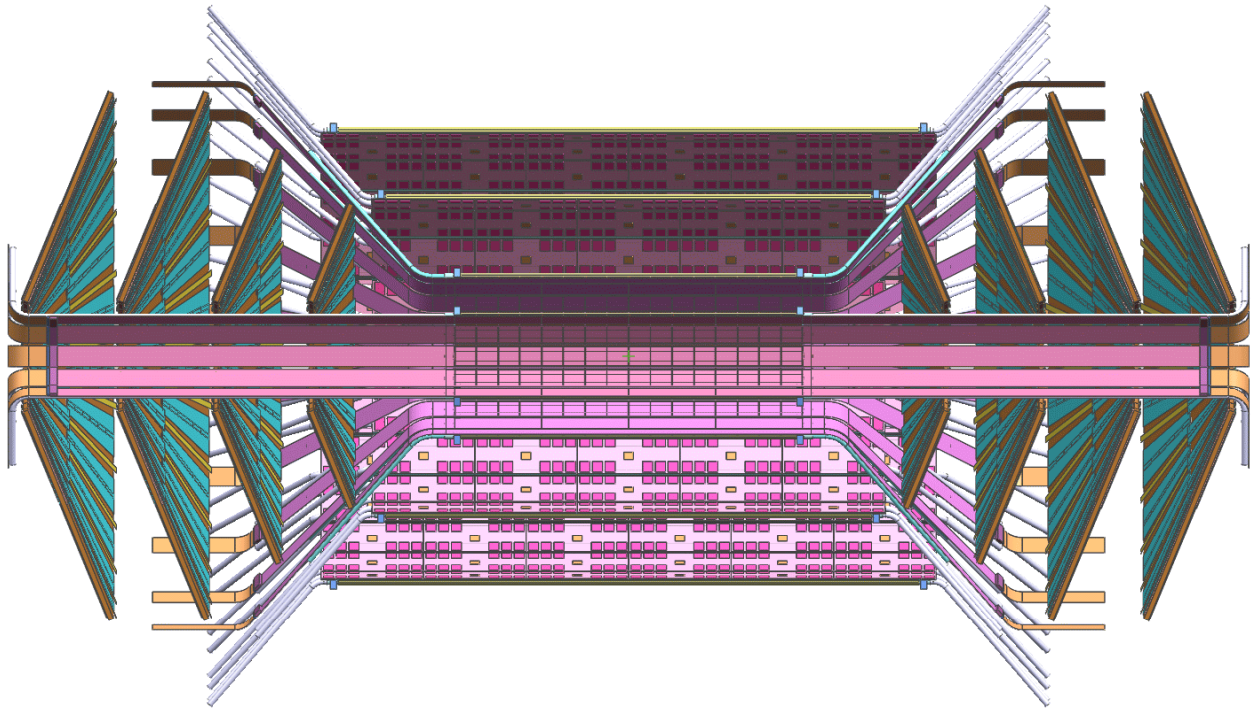
FVTX Proposal Status and Plans

Patrick L. McGaughey

Los Alamos

PHENIX DC Upgrades Meeting 11/8/05



PHENIX and Other Participants in FVTX

BNL, Charles Univ., Columbia,
Ecole Polytechnique, FNAL, FSU,
Hytec Inc., ISU, Korea Univ., Kyoto,
LANL, NMSU, Saclay, UNM, Yonsei
(based on expressions of interest)

Project Manager : Dave Lee (LANL)

We're actively looking for additional collaborators!

FVTX Project

- Construct two Forward Silicon Vertex Trackers (FVTX) for PHENIX.
- Extend vertex capability of PHENIX VTX to rapidities covered by muon arms.
- Robust detection of charm and beauty decays in *A+A*, *d+A*, and *p+p*.
- Measure gluons at small Bjorken-x.
- Improved reaction plane measurement.

Proposal Text

Text and figures written in these 5 sections:

- **Executive Summary - 3 pages, Done**
- **Physics Goals of the FVTX Endcap Upgrade - 18 pages, Done, except for spin section**
- **Simulations and Required Performance for the Si Endcap Upgrade - 12 pages, mostly written, but many new simulations underway**
- **FVTX Detector System - 15 pages, mostly written, similar to barrel proposal appendix**
- **R+D Schedule, Responsibilities and Budget - 8 pages, mostly written**

47+ figures and 5 tables, ~64 total pages.

Physics Goals
I. A+A collisions and the QGP

- **Study energy loss and flow of heavy quarks at $|y| \neq 0$.**
- **Provide open charm and beauty baseline for J/ψ and Υ.**
- **Detect $\Upsilon \rightarrow \mu^+\mu^-$ at $|y| = 0$.**
- **Improve mass resolution and S/N for J/ψ and Υ, enabling identification of ψ'.**
- **Provide accurate reaction plane.**
- **Reject copious backgrounds from K and π decays.**

II. d+A Collisions, small x physics

- **Measure Gluon saturation / shadowing in nuclei at small *x*.**
- **Determine cold nuclear matter effects on heavy quarks production.**
- **Set robust baseline for A+A measurements.**
- **Untangle physics of J/ψ and ϒ production in cold nuclear matter by measuring open heavy flavor →separating initial and final-state physics for the resonances.**

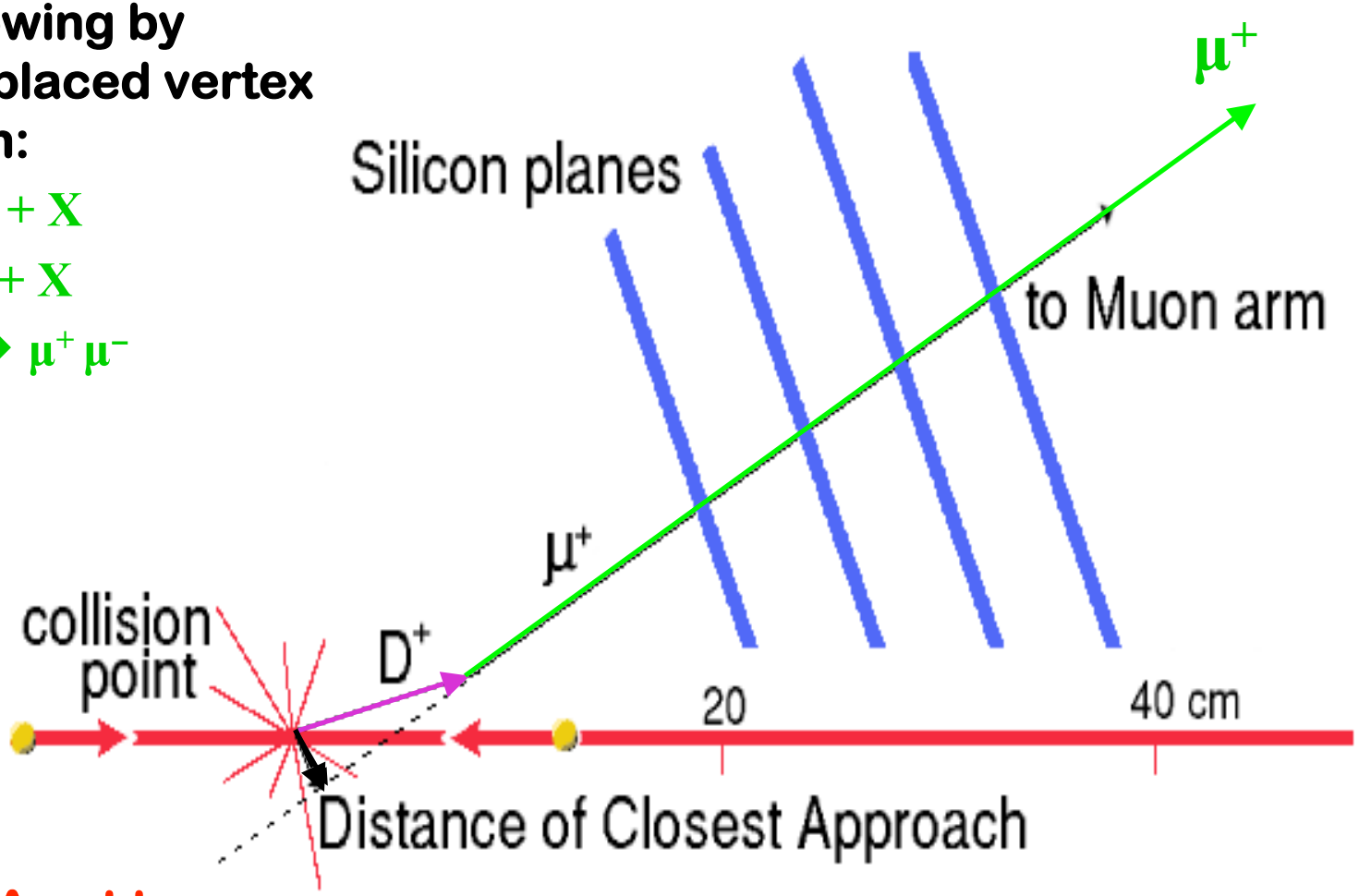
III. p+p and polarized p+p

- **Improved open heavy flavor and quarkonium baselines for d+A and A+A programs**
- **Extend gluon polarization ($\Delta G/G$) measurements to very low x. Larger x range (from 10^{-2} down to 10^{-3})**
- **Measure B → J/ψ + X**
- **Measure J/ψ polarization**

Forward Micro-Vertex Detector

Can detect following by observing a displaced vertex (DCA) of a muon:

- D (charm) → μ + X
- B (beauty)→ μ + X
- B → J/ψ + X → $\mu^+ \mu^-$



Use finite DCA cut to eliminate backgrounds from π or K → μ + X

Four Si planes constructed of pixels 50 um high by 2 to 13 mm long

Simulation Status

- Gluon x coverage for open charm, beauty, J/ψ and Υ - Done
- Extraction of gluon x values from charm and beauty decays - Done

- Z vertex and DCA resolution for single muons and pairs - Done for FVTX, not for FVTX + barrel
- Decay length calculations for charm and beauty - Done

- Resolution improvement of J/ψ - Done
- S/B improvement for J/ψ, Υ and continuum- Not done
- S/B for open charm and beauty - Hadron decays done, punchthrus not

Simulation Status, cont.

- Rates for D→μ, B→μ, B→J/ψ - Done, need to quantify reach in p_T
- Separation of B from D - Partly done

- Occupancy in Au-Au - Done
- Acceptance for FVTX + barrel - Done
- Matching to muon tracks in AuAu - Partly done
- Inclusion of barrel detector in track fitting - Not done

- Estimates of R_{AA} and flow sensitivity - Not done
- Reaction plane measurement - Not done
- Improved J/ψ polarization data - Not done

Backup slides

Introduction

- A new state of matter, the quark-gluon plasma (QGP), is being probed in collisions of heavy ions at RHIC.
- Heavy quarks (charm and beauty) are the cleanest probe of QGP. Next frontier of QGP physics. Want to measure their energy loss and flow in QGP.
- We propose to construct a forward silicon micro-vertex detector (FVTX) → unique heavy quark experimental capability at RHIC ($|y| > 0$).
- Close collaboration between theory, simulation and experiment.
- Quantitative determination of QGP properties.

Si Vertex Detector Mechanical Layout