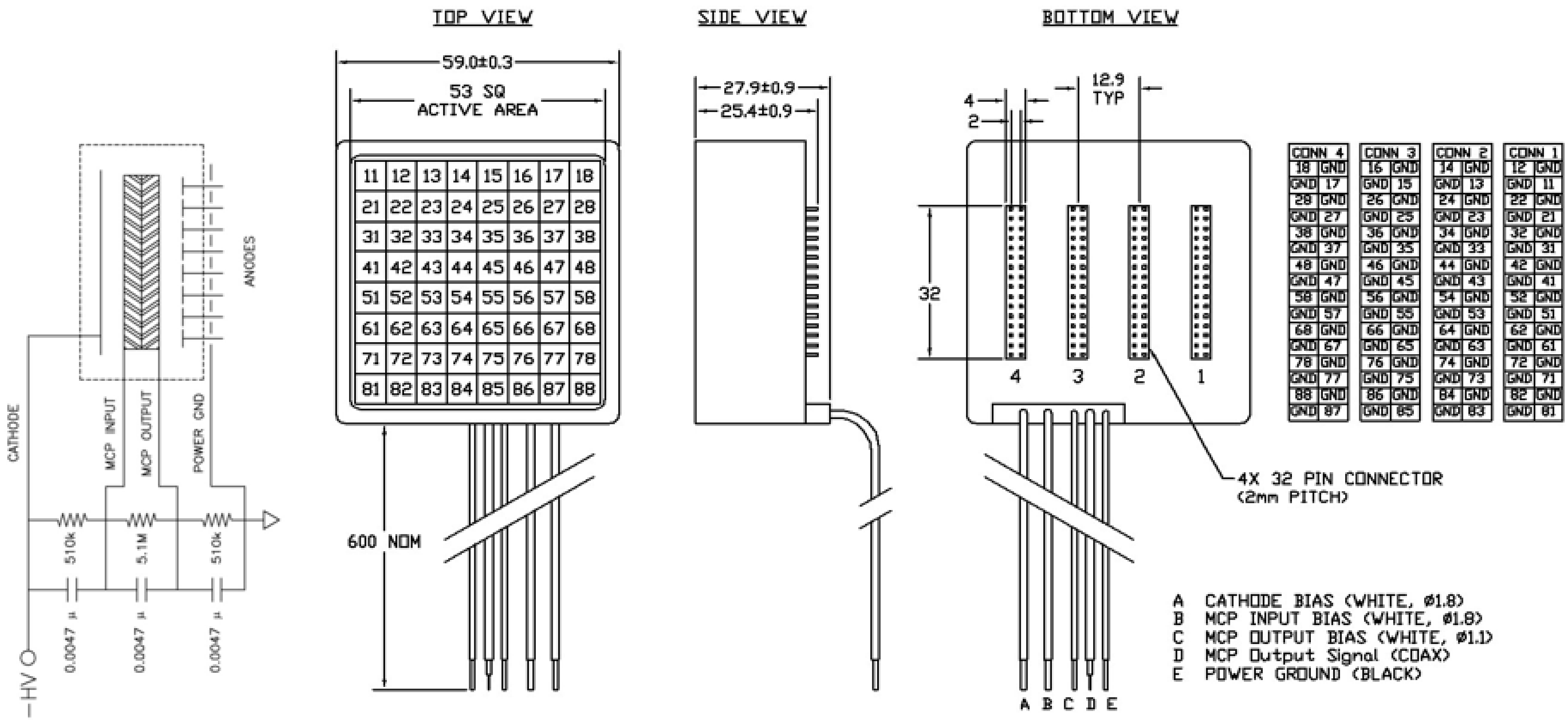
Window-side

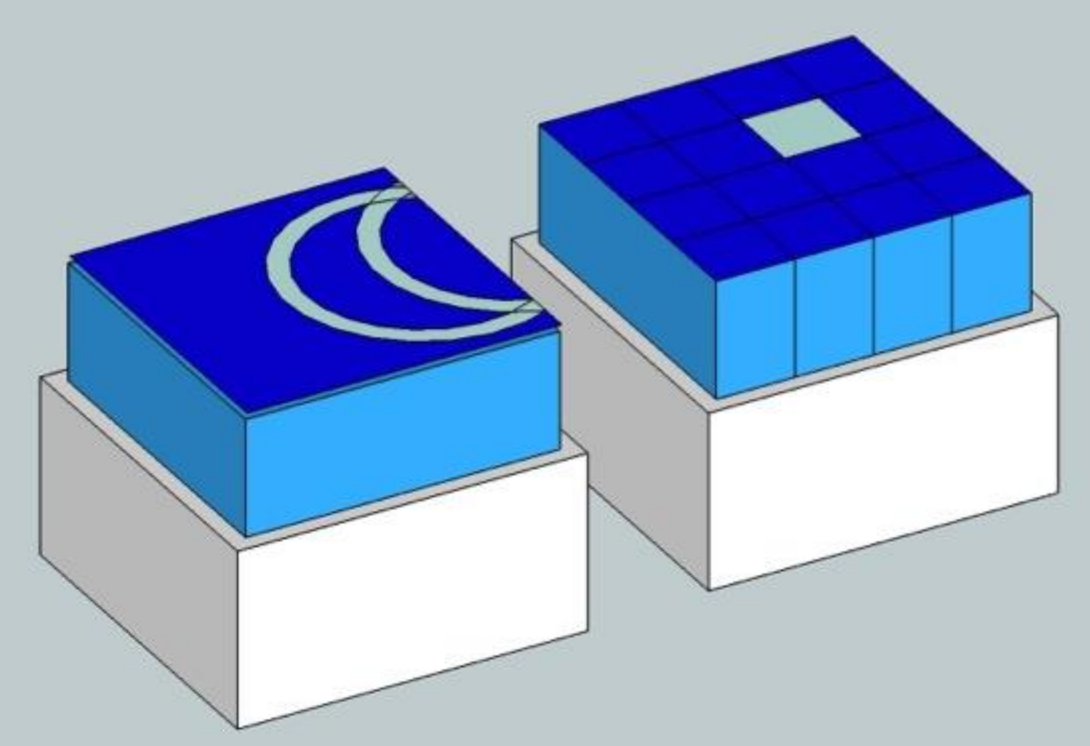
**Overall thickness ~30 mm**




Back-side

The anode of **XP85012** is **subdivided** into **64** units. This feature, together with fragmented radiator, could be used to **improve performance** and add **tracking ability** to T0





# Solid vs. fragmented quartz radiator

In case of a **solid radiator** the Cherenkov ring of light generated by a MIP spreads over a large surface of the light sensitive element. To register that diffused light, **higher amplification (HV)** is required.

The inner walls of a **fragmented radiator** reflect the light and contain it within the sub-unit of the radiator. As a result the light intensity falling on the MCP surface is higher. Therefore **lower amplification (HV)** is needed.