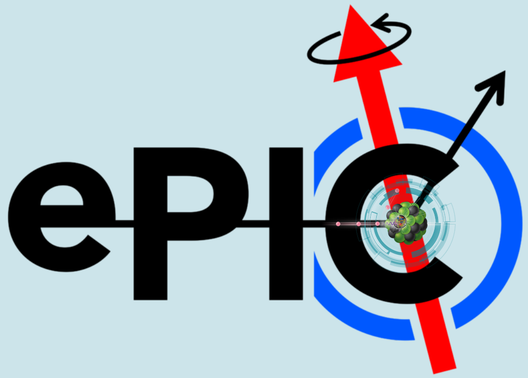


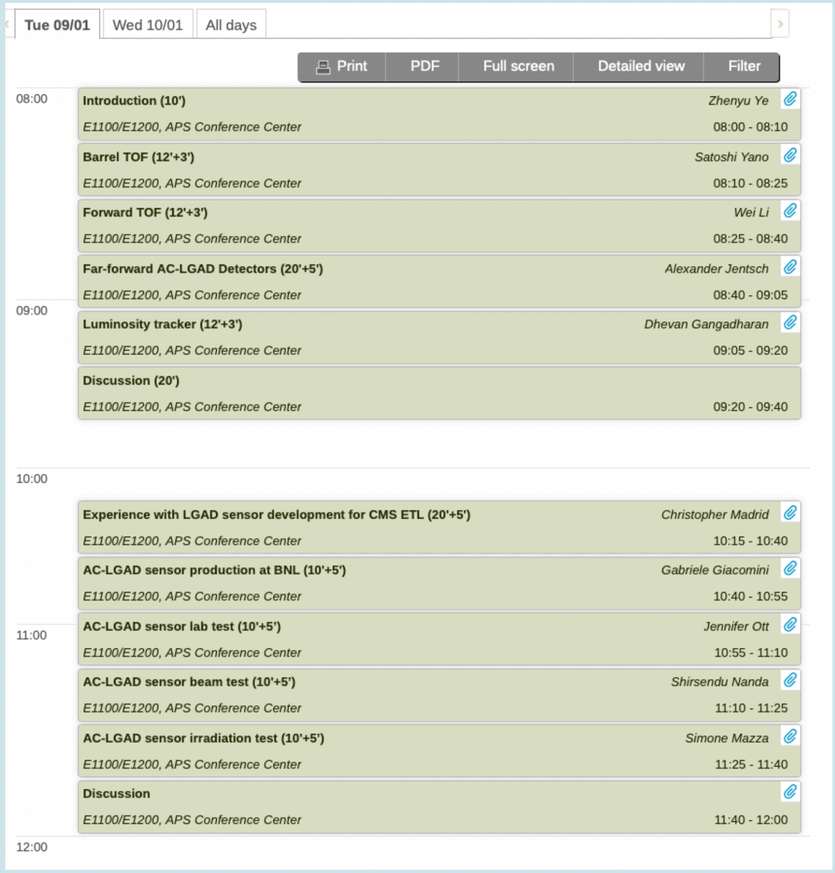
Summary of the AC-LGAD workfest

Satoshi Yano

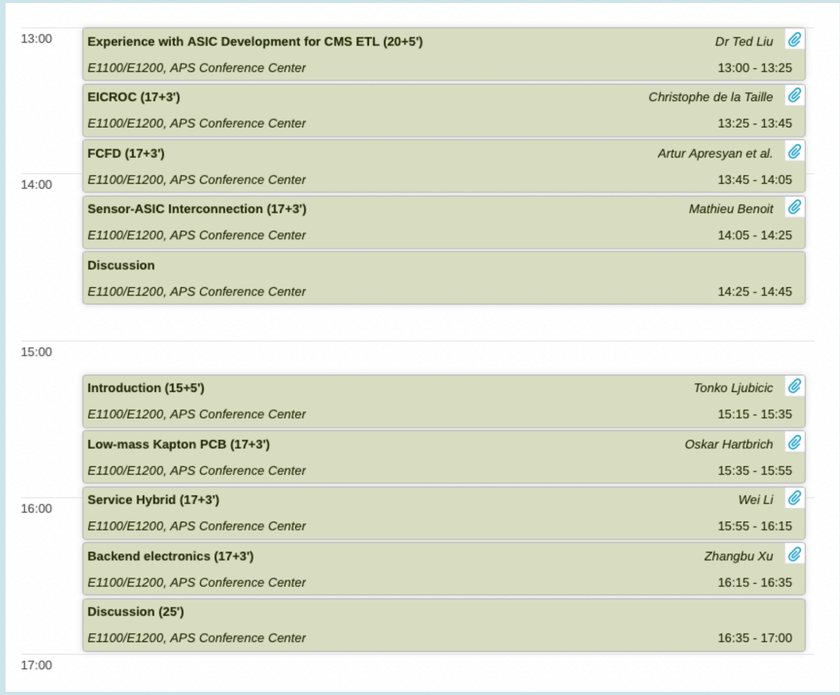
Hiroshima University SKCM²

AC-LGAD work fest

Jan.-09-2024 Morning



Jan.-09-2024 Afternoon

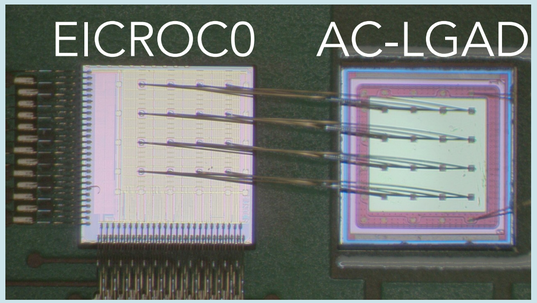


Jan.-10-2024 Morning

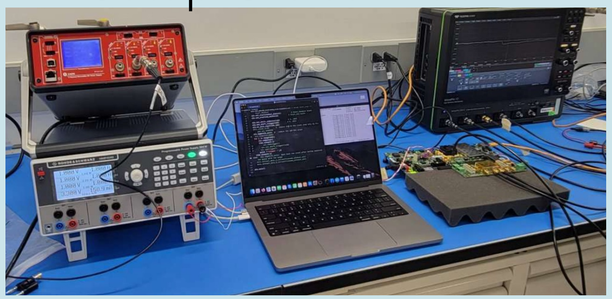
Jan.-10-2024 Afternoon

Successful demonstration of the EICROC

- The demonstration session of EICROC was held by the BNL and IJCLab teams



Setup @ clean room



Signal from ^{90}Sr

HGCROC capability for BTOF readout

- One comment about HGCROC compatibility with the strip AC-LGAD was gave

Strip-type AC-LGAD sensor
Size: 3.2 x 4 cm^2
Geometry: 64 * 4 strips
Readout: 1 cm and 500 um pitch
Detector capacitance: **O(10) pF**
Signal strength: **1 - 30 fC**

EICROC
32 x 32 = 1024 channels
Input capacitance: Cd = **1-5 pF**
Dynamic range: 1 - 50 fC
ToA and ADC
Jitter: 15 ps @ 10 fC
Power consumption: **1mW/ch**

HGCROCv2/3
36 x 2 = 72 channels
Input capacitance: Cd = **5-50 pF**
Dynamic range: 1 fC - 10 pC
ToA, ToT, and ADC
Jitter: **> 100 ps @ 15 fC (v3)**
Power consumption: **5-10mW/ch**

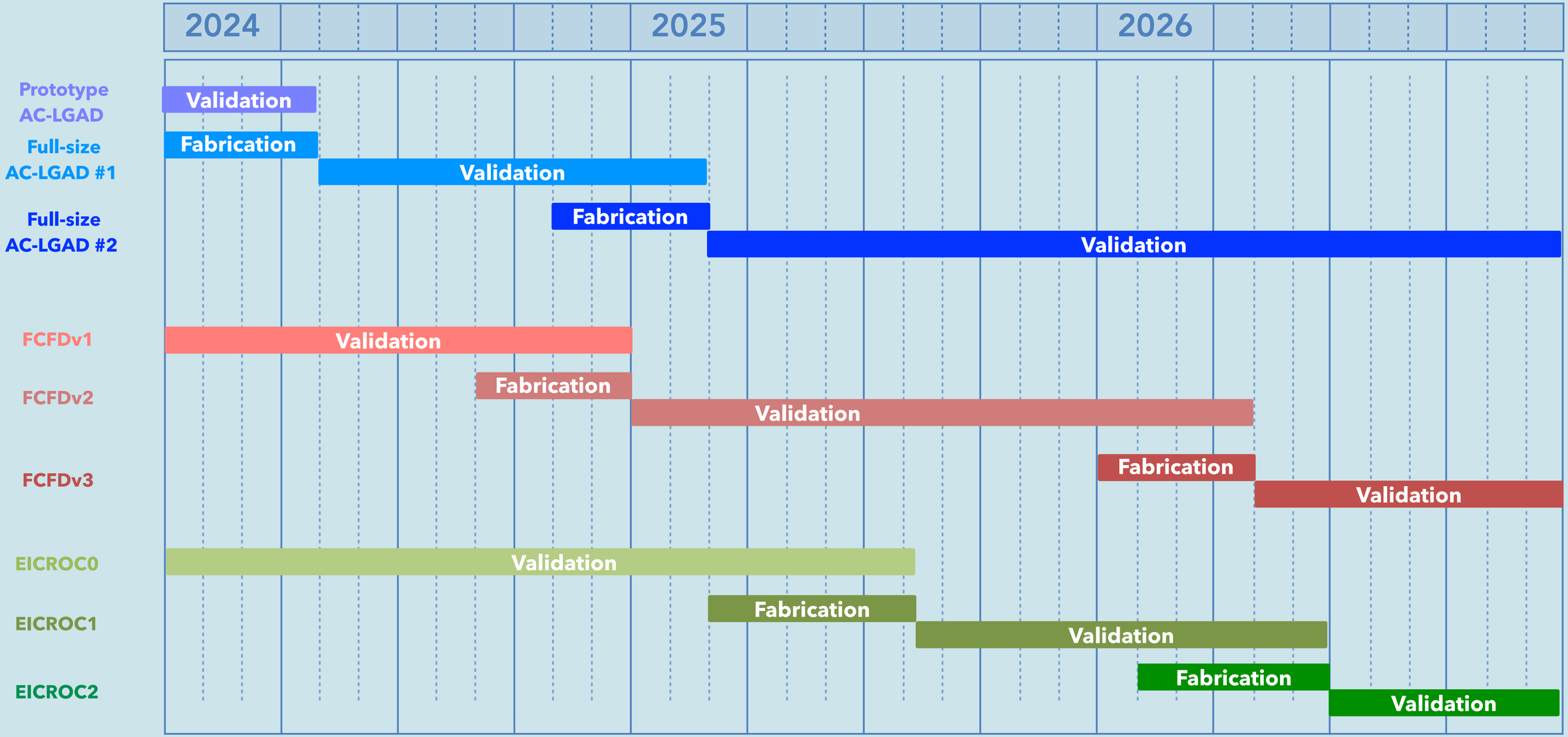
- HGCROC information is extracted here
- Input capacitance meets the requirement
- Is it fine from the jitter point of view?
- More cooling power is necessary

Kapton Flex Hybrid (PCB)

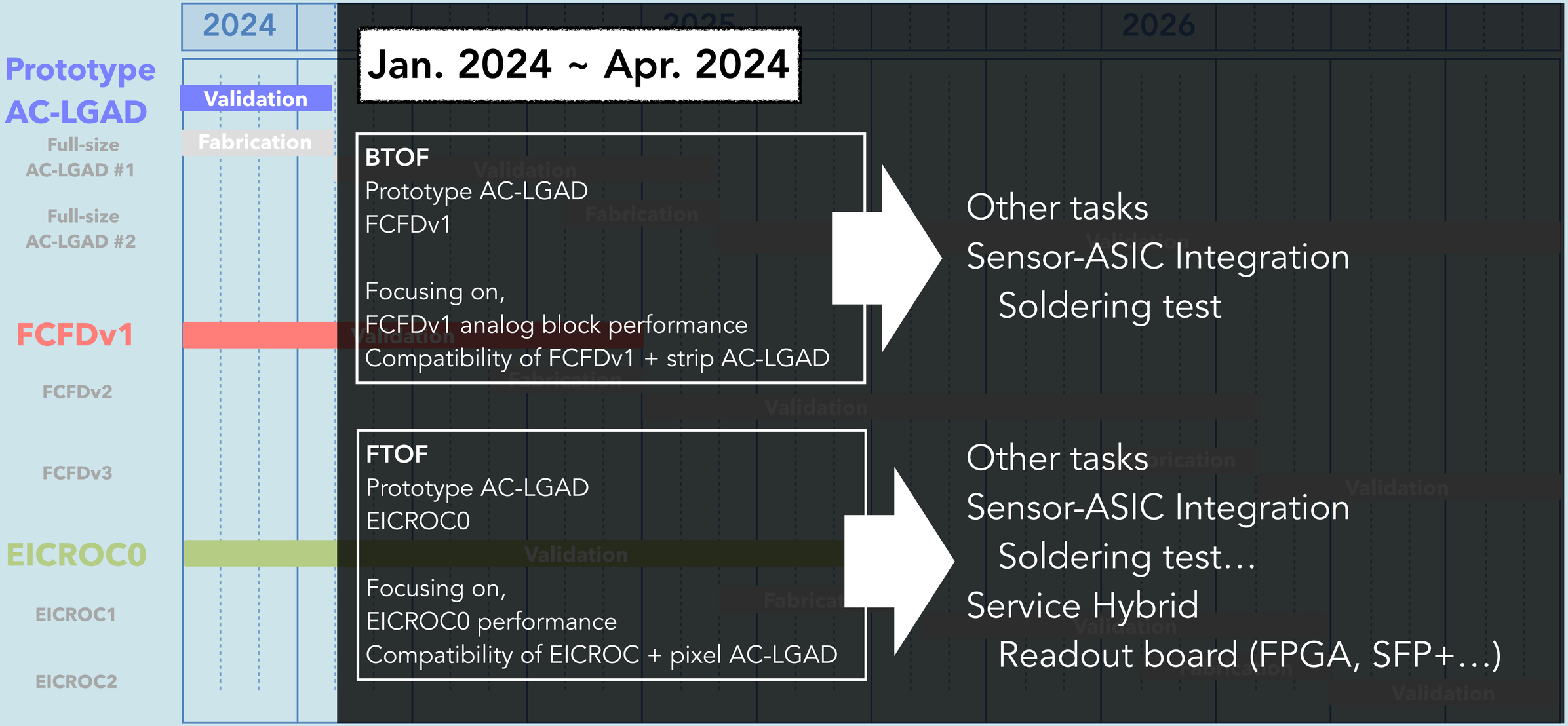
- After Oskar's presentation, a suggestion to contact the sPHENIX INTT team was gave
- The INTT is the silicon strip tracker similar to the ePIC BTOF
  - It has been built by Japanese and Taiwan colleagues
- The long PCB (1.3m) has been established and already used in sPHENIX
- Note: they use the PCB for extending (like connecting module to service hybrid in our case), so it is not sure that we can use it as in BTOF
- The paper has been sent to Tonko and Oskar
- RIKEN and Nara Woman University is very interested in the cooperation with the PCB R&D

Backup

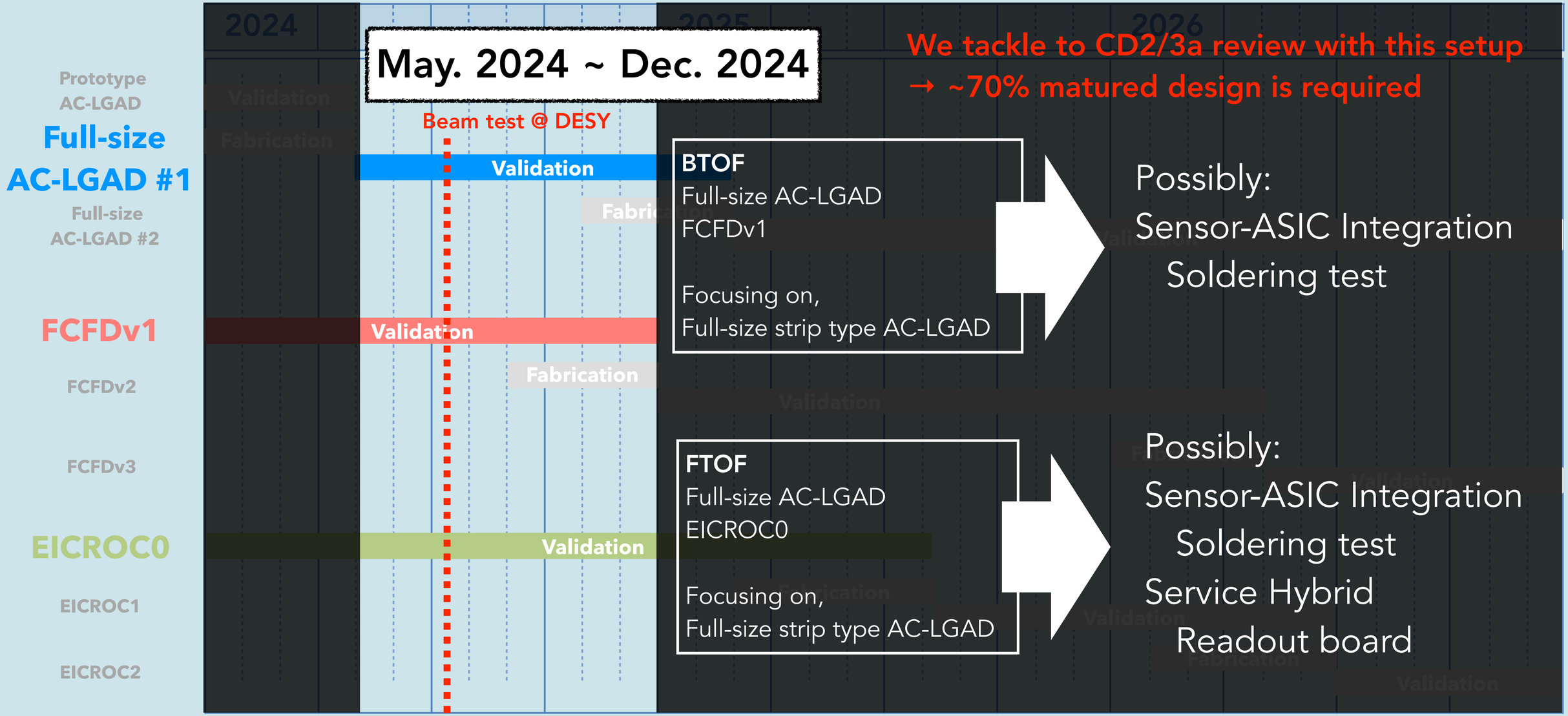
Rough schedule of sensors + ASICs



Rough schedule of sensors + ASICs

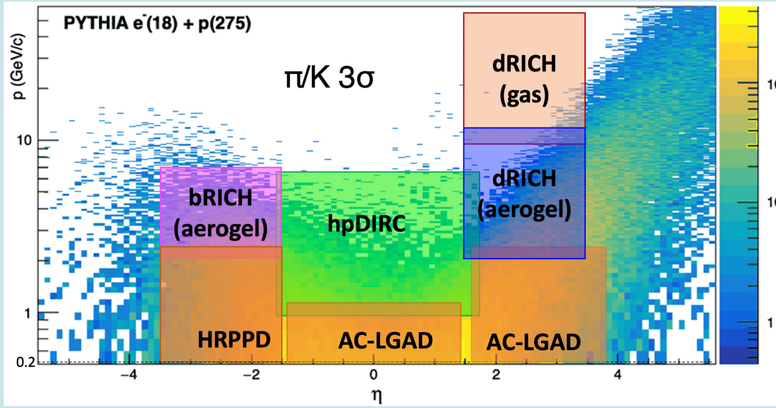


Rough schedule of sensors + ASICs



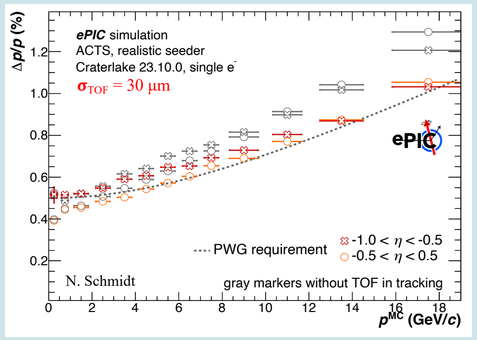
BTOF in the ePIC detector

- BTOF is a main PID detector covering low-p_T at mid-rapidity
- High momentum particle momentum resolution is improved by BTOF
- Beam-induced background can be rejected by timing information

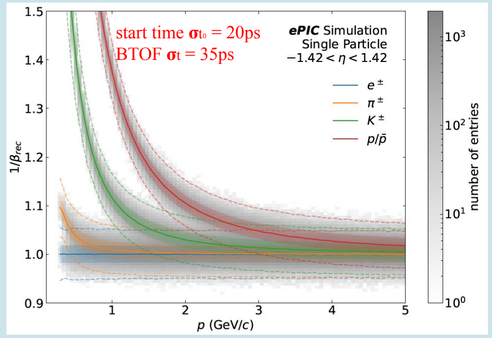


- Timing resolution of 35 ps and spatial resolution of 30 um is required
  - 3 sigma π/K separation up to ~1.2 GeV/c

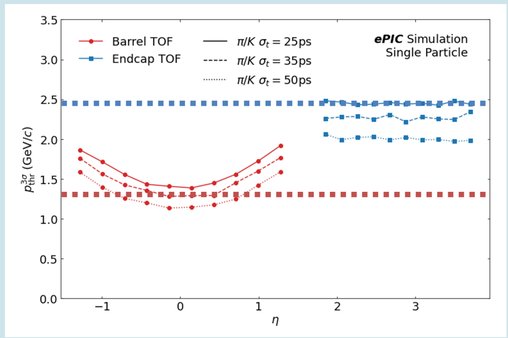
- Strip AC-LGAD technology meets the requirements
  - To reduce total readout channels, strip AC-LGAD will be adopted (~12 m^2)



By N. Schmidt

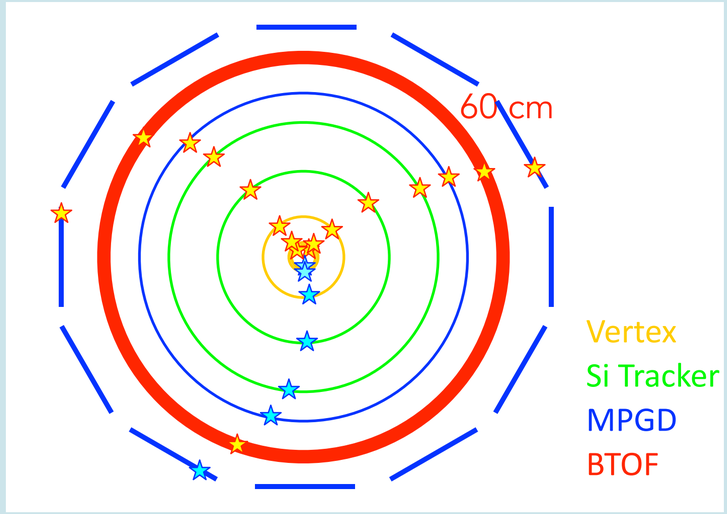


By O. Hartbrich



By O. Hartbrich

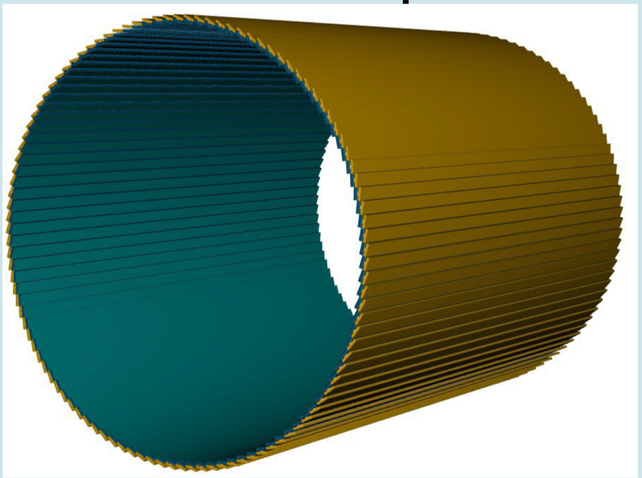
Tracking detectors in ePIC



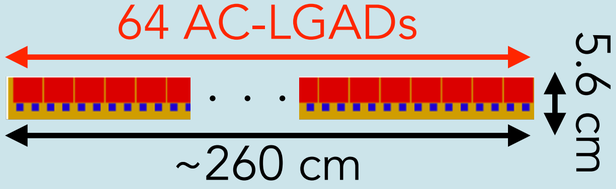
Detector Layout

- BTOF is composed of 144 modules to make a cylindric
- 64 AC-LGAD strip sensors are attached to one module
  - ASIC place is under discussion (depending on the ASIC pixel geometry)
- Radius is 60 - 63 cm from the beam pipe covering $-1.42<\eta<1.77$
- Total material budget in acceptance is ~0.01 X/X_0

BTOF shape



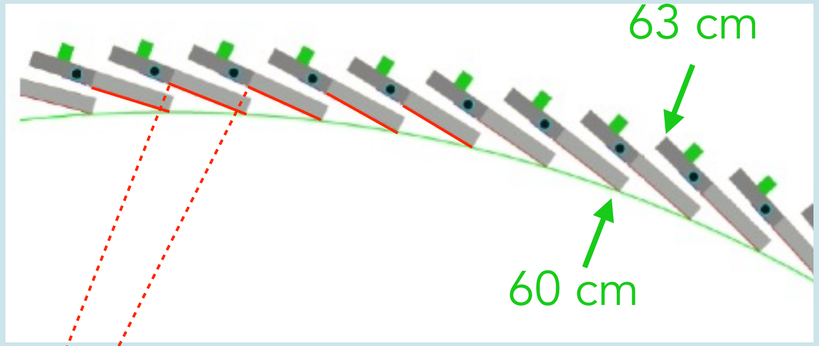
Module top view



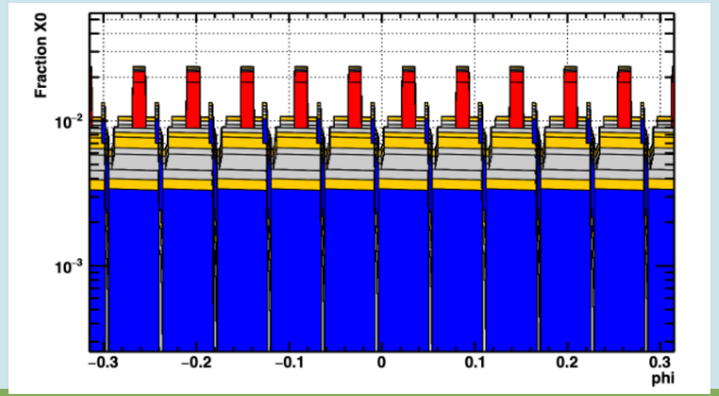
Module cross section

Cylindrical structure by modules

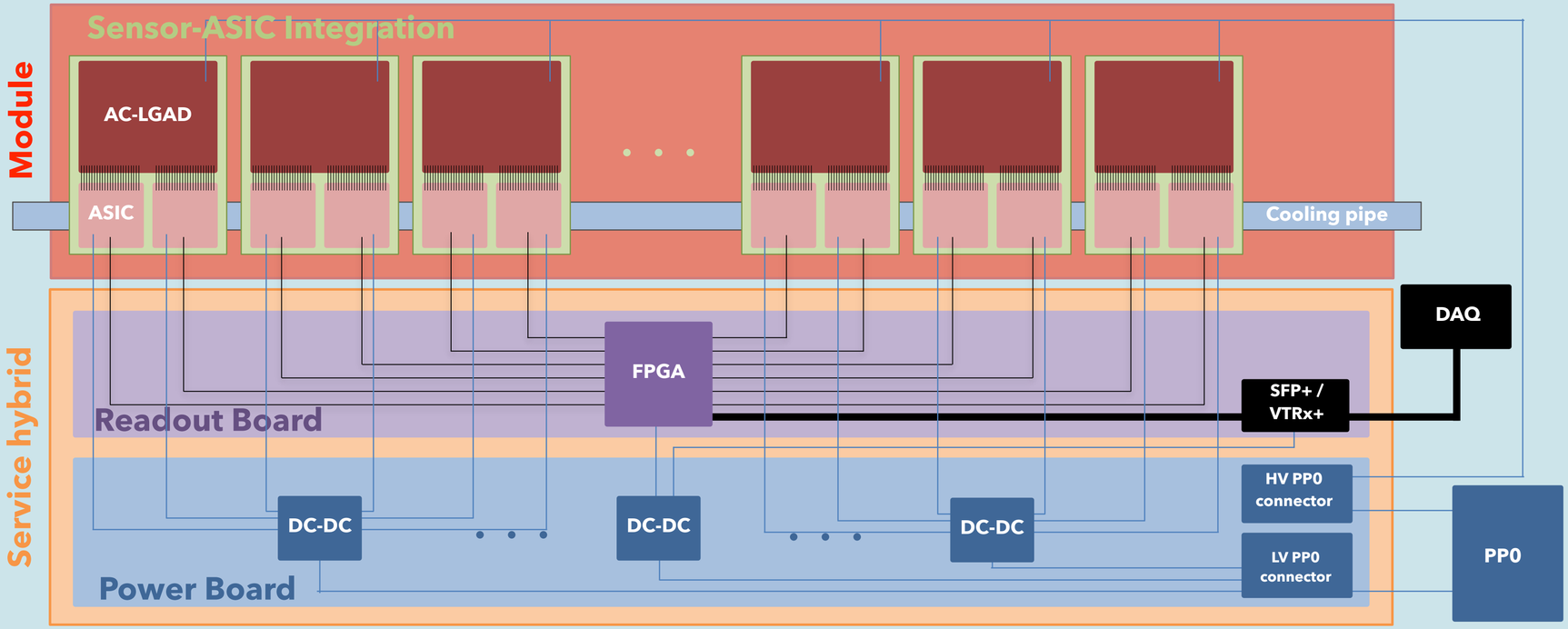
3 mm overlap in Φ

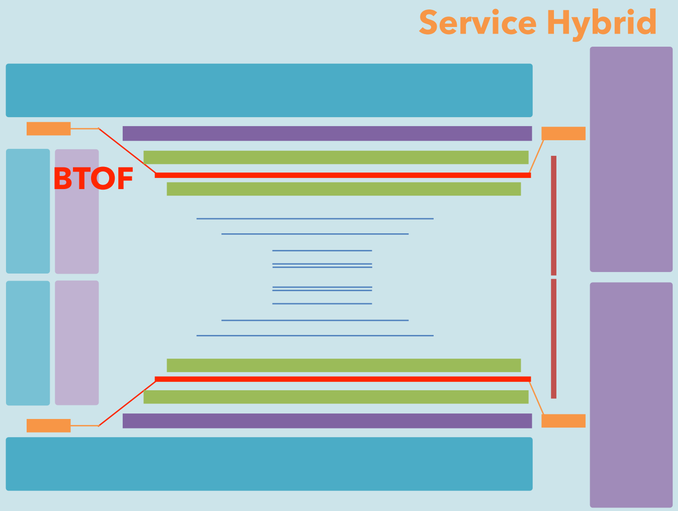


Material budget



BTOF system structure

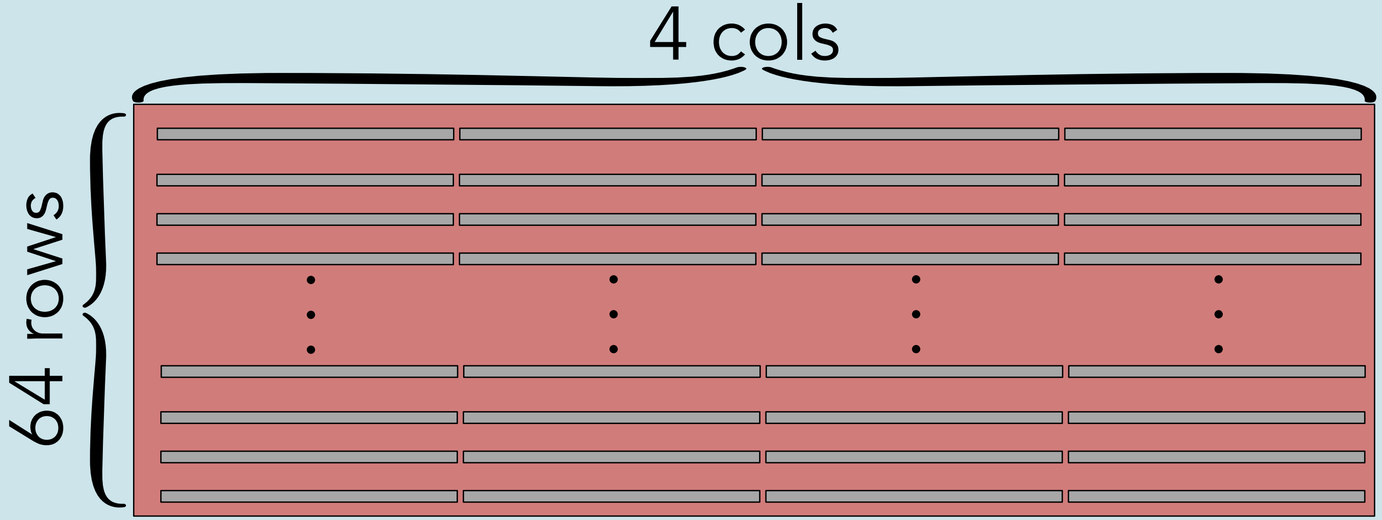




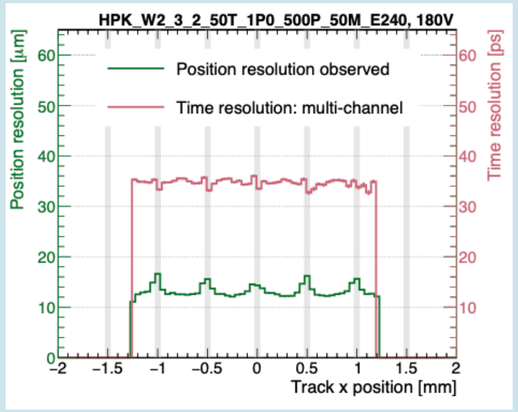
- Sensor signal is readout by 2 ASICs
- ASICs which is the main heat source are cooled by a water pipe embedded inside the module
  - Beam pipe geometry depends on the position of the ASIC
- Data I/O and power supply are controlled by the Service-hybrid
- The service-hybrid is placed outside of the acceptance

BTOF AC-LGAD sensor

- AC-LGAD technology meets the strict spatial and time resolution requirements
- Strip-type sensor, 3.2 x 4 cm^2 sensor size with 0.05 x 1 cm^2 metals, is used in BTOF
  - The readout metal geometry in a sensor is 64 x 4 and 256 channels each
- Due to charge sharing between multiple readout electrodes, 30μm spatial resolution can be achieved in φ direction



eRD112 FY24 Proposal



- Total information
  - **9216 sensors**
  - **11.8 m^2**
  - **2.4 M readout channels**

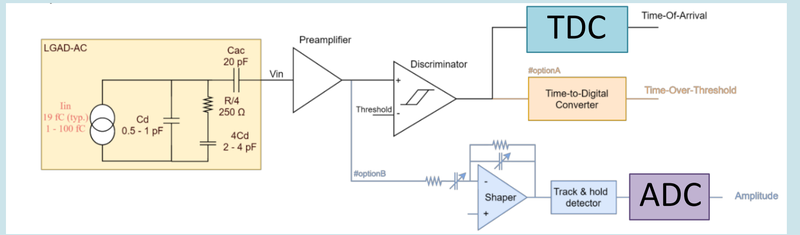
BTOF ASIC

- Not only high-time resolution TDC but also ADC must be measured
- Due to the large capacitance and readout geometry characteristics caused by the strip type, care must be taken when selecting an ASIC

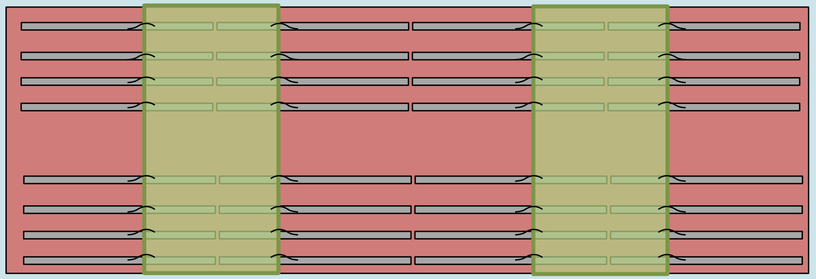
- EICROC (16x16) is one of the common ASICs used in ePIC
  - Design focuses on pixel AC-LGAD readout (tuned for low capacitance)
  - 10-bit TDC and 8-bit ADC is now available (EICROC0)
  - Modification is necessary to read higher capacitance sensor (strip AC-LGAD)

- FCFD is a new ASIC to use strip AC-LGAD readout
  - FCFD can read higher capacitance AC-LGAD sensor
  - Multiple-channel analog is available for FCFDv1

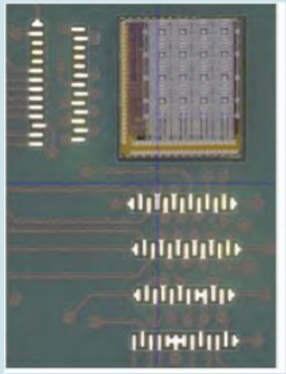
- A variety of third-party ASICs continue to be explored as back-up solutions



ASIC



EICROC0



FCFDv0