PHENIX Beam Use Proposal for Runs 11 & 12

- PHENIX productivity
- Accomplishments in Run-10
- Upgrades for Run-11
  
  Big drivers of our beam use proposal!

- Beam Use Proposal
  
  Run-11
  
  W asymmetry, heavy flavor in medium
  Flow/jet quenching excitation function
  U+U “engineering run” for event selection

Run-12

Barbara Jacak for the PHENIX Collaboration

Special thanks to Stefan Bathe (Run-10 Coordinator)

What does PHENIX do?

Our key physics goals
Establish nature of RHIC’s new state of matter
  sensitive, rare probes: di-leptons, heavy flavor, jets
Spin of the proton:
  \( g, \bar{q} \) polarization & parton/nucleon spin correlation

- **PHENIX philosophy**
  Rare process sensitivity
  High rate capability + selective triggers
  Precision measurement in multiple channels
  Incremental upgrades of capabilities

- *Keep up with data analysis in parallel with:*
  *taking data*
  *constructing upgrades*
  *writing high impact papers (27 topcite 100+, 29 topcite 50+, and 3 with 49 citations)*
How well do we do it?

- 88 papers published, 51 of them PRL’s
- + one in proof, 6 in referee process
- 3 major archival papers within the last 12 months!

![Graph showing publication rates over days since publication]
Recent scientific accomplishments

- Thermal radiation at RHIC *PRL* 104, 132301 (2009)
- Di-electrons in Au+Au & p+p *PRC*81, 034911 (2010)
- heavy flavor $R_{AA}$ and $v_2$ 1005.1627
- $\gamma$-h and h-h correlations 1006.1347, 1002.1077
- J/$\psi$ polarization 0912.2082
- $\eta$, $\phi$ suppression 1005.4916, 1004.3532
- high $p_T$ $\pi^0 v_2$ *PRC*80, 054907 (2009), 1006.3740
- Meson systematics in p+p 1005.3674
- Charged hadron $v_4$, $v_2$ 1003.5586
- Helicity sorted jet $k_T$ *PRD*81, 012002 (2010)
PHENIX is productive & educational

- 104 Ph.D’s granted, to date
- 24 Masters’ degrees
- >90 students currently working on PHENIX

Number of PHENIX PhDs Awarded

![Bar chart showing the number of PHENIX PhDs awarded from 2000 to 2010.](image-url)
Milestone! PHENIX data rate >1 PB/year

A world-wide first!

- Production teams drawn from collaboration
  Run-10: Jeff Mitchell, Nathan Grau

PHENIX
Unprecedented data range & precision

Central Au+Au

In p+p

PHENIX Preliminary
So, how are we doing?

NB: Run 10 just ended, have unprecedented >1 PB in the “can”!

PHENIX physics in Run-10:
- low mass dilepton excess
- \( J/\psi \) suppression
- excitation function for flow and jet quenching

But, we have analyzed Run-9…
Run-10 focus: Hadron Blind Detector

Windowless Cerenkov detector with CF4 avalanche/radiator gas (2 cm pads)

- Signal electron
- Partner positron needed for rejection
- CsI photocathode covering triple GEMs
- Removes Dalitz & conversion pairs (small opening angle)

\[ \theta_{\text{pair}} \approx 1 \text{ m} \]
HBD response in Au+Au same as Run-9

From initial analysis of peripheral Au+Au events
Expect good separation of signal & background!
Background suppression: effective statistics up by 6-16

Signal (separated electrons):
~ 20 photo-electrons

2 e backgrd (Dalitz, conversion):
40 photo-electrons
Excellent Collider performance!

Table 1: PHENIX Data Sets in Run-10

<table>
<thead>
<tr>
<th>SPECIES</th>
<th>$\sqrt{s_{NN}}$</th>
<th>Requested</th>
<th>Recorded</th>
<th>Recorded (events)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Au+Au</td>
<td>200</td>
<td>1.4 nb$^{-1}$</td>
<td>1.3 nb$^{-1}$</td>
<td>8.2G</td>
</tr>
<tr>
<td>Au+Au</td>
<td>62.4</td>
<td>350M events</td>
<td>0.11 nb$^{-1}$</td>
<td>700M</td>
</tr>
<tr>
<td>Au+Au</td>
<td>39</td>
<td>50M events</td>
<td>40 $\mu$b$^{-1}$</td>
<td>250M</td>
</tr>
<tr>
<td>Au+Au</td>
<td>7.7</td>
<td>0.26 $\mu$b$^{-1}$</td>
<td></td>
<td>1.6M</td>
</tr>
</tbody>
</table>

So, what do the larger than expected data sets allow?
Q1: low mass di-electron excess?

In central collisions

Run-4 PRC81, 034911 (2010)

and low $p_T$
Source of low mass, low $p_T$ excess?

Not hadronic
Not $q$-$ar{q}$bar
Not charm...

Speculate (bvj): pre-equilibrium emission?

PRC81, 034911 (2010)
HBD impact in Run-10 200 GeV Au+Au

Improves effective signal by factor of 8-16 (w/o and w/ added e ID effect)

1.4 /nb recorded improves effective statistics by ≥ 35 vs. old Run-4 result

∫ L (units of Run-4)
Constraints on in-medium $\rho$?

Run-10: decrease $\sigma_{\text{stat}}$ by $\sim \sqrt{3.5} \sim 6$, $\sigma_{\text{syst}}$ also?
Modified $\rho$? 1.5$\sigma$ effect $\rightarrow$ 6$\sigma$ effect??
With \(~400\) million recorded in \(\pm 20\)cm minimum bias events and

1) a similar low mass enhancement to our published Run-04 AuAu @ 200 GeV result
2) predicted background rejection increase statistical significance \(\times 2\).

The Run-04 @ 200 GeV low mass enhancement is \(2.6\) \(\sigma\) effect.

Thus, the Run-10 @ 62 GeV result would be a \(5.2\) sigma effect.

62.4 GeV improvement factor w.r.t. Run-4@200GeV as function of # of events
Dilepton Measurement at 39 GeV

How do dilepton excess and $\rho$ modification at SPS evolve into the large low-mass excess at RHIC?

- 200M events in ± 20cm vertex
- If excess same at 39 GeV as 200
  Measure $\times 4.7 \pm 0.77$ (total);
  6 $\sigma$ result
  If excess is 1/3 that at 200 GeV:
  Measure $\times 1.57 \pm 0.77$ (total)

*NB: BUP request was 400M

NB: study is tricky, no simple scaling rules
combinatorial background ↓ $N_{ch}^2$ and ↓ ~ 8-16 (HBD)
foreground: inclusive - remaining background (S/B~1/10-1/20)
physics signal is?

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Q2: Initial temperature at 62.4 GeV?

- Hard to measure, quality of result hard to predict!
  Extraction requires constraining hydro with data
- Simulation efforts were focused on Run-11 physics!

Fact: recorded 700M events at 62.4 GeV
Fact: Run-4 analysis used 800M events
Fact: in Run-4 S/B is
~1:1 $p_T > 2$ GeV/c
~0.05-0.2 1-2 GeV/c

What can I guess?

$T_{\text{init}} = 300$-$600$ MeV at 200 GeV
$T_{\text{init}} = 170$-$190$ MeV at 17 GeV
Both S and B differ from 200 GeV case!

- Signal scales as $T^4$
  
  $T$ goes as $dE_T/d\eta$ and $1/\tau_0$
  
  $\tau_0 \sim 0.5$ fm/c at $\sqrt{s}=200$ GeV, 1 fm/c at 62, 2 at 17 GeV
  
  $E_T$ ratio to 200 GeV $\sim 0.4$ at 17, 0.7 at 62.4 GeV
  
  Expect $T_{\text{init}} \sim 170$ MeV $\sqrt{s}=17$ and $\sim 230$ MeV at $\sqrt{s}=62$
  
  Steeper spectrum & fewer measurable points

- Combinatorial background reduced by factor $\sim 6$-16 based upon data sample size and HBD rejection
  
  Being conservative: $\gamma$ statistical significance $x2$

- But, PHYSICS background: $\gamma_{\text{th}} / \gamma_{\text{decay}} \sim 0.1$ for $\int p_T$
  
  (according to hydro calculations at RHIC, SPS)
  
  Virtual photon method yields $\gamma^{*\text{th}} / \gamma_{\text{cocktail}} \sim 0.5$
  
  $\therefore$ S/B goes from 1/10 to 1/2
  
  $\therefore$ should be able to measure slope to $\sim 3$ GeV/c
Q3: What’s going on with the J/ψ?

Suppression larger at forward rapidity!

Doesn’t track maximum energy density!

Final state $c\bar{c}$ coalescence (aka recombination)?


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J/ψ in Muon Arms in Run-10 @ 200 GeV

Analyzed Luminosity (for mass plots):
147.7 µb⁻¹ gives 18.8 ± 0.4 (stat) J/Ψ per µb⁻¹
Compared to Run7 Au+Au which had about 18.2 J/Ψ per µb⁻¹

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J/ψ: analyzed 25% of 62 GeV statistics

- Recombination
  (e.g. Rapp et al.)
  J/ψ yield at 200 GeV is dominantly from recombination

- Predict suppression
greater at 62 GeV
  J/ψ yield down by 1/3
  Recombination down 1/10

600 M min. bias events → 500 J/ψ ∴ measure J/ψ suppression

Key test of recombination!
Success at 7.7 GeV Au+Au!

The trick?
Tight timing cut on BBC N vs. S!

URQMD AuAu @ 7.7 GeV through PHENIX full simulation

PHENIX AuAu @ 7.7 GeV Data w/ BBCLL1(>0 tubes) |z| < 30 cm

URQMD normalized to match real data integral for PC1 hits > 40.

PHENIX AuAu @ 7.7 GeV Data w/ BBCLL1(>1 tubes) |z| < 30 cm

URQMD not matched to z distribution in real data. **However, note that there is no rescaling of the x-axis.**

Then comparing the integrals implies (as a first look) that the BBCLL1(>0 tubes) fires on 77% of the cross section and the BBCLL1(>1 tubes) fires on 70% of the cross section.

No indication of deviation at low PC1 hits from background (at least by this particular check).
Looking ahead to Runs 11 and 12

How’s the detector doing?
PHENIX Detector

Central Arm Tracking
Drift Chamber
Pad Chambers
Time Expansion Chamber

Muon Arm Tracking
Muon Tracker

Calorimetry
PbGI
PbSc
MPC

Particle Id
Muon Identifier
RICH, HBD
TOF E & W
Aerogel
TEC

Global Detectors
BBC
ZDC/SMD Local Pol
Forward Hadron Calo
RXNP

DAQ and Trigger System
Online Calib. & Production

VTX
Replaces HBD
Muon Trigger: µTr FEE
RPC station 3
Muon Trigger Upgrade

**Trigger idea:**
Reject low momentum muons
Cut out-of-time beam background

**Upgrade:**
- muTr trigger electronics: muTr 1-3 \(\Rightarrow\) send tracking info to level-1 trigger
- RPC stations: RPC 1+3 \(\Rightarrow\) tracking + timing info to level-1 trigger

Note: RPC1 has larger acceptance than RPC3 at large radii, RPC1+ RPC3 give best coverage for timing needed for background rejection.
RPCs: trigger level timing

- Timing used in Run-9 to characterize background
- RPC3-N installed for Run-10
- Commissioned & ready

From collision or outgoing beam

From beam background

Test assembly of RPC-3 half octant support structure at UIUC
MUTRIG ready for physics in Run-11

- Good efficiency for MIPs
- MUTR.N installed for Run-9
- MUTR.s installed for Run-10
- ready to go
Muon arm background reduction

Stainless steel SS-130 absorber
2 interaction lengths, based upon simulations

Install on muon arms during shutdown
Parts are ordered.
Silicon Vertex (VTX & FVTX)

VTX: silicon Vertex barrel tracker
- Fine granularity, low occupancy
- 50\(\mu\)m\(\times\)425\(\mu\)m pixels for L1 and L2
- R1=2.5cm and R2=5cm
- Stripixel detector for L3 and L4
- 80\(\mu\)m\(\times\)1000\(\mu\)m pixel pitch
- R3=10cm and R4=14cm
- Large acceptance
  - |\(\eta\)|<1.2, almost 2\(\pi\) in \(\phi\) plane
- Standalone tracking
  - Install for Run-11

FVTX: Forward silicon VerTeX tracker
- 2 endcaps with 4 disks each
- Pixel pad structure (75\(\mu\)m x 2.8 to 11.2 mm)
  - Install for Run-12
VTX: Strips on track to complete by RUN11

- Place modules on a stave
- Align the modules
- Testing a new ladder
- 17 ladders out of 40 done
VTX Pixels: Preparing for barrel assembly

16 ladders out of 30 assembled at RIKEN. They will start arriving at BNL soon

Test fit a ladder on the mounts

A ladder on the mounts
What do we want?

Physics goals:
- $W$ asymmetry $\rightarrow q, \bar{q}$ spin contributions
- Heavy flavor suppression
- Excitation function for constituent quark flow
- Jet suppression
- First look at U+U
  how to select the geometry?
## PHENIX beam use proposal

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<thead>
<tr>
<th>RUN</th>
<th>SPECIES</th>
<th>$\sqrt{s_{NN}}$ (GeV)</th>
<th>PHYSICS WEEKS</th>
<th>$\int \mathcal{L} dt$ (recorded)</th>
<th>p+p Equivalent</th>
<th>Polarization</th>
</tr>
</thead>
<tbody>
<tr>
<td>11</td>
<td>p+p</td>
<td>500</td>
<td>10</td>
<td>50 pb$^{-1}$</td>
<td>50 pb$^{-1}$</td>
<td>50%</td>
</tr>
<tr>
<td></td>
<td>Au+Au</td>
<td>200</td>
<td>8</td>
<td>0.7 nb$^{-1}$</td>
<td>28 pb$^{-1}$</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Au+Au</td>
<td>27</td>
<td>1</td>
<td>35M events</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Au+Au</td>
<td>18</td>
<td>1.5</td>
<td>37M events</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>U+U</td>
<td>192.8</td>
<td>1.5</td>
<td>150-200M events</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>p+p</td>
<td>500</td>
<td>8</td>
<td>100 pb$^{-1}$</td>
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<tr>
<td></td>
<td>Au+Au</td>
<td>200</td>
<td>7</td>
<td>0.7-0.9 nb$^{-1}$</td>
<td>28-36 pb$^{-1}$</td>
<td></td>
</tr>
<tr>
<td></td>
<td>p+p</td>
<td>62.4, 22.4</td>
<td>2.5</td>
<td>1.0, 0.01 pb$^{-1}$</td>
<td></td>
<td>0%</td>
</tr>
</tbody>
</table>

**If less than 30 cryo weeks:**

- Shorten U+U from 1.5 weeks to 0.5 weeks
- Shorten 500 GeV p+p from 10 weeks to 8.5 weeks
- Remove Au+Au at 18 GeV.
- Shorten 200 GeV Au+Au from 8 weeks to 7 weeks.
So, what are we going to measure?
And how well are we going to do it?
Q.4: **W cross section & asymmetry?**

- **Raw counts (Charge combined)** (EMCal cluster associated with track)
- **Data driven BG estimation** (10-20GeV assumed to be all BG)
- **BG+PYTHIA (normalized)**

**Run-9 preliminary**

\[ A_L \, W^+ \rightarrow e^+ (|y_e| < 0.35) \]

---

**PHENIX**

**Preliminary**

- **30-50GeV/c range**
  - \( <p> = 0.39 \pm 0.04 \)
  - Dilution: 1.11 ± 0.04

PHENIX
150 pb$^{-1}$ * 500 GeV p+p, 50% polarization

\[ A_L(\text{forward } W^- \rightarrow \mu^-) \approx \Delta d/d. \quad A_L(\text{backward } W^- \rightarrow \mu^-) \approx \Delta \bar{u}/u. \]

*(PHENIXlive = 0.97) \times (PHENIXup = 0.65) \times (\text{vertex} = 0.55) = 0.35%*
Run-11 + Run-12: 150 pb$^{-1}$ sampled

Significant improvement on sea quark polarizations!
Q5: what's $\Delta G$? ($\pi^0 A_{LL}$ at 500 GeV)

Run-9 preliminary
Q6: heavy quark suppression & flow?

Collisional energy loss? 
$v_2$ decrease with $p_T$?
role of $b$ quarks?
VTX to tag displaced vertex

- Commission and take first data in Run-11!
- Commissioning plan
  - Run p+p first, commission with low multiplicity
  - Longest running period → max time to study VTX
  - Then switch to full energy Au+Au
  - Respect CA-D guidance of max energy first
  - Commission at high multiplicity & data rate
  - Collect data at 200 GeV Au+Au
    - serves both commissioning & physics
- Physics goals
  - Demonstrate the electrons are from heavy flavor
  - First direct look at separated b and c in Au+Au
With 8 weeks Au+Au at $\sqrt{s} = 200$ GeV

Assumption here:
Full 8 weeks used for data taking
Heavy quark flow in Run-11

Assumption:
Full 8 weeks data taking

NB: simulated limited $p_T$ range.

Good sensitivity for $v_2$ decrease at high $p_T$
Q7: Quark number scaling of $v_2$

- $v_2/n_q$ vs. $p_T/n_q$ or $KE_T/n_q$ follows a universal curve
- Reproduced by hydrodynamics
- Evidence for collective flow developed in QGP phase

Does scaling break at same $\sqrt{s}$ where $v_2$ saturates?
Error bars in Run-11

√ s=27 GeV

√ s=18 GeV

Test scaling to 0.5 GeV

vertex in ± 30cm

vertex in ± 10cm
Q8: Jet suppression $\sqrt{s}$ dependence?

- Where between 22.4 and 62.4 GeV does $R_{AA}$ become less than 1?

NB: firm conclusion on jet quenching will also require control of Cronin effect
Jet suppression in Run-10

Enhanced $p_T$ reach (Run-10)

Previous $p_T$ reach (Run-4)

Run-10 Raw $\pi^0$ yields

$62$ GeV

$39$ GeV
Projection for Run-11

uncertainty at $p_T = 3.5$ GeV:
~14% at 27 GeV
~30% at 18 GeV

Vertex cut ± 10 cm
### Basis for time estimates

<table>
<thead>
<tr>
<th>$\sqrt{s_{NN}}$</th>
<th>ave.lumi. $(cm^{-2}sec^{-1})$</th>
<th>$\sigma$ (b)</th>
<th>Events/Day in 30 cm</th>
<th>Events/Day in 10 cm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Au+Au</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>6.00 E+25</td>
<td>6.8</td>
<td>3.73 M</td>
<td>1.24 M</td>
</tr>
<tr>
<td>27</td>
<td>8.00 E+25</td>
<td>6.8</td>
<td>4.98 M</td>
<td>1.66 M</td>
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<tr>
<td>p+p</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>22</td>
<td>2.50 E+29</td>
<td>0.03</td>
<td>68.6 M</td>
<td>22.9 M</td>
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<tr>
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<td>0.032</td>
<td>176 M</td>
<td>58.5 M</td>
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<tr>
<td>39</td>
<td>2.40 E+30</td>
<td>0.033</td>
<td>724 M</td>
<td>241 M</td>
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<tr>
<td>62</td>
<td>4.80 E+30</td>
<td>0.0356</td>
<td>1.56 B</td>
<td>521 M</td>
</tr>
</tbody>
</table>

- Projections from W. Fischer
U+U “engineering” run simulations

The goal

The problem

The solution: 200M evt
~ 400k tip-tip events

0.2% of $N_{ch}$ 0.04%

0º E

PHOENIX

mb

$e_{0}$ (GeV fm$^{-3}$)

$s_{0}$ (fm$^{-3}$)

$N_{part}$

$\varepsilon_{part}$
Run-12 Physics goals

- Reach 150 pb-1 sampled for W in 500 GeV p+p
- Full energy Au+Au
  Extend open heavy flavor study to forward angle
- Low energy p+p comparison running
Run-12 FVTX physics

Run-12 Goals:
Commission
Take first part of this data set
Low energy $p+p$ comparison running

Measurement way better than fit!
But, $p+p$ data run out at 7 GeV/c $p_T$ so we request new run

Key: $p+p$ data at $\sqrt{s} = 22.4$ GeV
For Cu+Cu statistics, require 0.01 pb$^{-1}$
I.e. 6 days + changeover

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● backup slides
Beauty & charm separation at different muon $p_T$
Backgrounds at 500 GeV

- Data analysis underway...
- First taste of >1 MHz interaction rates
- Demonstrated operability of detectors
- Multiple collisions per crossing and in adjacent crossings
  - Learned how to deal with it
  - Revised drift chamber calibration approach
- Scaling the backgrounds to the collision rate worked OK as a rule of thumb
- RPCs provided key monitoring instrumentation
  - Probably would like to install additional monitors
<table>
<thead>
<tr>
<th>Year</th>
<th>#</th>
<th>Milestone</th>
</tr>
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<tbody>
<tr>
<td>2009</td>
<td>DM4</td>
<td>Perform realistic three-dimensional numerical simulations to describe the medium and the conditions required by the collective flow measured at RHIC.</td>
</tr>
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<td>2010</td>
<td>DM5</td>
<td>Measure the energy and system size dependence of J/\psi production over the range of ions and energies available at RHIC.</td>
</tr>
<tr>
<td>2010</td>
<td>DM6</td>
<td>Measure $e^+e^-$ production in the mass range $500 \leq m_{e^+e^-} \leq 1000$ MeV/c$^2$ in $\sqrt{s_{NN}} = 200$ GeV collisions.</td>
</tr>
<tr>
<td>2010</td>
<td>DM7</td>
<td>Complete realistic calculations of jet production in a high density medium for comparison with experiment.</td>
</tr>
<tr>
<td>2012</td>
<td>DM8</td>
<td>Determine gluon densities at low $x$ in cold nuclei via $p + Au$ or $d + Au$ collisions.</td>
</tr>
<tr>
<td>2015</td>
<td>DM9</td>
<td>Measure bulk properties, particle spectra, correlations and fluctuations in Au + Au collisions at $\sqrt{s_{NN}}$ from 5 to 40 GeV to search for evidence of a critical point in the QCD matter phase diagram.</td>
</tr>
<tr>
<td>2014</td>
<td>DM10</td>
<td>Perform calculations including viscous hydrodynamics to quantify, or place an upper limit on, the viscosity of the nearly perfect fluid discovered at RHIC.</td>
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<tr>
<td>2014</td>
<td>DM11</td>
<td>Measure jet and photon production and their correlations in $A\approx200$ ion+ion collisions at energies from $\sqrt{s_{NN}} = 30$ GeV up to 5.5 TeV.</td>
</tr>
<tr>
<td>2016</td>
<td>DM12</td>
<td>Measure production rates, high $pT$ spectra, and correlations in heavy-ion collisions at $\sqrt{s_{NN}} = 200$ GeV for identified hadrons with heavy flavor valence quarks to constrain the mechanism for parton energy loss in the quark-gluon plasma.</td>
</tr>
<tr>
<td>2018</td>
<td>DM13</td>
<td>Measure real and virtual thermal photon production in $p + p$, $d + Au$ and $Au + Au$ collisions at energies up to $\sqrt{s_{NN}} = 200$ GeV.</td>
</tr>
</tbody>
</table>
## Spin Physics Milestones

<table>
<thead>
<tr>
<th>Year</th>
<th>#</th>
<th>Milestone</th>
</tr>
</thead>
<tbody>
<tr>
<td>2013</td>
<td>HP8</td>
<td>Measure flavor-identified $q$ and $\bar{q}$ contributions to the spin of the proton via the longitudinal-spin asymmetry of $W$ production.</td>
</tr>
<tr>
<td>2013</td>
<td>HP12</td>
<td>Determine if gluons have appreciable polarization over any range of momentum fraction between 1 and 30% of the momentum of a polarized proton.</td>
</tr>
<tr>
<td>2015</td>
<td>HP13</td>
<td>Test unique QCD predictions for relations between single-transverse spin phenomena in p-p scattering and those observed in deep-inelastic lepton scattering.</td>
</tr>
</tbody>
</table>
Forward Silicon Vertex Detector (FVTX)

Single Muons:
- Precision heavy flavor and hadron measurements at forward rapidity
- Separation of charm and beauty
- Additional W background rejection

Dimuons:
- First direct bottom measurement via $B \rightarrow J/\psi$
- Separation of $J/\psi$ from $\psi'$ with improved resolution and S:B
- First Drell-Yan measurements from RHIC
ΔG not large: sea quarks polarized? d vs. u?

Probe Δq-Δq via W production

\[ Δd + \bar{u} \rightarrow W^- \]
\[ Δ\bar{u} + d \rightarrow W^- \]
\[ Δ\bar{d} + u \rightarrow W^+ \]
\[ Δu + d \rightarrow W^+ \]

p unpol.

100% Parity-violating: $-A_L = \frac{\sigma_+ - \sigma_-}{\sigma_+ + \sigma_-}$

Start: 2009(tests)/2010(trigger) with 500 GeV p+p
Charm & bottom cross section in p+p

CHARM
Dilepton measurement in agreement with single electron, single muon, and with FONLL (upper end)

BOTTOM
Dilepton measurement in agreement with measurement from e-h correlation and with FONLL (upper end)
Specifications:
Large acceptance ($\Delta \phi \sim 2\pi$ and $|\eta| < 1.2$)
Displaced vertex measurement $\sigma < 40 \, \mu m$
Charged particle tracking $\sigma_p/p \sim 5\%$ p at high pT
Detector must work for both HI and pp collisions.

Technology Choice
Hybrid pixel detectors developed at CERN for ALICE
Strip detectors, sensors developed at BNL with FNAL’s SVX4 readout chip

Hybrid Pixel Detectors (50 $\mu m$ x 425 $\mu m$) at R $\sim 2.5$ & 5 cm
Strip Detectors (80 $\mu m$ x 3 cm) at R $\sim 10$ & 14 cm

$|\eta|<1.2$
$\phi \sim 2\pi$
$z \sim \pm 10 \, \text{cm}$
FVTX Specifications:
- 2 endcaps
- 4 pixelpad layers/endcap
- ~550k channels/endcap
- Electronics a mod of BTeV readout chip
- Fully integrated mech design w/ VTX
- $2\pi$ coverage in azimuth and $1.2 < |\eta| < 2.4$
- Better than 100 $\mu$m displaced vertex resolution
Physics Program of FVTX includes

- Resolving $J/\psi$ and $\psi'$ in Muon arms
- Resolving $\Upsilon$ at $y=0$ using Muon arms
- Direct measure of $B$ meson through displaced $J/\psi$
- Drell-Yan Measurements in $dAu$ at both forward and midrapidities
- $c, b$ ID for both HI physics & $\Delta G$ spin measurements
- Nuclear modification factor (CGC effects) in $dAu$ using hadrons, $c, b,$ and $J/\psi$

$c, b$ suppression at forward $\eta$