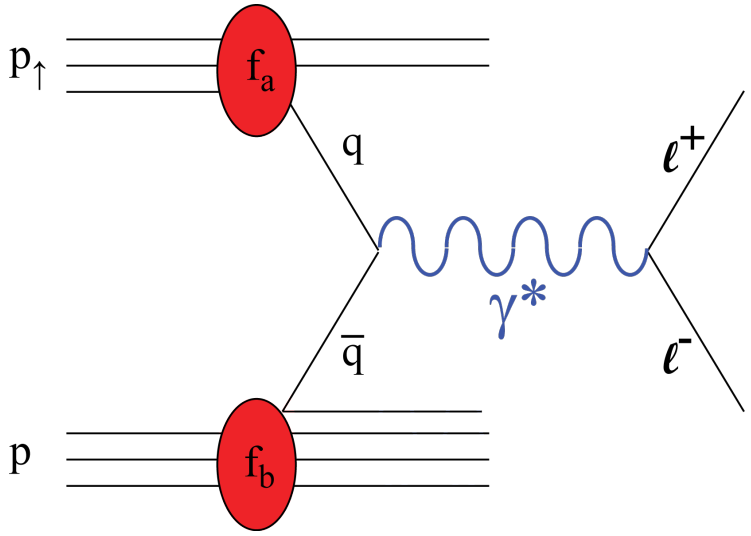
A_NDY Status

Commissioning with colliding beams

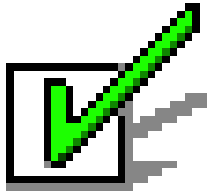


L.C.Bland, for AnDY

17 April 2012

Time Meeting, BNL

Requests from 20120407



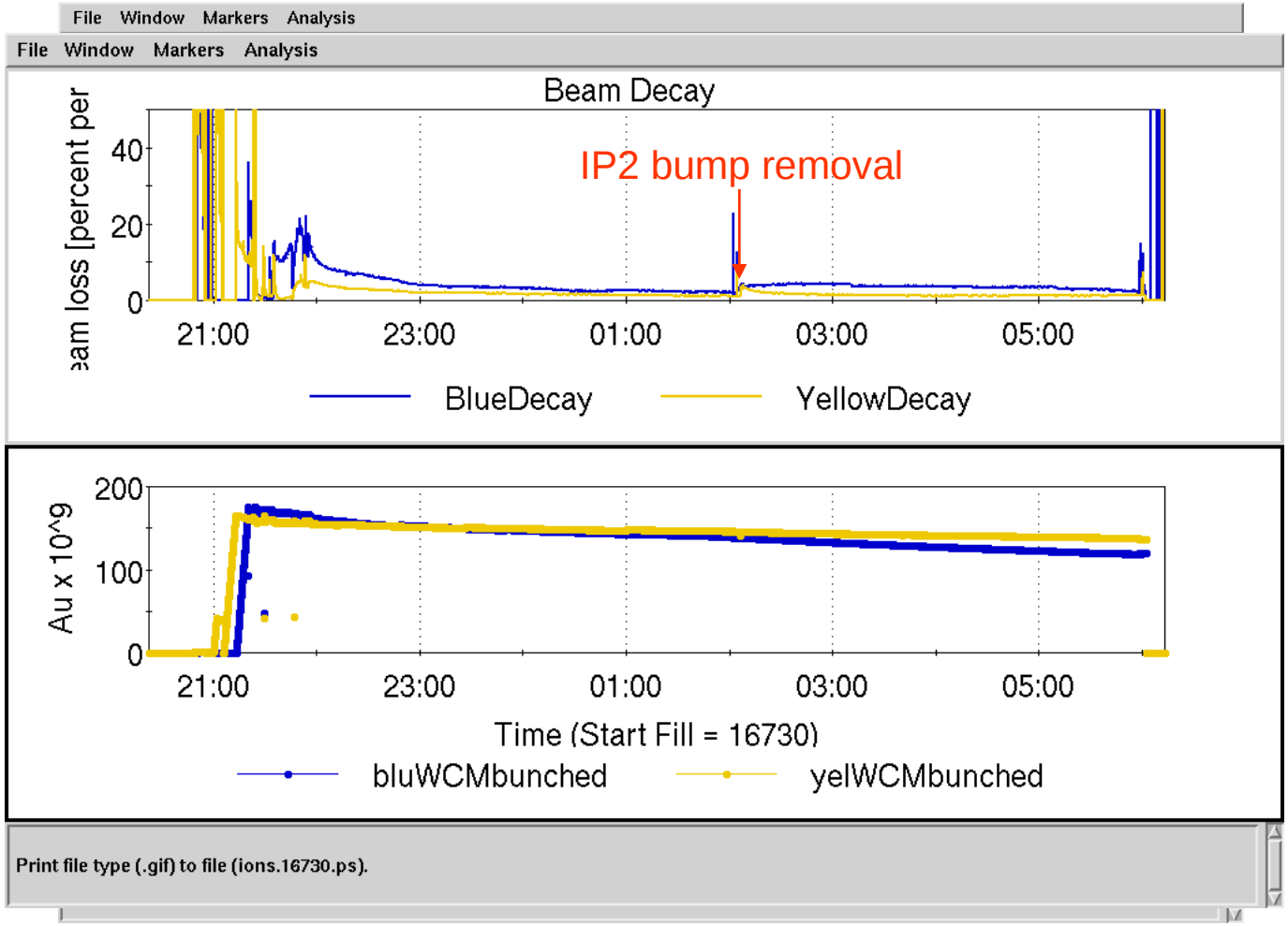
Complete end-of-store measurements to tune-up IP2 bump removal and collimation optimization to reduce backgrounds when IP2 goes into collisions.

- Bare minimum request is >2 fills wi… …s. 1 fill needed for final timing checks of separated … …p of run-12 apparatus. 2 fills needed with ECal in its out … …ablish from measurement effects from trigger bias …

IN PROGRESS

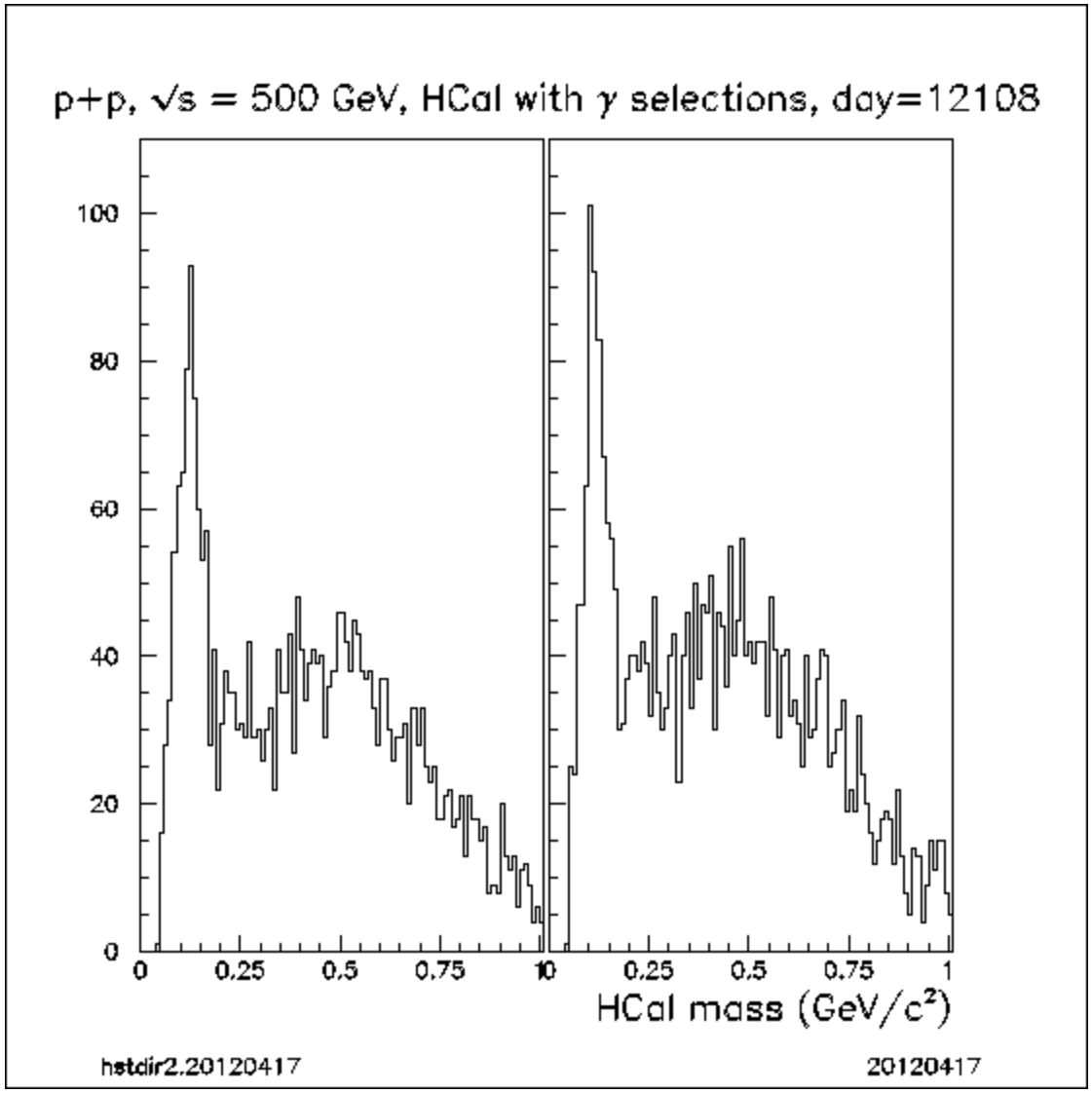
Many thanks to C-A (Angelika Drees; …)

Run-12 IP2 Bump Removal



Background impact reduced by collimation.
Reproducible push-button operation

ANDY Status



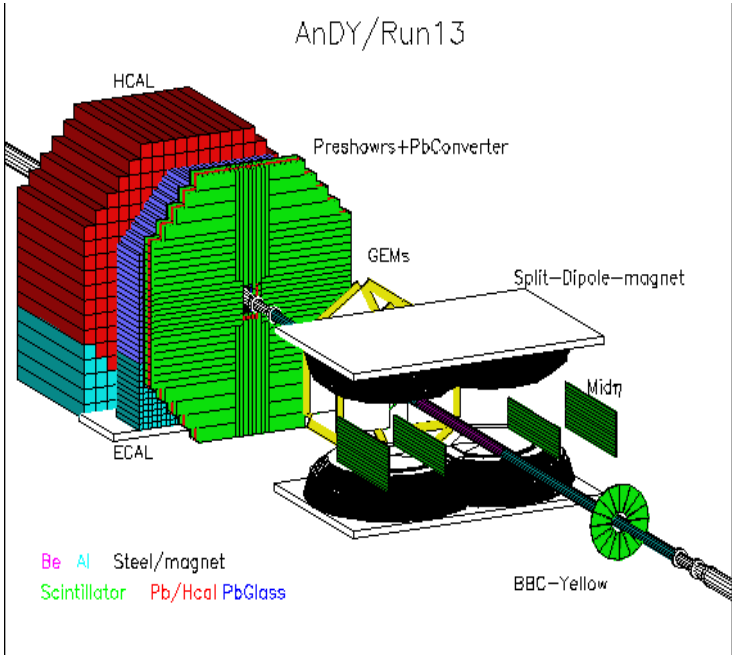
- Recommissioning complete
- >30M jets sans ECal shadow
- HCal calibration is shown to be within 10%, or better, of run-11 calibration
- In production…

Request

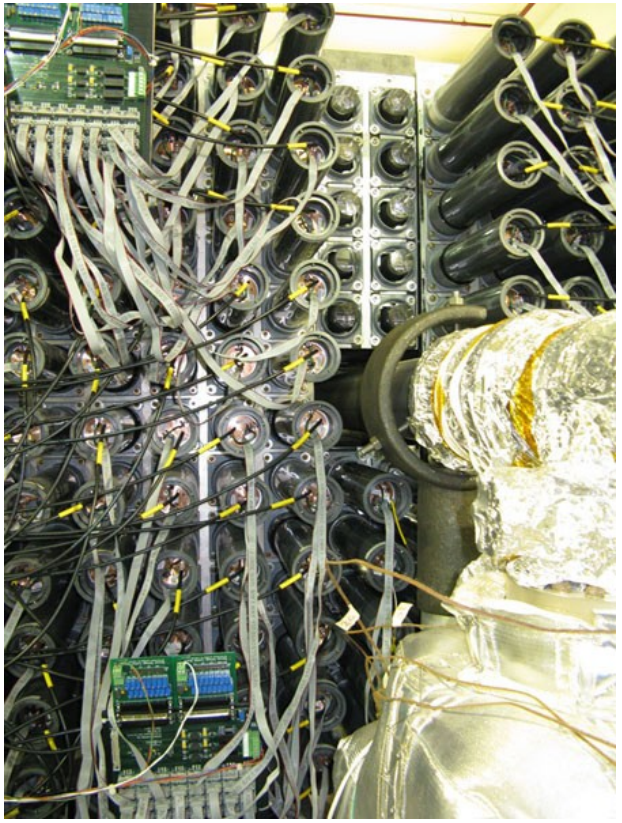
- IP2 vernier scan, to calibrate current data

Backup

Changes to A_NDY for Run-12



GEANT model of proposed A_NDY apparatus (run-13)



Thanks to C.Folz, et al.

- Proposed A_NDY detector (left), as submitted, consists of annular ECal, annular HCal, preshower + tracking through the (modified) PHOBOS split-dipole
- The HCal module pair used in run 11 was modified to become an annular 12-row x 20 column HCal for run 12. The picture to the right shows the phototube (PMT) end of HCal upon completion of its installation in December, before installing all PMT.
- Separated-beams test on 20120225 and 20120227 shows most things are working, and identifies some things to fix (a few holes) on the 20120229 access.

Ideal

Collide at IP2 and acquire 10 pb^{-1} of polarized proton collisions at $\sqrt{s}$=500 GeV with ECal moved to its out position, meaning no shadow cast on HCal. This fully eliminates trigger-bias from run-11 jet sample. The annular HCal will eliminate "sculpted combinatorics" as a background issue for $\rho^0 \rightarrow \pi^+\pi^-$, $\rho^{\pm} \rightarrow \pi^0\pi^{\pm}$ or $\omega \rightarrow \pi^0\pi^+\pi^-$ calibration of hadronic response of HCal.

Demonstration of 10 pb-1 / week delivered to 3rd IP could be useful to others in possible future endeavors at RHIC.

Summary of A_NDY Timeline

- March 2010 – initial documentation of plans
- June 2010 – letter of intent to program advisory committee (PAC)
- August 2010 – cleanup of IP2 begun
- December 2010 – implementation of run-11 apparatus complete
- June 2011 – run-11 goals achieved, proposal to PAC and approval
- July 2011 – completion of the move of BigCal from JLab to BNL
- February 2012 – run-11 stretch goal achieved and funding proposal
- March 2012 – BNL review of funding proposal

Many thanks to C-A for excellent support for an ambitious project!

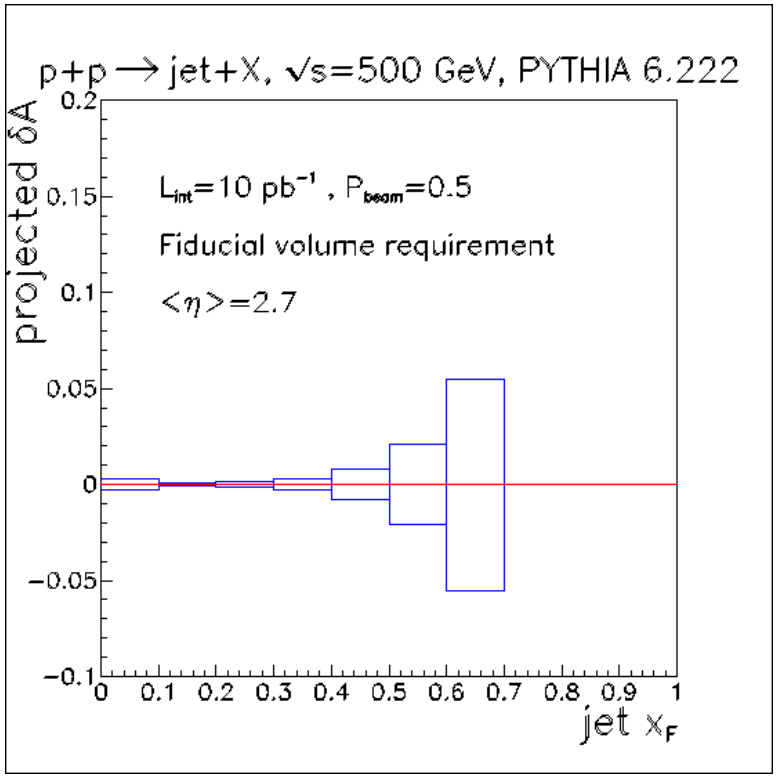
Outcome of Review

To: **andy-bnl-l@lists.bnl.gov**
cc: **Helmut Marsiske, Thomas Roser, Tom Ludlam, Edward O'Brien, Steven Vigdor**
From: **Hank Crawford**
Fri Apr 6 09:37:49 EDT 2012

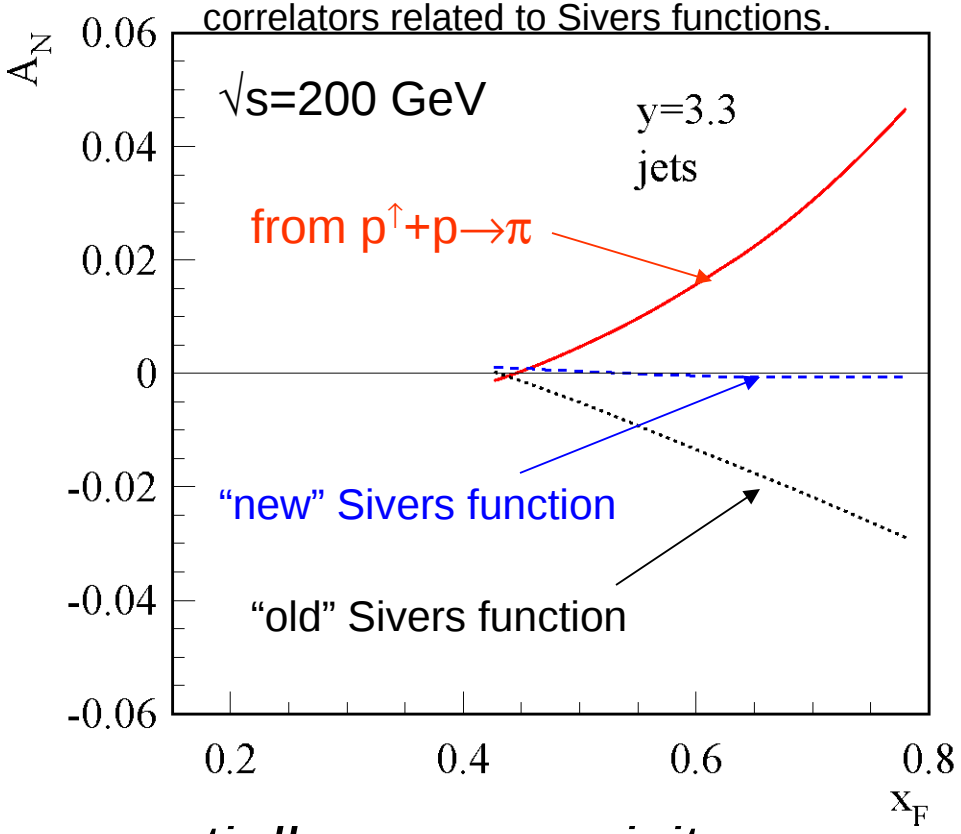
Hi - We have just come from a meeting with BNL management at which we were informed that AnDY will not be approved to go forward. We'll send the review committee report when we get it. - We disagree with management on most points discussed - we had assembled a great team and had a credible timeline but they disagree. We will continue analysis of the run11 data to uncover the jet signal. Thanks for all of your efforts. - Hank and Les

Run11 A_N(Jet)

- Siver's effect only (no collin's effect contribution)
- Need A_N(Jet) measurements before DY
- With ~10/pb & P=50%, AnDY run11 can measure A_N(Jet)

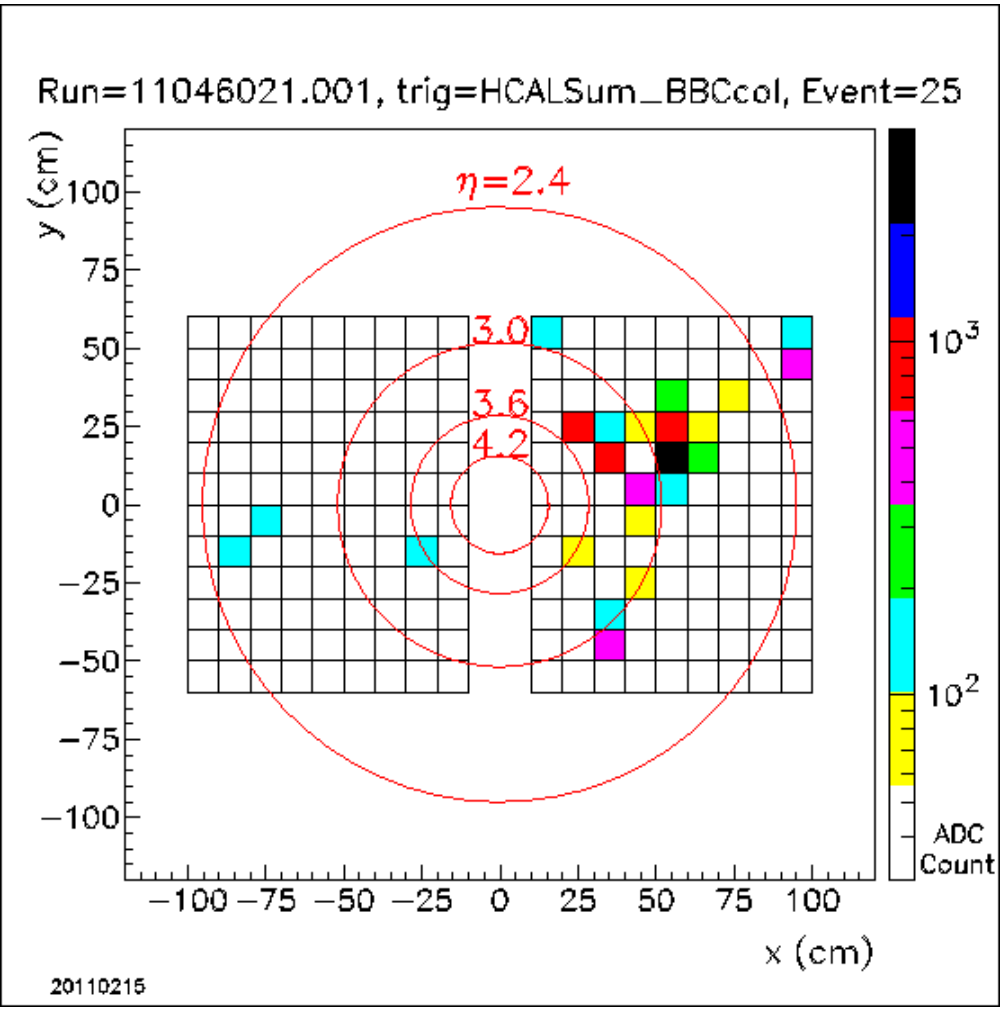


arXiv:1103.1591 jet A_N measurements are required to clarify signs of quark/gluon correlators related to Sivers functions.



Non-zero jet analyzing power essentially a prerequisite before proceeding to Drell Yan

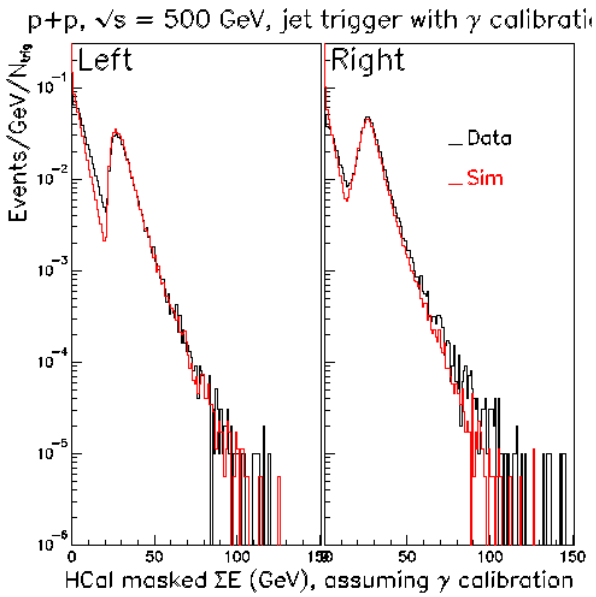
Jet Trigger Events



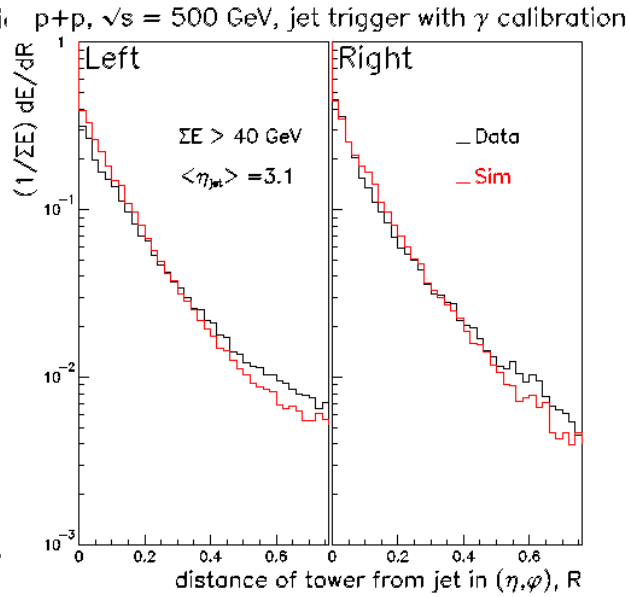
- Select from jet-trigger events for HCal “high-tower” to be centered in module
- Display for each detector of each module the ADC count as color scale (black=greatest count →yellow=lowest count)
- Events look “jetty”, as expected

Towards Forward Jets

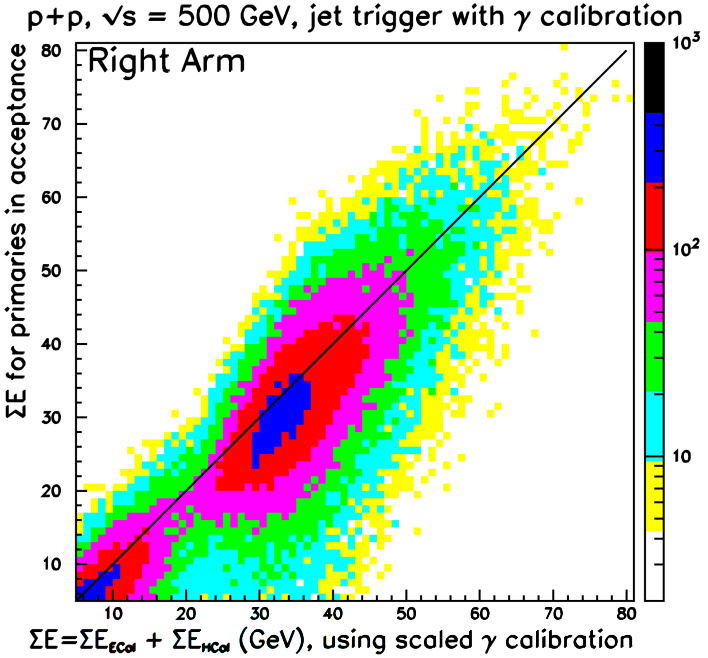
arXiv:1112.1812



(a)



(b)



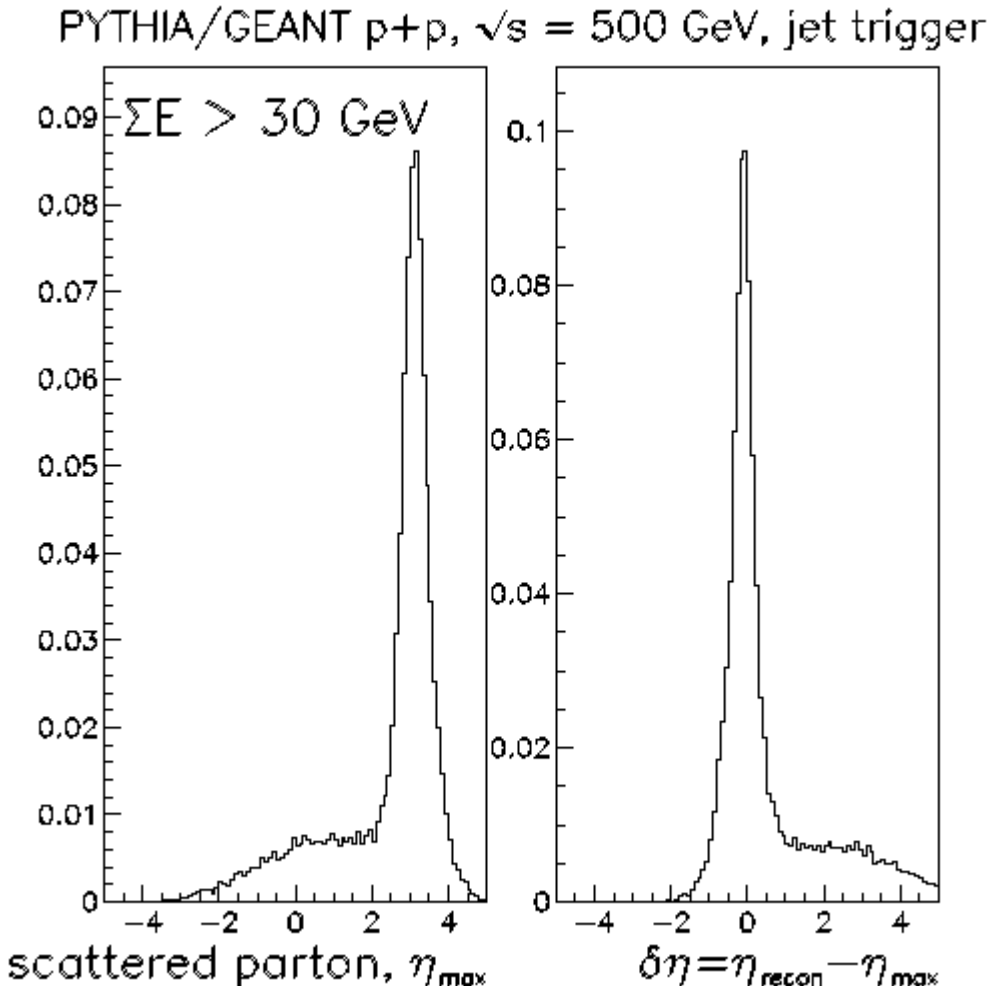
(c)

(a) Distribution of summed energy in HCal modules from the jet trigger.

(b) Distribution of fraction of energy in the jet as a function of distance in η-ϕ space from the jet center (jet shape).

(c) Jet energy from simulations versus reconstructed response in ECal+HCal

Are These Events Jets?

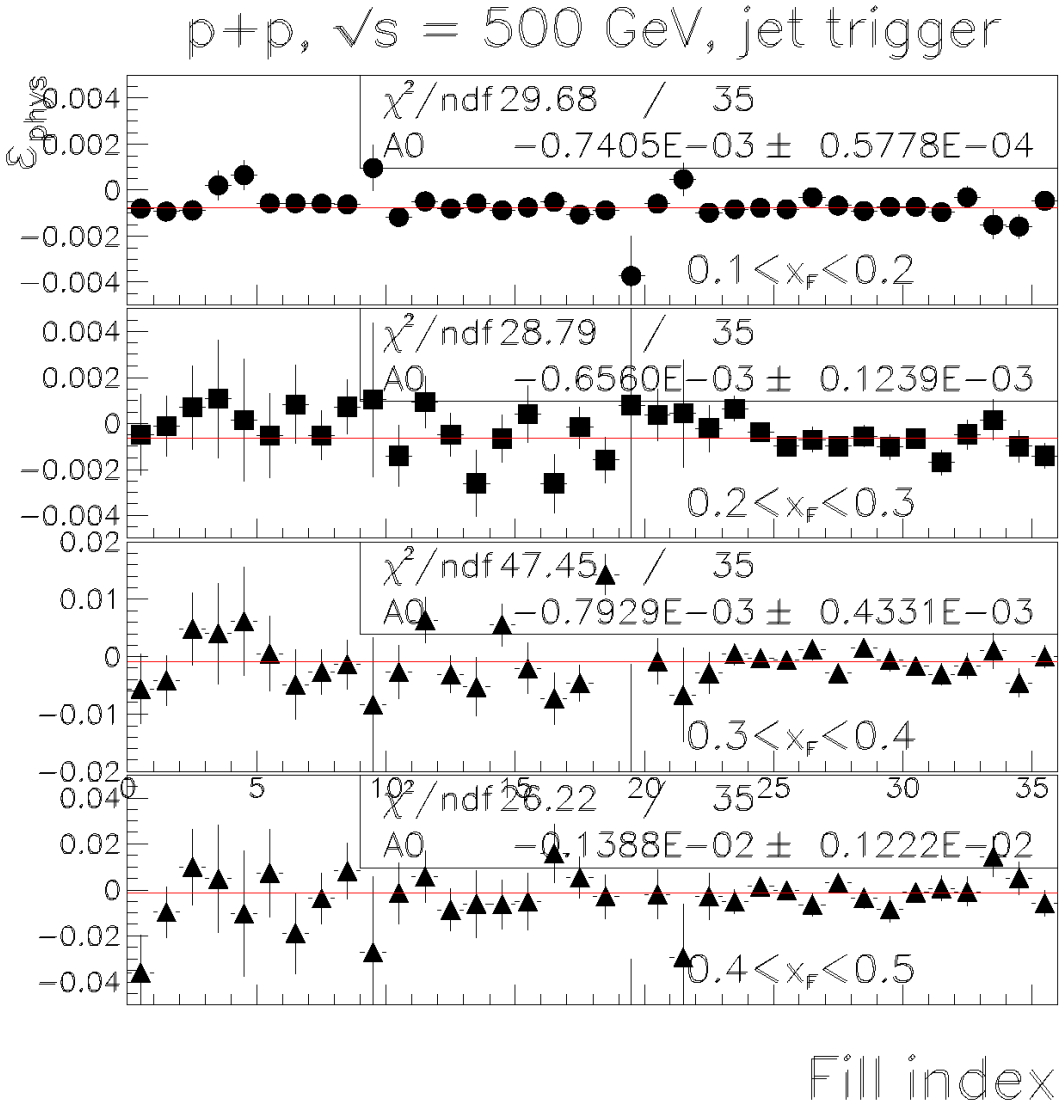


- Reconstructions of full simulation, as generated by PYTHIA 6.222 with detector response simulated by GEANT

$\forall$ η_{max} is the larger of the scattered parton pseudorapidity from PYTHIA $2\rightarrow 2$ processes

$\Rightarrow$ Run-11 A_NDY jet trigger primarily selects jets

Jet Spin Effects



All jet triggered runs 56<day<107

$$\varepsilon_{phys} = \frac{\sqrt{N_L^u N_R^d} - \sqrt{N_L^d N_R^u}}{\sqrt{N_L^u N_R^d} + \sqrt{N_L^d N_R^u}}$$

i.e., standard spin-sorted cross ratio analysis applied to run-11 jet-triggered events

- Evidence for non-zero jet analyzing power
- Jet clustering, energy scales, trigger bias (from ECal), HCal compensation systematic effects still to be done

Critical Run-12 Tests

…proposed...

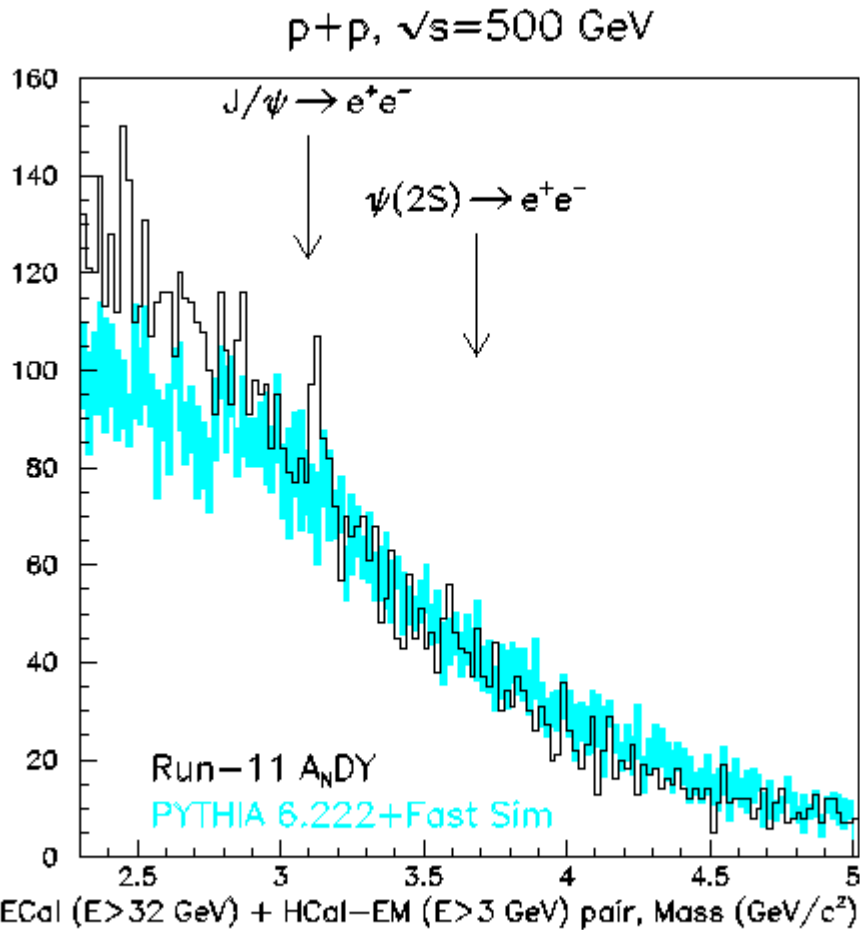
- *(1) Finish HCal calibration with new annulus: correction for hadronic response*
- *(2) Test operation of GEM prototype*
- *(3) Demonstrate 10 pb^{-1}/week at $\sqrt{s}$=500 GeV, as required for runs 13,14 A_NDY*

With run-12 test, becomes "measured to be"

Comments:

- *Corrections to run-11 HCal calibration for hadron showers expected to be ~20%*
- *GEMs improve position resolution from ~5cm (run-11) $\rightarrow$ ~0.1mm for calorimeter/preshower association required for **background discrimination** and other trackings*
- *Data from run-12 IP2 tests will improve run-11 J/ψ, enable B$\rightarrow$ J/ψ +K and start on concurrent $\sqrt{s}$=500 GeV A_N π^0 measurement required to determine sign of DY A_N*

Dileptons from Run 11 Data

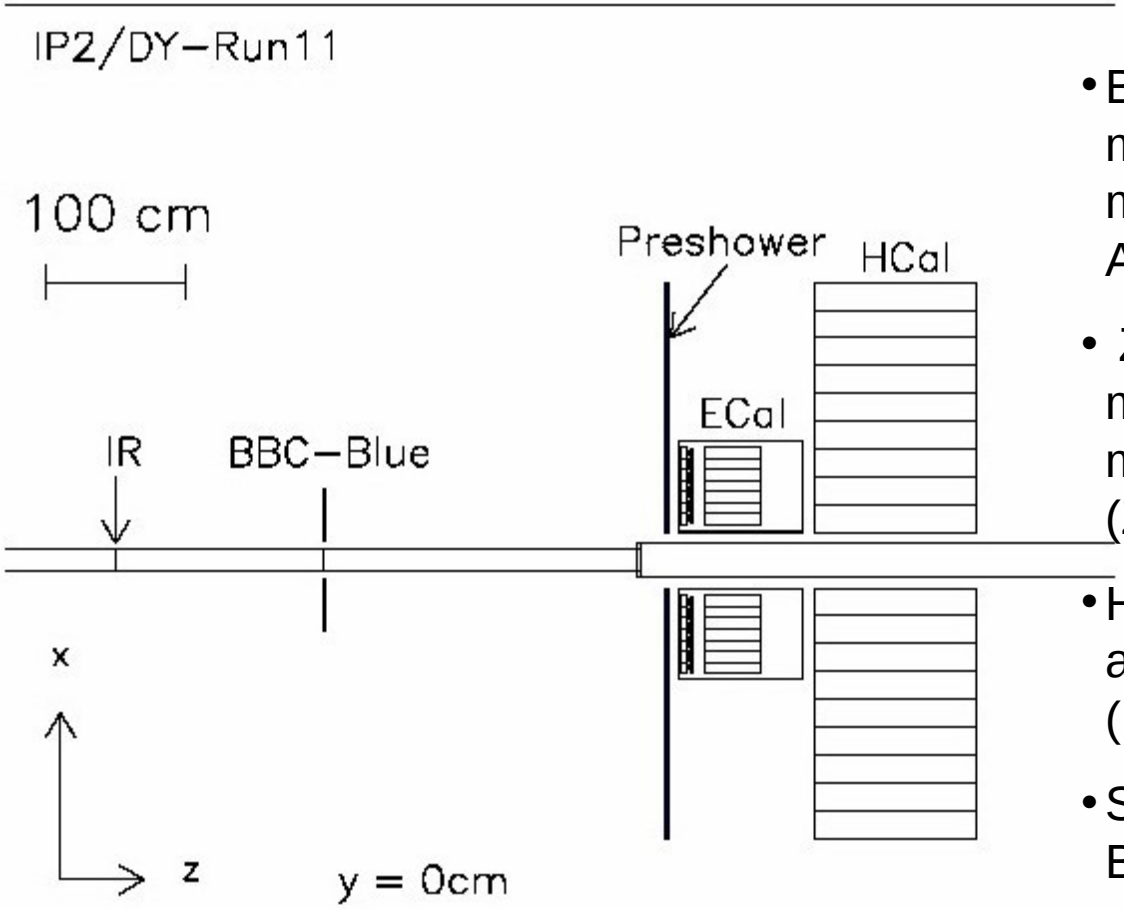


Run-11 data absolutely compared to fast-simulator used for DY estimates

- *A_NDY profiling methods were applied to a limited data sample (L_{int}=0.5 / pb) of run-11 ECal triggered data.*
- *Dominant backgrounds are now from γ, and are suppressed by using MIP response of beam-beam counters to tag clusters.*
- *Individual detector $\pi^0 \rightarrow \gamma\gamma$ calibration for HCal was an essential step to reconstruct J/ψ*
- *Limited granularity of BBC and poor position resolution of HCal-EM cluster results in less photon suppression than expected for final A_NDY apparatus (project ~100x better suppression)*
- *Hadron suppression is not yet required, but will be in going from dileptons to DY*
- *J/ψ→e+e- peak has ~120 events with 5.4σ statistical significance. PYTHIA 6.425 with NRQCD expects 420 events in the run-11 acceptance, approximately consistent with observation after crude efficiency correction. From PYTHIA 6.425, DY with M>4 GeV/c² is 170x smaller in this acceptance.*
- *J/ψ is a **window to heavy flavor** via $B \rightarrow J/\psi K$ and $\Lambda_b \rightarrow J/\psi p \pi-$ that would help quantify intrinsic b from proton backgrounds to DY*

Schematic of detector for Run-11

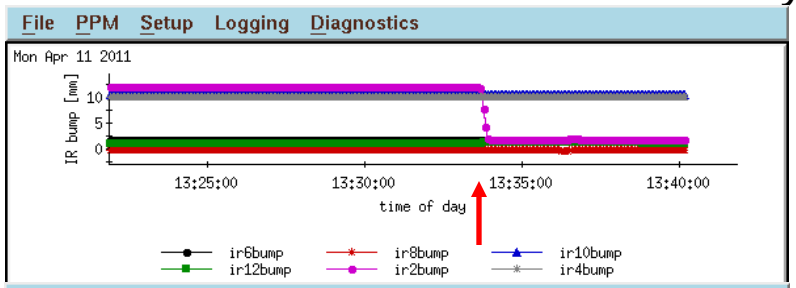
Polarized proton collisions at √s=500 GeV from February to April 2011

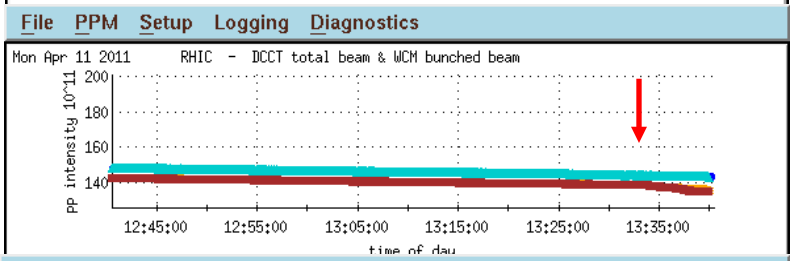


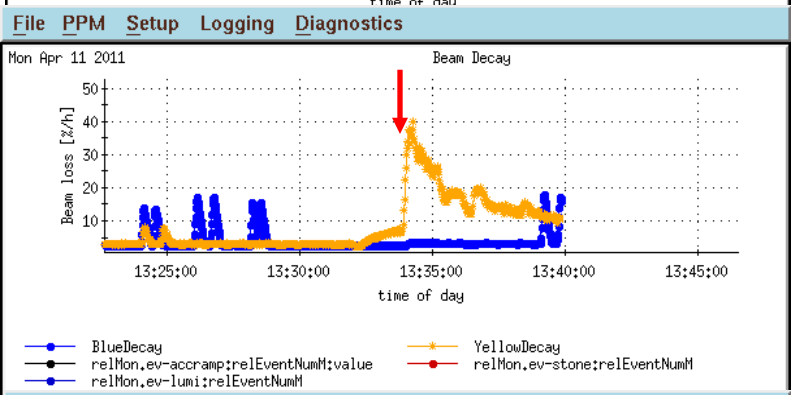
- Beam-beam counter (BBC) for minimum-bias trigger and luminosity measurement from PHOBOS [NIM A474 (2001) 38]
- Zero-degree calorimeter and shower maximum detector for luminosity measurement and local polarimetry (ZDC/ZDC-SMD, not shown)
- Hadron calorimeter modules (HCal) are 9x12 modules from AGS-E864 (NIM406,227)
- Small (~120 cells) ECal loaned from BigCal at JLab
- Pre-shower detector

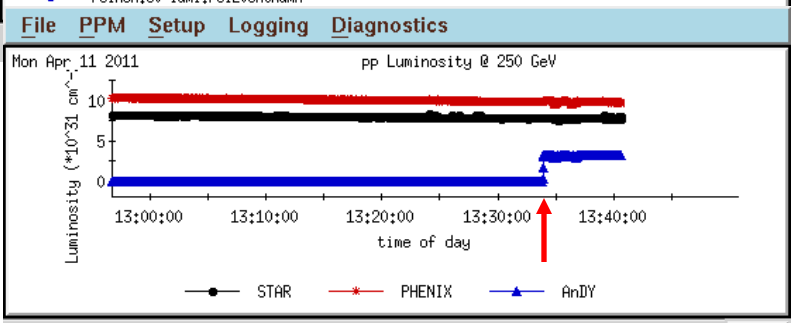
Impact of Collisions at IP2

The anatomy of initiating collisions at IP2









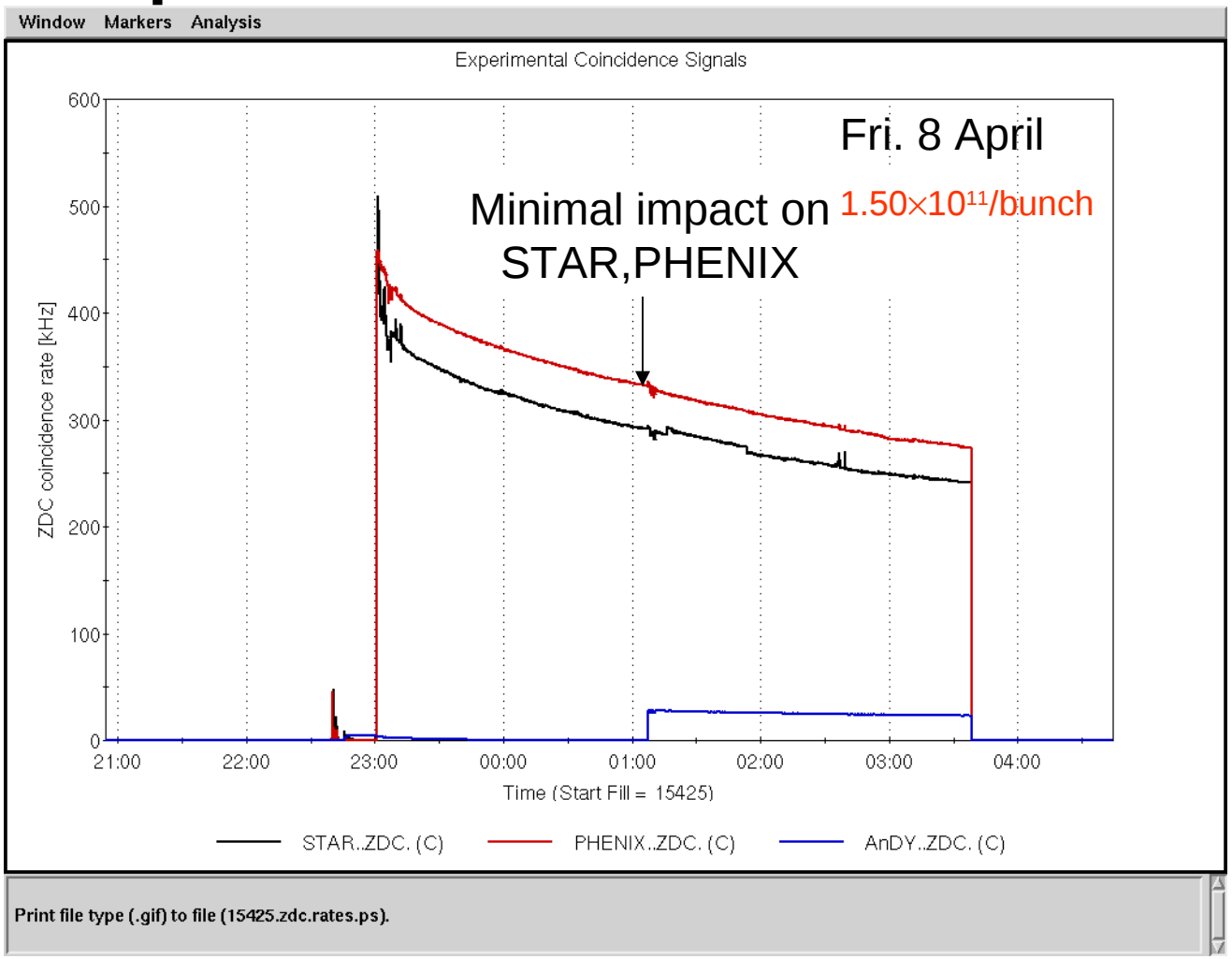
Early after a RHIC store is set up, beams are colliding at IP6 (STAR) and IP8 (PHENIX). Beams are transversely separated at IP2 (A_NDY). The arrow indicates when collisions begin at IP2

After the beam intensity decays to a threshold (here, 1.3 $\times 10^{11}$ ions/bunch), collisions begin at IP2. There is loss of beam in the Yellow ring.

The beam loss is monitored. The spikes in the Blue ring are due to insertions of carbon ribbons for measuring the beam polarization. Beam-beam tune shift causes loss of ions in Yellow when collisions begin at IP2. This loss typically decays with time, as shown.

Luminosity at IP6 (STAR) and IP8 (PHENIX) is mostly constant when collisions are initiated at IP2 (A_NDY).

Impact of IP2 Collisions



IP2 collisions have begun <3 hours after physics ON with minimal impact on IP6,IP8.