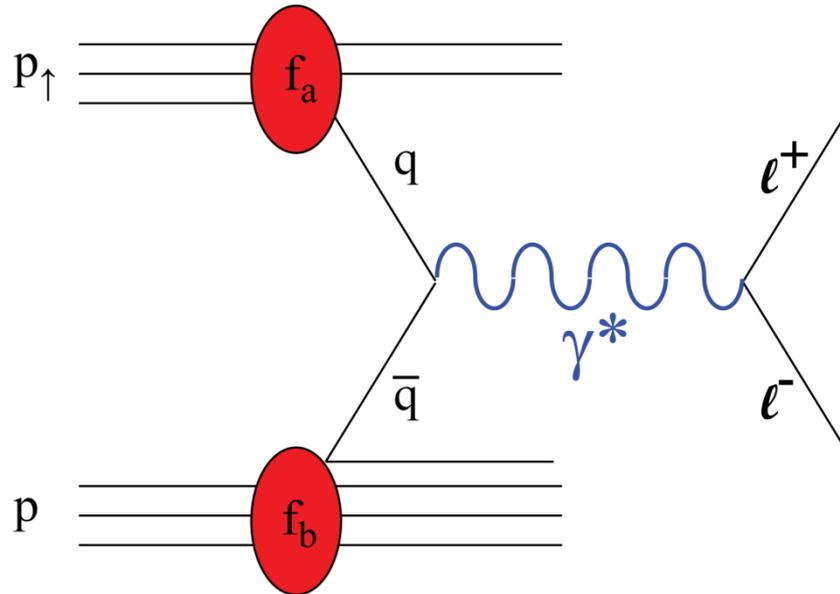# A Proposal for Run-11 AnDY

… preceded by some preliminary reminders about AnDY goals

L.C. Bland, for AnDY

1 March 2011

AɴDY members

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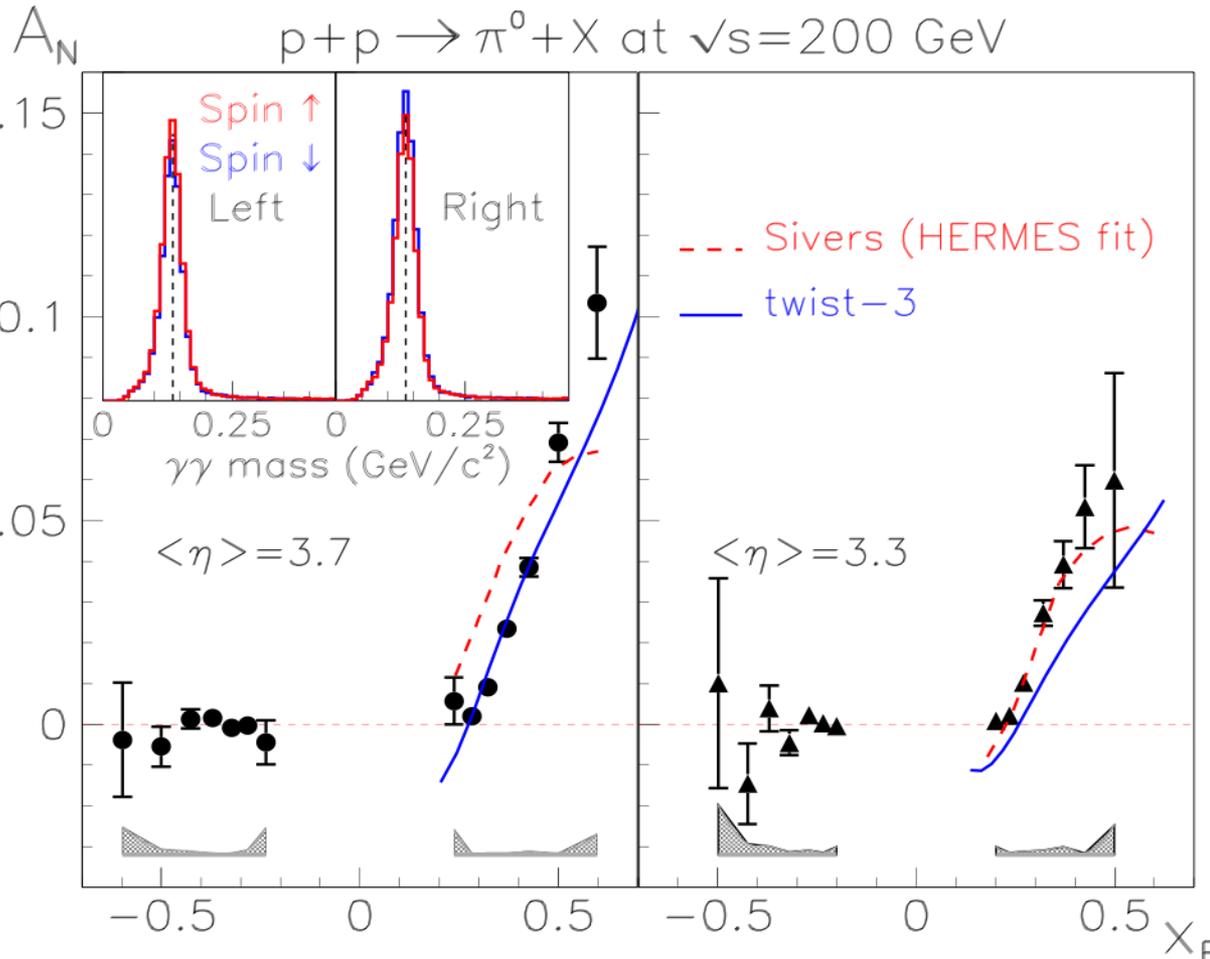
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x_F Dependence of Inclusive π^0 A_N
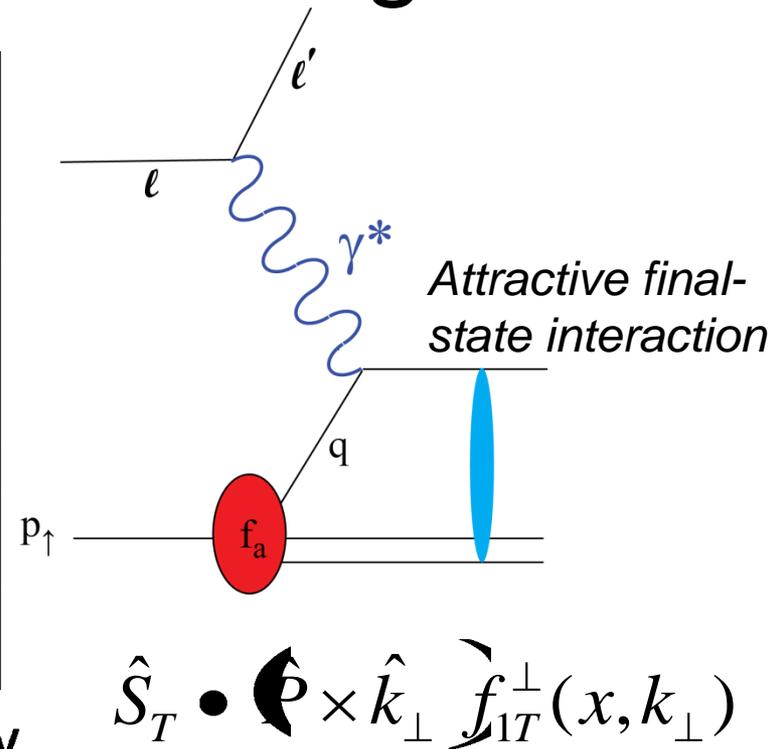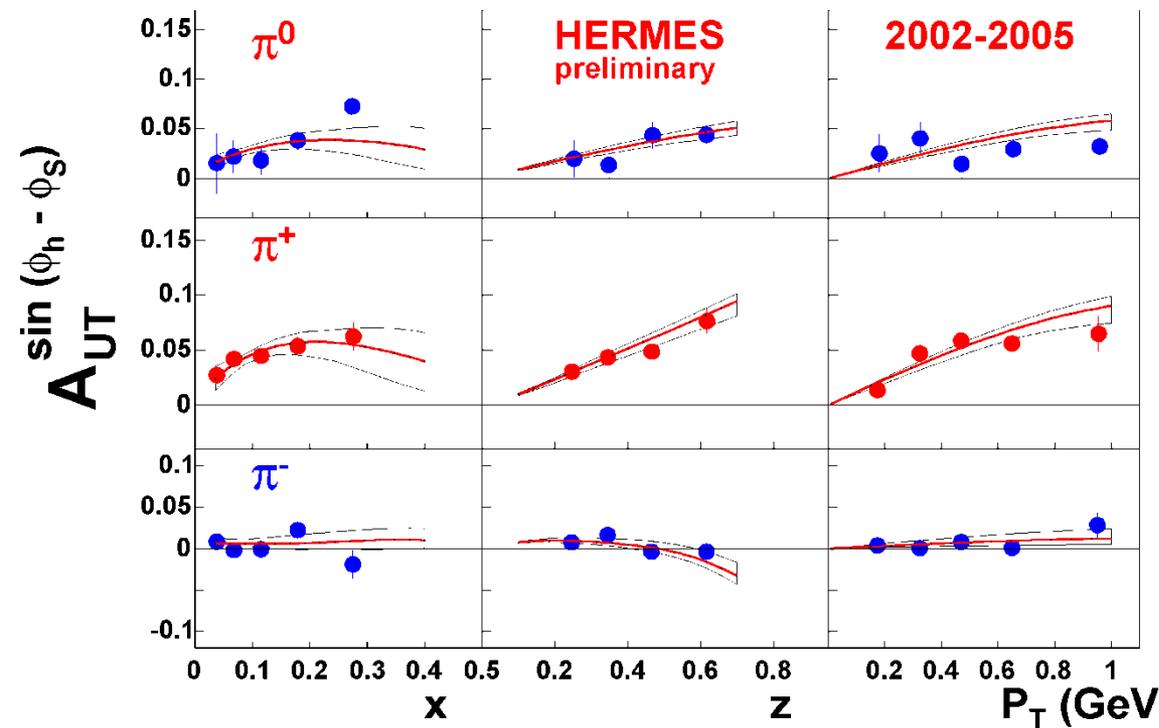
RHIC Run 6 with Forward Pion Detector

Fits to SIDIS (HERMES) are consistent with p+p→π+X data

A_N at positive x_F grows with increasing x_F

U. D'Alesio, F. Murgia
Phys. Rev. D 70, 074009 (2004)
arXiv:hep-ph/0712.4240

C. Kouvaris, J. Qiu, W. Vogelsang, F. Yuan,
Phys. Rev. D 74, 114013 (2006).

3

Sivers Effect in Semi-Inclusive Deep Inelastic Scattering

final HERMES data: PRL 103 (2009) 152002 [arXiv:0906.3918] (Sivers asymmetry) and arXiv:1006.4221 (Collins asymmetry)
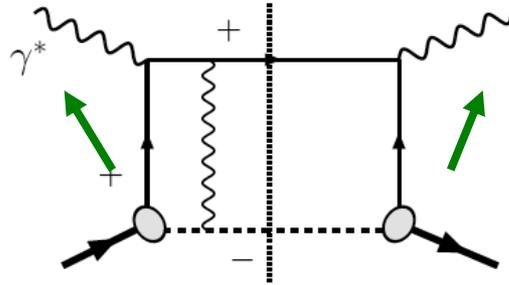
Phenomenological fits: M. Anselmino et al. EPJ A39 (2009) 89 [arXiv:0805.2677]

Final-state interaction: S.J. Brodsky, D.S. Hwang, I. Schmidt PL B530 (2002) 99 [hep-ph/0201296]
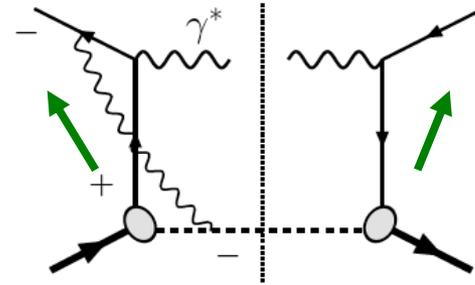
Attractive vs Repulsive Sivers Effects
Unique Prediction of Gauge Theory !
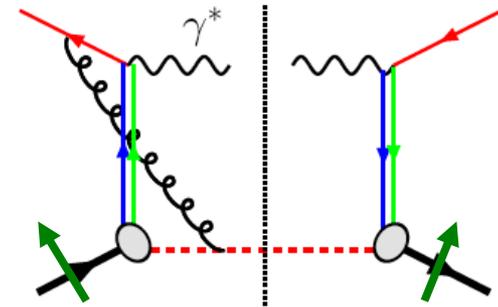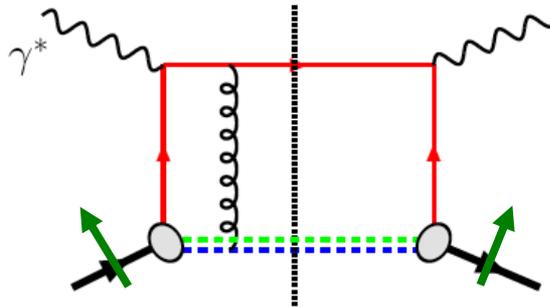
Simple QED example:

| **DIS: attractive** | **Drell-Yan: repulsive** |

Same in QCD:

As a result:

$$\text{Sivers}|_{\text{DIS}} = -\text{Sivers}|_{\text{DY}}$$

Transverse Spin Drell-Yan Physics at RHIC (2007)

http://spin.riken.bnl.gov/rsc/write-up/dy_final.pdf

5

Status

- Luminosity gains projected for $\sqrt{s}$=200 GeV polarized proton collisons were not realized, so L_{int}=30 pb^{-1} and P_{beam}=65% for transverse spin direct photon would be challenging.

- Theory community has revisited whether color-charge interactions are robustly calculable [arXiv:1001.2977] for transverse single-spin asymmetries for processes *other than Drell Yan production*

- Low-x/saturation physics looks to be very interesting at RHIC collision energies. Non-universality of k_T dependent distribution functions for di-jets may impact small-x as well as transverse spin [arXiv:1003.0482]. This should not be the case for *low-x probed by Drell-Yan production*

$\Rightarrow$ establishing the requirements for a large-x_F Drell Yan production experiment will provide the most robust test of theory for transverse spin, and lead to future avenues that provide the most robust interconnections between low-x probed at RHIC and low-x probed at EIC.

Requirements for DY

See http://www.bnl.gov/npp/docs/pac0610/Crawford_LoI.100524.v1.pdf

- Luminosity – estimate 150 / pb yields 10^4 DY e+e- pairs in AnDY

- Background Reduction – goal of run 11: benchmark simulations
    - o electron/hadron discrimination
    - o Charged/Neutral discrimination and photon conversion background
    - o Open heavy flavor (c,b) production
    - o Is charge sign discrimination required for like-sign pair subtraction?

Staging

Assumptions:

    1) ~4 week polarized proton test run at $\sqrt{s}$=500 GeV in RHIC run 11

    2) 12 week polarized proton W production run at $\sqrt{s}$=500 GeV in RHIC run 12

    3) 12 week polarized proton W production run at $\sqrt{s}$=500 GeV in RHIC run 13

Planned Staging:

1) Hcal + modular Ecal + BBC + newly constructed preshower at IP2 for RHIC run 11 with goals of establishing impact of 3IR operation and demonstrate calibration of Hcal to get first data constraints on charged hadron backgrounds Staging completed

2) Hcal + EMcal + neutral/charged veto + BBC for RHIC run 12 with goals of zero-field data sample with L_{int}~150 / pb and P_{beam}=50% to observe dileptons from J/ψ, Υ and intervening continuum. Split-dipole tests envisioned.

3) Hcal + EMcal + neutral/charged veto + BBC + split-dipole for RHIC run 13 with goals data sample with L_{int}~150 / pb and P_{beam}=50% to observe dileptons from J/ψ, Υ and intervening continuum to address whether charge sign discrimination is required

Run11 A$_N$(Jet)
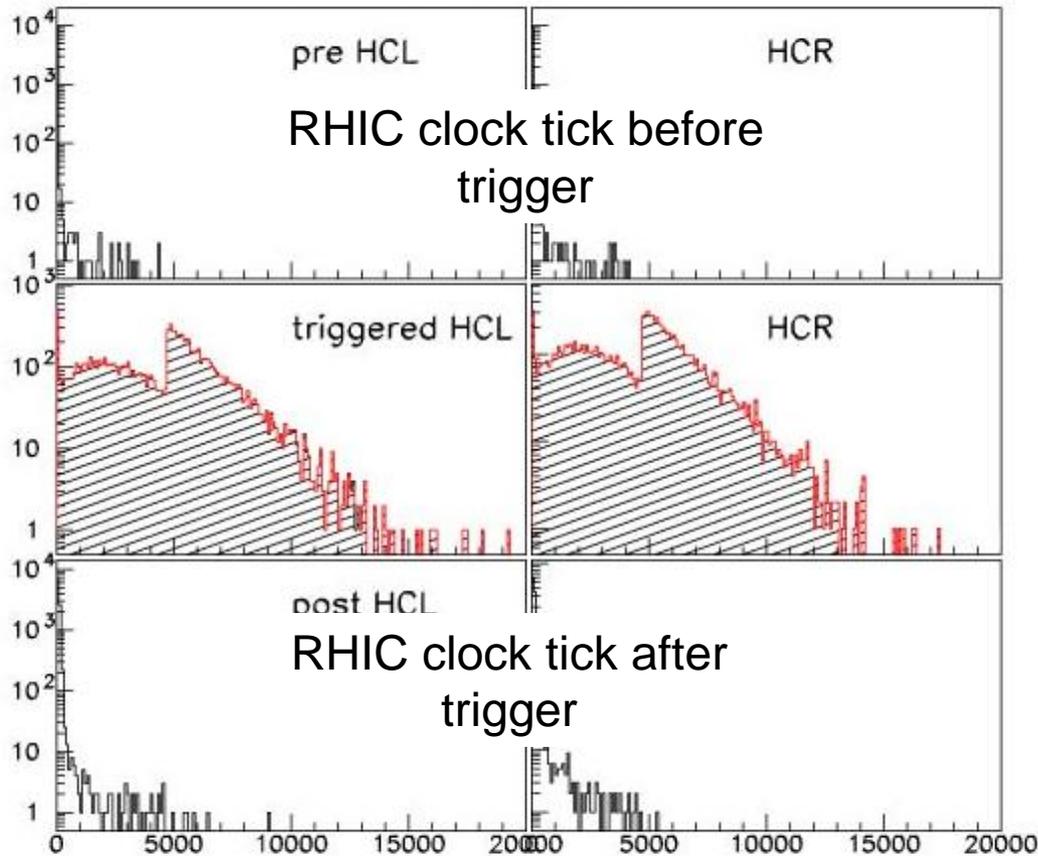
- Siver's effect only (no collin's effect contribution)
- Need A$_N$(Jet) measurements before DY
- With ~10/pb & P=50%, AnDY run11 can measure A$_N$(Jet)
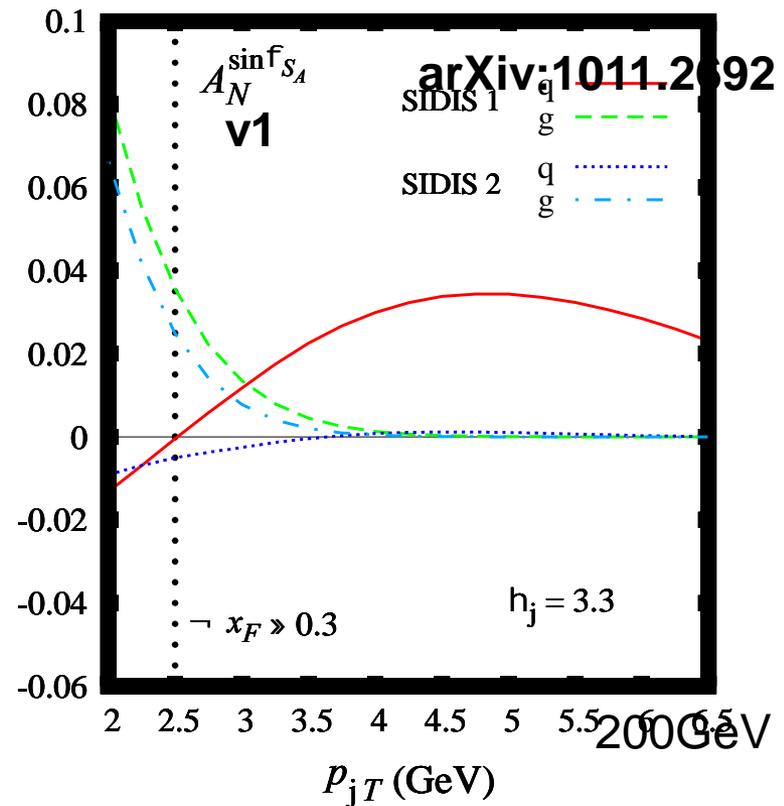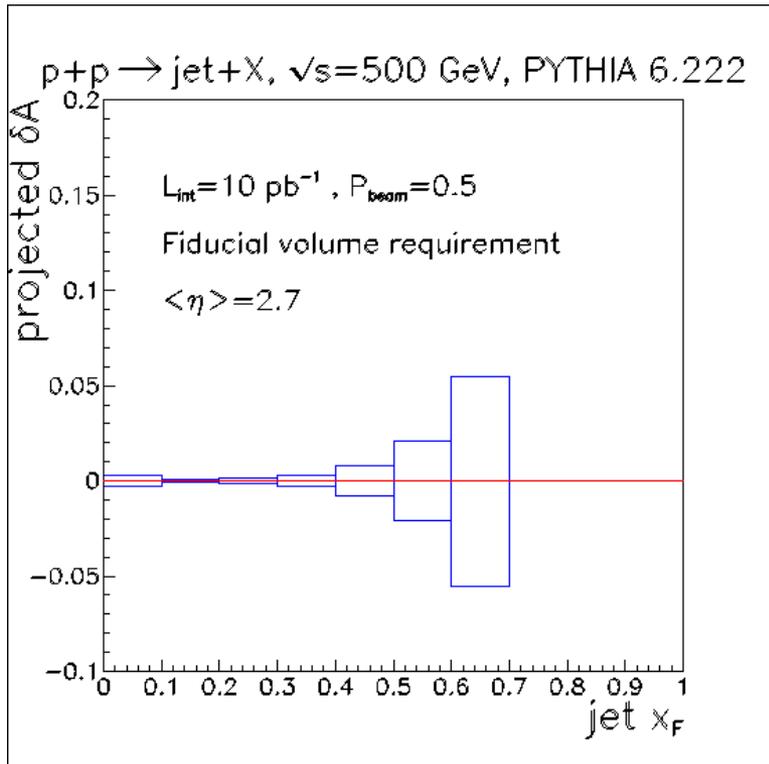
Non-zero jet analyzing power essentially a prerequisite before proceeding to Drell Yan

Jet Trigger Commissioned
on Saturday 12 February

Run=11043030.001, HCal sum

pre HCL

HCR

RHIC clock tick before trigger

triggered HCL

HCR

post HCL

RHIC clock tick after trigger

ΣQ excluding col=1 (QT=yellow, DSM=red)
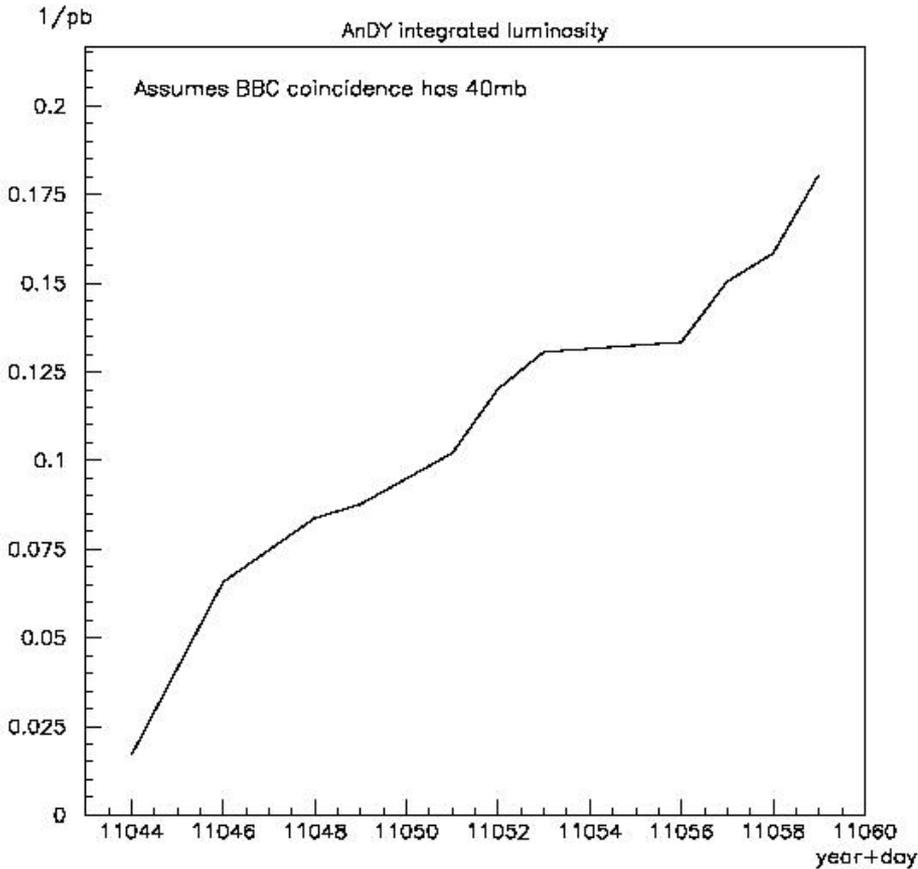
2011021

- ADC from Berkeley group ("QT") has FPGA used to form 17-bit sum of 12-bit ADC from each of 32 channels

- 32-bit data from four QT per HCal module transferred to second FPGA board from Berkeley (DSM), where 19-bit sum of four terms is made

- Threshold on 19-bit sum is then used as trigger

- HCal energy scale still to be determined

10

Accounting

year+day=11044 starts jets

- Thanks to Tom Throwe, we are storing CDEV information into mysql data base.

- Thanks to Akio Ogawa, we have begun tracking integrated luminosity at IP2, since jet trigger was first commissioned

- Presently, no accidentals correction (to be fixed in next access)

- Require vernier scan to establish effective cross section.

- Jet analyzing power measurement sets goal of 10 / pb for run 11.

Proposal

- Systematically increase bunch intensity for start of IP2 collisions from 0.8×10^{11}/bunch

- Spend between 0.5 and 1 shift to train IP2 DX to remove crossing angle

- Use APEX on 9 March (or development?) to work on optics:

  - IP2 β* reduction from 3m to 2m

  - IP6,8 β* tuning to run-11 design 0.65m values

  - Reduce β beat

These items can establish in run-11 whether 150 / pb is possible at IP2 in runs 12,13 and enable run-11 jet A_N measurement

Backup

World-Wide Interest

- Drell Yan production is of world-wide interest. Forward DY for low-x physics is the domain of colliders: RHIC or the LHC [e.g., see Golec-Biernat, Lewandowska, Stasto arXiv:1008.2652].

- Measurements of the analyzing power for DY production can be done (at $x_{F,\gamma*} \leq 0.1$) at PHENIX/RHIC with dedicated transversely polarized $p^\uparrow + p^\uparrow$ collisions and measurement of $\pi^- p^\uparrow \rightarrow \mu^+\mu^- + X$ has been proposed by COMPASS at CERN [S. Takekawa (COMPASS), Nucl. Phys. B 198 (2010) 124].

- Numerous other laboratories or experiments (e.g., FNAL/E906, J-PARC) have indicated interest in pursuit of this physics.

14

Schematic of detector for Run-11

IP2/DY-Run11

100 cm

IR   BBC-Blue

Preshower   HCal

ECal

x

z   y = 0cm
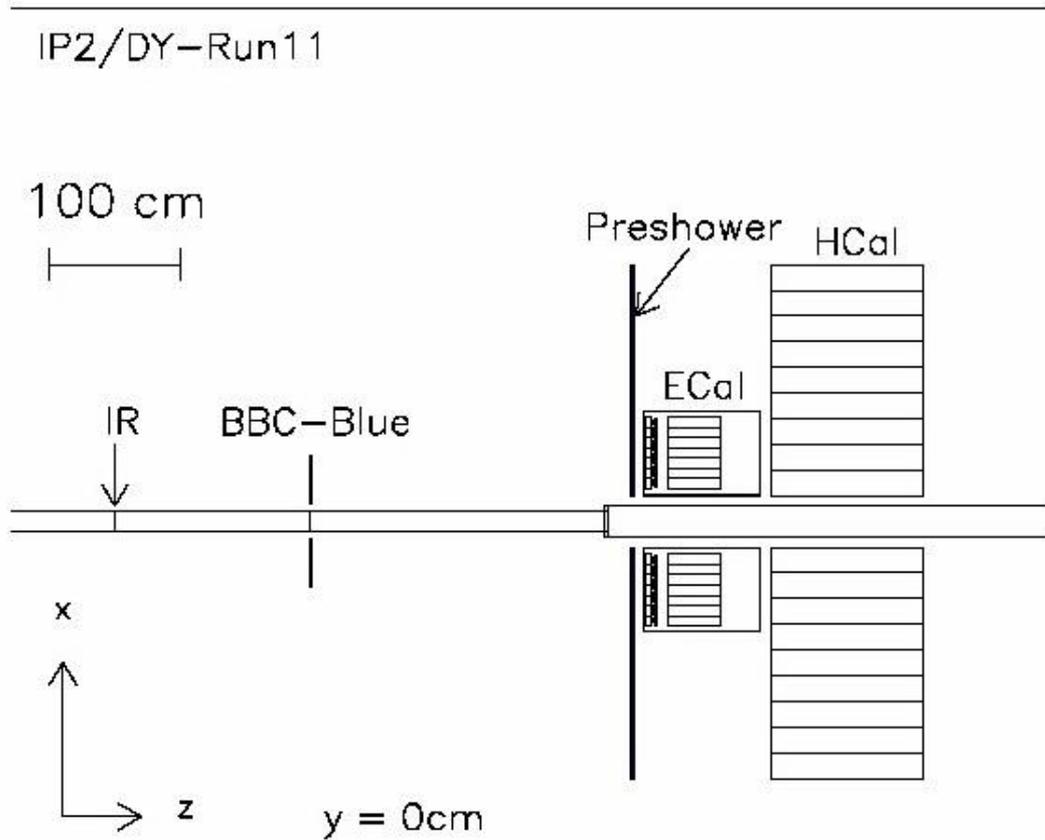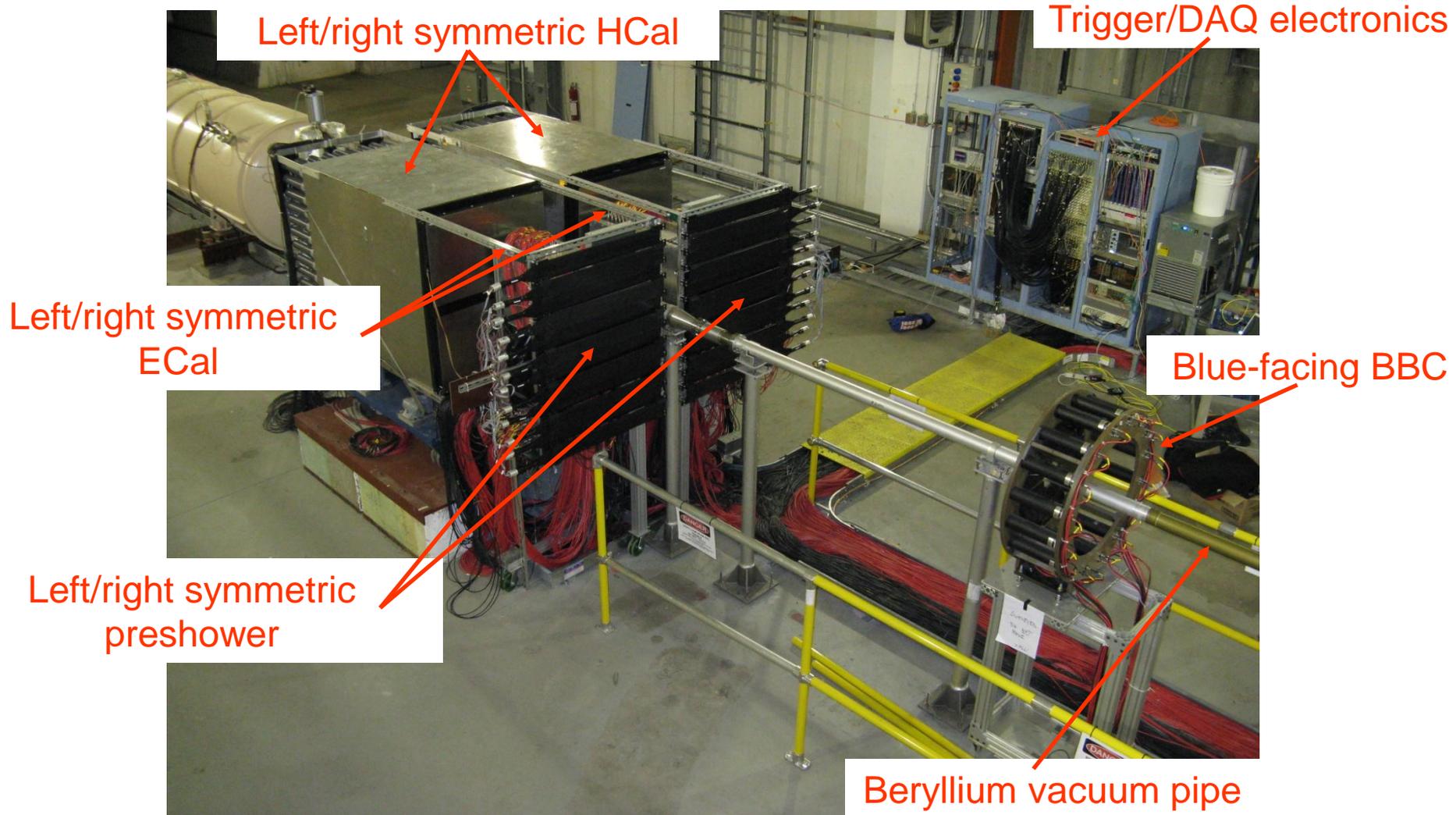
Equipment in place:

- HCal is two existing 9x12 modules from E864 (NIM406,227)

- ECal are two small lead-glass modules from BigCal at JLab

- BBC (from PHOBOS) and ZDC

- Preshower is newly constructed scintillator arrays

Goals:

- Establish impact of 3IR operation on PHENIX/STAR luminosity

- Calibrate HCal

   - relative gain via cosmic-ray μ

   - absolute energy scale via $\rho, \Lambda, K_S \ldots$

- Measure hadronic backgrounds to benchmark simulations

- Measure jet analyzing power ($L_{int} \sim 10$ / pb, P=50%)

IP2 in January, 2011
Run-11 Staging of A$_N$DY

Left/right symmetric HCal

Trigger/DAQ electronics

Left/right symmetric ECal

Left/right symmetric preshower

Blue-facing BBC

Beryllium vacuum pipe

See http://hena.lbl.gov/IP2/Business/status/<date> for pictures of progress