Upgrade of the APV25-SRS Readout Electronics for Super Bigbite Spectrometer (SBS) Back Tracker GEMs in Hall A @ JLab

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Outline

- SBS and Back Trackers GEMs in Hall A at JLab
- Two options for APV25 Electronics for SBS Back Tracker GEMs
- Required upgrades of the SRS

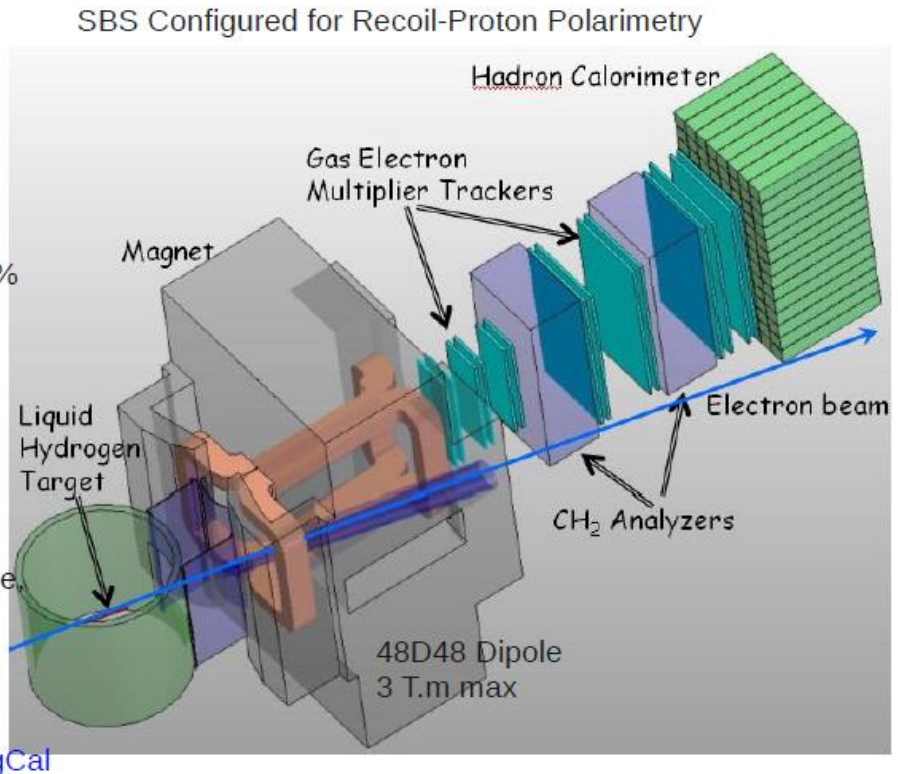
Super Bigbite Spectrometer (SBS) in Hall A @ JLab

- SBS is the first apparatus in Hall A for the CEBAF 12 GeV upgrade at JLab
- Set of instrument for flexible spectrometer configuration

- Dipole Magnet
- GEM for Tracking
- Calorimeters
- CH2 Analyzer for Proton Polarimeter for GEp (5)
- Dual-radiator RICH for SIDIS Program

SBS Configured for Recoil-Proton Polarimetry

- High Luminosity: 8 x 10^{38} $cm^{-2}s^{-1}$
- Support high background: 500 kHz/cm^2 (low energy photons mainly)
- Forward angle
- Large acceptance
- Good angular (0.2 mr) and reasonable momentum (0.5% @ 4-8 GeV/c) resolution
- Flexibility: use the same detectors in different experimental setup
- 2 tracker geometries, same base module
  - 1st front, momentum, angle, vertex
  - 2nd polarimeter, asimuthal scattering
- Also GEM in BigBite and BigCal

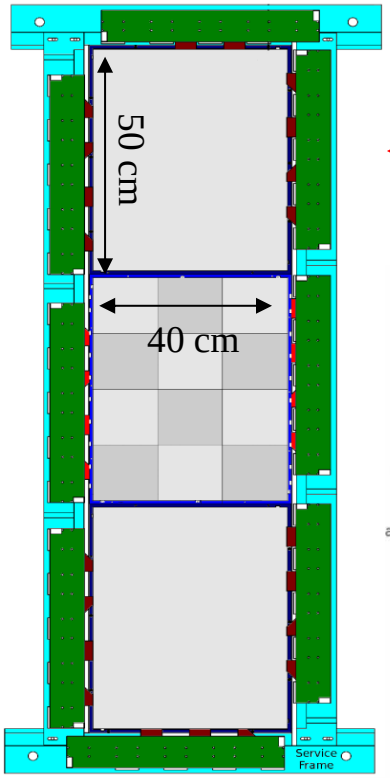


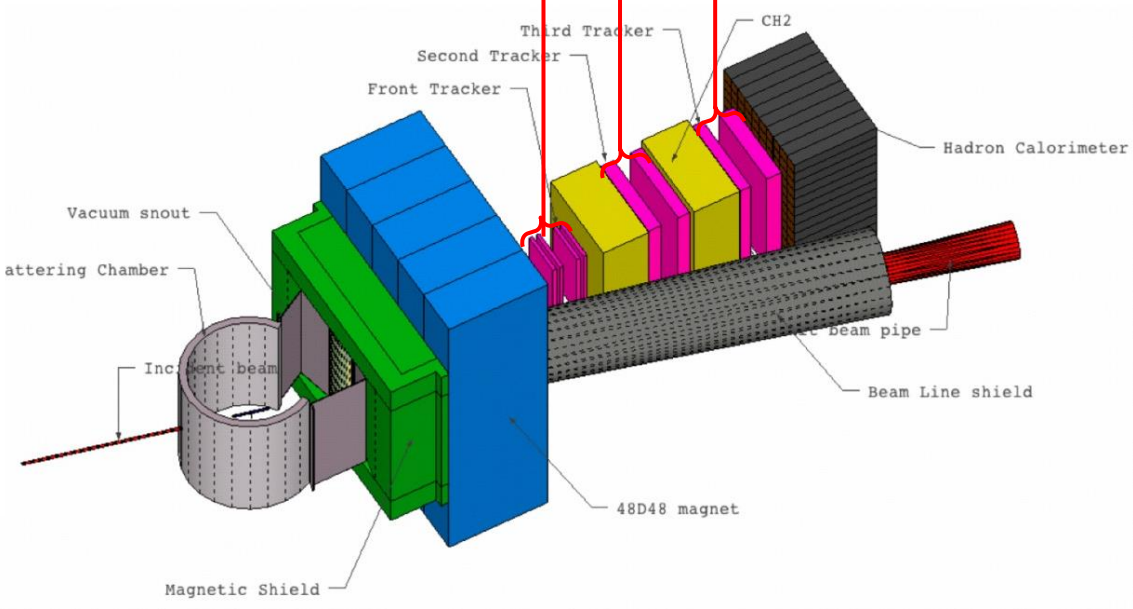
J.R.M. Annand, JointGEM Meeting, Helsinki, July 2010

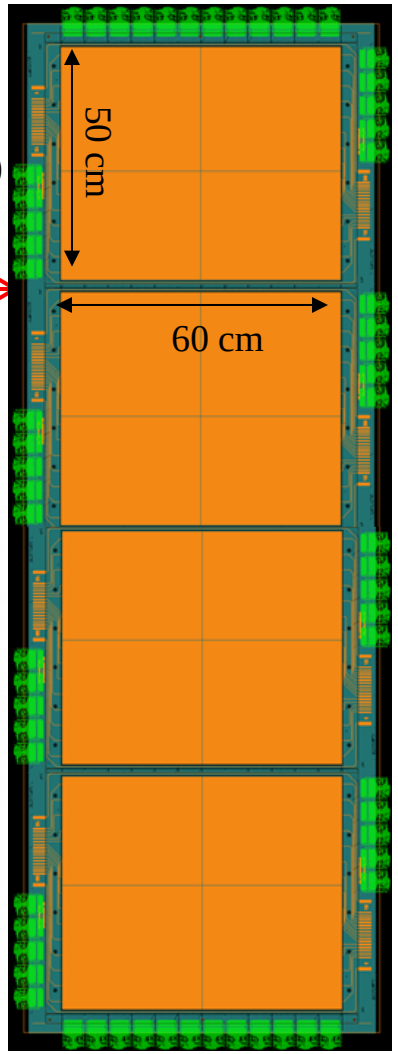
GEM Trackers for SBS

- Front Tracker: *E. Cisbani (INFN Roma, Italy)*
  6 GEM Layers (150 × 40 cm^2)
  Each layer = 3 GEM modules (50 × 40 cm^2)

- Back Tracker : *N. Liyanage, (Uva, Virginia, USA)*
- 10 GEM Layers (200 × 50 cm^2)
- Each Layer = 4 GEM modules (50 × 60 cm^2)







Proton arm layout for GEp (5) experiment

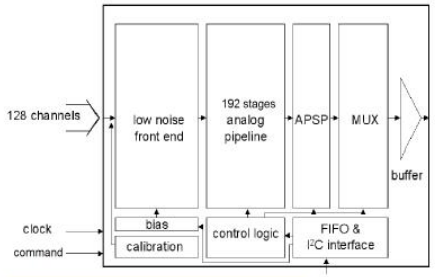
APV25 Electronics for SBS GEMs

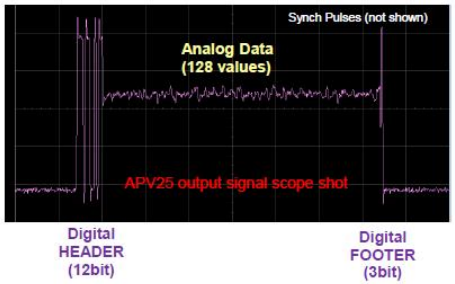
Two readout systems are currently under consideration for SBS GEMs

MPD: (INFN Genoa, P. Musico)

- Multi Purpose Digitizer
- Adopted for SBS front tracker GEMs
- Option for the back tracker GEMs

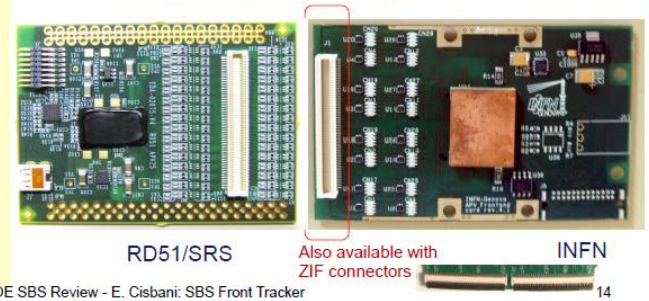
Front-end hybrid (APV25)





- 128 analog ch / ASIC
- 3.4 µs trigger latency (analog pipeline)
- Capable of sampling signal at 40 MHz
- Radiation tolerant
- Multiplexed analog output
- Configurable / Calibration circuit

Two similar implementations



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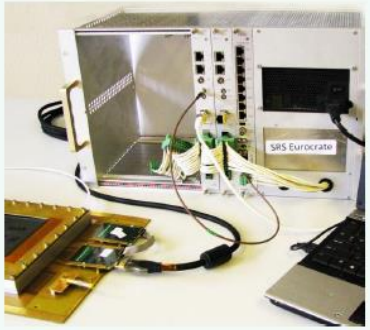
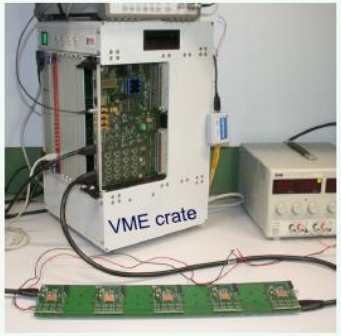
Readout Systems

RD51/SRS	MPD/INFN
	
Hybrid (APV25)⇨ADC⇨FEC⇨SRU⇨DAQ	FE (APV25)⇨Backplane⇨MPD (VME)⇨DAQ
Based on GigaBit Ethernet and EUROCRATE modules	Based on VME64x with VXS extension (JLab std.)
Oriented to flexibility, suitable for different ASIC and final applications	Custom design, designed for JLab DAQ environment

Originate from COMPASS electronics; several sc

Courtesy E. Cisbani

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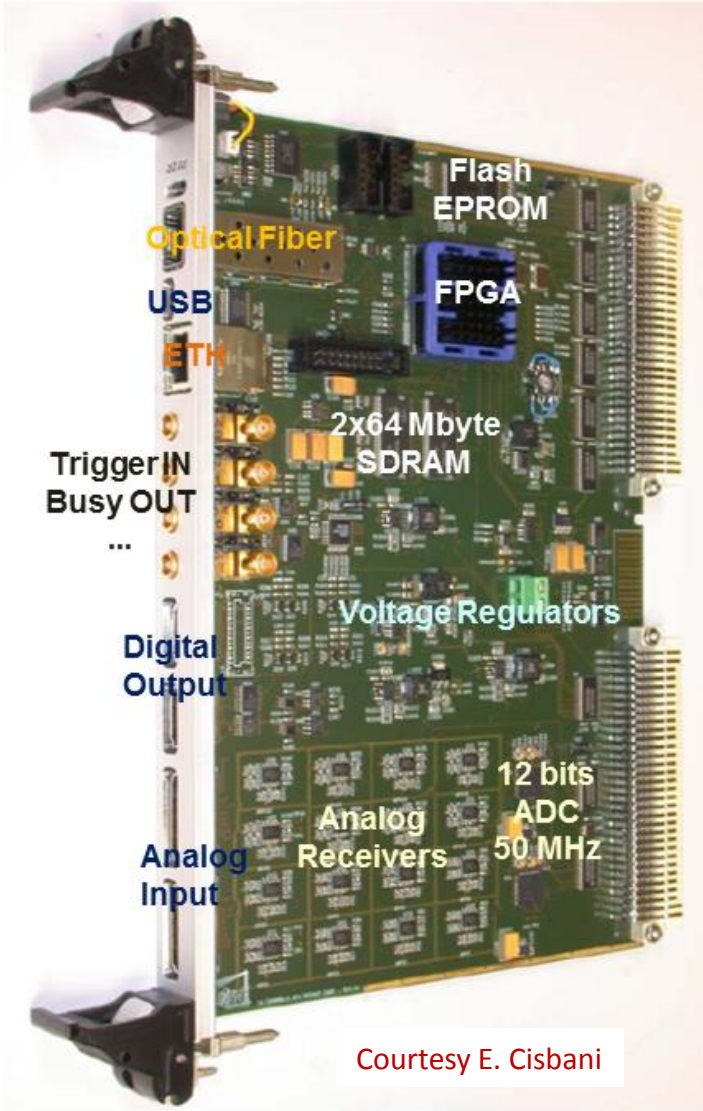
- SRS (RD51-CERN, H. Muller)
  - Scalable Readout System
  - Under consideration for SBS Back tracker
  - Final decision depends in part on the feasibility and timescale of the upgrade

APV25-MPD: Multi Purpose Digitizer

- VME interface (VME64x with VXS extension and JLab custom multiblock transfer).
- ADS5281 interfacing (2 x 8 channels, up to 50 MHz (40 MHz typical), 12 bit ADC, with DDR serial interface @ 480 Mbit/s).
- I2C protocol for on-board devices and APV25 configuration.
- APV25 triggering.
- Coaxial front panel I/O with configurable levels (LVTTL – NIM).
- Large memory buffer implemented with external DDR SDram (2 x Micron MT46V64M8: 128 M x 8 bits)
- Micro SD-Card interface (version 4.0)
- Ethernet 10-100 MAC (to be implemented in firmware).
- High speed optical protocol using SFP transceiver (to be implemented in firmware).
- User configuration switches, LEDs, ...
- Expansion PMC connectors.



Experience with APV25-SRS @ UVa

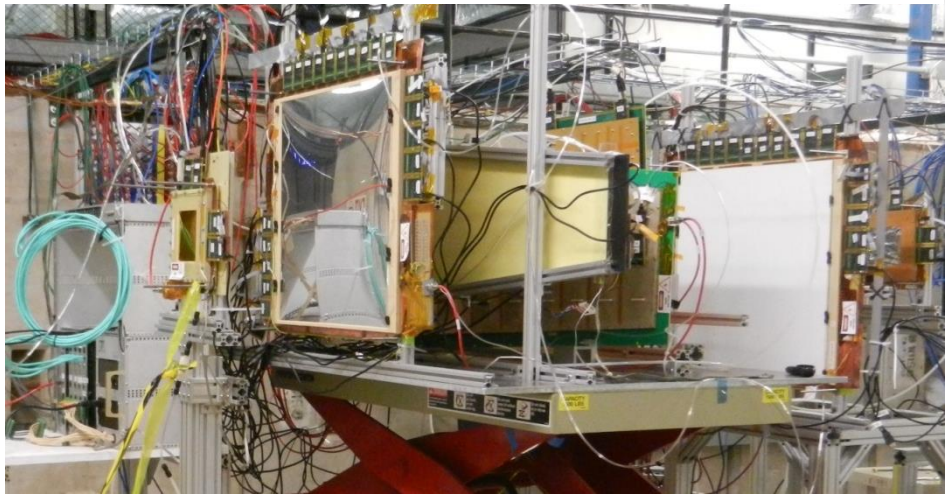
SRS with the SRU

- Small size in use in UVa lab for 2 years
- Successful run with medium size SRS during test beam at FNAL and JLab
- But system not designed for real experiment-environment like the SBS GEMs

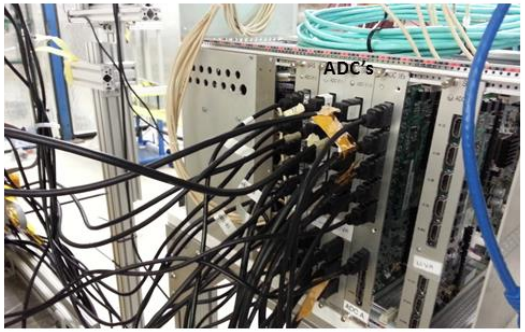
Shortcomings of the current APV25-SRS

- APV25 hybrids are not rad hard compliant
- HDMI cables length is a limitation for a system that need to be at some distance from the detector area
- Limitation on acquisition rate: 5 khz expected for SBS GEp5 experiment
- Safety concerned and crate certification issues raised for operation in environment like JLab

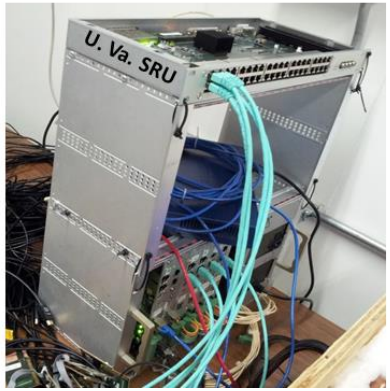
Large GEM Test Beam setup @ (FNAL) by UVa and Florida Tech



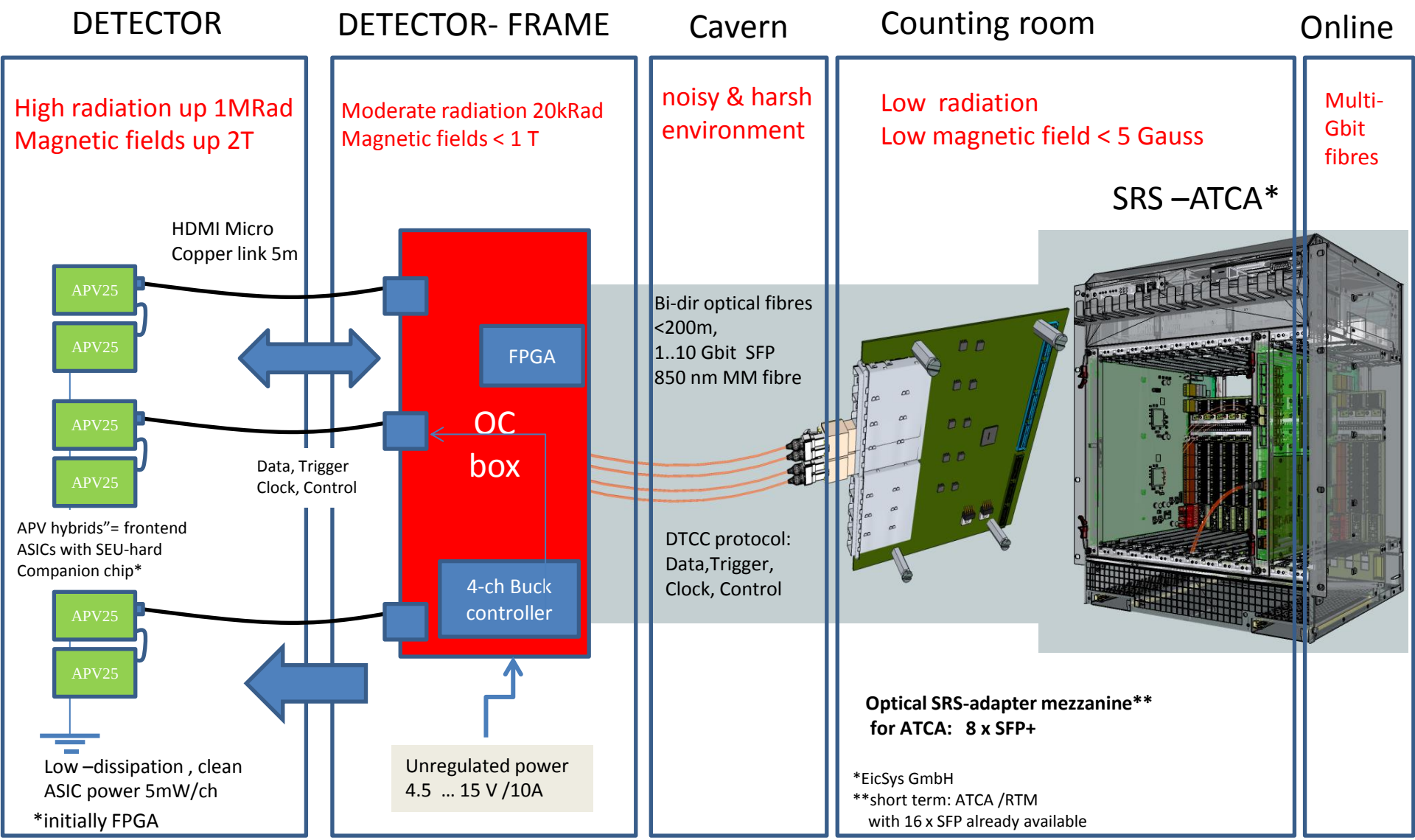
SRS + SRU Readout using DATE @ FTBF



- 64 APV's read out by SRS
- Acquiring data from FECs with an SRU
- Current DAQ rate is ~150 Hz
- Using 6-9 25ns time slices for digitization
- Beam structure: 4s spills, 1min rep. time, 10 - 20k particles/spill
- Trigger: coincidence of 3 scintillators



ATCA-SRS for Back Tracker GEMs



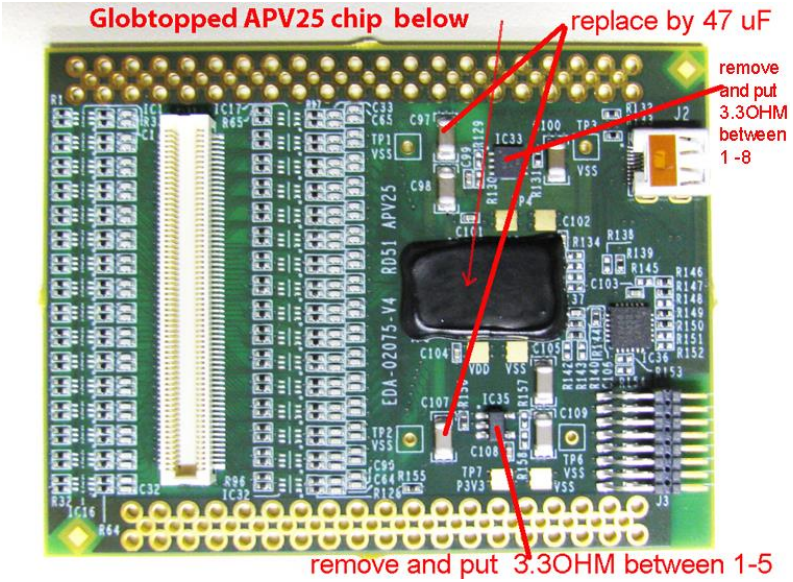
Upgrades needed for SBS Back Tracker GEMs

Key points

- Optical to Copper Box with ADC option
  - Link from OC directly to the RTM
  - Skip digital mezzanine adapter board
- APV-hybrid with radiation tolerant capability
  - Remove the voltage regulator
  - hybrids powered from OC boxes through HDMI
- New development must be compatible with the ATCA version
  - High density readout and high rate capability
  - certified ATCA crate, safety concerns need to be addressed

Radiation tolerant APV25-SRS hybrids v5

- APV25 chip are specified for rad hard operation up to O (10 MRad), but the linear voltage regulators (LDO) on the hybrids for local power conversion will most likely fail at integrated radiation levels
- Ongoing study the feasibility of an LDO-free APV25 hybrid revision (v5) for remote powering via the readout cables. Such a scheme eliminates local voltage regulators from the hybrids.

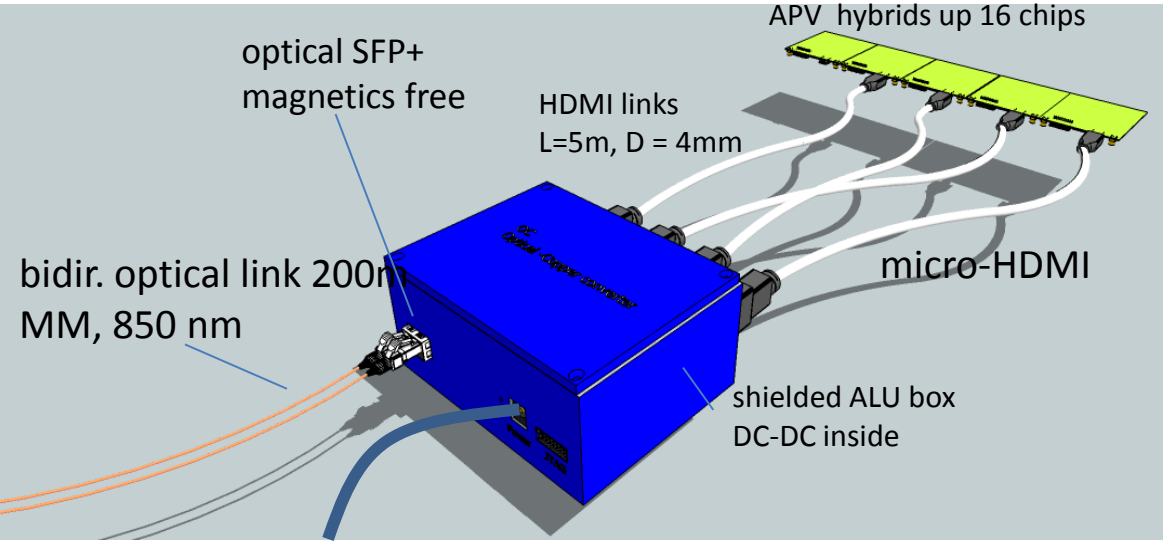


Latest from Hans:

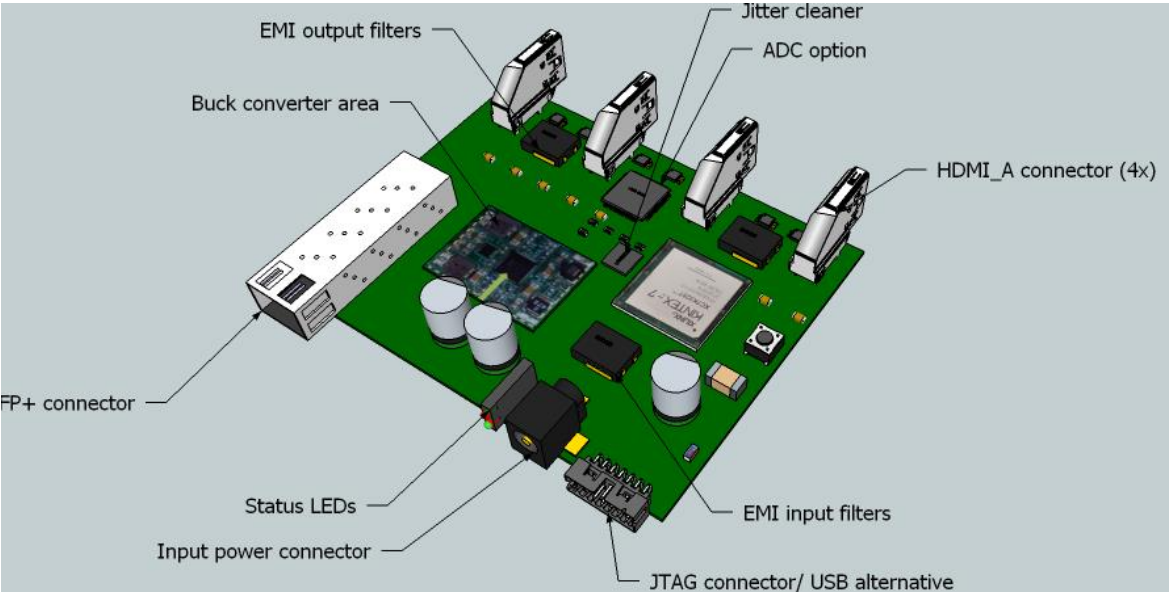
- Powering scheme of the VMM chip via OC box through HDMI lines is understood now (supported by ATLAS NSW group)
- Powering of the APV hybrids will be the same as for the current development with the VMM hybrid
- Likely 2 versions of APV25-SRS v5 to be available:
  - a.) voltage regulators for standard SRS user,
  - b.) voltages via the HDMI for OC box users
- UVa is willing to support this effort to some extent

If the SRS is adopted for SBS Back Tracker GEMs, a minimum of 550 APV (v5) hybrids would be needed

Optical to Copper (OC) Box with ADC option

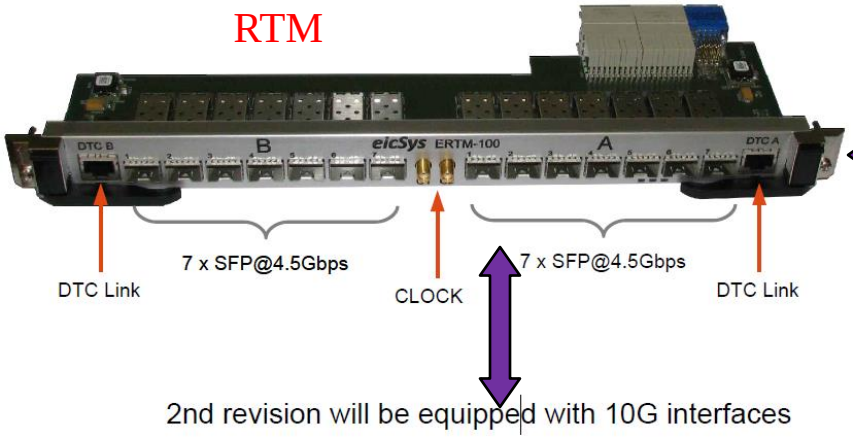


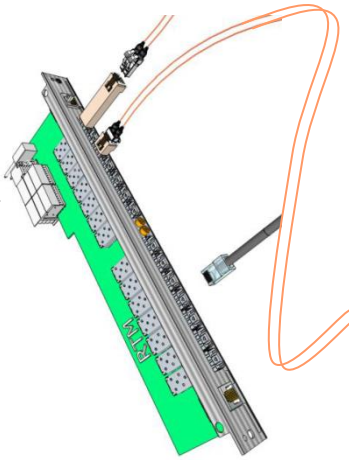
1 optical link (up 200m) ➔ SRS multiplexed DTCC protocol :
1 fiber = 4 x copper = 1k ch.

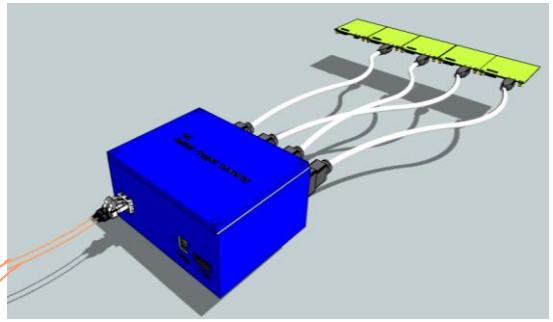


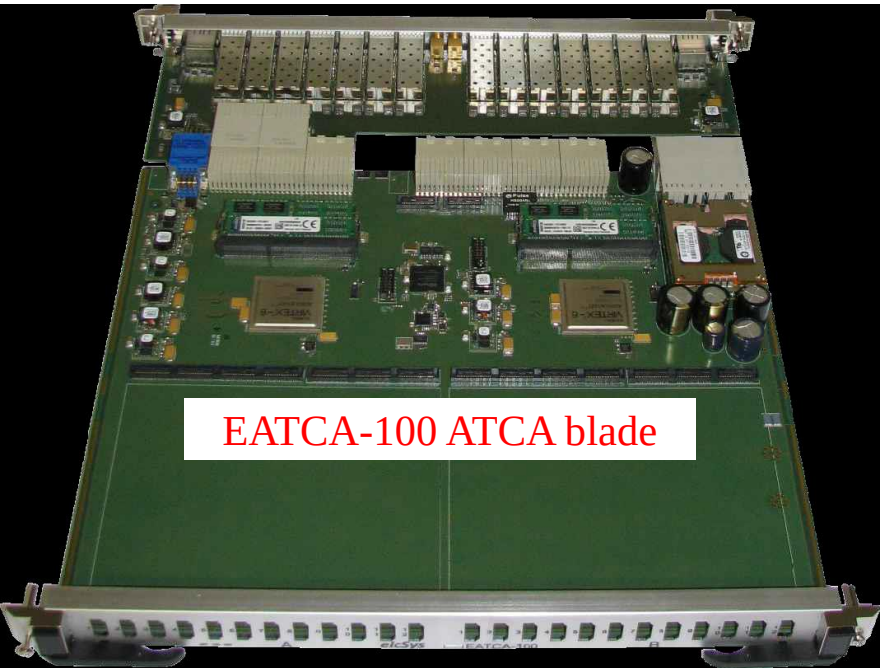
- Key feature of interest for SBS is to have the ADC in the OC box
- This provide a system with analog chip like APV25 alongside the development around VMM chip for ATLAS NSW
- This could be of interest for other RD51 users as well

From the OC box to the RTM and ATCA blade









- Current solution with the digital data from the OC directly to the RTM, bypass the optical adapter mezzanine card
- Data from RTM to ATCA Blade
- But this scheme need to be tested and the performance to be evaluated
- For SBS, common mode correction and zero suppression need to be implemented

Summary

- APV25-based SRS readout is one of the option under consideration for readout system of the Super Bigbite Spectrometer Back Trackers GEMs in Hall A at JLab
- The current version of the SRS is not adequate for the harsh condition and high rate environment of the SBS experiments at JLab
- Ongoing upgrades of the SRS system toward real experiment friendly environment is currently underway by the RD51 and ATLAS NSW group
- We are willing to contribute to these efforts to develop a final system that would satisfy the requirement for SBS Back Trackers readout electronics
- The timeline of the readiness of these upgrades can be a critical factor in the final decision of the SBS collaboration to adopt SRS for the Back Tracker GEMs