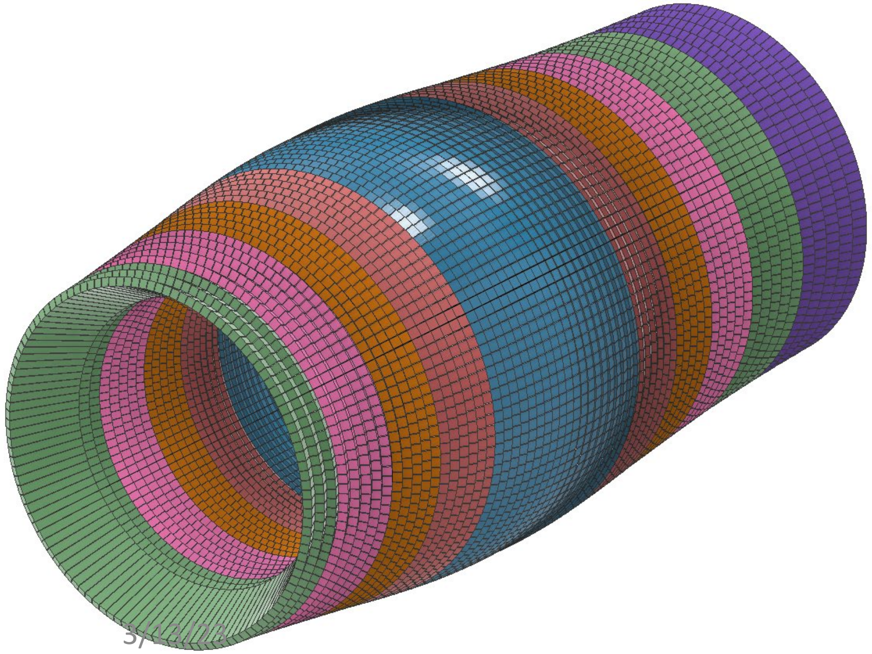
SciGlass: Sensors and FEE Barrel ECAL Review

Rosi Reed

Lehigh University



Charge

4. Sensors and FEE:

a. Status of sensor selection (a single consolidated option, more options under consideration) and photosensor characteristics?

b. Status of the sensor validation for the specific application and related potential issues?

c. Perspectives of sensor mass production and timelines for the production period?

d. Status of FEE selection (a single consolidated option, more options under consideration)?

e. Characteristics of the FEEs considered?

f. Status of the FEE development and related potential issues?

g. Perspectives of FEE mass production and timelines for the production period?

R&D Timeline

See T. Horn's talk for more details!

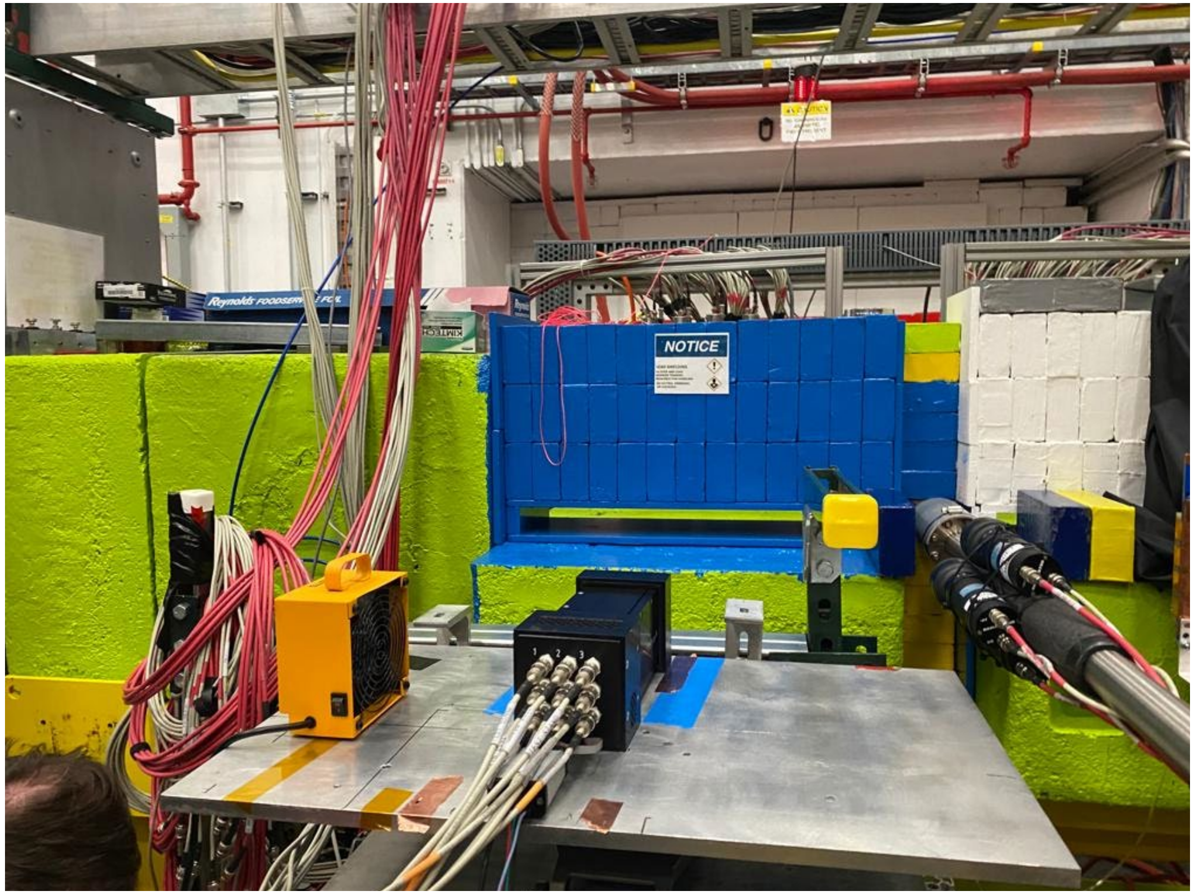
2.A R&D: eRD105 Milestones for FY23 and beyond

- **FY23: Scale-up to 40 cm complete**
  - Receive ~25 test samples
  - Beam test with 3x3 (5x5) prototype with 40+ cm. (CUA, AANL, JLab)
    - HallD Jlab beam test logistic: installation, safety, DAQ etc. (JLab)
    - Beam test preparation and data analysis (CUA, AANL)
  - Develop and implement a SiPM-based readout (INFN-GE)
  - Design and test an optimized streaming RO chain (INFN-GE)
  - Sciglass blocks characterization, including Irradiation (IJCLab-Orsay, Kansas U.)
  - Implement process for different geometries (CUA)

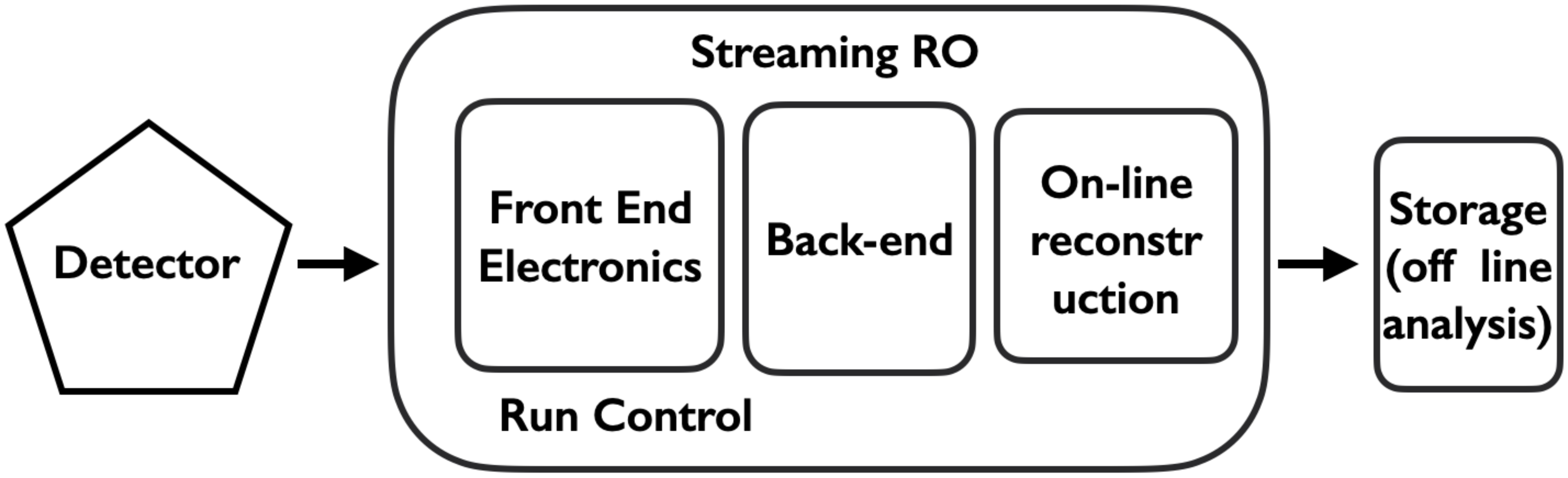
Cosmic and on-beam tests of SciGlass prototype

- Goal: test JLab/EIC streaming readout framework using 5x5 SciGlass prototype
  - Jefferson Lab, Hall-D (PS e^+e^- 4 GeV beam), Hall-B (cosmic muons)
  - Feb 15 - March 20, 2023 (Ongoing!)
- Work done by: M.Battaglieri (INFN-GE), V.Berdnikov (JLab), S.Boiarinov (JLab). M.Bondí (INFN-CT), T.Chiarusi (INFN-BO), J.Chrafts (CUA), A.Fulci (UniME), Y.Ghandilyan (CUA), C.Fanelli (W&M), V. Gyurgjan (JLab) S.Grazzi (UniME), T.Horn (CUA), D.Lawrence (JLab), C.Pellegrino (INFN-CNAF), A.Somov (JLab), M.Spreafico (UniGE)

Setup in Hall D



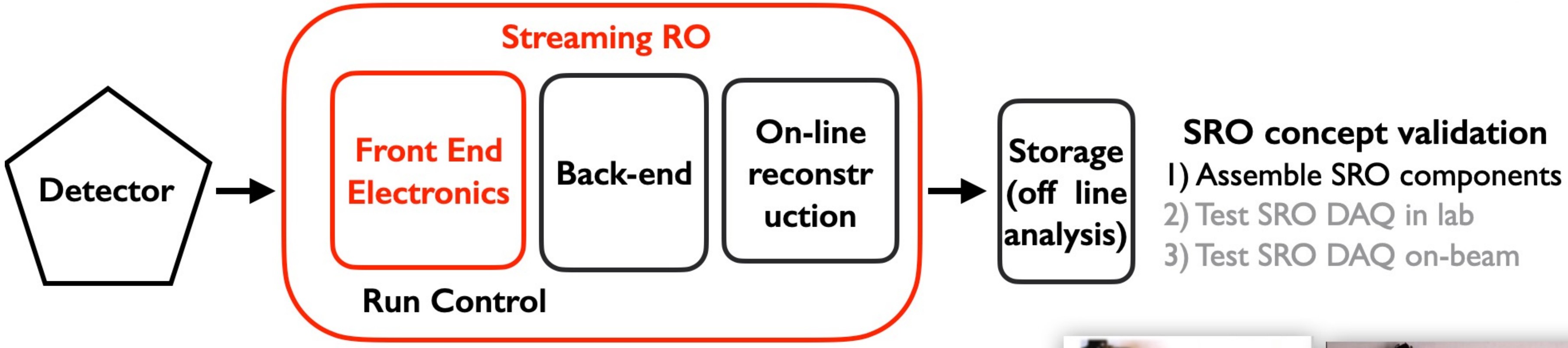
Streaming Read Out Components



SRO concept validation

1) Assemble SRO components
2) Test SRO DAQ in lab
3) Test SRO DAQ on-beam

Streaming Read Out Components: FEE



FrontEnd

D.Abbott, F.Ameli, C.Cuevas, P. Musico, B.Raydo

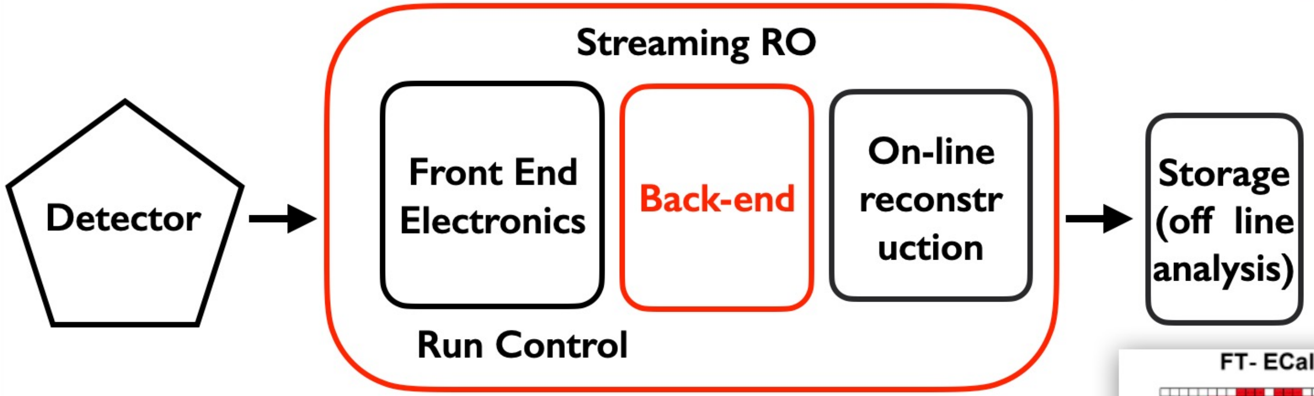
✳ **JLab fADC250 + VTP bord**

- JLab 250 MHz flash ADC digitizer currently used in many experiments
- Overcome VXS limitations (<24 Gb/s) using JLab VTP board (<40 Gb/s)
- Not optimised but reuse of existing boards: ready-to-go solution while waiting for fADC250.v2

✳ **INFN WaveBoard**

- SRO dedicated INFN 250 MHz flash ADC digitizer

Streaming Read Out Components: Backend



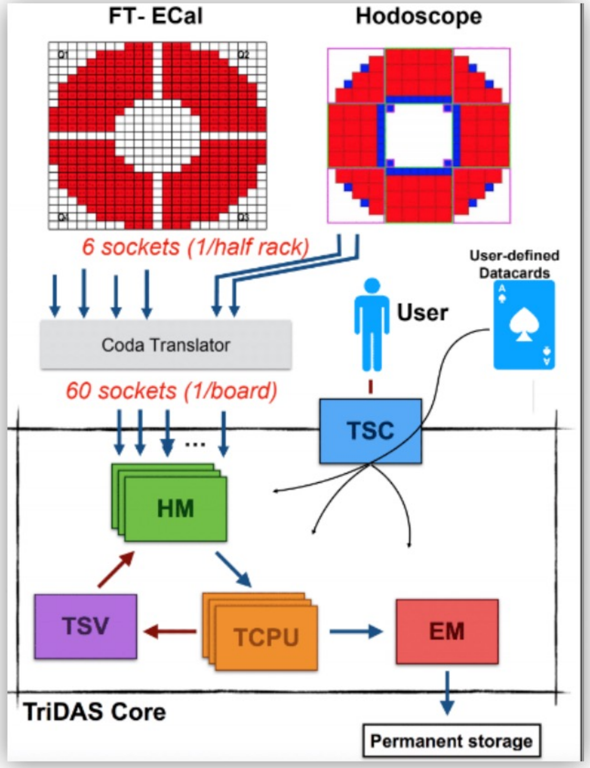
SRO concept validation
1) Assemble SRO components
2) Test SRO DAQ in lab
3) Test SRO DAQ on-beam

BackEnd

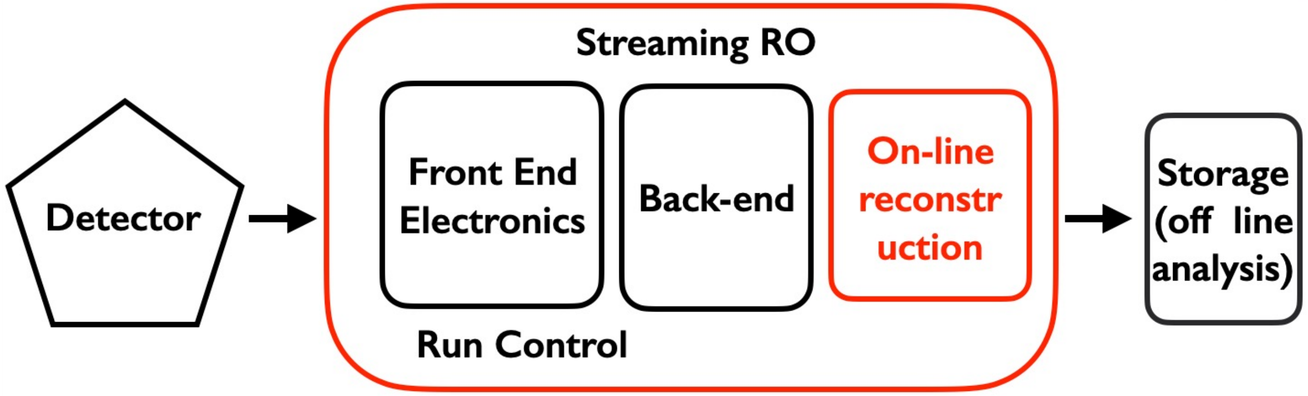
L.Cappelli, T.Chiarusi, F.Giacomini, C.Pellegrino

✳ **TRIggerless Data Acquisition System (TriDAS)**

- Developed for KM_3NET
- Installed on Hall-B DAQ cluster
- Multi CPUs, rate up to 20-30 MHz



Streaming Read Out Components: Online Reco



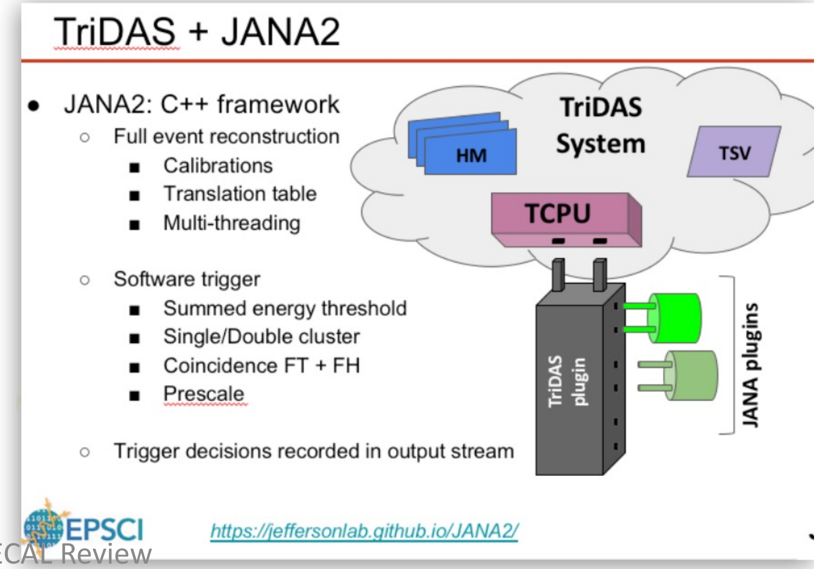
SRO concept validation
1) Assemble SRO components
2) Test SRO DAQ in lab
3) Test SRO DAQ on-beam

Jana2 + reconstruction

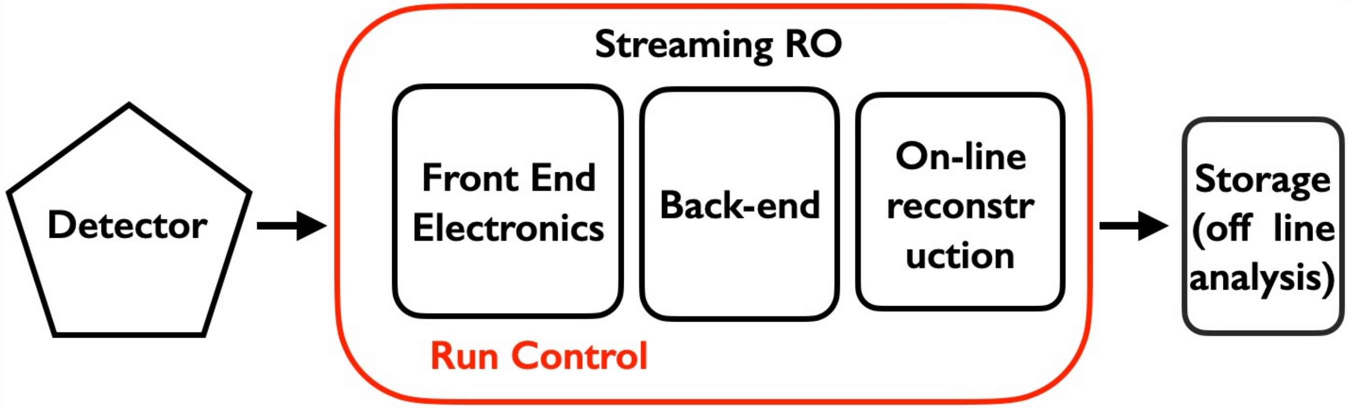
N.Brei, D.Lawrence,
M.Bondi', A.Celentano, C.Fanelli, S.Vallarino

✳ JANA2 + TriDAS

- Integration between On-line and off-line
- Real-time tagging/filtering data
- Offline algorithm development immediately available for use in Software Trigger
- Level 1 "minimum-bias": at least one crystal with E> 2 GeV
- Level 2 plugins (*tagging* and *filtering*)
  - "standard" FT-CAL clustering ($N_{cluster} \geq 1, 2, 3$)
  - cosmic tracking
  - AI clustering algorithm: at least two cluster in the FT-CAL



Streaming Read Out Components: Online Reco

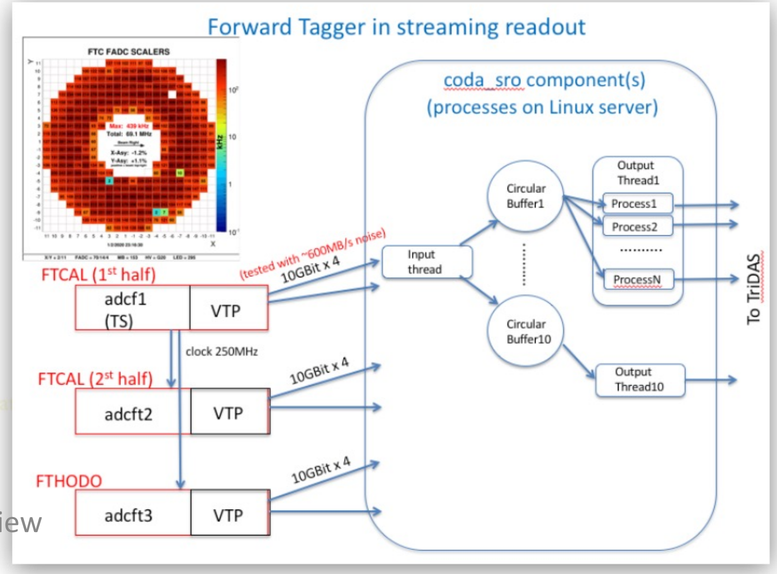


SRO concept validation
1) Assemble SRO components
2) Test SRO DAQ in lab
3) Test SRO DAQ on-beam

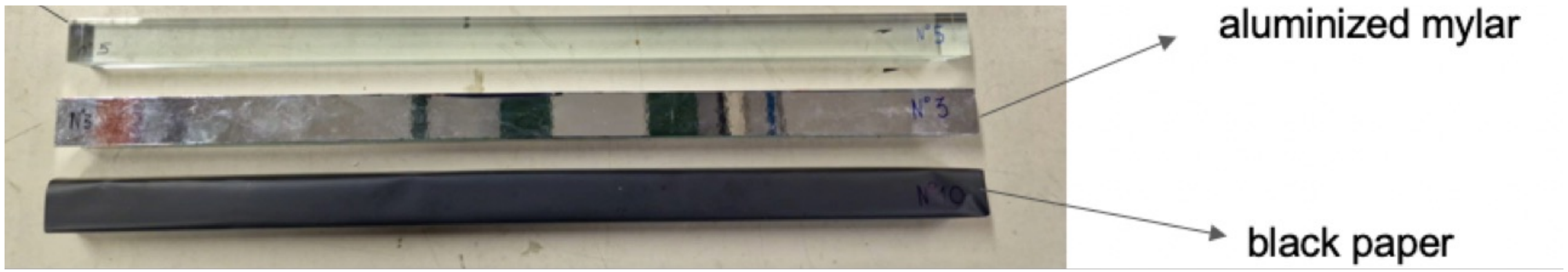
Cebaf Online Data Acquisition (CODA)

S.Boyarinov, B.Raydo, G.Heyes

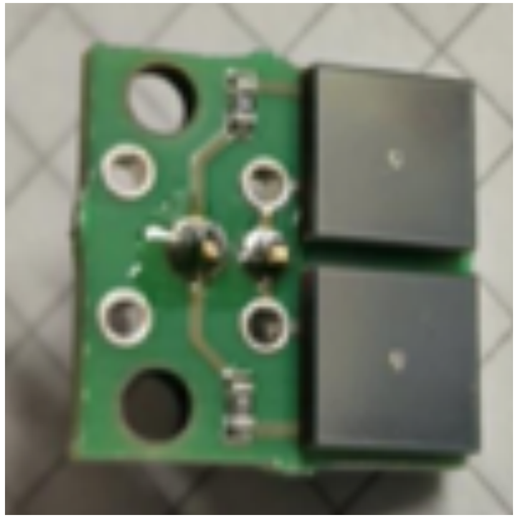
- Originally designed for trigger-based readout systems
- Controllers (ROCs) and VXS Trigger Boards (VTPs)
- The Trigger Supervisor (TS) synchronizes components using clock, sync, trigger and busy signals.-time tagging/ filtering data
- CODA adapeted to the SRO
  - Replaced EB to use timestamp)
  - ROC communication via VTP (not VXS bus)

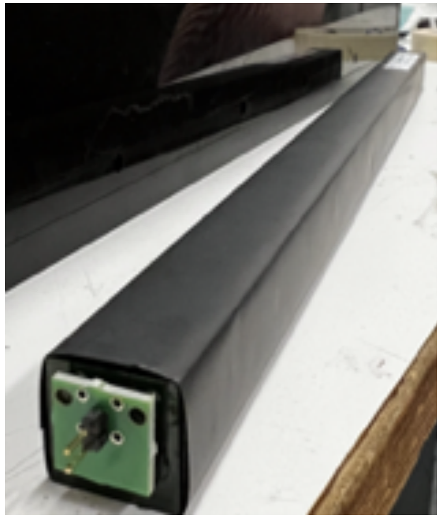


Cosmic and on-beam tests of SciGlass prototype



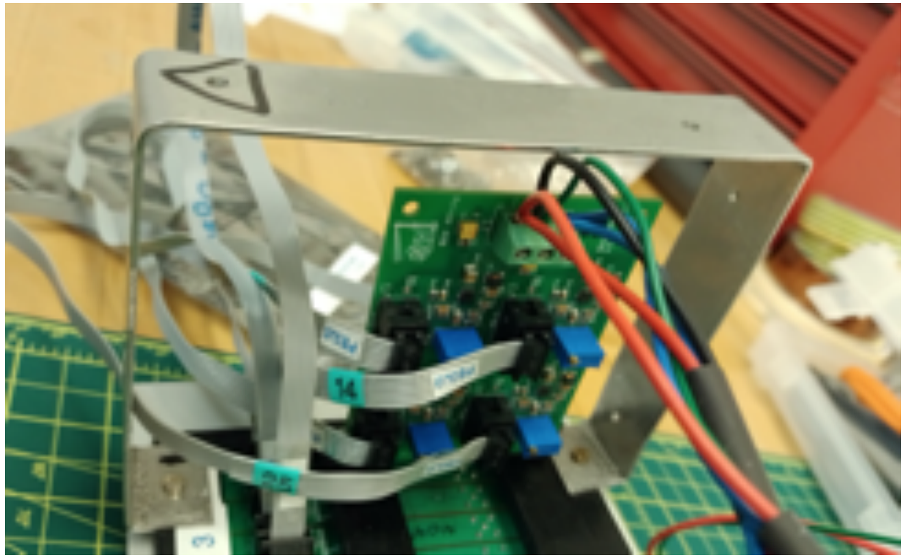
- Each scintillator read by 2 Hamamatsu S14160-6050hs
  - area: 6x6 mm2
  - pitch: 50um
  - PDE ~ 50%
- Bias voltage provided by a INFN-Genova custom-designed board
- Signal amplification obtained by INFN-Genova custom transimpedance amplifier





Cosmic and on-beam tests of SciGlass prototype

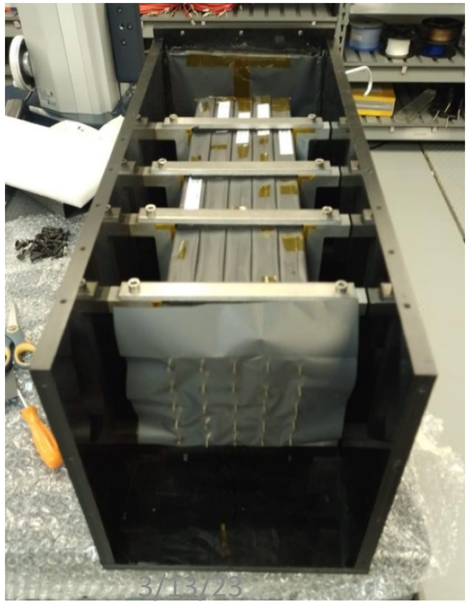
- Streaming RO tests in Hall-B and Hall-D: real-time calibration and AI-supported algorithms to distinguish cosmic from (e-) EM showers
- Bias voltage provided by a INFN-Genova custom-designed board
- Signal amplification obtained by INFN-Genova custom transimpedance amplifier

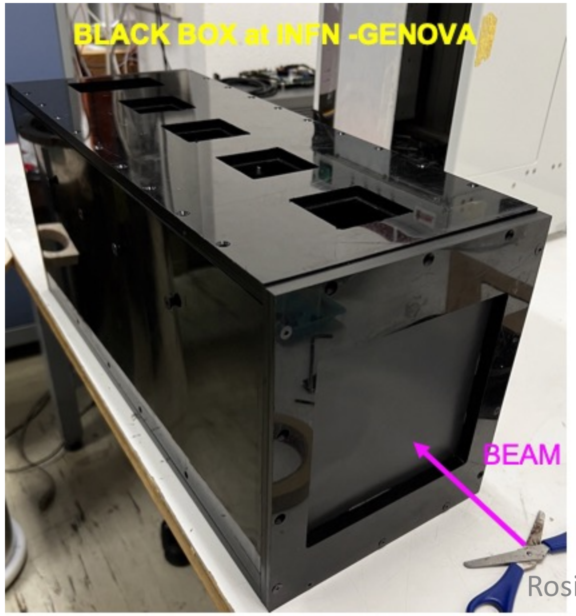


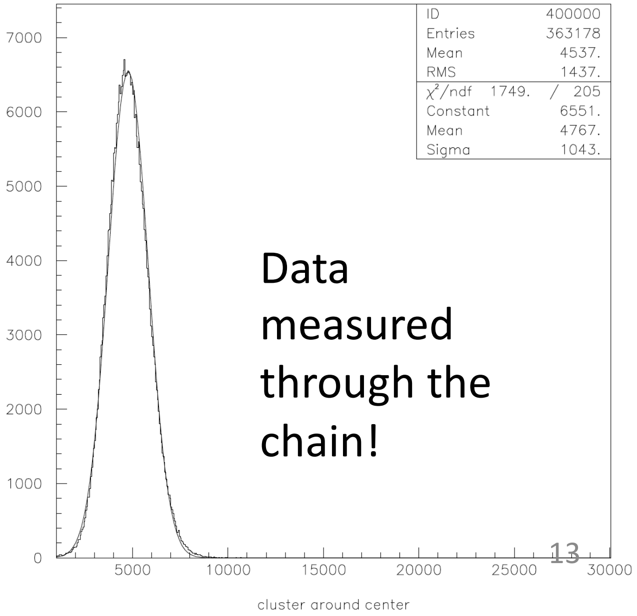
Cosmic and on-beam tests of SciGlass prototype

- FE: 5x5 EIC prototype ECAL → 2x2x40 cm^3 scintillating glass, 2x SiPMs + custom preamps + 2 x fADC250 + VTP
- BE: CODA+ TRIDAS+JANA2
- x3 matrix installed in Hall-B counting house:
- 5x5 matrix installed in Hall-B PS
- Currently taking data in Streaming mode in both Hall-B (cosmics) and D (cosmics and EM shower)

See T. Horn and D. Kalinkin's talks for more details!







Data measured through the chain!

Charge

4. Sensors and FEE:

a. Status of sensor selection→ Hamamatsu S14160-6050hs

b. Status of the sensor validation for the specific application and related potential issues? → Tests ongoing, no SiPM performance issues

c. Perspectives of sensor mass production and timelines for the production period? → Hamamatsu

d. Status of FEE selection → JLab fADC250+VTP Board works in prototype tests, v2.0 on the way

e. Characteristics of the FEEs considered? → Custom designed based on previous successful boards, need to operate in large magnetic fields, data reduction, serviceability, etc

f. Status of the FEE development and related potential issues? → Working prototype w/SciGlass tests in process, some R&D work needed

g. Perspectives of FEE mass production and timelines for the production period?

Back-Up

Requirements and Design Philosophy

- Front-End Boards custom designed for each detector, populated with ASICs/COTS, operate in largemagnetic fields.
- ASICs/COTS process analog signals and digitization tailored to each type of detector technology, data reduction (e.g., zero suppression) desirable.
- Maximize synergies in electronics and minimize cabling.
- Electronics, including digitizers, close to the detector as much as possible and where applicable.
- Prefer to limit FPGA use inside detector volume.
- Serviceability as a design criteria.
- Triggerless operation of the electronics as default; triggered operation for calibration, test, debugging.
- Meet current US standards per NEC, UL, FCC, NEMA:
- Equipment assessment reviews for conformance to EHS&Q.
- Radiation levels at EIC are much lower than at LHC by O(100). EIC detector radiation map has been updated and will guide formulation of electronics requirements for radiation hardness/ tolerance.
- Requirements and Design Philosophy