

ePIC-ZDC status

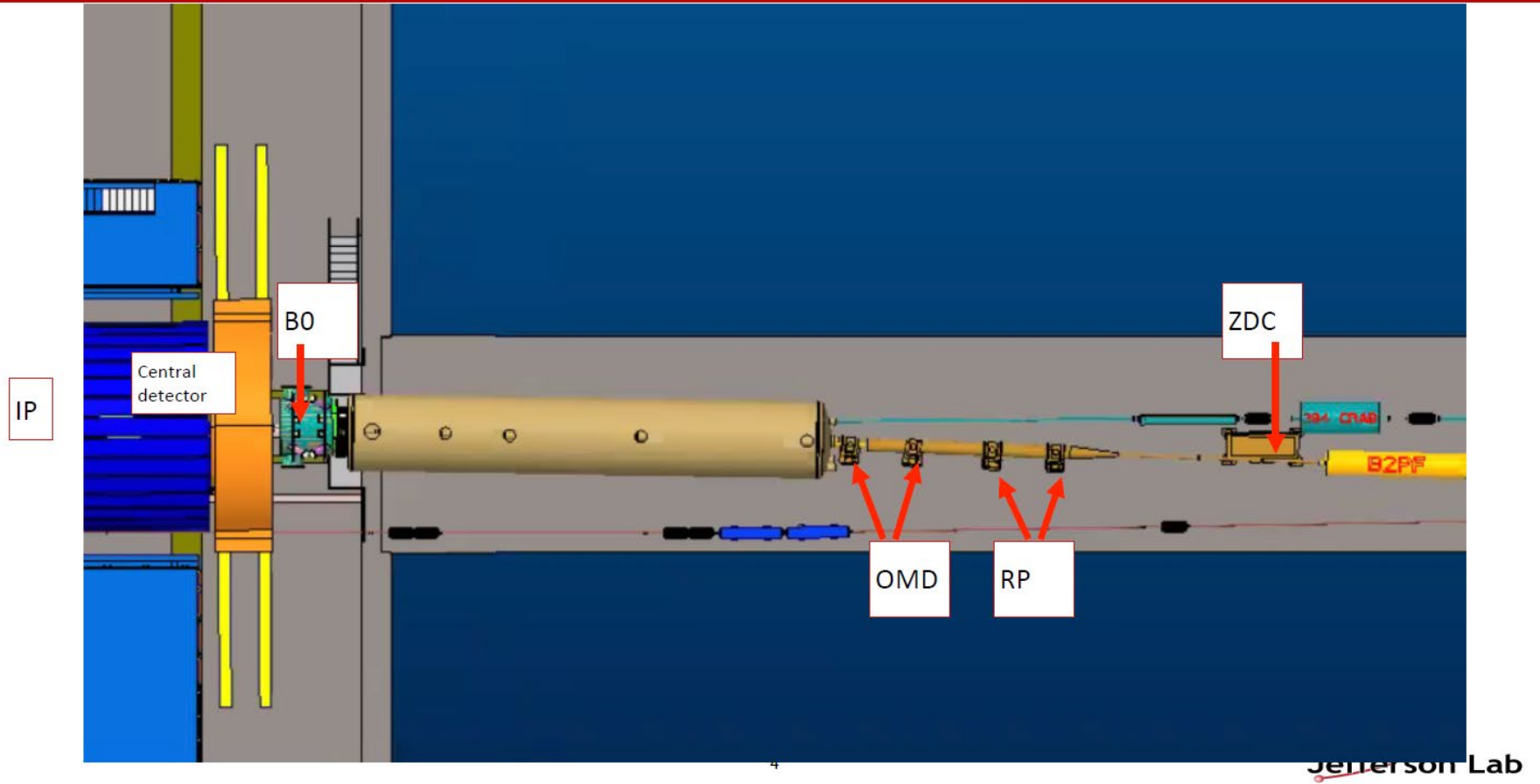
EIC日本グループ会合

2023年6月29日(木)

後藤雄二 (理研)

Far-Forward detectors

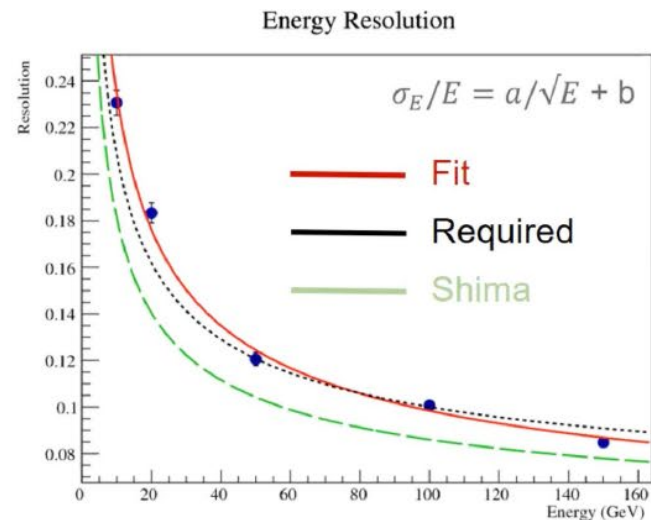
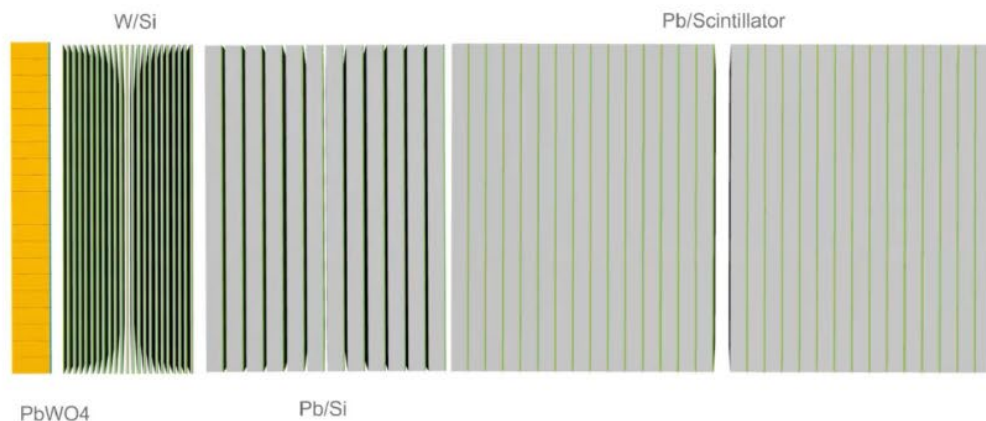
FAR-FORWARD DETECTORS



ZDC simulation by Po-Ju

ZDC RESOLUTION (NEUTRONS)

Po-Ju Lin (CEA- Université Paris-Saclay)



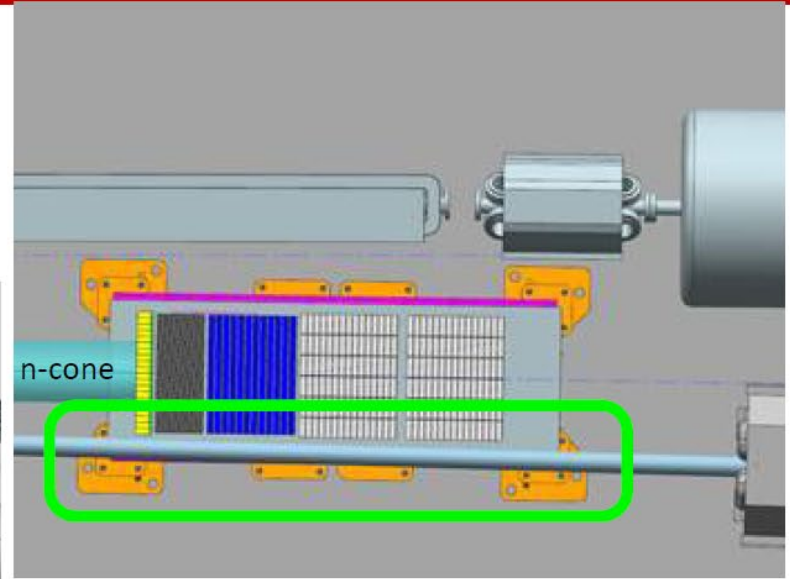
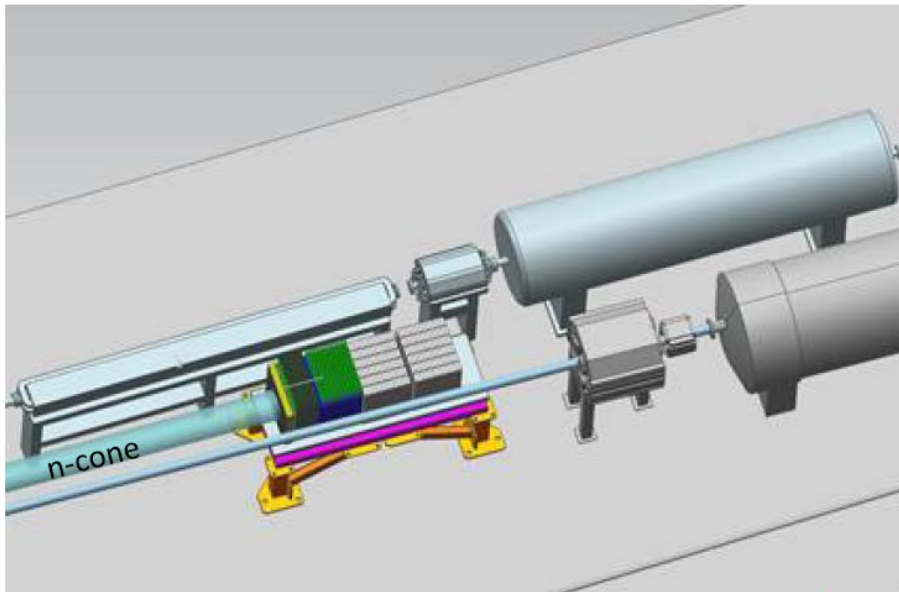
- Fit: $\frac{63\%}{\sqrt{E}} + 3.6\%$
- Required: $\frac{50\%}{\sqrt{E}} + 5\%$
- Shima: $\frac{44\%}{\sqrt{E}} + 4.2\%$

ZDC integration

ZDC

“Stay-clear” zone around the beam-pipe (1.5-3cm)
Placement of readout boards

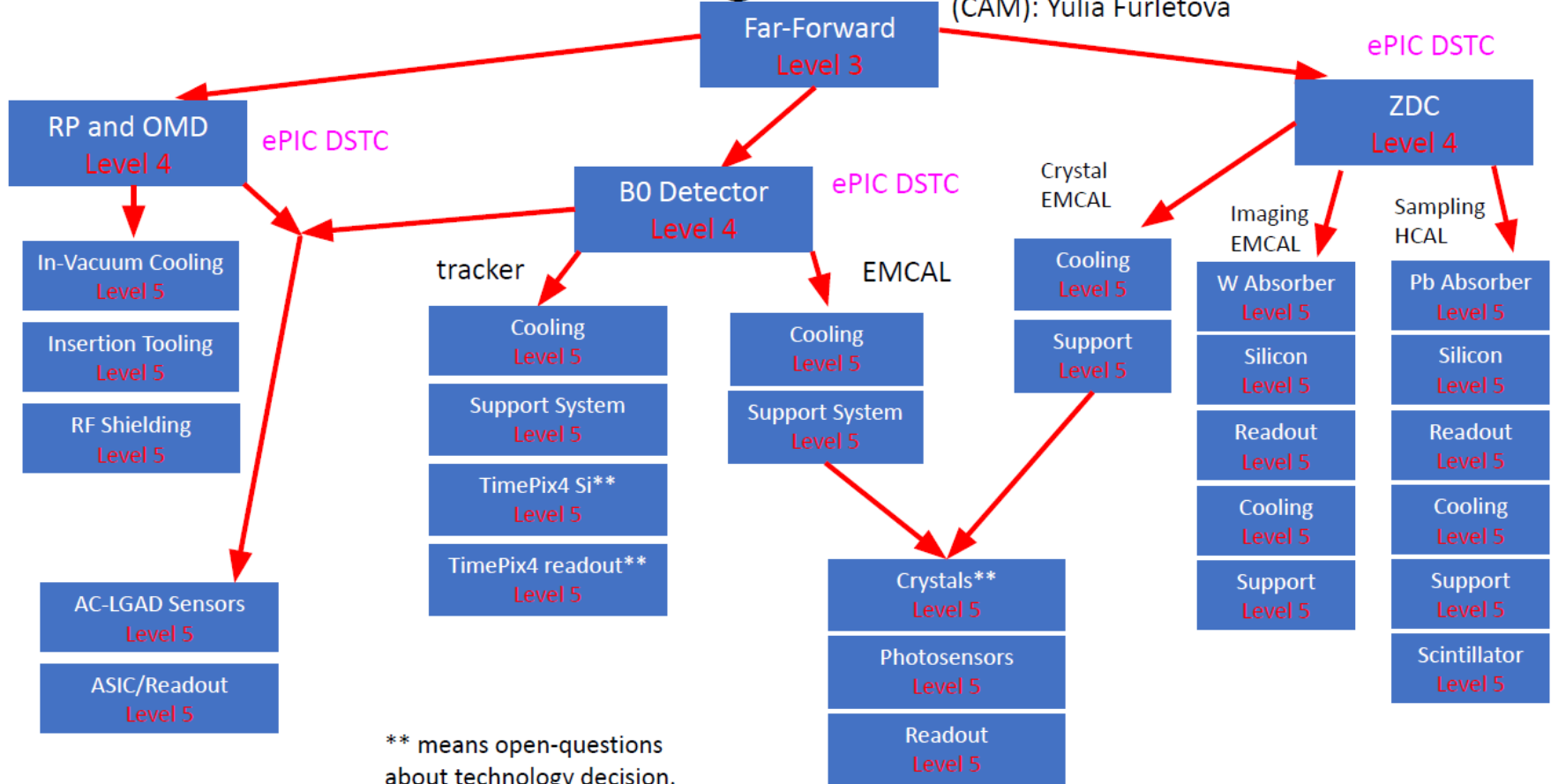
Z-placement , transverse size



Far-Foaward Work Packages

Far-Forward Work Packages

Control Account Manager
(CAM): Yulia Furletova



ZDC Work Packages

- Crystal EMCAL
 - Taiwan group - NCU (Ming Kuo), Academia Sinica
- Crystals (Common with B0 EMCAL)
 - Compare and select the type of crystal; PWO, LYSO, or else (incl. glass scintillator)
 - Optimize the size of the crystal by simulation calculations
 - Radiation hardness
- Photosensors (Common with B0 EMCAL)
 - Compare and select the type of photo sensors; SiPM, APD, or else
 - Evaluate light yield and optimize design with crystal and photosensor combination
 - Radiation hardness
- Readout (Common with B0 EMCAL)
 - Design readout scheme; ASIC and downstream; FPGA, bus, cable, etc.
 - Radiation hardness
 - Electrical engineer needed
- Cooling
 - Evaluate how much cooling power required
 - Design the cooling system
- Support
 - Evaluate how much support required and design modules
 - Design how to integrate modules as a detector subsystem
 - Mechanical engineer needed

ZDC Work Packages

- Imaging EMCAL
 - RIKEN (Goto), Kobe (Yamazaki), Tsukuba (Chujo, Inaba)
 - W absorber
 - Simulation calculations to be performed to determine thickness and number of layers, or radiation length incl. the crystal EMCAL
 - Determined the size of the W plate and how to fix it
 - Silicon
 - Determine if there are any changes to the FoCal-E Pad sensor
 - Consider how to realize the Pixel layer; small-Pad sensor, LYSO-SiPM (with timing information), or else
 - Radiation hardness
 - Readout
 - Consider whether to use HGCROC as well as FoCal-E Pad, dynamic range, etc.
 - Design readout scheme downstream from ASIC (HGCROC); FPGA, bus, cable, etc. (from top side or bottom side?)
 - Radiation hardness
 - Electrical engineer needed
 - Cooling
 - Evaluate how much cooling power required
 - Design the cooling system
 - Mechanical engineer needed
 - Support: Taiwan group
 - Evaluate how much support required and design modules
 - Design how to integrate modules as a detector subsystem
 - Mechanical engineer needed (Taiwan group?)

ZDC Work Packages

- Sampling HCAL
 - Korea group - Sejong (Yongsun Kim)
- Absorber
 - Compare and select material; Pb, Cu, or else
 - Evaluate and optimize absorber + active (sampling) material to get correct ratio for compensation (e/h around 1)
- Sampling method
 - Compare and select material; silicon, plastic scintillator, fused silica, dual-readout, etc.
 - Radiation hardness
- Readout
 - Silicon sensor or photosensor, etc.
 - ASIC and downstream; FPGA, bus, cable, etc.
 - Radiation hardness
 - Electrical engineer needed
- Cooling
 - Evaluate how much cooling power required
 - Design the cooling system
- Support
 - Evaluate how much support required and design modules
 - Design how to integrate modules as a detector subsystem
 - Mechanical engineer needed

Backup Slides

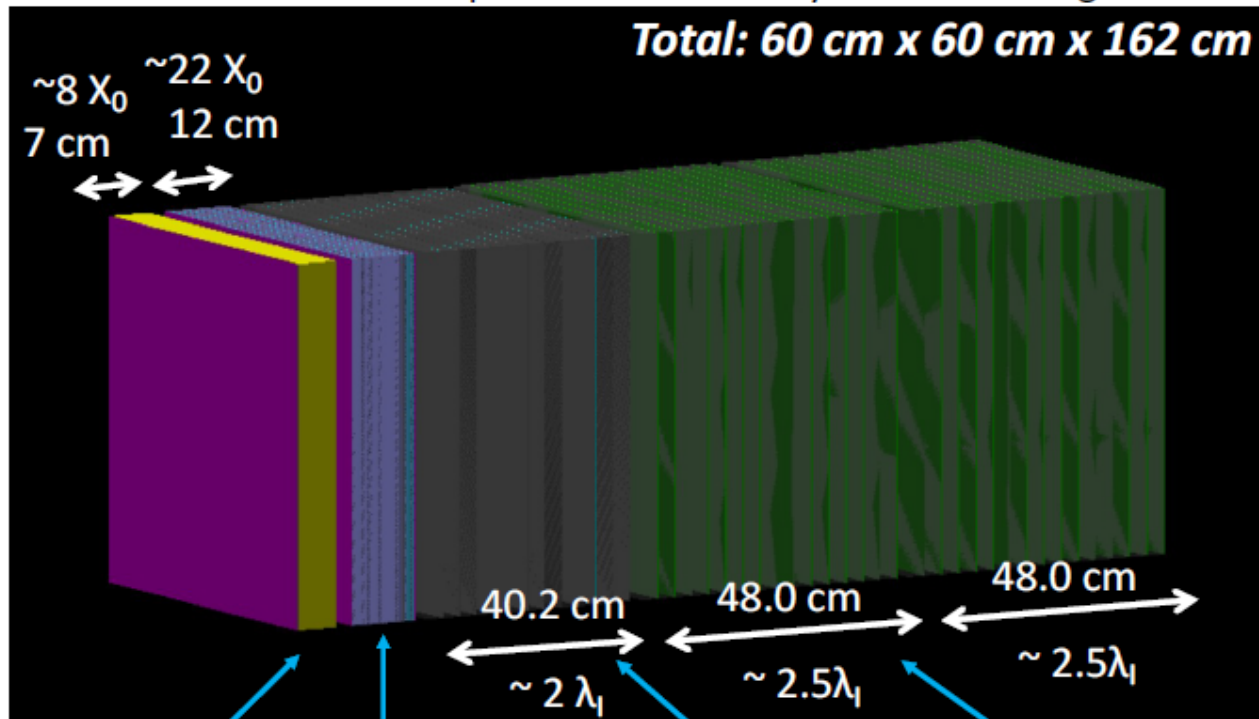
Task Assignment

- Timeline and goals
 - Pre-TDR → CD3a (2024.1)
 - No need because of no Long Lead-time Procurements
 - TDR → CD2/3 (2025.4)
 - Final design (80% ready): 2024.4?
 - Specs/docs/first article, etc.
 - Construction: 2025-2030?
 - Start: 2025.5?
 - Integration: 2030-2031?
- Review the detector design
 - Optimization including cost review
- Integration & Mechanical design
- Readout devices, electronics, DAQ
- Prototype production, test & evaluation
- Software development & simulation studies

ePIC-ZDC 1st design

Current ZDC design

*note: space for readout may extend the longitudinal length.



Crystal (PbWO_4)
+ Silicon Pixel layer

W/Si calo.
3 Pixel layers are inserted.

Pb/Si calo.

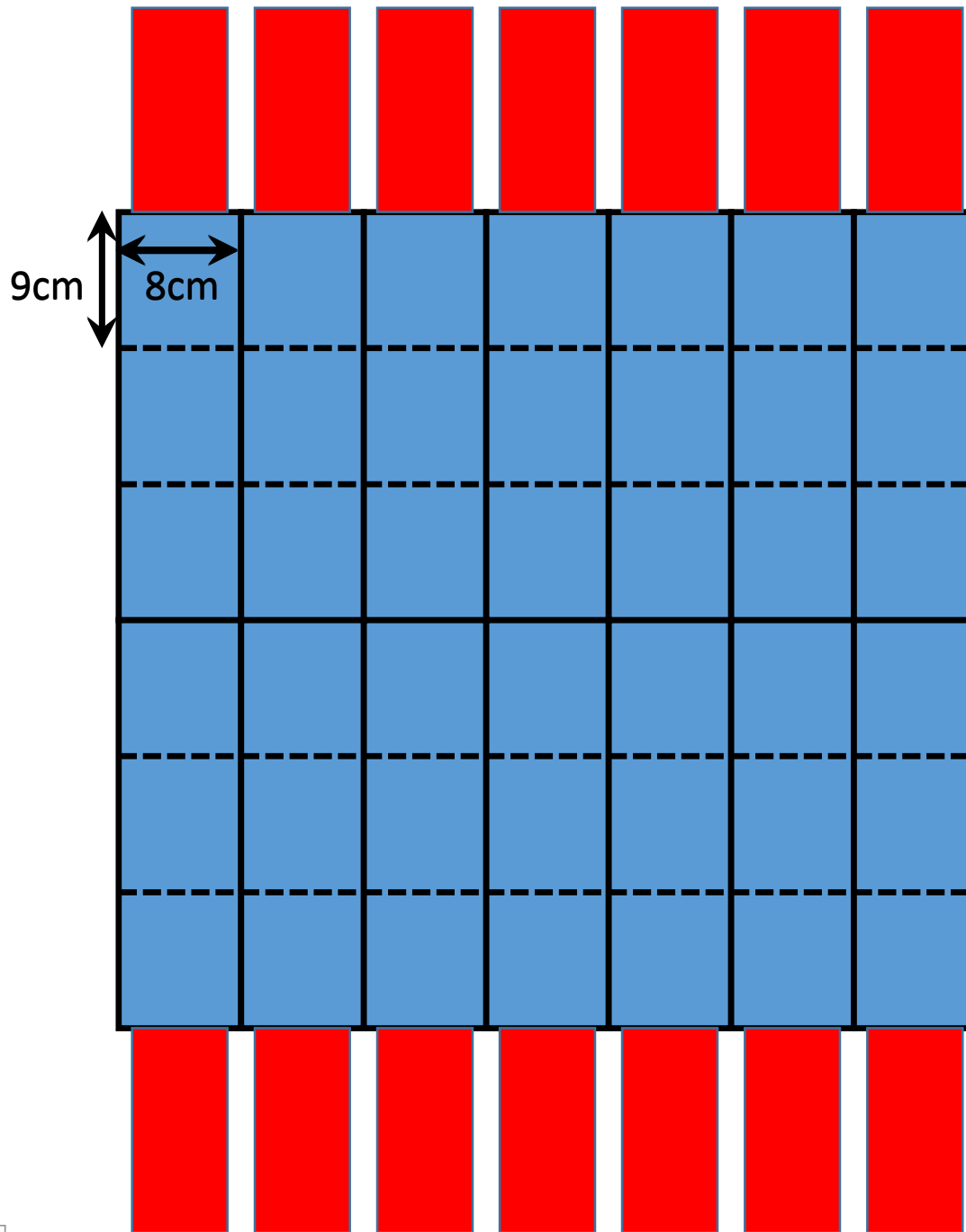
Pb/Sci. calo.

2023 task plan

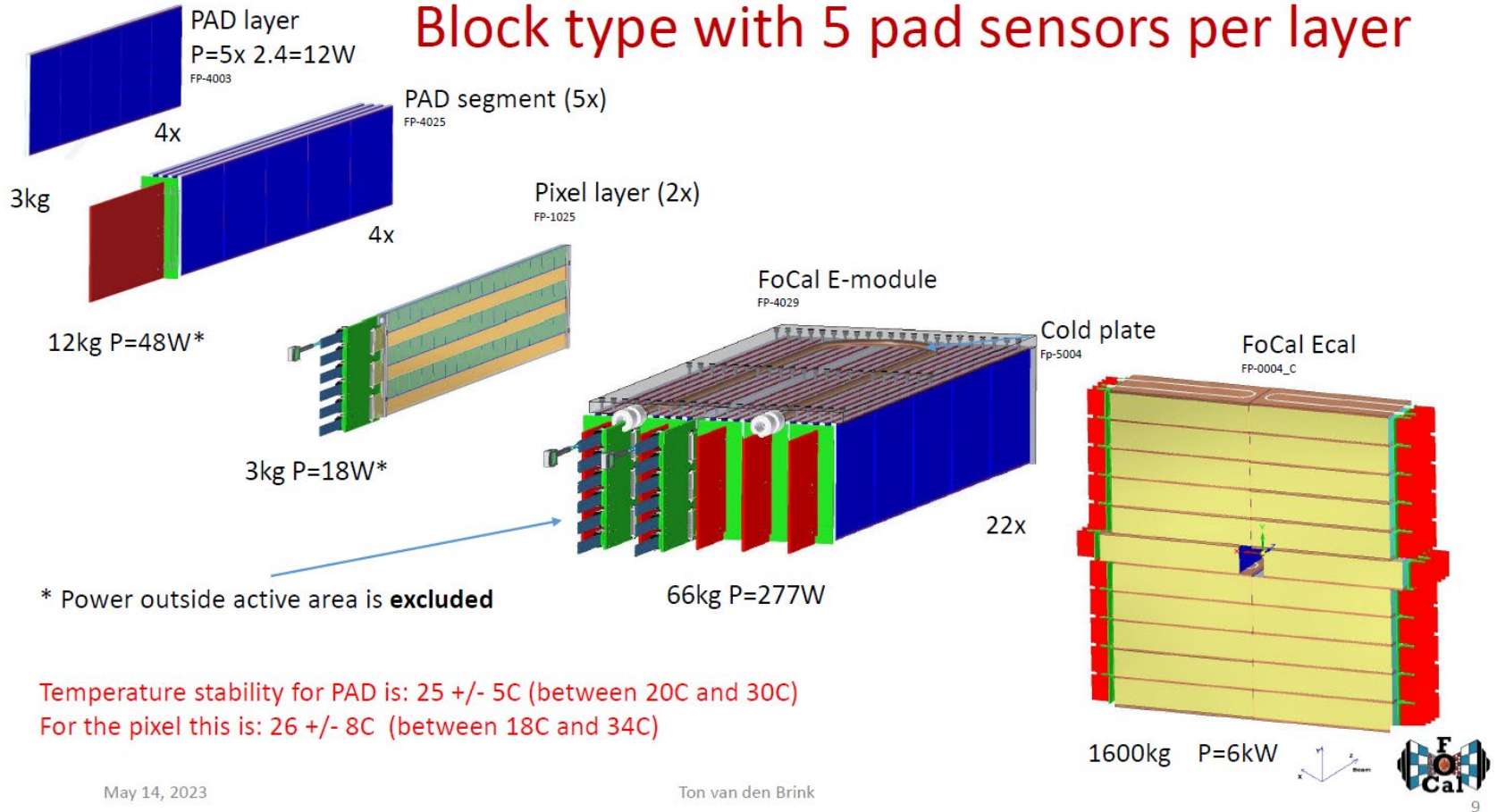
- Plan for “timeline & goals”
 - Plan and discussion for each task assignment
- Software development
 - Cooperation between US (PNNL) & Asia groups
- Simulation studies
 - Revisit radiation dose
 - Comparison with FLUKA result
- Prototype production
 - Crystal + Imaging calorimeter (W-Si)
- Test beam at ELPH, Tohoku Univ.
 - 2023 Autumn beam time
 - Participation of Asia (Taiwan) group
- Radiation tolerance test (neutron irradiation) @ RIKEN RANS
 - Comparison of new & old ALICE-FoCal-E Pad sensors

Review the detector design

- Crystal calorimeter
 - 1st design: 60cm x 60cm PWO crystal $8X_0$
 - Design update option:
 - Smaller lateral dimension? 60cm x 60cm necessary to cover lateral hadron shower leakage (EM shower leakage smaller)
- W-Si imaging calorimeter
 - 1st design: 60cm x 60cm W-Si $22X_0$ (22 layers)
 - Design update option:
 - Smaller lateral dimension? e.g. ALICE-FoCal-E Pad size 9cm x 8cm $\rightarrow 6 \times 7 = 54\text{cm} \times 56\text{cm}$?
 - Smaller number of layers? e.g. $1X_0 \times 22$ layers $\rightarrow 2X_0 \times 11$ layers?
- Hadron calorimeter
 - 1st design:
 - Pb-Si $0.16\lambda_7$ x 12 layers (40cm)
 - Pb-Scintillator 10cm x 10cm x 48cm ($2.5\lambda_7$) tower, 10 x 10 x 2
 - Design update option:
 - No imaging (Pb-Si) layers?
 - Pb-(Scintillator + Fused silica) 10cm x 10cm x 48cm tower 4 x 4?

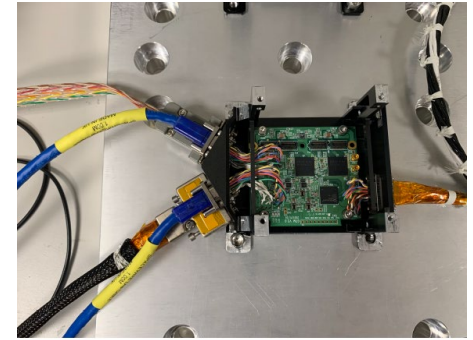


Block type with 5 pad sensors per layer



Crystal calorimeter prototype

- Plans by Taiwan group
 - Discussed today in the ePIC-ZDC discussion meeting
- Place the order for LYSO crystals
 - Need to determine the cross section area
 - Worry: large LY of LYSO so that saturation → smaller cross section can be better (6mm x 6mm ?)
 - G4 study is underway to estimate the energy deposit with the beams at Tohoku university
- Purchase SiPM
- Design an adapted board
 - Readout board designed by Chih-Hsun Lin of Academia Sinica



Crystal calorimeter prototype

- ALICE-Phos PWO prototype
 - Hiroshima Univ.
 - 2cm x 2cm x 18cm
 - APD readout
 - Shipped to RIKEN
 - Some towers to be sent to Taiwan for prototype module
- Evaluation using a test beam with FoCal-E W/Si-Pad

