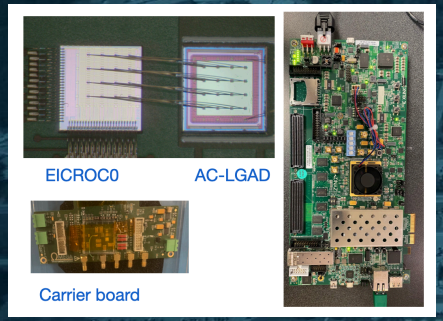
R&D on AC-LGAD Time-of-Flight for ePIC

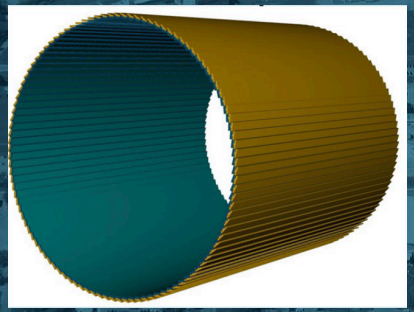
Project Goal: Completing the readout chain for an AC-LGAD based TOF

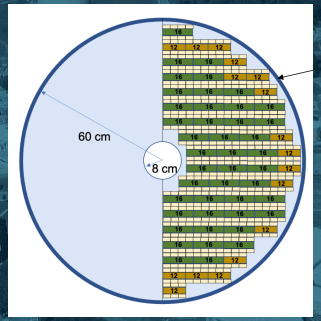
Principal investigators: Souvik Paul (100% SBU/BNL), Prashanth Shanmuganathan (25% BNL), Prithwish Tribedy (50% BNL), Tonko Ljubicic (BNL/Rice), Zhangbu Xu (BNL/Kent)

Other collaborators:
Alex Jentsch (BNL)
Alessandro Tricoli (BNL),
Gabriele D'Amen (BNL),
Giacomini Gabriele (BNL),

Students: Hijas Farook (UNM/BNL)
External Collaborators:
Dominique Marchand (IJCLab)
Wei Li (Rice)
Zhenyu Ye (UIC/LBNL)





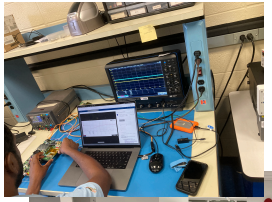


Funding: eRD109 (prototyping the RDO), Physics Department

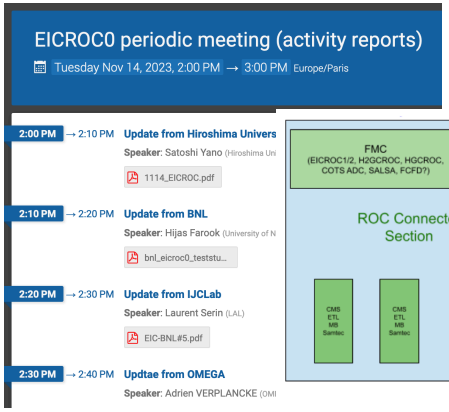
Possible BNL group commitment: Understand the sensor + ASIC response & FPGA project: develop the RDO, make it compatible with ePIC DAQ protocol, implement the simulation

Commitments/activities/challenges (mid 2022-now)

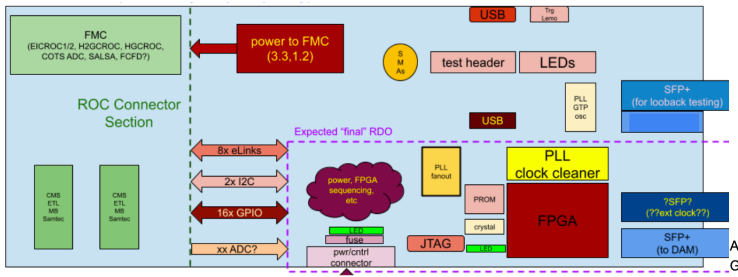
Test lab setup:
BNL instrumentation



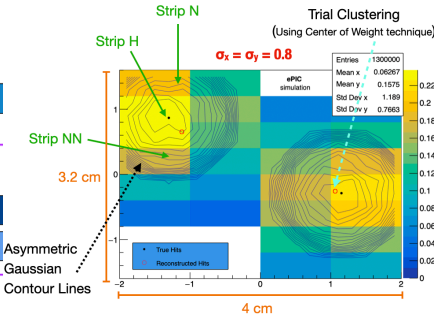
Periodic (bi-weekly) meeting on development of EICROC0 with French and Japanese group

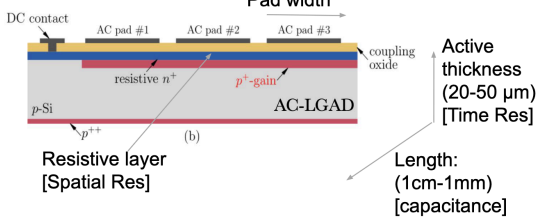


Development of prototype RDO with Rice and UIC/ LBNL



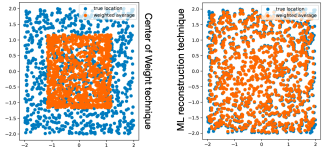
Implement Sensor+ ASIC response to ePIC simulation AI/ML technique to improve space/time performance





Milestones:
Jitter reduction,
cross-talk reduction
Working ADC module
Compatibility with strip sensor

Milestones:
PCB layout, FPGA firmware, compatibility with EICROC



Milestones:
Input from hardware, implement full digitization model implemented in ePIC simulation, reduce data throughput & noise reduction

Milestones: Modify sensor geometry for sensor-ASIC compatibility & TOF requirement

Pros and cons: ACLGAD based TOF (bTOF/FTOF)

	Pros	Cons	Remedy
Interest in TOF	Historically BNL heavy ion group started with interest in low-pT PID, semi-inclusive physics (STAR TOF bkg.)	Some members are moving, not enough people currently working	Need more people/support who will be interested in TOF
Opportunities in ePIC	Many lead opportunities still available with core part of project, other national labs are not taking lead roles	Recent BTOF leader has stepped down, cannot be done without strong electrical engineers, FPGA experts	Engineering FTE needed
Sensor Technology	AC-LGAD is premier tech, many future applications, BNL only fab capable US lab	No previous AC-LGAD detector, no expert in the EIC group	EIC group needs to hire or partially support AC-LGAD expert, or Inst-HEP-NP collab.
ASIC	EICROC is already available, pixel compatibility, possibly same ASIC for HRPPD (pfRICH), expertise will help	Need candidate for strip sensor: No expertise for design. Pixel ADC need work, cross talk, no streaming yet	HGCROC & FCFD could be a candidate for strip-sensor. EIC group can work closely with Inst. to modify the sensor
Readout	Couple be the major role from BNL group closely tied to DAQ group	Not possible without and FPGA expert/EE. EICROC not ready for fully functional dev.	Any TDC capable ASIC can be used to dev. ppRDO