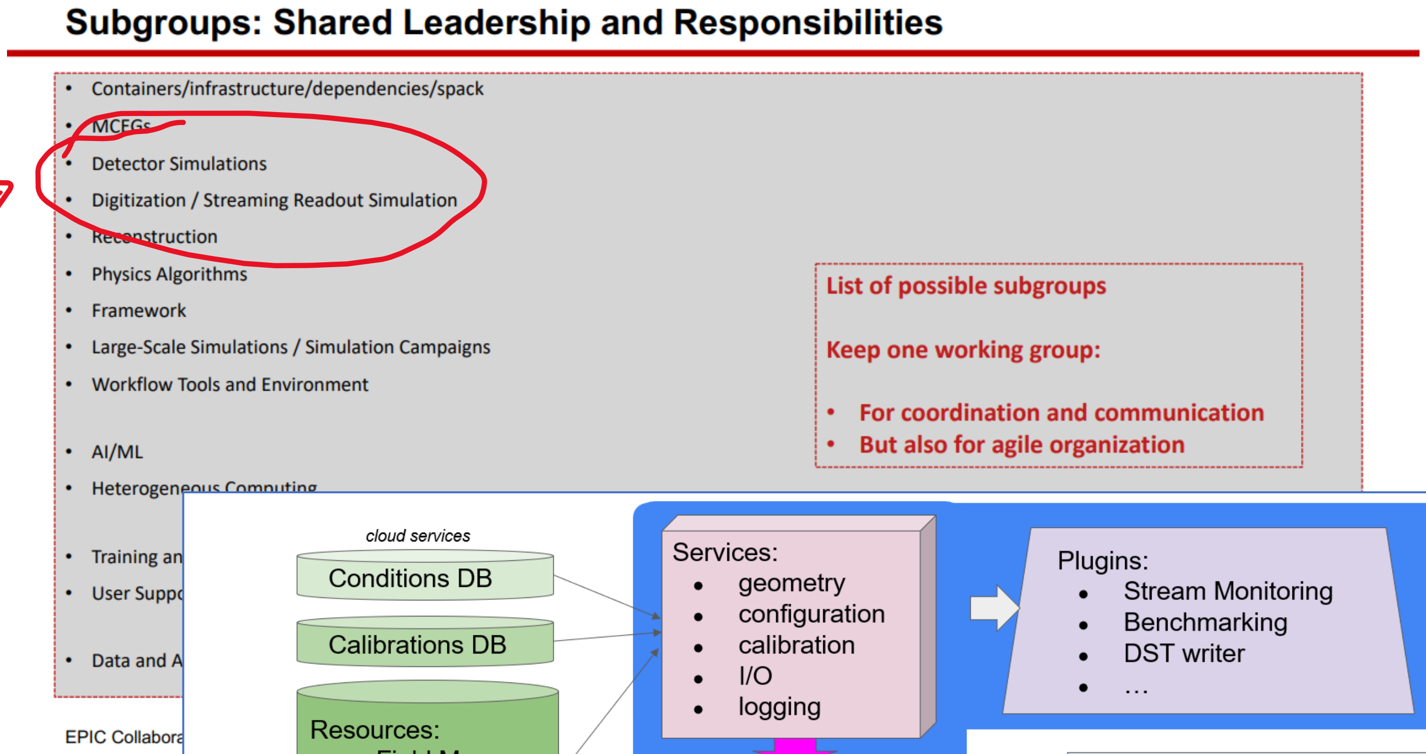
Summary of EPIC Collaboration Meeting (DAQ Perspective)

Jeff Landgraf

Software / Computing

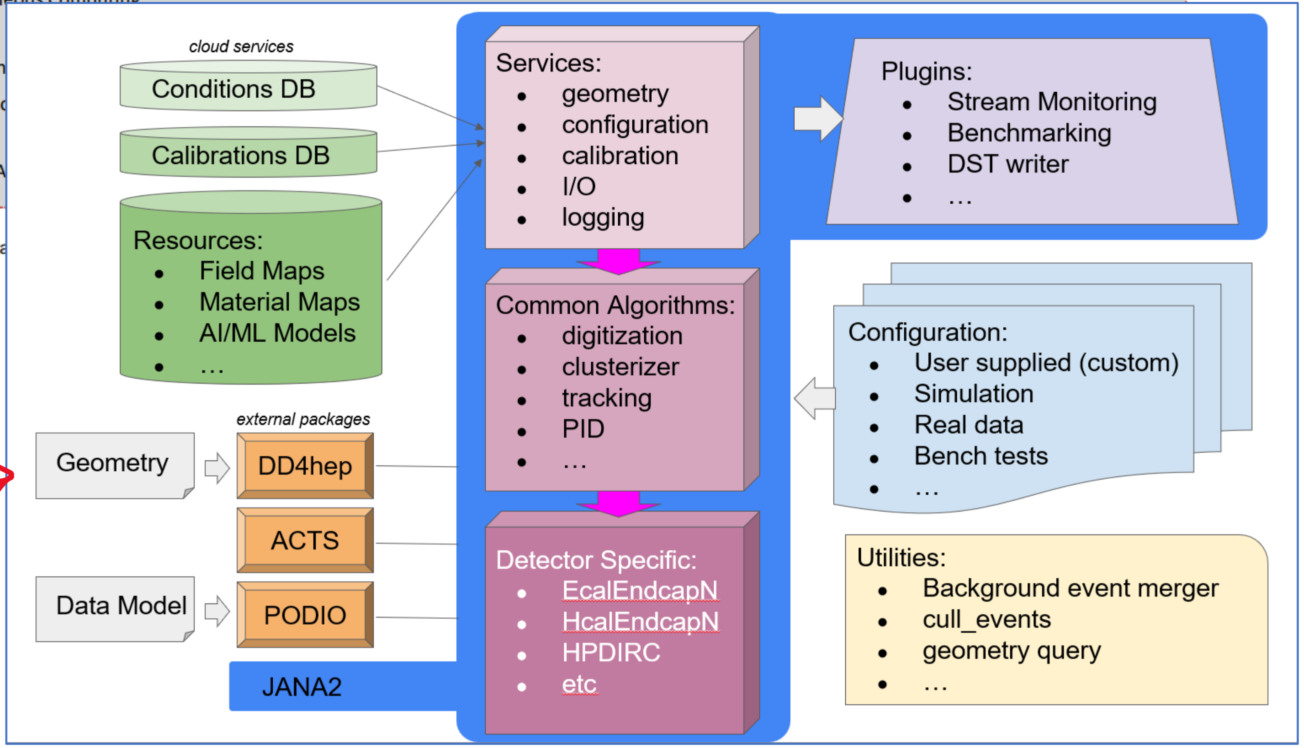
Markus Diefenthaler:

- Subgroups
- Digitization / Streaming Readout



Nathan Brei:

- Jana2 (framework)
  - Providing information
  - QA & other processing
  - DAQ integration?



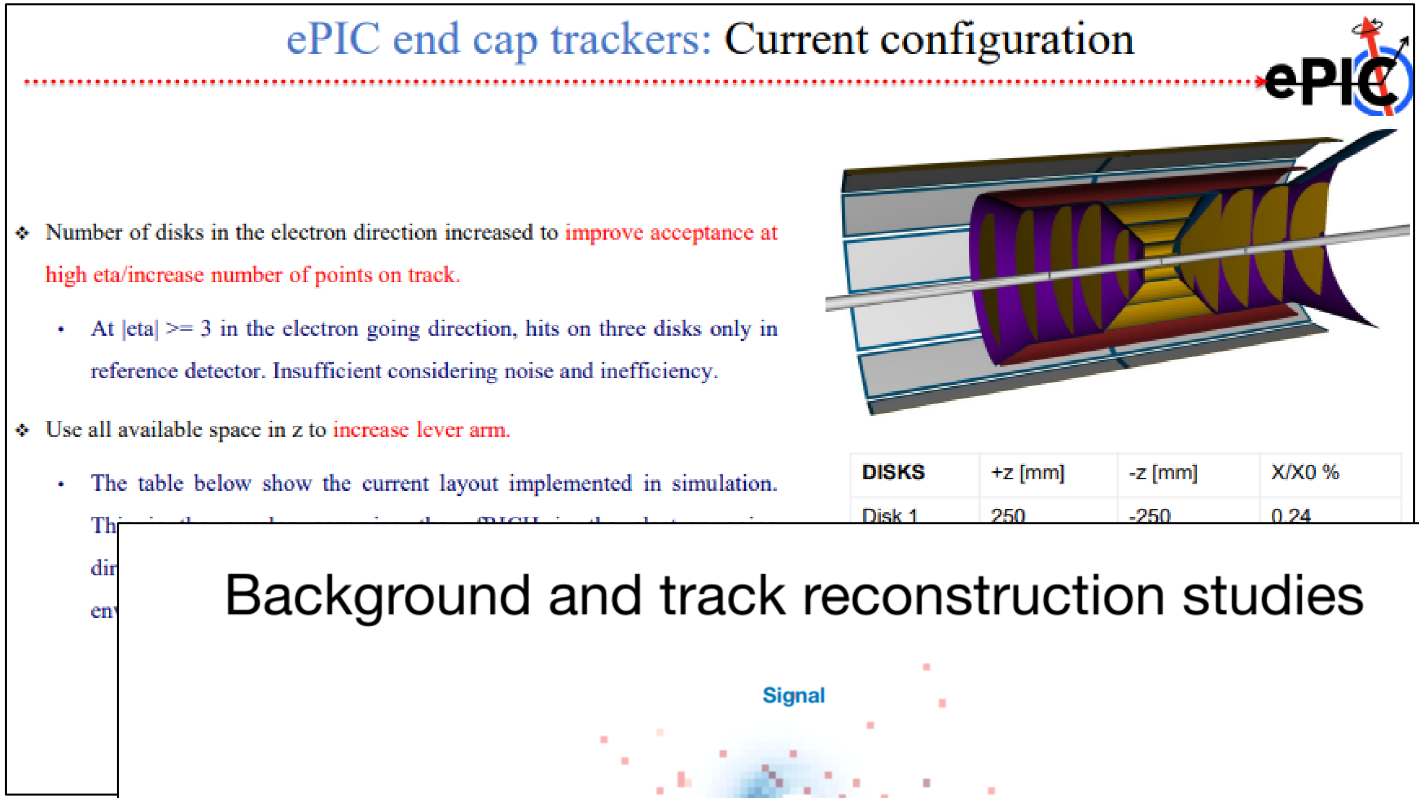
Tracking

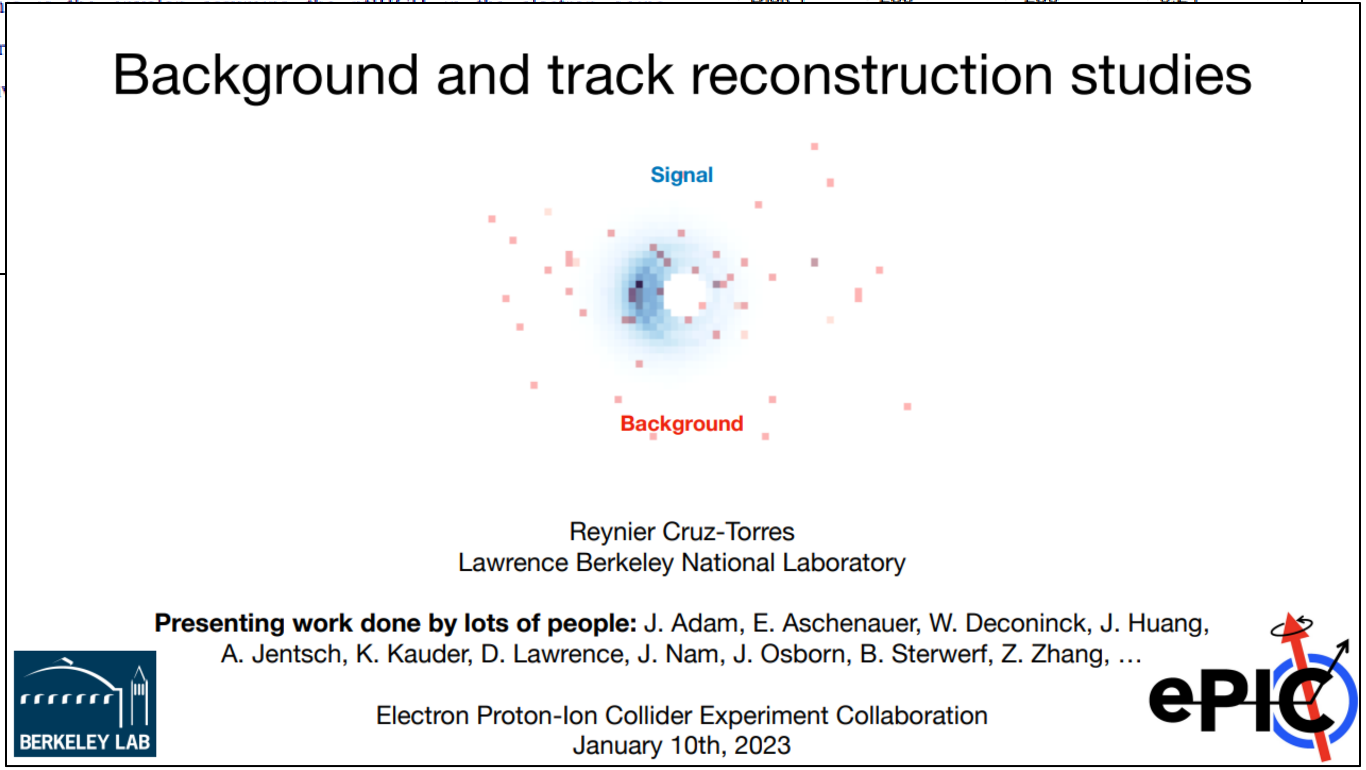
Kondo Gnanvo, Stephen Maple, Wenqing Fan:

- Some updates to detector (minor from DAQ point of view)
- Lots of tracking studies
- MAPS integration time unknown but assumed ~2us

Rehnier Cruz-Torres:

- Background results starting to come out…
- DAQ attention needed
    - Need to convert to Data Volumes
    - Need to convert to electronics impacts
    - Need to estimate noise/dark currents





Calorimetry

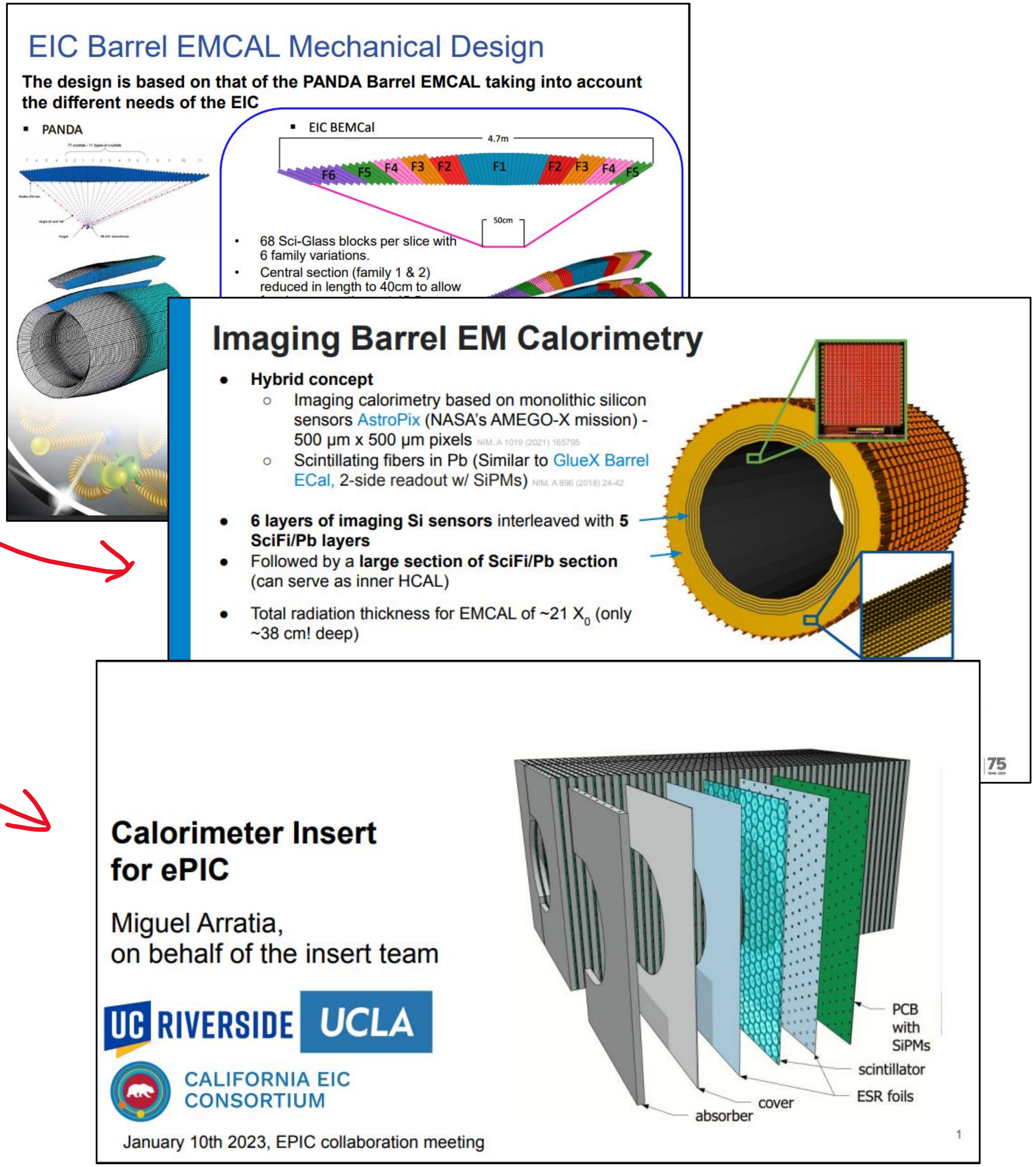
Joshua Crafts, Maria Zurek

- The Barrel Ecal technology still not decided, but lots of details of each technology described

Miguel Arratia:

- Insert not in baseline
- Argued that it should be, and if it shall ever be installed ***must*** be in baseline

- No clarification regarding the two competing readout schemes (HDCROC32 for all vs ADC/FPGA for some)



Cherenkov PID

Pietro Antonioli:

- LAPPD technology for mRICH/pfRICH
- mRICH vs pfRICH not determined
- LAPPD or MCP-PMT for hpDIRC
- SiPM dark currents better than previous estimates by ~x5 because of continuous/semi-continuous annealing.

the candidates table (June 2022)

eRD110 presentation shown at "From RICH to EIC" / AGS/RHIC user meeting – June 2022

B-field (LAPPD)

Radiation (SiPM))

commercially available (ex.: Planacon XP85122) with (< 100 ps time resolution are ok. Problem is price tag (hpDIRC)

move from prototypes to "production" (LAPPD)

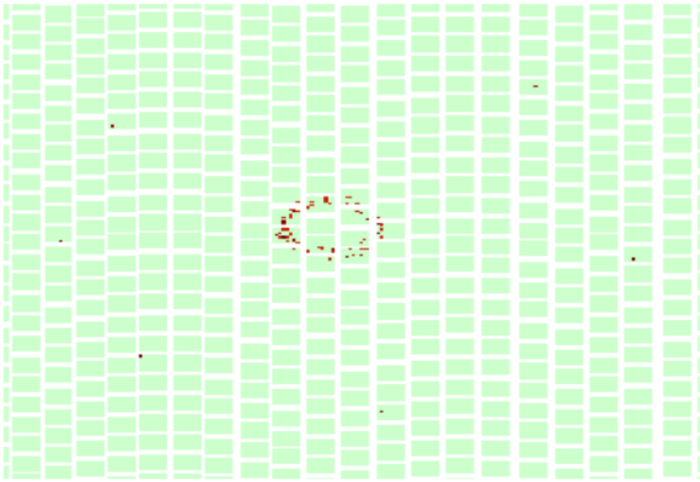
	MCP-PMT/Planacon	SiPM	LAPPD
Area	5x5 cm^2	Tiles available 5.76 cm^2	20x20 cm^2
Pixel		3x3 mm^2	25 x 25 mm available → 3x3 mm in future?
Magnetic field	Seen drop in collection efficiency at angle > 10 deg	insensitive	[illegible].7 T on 20 μm MC seems ok, depending orientation. Smaller MCP's for larger field
Radiation	insensitive	neeeds test + assess mitigation protocol (annealing)	No data, but reasonable to expect not a problem
Availabteyility	In stock*	In stock*	"In-stock" for 20 μm
Manufacturers	Photonis/Photek	many (HPK, OnSemi, FBK/L-Foundry, Ketek/Boradcom)	Incom
Price	\$ 15-20 k\$ each (few units)	1 k\$ /(8x8 tile 3x3 mm)	\$25-50K each LAPPD (20x20 cm^2 or 10x10 cm^2 similar price)
Unit price	16 k\$/25 cm^2 = 600 \$/cm^2	≈50-100 \$/cm^2	62.5-500 \$/cm^2
Concerns	cost	DCR increase with radiation	Cross talk, integration, availability
Risks	None	None if mitigation of DCR increase "manageable"	Achievable with risk, time schedule challenging

Jan 10 2023 – ePIC meeting   P. Antonioli – Cherenkov PID: photosensors   3

Christopher Dilks:

- Outer ring ~7hits… To be found in high noise environment for dRICH

Event Display: digitized hits



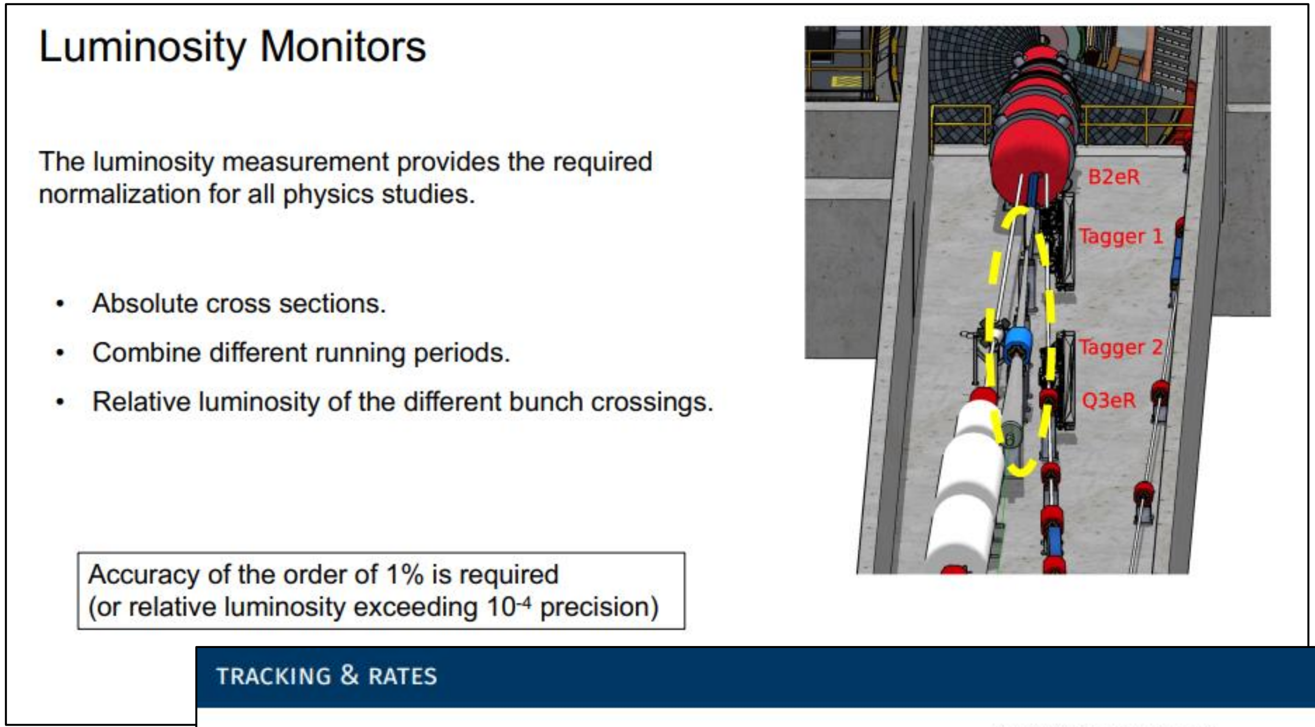
- Digitization:
  - Quantum Efficiency (20-40%)
  - Pixel gap cuts (88%)
  - Safety factor (70%)
- # hits << # photons
- Still does not include SiPM noise!

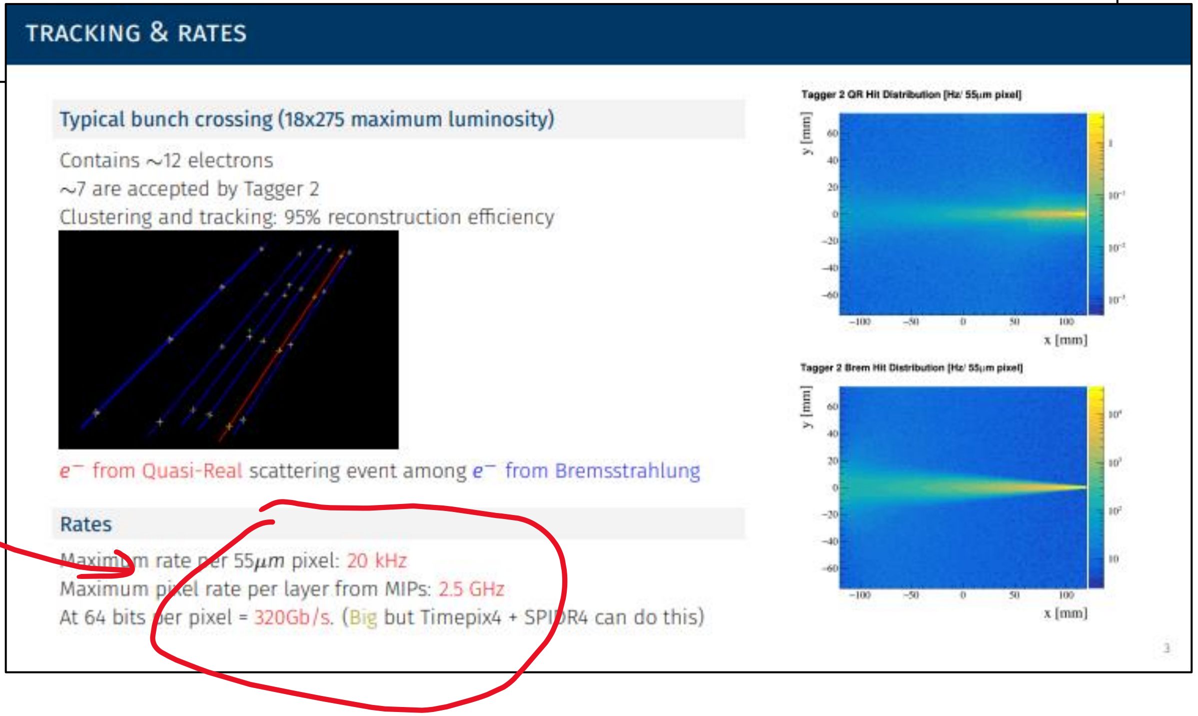
C. Dilks   ePIC dRICH   18

Far Backward

Igor Korover, Jae Name, Dhevan Gangedharan:

- Detectors physical positions changing
- Still shifting in terms of technologies (or perhaps it's my understanding that is shifting ☺)





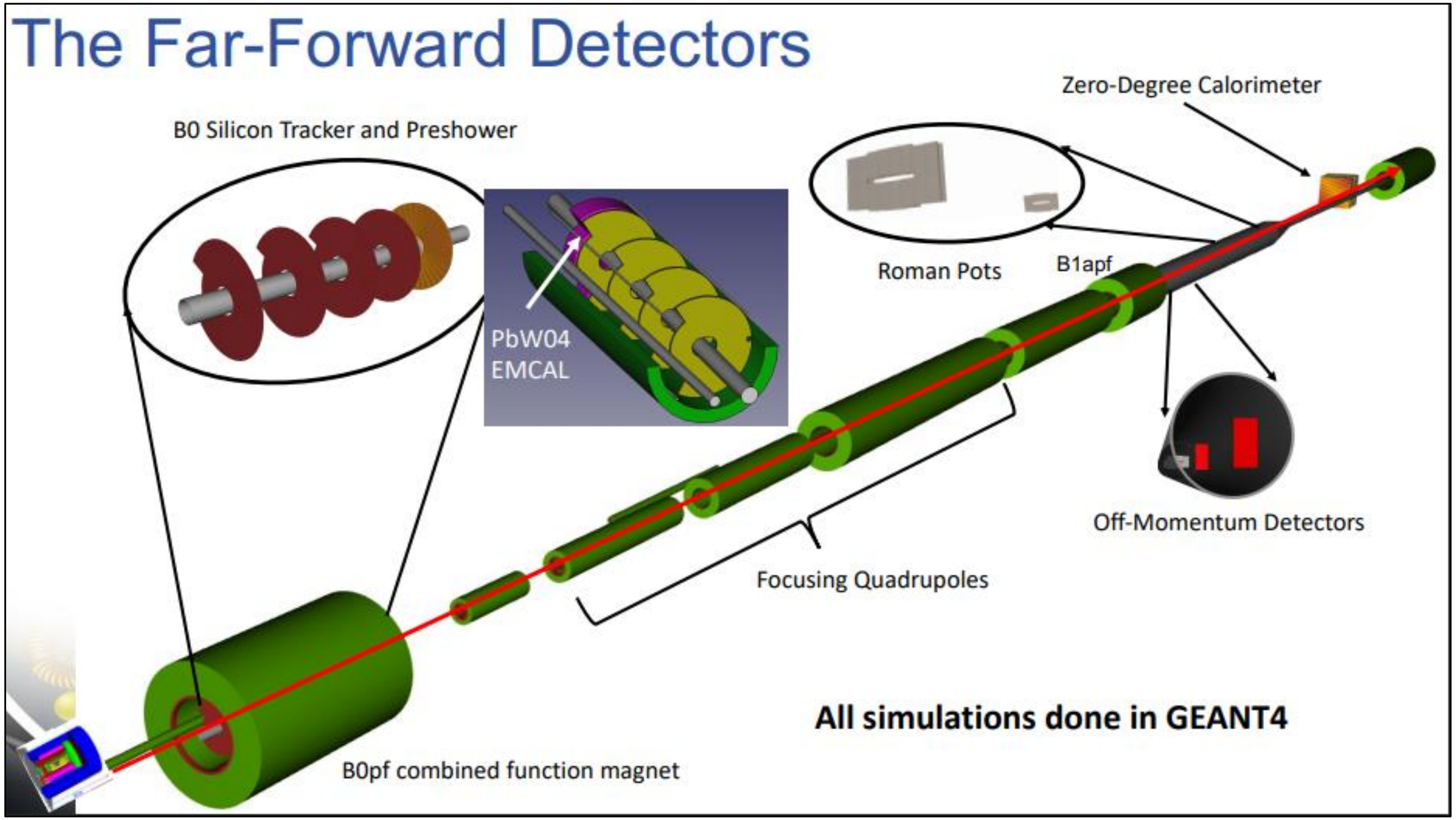
Simon Gardner (Low Q^2 Taggers):

- 320 Gb/s is about 3x previous estimates
  - More FELIX must be allocated
  - Define analysis, Organize Analysis (data in separate computers?), ensure resource for analysis.

Far Forward

Alexander Jentsch:

- Focus was on tracking & detector performance



TOF

Zhenyu Ye:

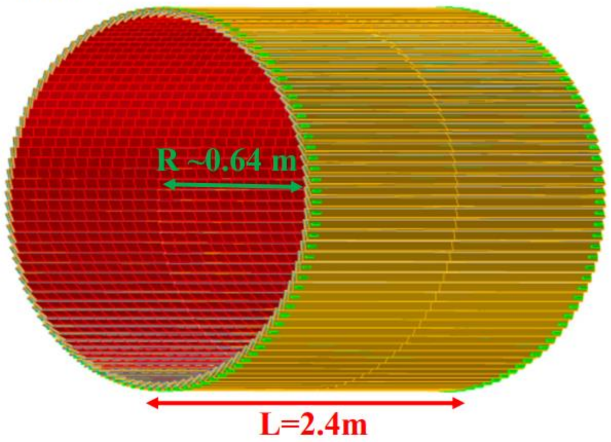
- Decisions
    - Strips for barrel
    - Pixels for Endcap
    - No Backward Endcap (LAPPD RICH readout)

- Refers to DAQ plans (via tonko)

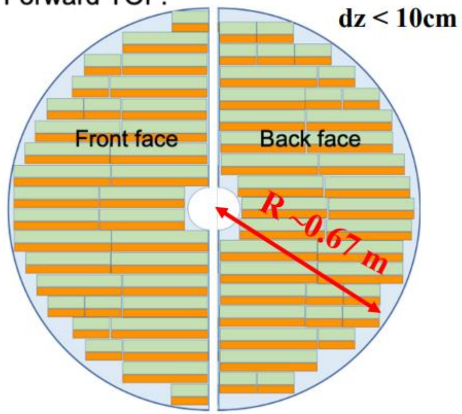
TOF Layout

More details: https://indico.bnl.gov/event/16765/
https://indico.bnl.gov/event/17336/

Barrel TOF:



Forward TOF:



- 288 staves, each with 32 strip sensors wire-bonded to 64 fro
- Po for
- 212 modules, each with 24 to 96 bump-bonded

1/11/23

On-detector Electronics Development

Approved R&D proposal (eRD109) includes readout electronics work from ORNL. Further PED request by BNL, Rice and other institutions through DAQ group is anticipated

- ORNL: Readout R&D for barrel implementation
    - Targeting kapton flex design for minimal material budget
    - Integration into barrel mechanics
- BNL:
    - Readout board reference prototype
    - Precision clock distribution
- Rice: Readout board implementation for TOF endcap, power board
    - Based on CMS-ETL service hybrids

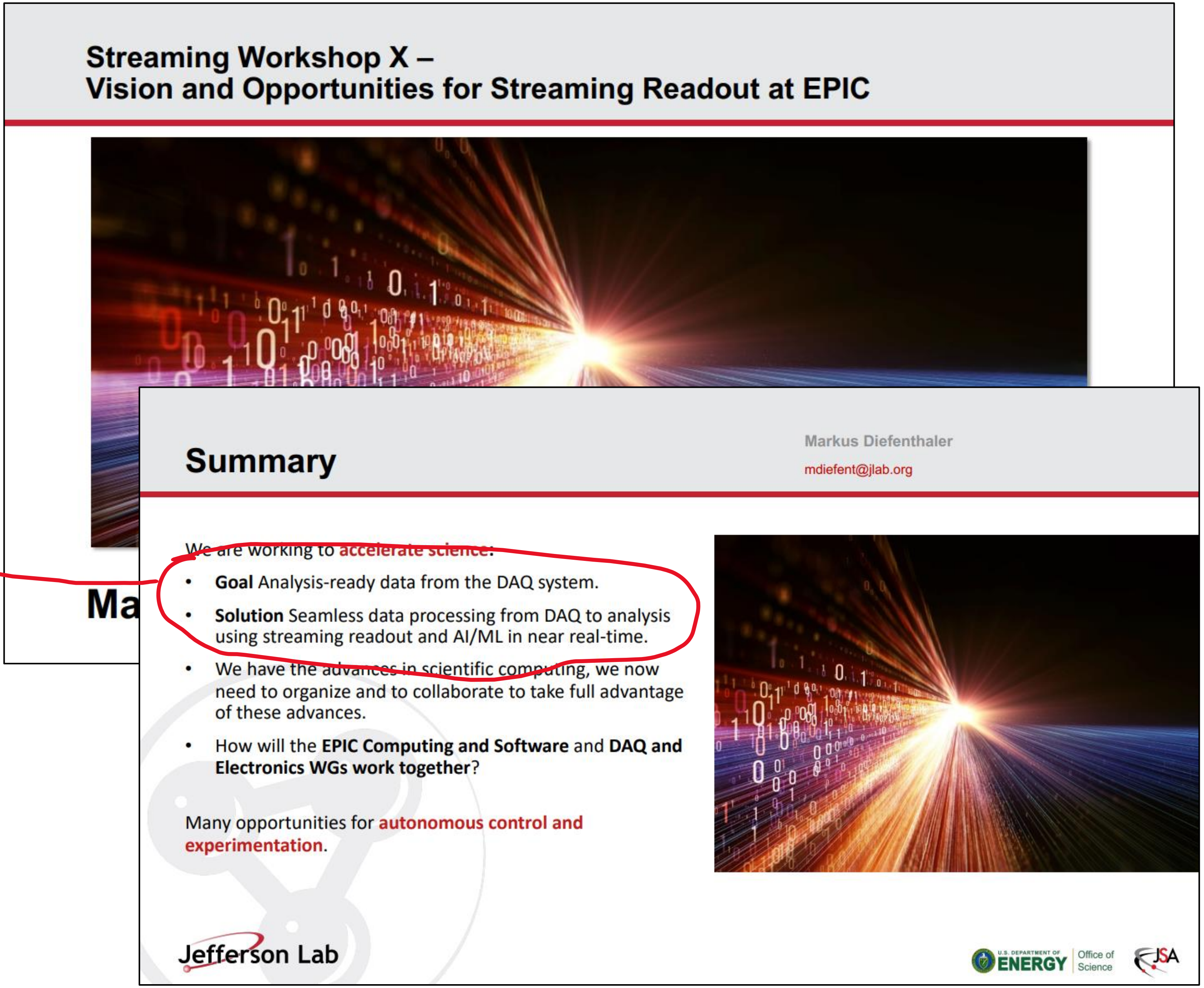
1/11/23 Zhenyu Ye @ UIC 7

DAQ (1):

Markus Diefenthaler:

- Comment from Rolf on point:
  - Need to actually define what these points look like in detail

- Direct conversations:
  - Lots of interest in what this will look like for analysis



DAQ (2):

Jeff Landgraf:

- Focus on status / plans

Working Towards CD2/3A

- ❑ 60% Design Maturity
  - Working towards pre-TDR (or draft of TDR)
  - Defined and Defendable Cost
    - Naming, Defining, & Counting the components
  - Define how DAQ will operate
  - Describe and defend that the system will work. Answer questions like:
    - What will the data volume on this link, and what kind of safety margin do you have?
    - Will radiation destroy your components, or make them misbehave?
    - How can you ensure that the data from these two detectors correspond to the same collision?
    - What happens if you get a hot channel?

EPIC Electronics / DAQ

Standard Component Names and Functions

Global Timing Unit (GTU)

-Interface between collider, Run Control, &
-Config & Control
-Clock & Timing

Name	Sensor	Adapter	Front End Board (FEB)	Readout Board (RDO)	Data Aggregation Module (DAM)	Comp
Sharing	Detector Specific	Detector Specific	Detector Specific	Few Variants	Common	Comm
Function	-Multi-Channel Sensor	-HV/Bias distribution -HV divider -Interconnect routing	-Amplification -Shaping -Digitization -Zero Suppression	-Communication -Aggregation -Formatting -Data Readout -Config & Control -Clock &Timing	-Computing Interface -Aggregation -Software Trigger -Clock & Timing -Config & Control	-Data -Run -Calib -QA / -Collis -Even -Softw -Moni
Attributes	-MAPS -AC-LGAD -MCP-PMT -SiPM -LAPPD	-Sensor Specific -Passive	-ASIC/ADC -Discrete -Serial Link	-FPGA -Fiber Link	-Large FPGA -PCIe -Potentially Ethernet	

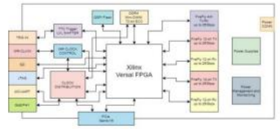
Summary of Current and Pending Activities

- ❑ Hardware Acquisition and Development
  - ❑ Have the opportunity buy 1 or 2 FELIX-182 boards being assembled for the ATLAS FELIX upgrade (Thanks to Hao Xu)
  - ❑ Obtaining FPGA Development Kits, Timing modules (which combined with existing electronics) will be sufficient to stand in for 5 GTU/DAM/RDO chains
- ❑ Evaluate Timing Synchronization Feasibility
  - ❑ Transmit clock by reconstructing it from data transmitted on fiber
    - ❑ 5ps jitter
    - ❑ Phase stability (even across power cycles)
  - ❑ Must demonstrate it is possible using the <$300 FPGAs for use in RDO.
  - ❑ Formed RDO/Synchronization and Timing group to demonstrate this
    - ❑ Jo Schambach, William Gu, Marius Wensing, Tonko Ljubicic, & Pietro Antonioli
  - ❑ First active development towards working RDO

Prototype: FLX-182

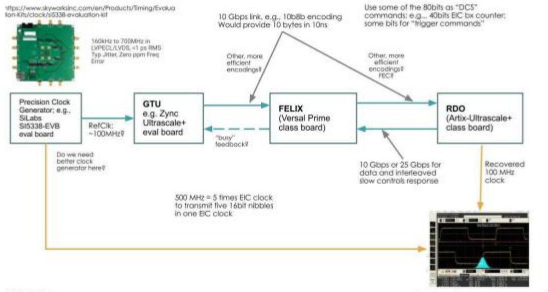
FPGA: Xilinx Versal Prime XCVM1802-1MSEVSVA2197 production device

- PCIe Gen4 x16: PL and CPM compatible
- 24 FireFly links with 3 possible configurations
  - 24 links @25 Gb/s
  - 24 links @10 Gb/s (CERN-B-Y12)
  - 12 links @25 Gb/s + 12 links @10 Gb/s
- 4 FireFly links with 2 possible configurations
  - LTI interface
  - 100GbE
- Electrical signals on front panel
  - 3 inputs and 3 outputs
- 1 DDR4 Mini-UDIMM
- USB-JTAG/USB-UART



Block diagram of FLX-182

Brookhaven National Laboratory



Oak Ridge National Laboratory schambachj@ornl.gov

DAQ (3):

Proposals

- ❑ Five (5) proposals were received and originated from various EIC sub-detector groups. These cover the R&D efforts for ASICs and Electronics in support of the EIC detector readout:

Proposal	File	Authors	Sub-Detector	Sensor Type	Readout Solution
A	eRD109_pECAL_readout_prototype_FINAL	G. Visser (IU), et al.	Calorimeter	SiPM	Discrete, COTS, ASIC
B	eRD109CalorimeterReadout	N. Novitzky (ORNL), et al.	Calorimeter	SiPM	ASIC (HGCROCv3)
C	eRD109-alcor	M. Ruspa (INFN), et al.	dRICH	SiPM	ASIC (ALCOR)
D	ACLGAD_ASIC_Electronics_FY23	Z. Ye (UIC), et al.	Central, Far-Forward	AC-LGAD	ASIC (EICROC1, FCFD1, 3rd Party)
E	eRD109_SALSA_proposal_vfinal1	D. Neyret (CEA), et al.	Micromegas, GEM, MicroRWell	MPGD	ASIC (SALSA)

- ❑ For further details, refer to the documentation submitted for each of the proposals.

Electron-Ion Collider 5