

TOF DSC ORG

- **Leadership Structure**

- **Work packages combining BTOF and FTOF**

1. Sensors (2 coordinators)

Jennifer Ott (TBC), Satoshi Yano

2. Frontend Electronics (all electronics that are on the detector) (2 coordinators)

Wei Li

3. Module local integration and assembly (2 coordinators)

Mathieu Benoit, Simone Mazza

4. System tests and validation (2 coordinators)

[Prithwish Tribedy \(FF Liaison\)](#)+Takashi Hachiya

5. Mechanical structure, cooling and global integration (2 coordinator)

Andy Jung, Yi Yang

6. DAQ & Clock distribution (1 coordinator)

Tonko Ljubicic

7. Power system, Detector slow control, monitor and safety system (1 coordinator)

[Frank Geurts](#)

8. Simulations, software & calibration, Database(1 coordinator)

Kentaro Kawade, Tommy Tsang (deputy)

Position	Candidate(s)
1 Detector Subsystem Leader	Zhangbu Xu
1 Deputy DSL	Satoshi Yano
2 Detector Subsystem Tech. Coordinators	Mathieu Benoit, Simone Mazza

	10/2023	Contact Person	NOW (TDR->Project)
Brookhaven National Laboratory	BTOF: sensor , sensor-ASIC integration , module assembly; CS: backend electronics; DP: simulation and reco	Prithwish Tribedy tribady@bnl.gov	DAQ readout chain readout, sensor-ASIC integration , sensor with FF AC-LGAD; EICROC testing
Fermi National Accelerator			FCFD ASIC (no ePIC)
Los Alamos National Laboratory	FTOF: sensor , module assembly; CS: cooling system and support structure; DP: simulation and reco.	Xuan Li xuanli@lanl.gov	
Rice University	BTOF/FTOF: Front-end electronics; CS: backend electronics; DP: simulation and reconstruction	Wei Li wl33@rice.edu	B/FTOF FEE?, Backend electronics (postdoc) , simulation and reconstruction
Oak Ridge National Laboratory	BTOF/FTOF: sensor , sensor-ASIC integration , frontend electronics, module assembly	Oskar Hartbirsch hartbricho@ornl.gov	sensor-ASIC integration , frontend electronics (waffle probing), module assembly
Ohio State University	BTOF/FTOF: module assembly; CS: backend electronics, alignment; DP: simulation and reco.	Daniel Brandenburg Brandenburg.89@osu.edu	BTOF/FTOF: module assembly ; backend electronics
Purdue University	BTOF/FTOF: module structure; CS: cooling system and support structure	Andreas Jung anjung@purdue.edu	Module assembly
Univ. of California, Santa Cruz	BTOF: sensor , sensor-ASIC integration , module assembly	Matthew Gignac mgignac@ucsc.edu	Sensor , sensor-ASIC integration , module assembly (no in-kind)
University of Illinois at Chicago	BTOF/FTOF: sensor , sensor-ASIC integration , module assembly; DP: simulation and reconstruction	Olga Evdokimov mailto:evdolga@uic.edu	
Hiroshima University	BTOF/FTOF: sensor , ASIC ; DP: simulation and reconstruction	Kenta Shigaki shigaki@hiroshima-u.ac.jp	FTOF EICROC testing, sensor testing (30%), simulation
RIKEN	BTOF/FTOF: module assembly	Yuji Goto. goto@bnl.gov	BTOF: module assembly
Shinshu University	BTOF/FTOF: sensor	Kentaro Kawaide kawade@shinshu-u.ac.jp	Sensor testing , simulations
University of Tokyo	CS: streaming readout; DP: online reconstruction	Taku Gunji gunji@cns.s.u-tokyo.ac.jp	DAQ streaming readout
South China Normal University		Shuai Yang syang@scnu.edu.cn	
Univ of Sci. and Tech. of China		Yanwen Liu	
Indian Institute of Tech., Mandi	DP: simulation and reconstruction	Prabhakar Palni prabhakar.palni@unigoa.ac.in	FTOF Module Assembly/QA , sensor testing
National Inst. of Sci. Edu. Res.		Ganesh Tambave ganesh.tambave@niser.ac.in	Module Assembly
National Central University	DP: simulation		FF AC-LGAD (sensor QA)
National Cheng-Kung University	BTOF/FTOF: module structure; CS: cooling system and support structure	Yi Yang yyiang@ncku.edu.tw	2
National Taiwan University	BTOF: sensor-ASIC integration , frontend electronics, module assembly	Rong-Shyan Lu rslu@phys.ntu.edu.tw	FF AC-LGAD; module assembly

Institute	Contact Person	NOW (TDR->Project)
Brookhaven National Laboratory	Prithwish Tribedy tribady@bnl.gov	DAQ readout chain readout, sensor-ASIC integration , sensor with FF AC-LGAD; EICROC testing
Fermi National Accelerator	Artur Apresyan Artur.Apresyan@cern.ch	FCFD ASIC (no ePIC)
OMEGA	Dominique Marchand dominique.marchand@ijclab.in2p3.fr	EICROC
Los Alamos National Laboratory	Xuan Li xuanli@lanl.gov	
Rice University	Wei Li wl33@rice.edu	B/FTOF FEE?, Backend electronics (postdoc) , simulation and reconstruction
Oak Ridge National Laboratory	Oskar Hartbirsch hartbricho@ornl.gov	sensor-ASIC integration , frontend electronics (waffle probing), module assembly
Ohio State University	Daniel Brandenburg Brandenburg.89@osu.edu	BTOF/FTOF: module assembly ; backend electronics
Purdue University	Andreas Jung anjung@purdue.edu	Module assembly
Univ. of California, Santa Cruz	Simone Mazza simazza@ucsc.edu	Sensor , sensor-ASIC integration , module assembly (no in-kind)
University of Illinois at Chicago	Olga Evdokimov mailto:evdolga@uic.edu	
Hiroshima University	Kenta Shigaki shigaki@hiroshima-u.ac.jp	FTOF EICROC testing, sensor testing (30%), simulation
RIKEN	Yuji Goto. goto@bnl.gov	BTOF: module assembly
Shinshu University	Kentaro Kawaide kawade@shinshu-u.ac.jp	Sensor testing , simulations
University of Tokyo	Taku Gunji gunji@cns.s.u-tokyo.ac.jp	DAQ streaming readout
South China Normal University	Shuai Yang syang@scnu.edu.cn	
Univ of Sci. and Tech. of China	Yanwen Liu	
Indian Institute of Tech., Mandi	Prabhakar Palni prabhakar.palni@unigoa.ac.in	FTOF Module Assembly/QA , sensor testing
National Inst. of Sci. Edu. Res.	Ganesh Tambave ganesh.tambave@niser.ac.in	Module Assembly
National Central University		FF AC-LGAD (sensor QA)
National Cheng-Kung University	Yi Yang yiyang@ncku.edu.tw	Mechanics and cooling systems
National Taiwan University	Rong-Shyan Lu rsly@phys.ntu.edu.tw	FF AC-LGAD ; module assembly
Univ. Técnica Federico Santa María		Simulations
LBNL	Zhenyu Ye yezhenyu2003@gmail.com	BTOF ASIC testing; SH
Kent State University	Zhangbu Xu zxu22@kent.edu	Simulation, readout test, machine shop (in-kind)
Nara	Takashi Hachiya hachiya@cc.nara-wu.ac.jp	BTOF module assembly /validation/FPCB

funding from Japan
for BTOF construction

Call for institution
responsibilities/schedule
/cost/manpower

DSC meeting weekly
Wednesday 10:30AM

Coordinator meeting weekly
Thursday 11AM
try to move this to evening

DSC covers 8 different time
zones: EST, CST, PST, Hawaii,
Europe, Japan, Taiwan, India

★ CD2 ★ Install to ePIC
★ CD3 ★ Early-CD4

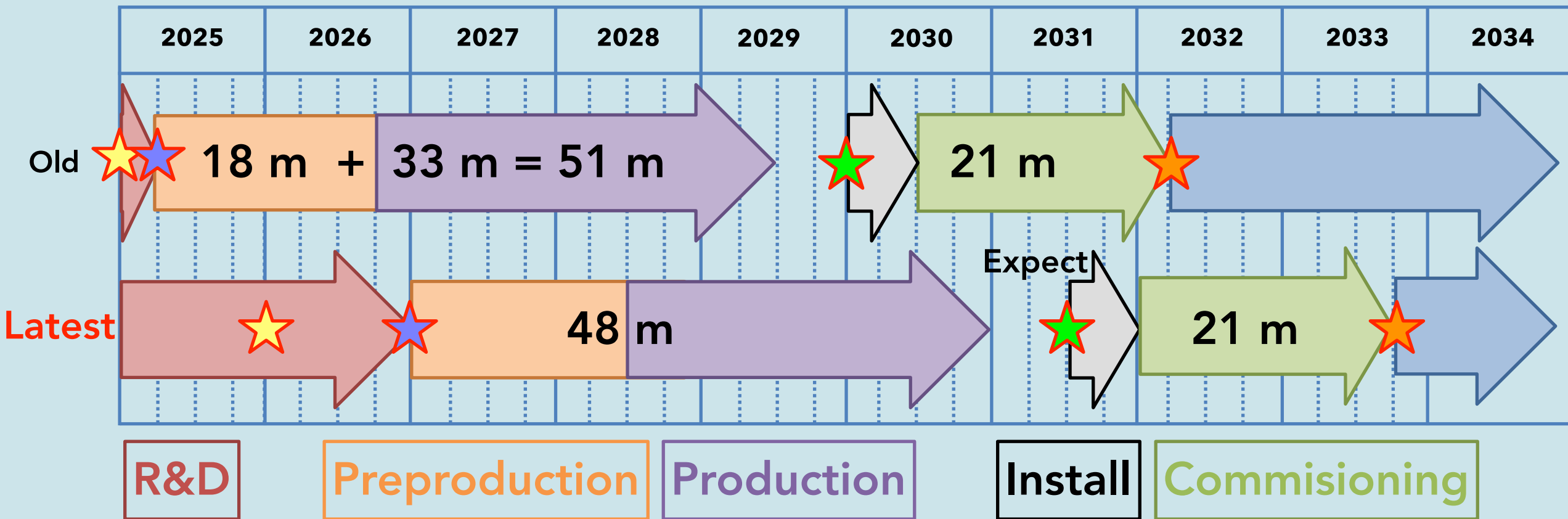
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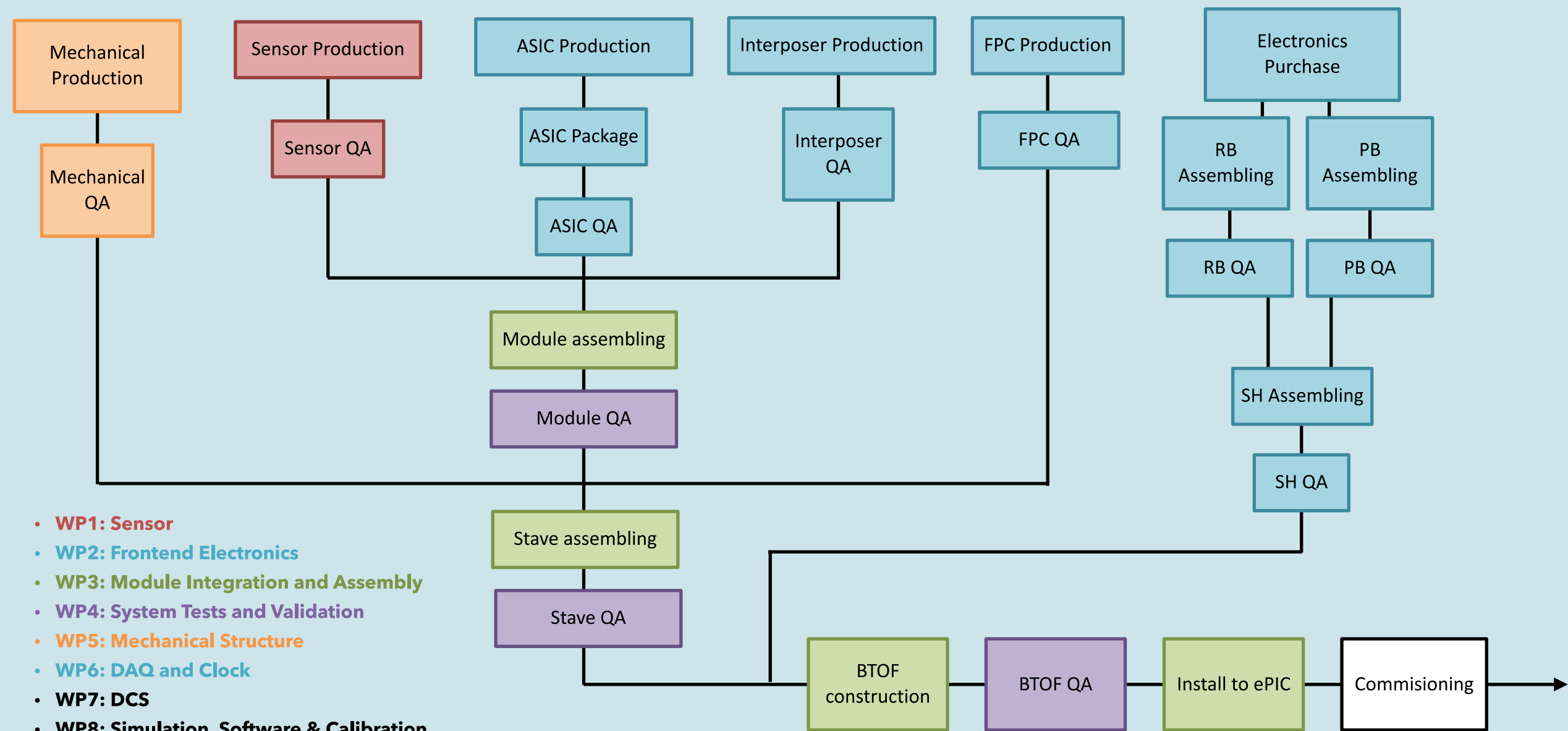
EIC Critical Decision Plan (Old)

CD-0/Site Selection	December 2019
CD-1	June 2021
CD-3A	Jan 2024
CD-3B	Jan 2025
CD-2	Jan 2025
CD-3	Apr 2025
Early CD-4	Apr 2032
CD-4	Apr 2034

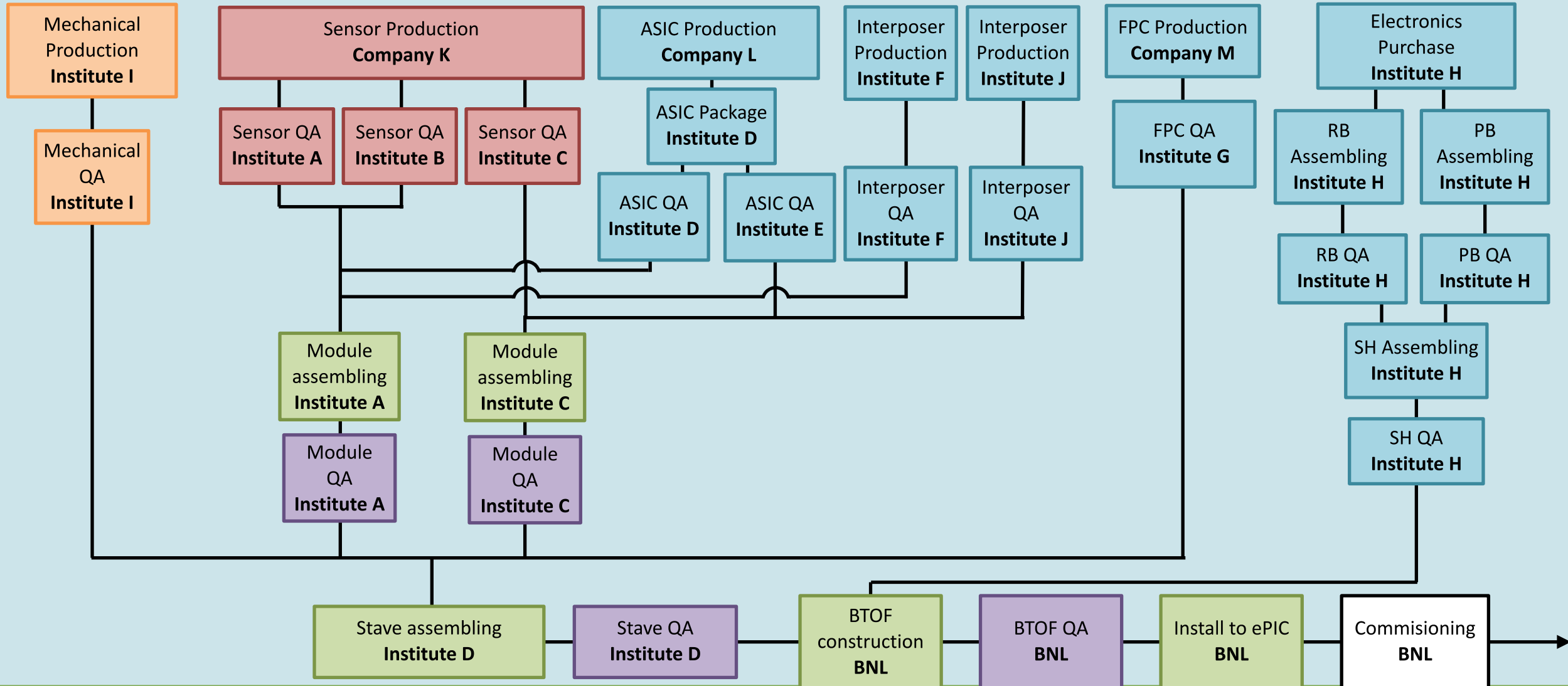
EIC Critical Decision Plan (Latest)

CD-0/Site Selection	December 2019
CD-1	June 2021
CD-3A	March 2024
CD-3B	January 2025
CD-2/3C	Q2 FY26
CD-3	Q2 FY27
Early CD-4	Q1 FY34
CD-4	Q4 FY35





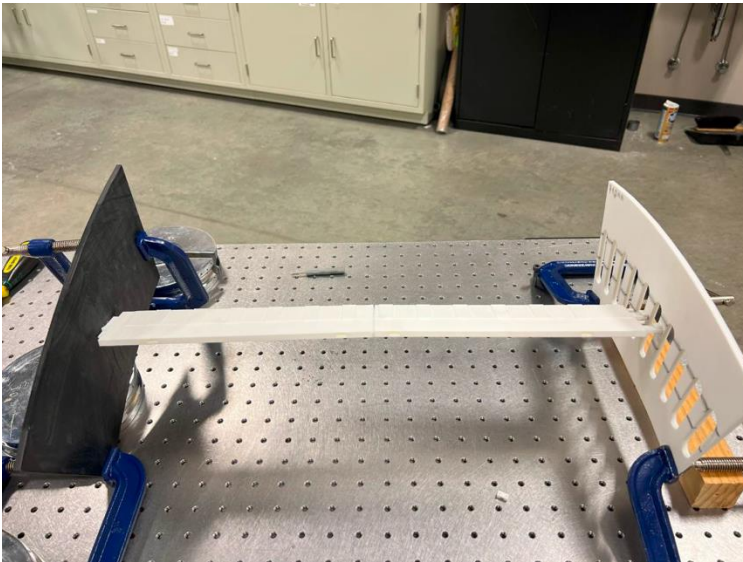
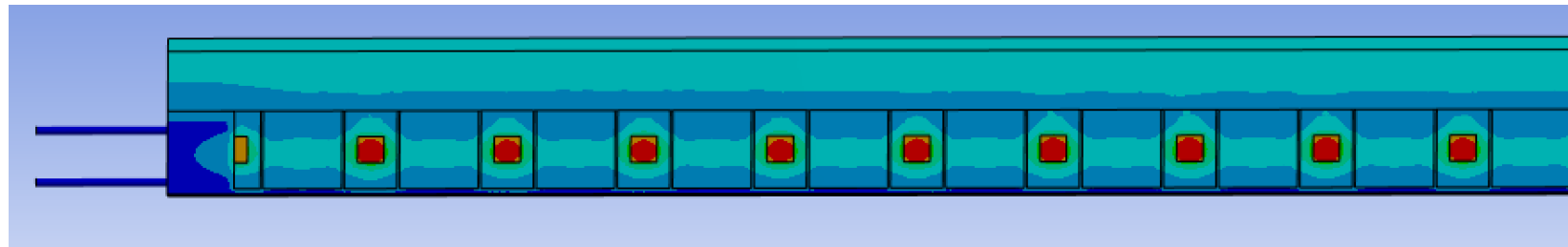
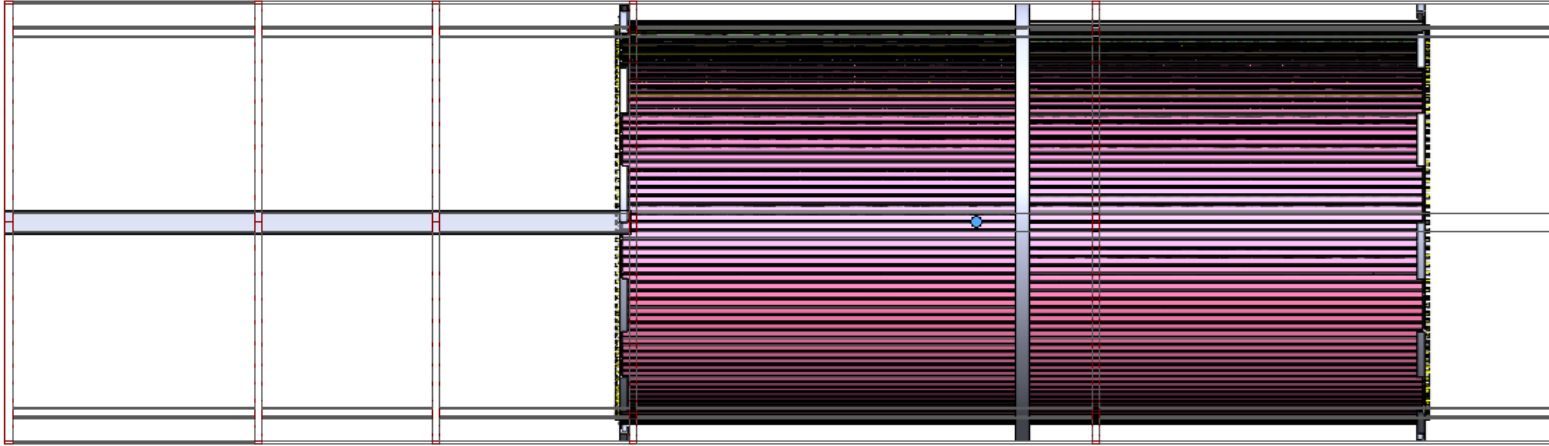
In the near future...



Mechanic design of bTOF

Symmetric halves,
Mounting structure design procedures
Significant design change in last weeks
Thermal test of cooling system

Priority: finalize design
With Cooling capacity



Subsystem	Area (m^2)	dimension (mm^2)	channel count	timing σ_t (ps)	spatial σ_x (μm)	material budget (X/X_0)
Barrel TOF	12	0.5*10	2.4M	35	30 ($r \cdot \phi$)	3%
Forward TOF	1.1	0.5*0.5	3.2M	25	30 (x, y)	5%

Table 8.1: Required performance for physics and proposed configurations for the TOF detector system. The Barrel TOF consists of strip sensors with a pitch of 0.5 mm in the azimuthal direction and a length of 1 cm along the beam direction, while the Forward TOF consists of pixel sensors with a pitch of 0.5 mm.

Simulation framework

Updating Simulation geometry to match the latest CAD drawing

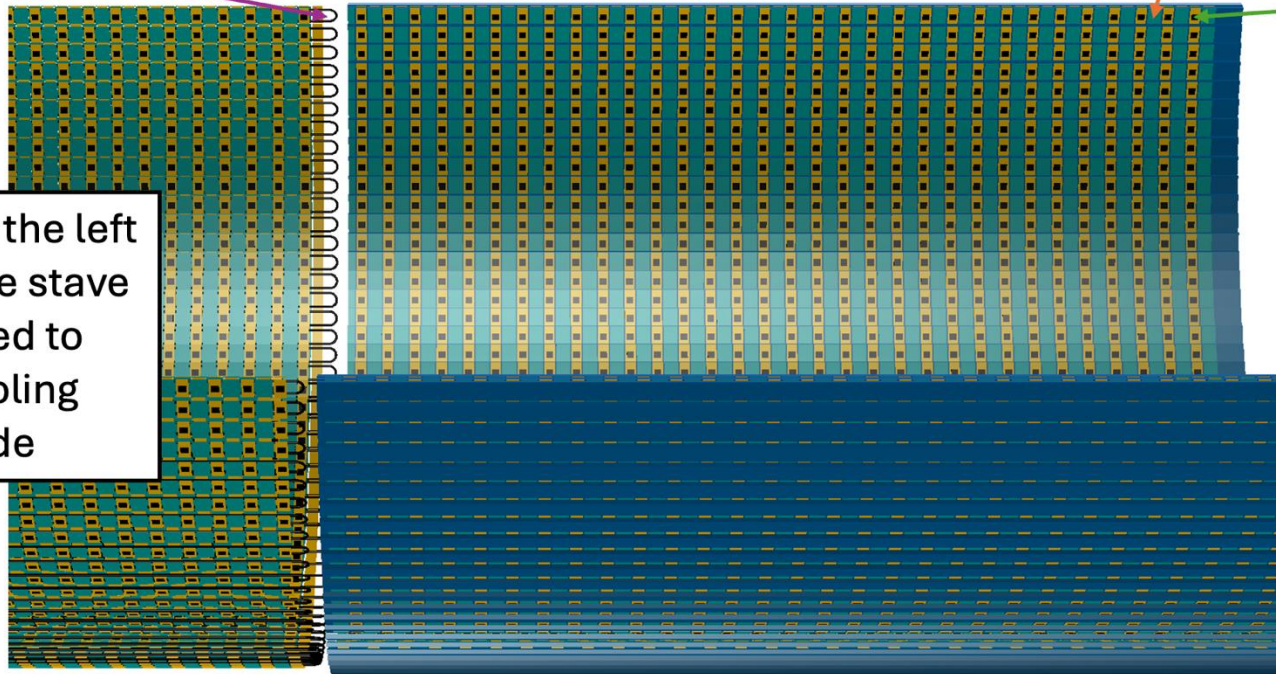
Cooling tubes with the
U shaped bent

Rendering from TGeoManager

Sensor

ASIC

Foam on the left
half of the stave
is removed to
show cooling
pipe inside



Verify material budget to
be 2-3% is OK for angular resolution
requirement from detectors behind TOF

ePIC Collaboration-wide subsystems are
using and extending our digitization code

LOWQ2 detector uses our digitization routine
since this pull request:

<https://github.com/eic/ElCrecon/pull/1758/files>

In the same pull request, they also wrote a noise
class to extend our digitization routine to
simulate electronic noise.

Priority: realistic material with
tracking and timing performance
with all detectors

NOTE: FTE numbers are extremely tentative (Simone)

Remaining sensor/chip R&D

- Test bare AC-LGAD sensors: IV/CV
 - Need: probe station, LCR meter
 - FTE: a few FTE students + 10% FTE scientific staff managing
- Test bare AC-LGAD sensors: TCT laser
 - Need: TCT station
 - FTE: a few FTE students + 10% FTE scientific staff managing
- Irradiation campaign organization
 - 5% FTE scientific staff managing
- Test FCFD
 - Need: source, TCT station, FPGAs
 - ? FTE
- Test beam activity
 - Support assembly of devices (need wirebonder) and pre-test
 - Support the data taking and analysis
 - Travel + 20% FTE of grad student or postdoc
- Stave and cooling development

Pre-assembly R&D

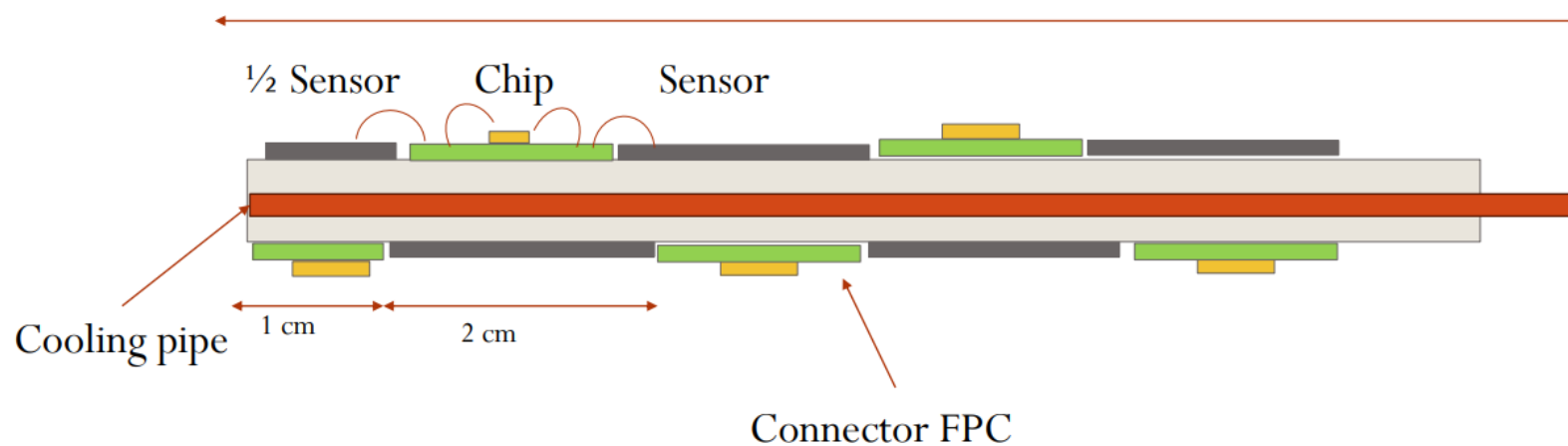
- Development of assembly 'stavelet' tooling and procedure
 - Need: wire bonder, engineering time, glue dispenser (automated), metrology
 - 10% FTE tech
- Development of assembled 'stavelet' DAQ board
 - Need: engineering time, FPGA
 - 20% FTE tech
- Thermal study and QC on demonstrators
 - Need: ?
 - 10% FTE scientific staff
- Development of full stave assembly
 - Need: engineering time, large assembly area
 - 20% FTE tech
- Development of FPC
 - Need: engineering time
 - ? FTE
- Development of edge board?
 - Need: engineering time
 - ? FTE
- Shipping R&D, support for shipping and carrier qualification
 - Need: tech time
 - 5% FTE scientific staff managing
 - 5% FTE tech
- Full stave prototype assembly
- Large-scale sensor QC, define QC procedure
- Large-scale chip QC, define QC procedure

Work in progress

BTOF Assembly Plans

Assembly

- 'Stavelet' assembly (multiple sites)
 - Need: wire bonder, engineering time, glue dispenser (automated), metrology...
 - FTE: assuming 4 sites, ~20% Tech FTE over 2 years (1 day per week)
- Stave and pipe production
- Full stave assembly (fewer sites?)
 - Need: engineering time, large assembly area
- Sensor QC
 - Need: probe station, LCR meter
- Chip QC
 - ?
- 'Stavelet' QC
 - ?
- Full stave QC
 - Need: working edge board system
- Final assembly (just BNL?)



Project: *ePIC Forward Time-of-Flight (FTOF)*

Version: Rev 1.0, April 16, 2025

Contacts(s): M. Benoit, W. Li, M. Matveev, T. Ljubicic

Detector Envelope:	1
Sensor and ASICs:	1
Module:	2
Service Hybrids and Powering Scheme	3
Detector Layout	7
Material budget	9
Power budget	9
Power system (HV, LV) and data acquisition system (DAQ)	10
Common components needed	11

Detector Envelope:

Latest detector envelope can be found at: [link](#)

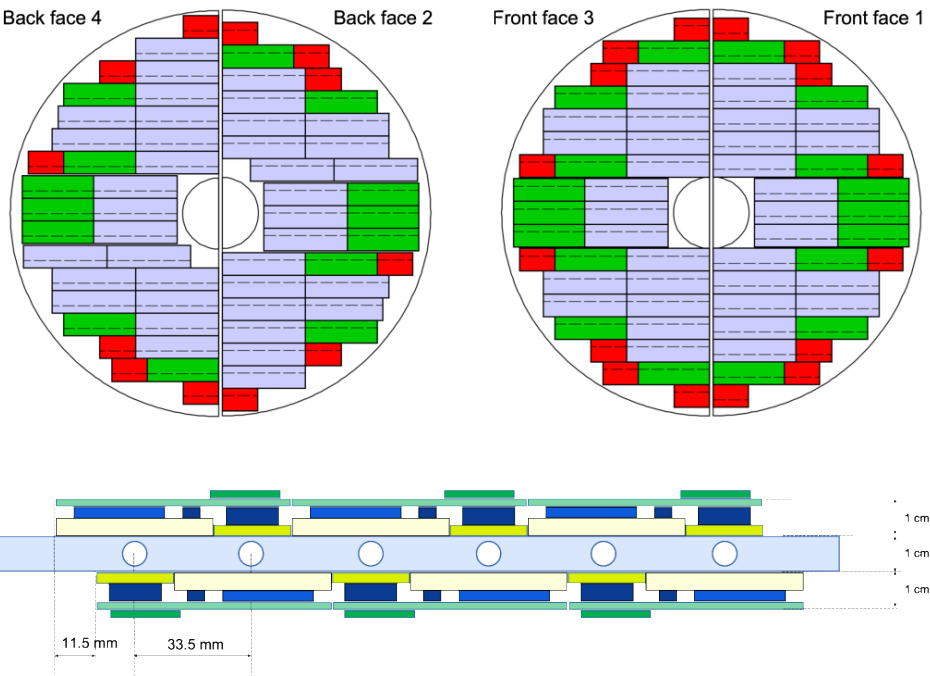
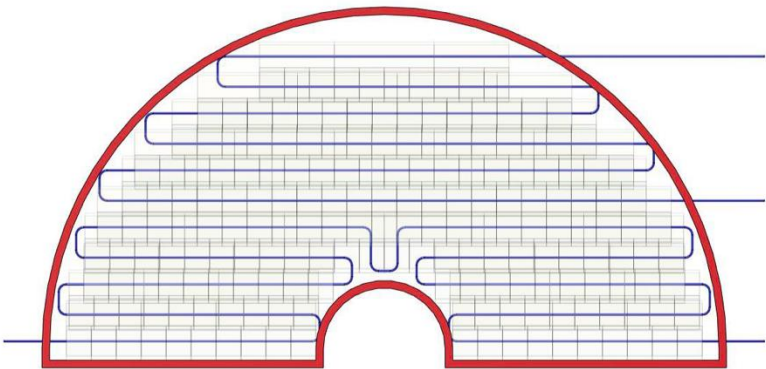
The FTOF dimensions are:

- **Length:** 8 cm (from 185 cm to
- **Inner radius:** 10.5 cm
- **Outer radius:** 60 cm
- **Total area:** 1.096 m²

Sensor and ASICs:

Sensor Specifications

- **Type:** Pixel AC-LGADs
- **Pixel Pitch:** 500 microns



With these considerations in mind, we can populate the disk with the following numbers of each type of service hybrid as shown in Table 1.

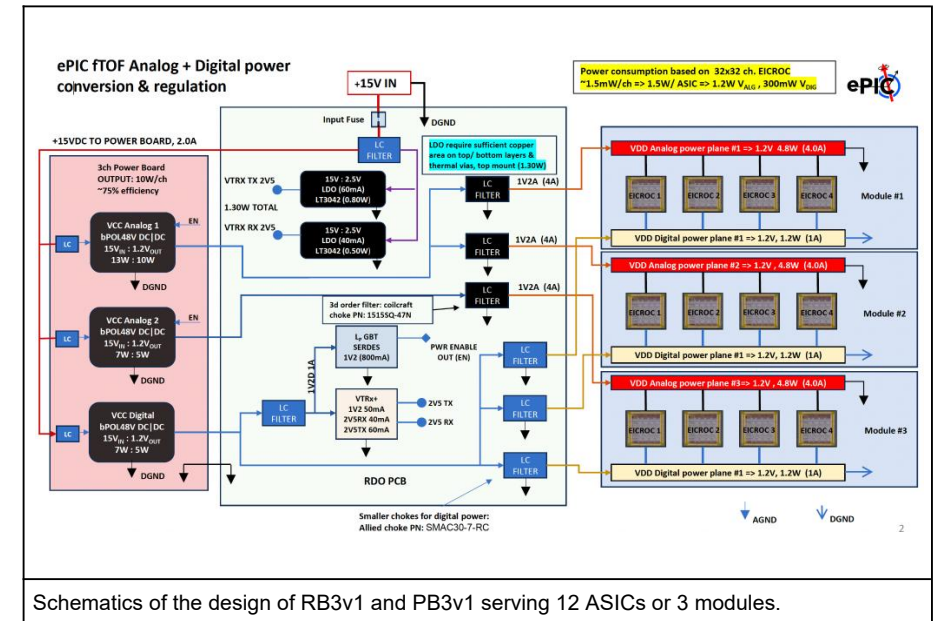
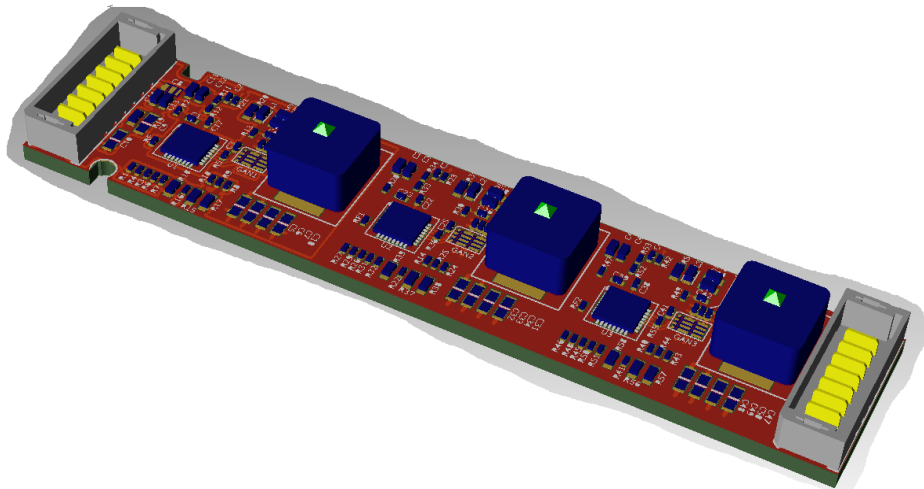
Type	FACE 1 & 3	FACE 2 & 4	Total
3 module SH	8	6	28
6 module SH	9	8	34
7 module SH	17	18	70
Modules	197	192	778
Sensors	788	768	3112

Number of Service Hybrids (SH) and modules of the detector.

Electronic readout boards

chips. The PB connects to the RB through board-to-board connectors. The following configurations are being considered:

- a. **PB3:** Powers an RB3 setup (3 modules).
- b. **PB6 and PB7:** Each 6-module and 7-module SH configuration will use **two PBs**.
- c. **Alternative Option:** Instead of using multiple PB3s, separate PB6 and PB7 designs may be developed for better integration.



Rice is waiting for PED fund delivery

Sensors and ASIC

Production of new AC-LGAD sensors.

Testing of several EICROC0 ASICs with pixilated AC-LGADs.

Continued development of a readout ASIC for the strip AC-LGADs.

Analysis of previous test-beam data important to inform choices for the FY24 sensor production campaigns.

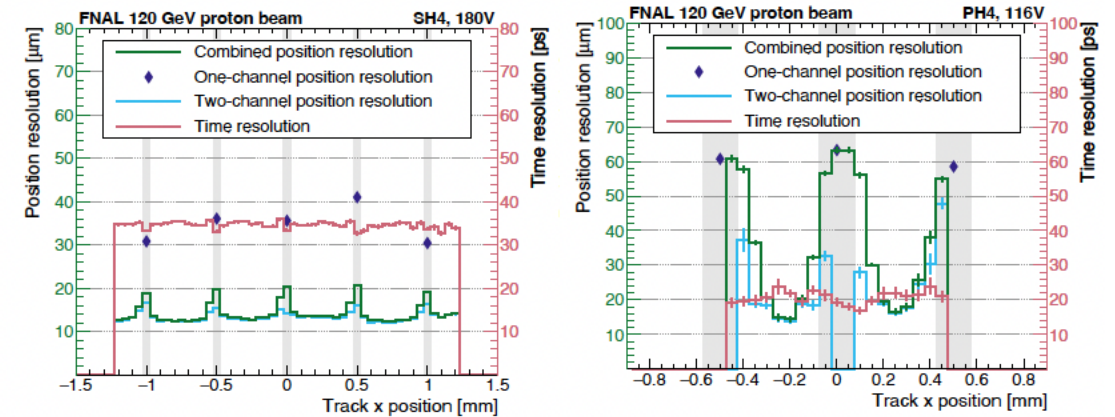
Irradiation campaign for the sensors: shows sensors are adequate for the radiation dose at EIC

Several groups have made progress in testing and characterizing AC-LGADs

First tests with “full-size” sensors

Transition to PED from R&D

ASIC versions, We anticipate EICROC0A and EICROC1 in the coming months



Baseline sensors from beam test perform close to requirement
50 um thickness sensors from HPK had low yield, and it seems to be resolved

Japan funding to continue with different sensor production with HPK

Beam test for 50,30, 20um sensors proposed in the second half of 2025