Hall-B Beamline

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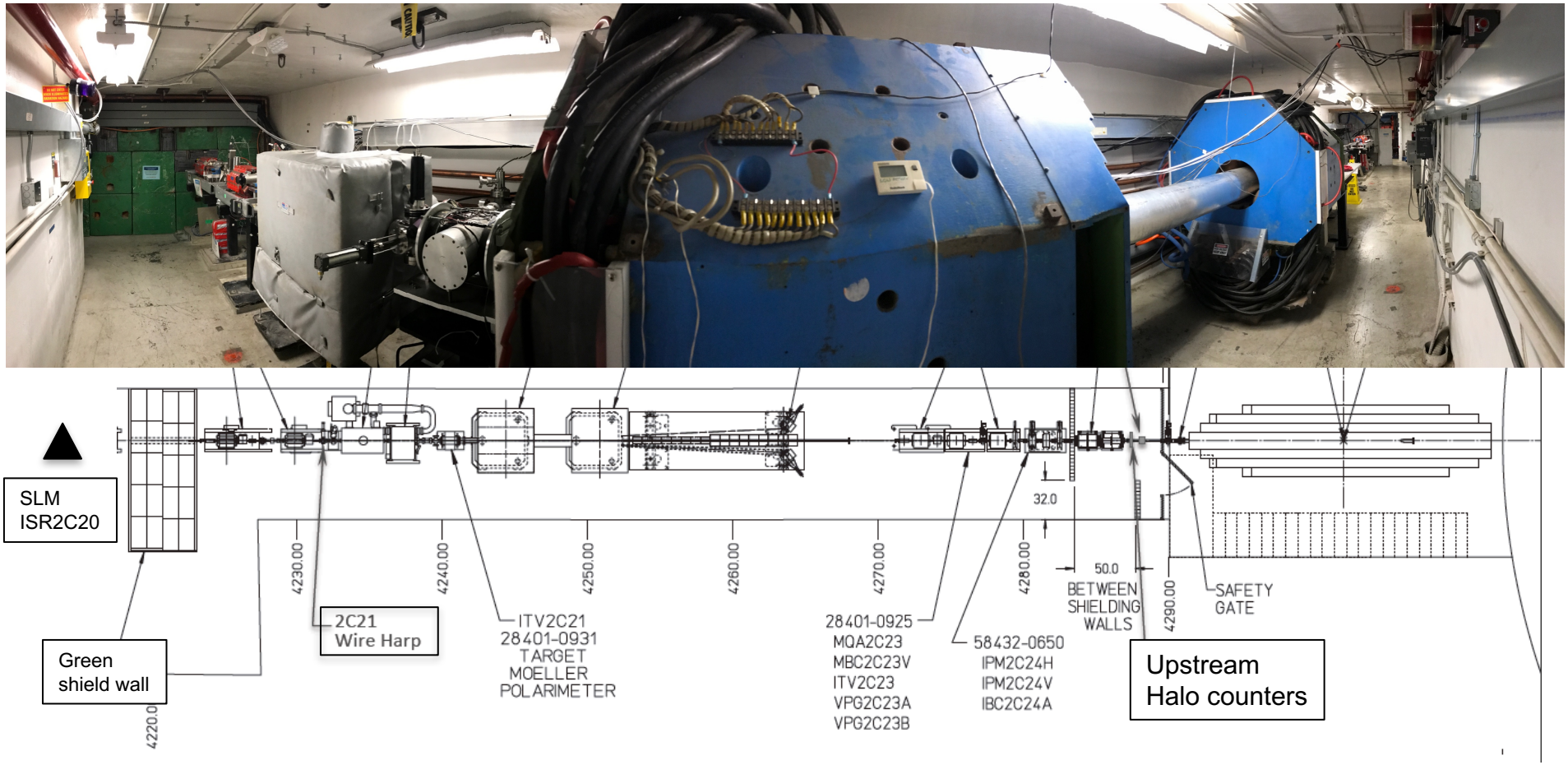
State of the Beamline is Strong!

Almost all design requirements have been met

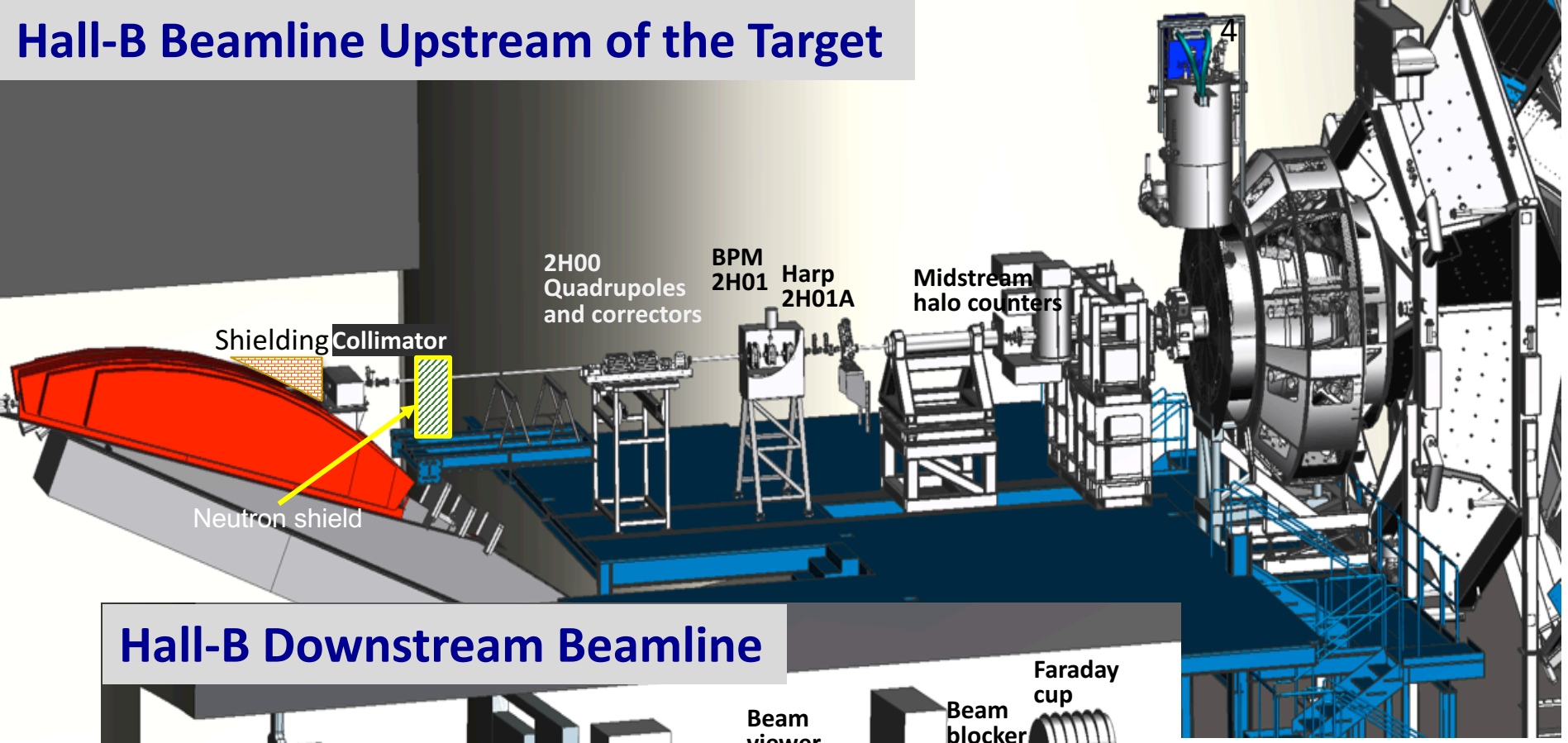
PARAMETER	DESIGN VALUE	Achieved
Beam energy	≤11 GeV (up to 5 pass)	✔
Beam energy spread	~10^{-4}	✔ (acc.)
Beam power	≤5000 W (450 nA at 11 GeV)	✔
Beam current stability	<5%	✔
Beam size at the target	≤0.4 mm	✔
Beam position stability	≤0.1 mm	✔
Beam halo	~10^{-4} of the core	✔
Beam polarization	~80% (if requested)	✔ (> 80%)
Polarization measurement accuracy	~3%	± 4%
Helicity correlated charge charge asymmetry	~0.1%	✔

- Machine delivered high quality, reproducible beam over months of running
- Our beamline devices provided adequate control and monitoring of relevant parameters for beam quantity and quality

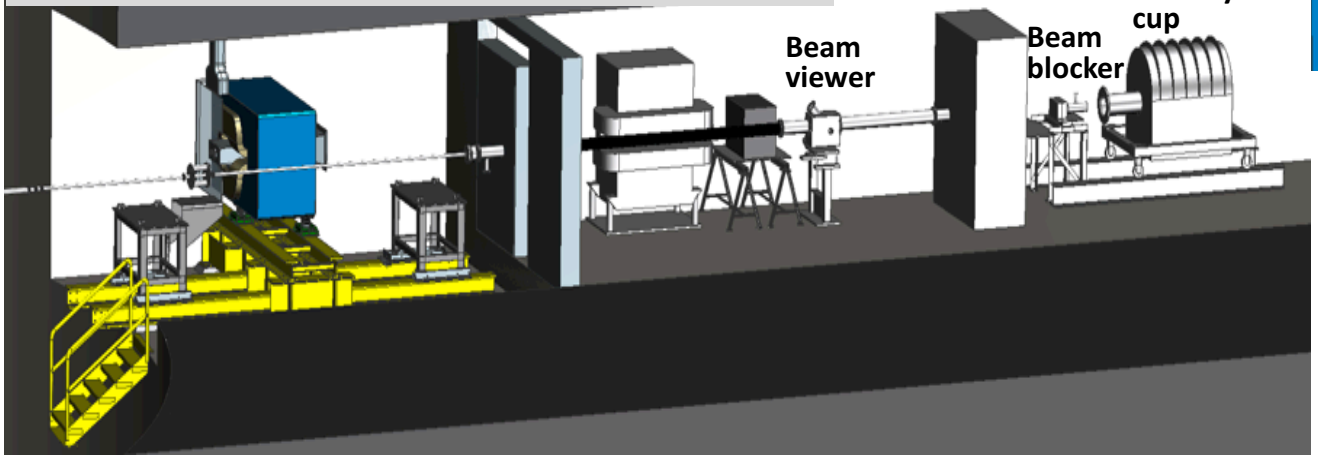
Hall-B beamline: 2C-line (upstream tunnel)



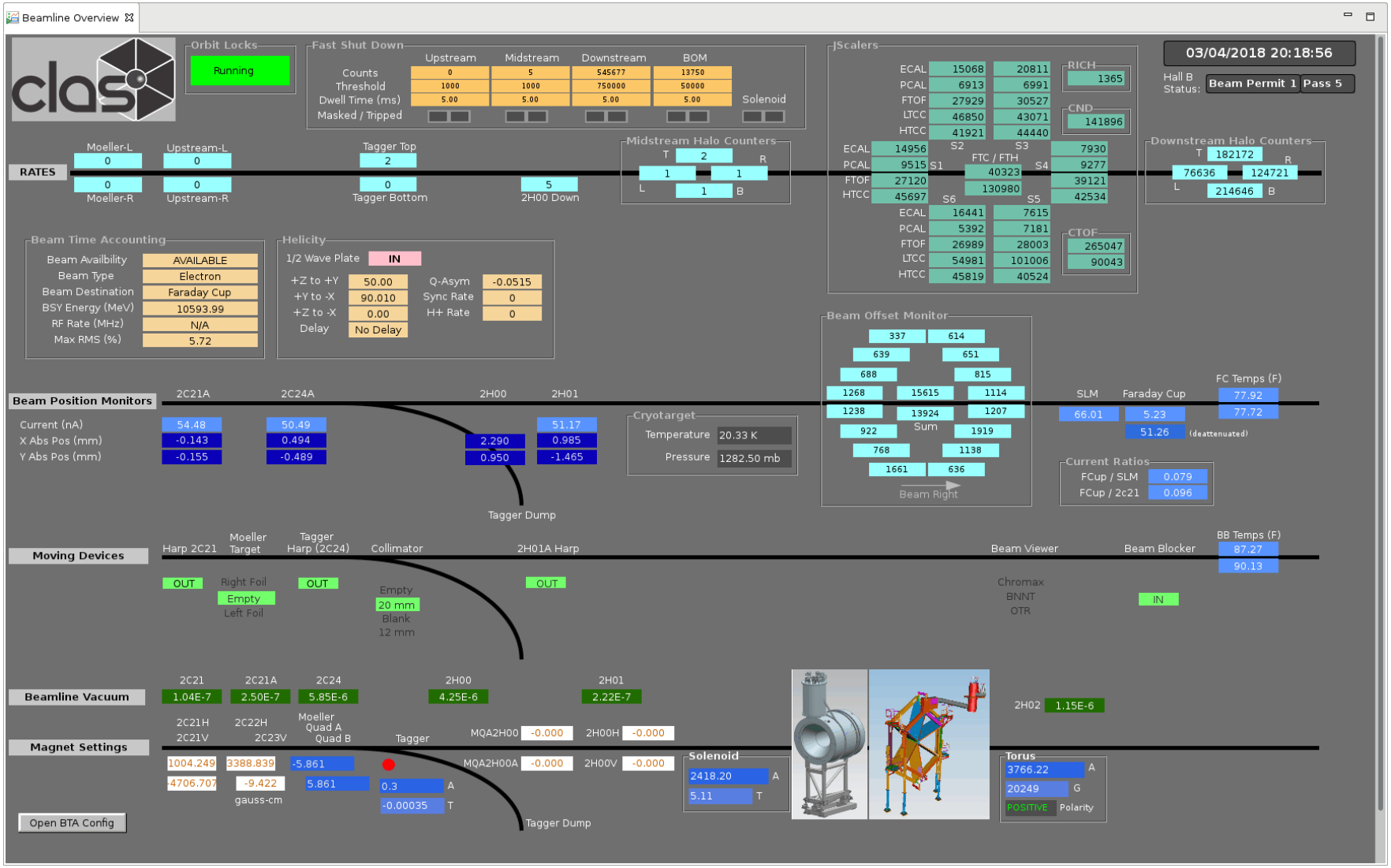
Hall-B Beamline Upstream of the Target



Hall-B Downstream Beamline

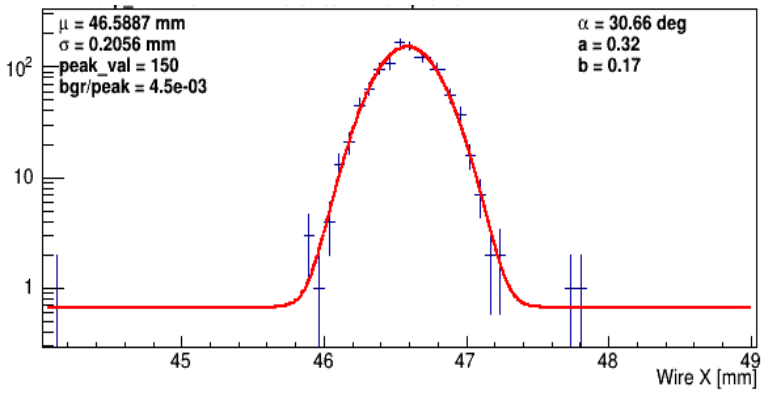


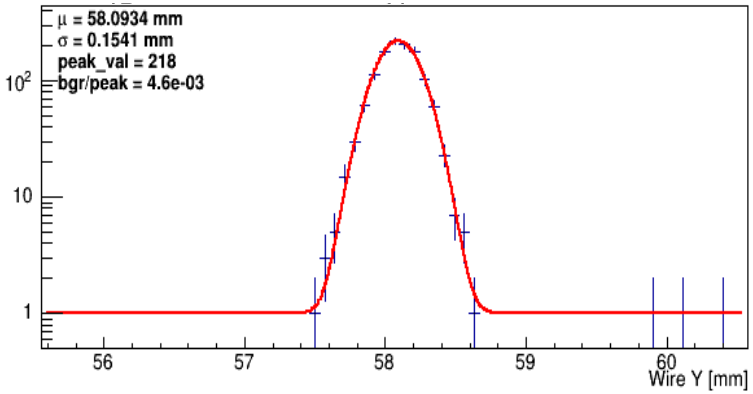
Main monitoring GUI



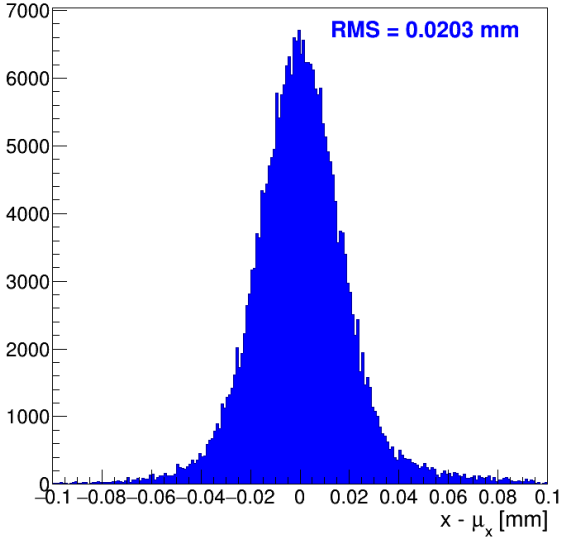
Beam profile and position stability

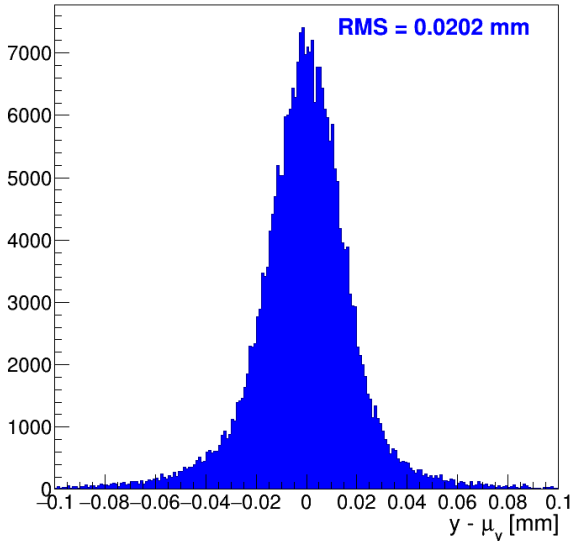
5-pass beam profile at 2H01A harp, 7 m upstream of the target





Beam position stability at 2H00 BPM with $I_B \approx$ 50 nA (Feb. 2-28)

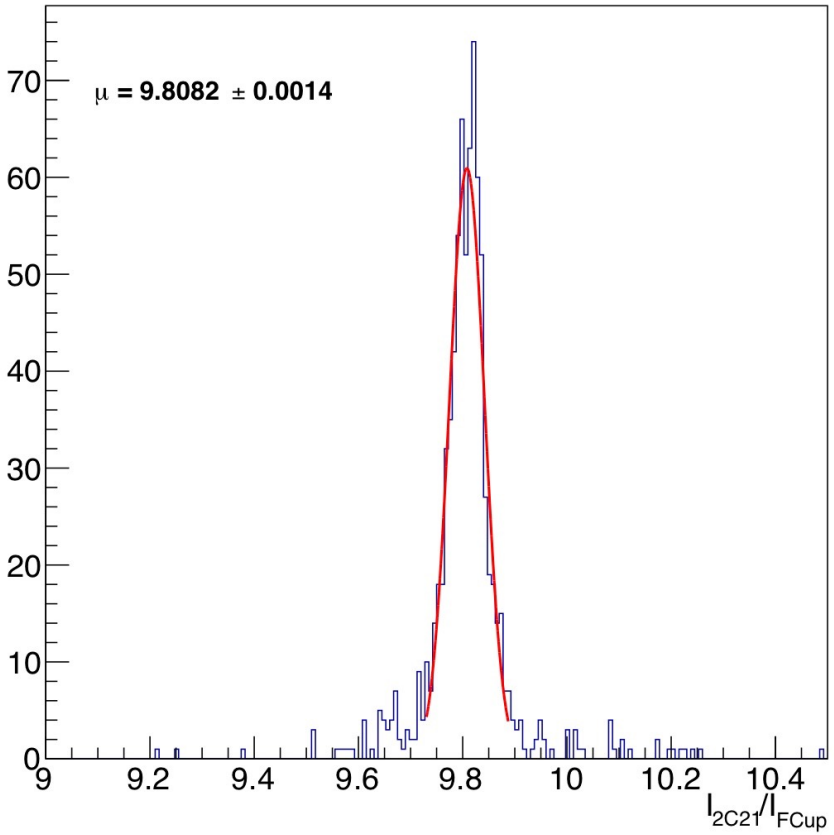




Beam current

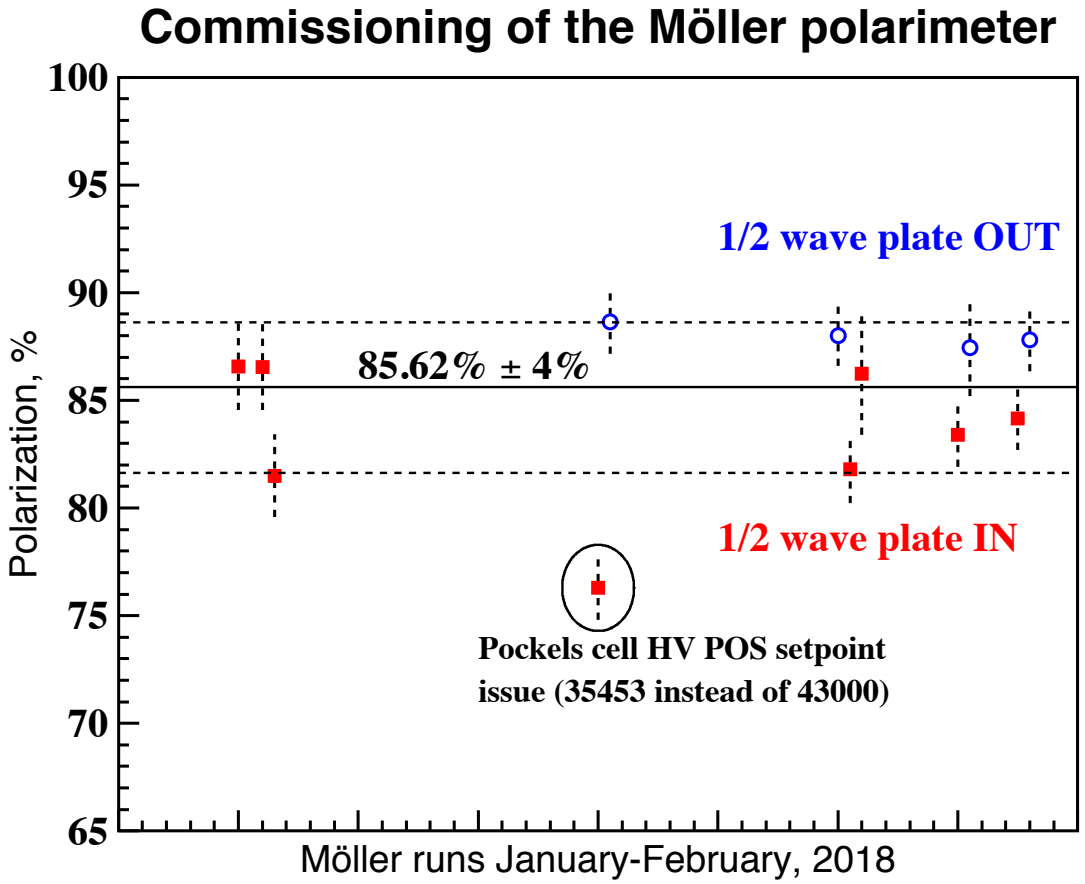
- The Hall-B Faraday cup is the main source of the beam charge for CLAS12 experiments
- Most of CLAS12 experiments will run with a beam blocker in front of the Faraday cap due to 170 W power limit for Faraday (~15 nA at 11 GeV)
- With beam-blocker on the beam, some fraction of the beam power and the charge leak to FC
- The leakage amount is beam energy dependent, (has been studied with simulations, backed up with measurements at few energy points, CLAS12 Note 2016-004) and must be measured for each energy setting

Fraction of the beam current for 5-pass, 10.6 GeV beam



- CLAS12 notes are in archive for 3- and 5- pass beams of engineering and RG-A energies, CLAS12 Note 2018-003 and CLAS12 Note 2018-004

Beam polarization

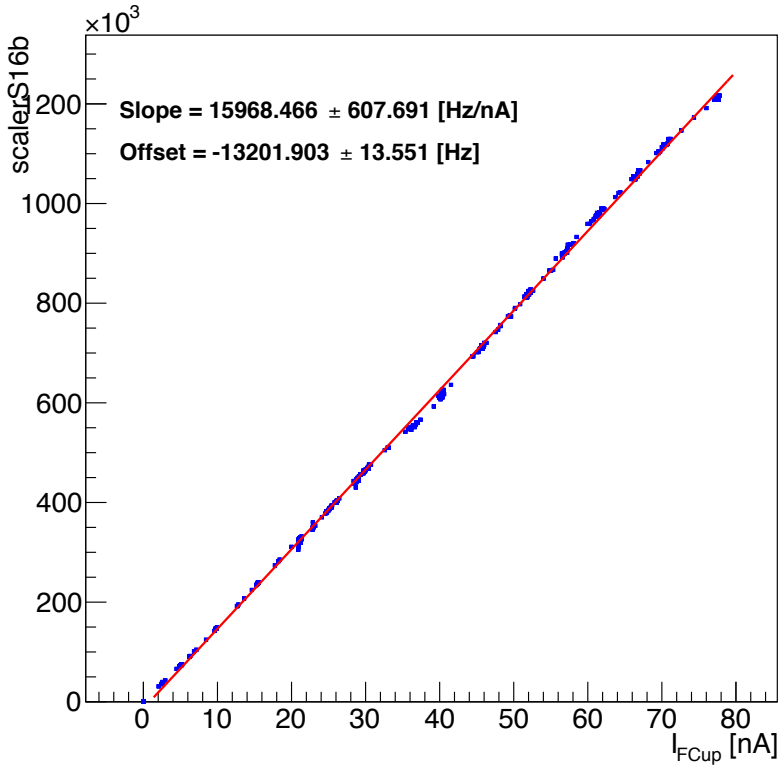


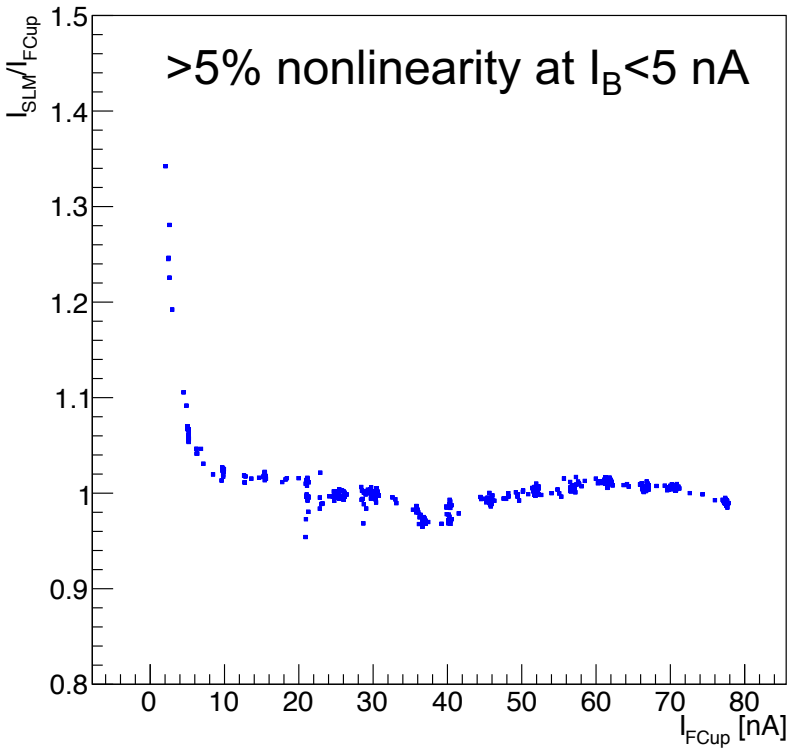
- No dependence of the polarization magnitude on Helmholtz coil current >3 A
- Consistent values and sign change of polarization with change in Helmholtz field direction
- Zero polarization when Pockels cell HV is OFF
- Polarization with ½ wave plate OUT consistently higher than ½ wave plate IN, but still within stat err.

- Still working on determination of the correct analyzing power (Brian)
- Will aim to make Moller polarimeter setup “one-button” operation for the future

ISR2C20 SLM

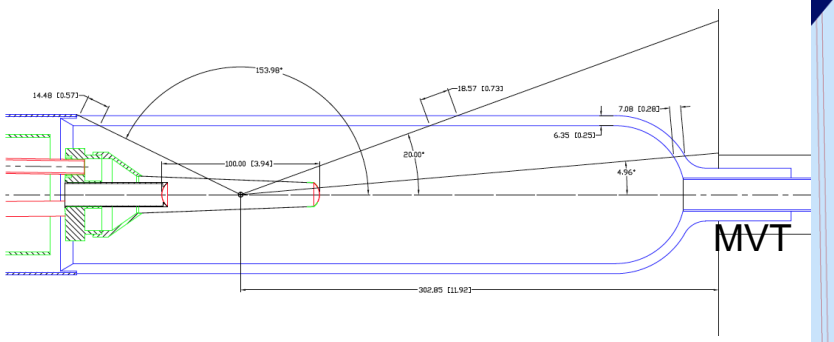
- Important beam current monitor for helicity dependent beam charge accounting (need a fast, reliable charge measurement).
- SLM performs reasonably well, with the new optics (acc.) and the new PMT rate is ~16 kHz/nA at normal operating gain (~530 Hz/nA for each helicity flip)

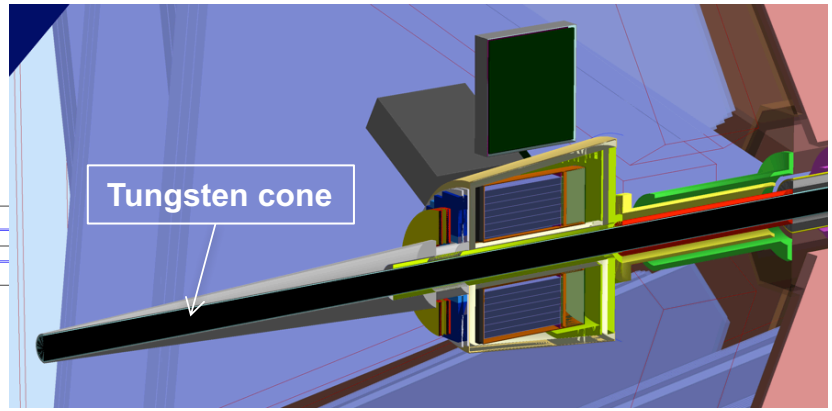




Target

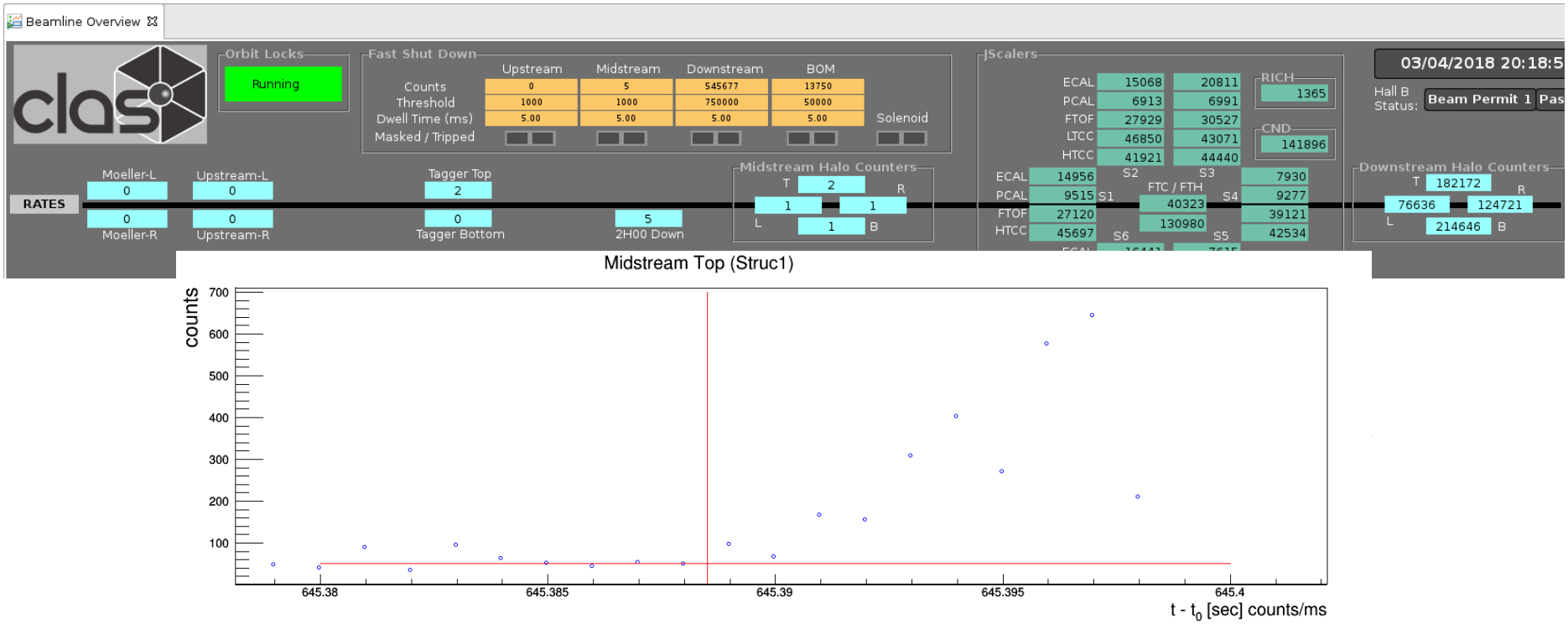
- CLAS-6 cryo. target system (Saclay target) with few modifications will be used:
  - updated controls
  - a new, larger diameter cell with 10 mm diameter 30 μm *Al* windows
  - a longer pipes to the cryostat
- A new foam scattering chamber accommodates the new geometry
- Alignment of the target cell and FTCal and tungsten Moller shield is within 1.5 mm. Beam always is aligned relative to FTCal
- All-in-all Cryo target (LH_2) performed very well
- To further improve reliability, controls for the buffer dewer will be moved under PLC control, similar to other cryo. controls for the magnets





FSD system

- Signals from halo counters are used as inputs to FSD – OR of 4-midstram counters (ch.#1), 4-downstream counters (ch.#2), 2-upstream counters (ch.#3), and the sum of BOM 16 channels (ch.#4), and a channel for the solenoid
- System has been tested using a fast readout of FSD input signals on Struck scaler, performance turned to be in line with expectations



Summary

- The Hall-B beamline achieved its design goals
- With very few hiccups (BOM, downstream camera, IOC trips due to insufficient shielding) beamline performed quite well during the CLAS12 engineering run and ongoing RG-A run
- Despite some struggle with high current running and changing conditions, accelerator was able to deliver high quality, reproducible beam over months of running
- Beamline manual and the operational procedures for shifters served its purpose very well, and has been updated few times already based on the feedbacks of users
- There are list of improvements and upgrades for future experiments that will be dealt with after the run