The View from PHENIX

Xiaochun He @ RHIC Run-12 Retreat

Georgia State University

Outline

- PHENIX Run-12 goals
- How did PHENIX do?
  - Detector commissioning and performance
  - Data taking and fast analysis
- General comments

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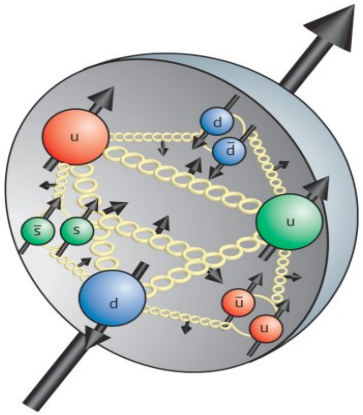

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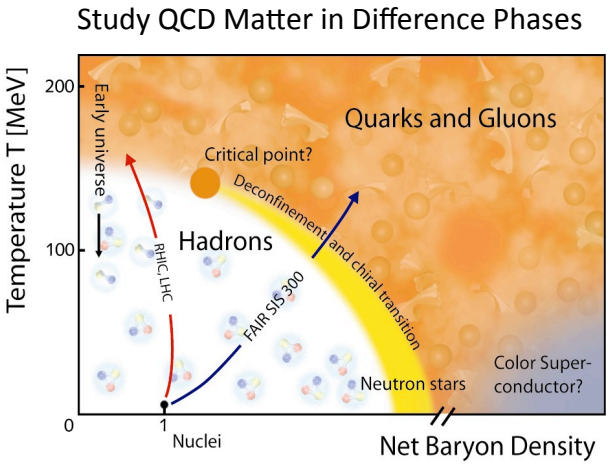
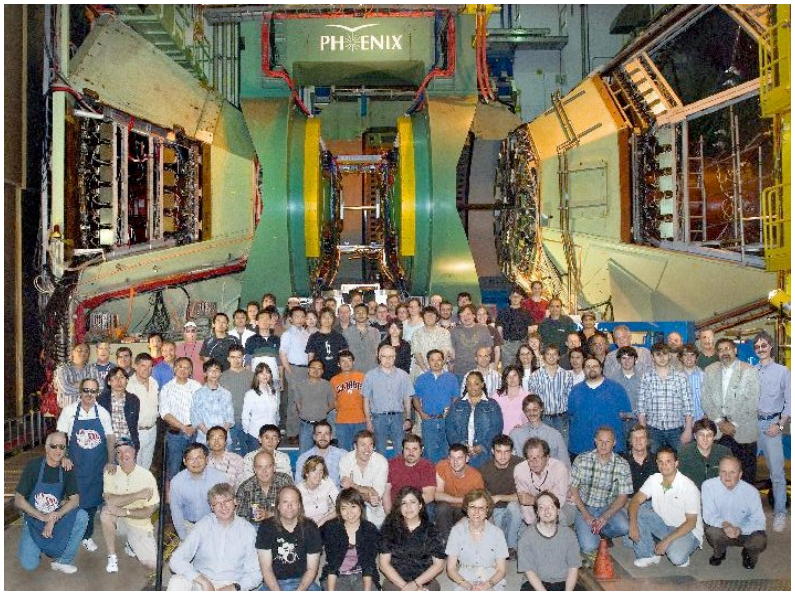


Cast and Crew



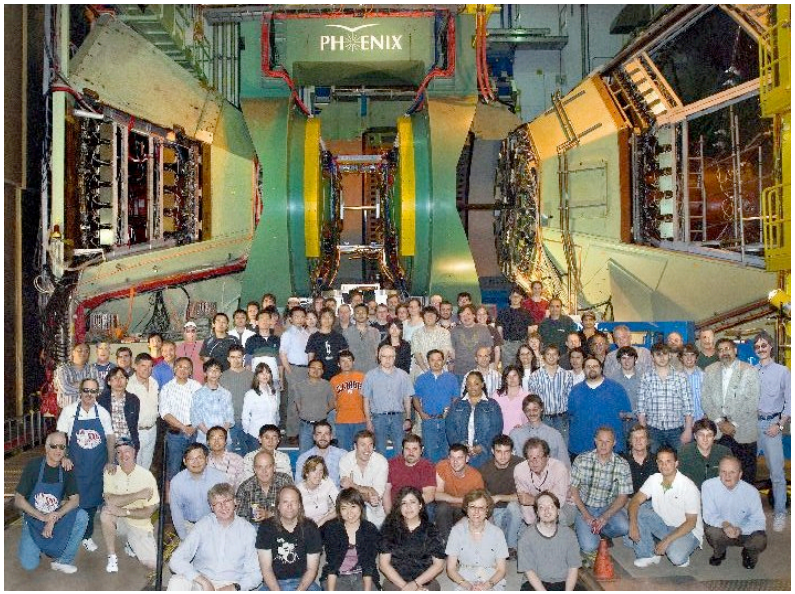
Update From RHIC Run 12:

One World Record, Three World Firsts

Roger Stoutenburgh D2600512

Run 12 at RHIC provides world's highest beam energy for polarized protons, uranium-uranium collisions, increasing luminosity for colliding uranium beams, and copper-gold collisions

Cast and Crew



- There were 246 participants who sat at least one data-taking shift.
- One run coordinator and one spin coordinator.
- Thirteen period coordinators.
- There were twenty-one weeks of fully staffed shifts (4- or 5-person), and three weeks of 2-person watch-shift started on Jan 11th at the beginning of the run and three days of 2-person watch-shift ended at midnight on June 28.

Recent and Future RHIC Run Summary

Run	Species	√s	Wks	±30 cm	±10 cm	Pol	Comments
11	p+p	500	10	27 pb^{-1}		50%(L)	W program + ΔG
	Au+Au	19.6	1.5	13.7M MB evts			energy scan
	Au+Au	200	7	915 μb^{-1}	790 μb^{-1}		heavy flavor (VTX)
	Au+Au	27	1	5.2 μb^{-1}			energy scan
12	**p+p**	**200**	**4.4**	**9.2 pb^{-1}**	**2.9 pb^{-1}**	**~60%(T)**	**HI ref. + transv. spin**
	p+p	**510**	**4.9**	**30.0 pb^{-1}**	**10 pb^{-1}**	**50%(L)**	**W program + ΔG**
	U+U	**193**	**2.9**	**171.2 μb^{-1}**	**89.9 μb^{-1}**		**explore geometry**
	Cu+Au	**200**	**5.5**	**4.96 nb^{-1}**	**2.47 nb^{-1}**		**control geometry**
13	p+p	510	15	250 pb^{-1}		60%(L)	W program
	p+p	200	~5	20 pb^{-1}	5.5 pb^{-1}	60%(T)	HI ref. + transv. spin
14	Au+Au	200	6-8		1.0 nb^{-1}		high bandwidth

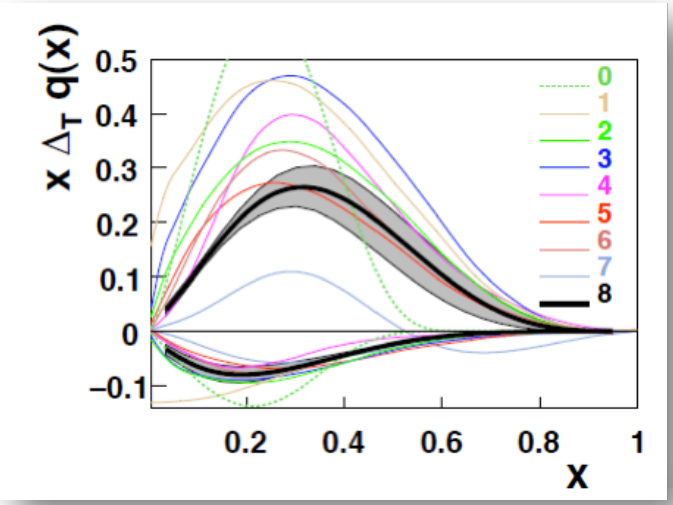
PHENIX Beam Use Proposal for Run-13 & Run-14 was recently submitted.

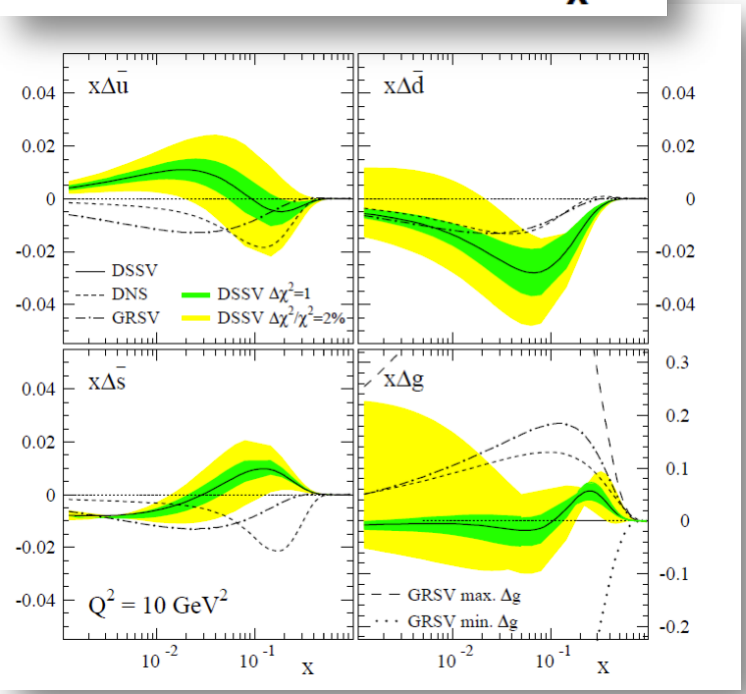
RUN-12 PHYSICS GOALS

Study QCD Matter Properties at Extreme High Temperature and Density, and Resolve the Puzzle of Proton Spin

PHENIX Run12 Spin Goals

- 200 GeV with Transverse Polarization
  - What is transverse structure of proton?
- 510 GeV
  - What is the sea quark and gluon spin contribution to the proton?





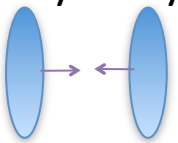
Transversity distributions from A. Prokudin
DSSV: *Phys.Rev.Lett.101:072001,2008*

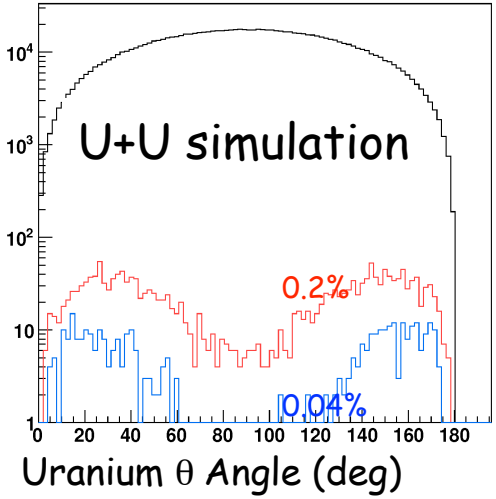
U+U Collisions

Allow us to explore early time dynamics and thermalization: a) varying the eccentricity for flow studies; b) varying path length for parton suppression studies.

Tip-tip

Body-body





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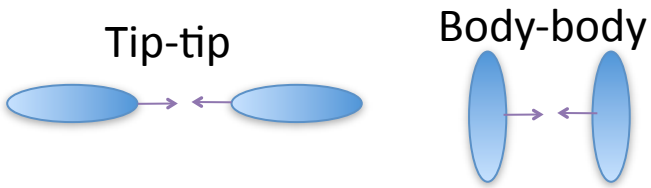

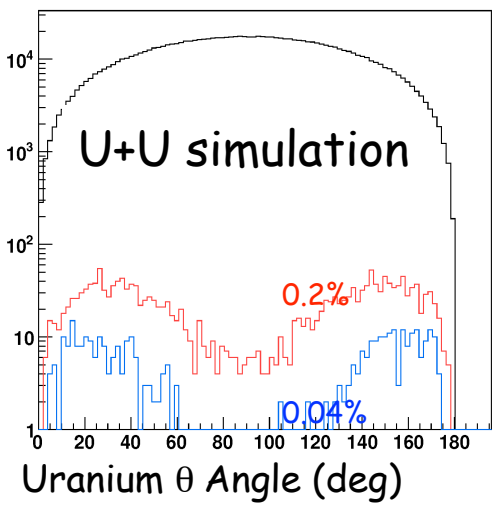

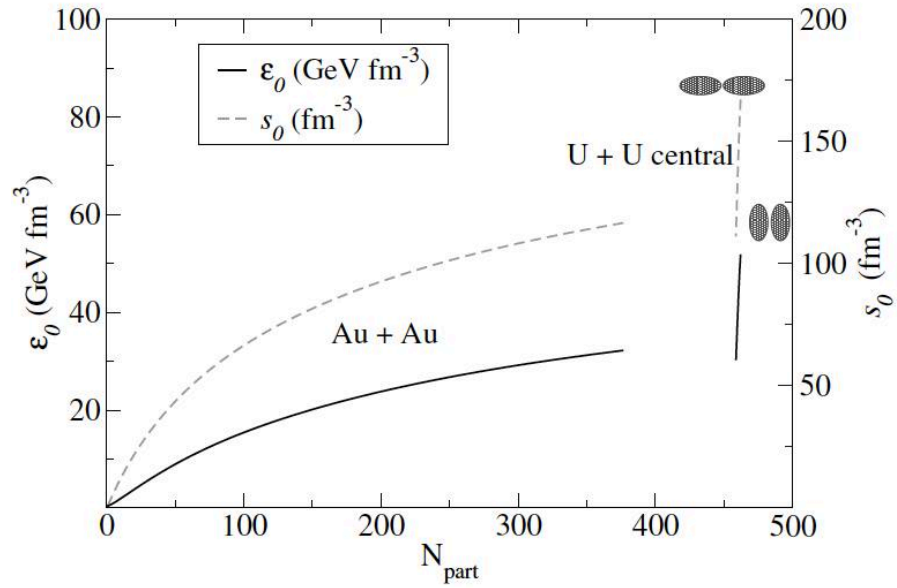

U. Heinz

U+U energy density (65% larger than Au+Au for tip-tip)

U+U Collisions

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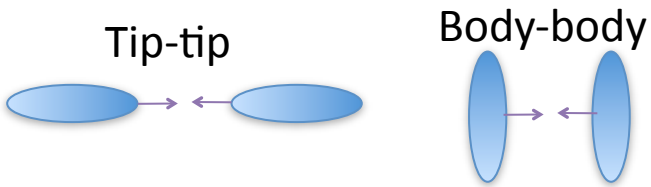

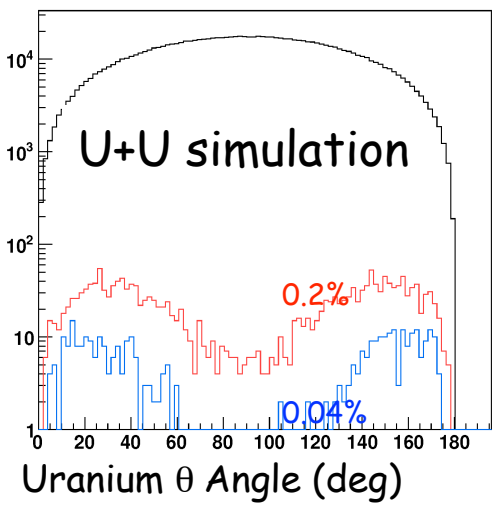

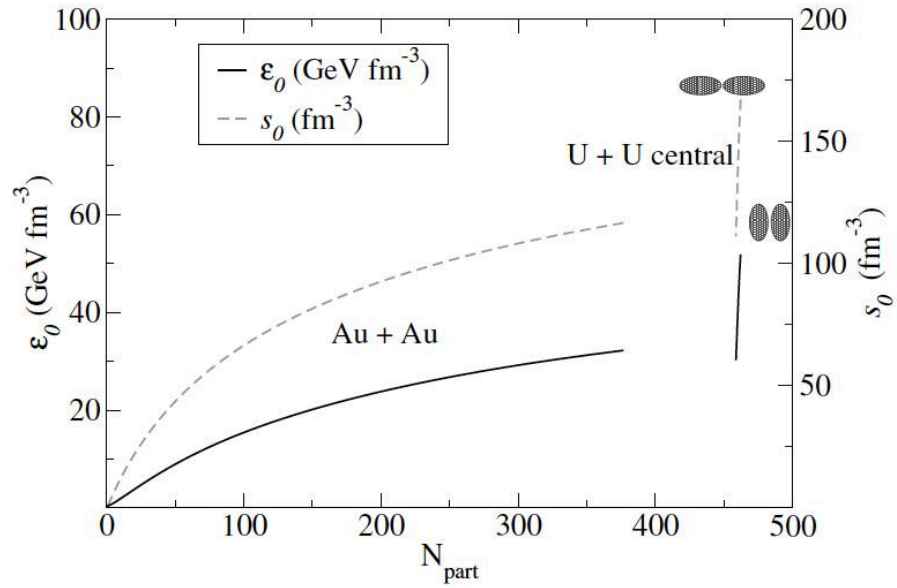

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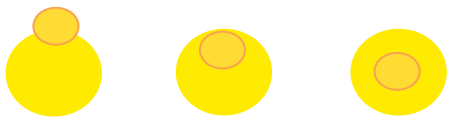
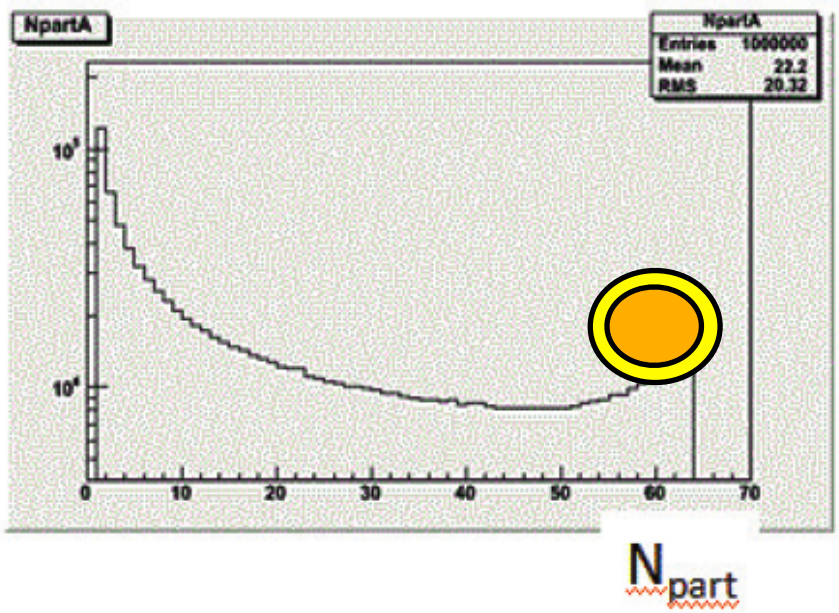
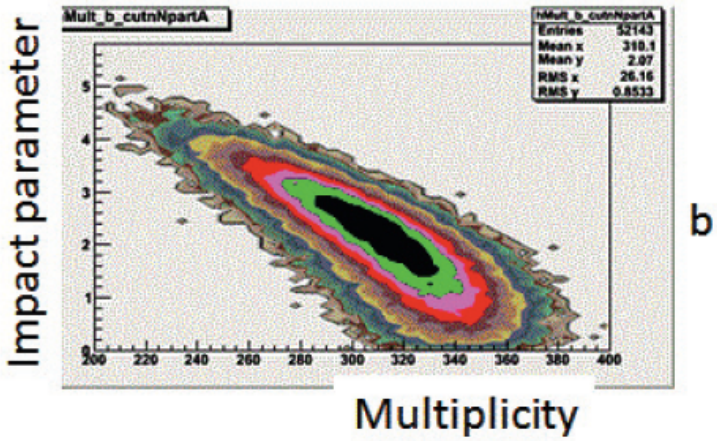
The key to utilizing UU collisions for these purposes is the ability to disentangle the various geometries of the individual interaction !!!

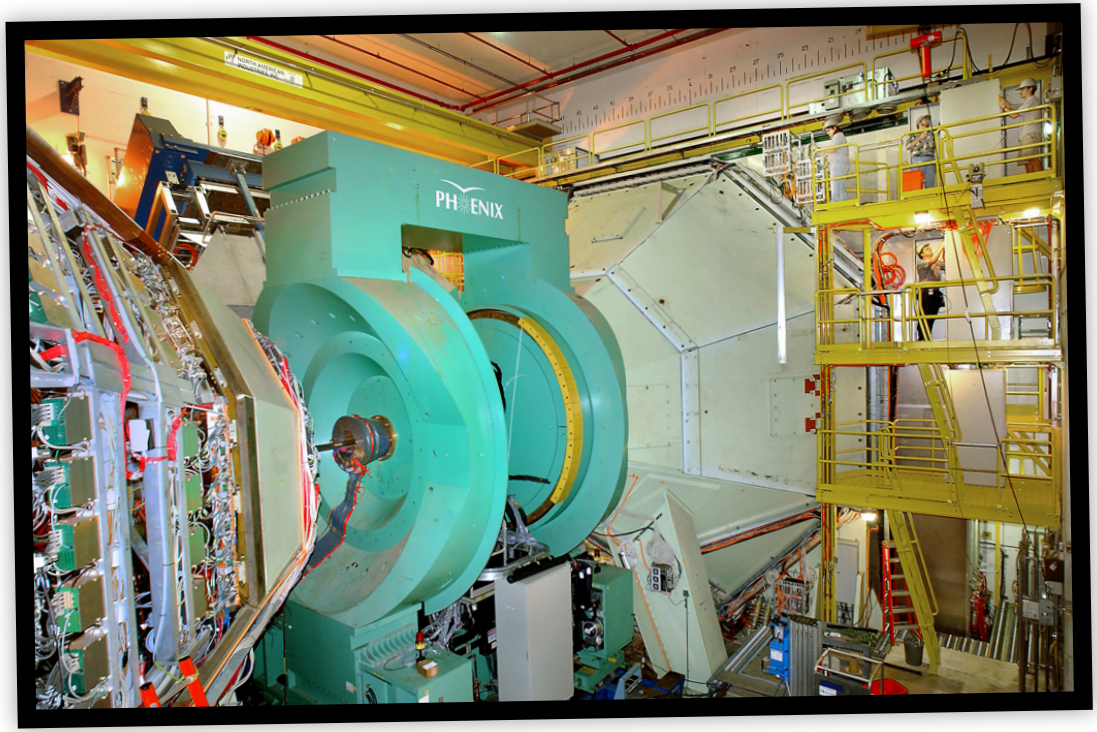
Cu+Au Collisions

- Cu buried inside Au for most central collisions
  - Minimize effects of the surface on hard probes
  - Select top 3% centrality class for this study
- Eccentricity w/o left/right symmetry for non-central collisions
  - Non-fluctuation source of odd harmonics.









PHENIX DETECTORS

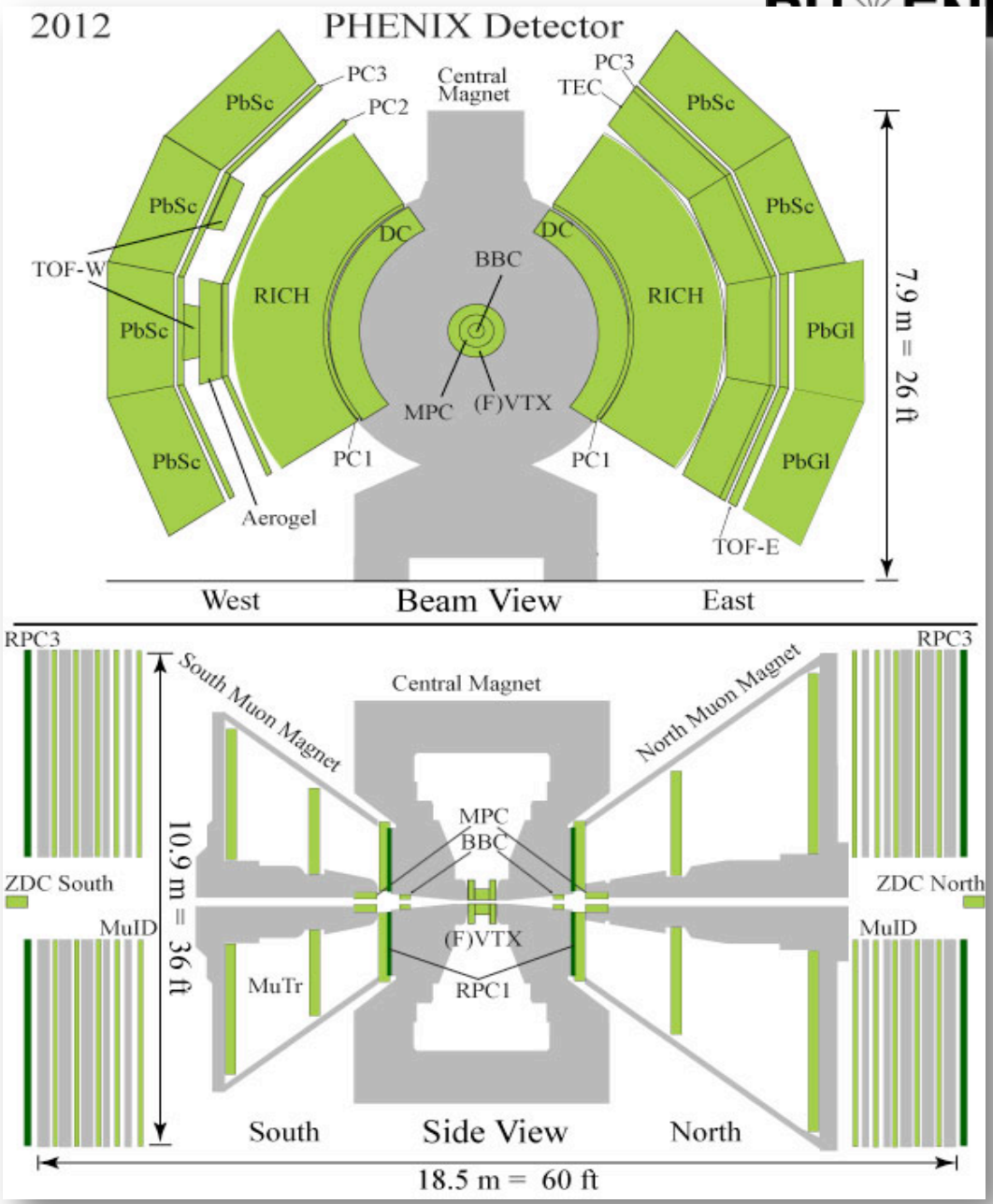
Emphasize newly commissioned detectors

Central Arms:
- hadrons, photons, electrons
- $|\eta| < 0.35$
- $\Delta\varphi = \pi$ (2 arms x $\pi/2$)

Global Detectors:
- Beam-Beam Counter (BBC)
- Zero Degree Calorimeter (ZDC)

Muon Arms:
- muons
- $1.2 < |\eta| < 2.2$
- $\Delta\varphi = 2\pi$

MPC:
- $3.1 < |\eta| < 3.9$
- $\Delta\varphi = 2\pi$



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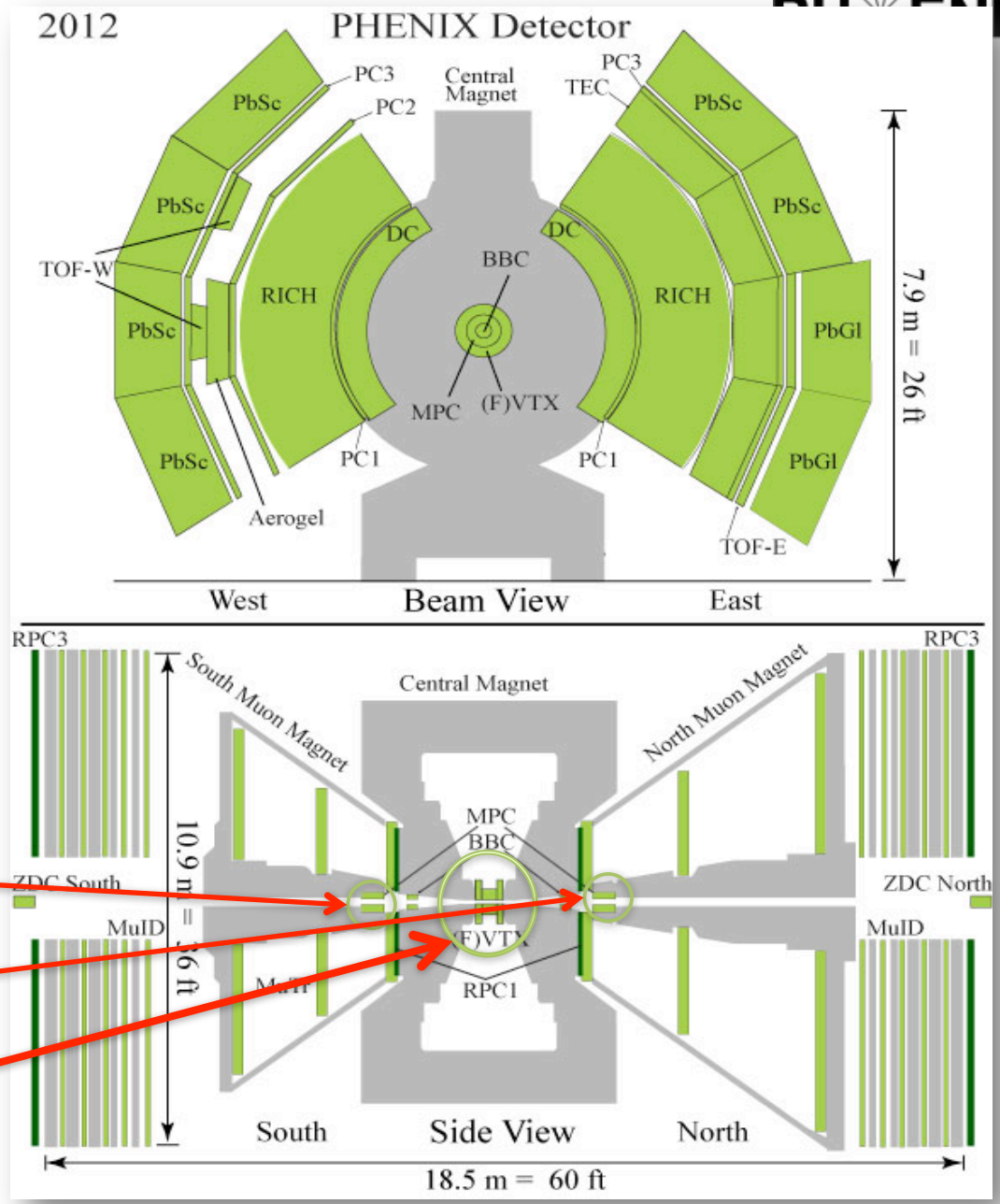
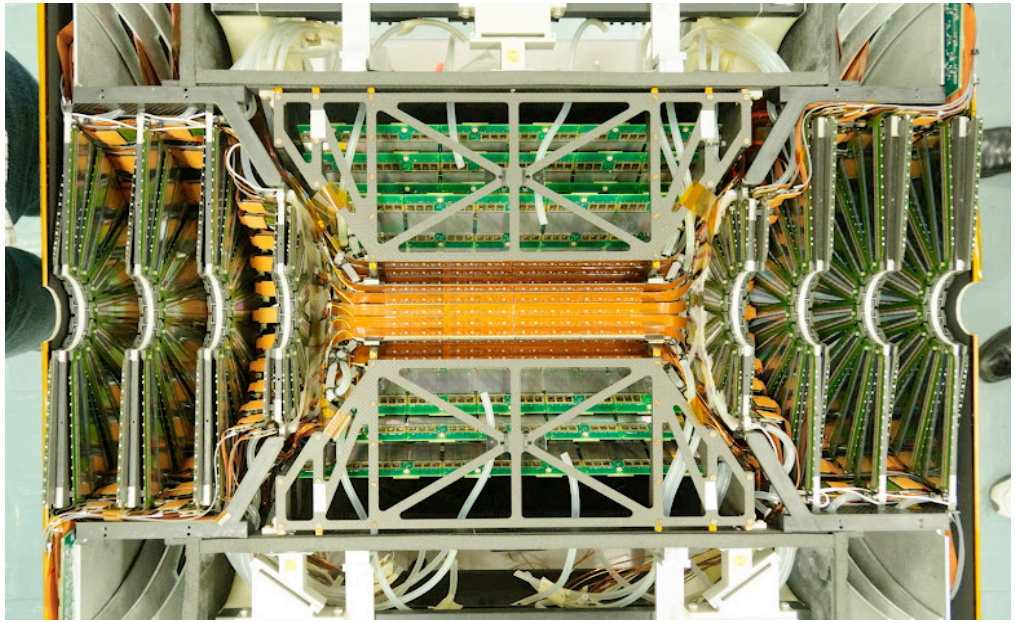
VTX/FVTX



New detector, better precision physics measurement, with new challenges too.



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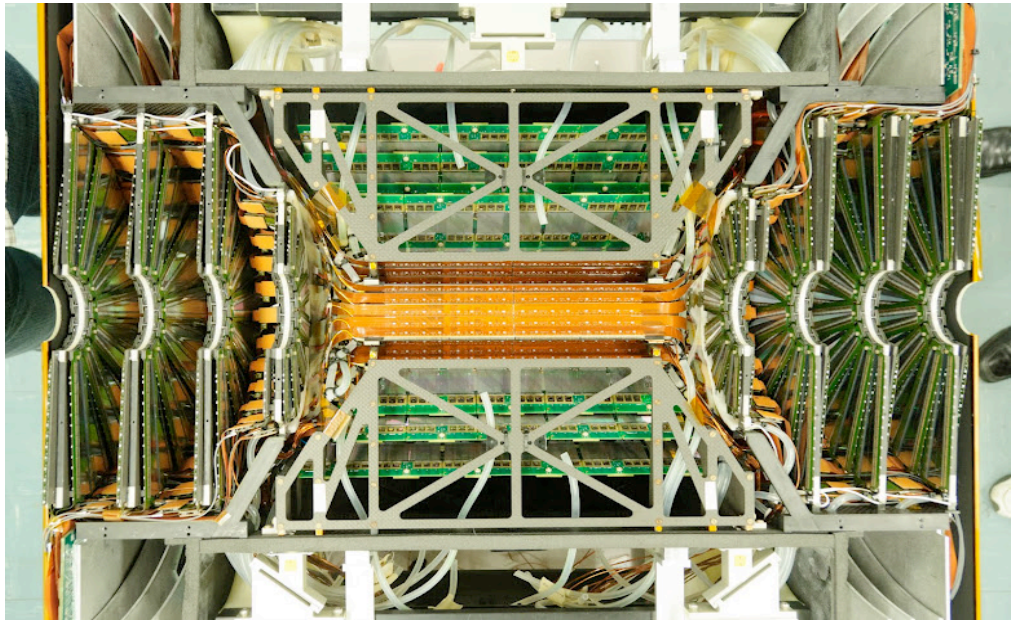

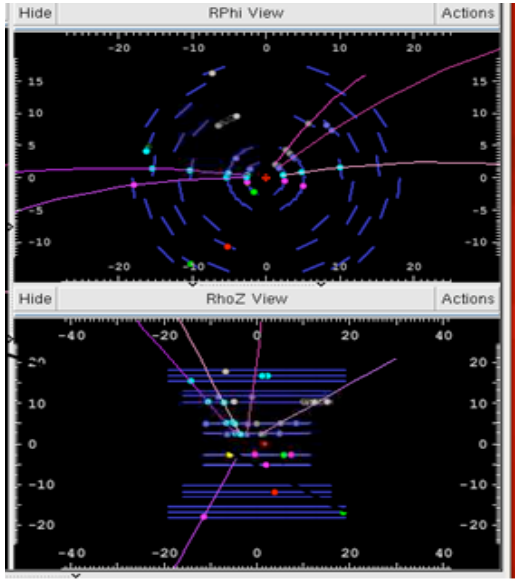

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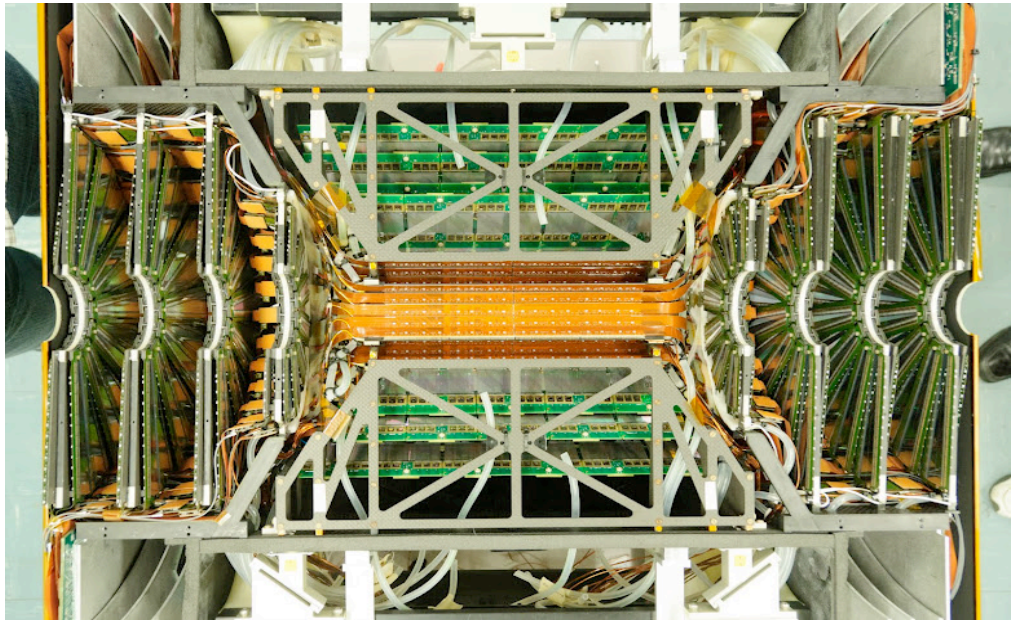
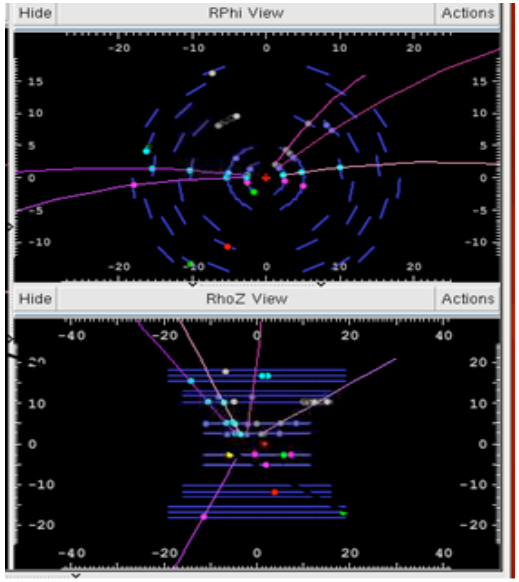
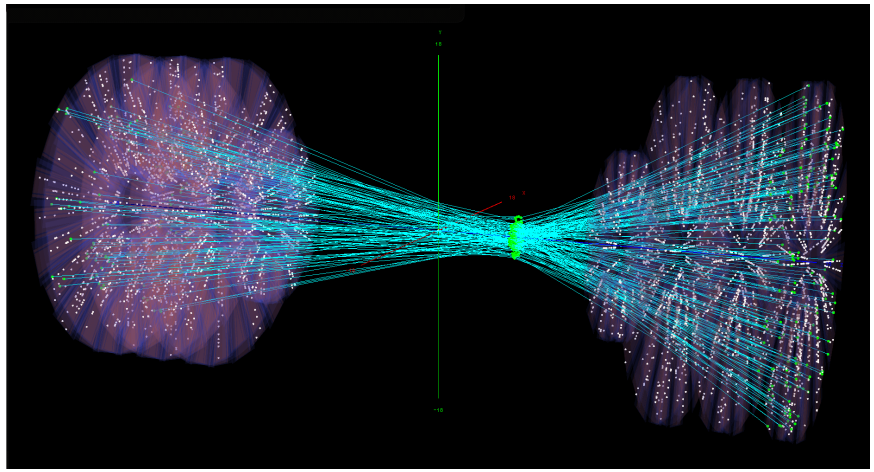
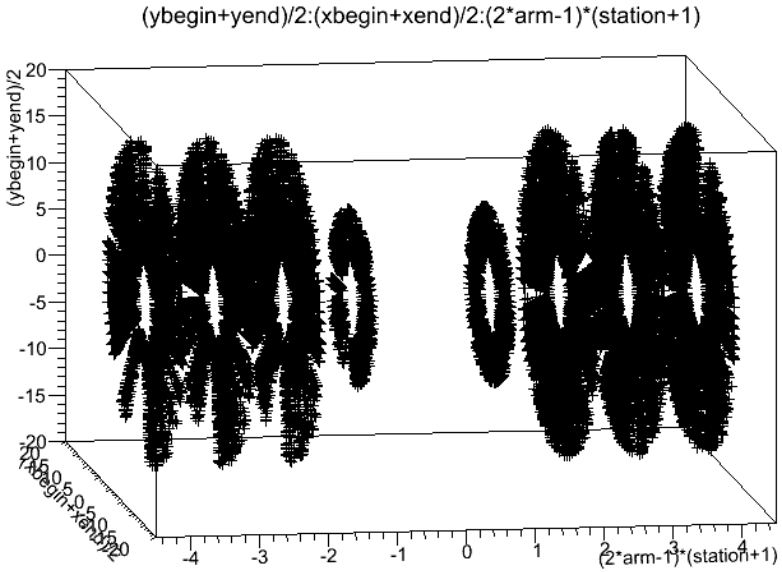




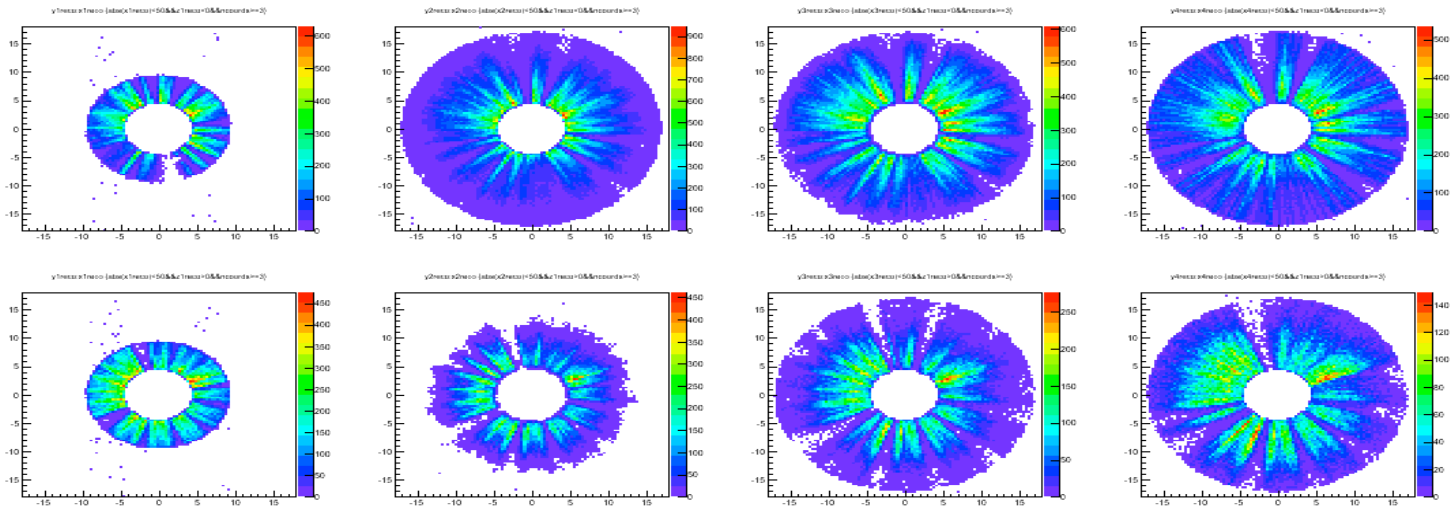


FVTX

Detector Commissioning + Software Development



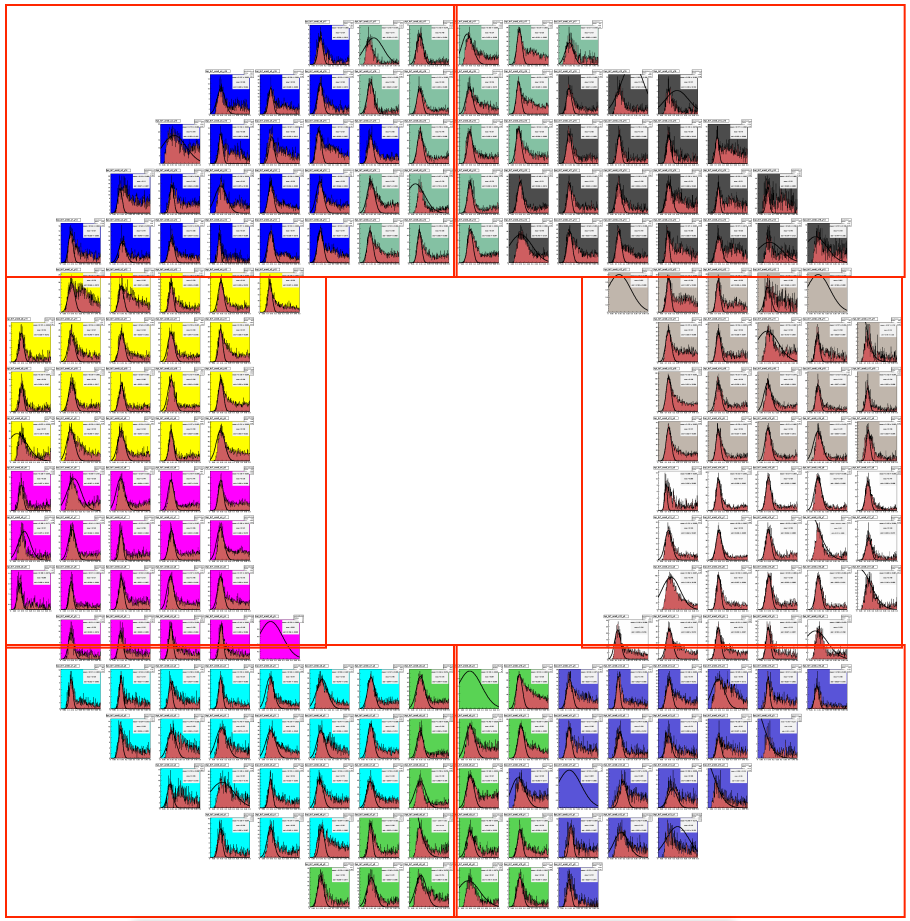
Close to IR



Away from IR

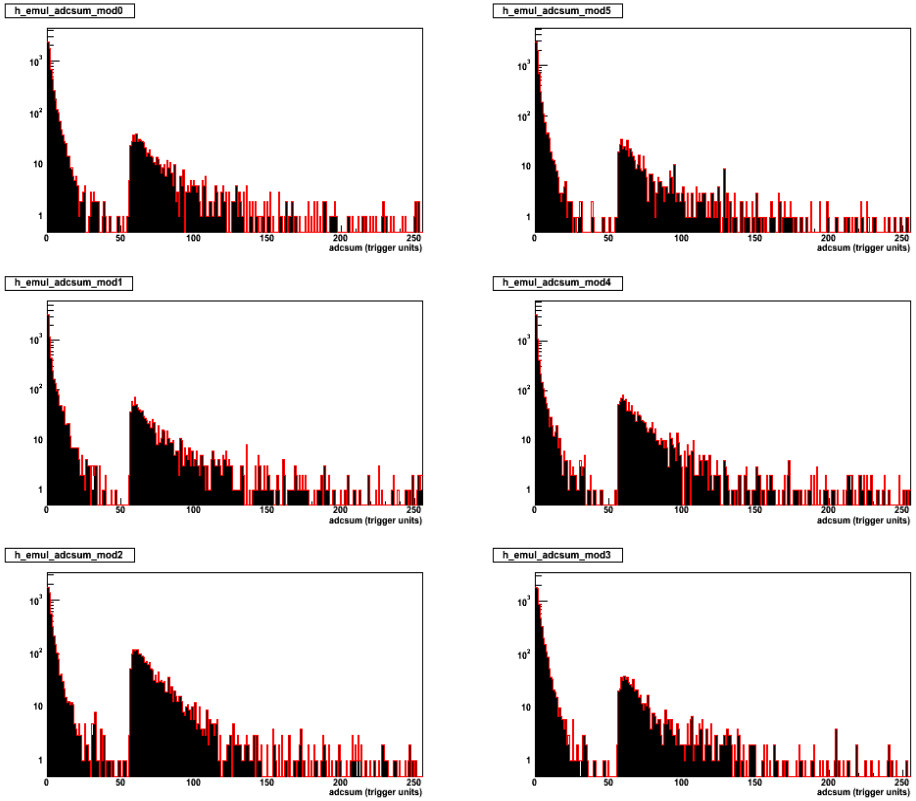
Hits distribution from matched tracks from existing muon spectrometer

MPC Electronics Upgrade



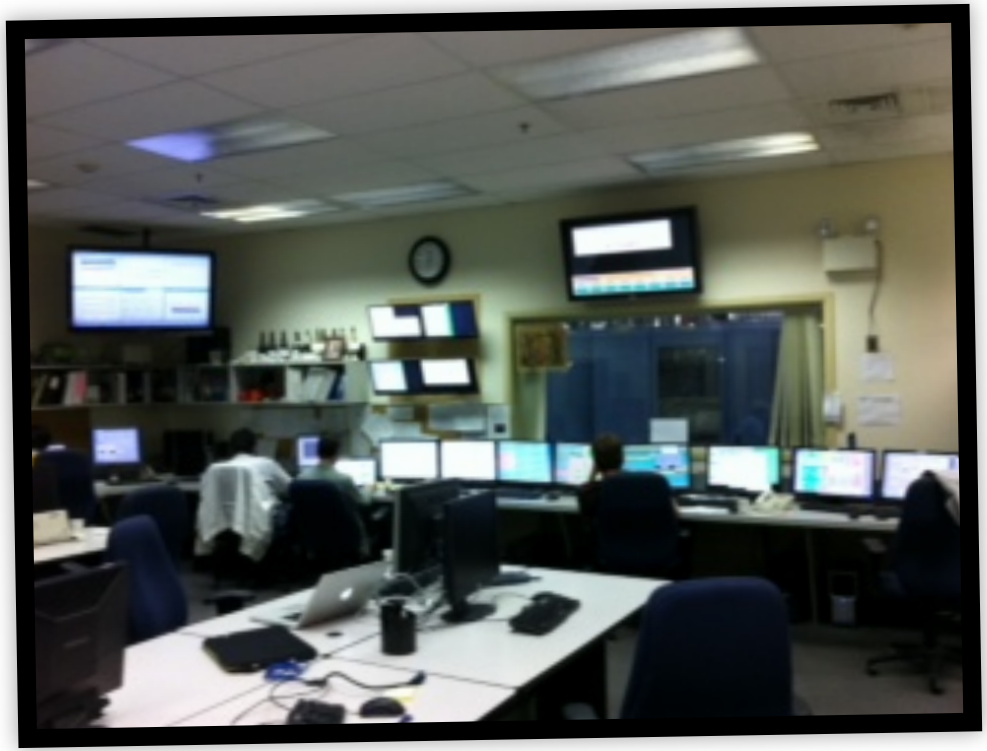
π^0 tower-by-tower calibration

Run 361772, 03-Mar-2012



Sharp (Digital) Trigger Threshold

Results from M. Chiu, S. Wolin, C. McKinney, E. Zarndt

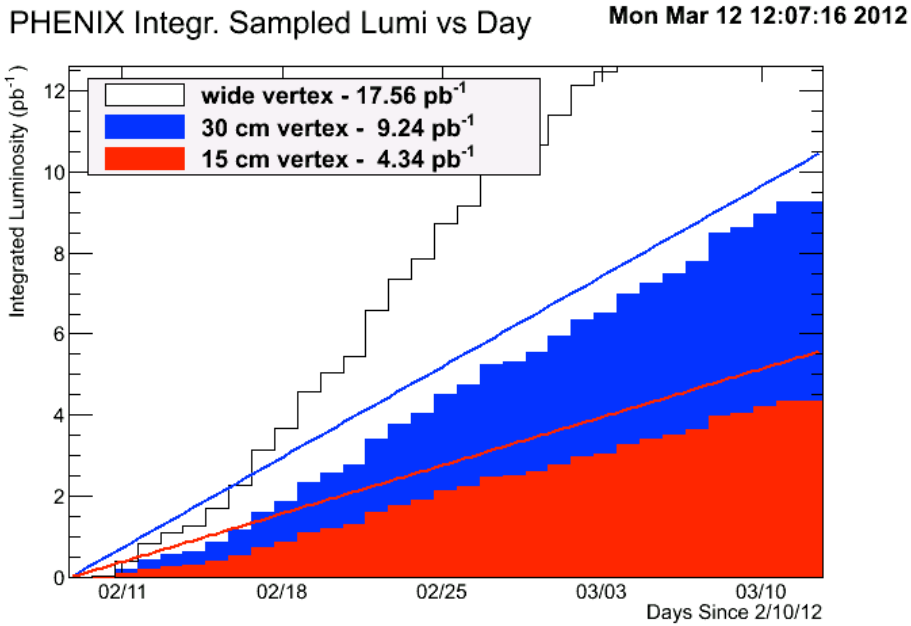


PHENIX DATA TAKING

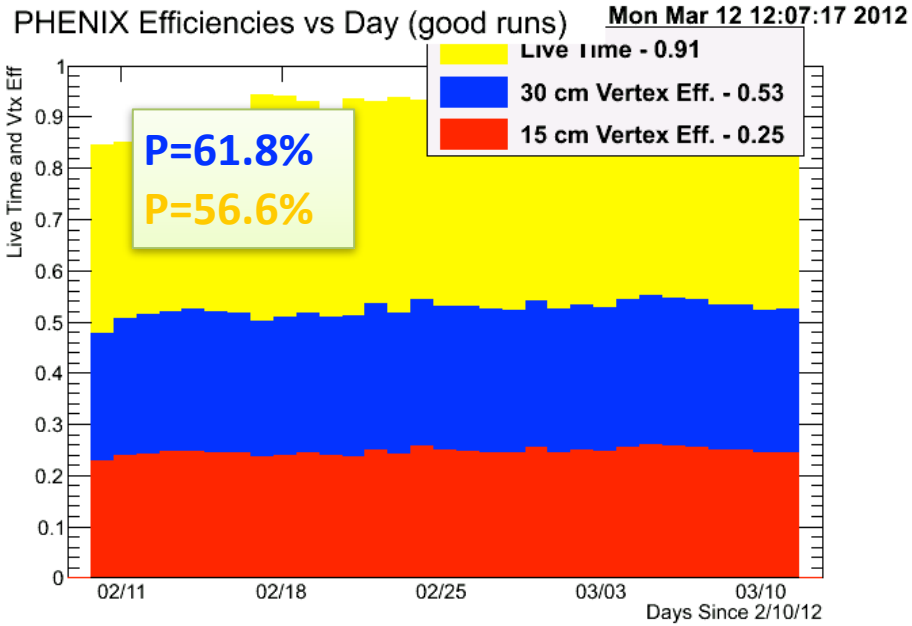
Sampled total luminosity, data taking efficiencies

Comparison Measurement
200 GeV p+p (polarized protons)

Integrated Sampled Luminosity



Collision Vertex Distributions



Goal: 10.5 pb^{-1} for $|z|<30$ cm & 3.8 pb^{-1} for $|z|<10$ cm

We collected over 4.5 billion physics events !!!

Comparison Measurement
200 GeV p+p (polarized protons)

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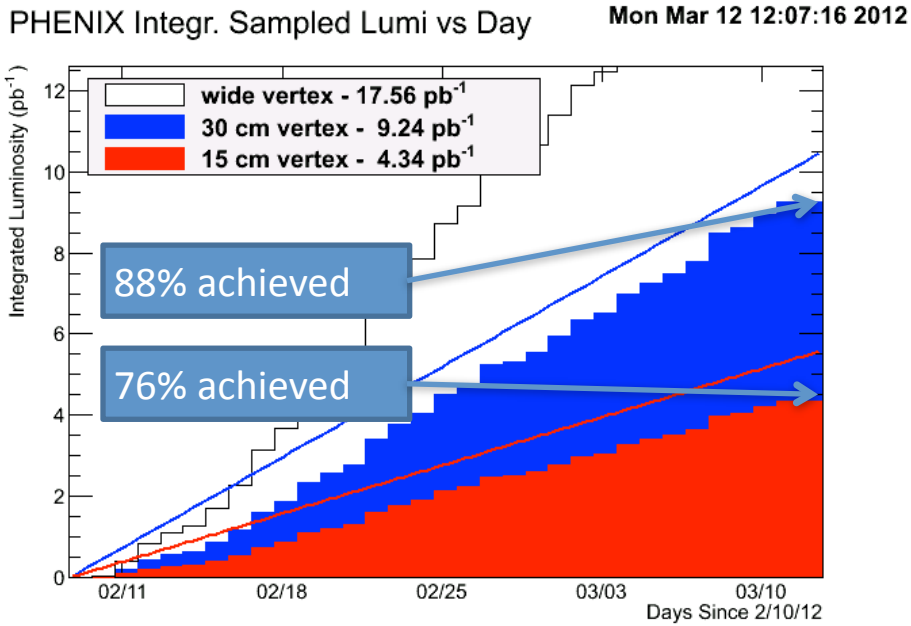

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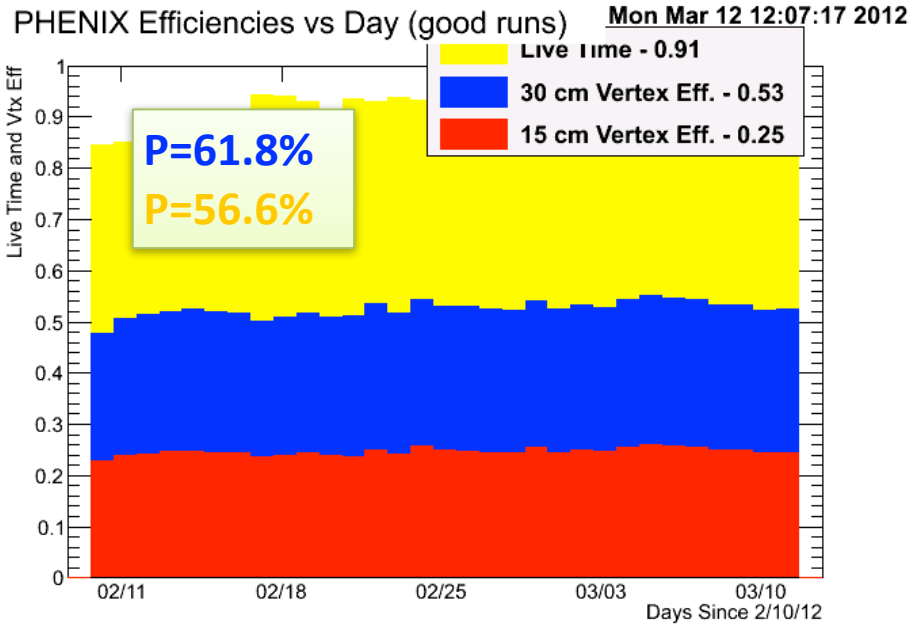

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W Physics Program
510 GeV p+p (polarized protons)

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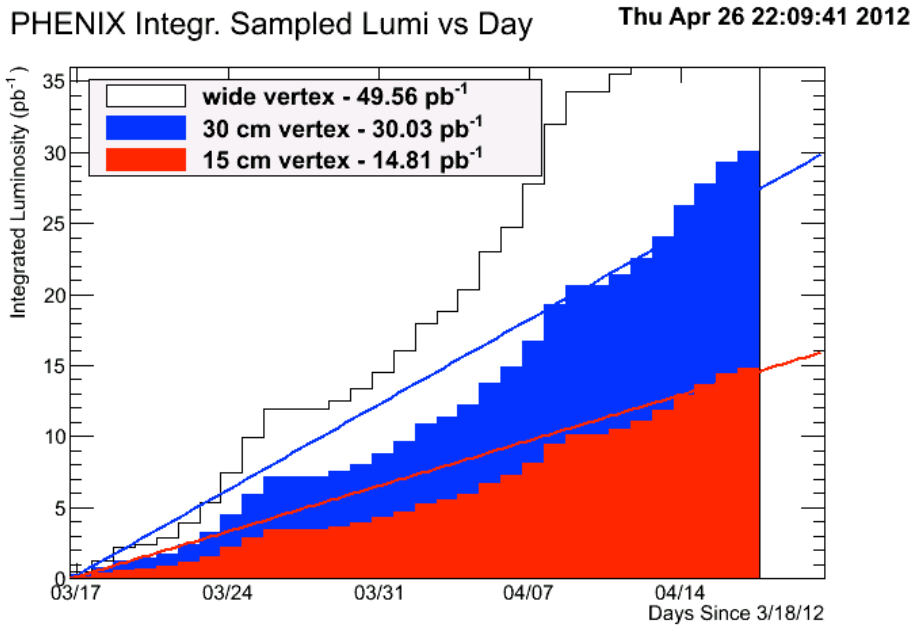

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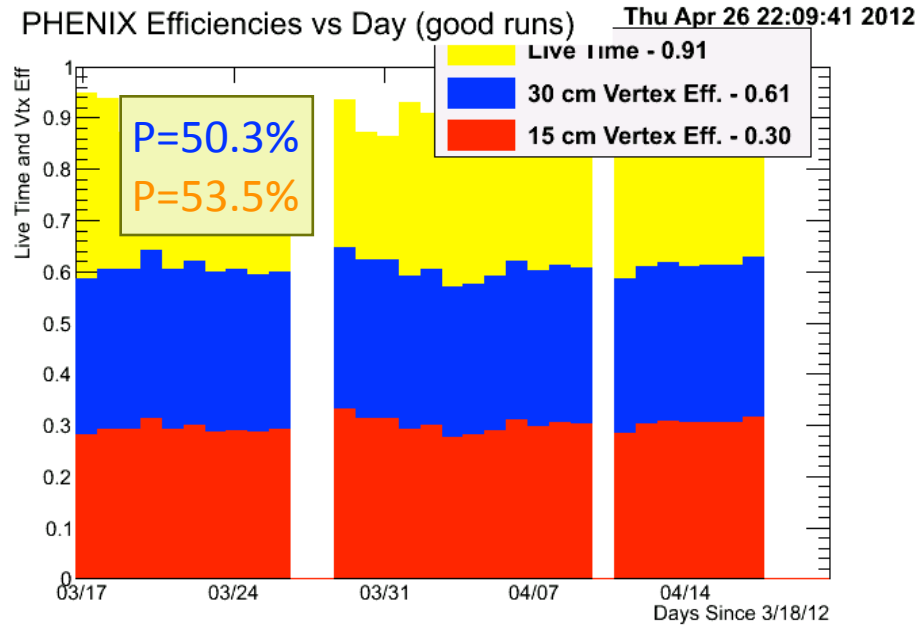

Goal: 30 pb^{-1} for $|z|<30$ cm & 10 pb^{-1} for $|z|<10$ cm

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W Physics Program
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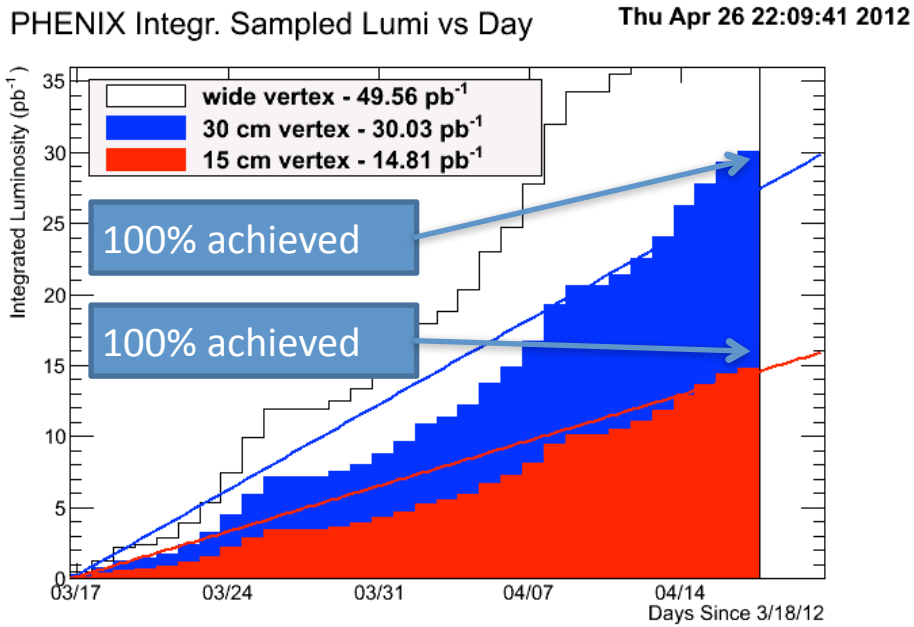

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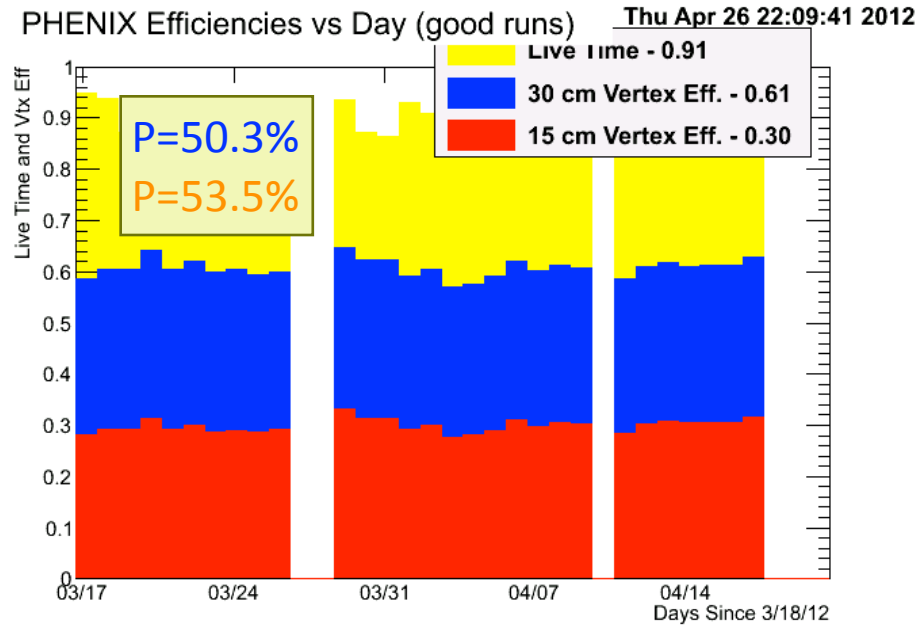

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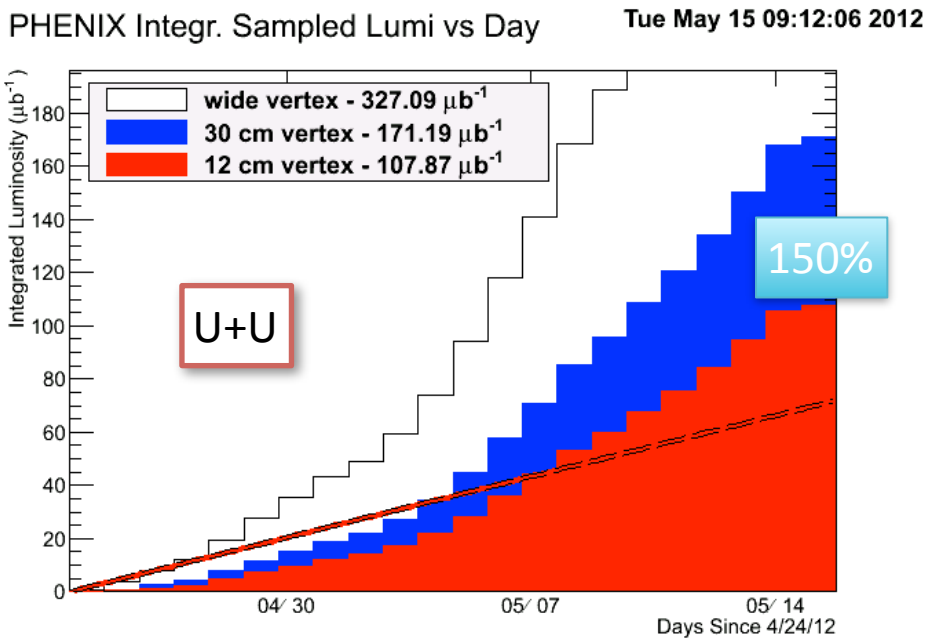
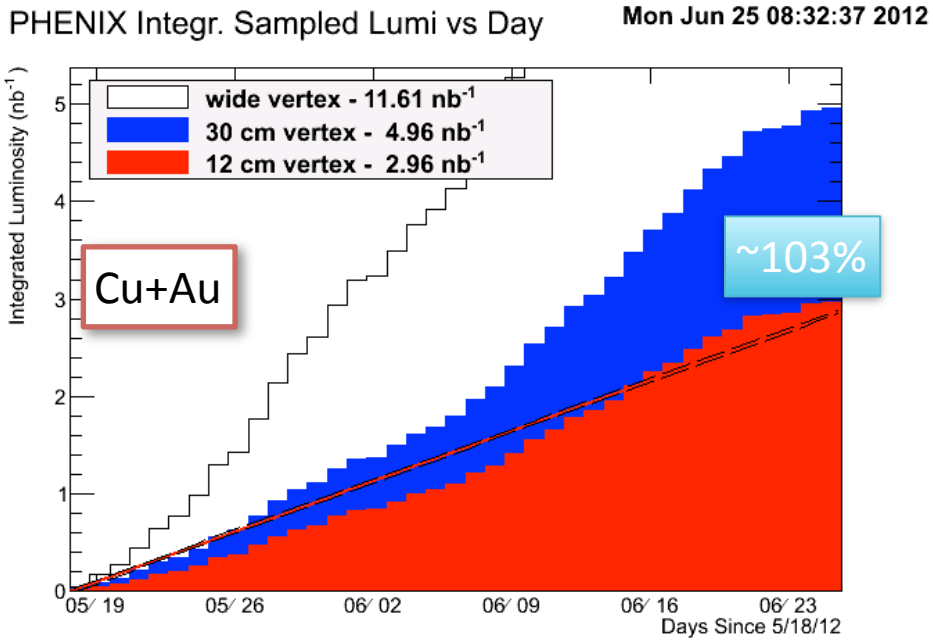
Sampled Luminosity (U+U & Cu+Au)





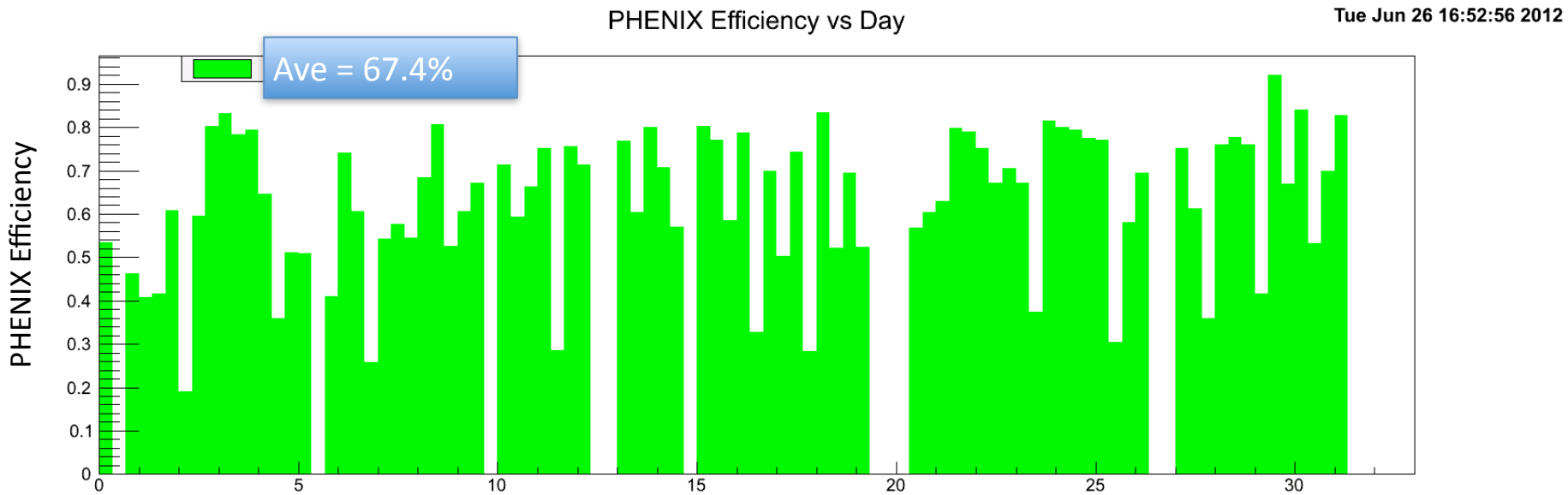
Goal: 60 μb^{-1} for $|z|<10$ cm

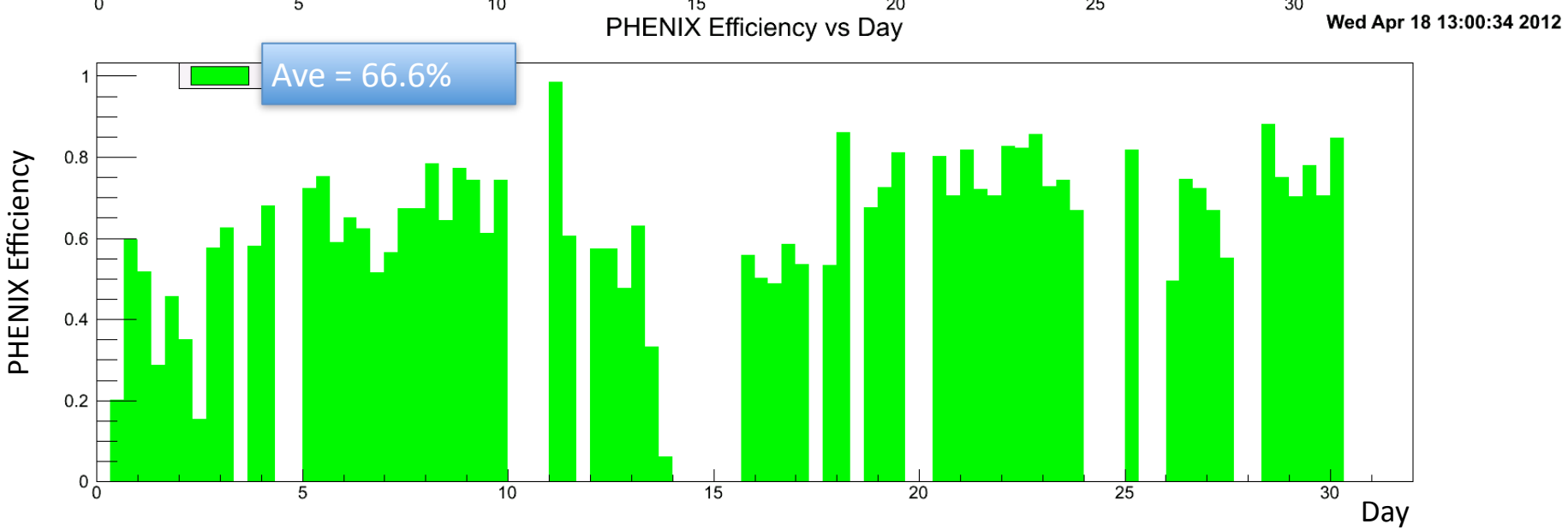
Goal: 2.4 nb^{-1} for $|z|<10$ cm

Collected over 3 billion events (4/25 – 5/15). Far exceeded the requested goal !!!

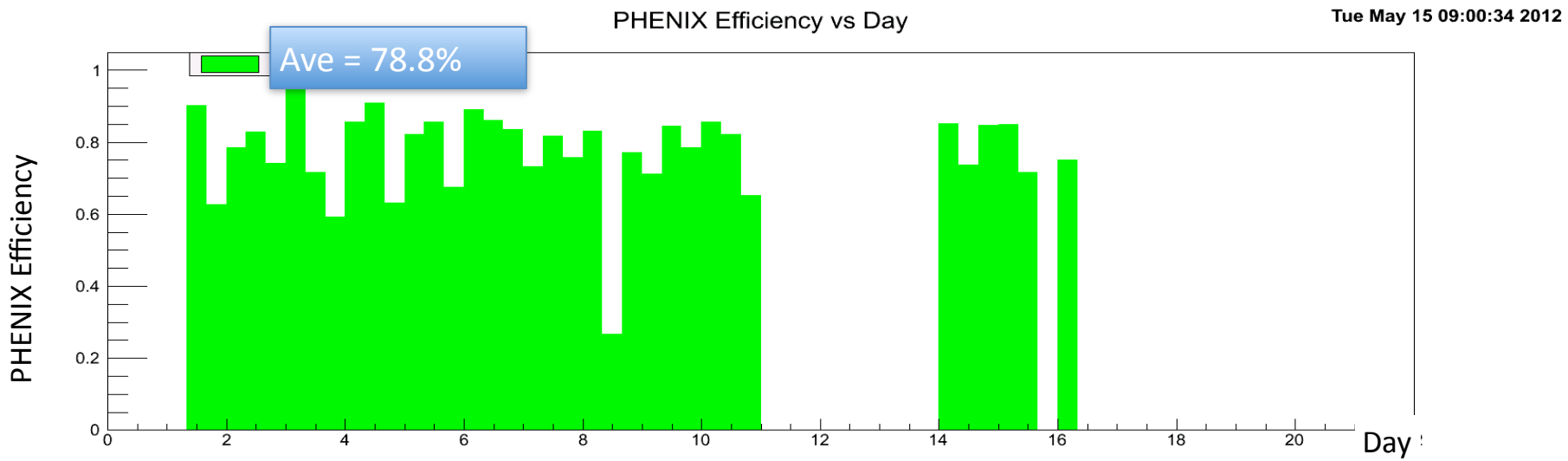
Collected over 9.8 billion events already, data taking was ended at 8am, June 25.

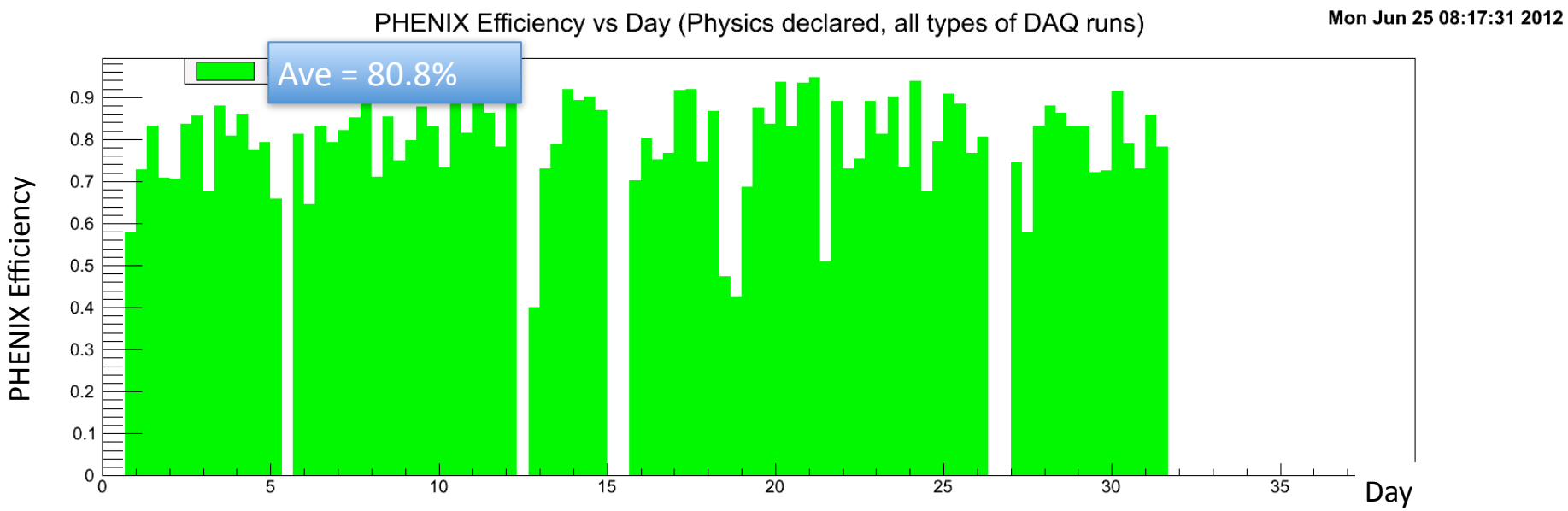
Data Taking Efficiency (200 & 510 GeV p+p)



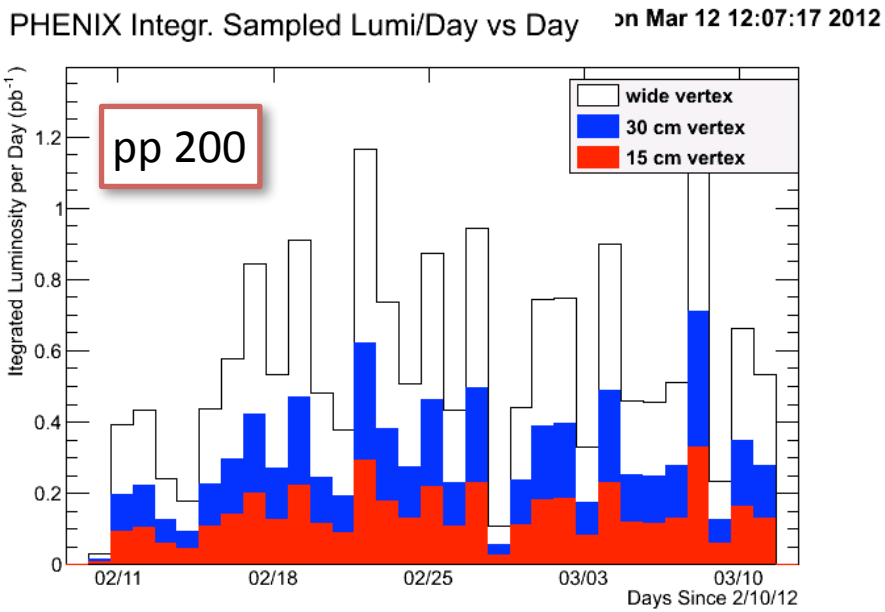


Data Taking Efficiency (U+U, Cu+Au)

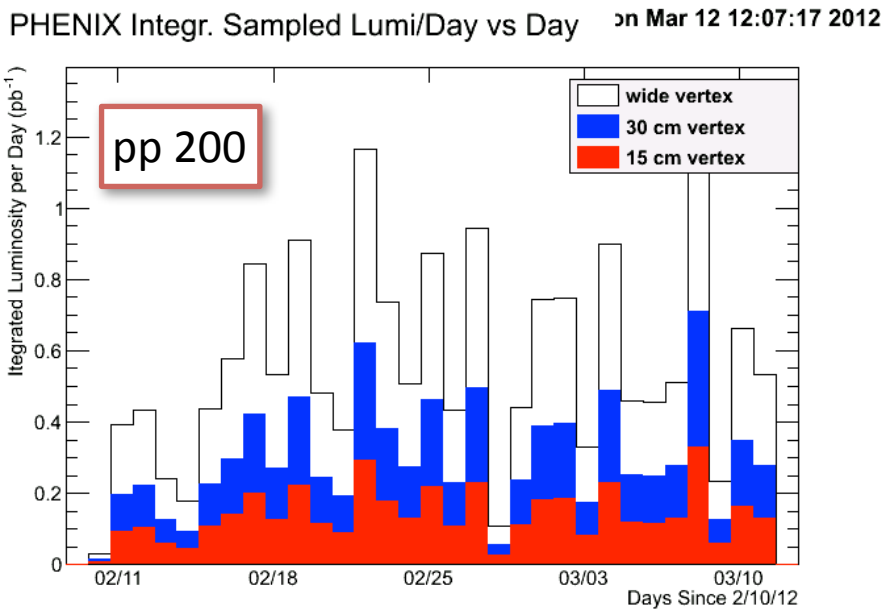


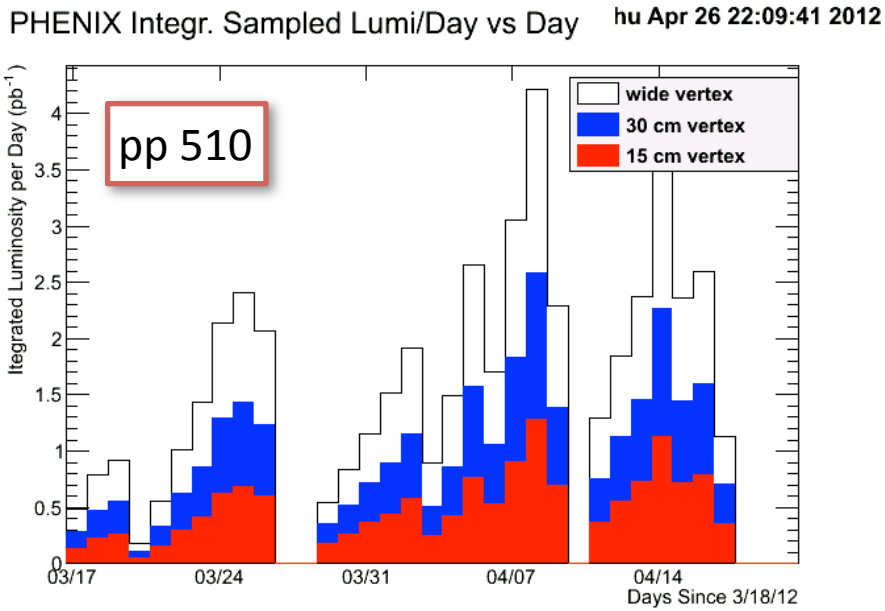


Daily Sampled Luminosities



Daily Sampled Luminosities





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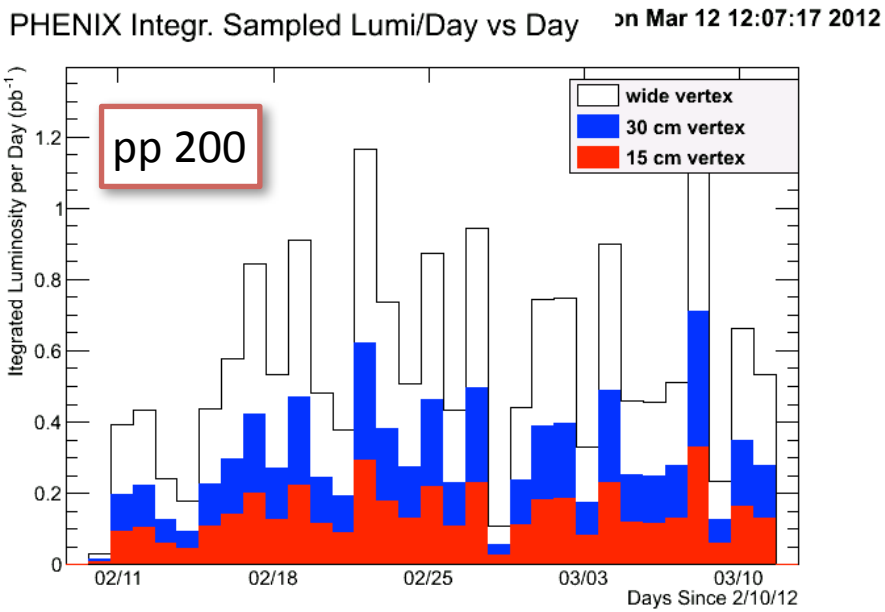

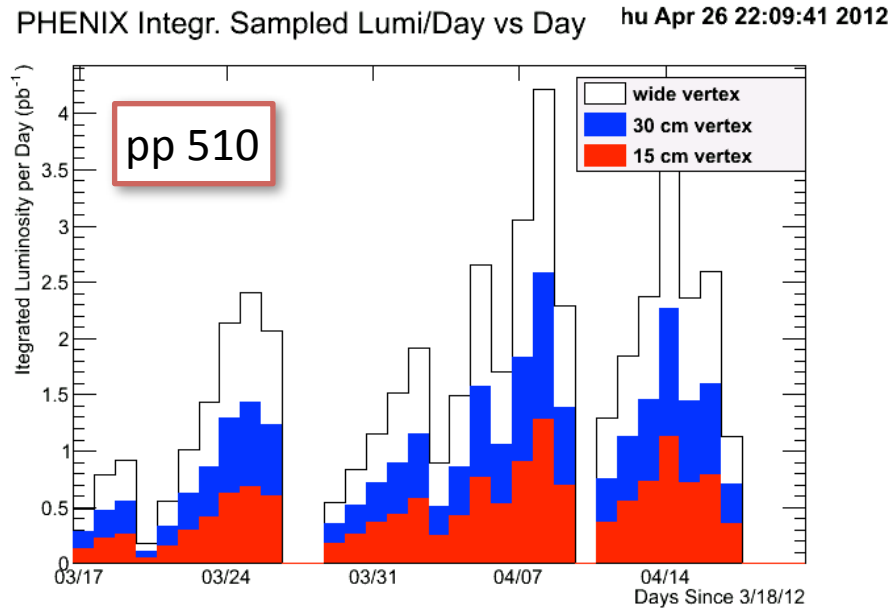

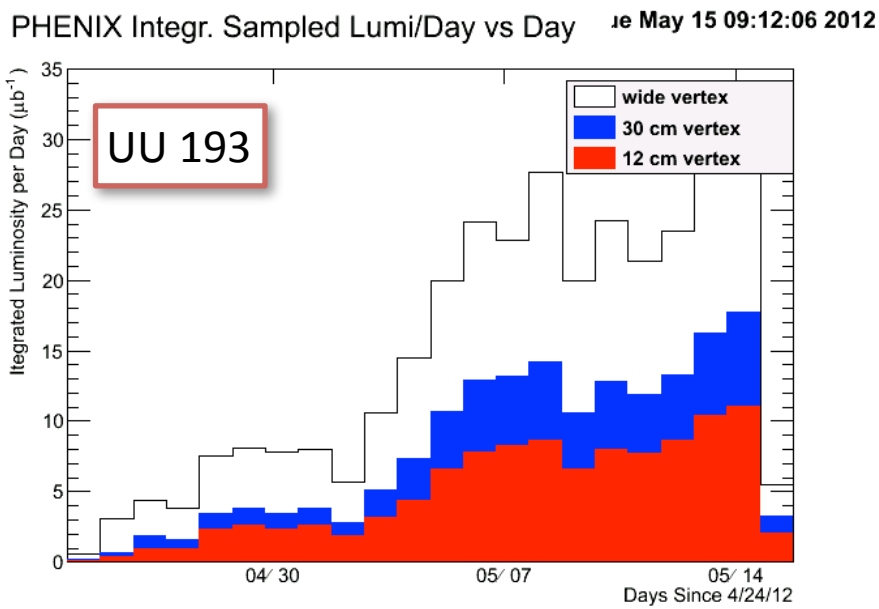

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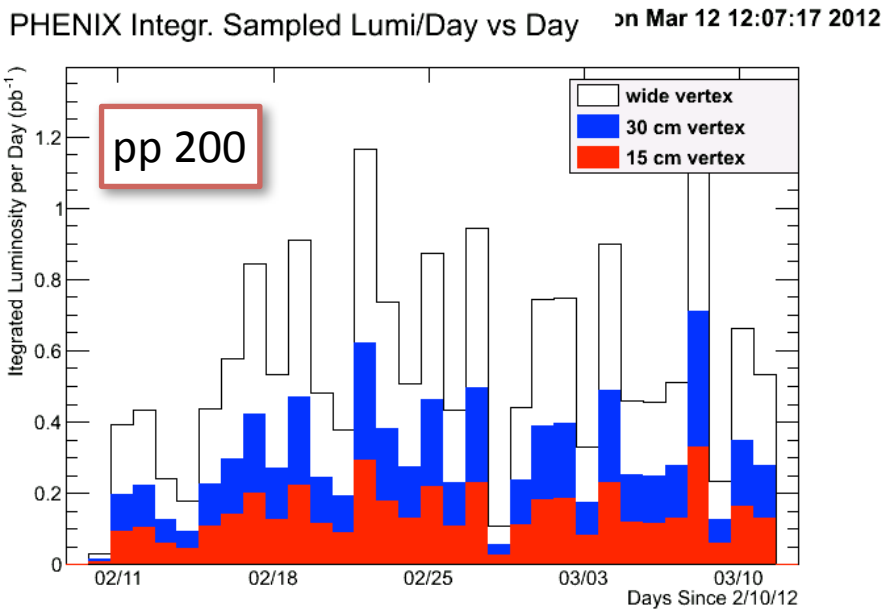
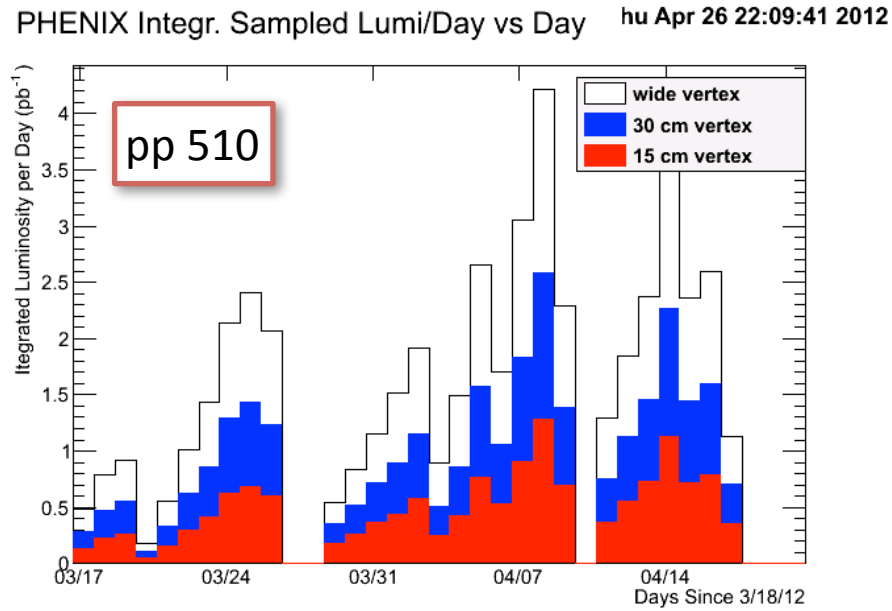
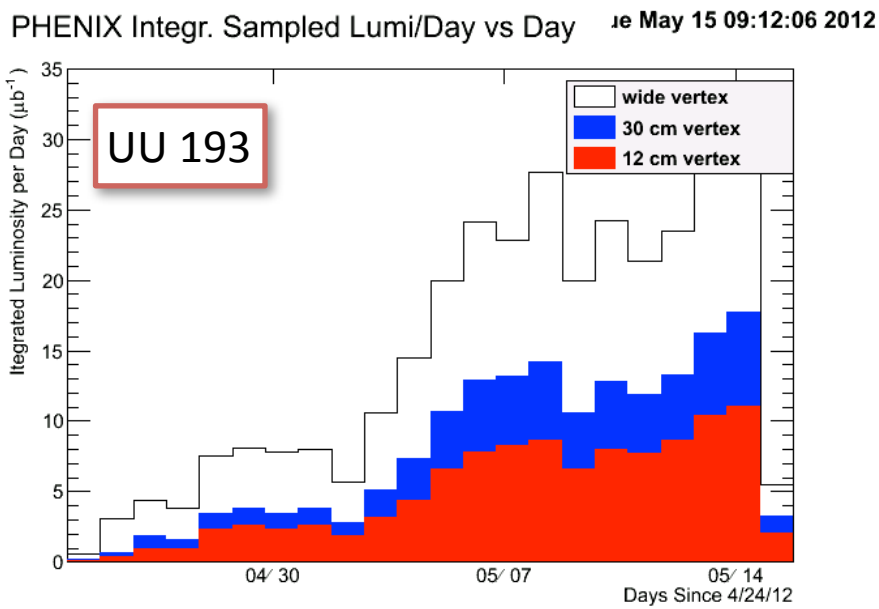
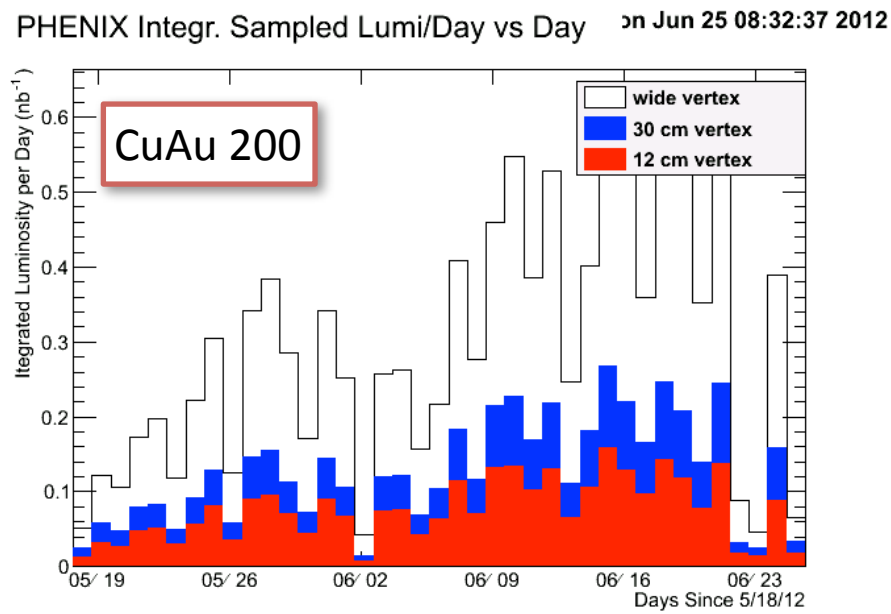
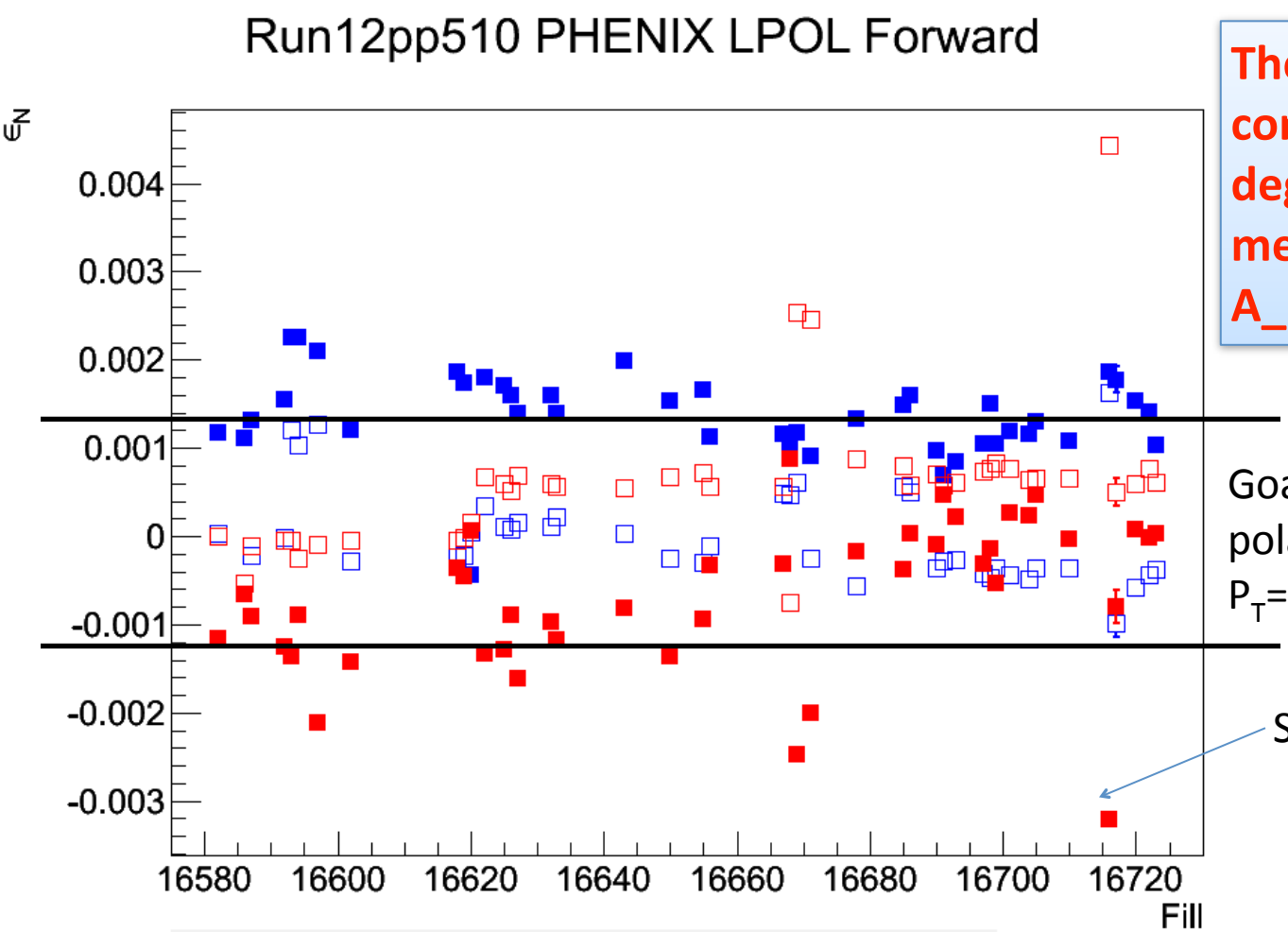








Online Local Polarimetry

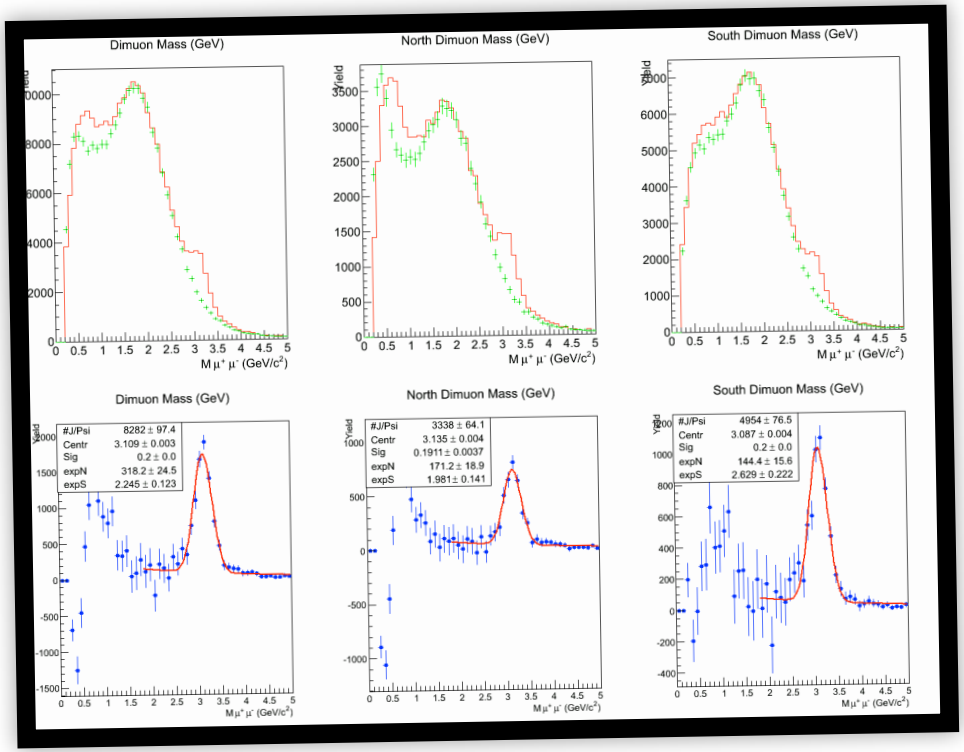


The large residual component will degrade our precision measurements of A_LL !!!

Goal zone for residual polarization P_T=2.5%

Some large outliers

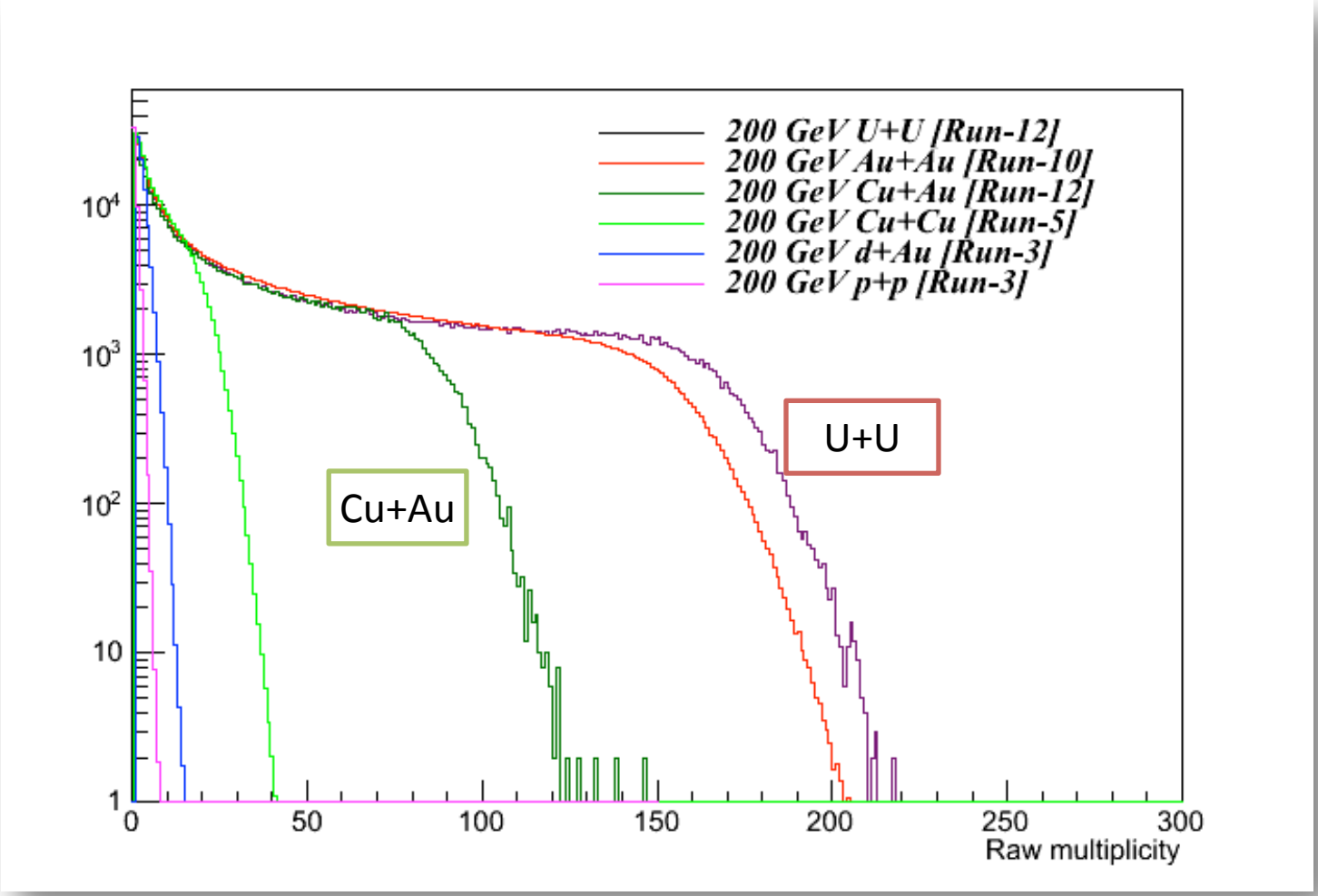
Blue and Yellow beam residual



FAST DATA ANALYSIS

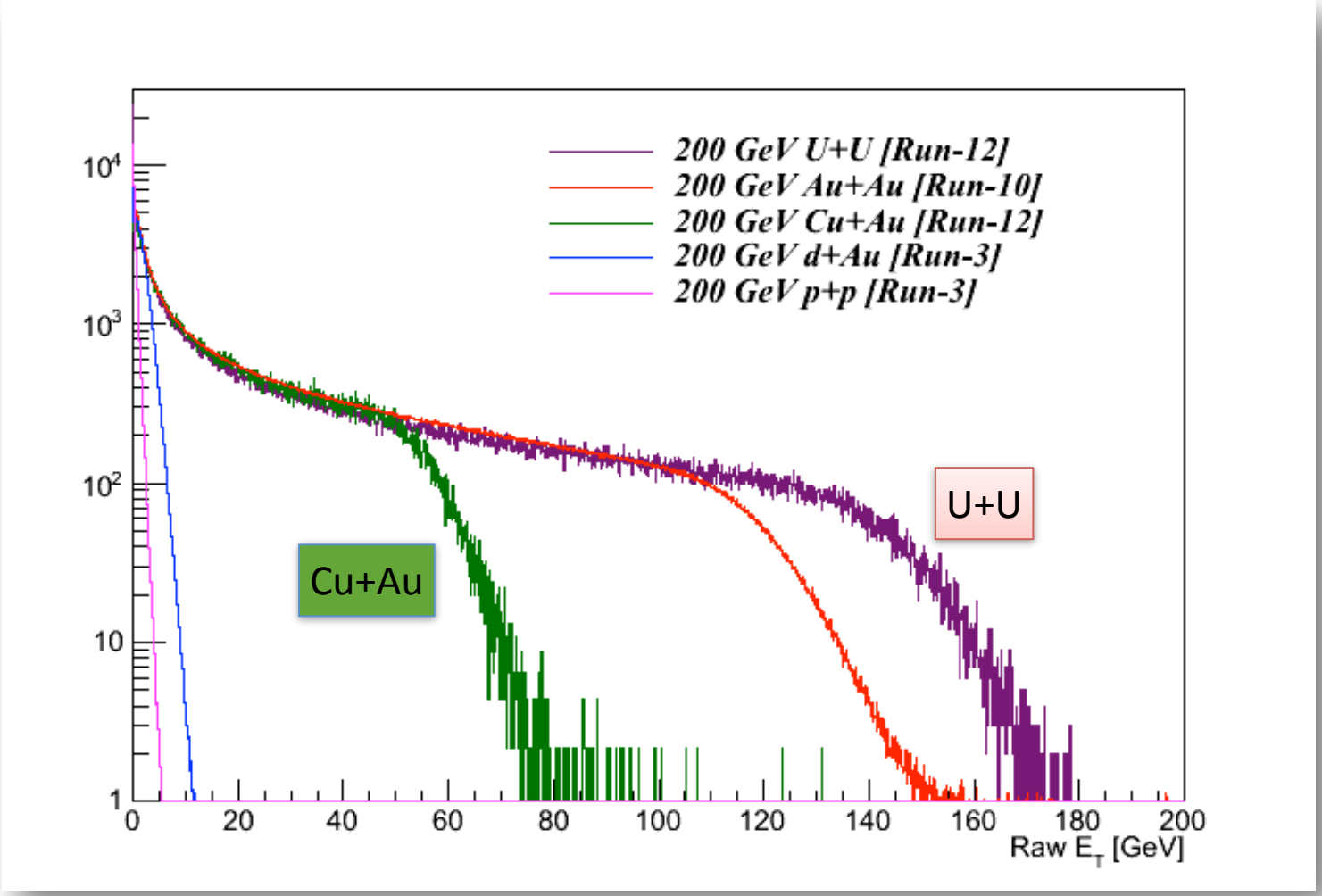
Provide near real-time feedback of detector performance and data quality

Multiplicity Distributions



These are all raw values. No corrections for acceptance, efficiency, etc. have been applied.

E_T Distributions



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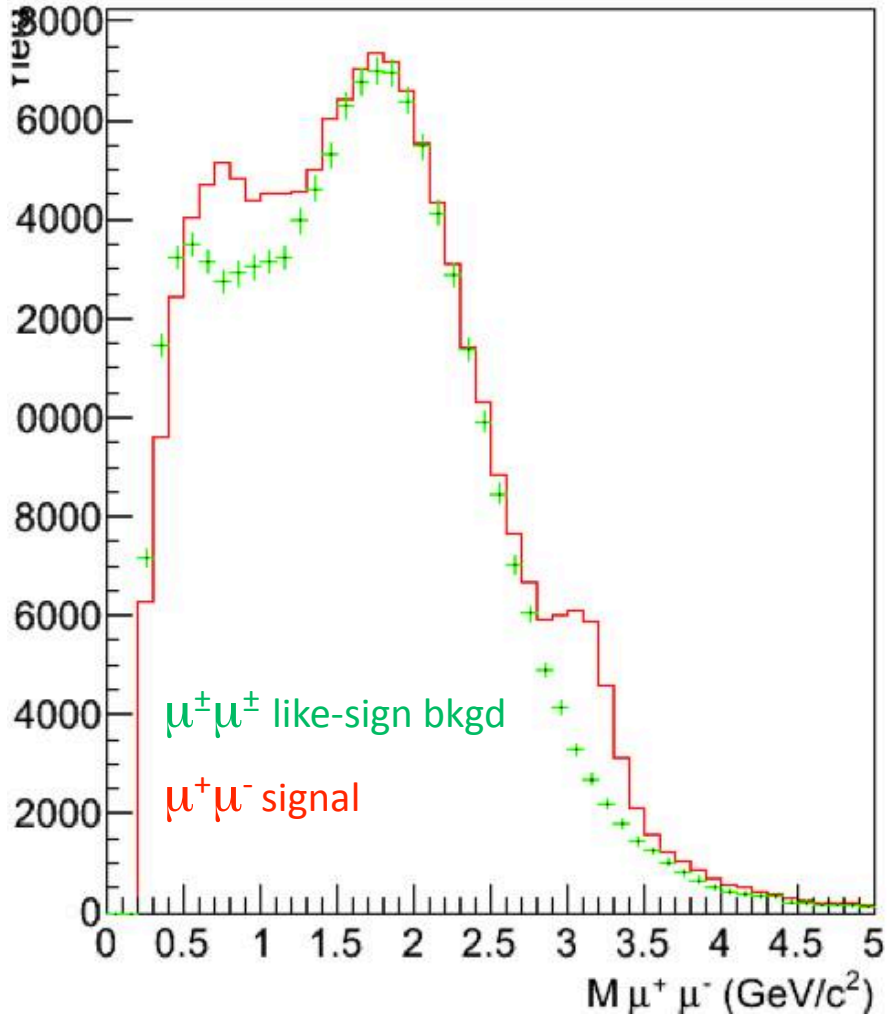
J/ψ Measurements (Cu+Au)

J/ψ yields from the PHENIX Muon Arms for Cu+Au Collisions

Run12 Cu+Au expectation: 62k J/ψ - for PHENIX wide-vertex luminosity goal of 4.6 nb^{-1}

We are only able to process less than 20% of the incoming data in the counting house before sending data to RCF HPSS



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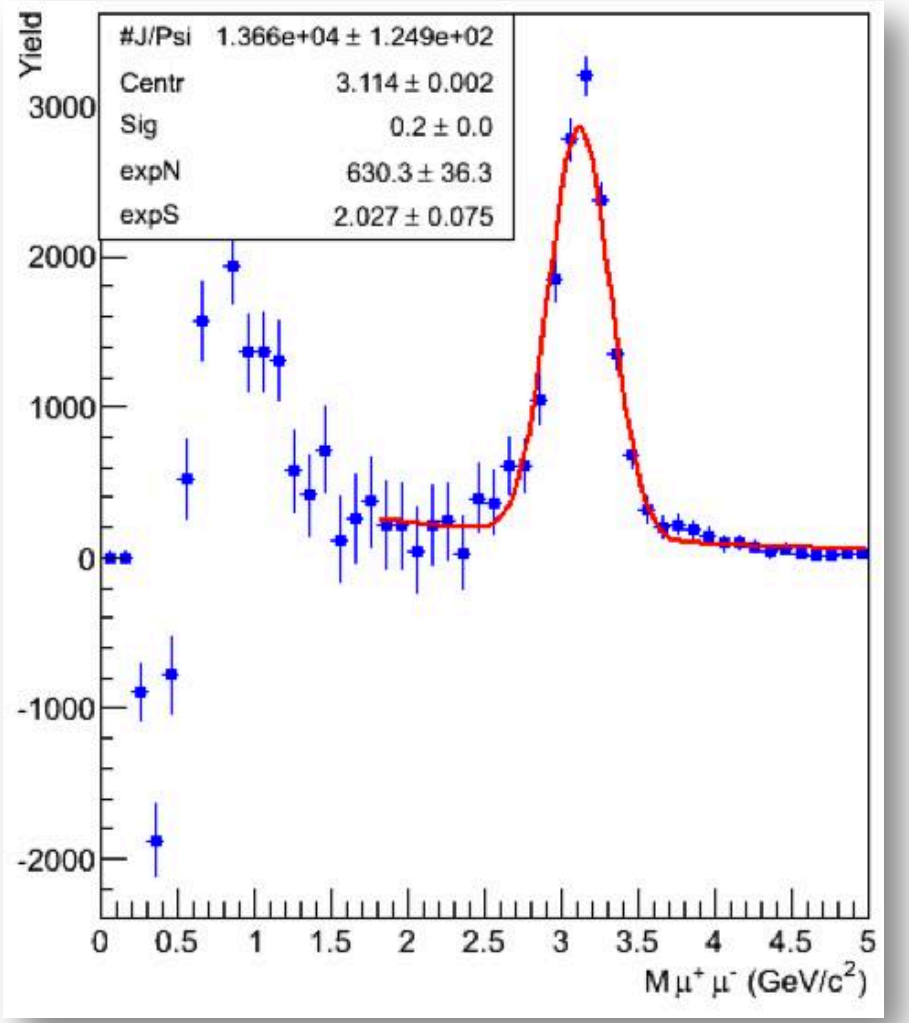

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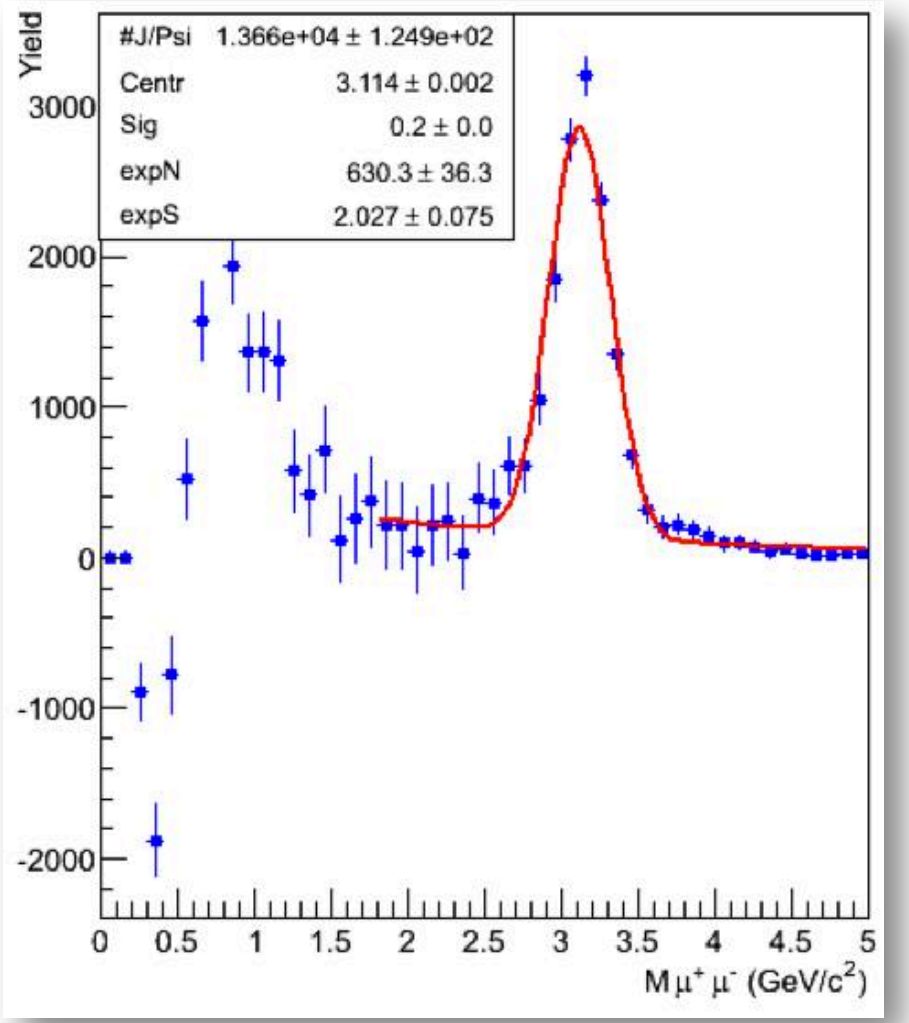

More J/ψ are sampled which allows us to make collision geometry dependent study!!!

OPERATIONAL LESSONS

- We had great support from CA-D for periodic detector repairs.
- Having a pre-planned/fixed CA-D run schedule made running the experiment much smoother.
- In the future, we need to plan ahead and agree on the balance between the machine studies and physics measurements.

Frequent APEX and MD Effect on

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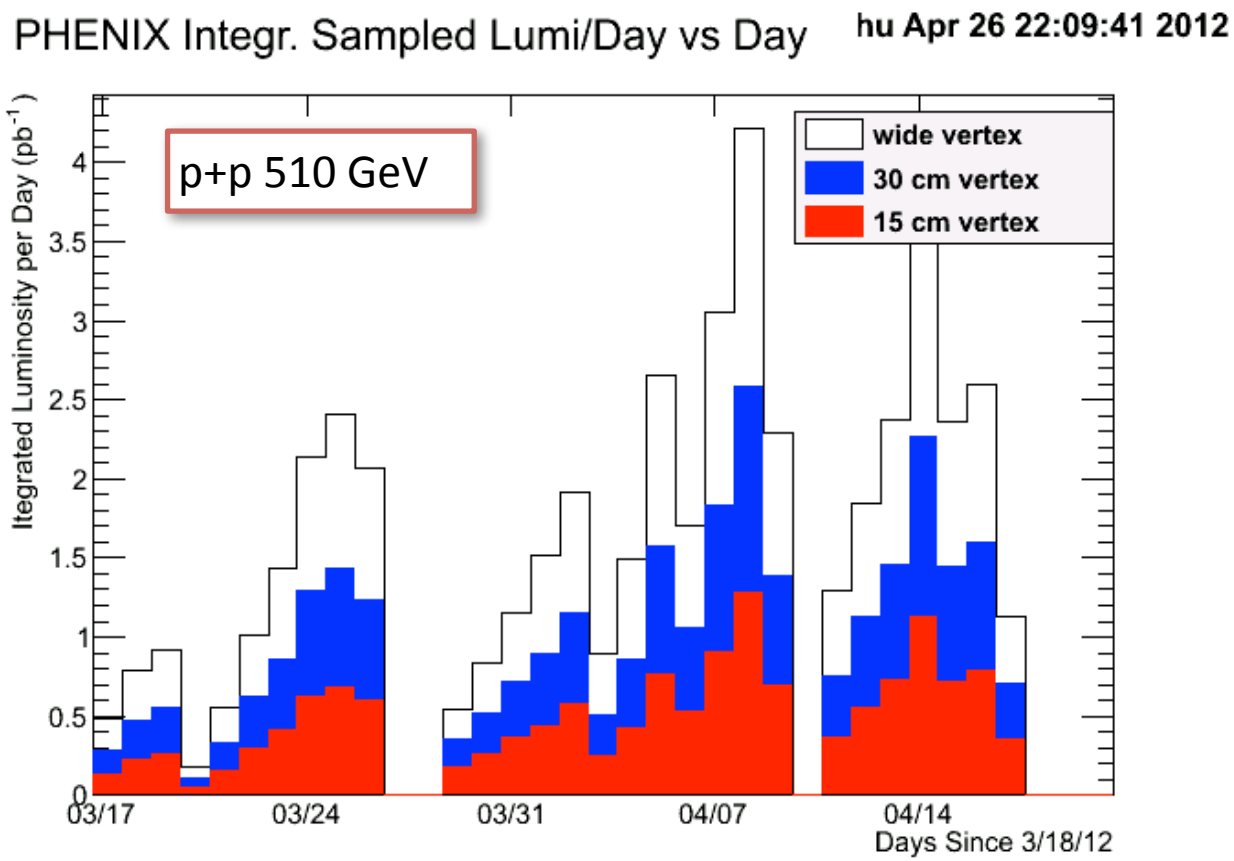

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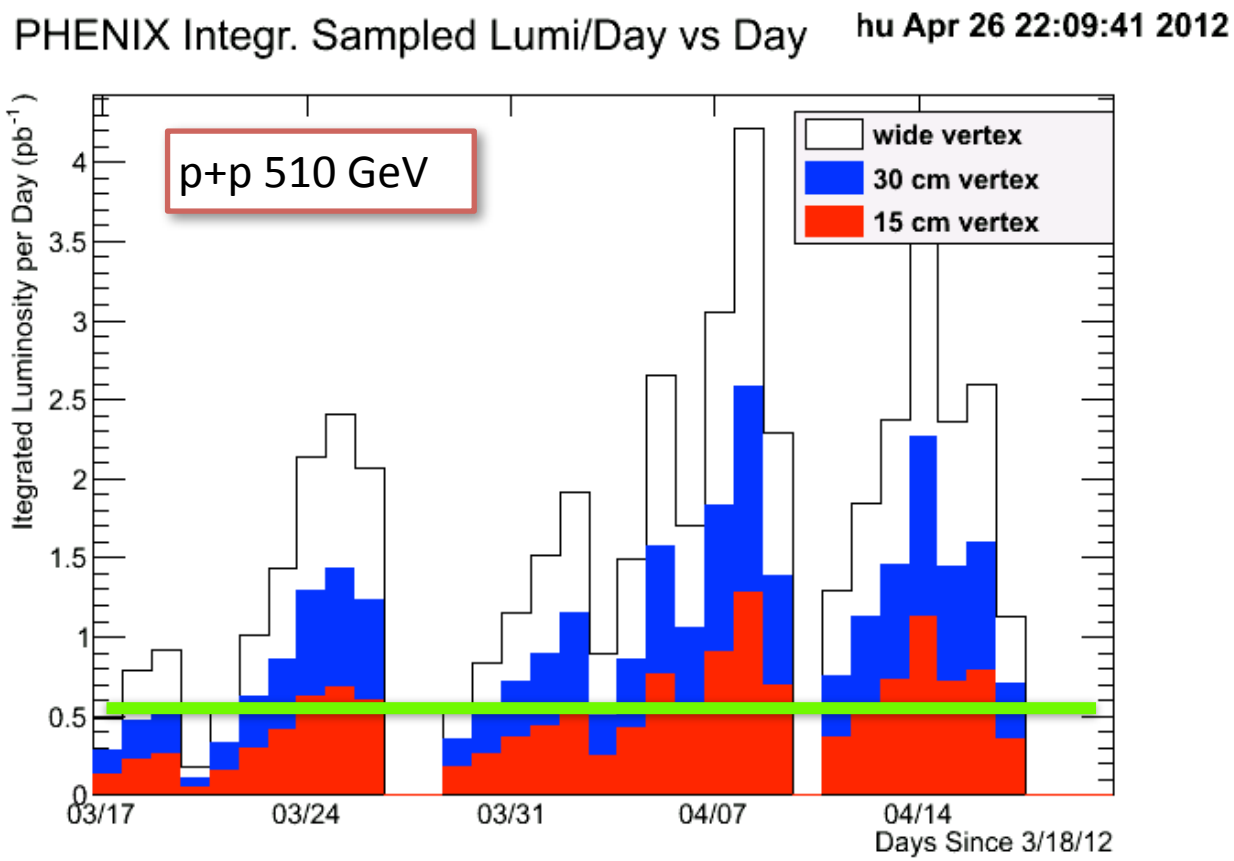
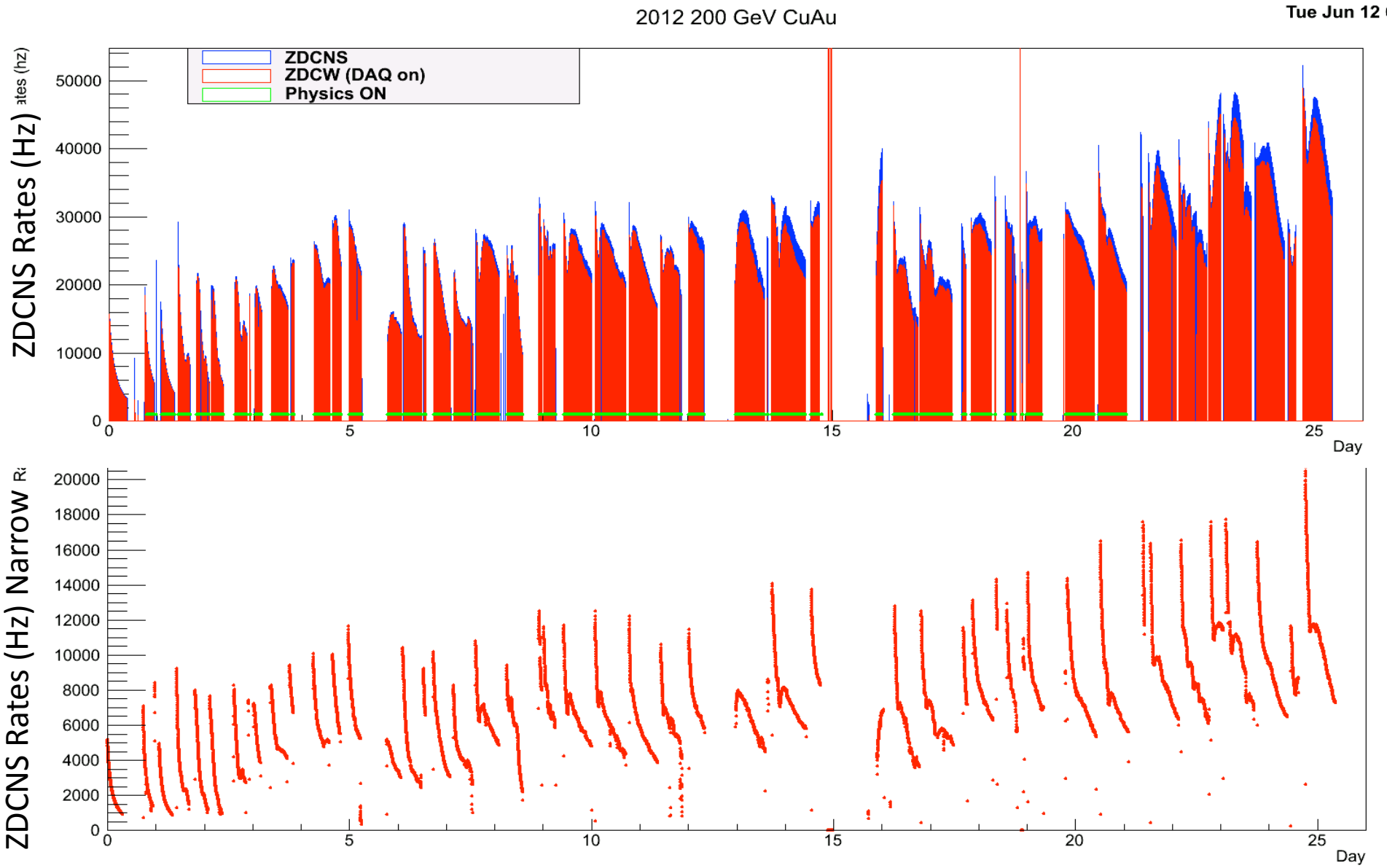


For future runs, we request less frequent interventions to increase the number of days when we can record "steady state" luminosity.

Everyday was a Record Breaking Day



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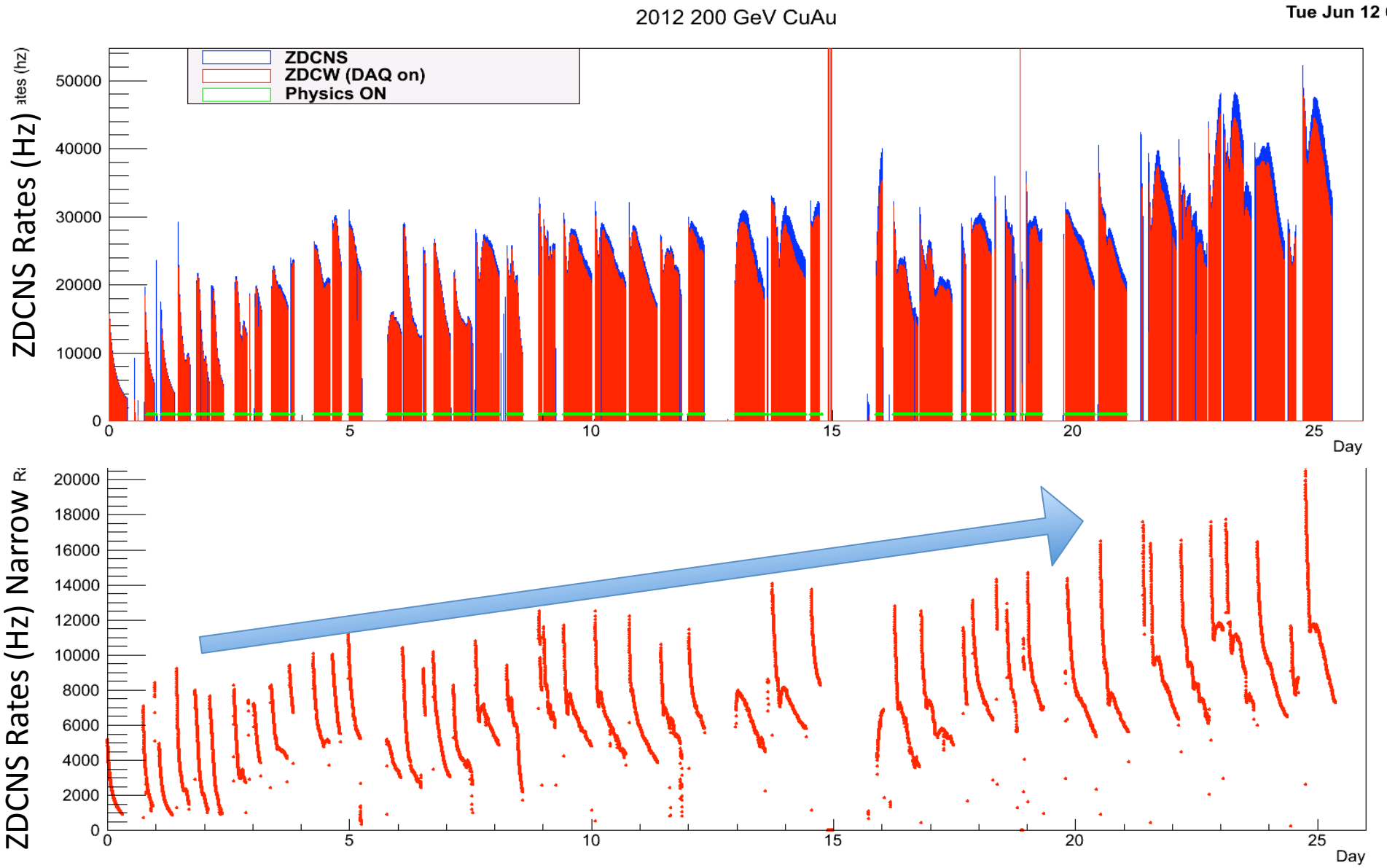

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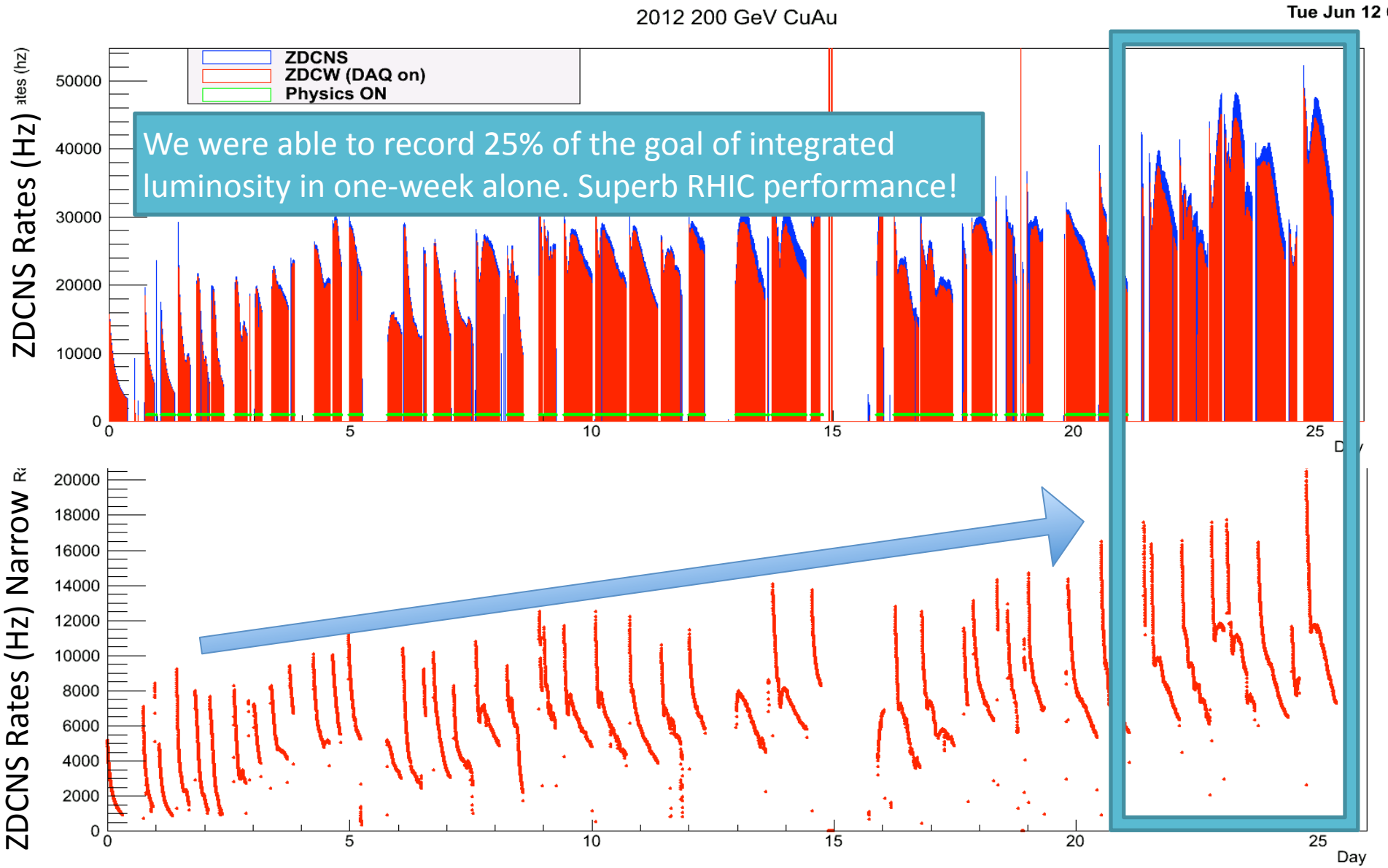

We were able to record 25% of the goal of integrated luminosity in one-week alone. Superb RHIC performance!

Force of Nature Impacted Data Taking

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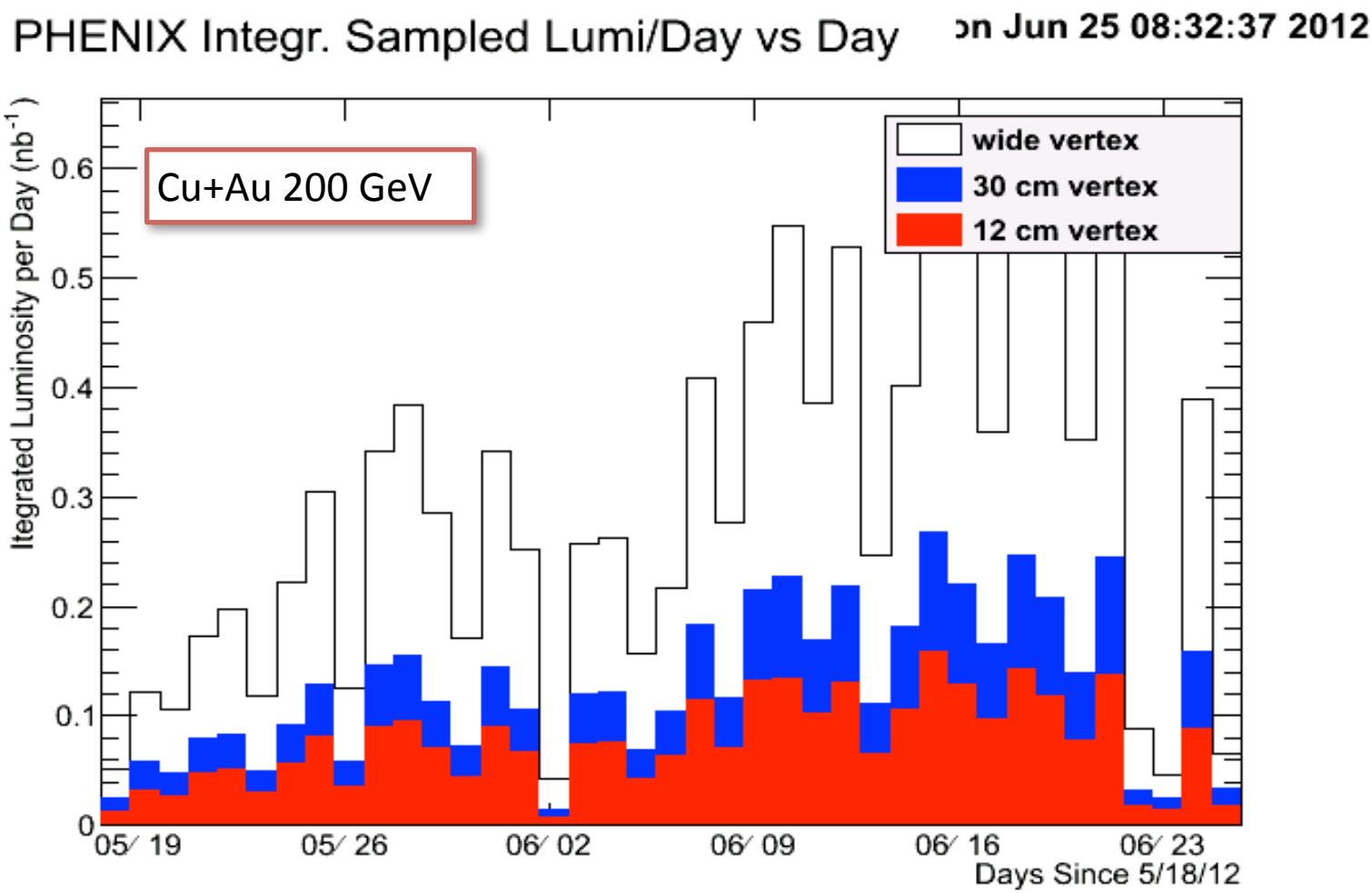

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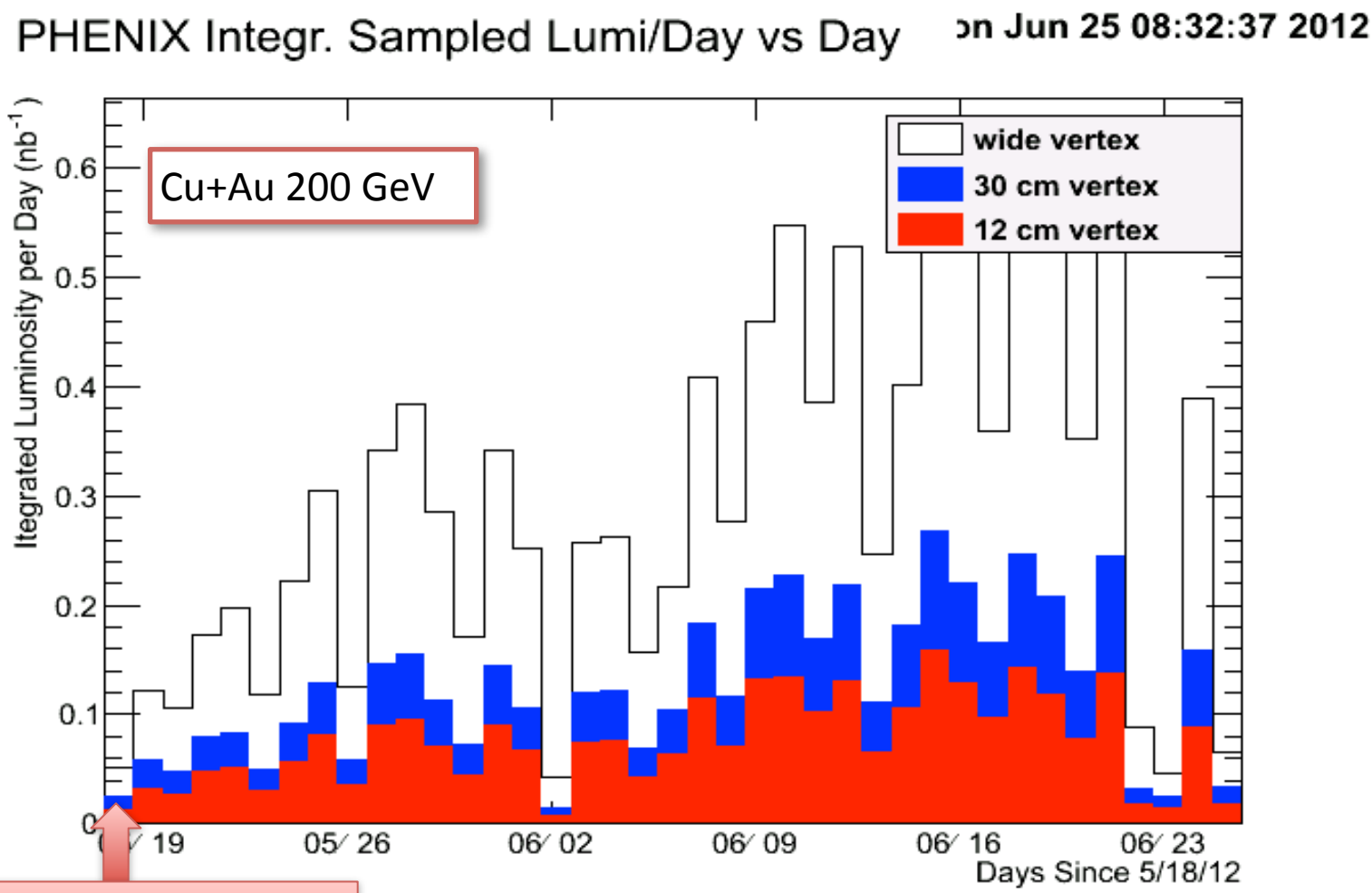

On 5/18, lost 3/4 of MPC detector modules from pre-fire event

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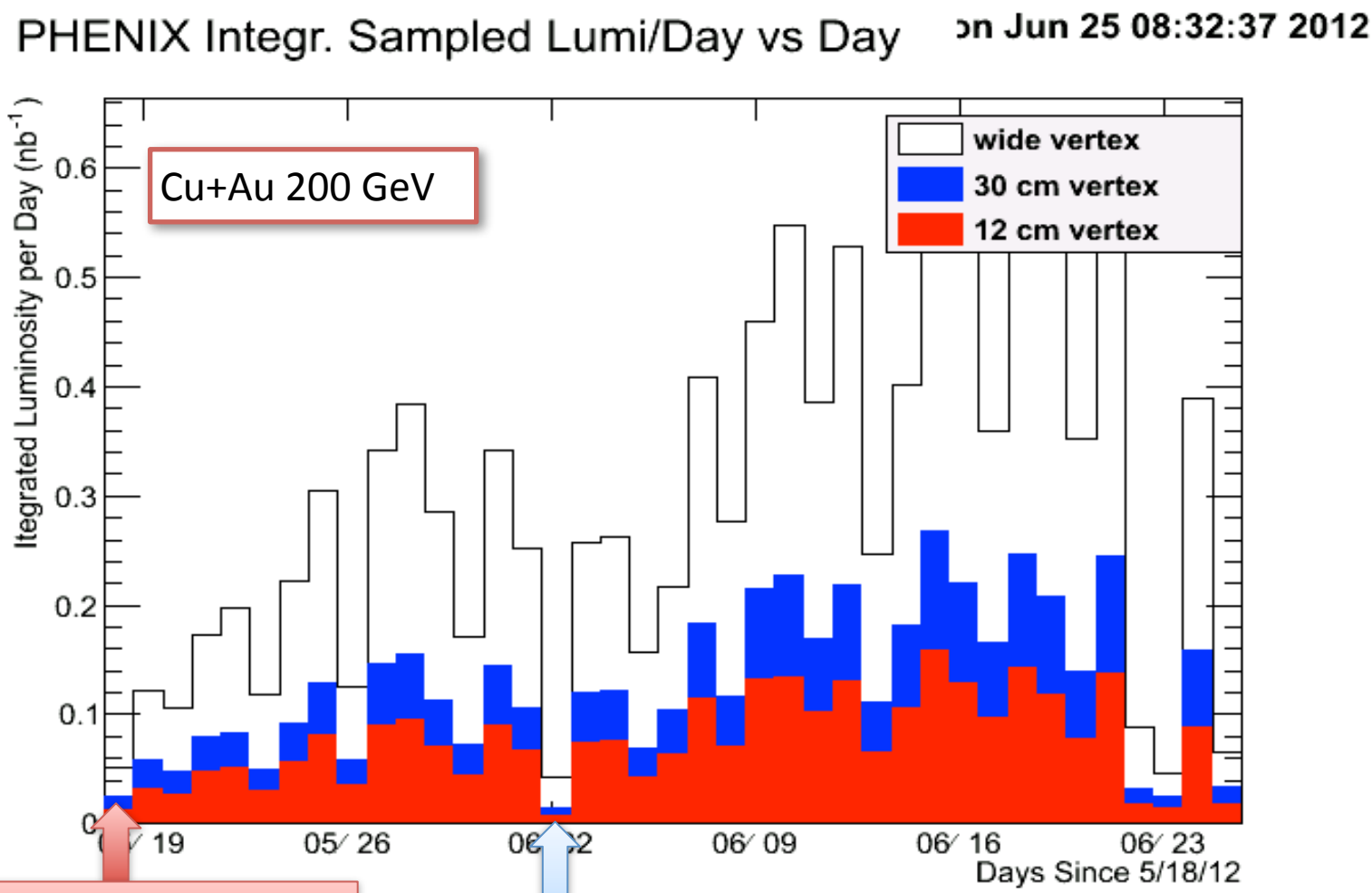

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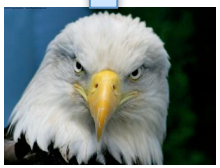

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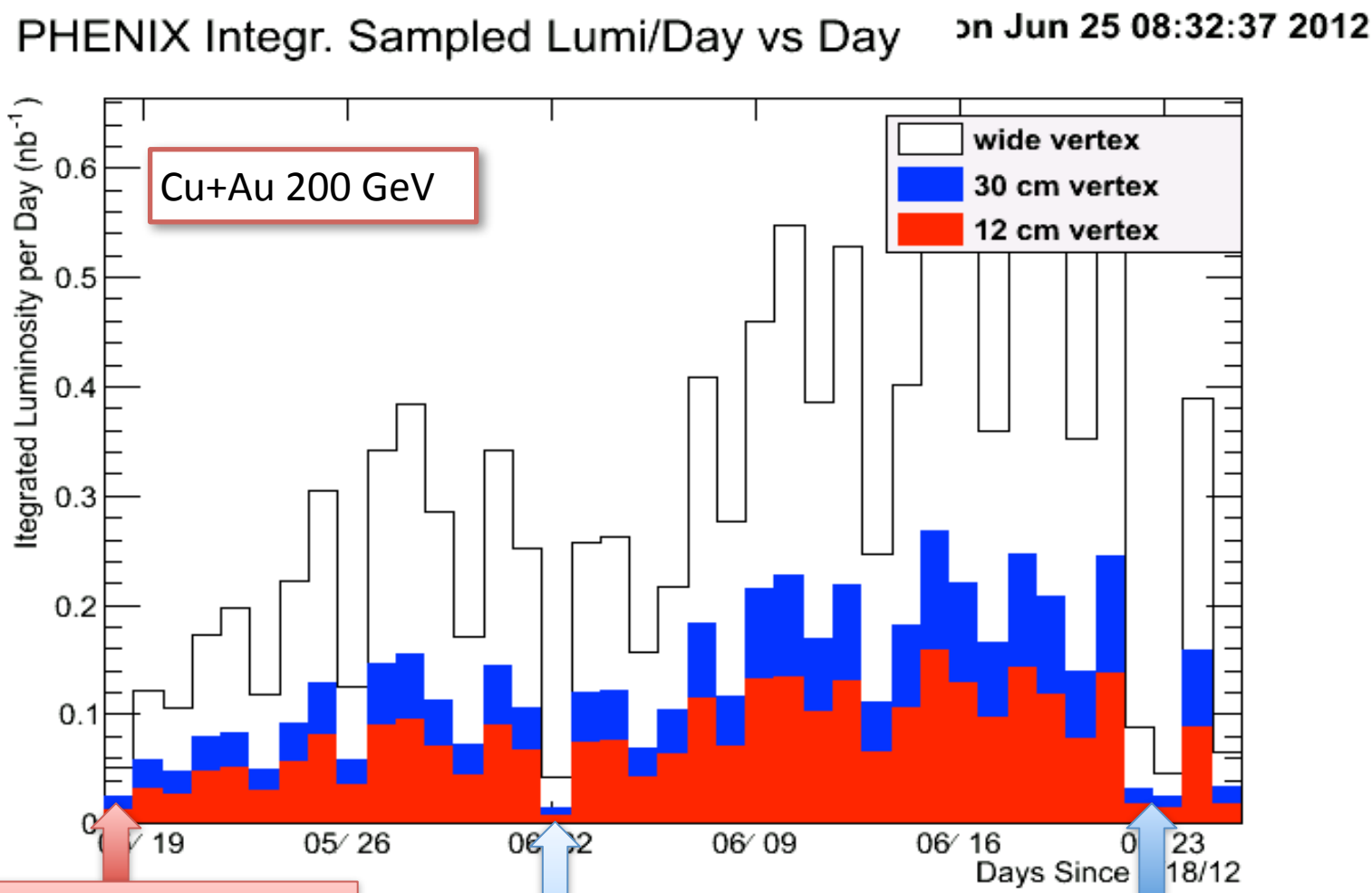

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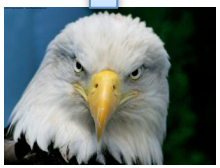
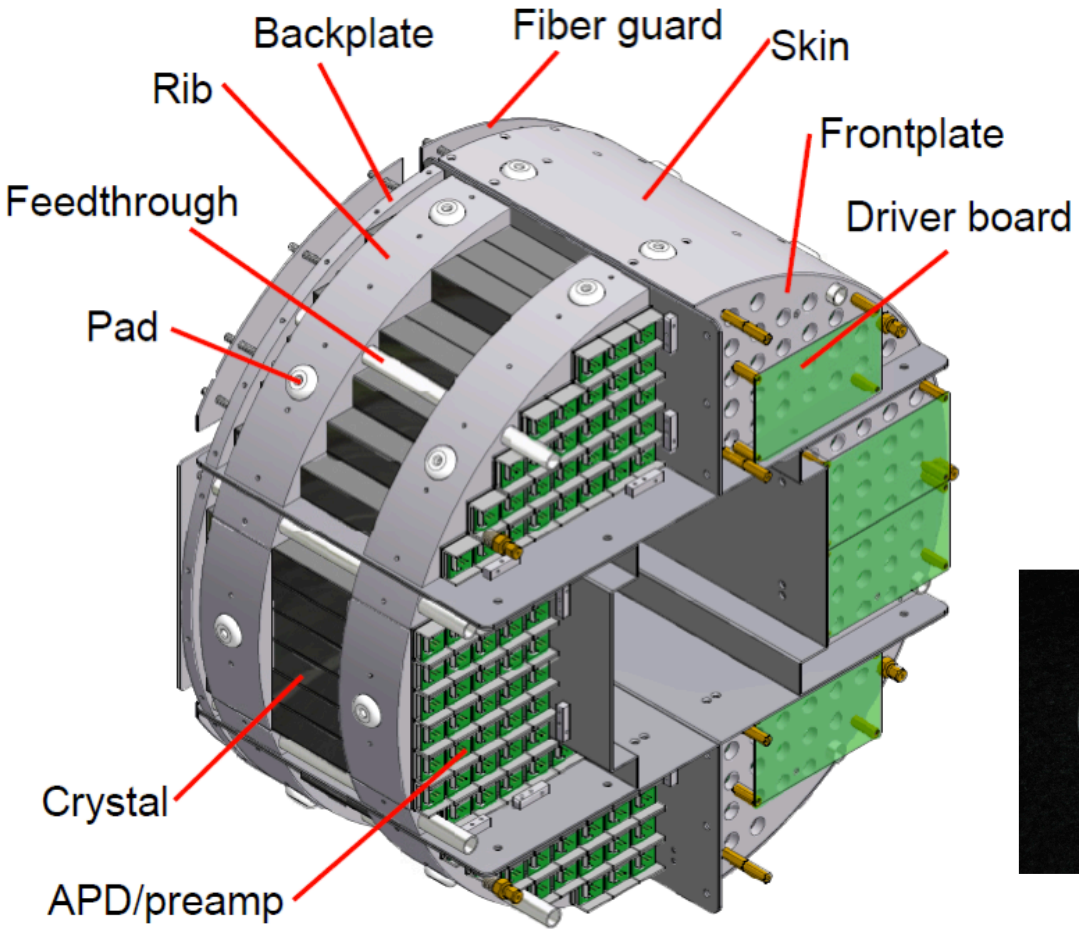
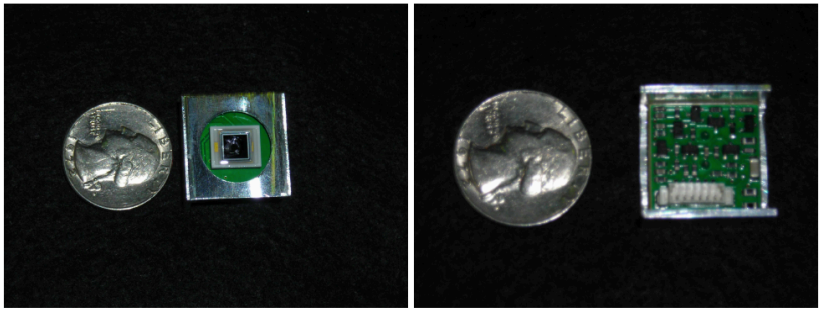


~36 hours of downtime caused by a lightning

About MPC

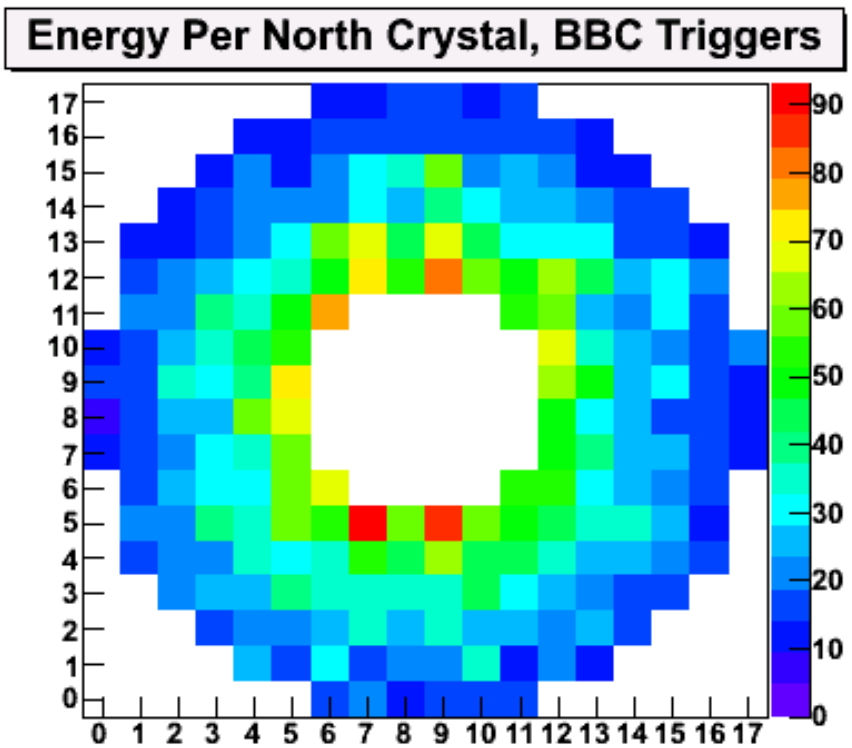


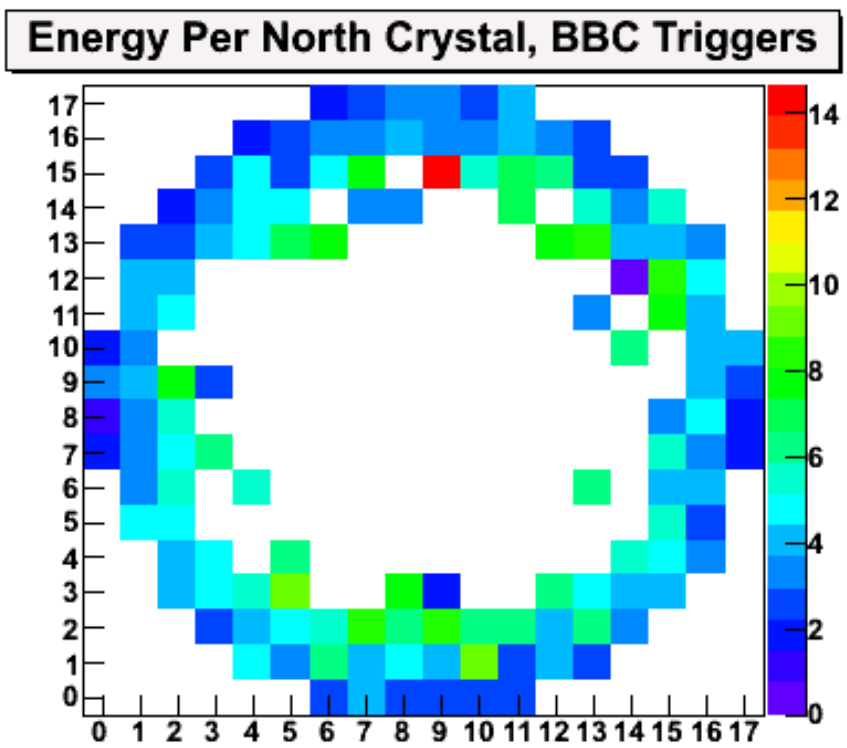


- Lost APD/preamp was not new to us but NOT in such a large scale.
- The last significant losses occurred during Run-10 period. We lost 5 readouts in each of unexpected beam dumps.

North MPC, Before and After

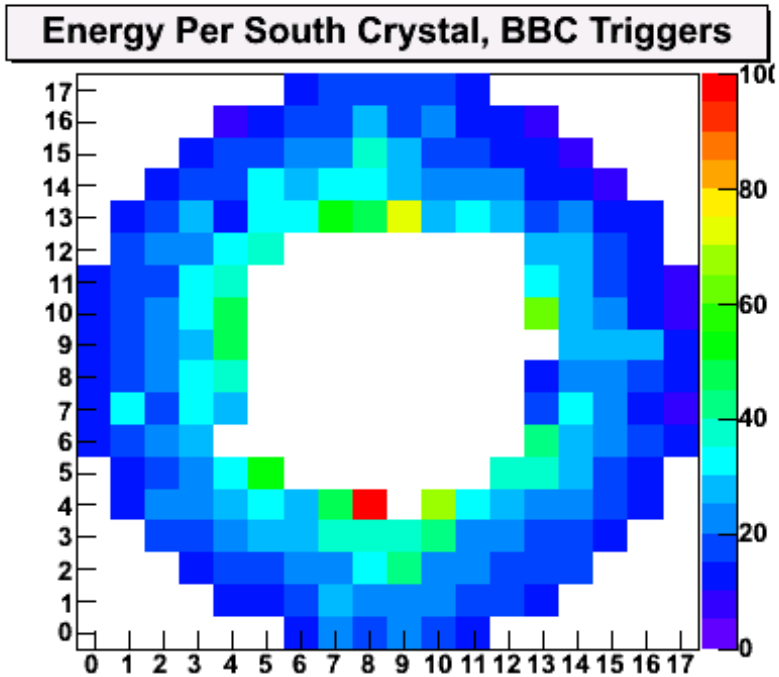
Cu beam going direction

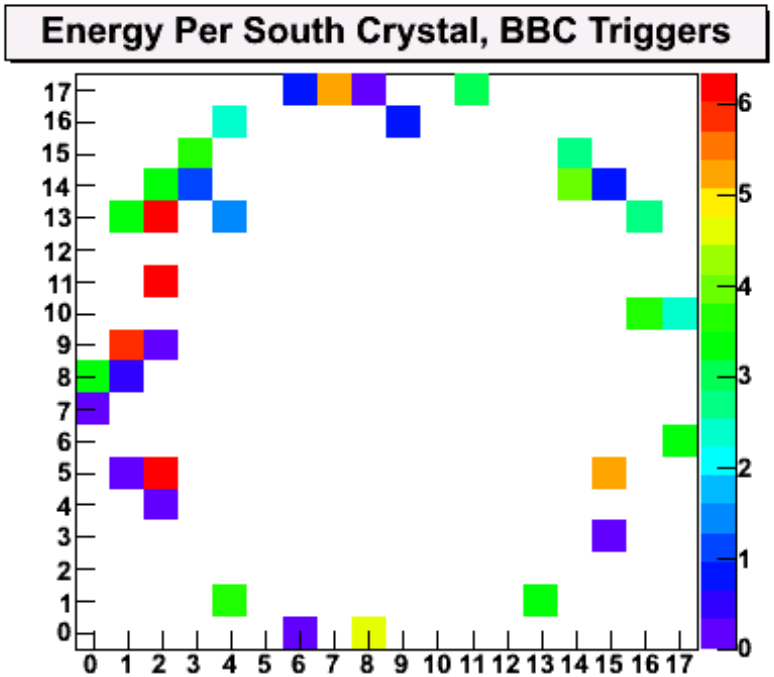




South MPC, Before and After

Au beam going direction





- We lost about 300 crystal readout out of 416 in total.
- The only way to fix the problem is to wait for summer shutdown.
- Add about 2-week extra work to the planned shutdown activities.
- Proper collimation between 10:00 and 08:00 clock should be helpful before Run-13

Extended Downtime near the End of Cu+Au Run (from CA-D eLog)

rhic-CuAu_2012 - **Sat_Jun_23_2012_8:59:59_AM**

Started: **2012-Jun-23 08:59:59** Ended:

Leader: **M. Lafky** Studiers: **R. Smith**

Title: **Sat Jun 23 2012** Log# **47**

æ 09:05:cp Updated Plan:
1) Next store: with 3 collisions.
2) Star test at IP2 still needs another 4 hours. After that, we will not provide collision at IP2.
2) BPM offsets can be installed after Star test is done. Call Al for the details. -Yun

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æ 09:06:cp Outstanding problems:
L18A chassis. W. Jappe is coming in.
H10 water. P. Callegari and S. Yakabowski are in.
Closed AGS sector valves. P. O'Grady is coming in for it.
-Lafky
09:38: Sector valves are open. -Lafky
09:53: L18A fixed. -Lafky
09:57: H10 fixed. We need to get the L10 RF cavity back on. -Lafky
10:33: Now waiting on L10 RF cavity and A10 house power supplies which keep interlocking on air flow faults (likely an A/C problem) -Lafky
10:40: L10 on and staying on. Nominal(ish) Au intensity in the AGS. We'll start taking shots and see where we're at with extraction. -Lafky
11:34: Extraction isn't going well. Left a message for Keith and Greg. -Lafky
12:28: Also contact Kevin or Tom to see if we need ATR synchro reset. -Yun
12:35: We're hitting a bunch, it disappears from the AGS. It's just not actually heading down the AtR. -Lafky
13:21: Spoke to Tom Hayes. He stated the kicker to bunch timing, about 1.5 microseconds, is correct. Steve Perlstein from the pulsed power group is coming in to look at G/H10 -Lafky
13:26: Vincent's looking from home. -Lafky

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It seemed taking too much time to recover!!!

Summary

- PHENIX/RHIC Run-12 run is a huge success.
- RHIC has demonstrated beautifully its versatile colliding capability of different species and energies in a single run-year: 200 and 510 GeV polarized p+p; U+U and Cu +Au collisions with increasing luminosity.
- RHIC computing facility is also a bright spot in Run-12, which supported a record-breaking data storage rates and provides efficient computing power for a fast physics data analysis.
- Great communication and feedback between CA-D and PHENIX.

Newest Phenixians

In Run-12, as far as I was informed, there were four new Phenixians born during this period. This magically matches the number of four types of collisions we had in Run-12.

Lisa (Maya and Takashi are the proud parent) came on June 26, 2012, one day after the end of Run-12 physics run.

ACKNOWLEDGEMENT

PHENIX would like to thank CA-D for the record-breaking performance in Run-12, especially to three run coordinators: Vincent, Yun and Christoph.

Update From RHIC Run 12:

One World Record, Three World Firsts

Roger Stoutenburgh D260005 12

Run 12 at RHIC provides world's highest beam energy for polarized protons, uranium-uranium collisions, increasing luminosity for colliding uranium beams, and copper-gold collisions

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Roger Stoutenburgh D2600512

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Run-12 Physics Programs

- p+p collisions at 200 GeV: Heavy ion reference measurements for separating charm and beauty; Measurement of the transverse structure of proton.
- p+p collisions at 510 GeV: Studying the sea quark and gluon spin contribution for resolving the proton spin puzzle.
- U+U at 193 GeV: Exploring colliding geometry.
- Cu+Au at 200 GeV: Use the unique geometry (core vs corona and asymmetric peripheral) of the colliding system

Projected Data Taking Goals

Species	sqrt(s_NN)	Weeks	Int L dt (|z| <10 cm)
p+p	200 GeV	4	3.8 pb^{-1}
p+p	510 GeV	5	9.9 pb^{-1}
U+U	193 GeV	3	60 μb^{-1}
Cu+Au	200 GeV	5	2.4 nb^{-1}

Efficiency for Good Physics Runs

- 2012 200 pp
  - Efficiency for Good Physics Runs vs All Runs = 0.829
- 2012 510 pp
  - Efficiency for Good Physics Runs vs All Runs = 0.881
- 2012 193 UU
  - Efficiency for Good Physics Runs vs All Runs = 0.971
- 2012 200 CuAu
  - Efficiency for Good Physics Runs vs All Runs = 0.970