Tracking Workshop

- A collection of excellent talks were given addressing three aspects of the tracking design of sPHENIX:
  - Simulations and Physics Demands
  - Silicon Technology
  - Micro Pattern Gas Detectors
- All of the presentations were of high quality and showed significant work.

Simulations and Physics Demands

- The momentum resolution of the tracking system is driven primarily by the need to separate the Upsilon 1s, 2s, and 3s states.
- Given the constraints of the decadal plan in terms of magnetic field and radius (2 Tesla & 60 cm) the tracking detectors should provide a pixel size in the bend direction of 80 μm, which corresponds to an RMS resolution of $\frac{80\ \mu m}{\sqrt{12}} \approx 25\mu m$ in order to separate these states.
  - Pixel sizes of 80 μm are easily achievable with Silicon Tracking.
  - RMS resolutions of 25 μm are, in principle, achievable with gas-based tracking, but are at the limits of current technology.
  - Typical gas detector resolutions (50-100 μm) will only separate the Upsilon states cleanly of the magnet parameters are changed.
- The 2^{nd} most demanding physics goal (in terms of tracking) is the charge sign separation of leptons from W decay.
- A broad effort is needed to formulate a vision for both the simulation and oberall analysis model for sPHENIX. This effort should:
  - Retain the best features of current PHENIX analysis.
  - Drop the worst features.
  - Overcome the separation of simulation, reconstruction, and analysis environments.
- Priorities for simulations should be established. Tasks involving tracking include:
  - Short term calculations
    - Simulation of the reconstruction of Upsilon states with RMS resolutions of 50 μm and 100 μm, typical of gas trackers.
    - Simulations to measure the quality of charge-sign assignment for W decays.
  - Longer term calculations
    - Rates of fake tracks as a function of momentum and number of layers in the tracker.
    - Efficacy of HCAL in removing these backgrounds as a function of momentum.
    - Possibilities for reconstruction of neutral Vs (K^o, Λ).
    - Electron ID quality with EMC as the only electron ID device.

Silicon Tracking

- The resolution requirements on Silicon-based tracking are easy to meet with existing technologies.
- Different Silicon technologies have varying degrees of radiation hardness. Although the radiation doses for heavy ion and electron-ion running are expected to be moderate, exact numbers for these expectations should be obtained.

Micro Pattern Gas Detectors

- Great progress has been made in recent years, principally on the technologies of μMEGAs and GEMs, both of which operate stably at high rates, and are quite cost effective.
- Channel counts can be kept low by various means:
  - Chevron or ZigZag pads using charge interpolation can deliver resolutions on the order of 100 μm with pad sizes as large as 2 cm x 2 mm.
  - The above Chevron segmentation results in about 125,000 channels at r=40 cm.
  - Cartesian readouts (X-Y strips) can resolve ambiguities by matching charge deposits of tracks with up to 10 tracks per X-Y region. Charge division strips with 300 micron picth measure position with roughly 50 μm in each direction.
  - At r=40 cm, there are 10 particles in a roughly 10cm x 10cm area. With a 300 micron pitch of strips, this would be 300 X-strips and 300 Y-strips. The tracking layer at r=40 cm contains roughly 500 such regions for a total channel count of 300,000 channels.

Miscellaneous

- If the simulations do not demonstrate a robust tracking with 6 layers, a hybrid tracking solution (high resolution points connected by interleaved lower resolution points) might be a viable option.
- We should calculate the required precision of the magnetic field map necessary to meet the physics goals.
- The BaBar and CDF magnets could become available and should be considered.
- Can we measure muons in addition to electrons (since muons do not suffer from a radiative tail).