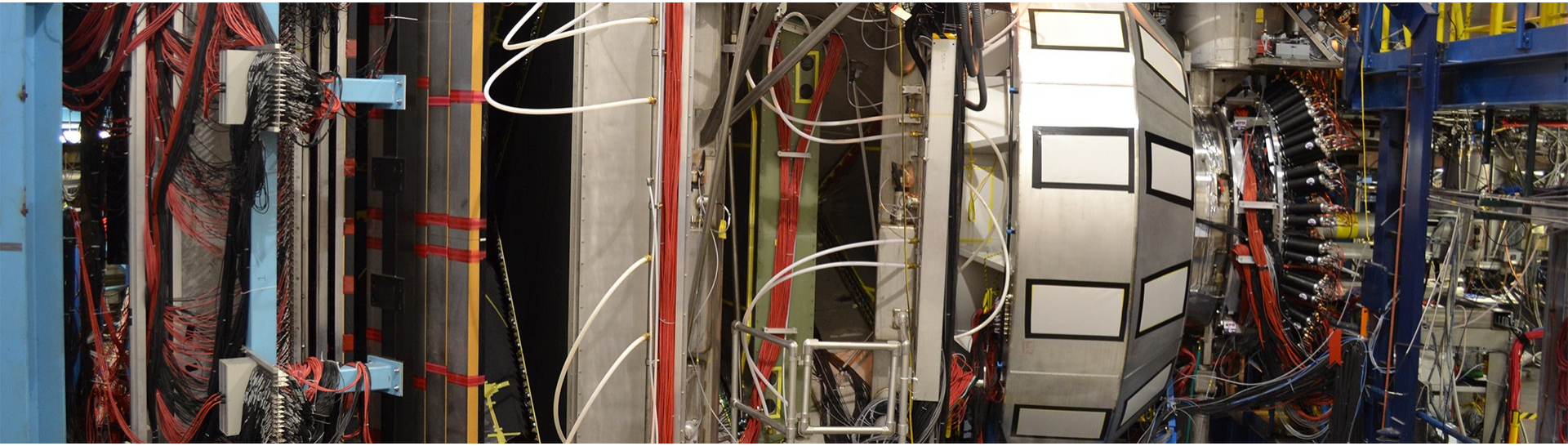
CLAS12 First Experiment



Status Report and Path to Publications

Latifa Elouadrhiri

CLAS Collaboration Meeting
November 14, 2018

Hall B/CLAS12 RG-A Experiments

Proposal	Physics	Spokespersons
E12-06-108	Hard Exclusive Electroproduction of π^0, η	P. Stoler, K. Joo, **V. Kubarovsky**, M. Ungaro, C. Weiss
E12-06-108A	Exclusive N*->KY Studies with CLAS12	**D.S. Carman**, R. Gothe, V. Mokeev
E12-06-108B	Transition Form Factor of the η' Meson with CLAS12	**M. Kunkel**, D. Lersch
E12-06-112	Proton's Quark Dynamics in SIDIS Pion Production	**H. Avakian**, K. Joo, Z.E. Meziani, B. Seitz
E12-06-112A	Semi-inclusive Λ Productiuon in Target Fragmentation Region	**M. Mirazita**
E12-06-112B	Higher Twist Colinear Structure of the Nucleon	S. Pisano, **M. Mirazita**
E12-06-119	Deeply Virtual Compton Scattering at 11 GeV	F. Sabatie, A. Biselli, H. Egiyan, **L. Elouadrhiri**, M. Holtrop, D. Ireland, W. kim
E12-09-003	Excitation of Nucleon Resonances at High Q^2	**R. Gothe**, V. Burkert, P. Cole, K. Joo, V. Mokeev, P. Stoler
E12-11-005	Hadron Spectroscopy with Forward Tagger	**M. Battaglieri**, R. De Vita, C. Salgado, S. Stepanyan, D. Watts, D. Weygand
E12-11-005A	Photoproduction of the Very Strangest Baryons	**L. Guo**, M. Dugger, J. Goetz, E. Pasyuk, I. Strakovsky, D. Watts, N. Zachariou, V. Ziegler
E12-12-001	Timelike Compton Scattering & J/ψ Production in e+e-	**P. Nadel-Turonski**, M. Guidal, T. Horn, R. Paremuzyan, S. Stepanyan
E12-12-001A	J/ψ Photoproduction and Study of LHCb Pentaquarks	**S. Stepanyan**, M. Battaglieri, A. Celetano, R. De Vita, V. Kubarovsky
E12-12-007	Exclusive φ Meson Electroproduction with CLAS12	P.Stoler, C. Weiss, **F.X. Girod**, M. Guidal, V. Kubarovsky

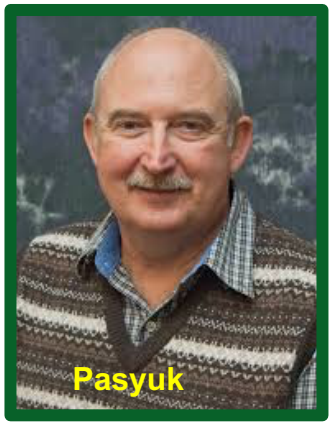
Experiment Parameters

Duration: **139 PAC days**
80 days high luminosity ($10^{35}cm^{-2}s^{-1}$)
39 days low luminosity ($5x10^{33}cm^{-2}s^{-1}$) in Progress
20 days torus polarity = negative
Energy: **11 GeV**
Target: **LH2**

Experiment	parameters
Beam energy	10.6 GeV, electrons polarized
Beam current	2nA (2.5 x 10^{33}) to 75 nA (1x10^{35})
Torus field and polarity	100% (75% negative particles in-bending & 25% out-bending)
Solenoid field and polarity	100% (nominal)
Trigger(s)	1. Electron trigger (HTCC/DC/PCAL/EC) 2. Electron in FT + 2 hadrons in CLAS12 3. Muon trigger 4. Calibration/Normalization Triggers
Target	5 cm LH2

CLAS12 First Experiment Coordination

Experiment coordinator



Physics Division Liaison (PDL)

Deep exclusive processes
E12-06-119, E12-06-108 and E12-12-007

Deep inclusive & SIDIS
E12-06-112, E12-06-112A and E12-06-112B

Quasi photo-production
E12-12-001 and E12-12-001A

Nucleon structure
E12-09-003, E12-06-108A, E12-06-108B

MesonX program
E12-11-005 and E12-11-005A

Run Coordination

- **Physics Division Liaison:** Eugene Pasyuk
- **Hall Coordinator**: Denny Insley
- **Experiment Coordinator:** Latifa Elouadrhiri
- **Run Coordinators:**
  - Dan Carman
  - Maxime Defurne
  - Raffaella DeVita
  - Latifa Elouadrhiri
  - Lei Guo
  - Andrey Kim
  - Nick Markov
  - Rafayel Paremuzyan
  - Stepan Stepanyan
  - Kubarovsky, Valery

Run Coordination/Meetings

- **Daily RC meetings**
  - Daily execution of the run
- **Weekly First experiment meetings**
  - Experiment monitoring
  - Detector calibration/Alignment
  - Software validation using data and MC simulations
  - High level/Detector efficiency/physics analysis
  - DNP Preparation
  - **Path to Publications (Our next Focus)**
- **Weekly TCB meeting**
  - Detector hardware performances
  - Maintenance weekly planning

In addition meetings with experiment spokespersons are scheduled as needed

Documentation can be found CLAS12 First Experiment
Hall-B
CLAS12ANA

RG-A- RUN Periods

Schedule	Experiment	Energy (GeV)	Polarization	Days	Total days
CY 2018					
2/5- 5/07	RG-A	6.4 & 10.6	max		
9/26 -10/23	RG-A	10.6	max	28	
10/26 – 11/25	RG-A	10.6	max	31	
11/29 – 12/09	RG-K	7.5	max	11	
12/13 – 12/19	RG-K	6.5	max	7	18
CY 2019					
03/11 – 04/07	RG-A	10.6	max	28	87

RG-A Experiment Configuration

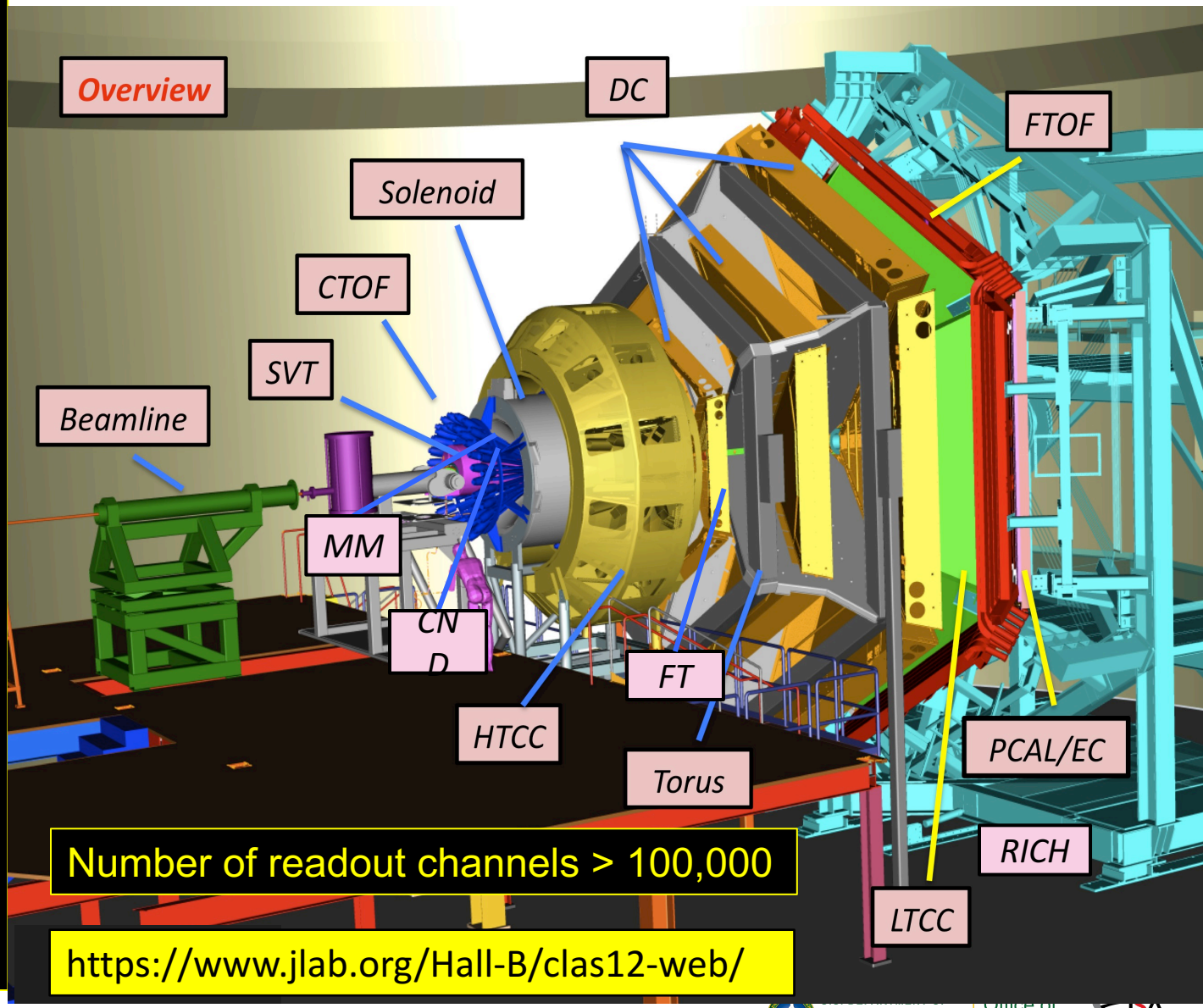
- **The experiment configuration for the fall 2018 RG-A run is very similar to the spring 2018 RG-A run:**
  - Forward tracker (FMT) removed downstream of target
  - Two LTCC boxes removed from Forward Carriage
  - **Improvement to the cooling system of the SVT**
  - Production runs (75% with torus -100%, 25% with torus +100%)
- **Start up of the experiment include:**
  - Background characterization of CLAS12
  - Luminosity scan
  - Detector & Trigger setting
- **Our weekly plans will typically be as follows:**
  - Moller polarimeter run/Change of the HWP
  - Empty target run
  - Low luminosity run
- **Requirements for beam to Hall B:**
  - Beam size at target < 200 mm
  - Position stability at target < 200 mm
  - Current stability ~5%
  - Beam polarization > 86%

CLAS12 Detector Systems

Forward Detector (FD)
- TORUS magnet
- HT Cherenkov Counter
- Drift chamber system
- LT Cherenkov Counter
- Forward ToF System
- Pre-shower calorimeter
- E.M. calorimeter
- Forward Tagger
- RICH detector

Central Detector (CD)
- Solenoid magnet
- Silicon Vertex Tracker
- Central Time-of-Flight
- Central Neutron Detector
- MicroMegas

Beamline
- Diagnostics
- Shielding
- Targets
- Polarimeter
- Faraday Cup



Number of readout channels > 100,000

https://www.jlab.org/Hall-B/clas12-web/

Detector Operation

- CLAS12 detector/DAQ performed well during RGA
- Two issues from our side:
  - Issue with the control system of the target at the beginning of the run. This has been fixed by Saclay team, excellent effort and team work!
  - Fast Dump of the solenoid that several times and it is now being addressed

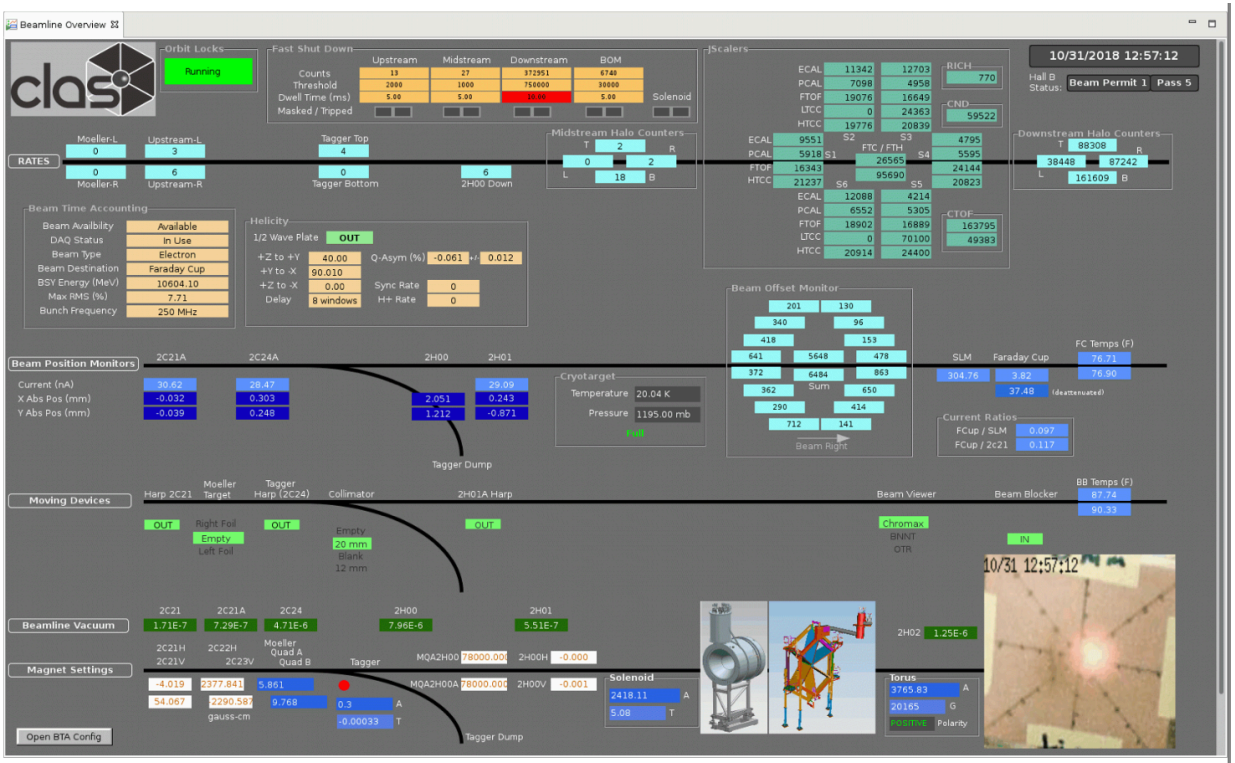
Solenoid – Fast dumps issues

- 6 fast dumps at low current (less than full field of 2416 A) - commissioning was completed in Sept 2017
  - 3 fast dumps due to PLC/software threshold voltage limits being too sensitive to noise
  - 2 fast dumps due to hard wired QD thresholds being too sensitive to noise
  - 1 fast dump due to an ESR cryogenic event
- After commissioning was completed, the magnet regularly achieved 2416 A (5.0 T)
  - A total of 15 fast dumps
    - 1 fast dump attributed to a malfunctioning voltage panel switch → *switch now replaced*
    - 1 fast dump attributed to an incorrect voltage threshold setting → *setting now corrected*
    - 13 fast dumps correlated to LCW make-up water flow rate increase causing a temporary loss of cooling water flow to the solenoid magnet power supply → *this is presently being investigated*
- Hall B engineering is investigating a way to minimize this LCW make-up water flow effect
- A transducer in the LCW line been added and may be used to initiate a controlled ramp down as a temporary measure
- We will continue working to reduce the overall cryogenic recovery time (presently 6 hours) after a fast dump
- Brief summary - data available through following link to access the events (B. Eng, DSG entry)

https://userweb.jlab.org/~beng/images/Solenoid%20Fast%20Dumps%20&%20LCW/

Beam Quality issues

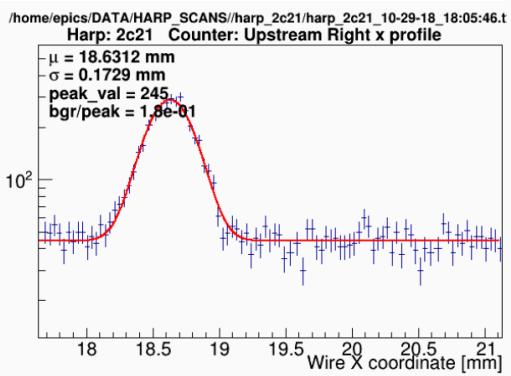
- High rates on upstream, midstream & downstream halo counters at the beginning of the week- High rate of FSD trips
- Also spikes in beam current observed

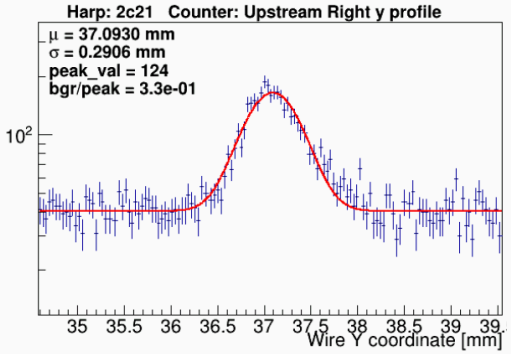


- Adjusting the slit from 15.9 to 16.20 appeared to help with the halo trip rate. Things are more quiet and stable since 10/31 swing shift.
- A trim card power supply was changed for the vertical Wein, seems to help clear the beam current spikes: **https://logbooks.jlab.org/entry/3619173 & https://logbooks.jlab.org/entry/3619180** , since 11/1 day shift.

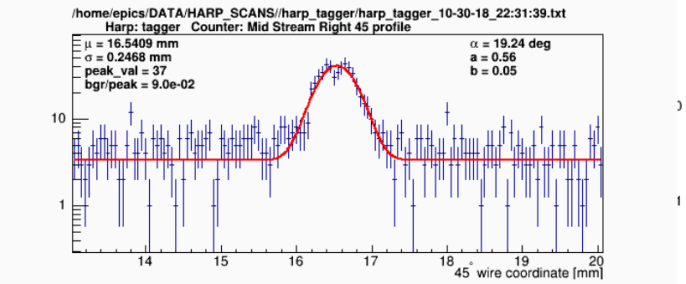
Beam quality

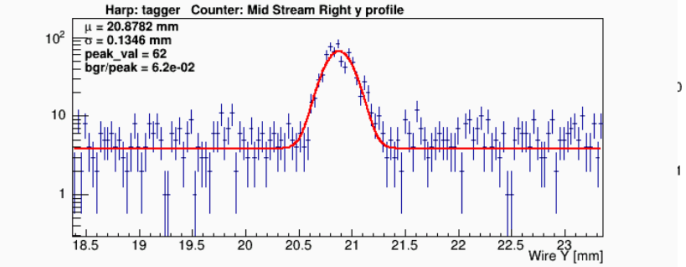
Harp: 2C21
10/29/18

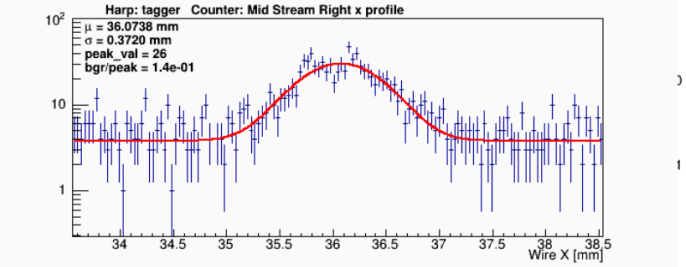




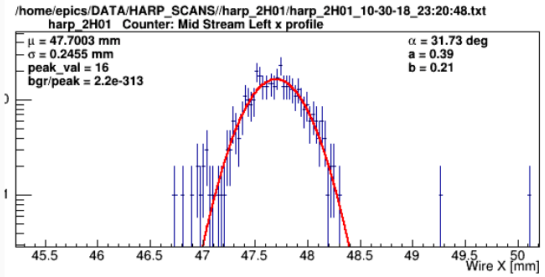
Harp: Tagger
10/30/18

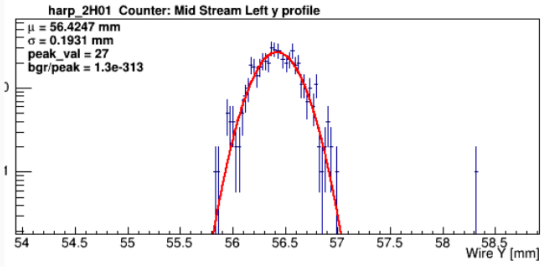


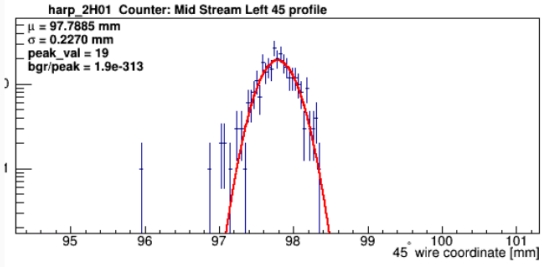




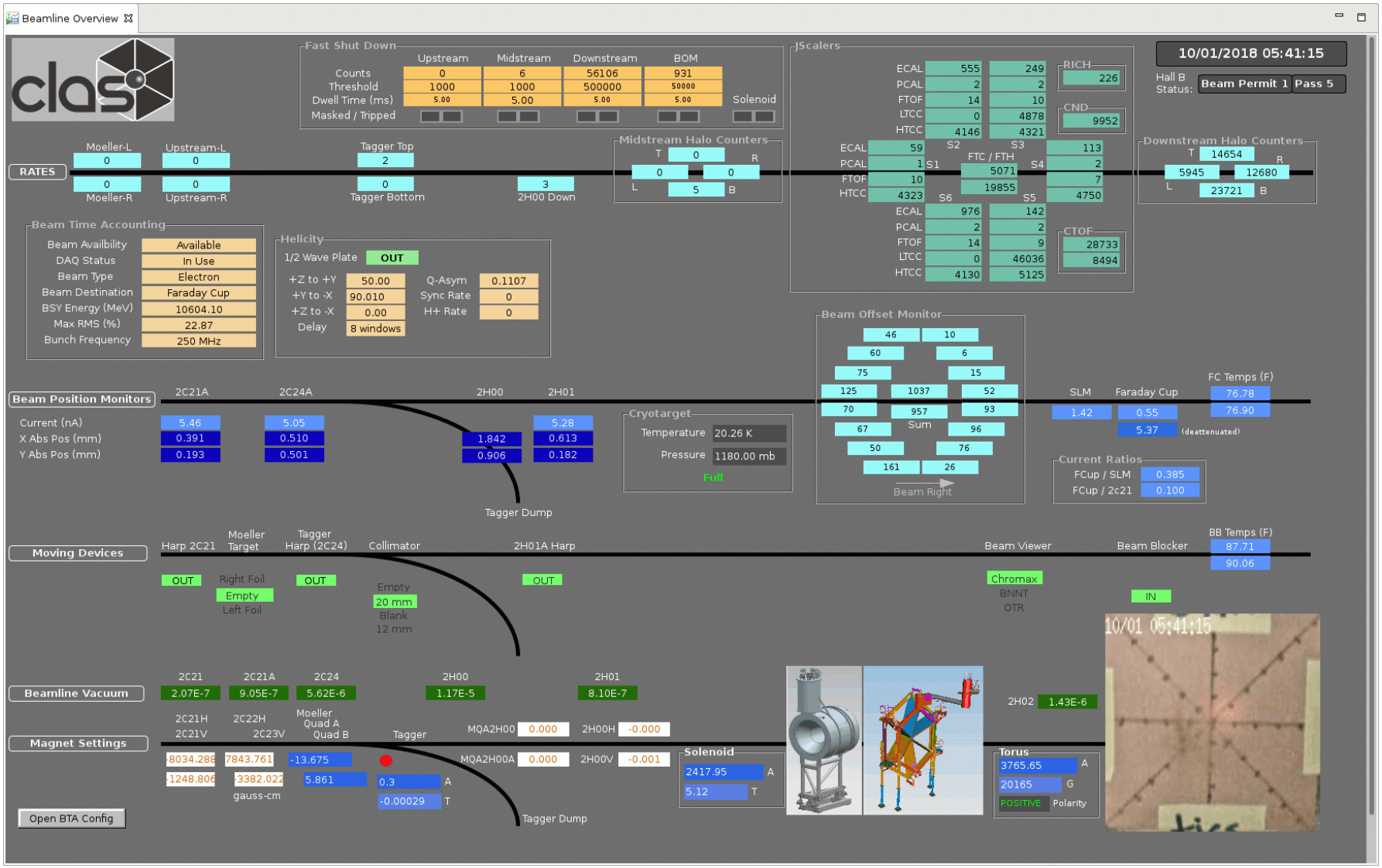
Harp: 2H01
10/30/18



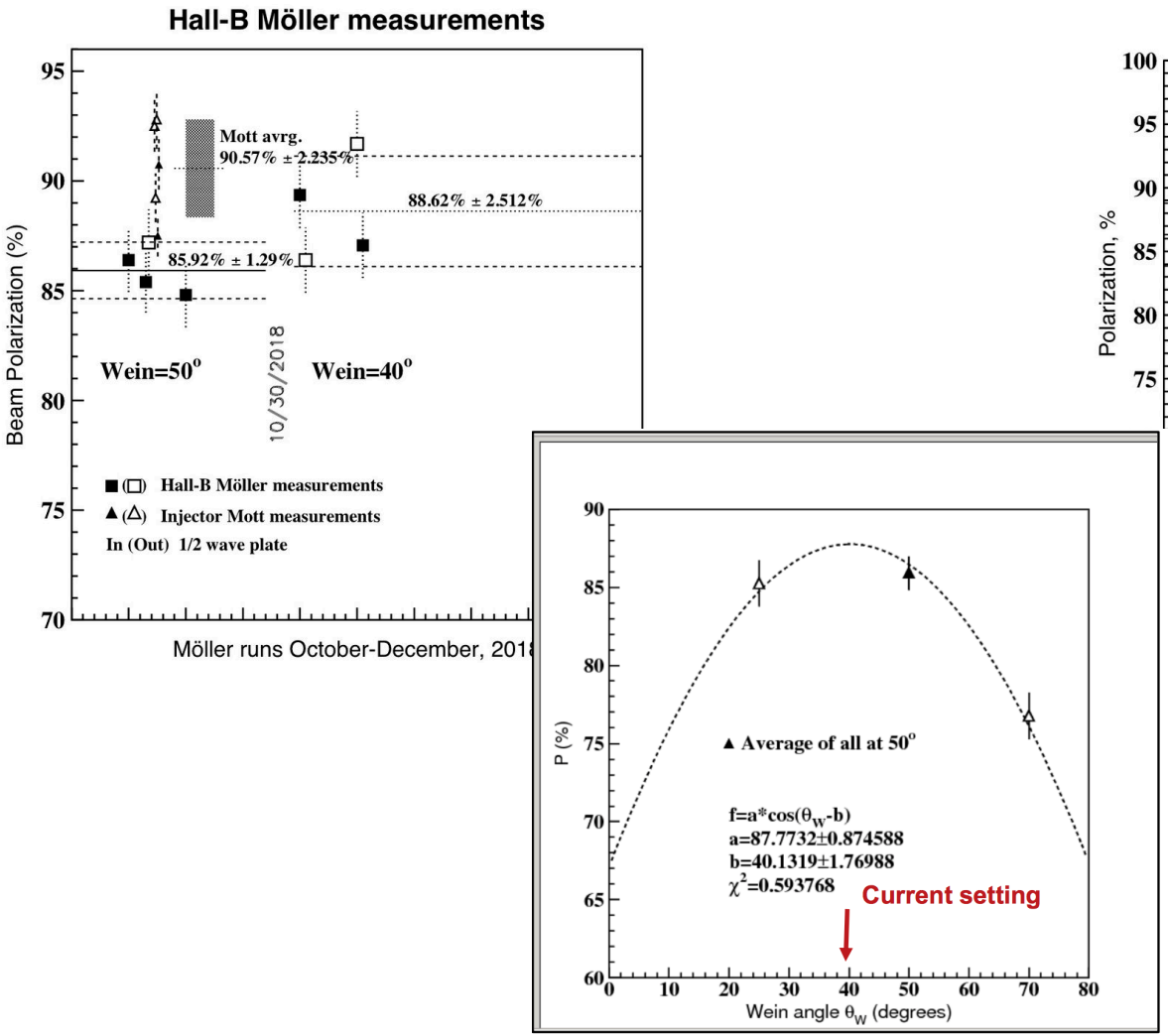


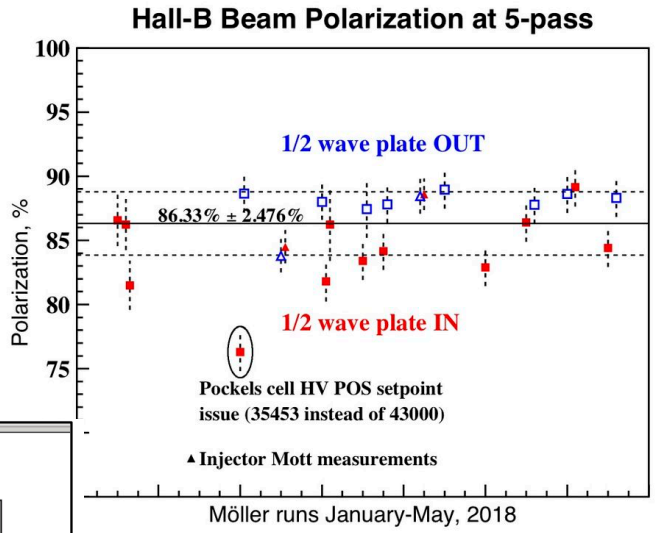


Beam Overview



RG-A Measured Polarization





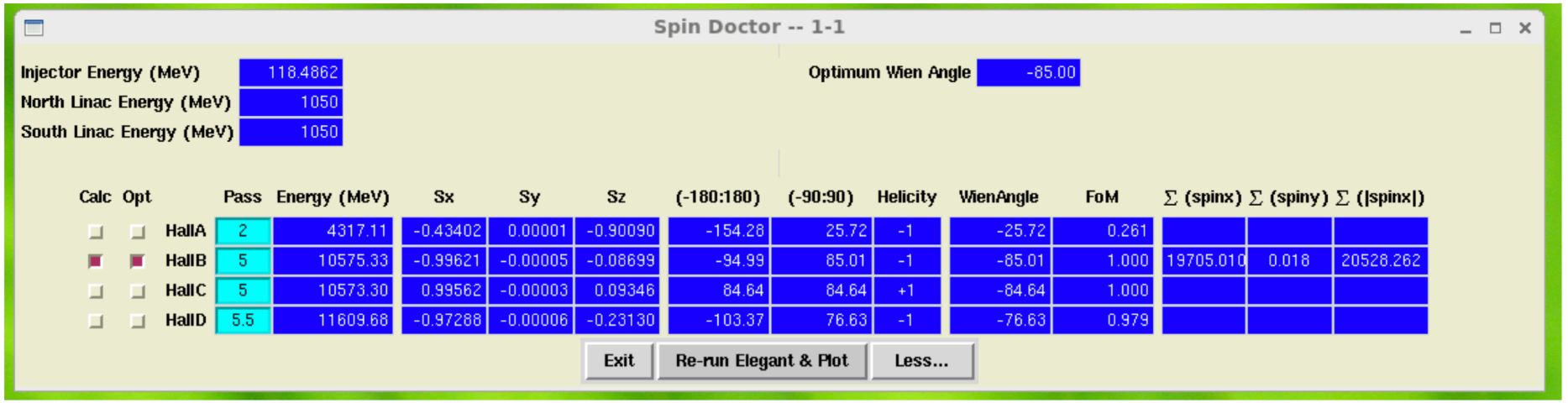
Other measurements:

no dependence of the polarization magnitude on Helomholtz coil current ≥ 3 A, sign change with change of the Helmholtz field direction

zero measured polarization when Packels cell HV is off

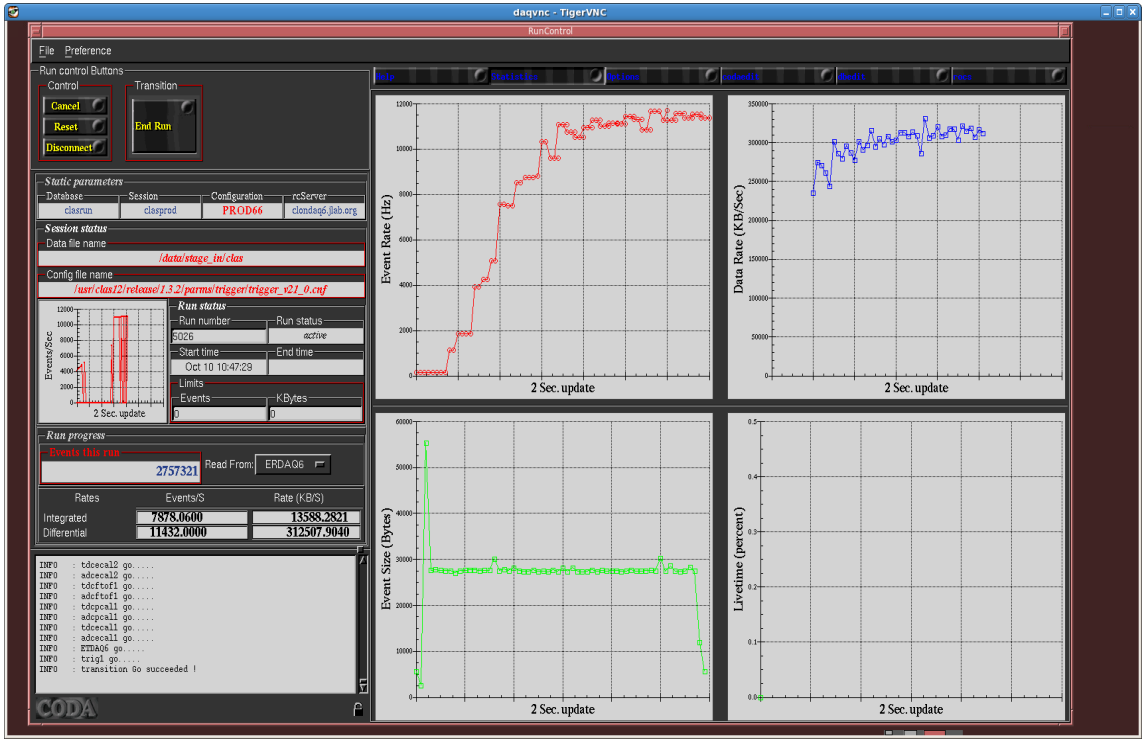
https://logbooks.jlab.org/entry/3617660

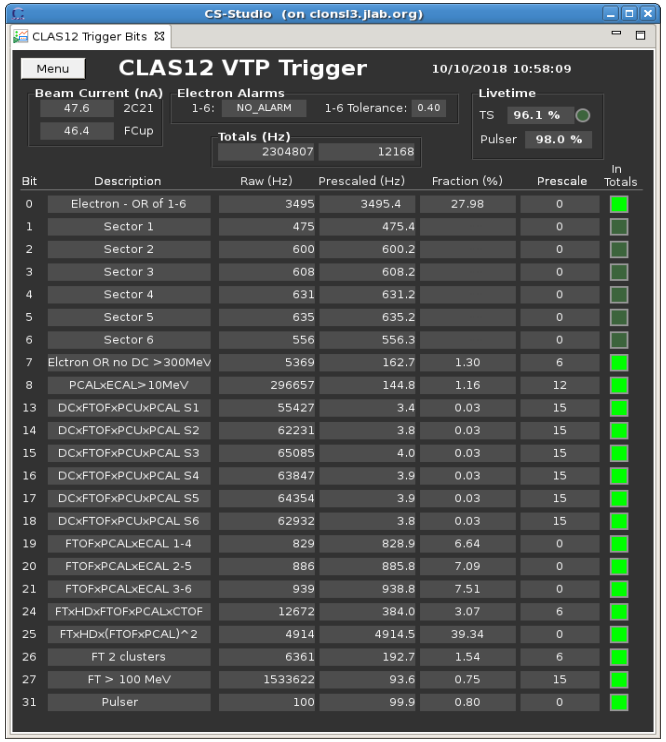
Beam Energy


Spin Doctor -- 1-1
Injector Energy (MeV) 118.4862
North Linac Energy (MeV) 1050
South Linac Energy (MeV) 1050
Optimum Wien Angle -85.00
Calc Opt Pass Energy (MeV) Sx Sy Sz (-180:180) (-90:90) Helicity WienAngle FoM Σ (spinx) Σ (spiny) Σ (|spinx|)
HallA 2 4317.11 -0.43402 0.00001 -0.90090 -154.28 25.72 -1 -25.72 0.261
HallB 5 10575.33 -0.99621 -0.00005 -0.08699 -94.99 85.01 -1 -85.01 1.000 19705.010 0.018 20528.262
HallC 5 10573.30 0.99562 -0.00003 0.09346 84.64 84.64 +1 -84.64 1.000
HallD 5.5 11609.68 -0.97288 -0.00006 -0.23130 -103.37 76.63 -1 -76.63 0.979
Exit
Re-run Elegant & Plot
Less...

CLAS12 DAQ/Trigger in fall 2018

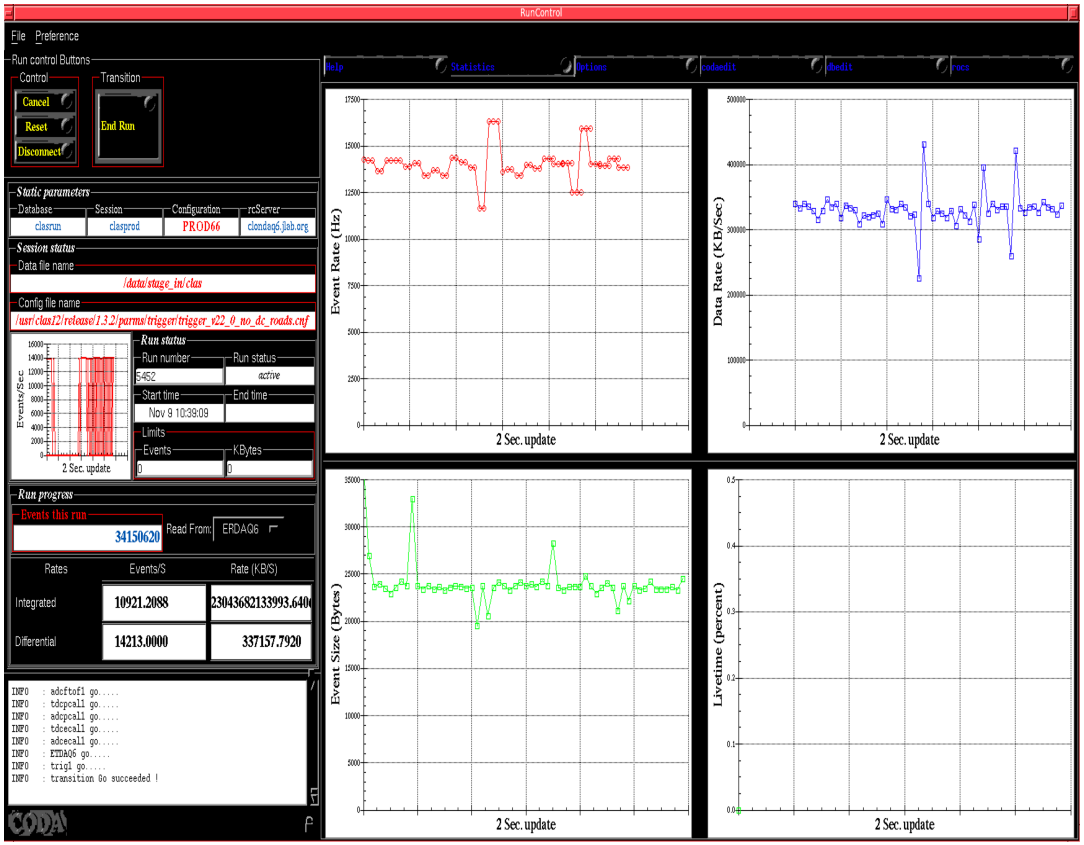
- Original DAQ requirements: 10kHz event rate, 100MB/sec data rate, LT>90%
- Trigger decision is based on PMT detectors and tracks in drift Chambers and configured for 3 groups of experiments: “electrons”, “mesonX”, “muons”
- Inbending: production rates at 45nA beam: 12kHz event rate, 300MB/sec data rate, LT=96%

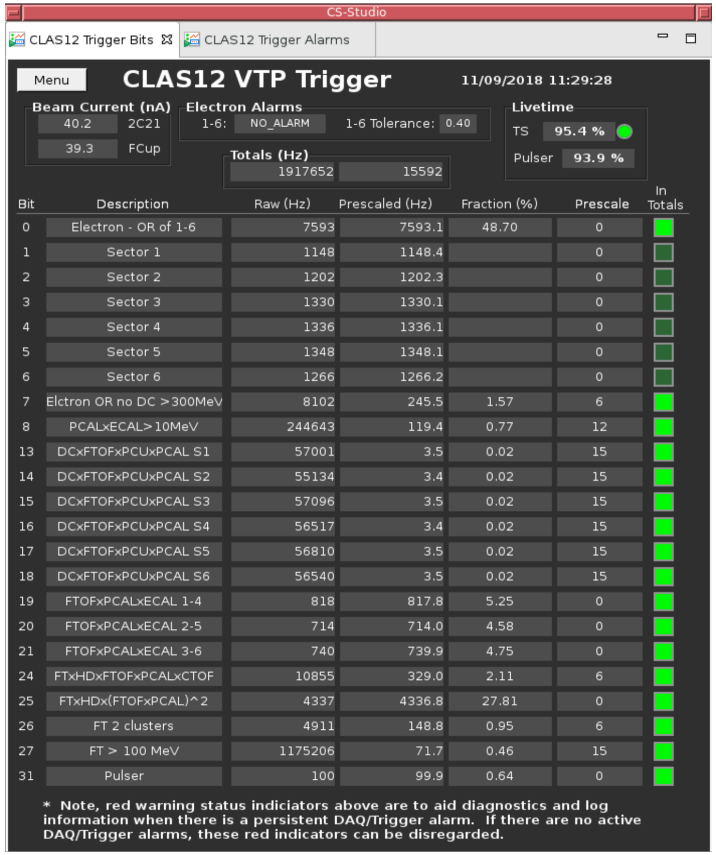




CLAS12 DAQ/Trigger in fall 2018 (cont.)

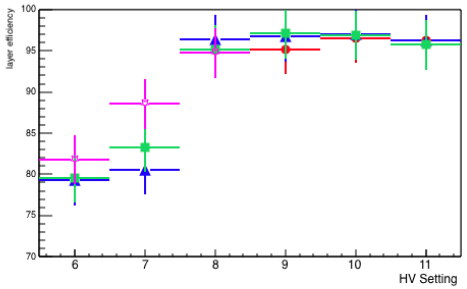
- Outbending: production rates at 40nA beam: 14kHz event rate, 330MB/sec data rate, LT=95%

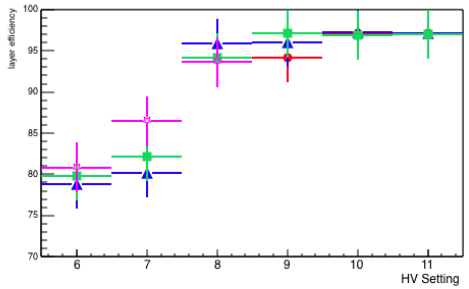




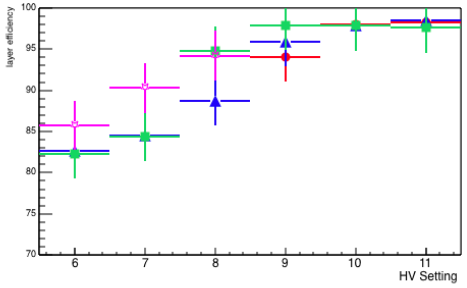
Drift Chambers Setting and layer efficiency

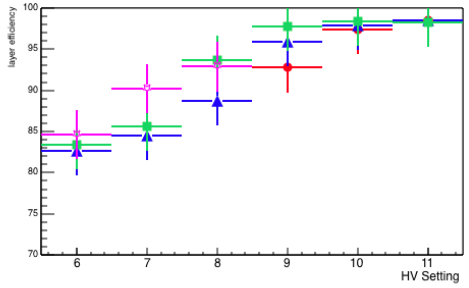
Region I



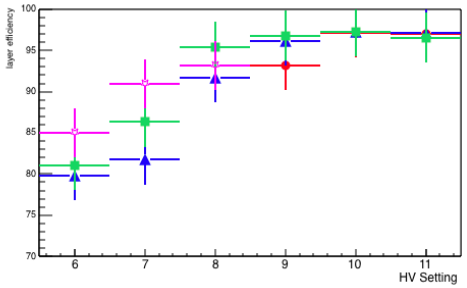


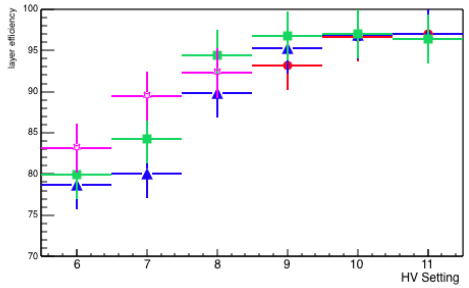
Region II





Region III



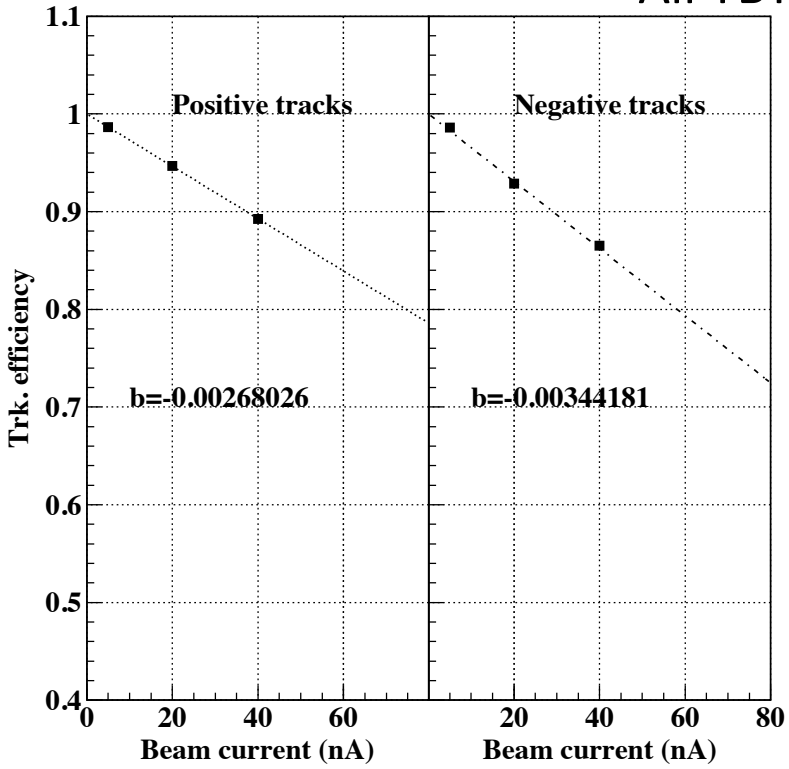


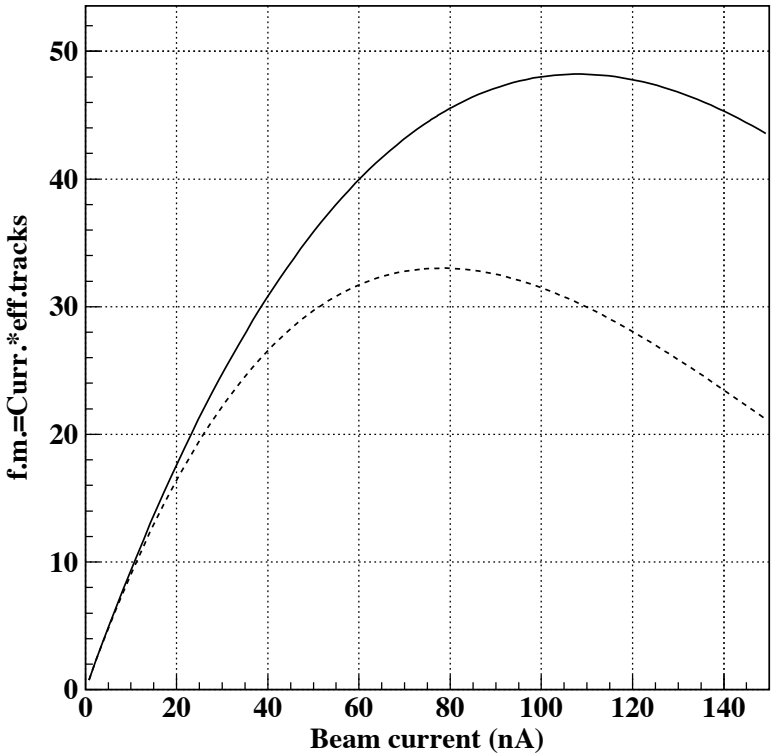
We choose the DC setting at which we have the maximum layer efficiency and No DC trips at the maximum operating current. Currently running at 9, 10, 10.

Operating Beam Current and tracking efficiency

Outbending Fall Run

All TBT tracks





At I=0 nA rates are normalized to 1.

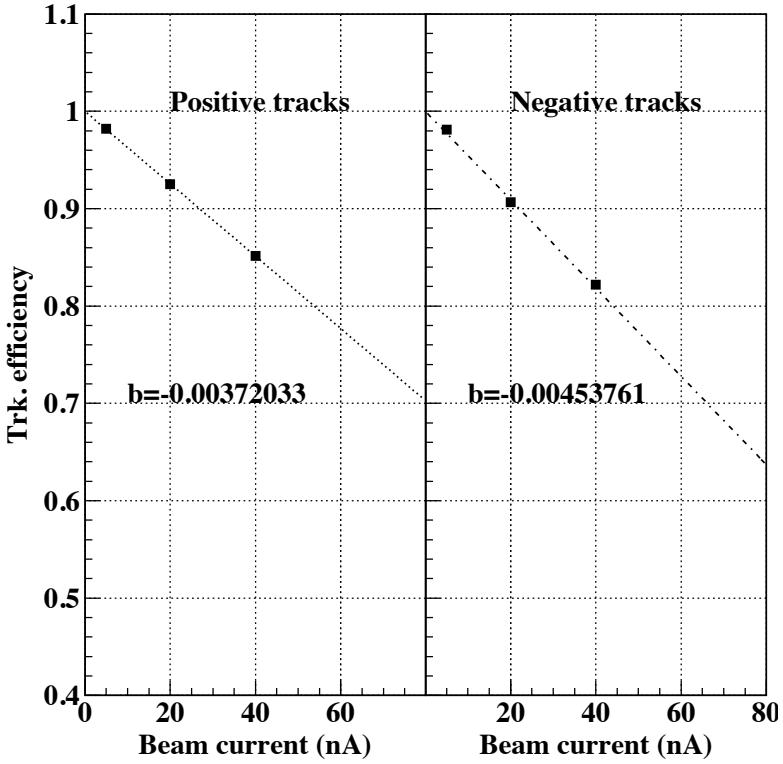
Currently running at 45nA

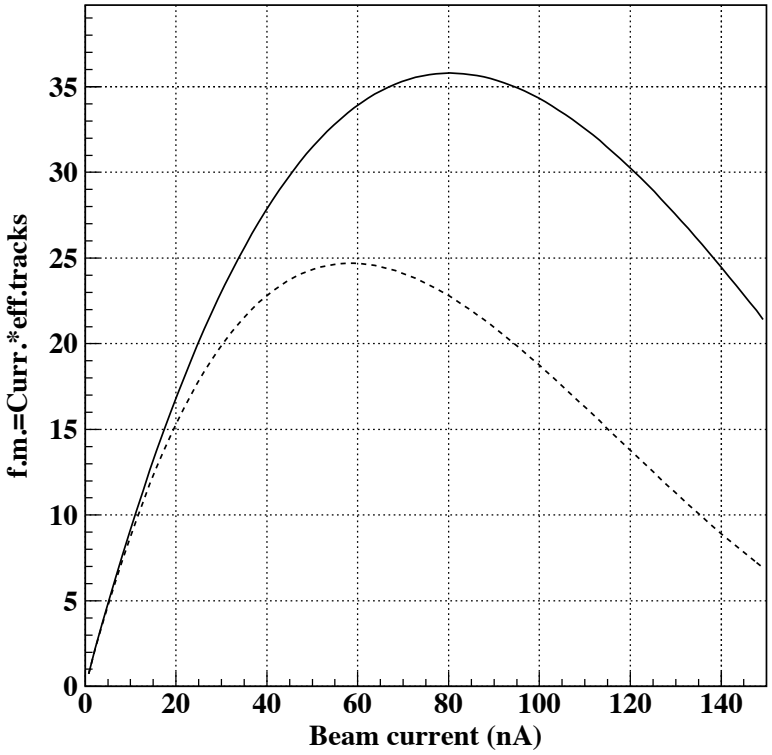
(See Stepan's Logbook CLAS12ANA entry 11/13)

Operating Beam Current and tracking efficiency

Outbending Fall Run

PID $|\chi^2| < 20$





At I=0 nA rates are normalized to 1.

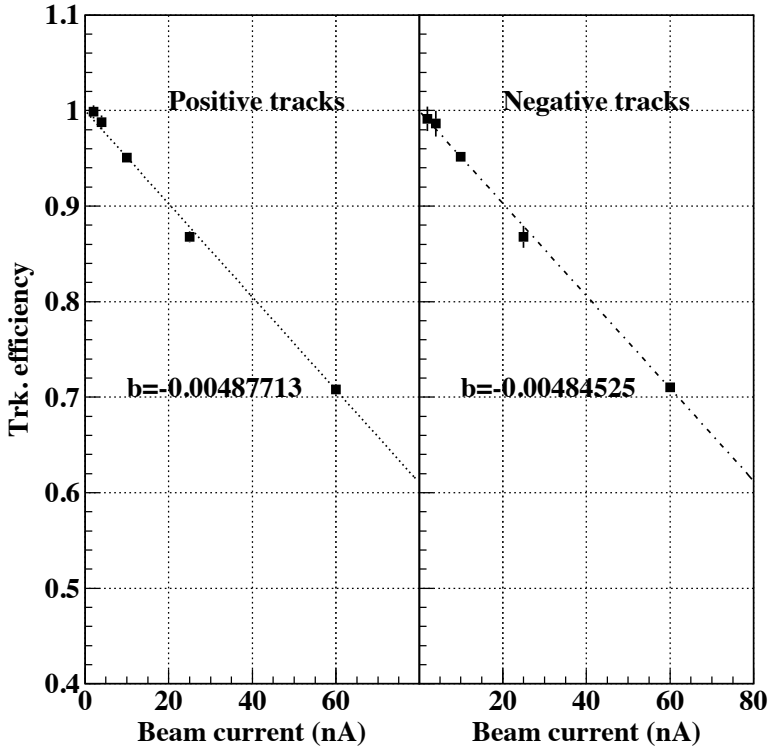
Currently running at 45nA

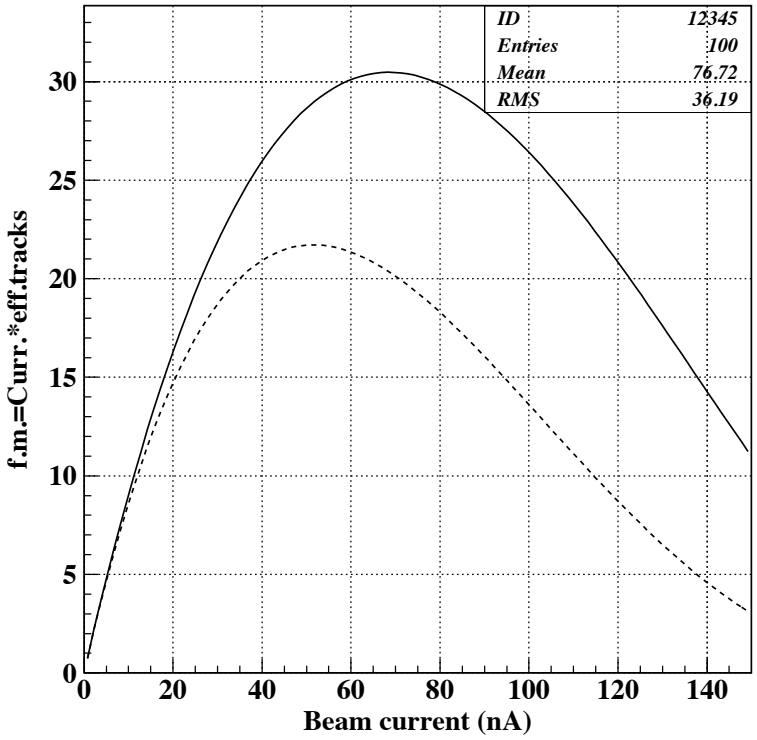
(See Stepan's Logbook CLAS12ANA entry 11/13)

Operating Beam Current and tracking efficiency

Inbending Fall Run

All TBT tracks





At I=0 nA rates are normalized to 1.

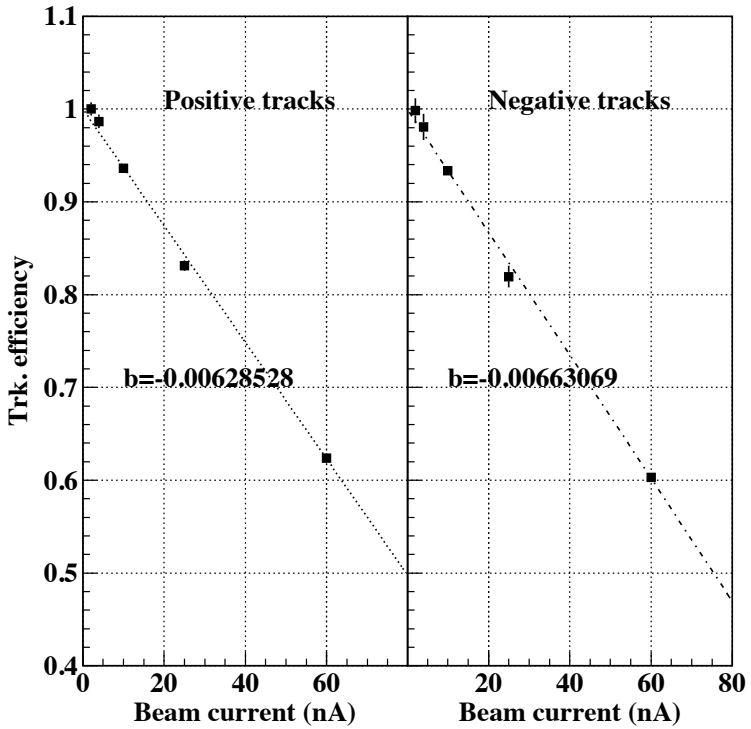
Took data at 55nA

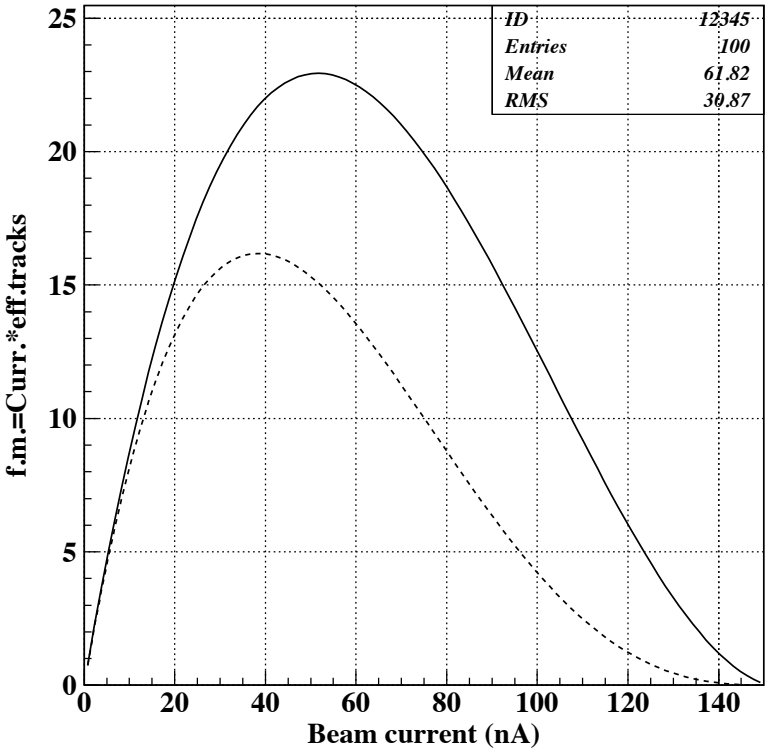
(See Stepan's Logbook CLAS12ANA entry 11/13)

Operating Beam Current and tracking efficiency

Inbending Fall Run

PID $|\chi^2| < 20$



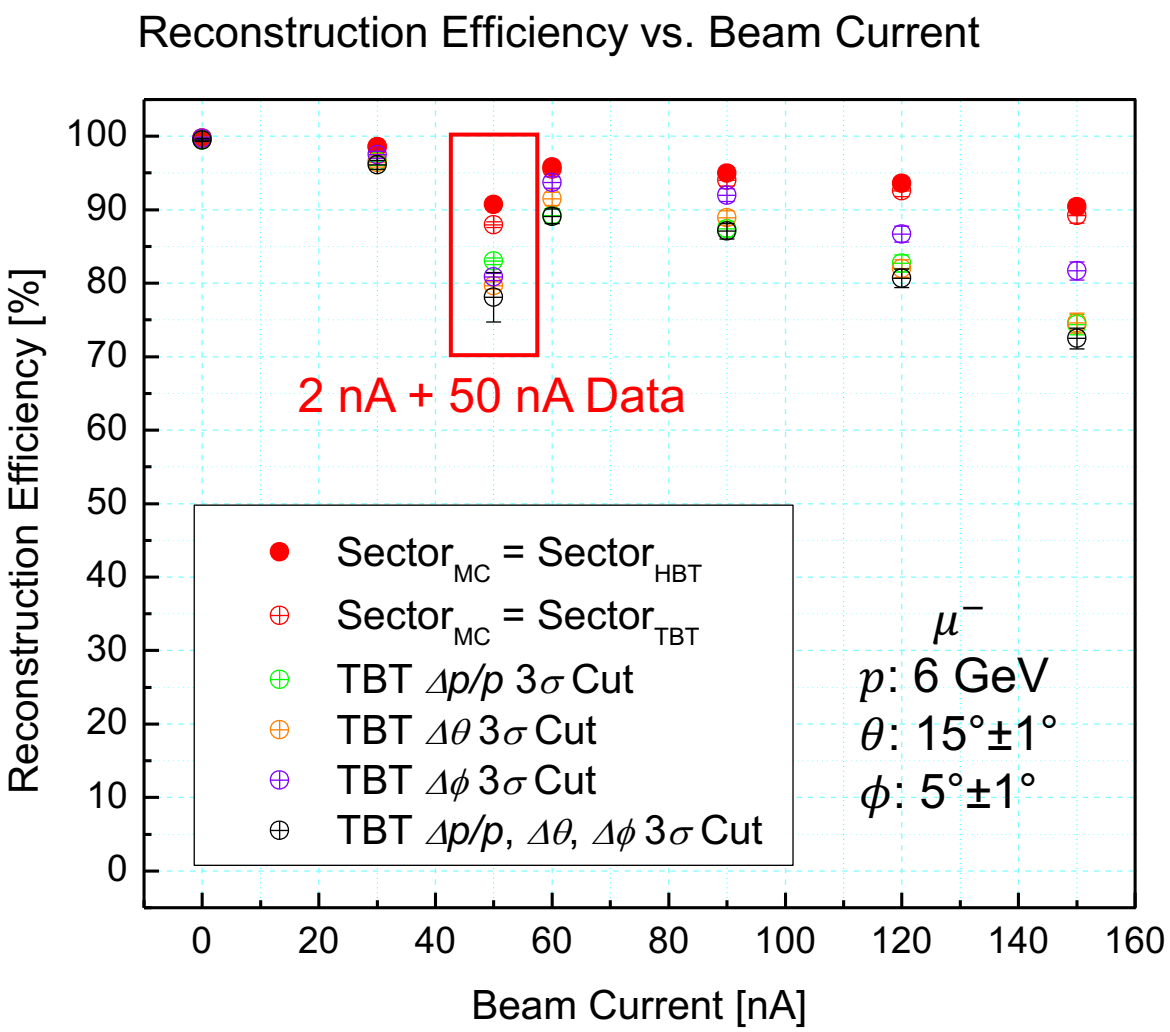


At I=0 nA rates are normalized to 1.

Took data at 55nA

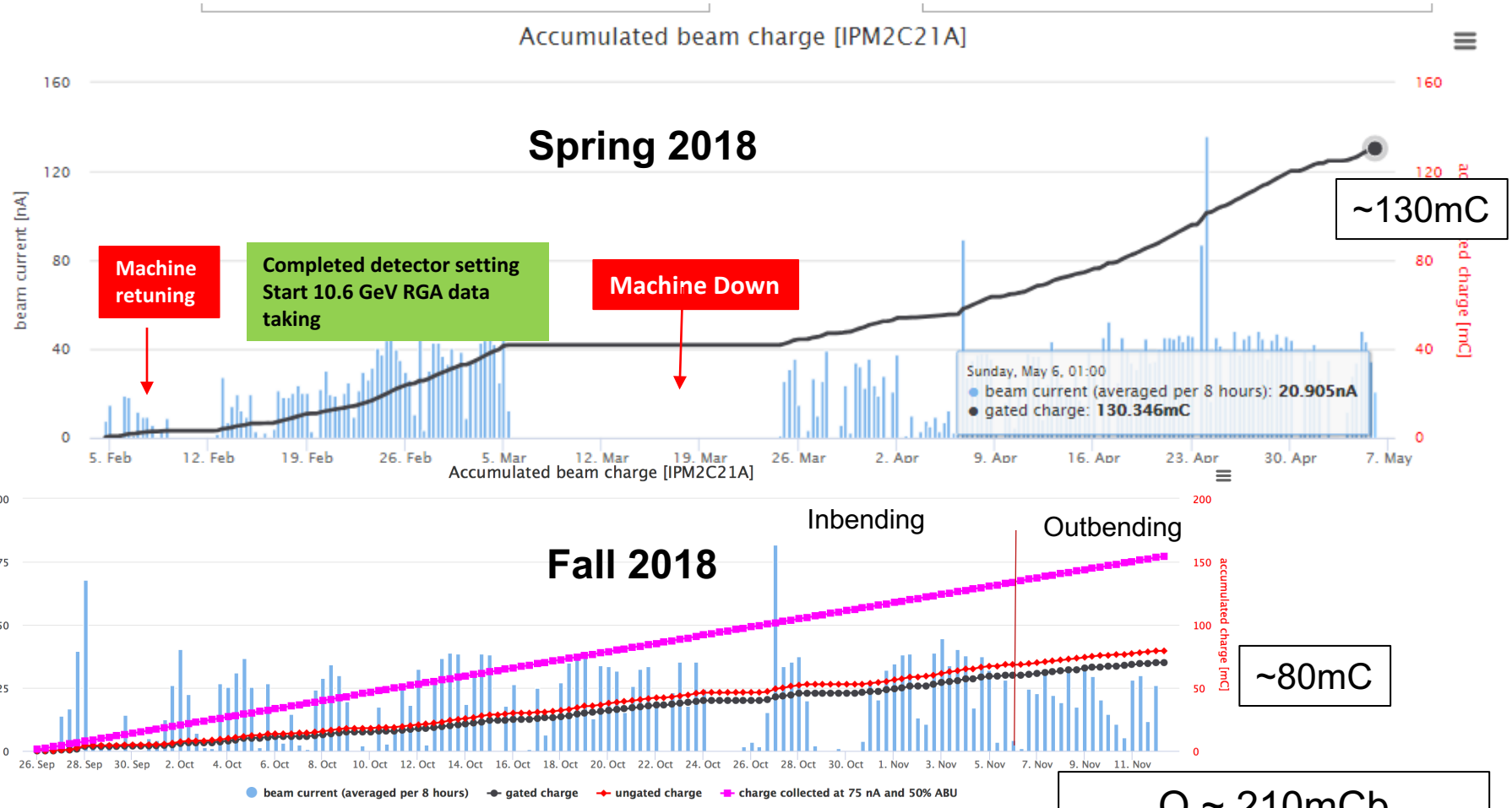
(See Stepan's Logbook CLAS12ANA entry 11/13)

Efficiency vs. Beam Current another method



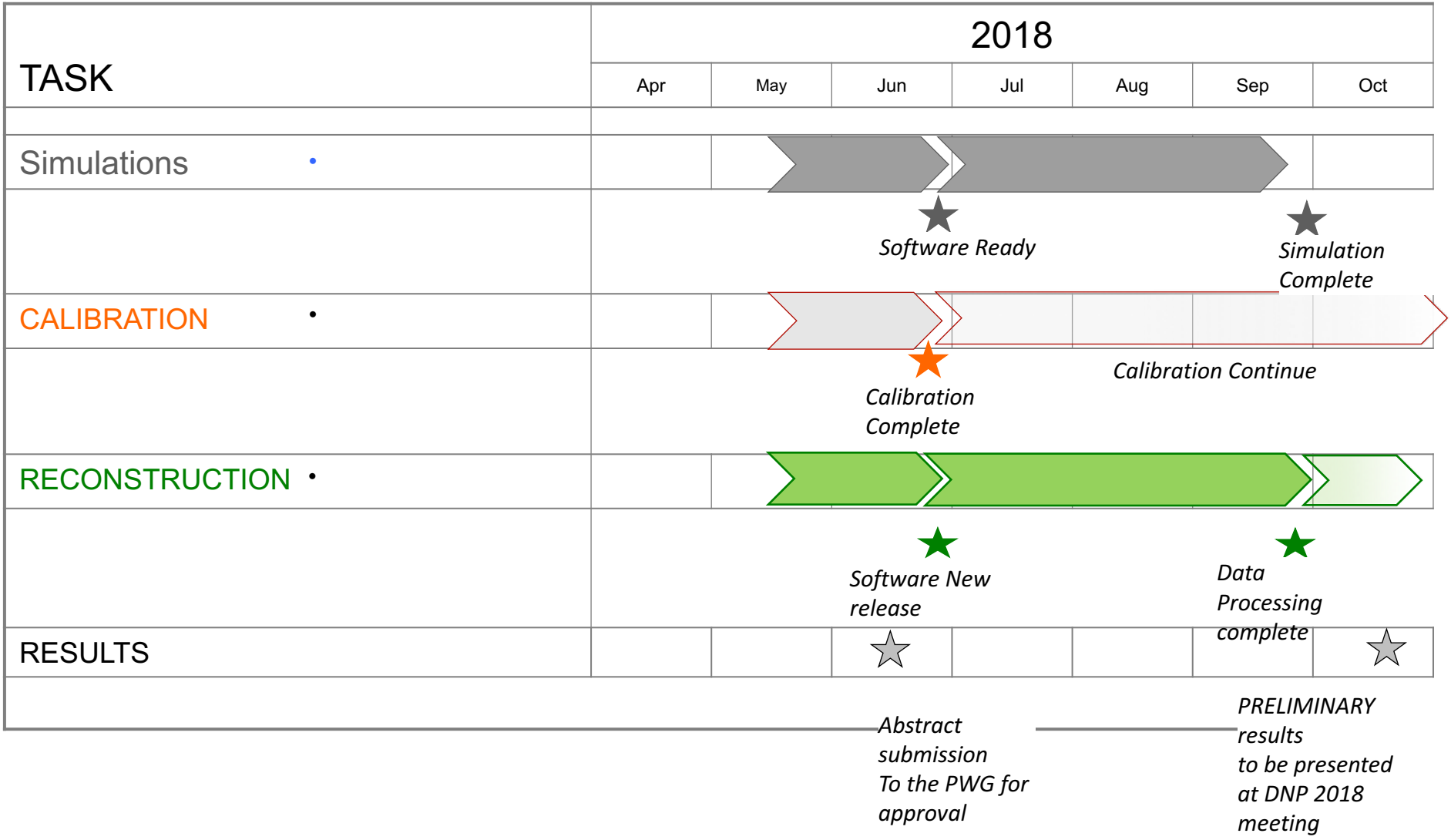
Being evaluated with latest tracking code and background in all detectors

RG-A Production Charge

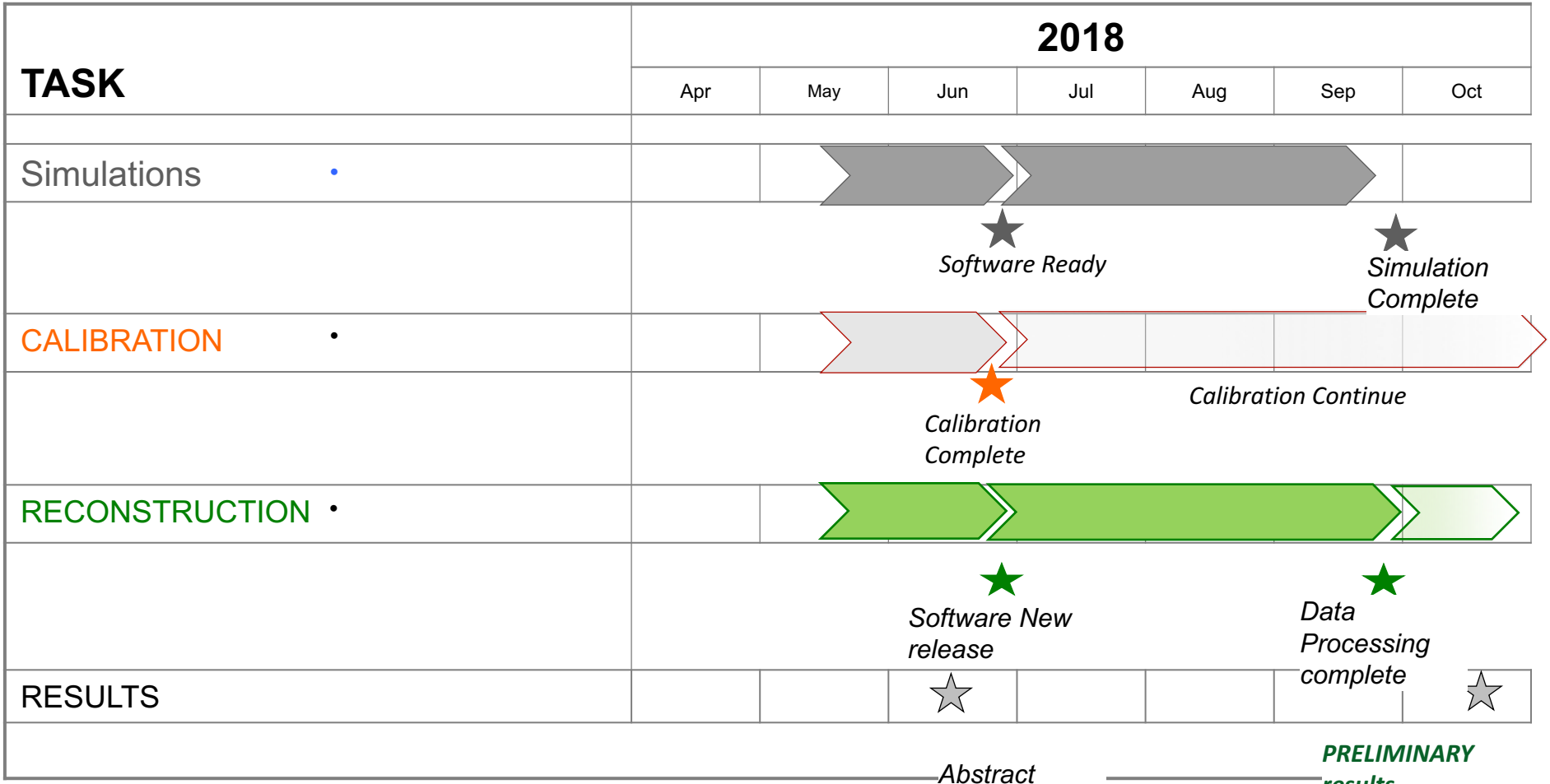


Q ~ 210mCb
expect total: 648mCb
Q/Q_{tot} ~ 32%

Timeline in preparation for the DNP



Timeline in preparation for the DNP



Achieved our goals except detector Alignment
Excellent presentations at the DNP!

CLAS12 First Experiment Calibration Status

Run	E_b (GeV)	I <nA>	Torus	Solenoid	Run Range	Period
2052	10.6	5	-85%	-100%	1900-2090	Spring
2091	10.6	10	-85%	-100%	2091-2139	Spring
2193	10.6	10	100%	-100%	2140-2365	Spring
2391	2.2	5	100%	-100%	2366-2597	Spring
3050	6.4	15	-100%	-100%	3000-3096	Spring
3105	6.4	10	75%	-100%	3097-3130	Spring
3222	10.6	25	100%	-100%	3131-3293	Spring
3432	10.6	50	-100%	-100%	3304-3862	Spring
3842	6.4	20	100%	-100%	3819-3861	Spring
4013	10.6	50	-100%	-100%	3862-4325	Spring
5036	10.6	45	-100%	-100%	5015-inf	Fall

Skims Currently in Place for Analysis trains

Skim #	Title	Description	Fraction*
Skim 1	J/ψ/TCS	Custom Wagon	0.0052
Skim 2	FT/π^0	$e^-\gamma\gamma$ in FT	0.0078
Skim 3	MesonX/VS	e^- in FT + 2 charged tracks	0.5489
Skim 4	Inclusive	e^- in the Forward Detector	0.3187
Skim 8	e^-P	e^- in FD Proton FD/Central	0.0874
Skim 9	$p\bar{p}$	$p\bar{p}$X	0.0321

CLAS12 Contributed talk 5th Joint Meeting of the APS DNP and the Physical Society of Japan

Title	Author(s)	Topic(s)	File(s)	Length	Edit
J/Psi Photoproduction Near Threshold	Joseph Newton	Physics	dnp_jpsi_jnewton.pdf	00:15	Edit
Search for Hidden-Charm Pentaquark with CLAS12	*Valery Kubarovsky*	*Physics*	*kubarovsky_DNP.pdf*	*00:15*	*Edit*
First Studies of Exclusive Reactions in the Resonance Region with CLAS12	Stefan Diehl	Physics	Diehl_DNP_excl...pdf	00:15	Edit
EE.00007: First Measurements of Inclusive Electron Scattering off Protons with CLAS12	Nick Markov	Physics	None	00:15	Edit
DNP di-hadron BSA talk and analysis note	Harut Avakian *et al.*	Physics	CLAS_Di_hadron...pdf DNPTalk2018Vos...pdf	00:15	Edit
SIDIS Pion Beam Spin Asymmetries with CLAS12 at 10.6 GeV	Stefan Diehl	Physics	Diehl_DNP_SIDI...pdf	00:15	Edit
Slides DNP Multiplicity pi0	Giovanni Angelini	Experiment	Slides Multiplicity	00:15	Edit
Exclusive ϕ Meson Electroproduction with CLAS12	Brandon Clary	Physics	clary_dmp_fina...pdf	00:15	Edit
DVCS at 10.6 GeV with CLAS12 at Jefferson Lab for DNP	Guillaume Christiaens	Physics Experiment	DVCSwithCLAS12...pdf	00:15	Edit
DVCS with JLab's CLAS12 at 6.4 GeV Polarized Electron Beam	Joshua Artem Tan	Physics	main_file ppt_version	00:15	Edit
TCS slides for DNP	Pierre Chatagnon	Physics	PresentationTCS.pdf	00:15	Edit

Session CK: Hadron Spectroscopy with Electron, Photon, and Hadron Beams I

Session EE: Mini-symposium: Photoproduction and Electroproduction of Hadrons I

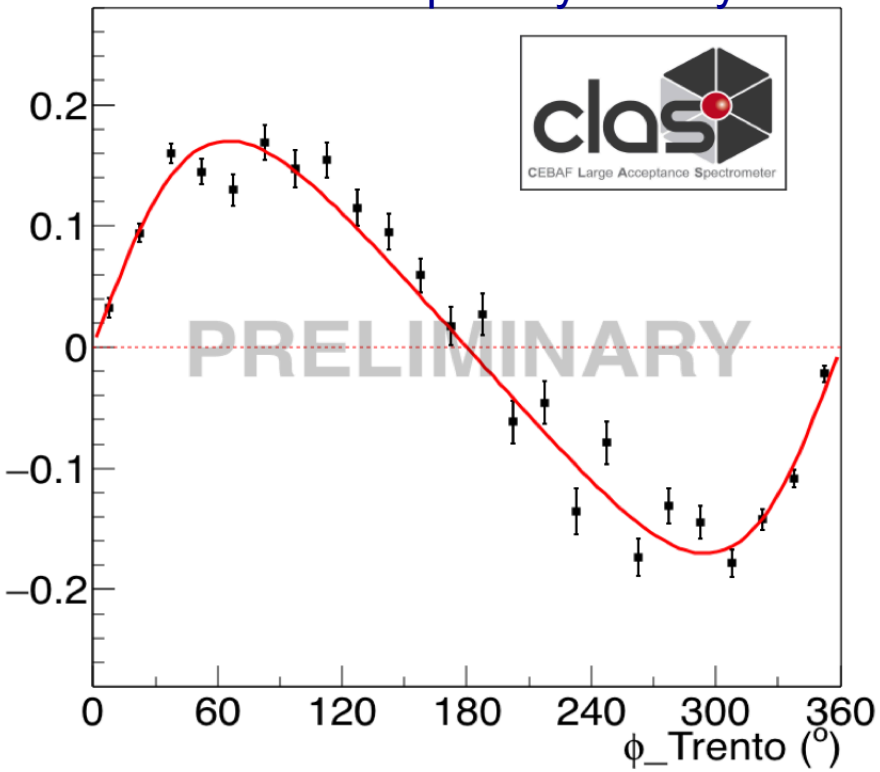
Session FE: Mini-symposium: Photoproduction and Electroproduction of Hadrons II

All the talks are posted on the CLAS12 First Experiment

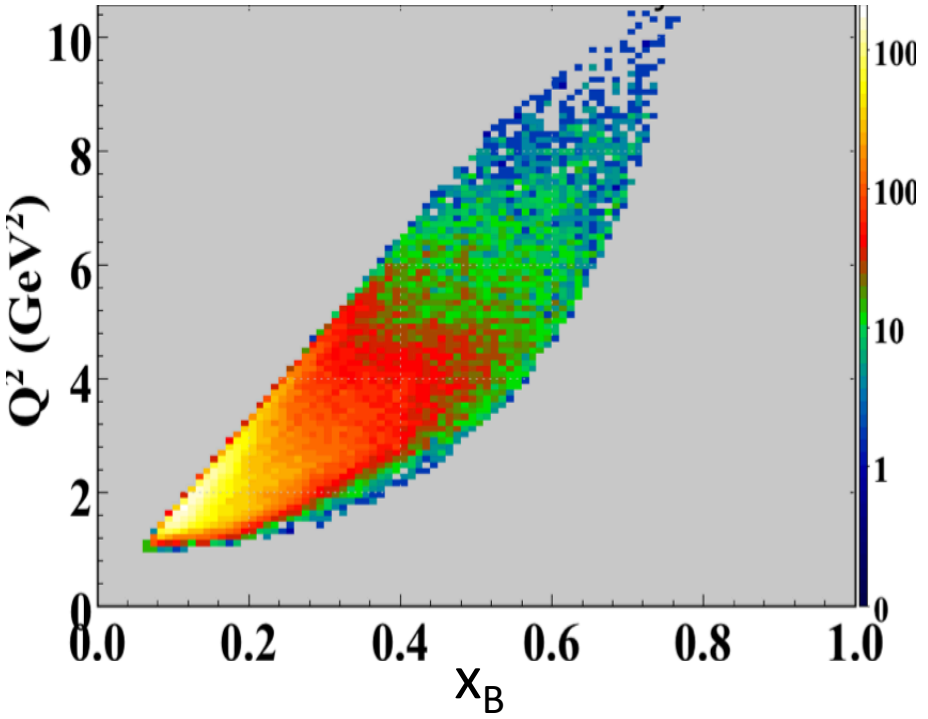
CLAS12 DVCS raw BSA

P_e=0.85 p(e,e'pγ)

beam spin asymmetry



kinematics after exclusivity cuts



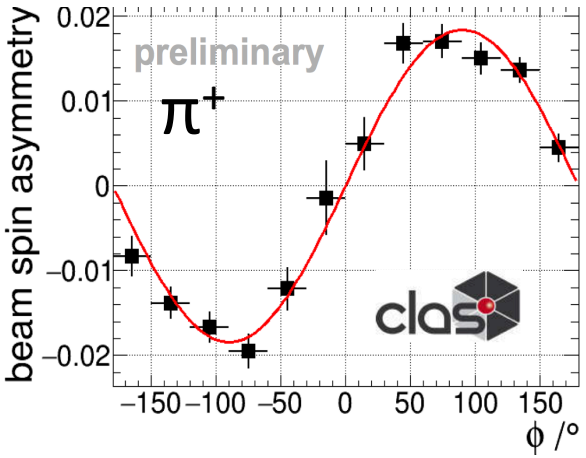
At same kinematics BSA at 10.6 GeV consistent with 6 GeV data
Preliminary data presented at DNP/JPS meeting in Hawaii 10/23-28

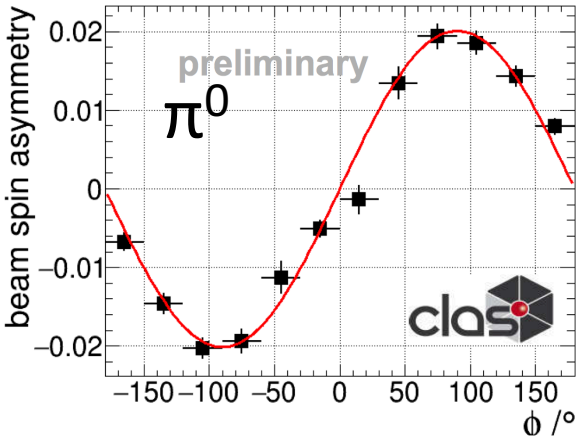
CLAS12 SIDIS raw BSA

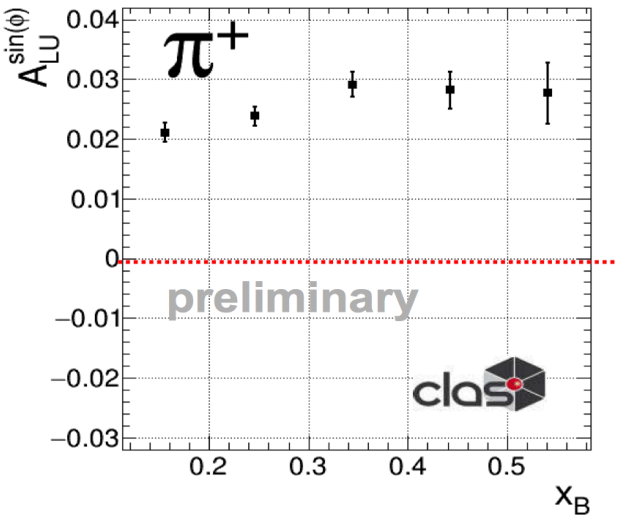
p(e,e'π)X

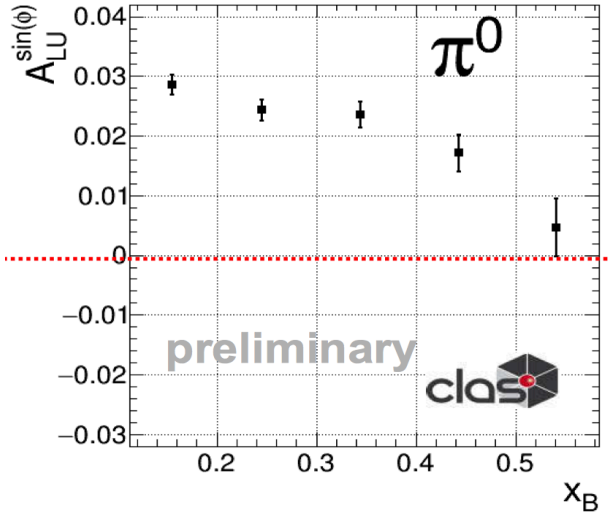
Input to TMD program to extract 3D images in quark momentum space.

$0.3 < z < 0.7$









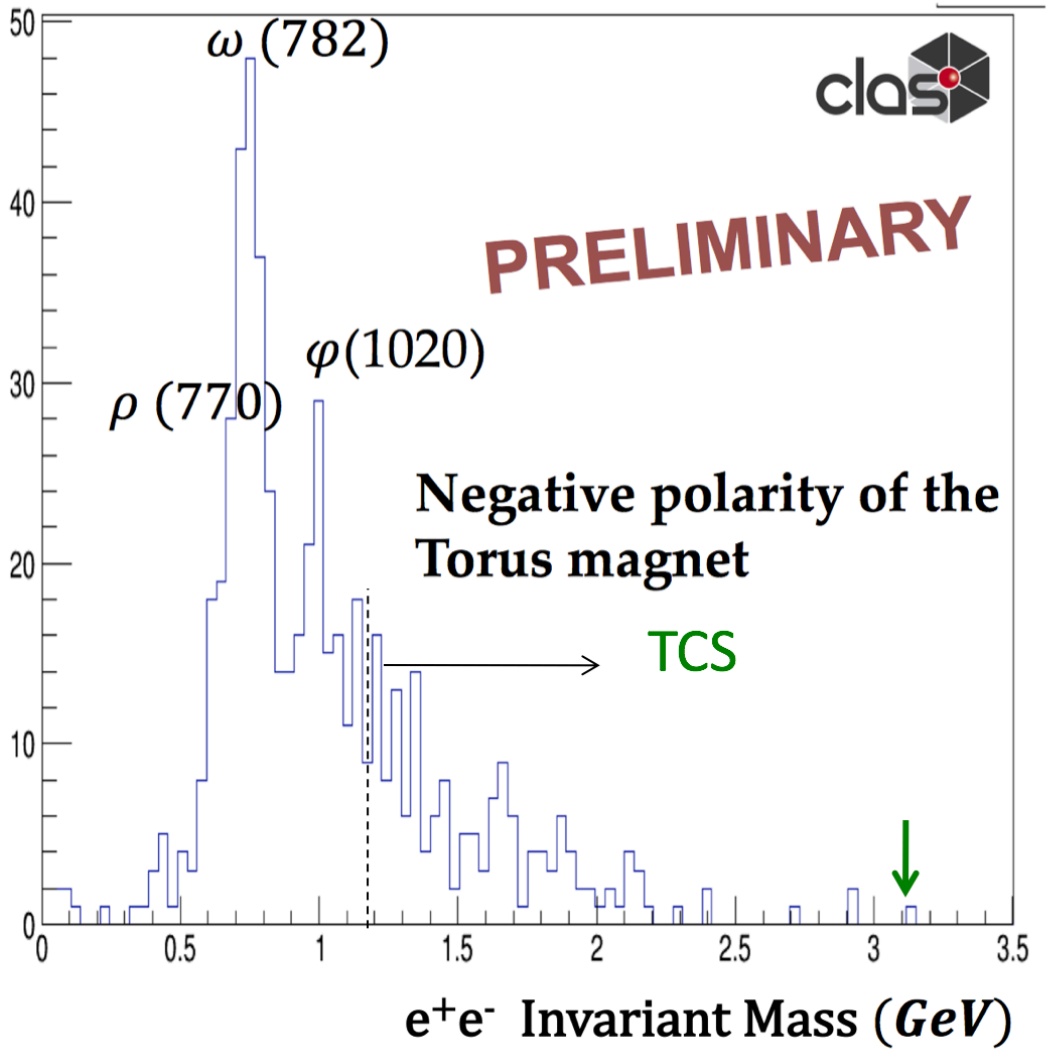
Measure small asymmetries with precision
=> Enables binning in several kinematical quantities

CLAS12 Time-like Compton Scattering

$$ep \rightarrow e^+e^-p'(e')$$

TCS complements DVCS as it enables direct access the real part of the Compton amplitude.

Narrow vector mesons (ω,ϕ) seen at right masses … waiting for J/ψ.



Remaining issues/Decisions

- CLAS12 geometry and alignment
- Understanding/quantifying detector efficiency
- Event reconstruction efficiency
- Tracking with the FMM ?
- RICH reconstruction and PID
- LTCC calibration
- Particle identification
- Documentation

Remaining issues/Decisions

- CLAS12 geometry and alignment
- Understanding/quantifying detector efficiency
- Event reconstruction efficiency
- Tracking with the FMM ?
- RICH reconstruction and PID
- LTCC calibration
- Particle identification
- Documentation

CLAS12 First Experiment Requirement

In addition to the detector complete new calibration and alignment, many experiments require absolute normalization, therefore we need to monitor and control as function of time:

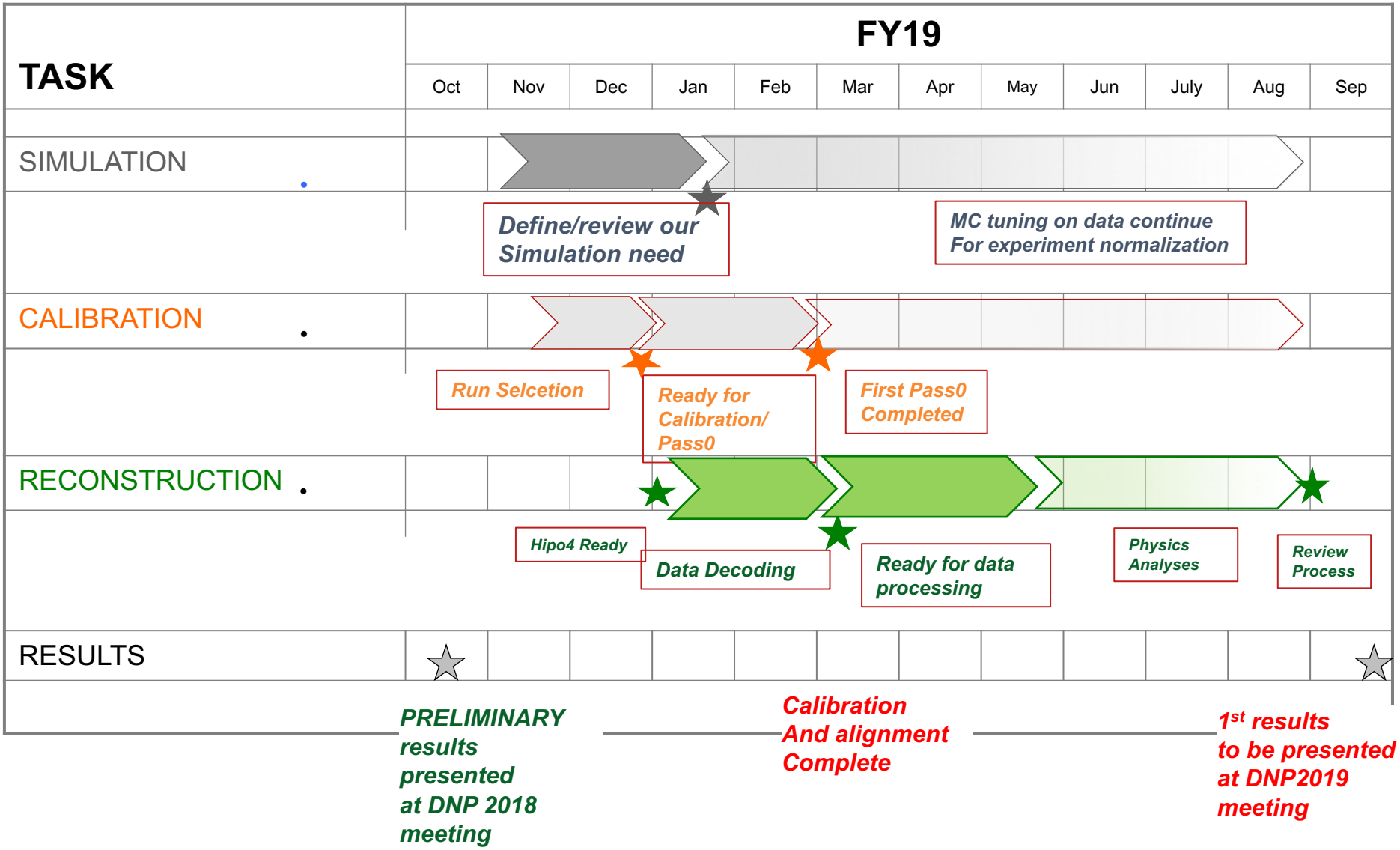
- Detector efficiency
- Event reconstruction efficiency as function of beam current
- Accumulated charge
- Target length and density
- Beam Polarization
- Acceptances
- Physics background contributing to the signal
- Realistic Monte Carlo Simulations
- Radiative corrections
- Others

All of this requires normalization validated with known cross-sections such as elastic, inclusive inelastic as has been done with CLAS

Towards Physics from Spring Run

- Validated release
- Calibration and alignment of CLAS12
- Magnetic Field
- Calibration organization manpower and procedures
- Particle Identification
- Kinematical corrections
- Kinematical fitting
- Good run selection (develop method/procedure)
- Assign Chef for spring data
- Validation/monitoring procedures organization
- Data Processing/trains
- Disk space requirement
- Data analysis Hipo/root what information we should keep
- Tracking efficiency, methods and procedures
- CLAS12 efficiencies as function of time Detector and Trigger
- Required simulations to understand/study detector performances
- Required simulations for physics analysis
- Offsite simulation needs
- **Detailed schedule with milestones towards physics from spring data and keeping up with the fall data and preparing for the next spring data**
- **Communication**
- **Documentation/Web page/Wiki**

Schedule towards Releasing Physics Results



Summary

- **Excellent progress has been made on all fronts from online data taking to physics analysis:**
  - Full chain for all major physics processes
  - Excellent presentations at the DNP meeting

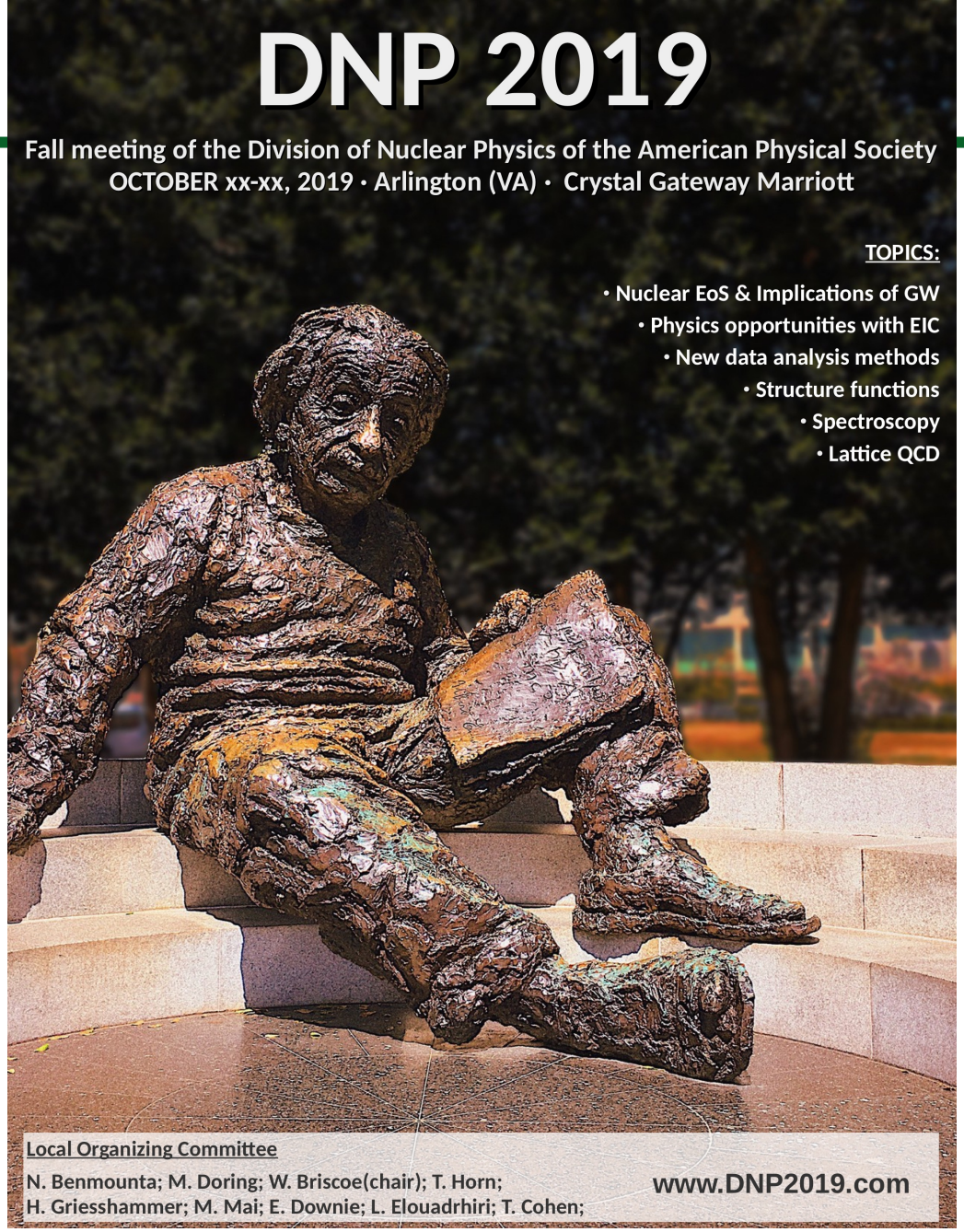
- **Now we need to re-define our work plan for next 10 months!**
  - Focused effort on systematic studies in coordinated way
  - Parallel efforts, close coordination
  - Detailed schedule with milestones towards physics from spring data
  - Plan in place to keep up with the fall data calibration and preparing for the next spring data taking

- **Need to start working with the theorist on high level analysis and physics extractions**

TEAM WORK!

DNP 2019

Fall meeting of the Division of Nuclear Physics of the American Physical Society
OCTOBER xx-xx, 2019 · Arlington (VA) · Crystal Gateway Marriott



TOPICS:

- Nuclear EoS & Implications of GW
- Physics opportunities with EIC
- New data analysis methods
- Structure functions
- Spectroscopy
- Lattice QCD

Local Organizing Committee

N. Benmounta; M. Doring; W. Briscoe(chair); T. Horn;
H. Griesshammer; M. Mai; E. Downie; L. Elouadrhiri; T. Cohen;

www.DNP2019.com