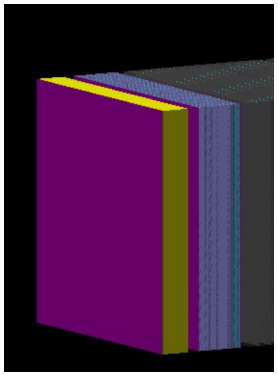
ZDC simulation

Checking details of the EM part of the EIC ZDC.



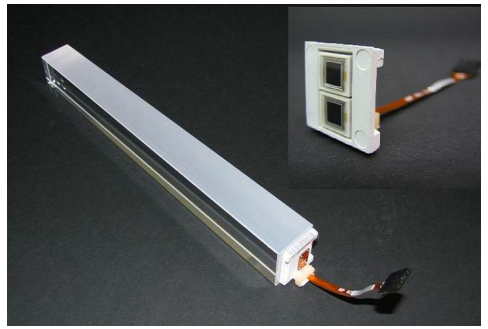
7cm crystal
22 layers of W/Si

- Added 2.5 mm PET after each crystal tower.

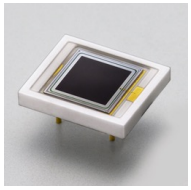
  cf. CMS ECAL

  2 APDs in a capsule per tower.

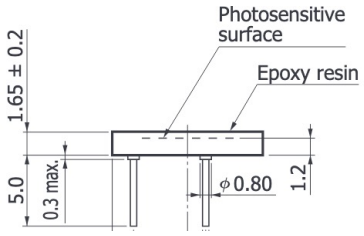
  – Hamamatsu S8148: sensitive area 5mm x 5mm, 6 µm thick



  cf. Hamamatsu S8664-55



  window: Epoxy resin
  package: Ceramic
  Effective area: 5 mm x 5mm



  Should I add more details?

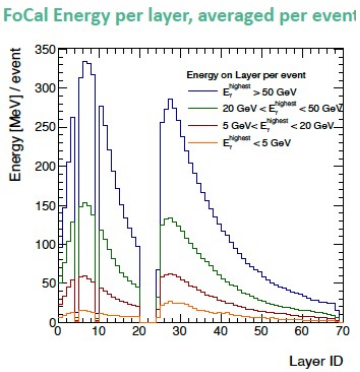
- Checked difference from the ALICE FoCal simulation
  - The current EIC ZDC simulation is based on the stand alone mini-FoCal simulation from Norbert.

Comparison of the simulation setup

	stand alone		ALICE FoCal	
Tungsten	W alloy	3.5 mm	Pure W	3.5 mm
Glue 1	PET (C10H8O4)	0.11 mm	G10 (H,C,O,Si)	0.5 mm
Sensor	Si	(pad) 0.32mm (pix) 0.3mm	Si	(pad) 0.5 mm (pix) 0.47 mm + 0.03 mm*
Glue 2	PET (C10H8O4)	(pad) 0.13mm (pix) 0.11mm	G10 (H,C,O,Si)	0.5 mm
Readout	PET (C10H8O4)	0.28mm	Cu	0.1 mm
Air Gap	Air	(pad) 1.2 mm (pix) 1.mm	Air	(pad) 5 mm (pix) 0.5 mm

* 0.47 mm as insensitive, 0.03 mm as sensitive

→ Probably the reason of the drops of deposited energy on pixel layers.

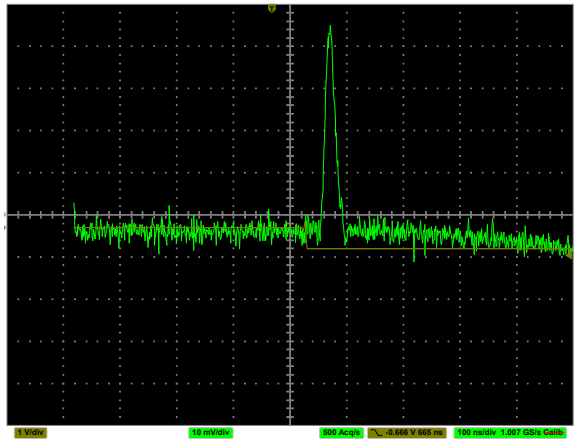


Measurements of APDs

- APDs are our first candidate for the readout of ZDC crystal calorimeters (and scintillators in Pb/Sci cal.)
- 4 APDs are irradiated in our first RANS irradiation test in March.
  - Feb: Yamazaki-san measured IV curve at Kobe U. before the test.
  - Mar: Irradiation test.
  - May: Residual radiation is still high (130 cpm on 19/May)
    → Yamazaki-san and I went to RANS for the IV measurement.

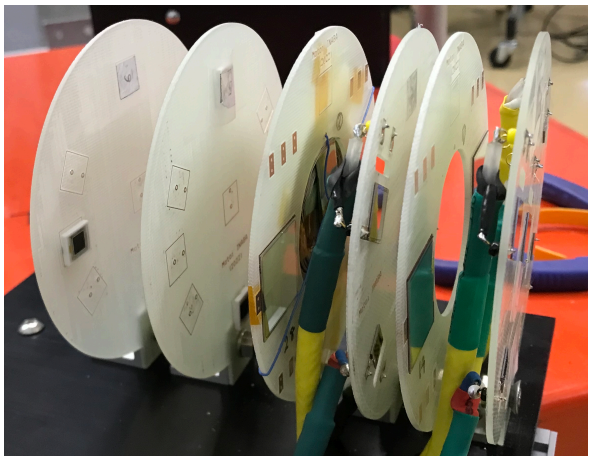
- 1 APD is not irradiated but measured.
  - May: We checked the APD response and measured IV curve in Lab.

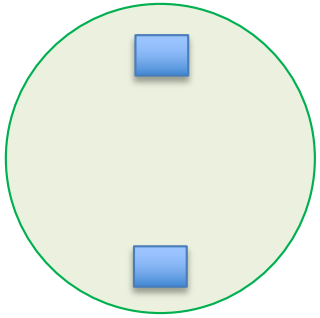
* It turned out that the preamplifier I used in the lab is broken.



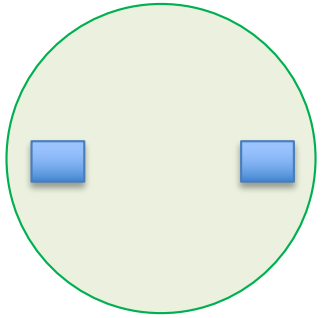
Irradiation test in March

- APDs were on Layer 5 and 6.





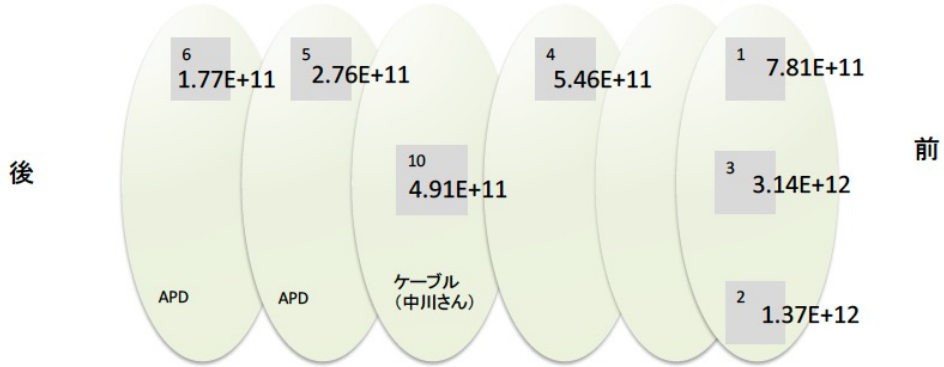
Layer 5



Layer 6

- Radiation Dose

Estimated dose in run 1 (indium foil)



2 days of irradiation
= run1 x 33.6

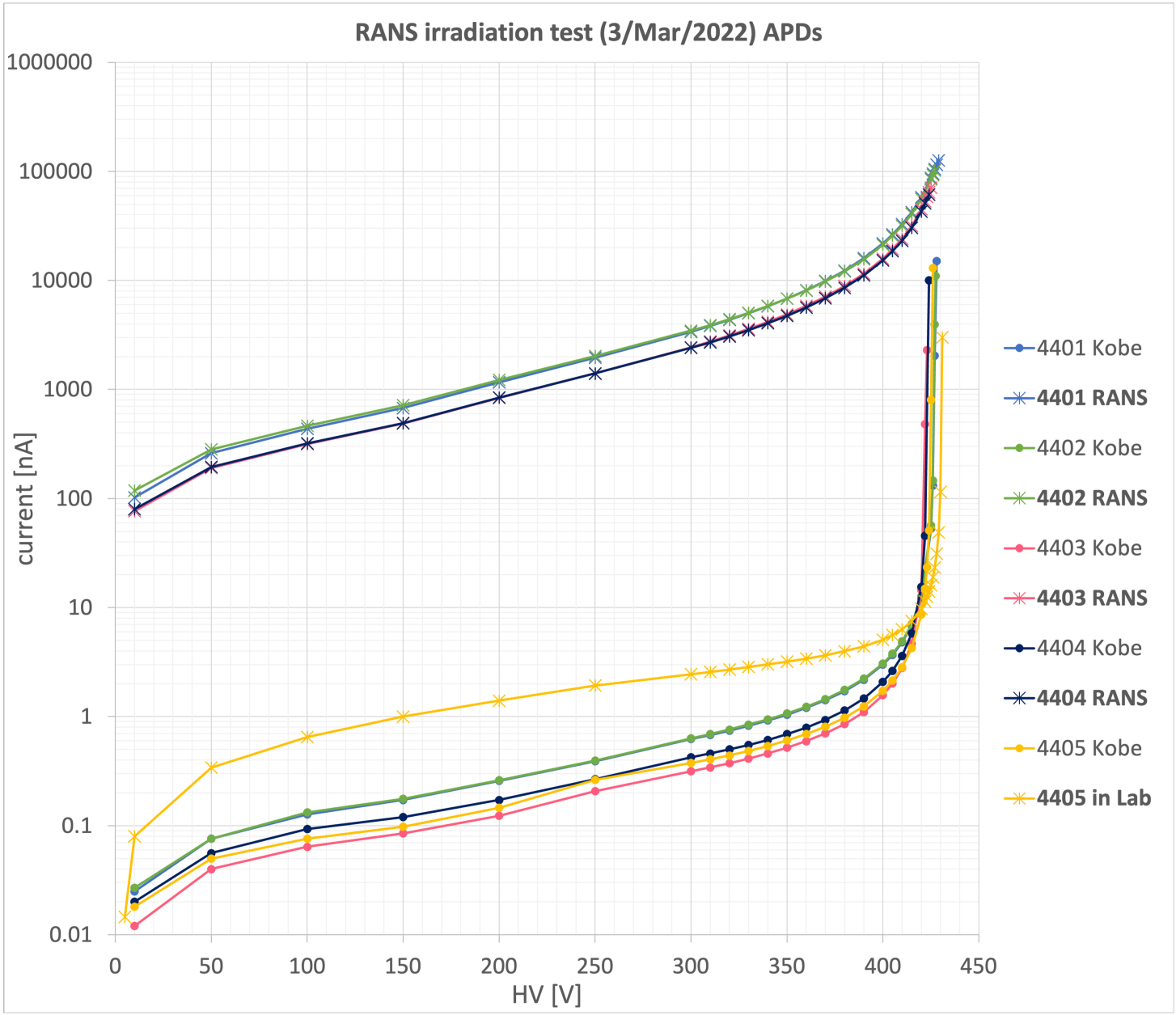
Layer 5: 9.3 x 10^{12} n/cm^2

Layer 6: 5.9 x 10^{12} n/cm^2

IV curve

Kobe:
measured on 23/Feb/2022

RANS/Lab:
measured on 23/May/2022



APD IDs

4401 & 4402
→ on layer 5

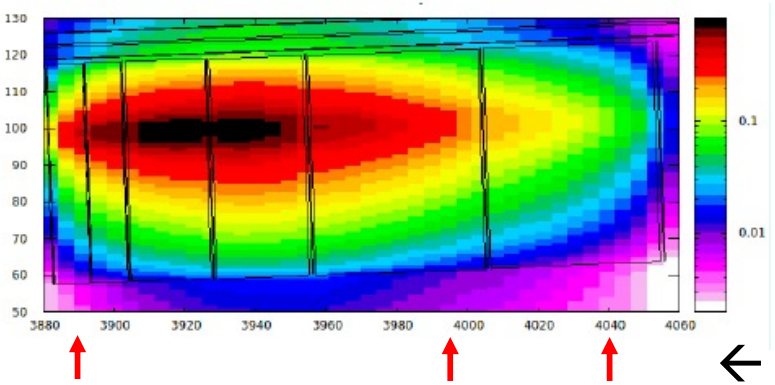
4403 & 4404
→ on layer 6

4405
→ not irradiated.

Conclusion from the test

- From ECCE Far Forward / Far Backward technical note: work by Vitaly

Estimated radiation from ep collisions



One MeV neutron equivalent fluxes F through the silicon material				
Detector.	Z cm	F_{p+rg} $neut./cm^2s$	F_{e+p} $neut./cm^2s$	F_{tot} $neut./cm^2OY$
ZDC Si 1	3880	1.2E+3	8.0E+4	8.1E+11
ZDC Si 2	3890	5.4E+3	3.0E+5	3.1E+12
ZDC Si 3	3910	6.6E+3	4.0E+5	4.1E+12
ZDC Si 4	3930	4.6E+3	8.0E+5	8.0E+12
ZDC Si 5	3960	3.6E+3	4.0E+5	4.0E+12
Si in B0	650	1.2E+3	1.5E+5	1.6E+11

← APD positions

➔ Operation of 1/3 of a year → **3.1 x 10^{12} n/cm²** for ZDC area 2

- From RANS test:

➔ APDs are broken after irradiation of ~ **6 x 10^{12} n/cm²**

APD seems not to be a safe choice for the crystal readout.

- Other possibilities? AC-LGAD as photon detector?
- Should we go without crystal calorimeters as suggested in the FF meeting??