PHENIX In Run 9

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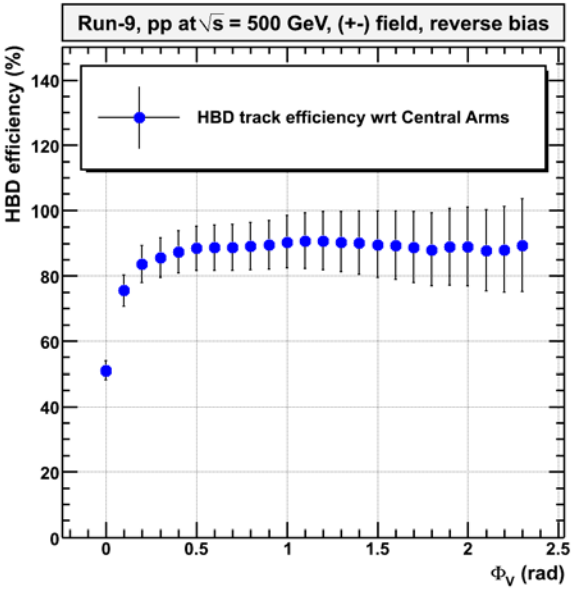
PHENIX

PHENIX in Run 9

- 23 weeks of operation
  - 4 physics weeks, 500 GeV longitudinally polarized pp
  - 10 physics weeks, 200 GeV longitudinally polarized pp
- New detectors
  - Rebuilt HBD
  - Muon trigger electronics
  - Muon RPC prototype
- Other improvements
  - EMCAL gain balancing (adjusted dynamic range for W)
  - Fastrak analysis
  - Reduced deadtime

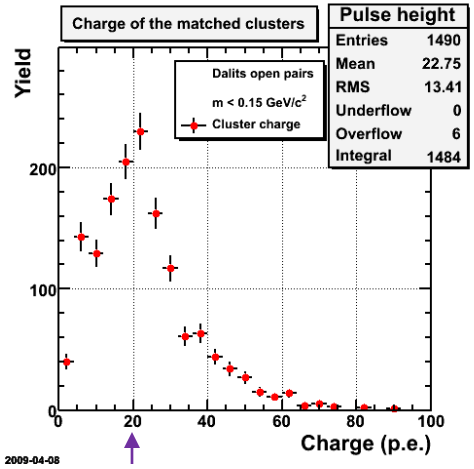
HBD performance



Electrons from Dalitz pairs in the mass region below 150 MeV. The number of photoelectrons is ~22, more than 50% increase from Run 7

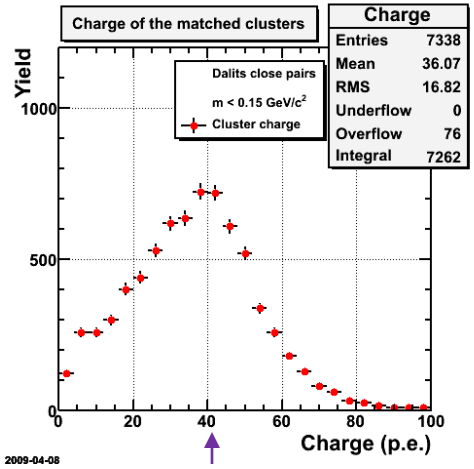
- Achieved desired performance in photoelectron yield
- Clearly separate single and double electrons

Single electrons



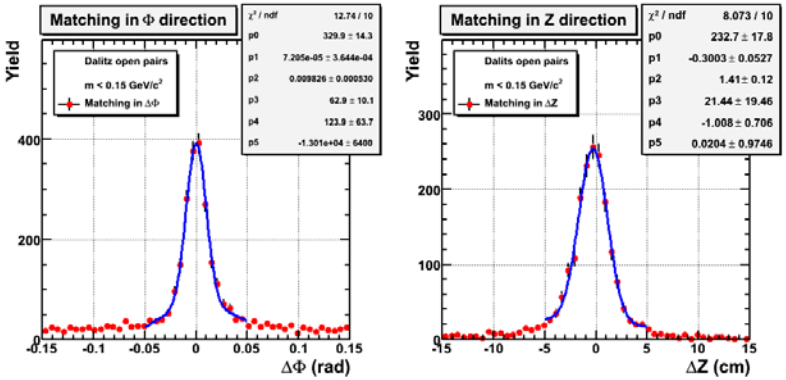
20 pe

Double electrons



40 pe

ϕ-z matching

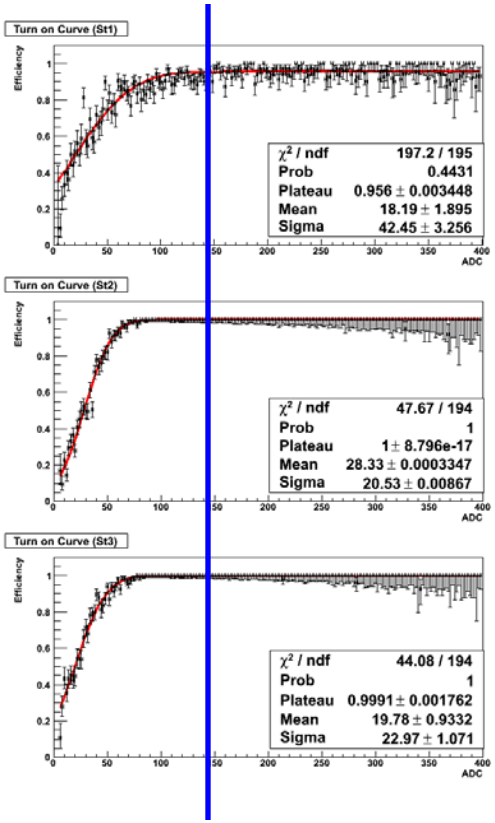


MUTRIG performance

Station 1

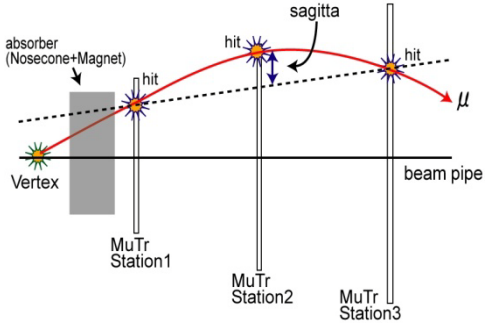
Station 2

Station 3



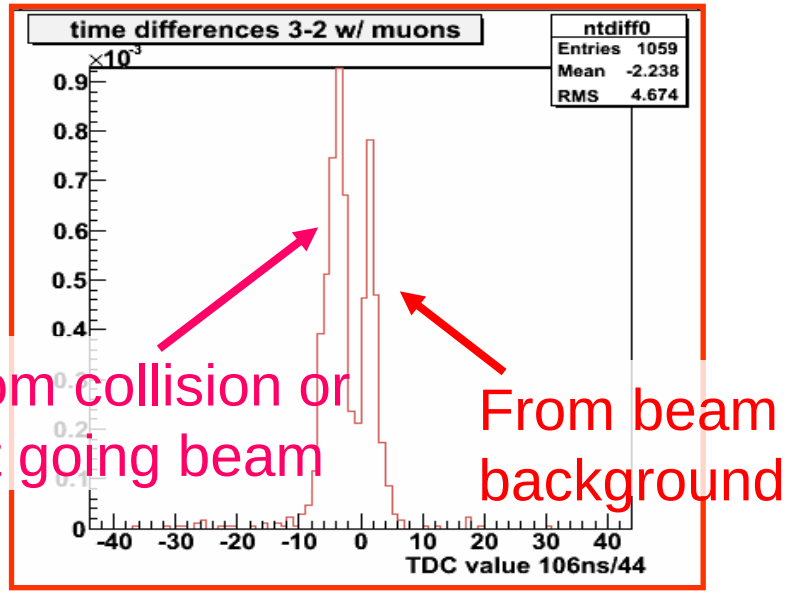
Minimum Ionizing Particle

- Good efficiency with 30 mV threshold
- Read out in data stream in MUTR.N for the entire run
- Small partial installation for test in MUTR.S to cover RPC
- Prototype trigger logic being tested



RPC

- Engineering run for sectors in 2 planes on south arm
- Timing has illuminated background already



200 GeV physics

PRL **103,** 012003 (2009) PHYSICAL REVIEW LETTERS week ending 3 JULY 2009

Gluon-Spin Contribution to the Proton Spin from the Double-Helicity Asymmetry in Inclusive π^0 Production in Polarized $p + p$ Collisions at $\sqrt{s} = 200$ GeV

A. Adare,[12] S. Afanasiev,[26] C. Aidala,[37] N. N. Ajitanand,[54] Y. Akiba,[48,49] H. Al-Bataineh,[43] J. Alexander,[54] K. Aoki,[31,48]

PRL **103,** 012003 (2009) PHYSICAL REVIEW LETTERS week ending 3 JULY 2009

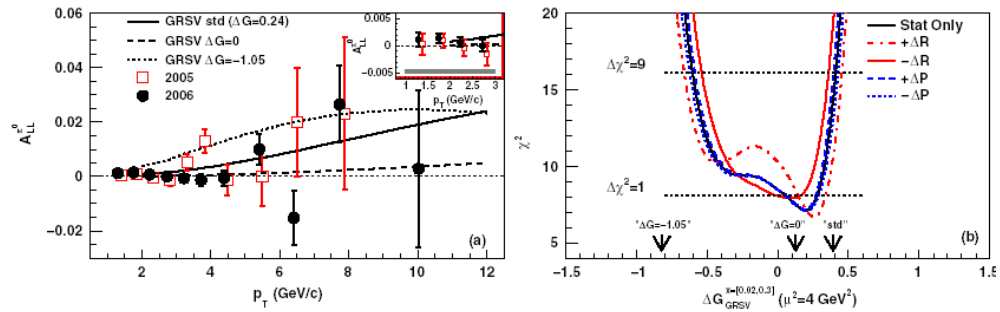
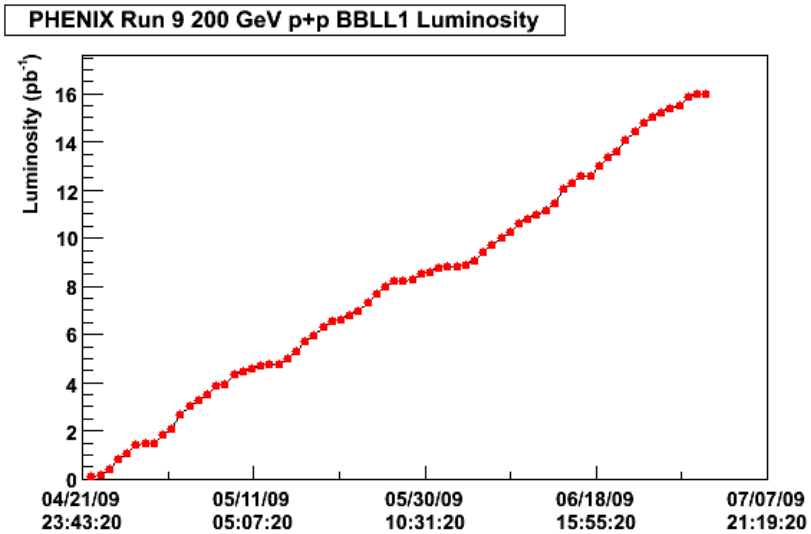


FIG. 2 (color online). (a) Asymmetry in π^0 production as a function of p_T. The error bars are statistical uncertainties. An 8.3% scale uncertainty due to the uncertainty in beam polarization is not shown. The p_T independent uncertainty of 7×10^{-4} due to relative luminosity is shown only in the inset as a shaded bar. For comparison, we also show our 2005 result. NLO pQCD expectations based on several inputs for ΔG in the GRSV parametrization are plotted. (b) The χ^2 profile as a function of $\Delta G_{\mathrm{GRSV}}^{[0.02,0.3]}$ using the combined 2005 and 2006 data considering only statistical uncertainty, or also varying by $\pm 1\sigma$ the two primary experimental systematic uncertainties, from beam polarizations ($\pm \Delta P$) and relative luminosity ($\pm \Delta R$).

Almost the same day Run 9 ended, Run 6 π^0 result (first ΔG result at 200 GeV) was published in *PRL*

200 GeV pp in Run 9



Run 6 analysis was based on 6.5 pb^{-1} with polarization ~0.56

Run 9 will be based on ~16 pb^{-1} (2.5 times Run 6) and about the same polarization

	Luminosity	Polarization	FOM
Goal	25 pb^{-1}	60%	3.24
Achieved	16 pb^{-1}	55%	1.46

200 GeV pp beyond Run 9

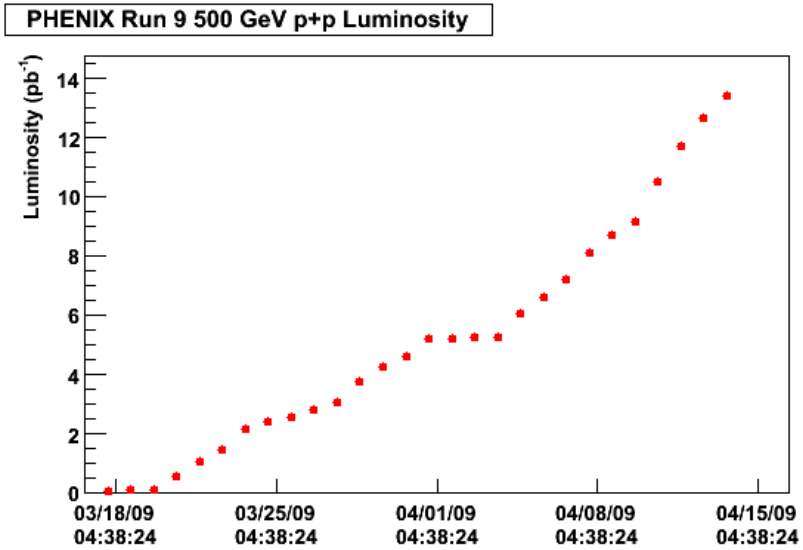
- Global fits for ΔG require high statistics and good polarization to have a real physics impact
- Updated spin plan
  http://spin.riken.bnl.gov/rsc/report/spinplan_2008/spinplan08.pdf
  calls for 50 pb^{-1} and 60% polarization* which allows:
  - Rare probes like direct photons
  - Increased statistical accuracy to affect global fits
- Physics program requires high luminosity and polarization to be competitive
  - PHENIX goal: $(50\ pb^{-1})(0.6)^4 = 6.5\ pb^{-1}$
  - This year: $(16\ pb^{-1})(0.55)^4 = 1.5\ pb^{-1}$
  - With no luminosity/polarization improvements, 33 more weeks to reach goal

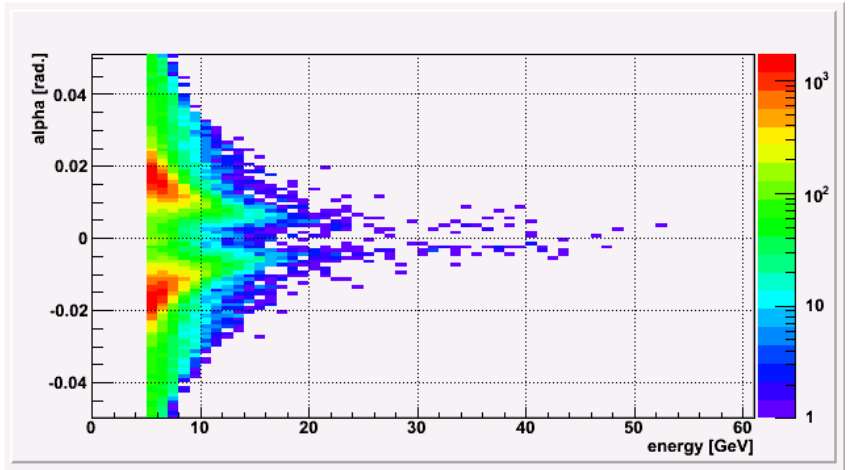
*2008 Spin Plan revised from 300 pb^{-1}

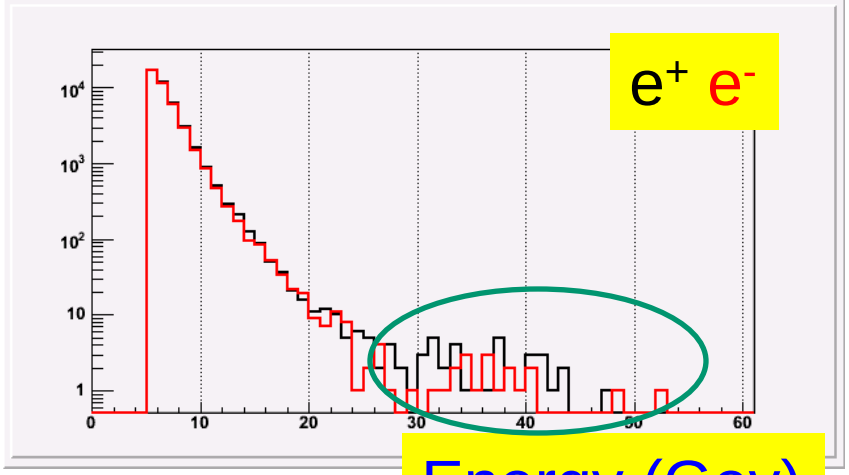
500 GeV pp in Run 9

- First look at 500 GeV pp
- We must complete our muon arm upgrades to measure W in the forward region, but this run gave us a critical first look at backgrounds, luminosity, polarization
- Looked for W→e in central region
  - Calibrated and reconstructed *all* W triggers during the run in the “Fastrak” analysis

500 GeV pp so far







About 14 pb^{-1} recorded within vertex cut… Fastrak analysis shows evidence for W→ev in central arms

500 GeV pp beyond Run 9

- Spin plan calls for 300 pb^{-1} and 60% polarization
  - W program: $(300\ pb^{-1})(0.6)^2 = 108\ pb^{-1}$
  - ΔG: $(300\ pb^{-1})(0.6)^4 = 39\ pb^{-1}$ FOM goal
  - Run 9 W: $(14\ pb^{-1})(0.35)^2 = 1.7\ pb^{-1}$
- Polarization is very far from where we need to be; with 5 pb^{-1}/week, here's what we'd need to reach the FOM goal:

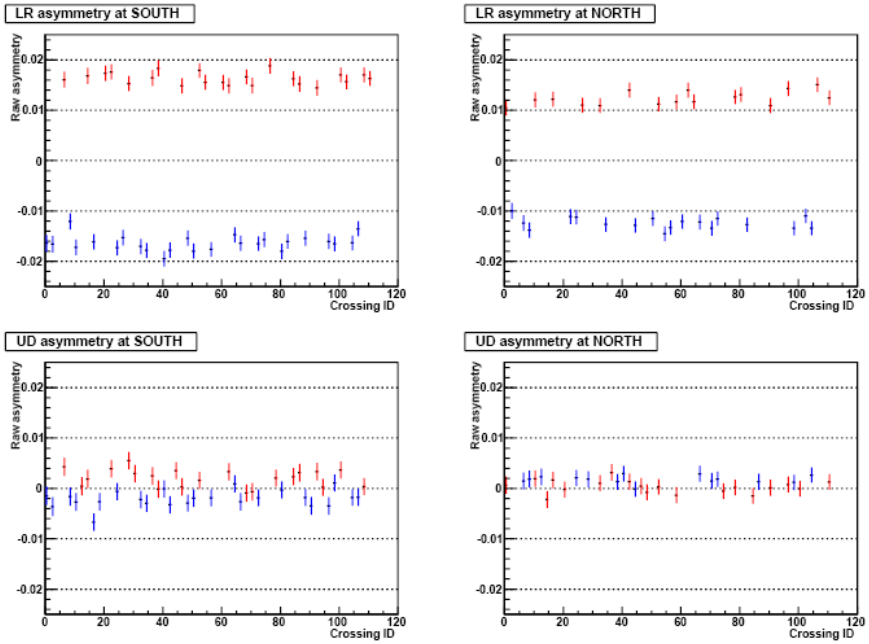
Polarization	Weeks for W	Weeks for ΔG
40%	135	304
50%	87	125
60%	60	60
70%	44	33

Polarimetry

- It's not only a PHENIX issue, I'll just comment that reliable and timely polarimetry is essential; polarimetry group is looking to improve this
- PHENIX Local Polarimetry gave rapid feedback

RED : yell pol. ↑
BLUE : yell pol. ↓

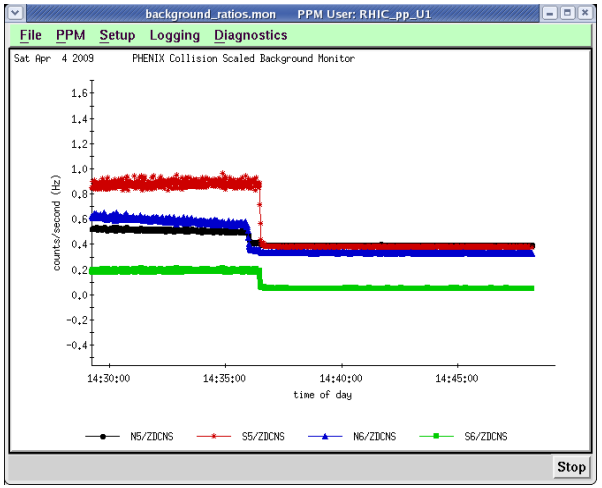
RED : blue pol. ↑
BLUE : blue pol. ↓



Transverse (10371)

Backgrounds

- First taste of >1 MHz interaction rates
- Demonstrated operability of detectors
- Multiple collisions per crossing and in adjacent crossings had to be reckoned with
- Scaling the backgrounds to the collision rate worked ok as a rule of thumb
- We probably need to install more instrumentation to monitor the background (larger counters, pulse height/time measurement), though some of that comes for free with the muon RPC's
- Is the axis of the beampipe aligned with the DX magnets? Survey… particularly the new smaller beampipe



RHIC upgrades for Run 9

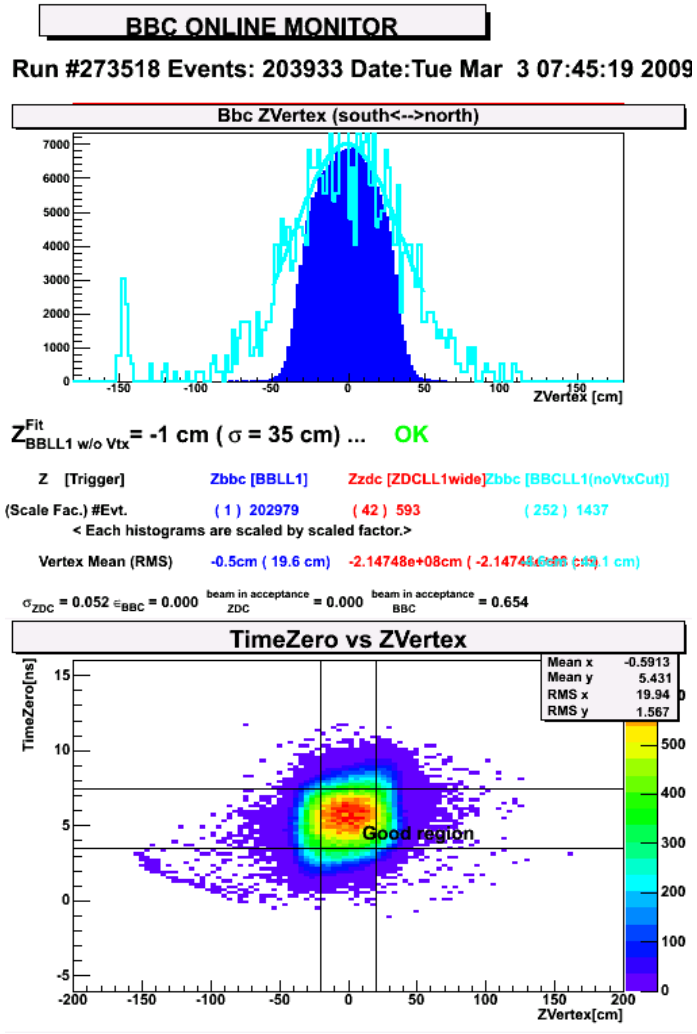
- During the physics run, there was installation and development of:
  - 9.4 MHz RF to reduce luminous region… not completed
  - Spin flipper to reduce systematic errors… not completed
  - AGS jump quads to increase AGS polarization… not completed (fire)
  - LLRF… not completed
  - Ramp development… lots completed
  - Weekly APEX

Lessons learned

- Accelerator components need to be installed before the run begins, don't waste beam time trying to install them while running
- Coordinated planning with the experiments is necessary *before* the run
- Is there any way to imagine ramp development taking less cryo time?
- More concentrated development and study periods would allow better experimental operation—longer APEX periods less frequently?

Longitudinal vertex distribution

- The longitudinal vertex distribution is unchanged since Run 1
- Looming issue for vertex detectors in Run11 which will only be useful ±10 cm

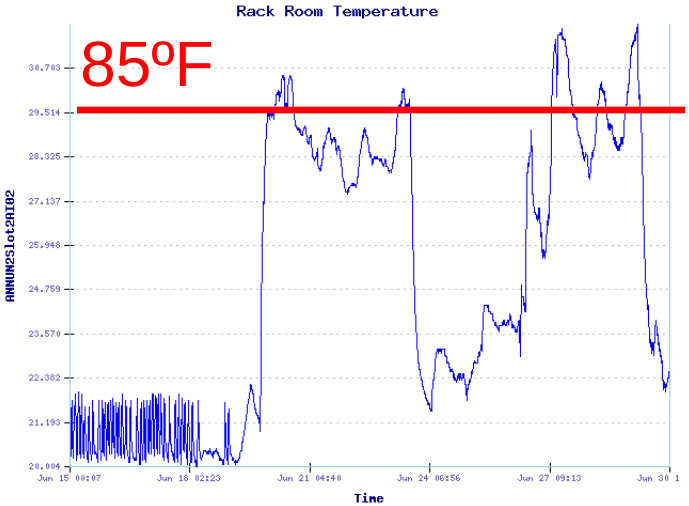


PHENIX infrastructure

- Air Cooling is critically important to many PHENIX systems and a silly waste of beam time when it fails
- Chilled water for electronic cooling is being improved (separate cooling loops for magnets and electronics)
  - Should have hot spare, redundant failover
  - Needs monitoring available to PHENIX
- IR air conditioning
  - Machines inaccessible
  - Only particular PE techs know anything about them
- Rack room air conditioning is a disaster waiting to happen
- Data errors, starting and stopping runs to download components… very inefficient operation

Rack room air conditioner replacement

- A thirty year old air conditioner is essential to PHENIX operation
- It fails, and the other two units don't keep up
- Exhaust fans?
- Needs redundant machines
- Needs engineering to sort out the ducts, review the installation (but we got phase loss monitoring when we asked after the third compressor blew up)



What worked, what didn't

- Communication with MCR was very good
- PASS worked well
- Magnets worked very well
- Came to agree on backgrounds
- Eliminated "beam hours" reporting

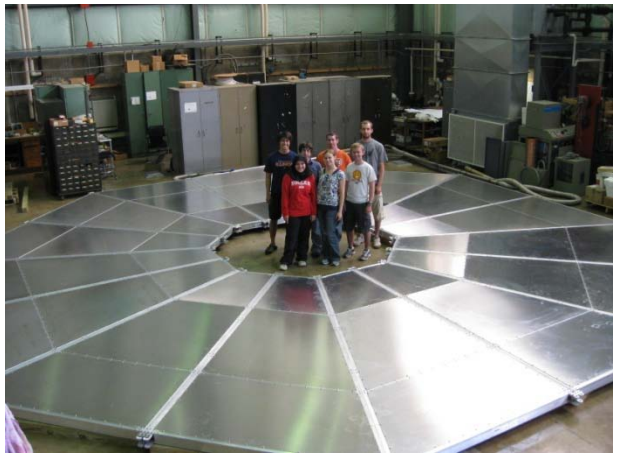
- Weekdays were not productive
- Power dips wreak havoc
- Air Conditioning!
- High polarization is what will make this program live or die

Conclusion

- Run 9 has some significant firsts
- The future will hold detector improvements (forward muon triggering, vertex detectors) that require
  - More luminosity in 200 GeV pp
  - Higher polarization in 500 GeV pp
- Our physics requires:
  - Spin flipper when systematic errors near statistical errors
  - Shorter vertex distribution to exploit the vertex detectors
- We cannot ignore infrastructure improvements

The shutdown begins…

With the gas purged,
safety system in bypass,
the shift crews go home
to prepare for Run 10….



Thanks

It has been a privilege to work with you this year… even when I didn't get what I want, I knew that you were doing your damndest. Thanks particularly to:

- Mei and Christoph, for doing a tough job with grace and skill, and Eduard for keeping us on schedule
- Everyone in MCR, but particularly the OC's who helped me many times
- Our liaison engineer, Dave Phillips, who was there for us
- Phil and Yousef for their support
- Everyone else whose dedication and knowledge makes this all possible, and Waldo for explaining it to me