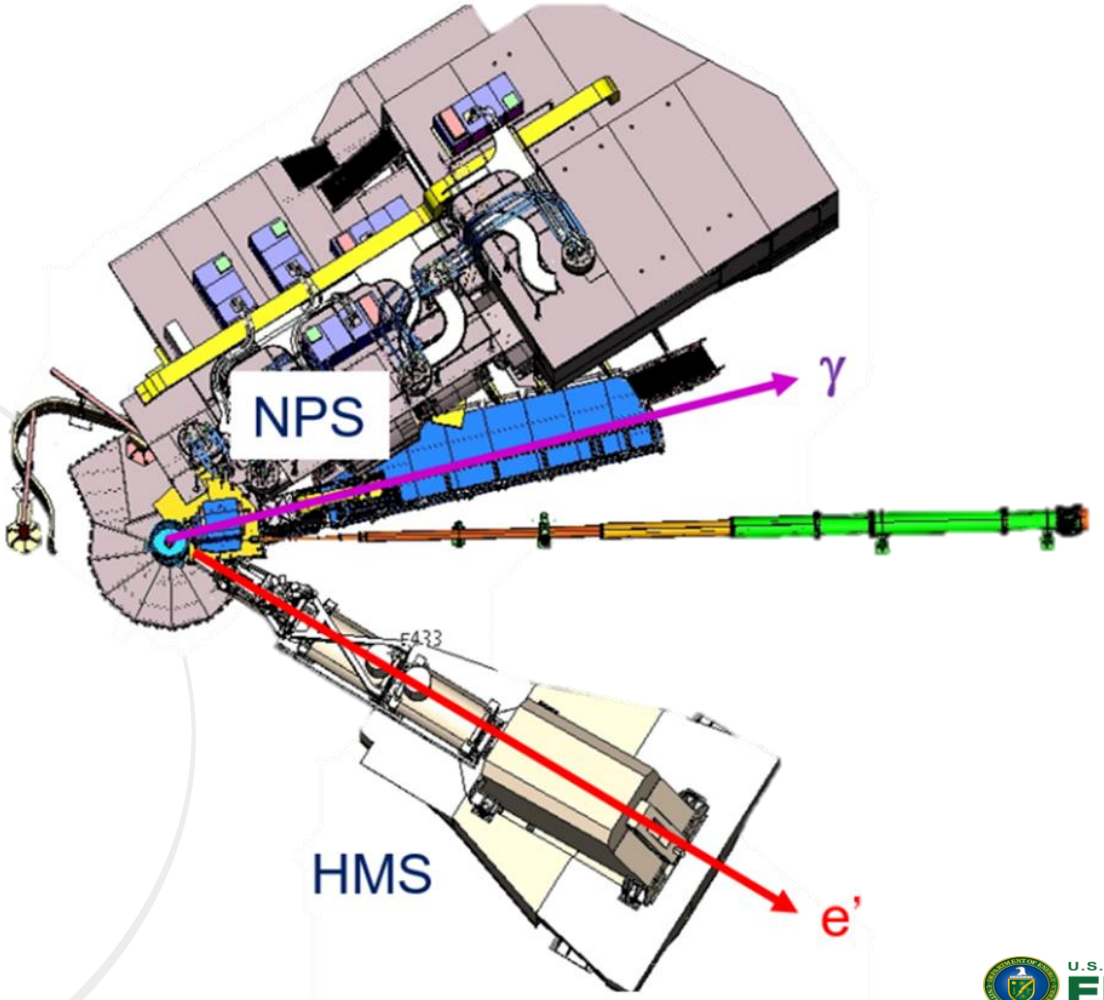
Hall C Status

APS April Meeting



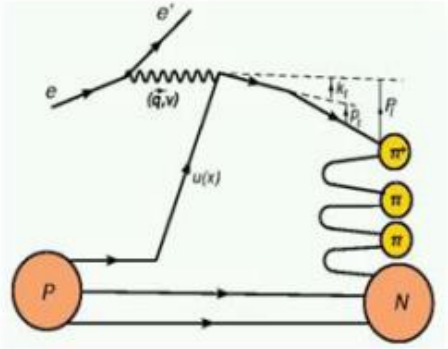
Hall C science of the currently running experiments

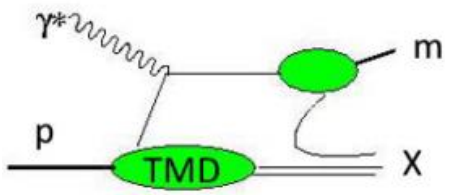
E12-13-007 & E12-23-014

E12-13-007 goal: Measure the basic SIDIS cross sections of π^0 production off the proton, including a map of the P_T dependence ($P_T \sim \Lambda < 0.5$ GeV), to validate(*) flavor decomposition and the k_T dependence of (unpolarized) up and down quarks

Linked to framework of *Transverse Momentum Dependent Parton Distributions*

Transverse momentum widths of quarks with **different flavor (and polarization)** can be different





$TMD^q(x,k_T)$

$P_T = p_t + z\,k_t + O(k_t^2/Q^2)$

PR12-23-014 expands on 12-13-007 (24 days) to include

- All three beam energies (not just 10.6 GeV)
- Both proton and deuteron targets

What it adds to JLAB12 SIDIS program:

- Precision measurement of R_{SIDIS} on π^0
- Precision proton/deuteron π^0 multiplicity ratios
- Larger Q^2 compared to CLAS12 for beam asymmetries, etc.

E12-13-010 (LH2) & E12-22-006 (LD2)

Simplest process: e + p → e' + p + γ (DVCS)

E12-13-010 DVCS measurements follow up on measurements in Hall A:

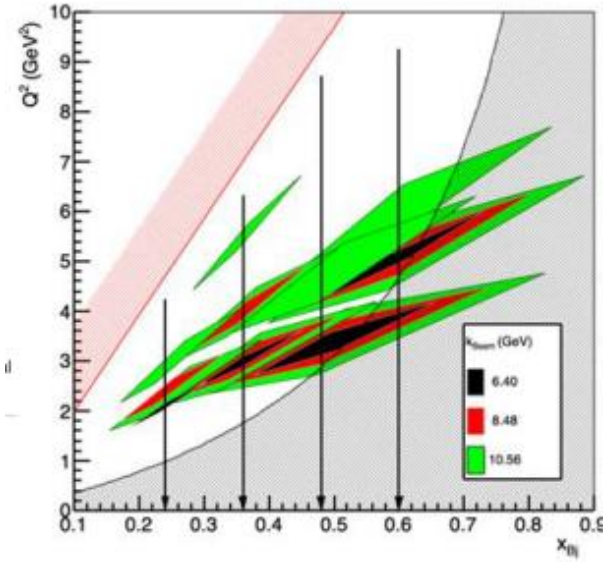
- Scaling of the Compton Form Factor
- Rosenbluth-like separation of DVCS:

$$\sigma = |BH|^2 + \mathrm{Re}\left[DVCS^{\perp}\ BH\right] + |DVCS|^2$$

($DVCS^{\perp} \sim E_{beam}^2$, $|DVCS|^2 \sim E_{beam}^3$)

- L/T separation of π^0 production

DVCS NPS/HallC/JLab 2023-2024



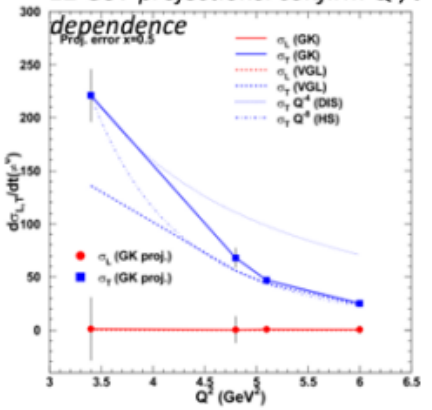
Projected Impact on flavor dependence of CFFs

- *Simultaneous fit of E12-13-010 (p) and E12-22-006 (n)*
- *Real and imaginary parts of CFFs H and $\tilde{H}$ and E (u & d) as free parameters (nDVCS not sensitive to $\tilde{E}$)*

π^0 Exclusive Cross Sections

- Relative L/T contribution to π^0 cross section important in probing transversity
- Results from Hall A at 6 GeV Jlab suggest that the longitudinal cross section in π^0 production is non-zero up to Q^2=2 GeV²

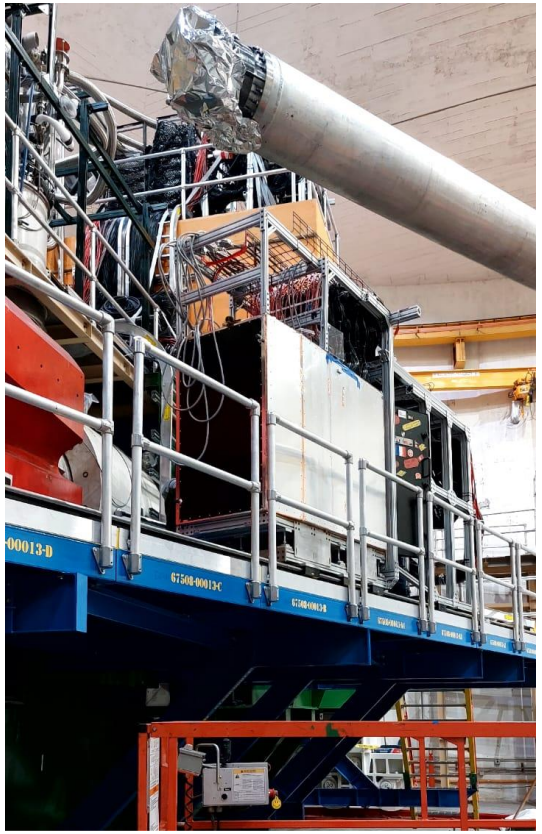
12 GeV projections: confirm Q^2/t dependence

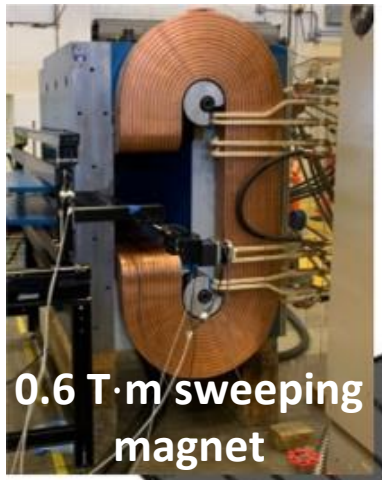


E12-13-010 provides also data on σ_T and σ_L at higher Q^2 for reliable interpretation of 12 GeV GPD data

Neutral Particle Spectrometer (NPS)

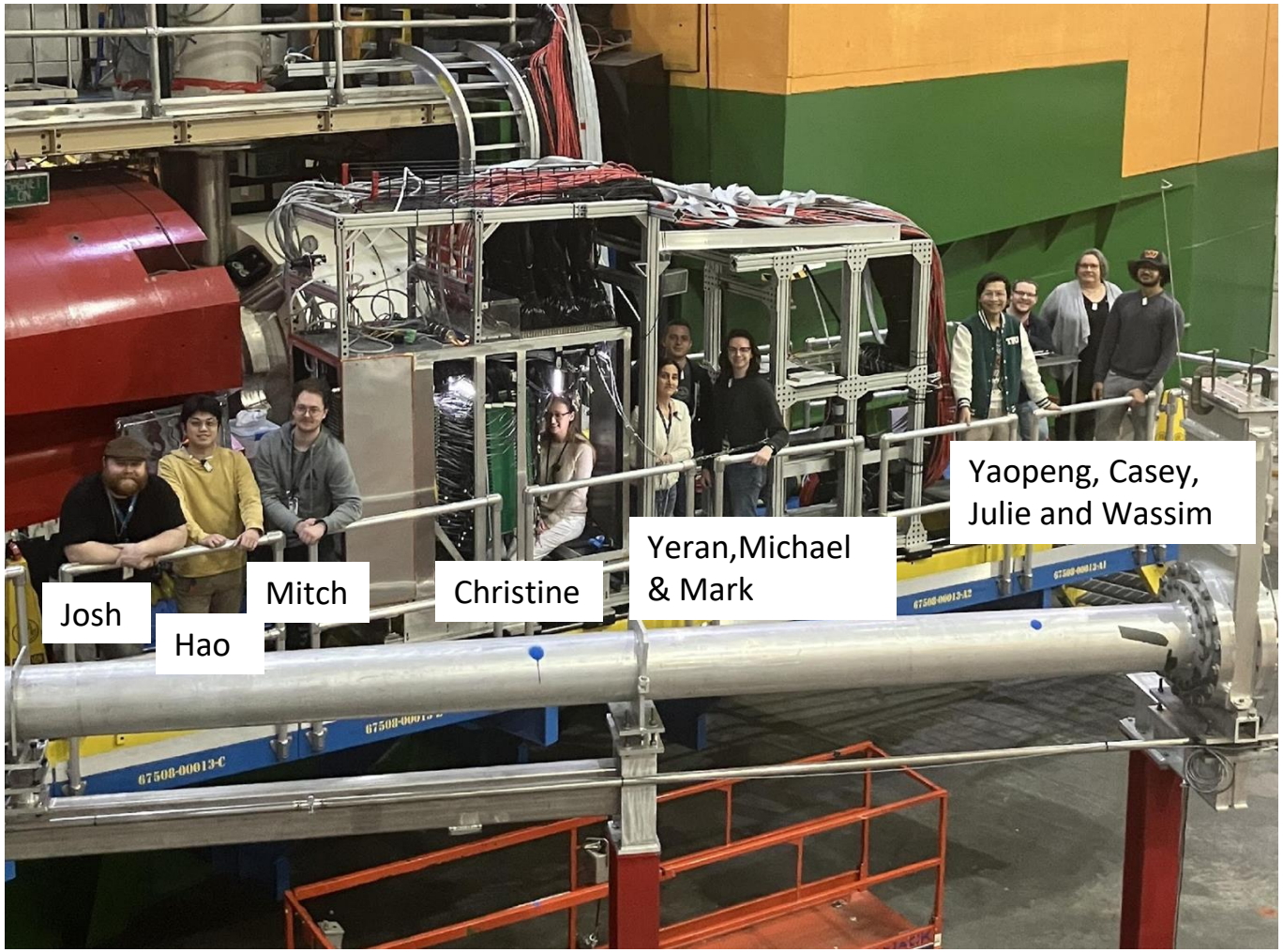
- 1080 $PbWO_4$ crystals
- 0.6 Tm sweeping magnet
- F250ADC sampling electronics
- Large opening angle beam pipe
- SHMS as carriage for rotation





Ongoing Hall C experiments using NPS

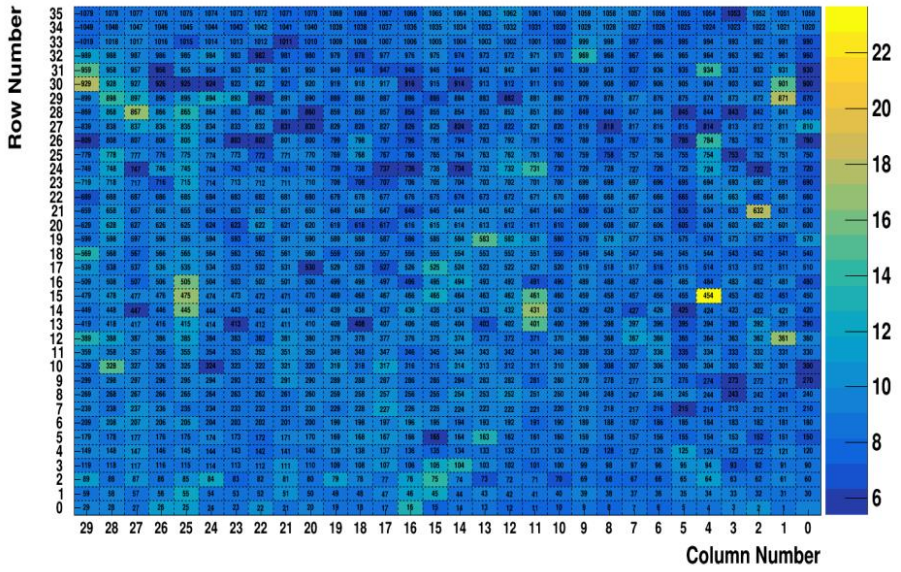
- E12-13-010 and E12-22-006
  - Exclusive Deeply Virtual Compton on proton and neutron
  - The exclusive π^0 electroproduction cross section and a longitudinal/transverse separation.
- E12-13-007 and E12-23-014
  - SIDIS p(e,e',π^0) cross section. Map the transverse momentum dependence and test of factorization.
  - Measure $R=\sigma_L/\sigma_T$ in SIDIS p(e,e',π^0) cross section.



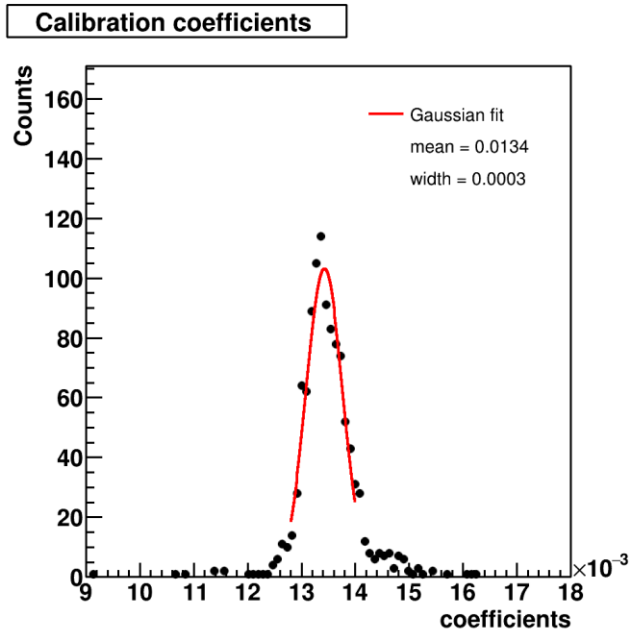
NPS experiments are running well

- Big effort to get all 1080 NPS blocks ready.
  - Large group installed the DAQ hardware, cabling, NPS hardware.
  - Needed modification to all HV/LV/signal distribution boards.
- Commissioning went well.
  - Software and calibration tools were ready.
  - First time in Hall C using CODA3 with FADC trigger for NPS in coincidence with HMS.
  - As always there are difficulties running experiments, but all encountered so far have been useful learning opportunities.

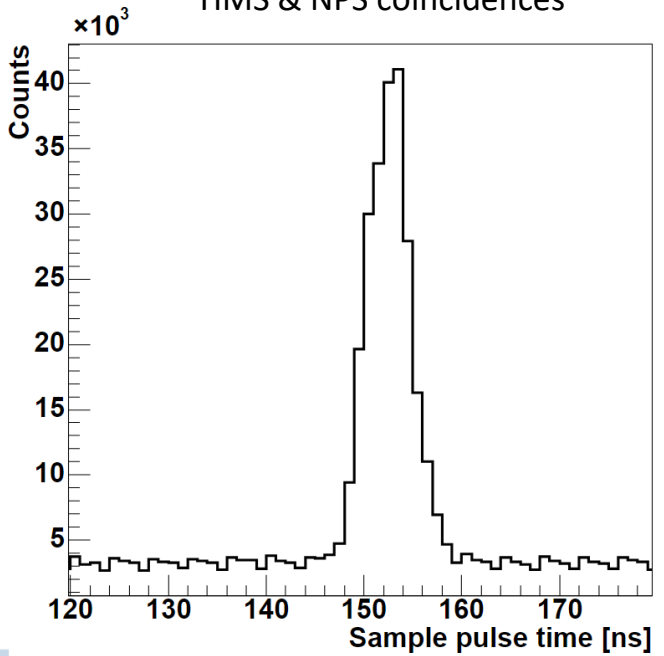
Cosmic run: mean amplitude per channel (mV)
All 1080 channels operational



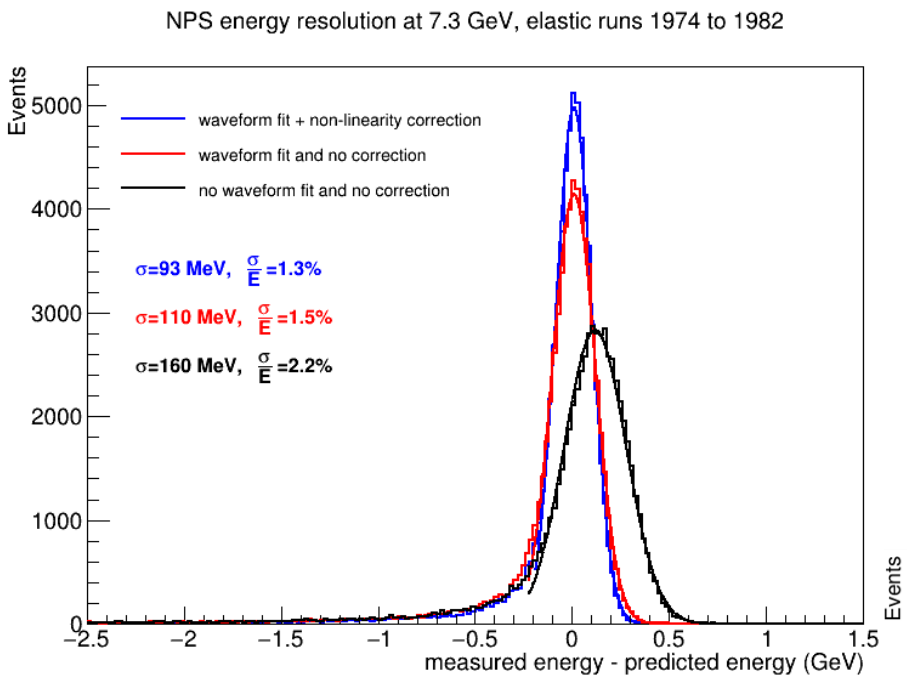
Initial calibration using elastics



FADC time distribution:
HMS & NPS coincidences



NPS calorimeter resolution

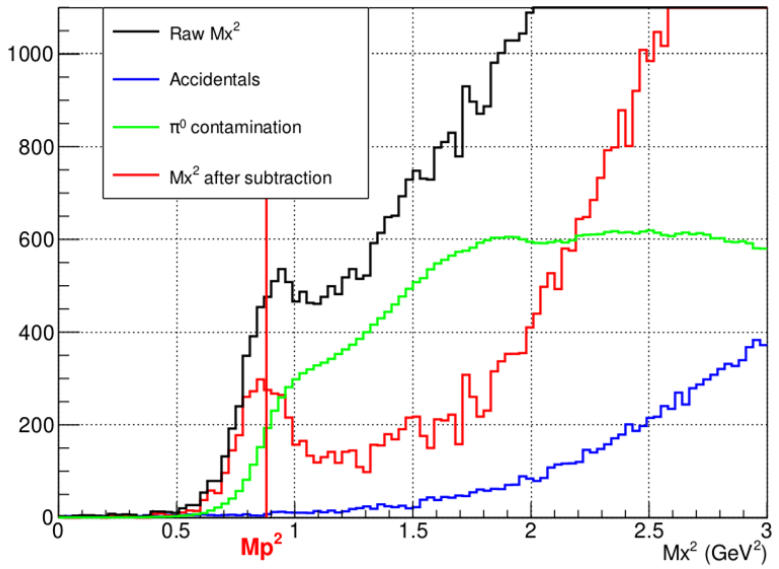


From elastic calibration (with p' in HMS and e' in calorimeter):

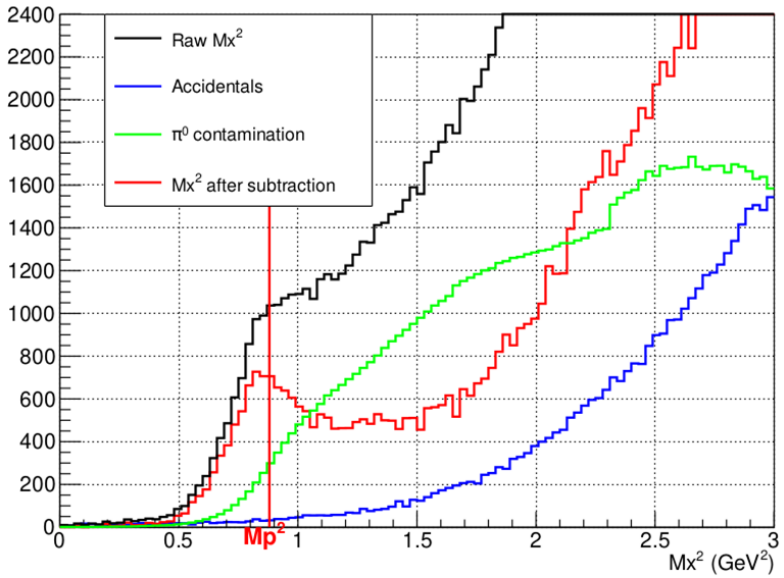
- **1.3% Energy resolution at 7.3 GeV**
- Compatible with previous PrimEx results:

$$\sigma/E = 0.009 \oplus 0.025/\sqrt{E} \oplus 0.010/E$$

Hydrogen Missing Mass Squared (Mx^2)



Deuterium Missing Mass Squared (Mx^2)

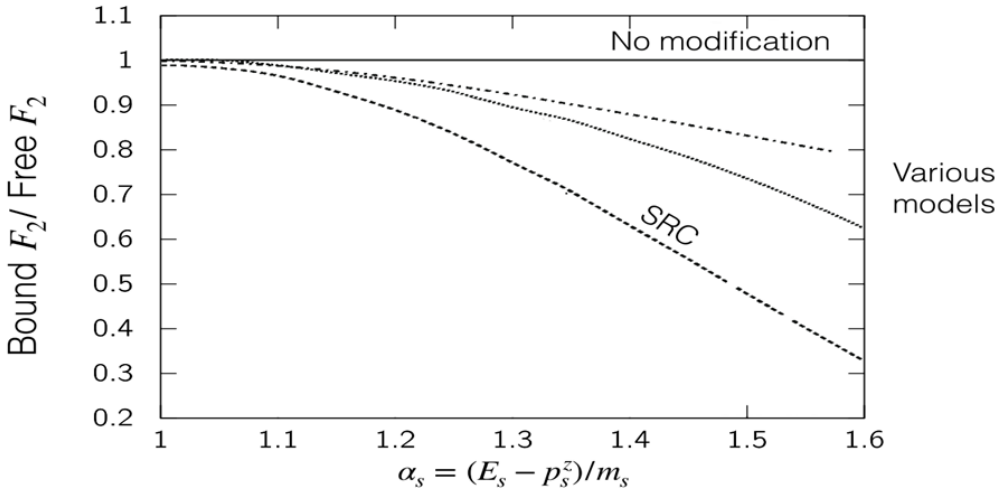


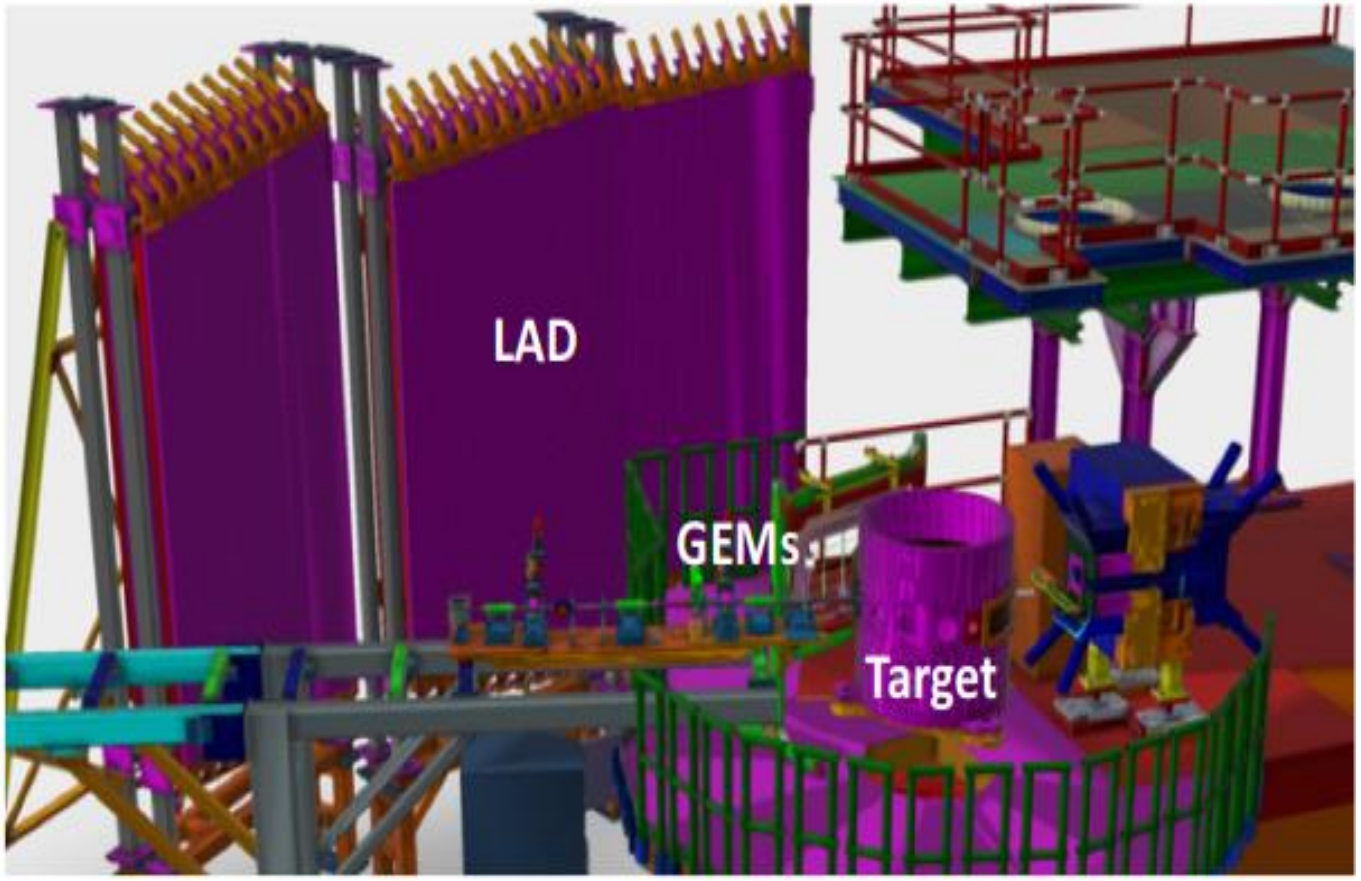
- Waveform analysis of PMT signals is crucial to obtain good energy resolution
- Clean invariant and exclusive peaks for π^0 production
- Analysis of DVCS channel ongoing

Upcoming Experiments

E12-11-107 LAD experiment

- Spectator tagged DIS d(e,e'ps)
  - Install Large Angle Detector
  - HMS/SHMS detect electron
- Does the EMC Effect depend on nucleon virtuality?
- Measure Bound F_2 by tagging the SRC proton in D(ee'p) DIS and look for nuclear effects
- Will provide crucial information needed for identifying the origin of the EMC Effect

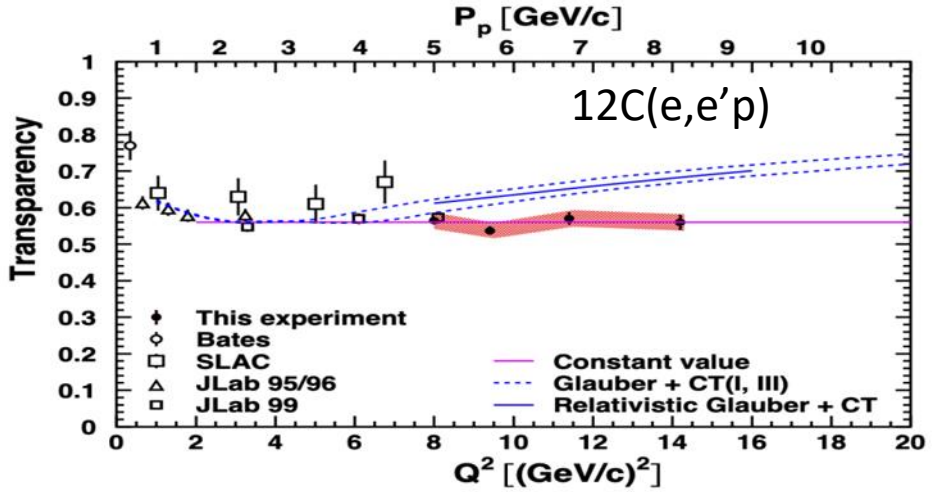




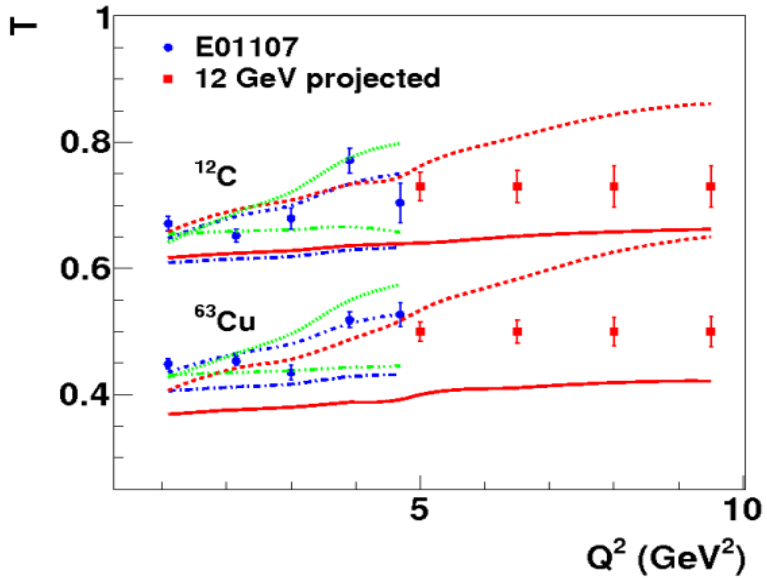
E12-06-107 Complete CT experiment

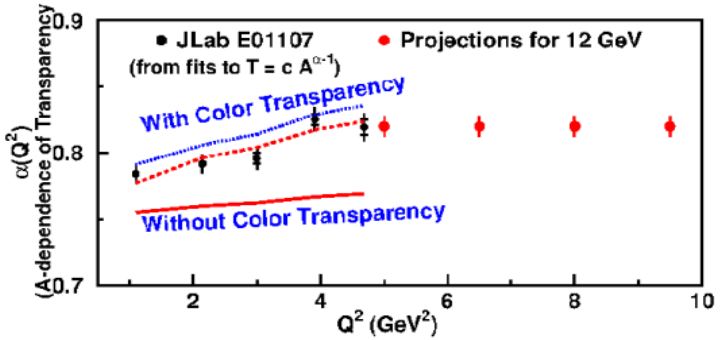
No Sign of Color Transparency for Protons Traversing Nuclei

- Unique prediction of QCD is that hadrons can be produced as a point like configurations in nuclei.
- CT is seen in other reactions.
- Phys. Rev. Lett. 126, 082301 (2021).



- Complete the experiment
- Measure Color Transparency in A(e,e π)
- Will the trend from earlier data continue?



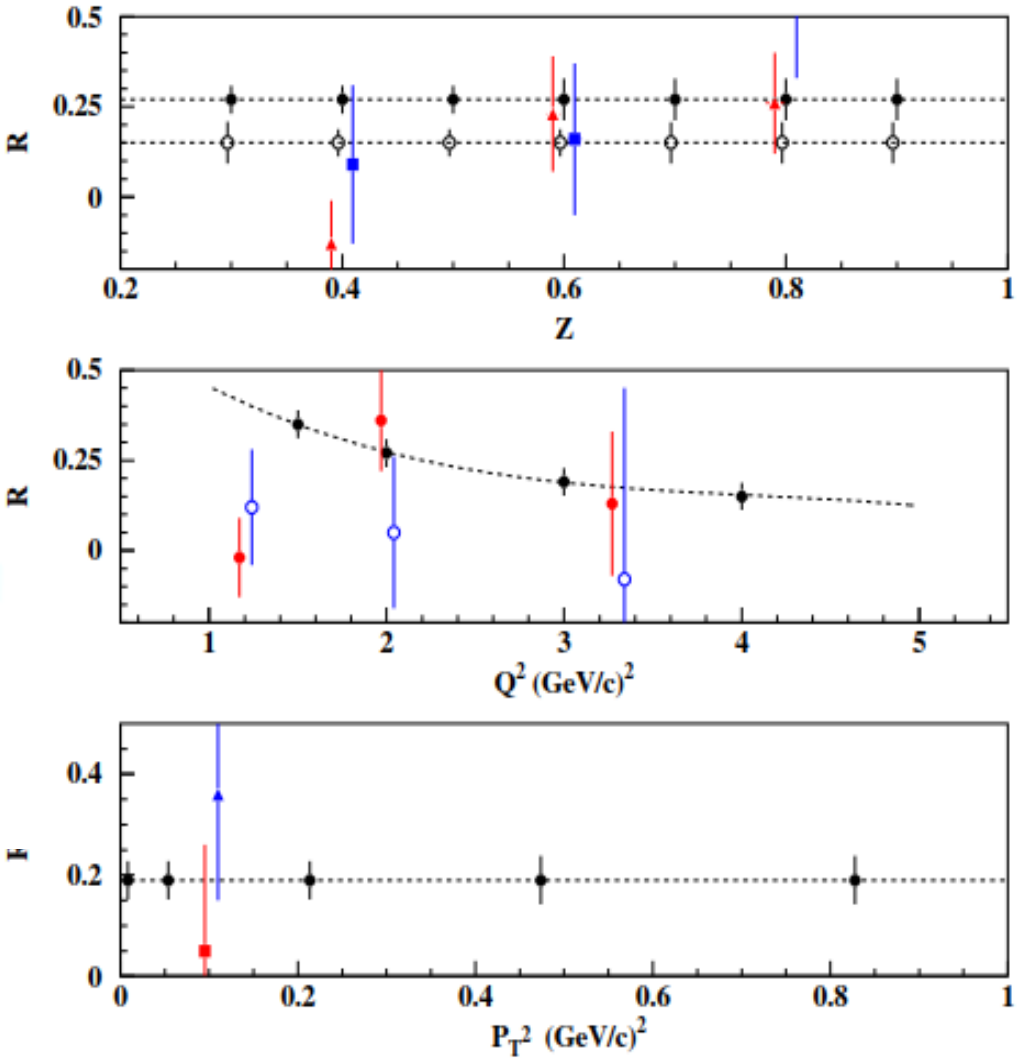


E12-06-104 R SIDIS

R=σ_L/σ_T in SIDIS charge pions

- Verify whether $R_{SIDIS} = R_{DIS}$.
- Check the z-dependence of R from the semi-inclusive to the exclusive region.
- Verify that R_{SIDIS} anneals to R_{DIS} at large p_T.
- Verify if R_{SIDIS} follows the Q^2 dependence of R_{DIS}, at two values of x.
- Verify that $R^{\pi^+}_{SIDIS} = R^{\pi^-}_{SIDIS}$ and $R^{H}_{SIDIS} = R^{D}_{SIDIS}$.
- With a factor of ten reduced statistics: map R^{K+}_{SIDIS} and R^{K-}_{SIDIS}.

- Map $R^{H}_{SIDIS} + R^{D}_{SIDIS}$ as function of z at $x = 0.2$ and $Q^2 = 2.0$ GeV^2 **(168 Hours)**
- Map R^{H}_{SIDIS} as a function of z at $x = 0.4$ and $Q^2 = 4.0$ GeV^2 **(319 Hours)**
- Map R^{H}_{SIDIS} as a function of p_T^2 at $x = 0.3$ and $Q^2 = 3.0$ GeV^2 **(311 Hours)**
- Add kinematics to map R^{H}_{SIDIS} for $Q^2 = 1.5$-5.0 GeV^2 **(88 Hours)**

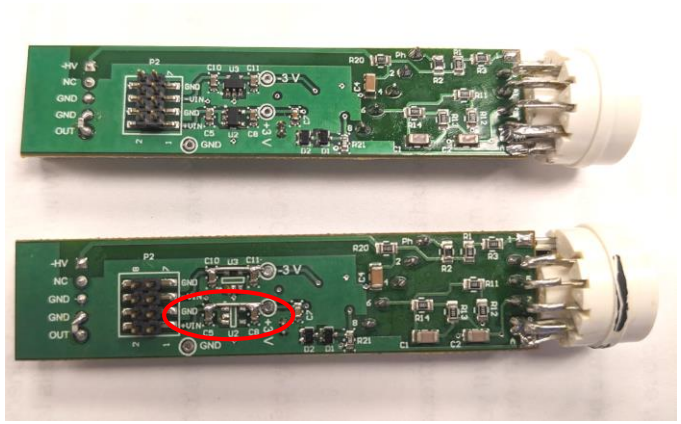


Thank you for your time

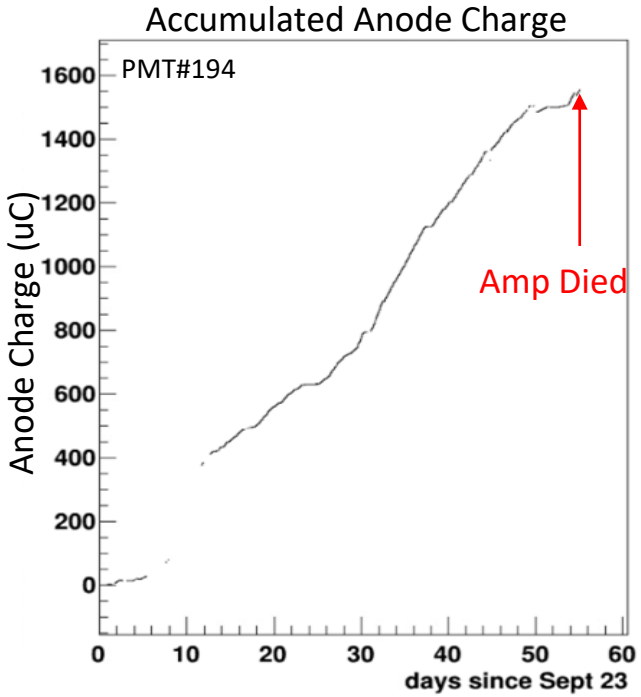
Backup Slides

Radiation damage

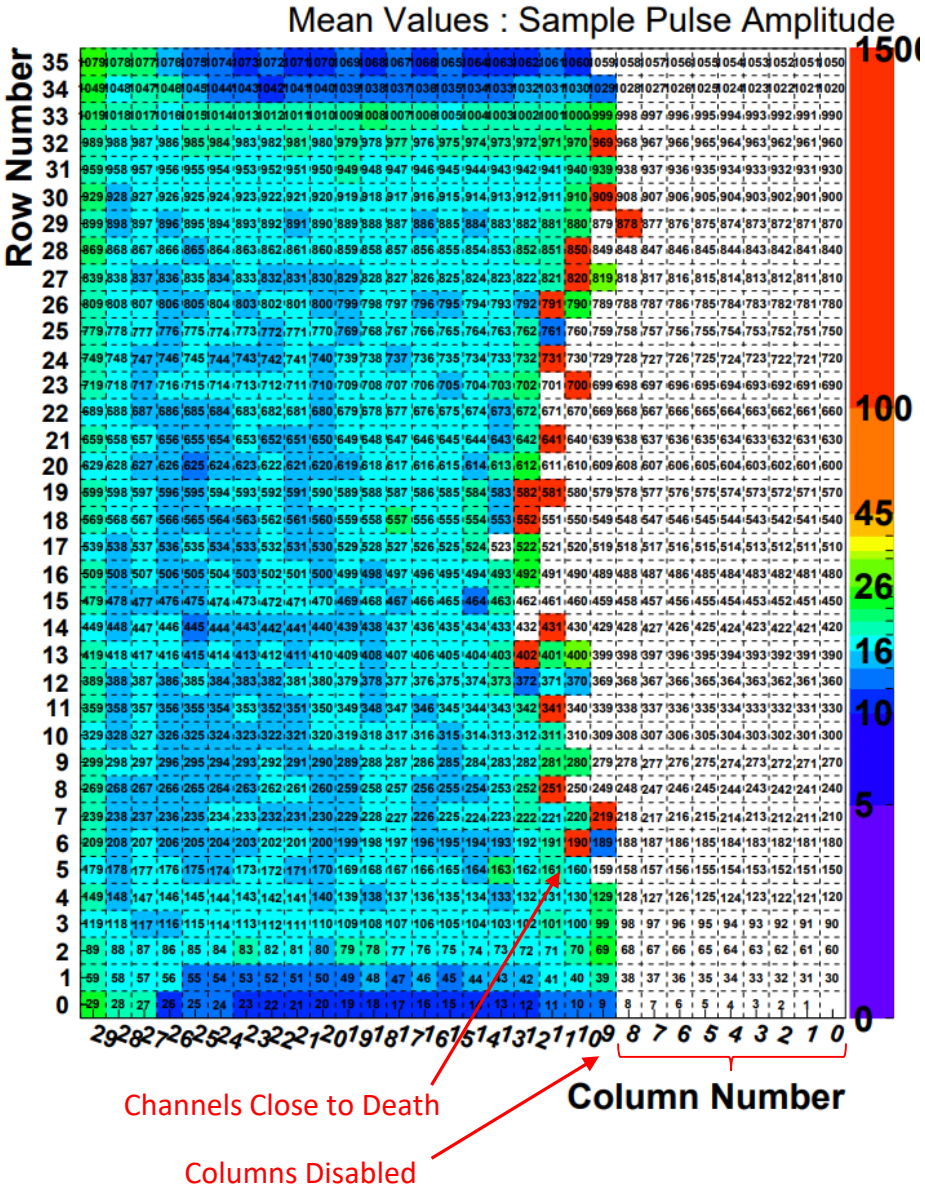
- Radiation damage identified to the LV regulators on the PMT divider pre-amps
- Damaged amplifiers cause instability in the LV power supply for all channels in the column
- Regions at beam height die faster (by December ≈1/3 of the detector was damaged)
- Accumulated anode charge provides information on when bases will die



Top:Original Bottom: Bypassed Amplifier



Detector status before Winter down



Run status

Kinematic Setting	Pass	SHMS Theta (deg)	NPS Theta (deg)	Revised Coulomb Goal Per Target
KinC_x36_1	3			1.20
KinC_x36_2	4	30.66	14.36	1.10
KinC_x36_2'	4	28.76	12.46	1.10
KinC_x36_2''	4	32.90	16.60	1.10
KinC_x36_3	5	32.26	15.96	0.60
KinC_x36_4	4			2.70
KinC_x36_5	5	28.42	12.12	1.40
KinC_x36_5'	5	30.30	14.00	0.50
KinC_x36_6	5	23.70	7.40	4.30
KinC_x50_0a	3	30.300	14.00	2.00
KinC_x50_0b	3	33.91	17.61	2.00
KinC_x50_0	3			
KinC_x50_1	4	35.29	18.99	1.90
KinC_x50_1'	4	33.38	17.08	1.90
KinC_x50_2	5	36.88	20.58	1.94
KinC_x50_2'	5	35.446	19.15	0.57
KinC_x50_2''	5	38.310	22.01	0.61
KinC_x50_3	5	31.75	15.45	4.76
KinC_x50_3'	5	30.32	14.02	0.68
KinC_x50_3''	5	33.179	16.88	0.70
KinC_x60_1	3	30.70	14.40	10.00
KinC_x60_2	4	32.87	16.57	4.75
KinC_x60_2'	4	28.76	12.46	4.75
KinC_x60_3	5	35.02	18.72	3.17
KinC_x60_3'	5	34.02	17.72	1.26
KinC_x60_3a	5	33.02	16.72	1.83
KinC_x60_3b	5	36.45	20.15	1.83
KinC_x60_4a	5	30.38	14.08	3.88
KinC_x60_4b	5	33.81	17.51	3.88
KinC_x25_1	3			1.30
KinC_x25_2	4			2.60
KinC_x25_3	5	28.92	12.62	2.60
KinC_x25_4	5	27.50	15.20	2.60

- Charges goals have been slightly revised based on actual running conditions (luminosity limit of NPS) and downtime for repairs
- Reasonably well on track to achieve revised goals by the end of the run