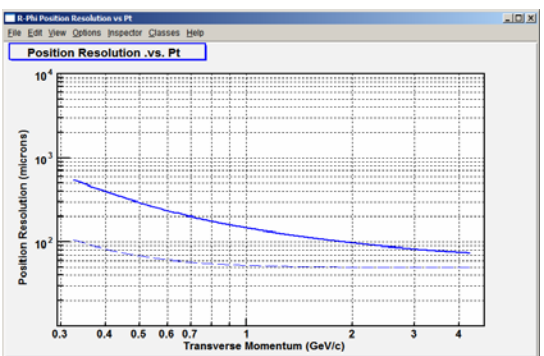
**Pads may not be necessary for an Intermediate Tracker at mid rapidity:**

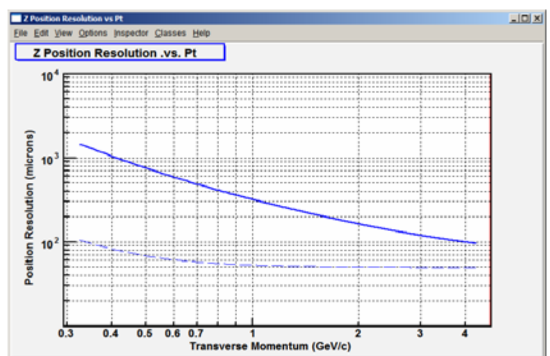
One good option for finding tracks at mid-rapidity and pointing them at the HFT is to use two IST detectors; one at 17 cm radius and another at 12 cm radius.

The canonical configuration for each IST detector is to sub-divide it into two layers. The first layer is a Si wafer containing ‘strips’ that are 3.8 cm long and 60 microns wide. These strips give excellent resolution in one direction, but not so good resolution in the other. The second layer is a Si wafer containing ‘pads’ that are 1.2 mm wide by 1.9 mm long. The two layers are sandwiched together to form an IST detector element. Note that the number of pads and strips is the same in both layers … which is convenient for electronic readout and a very cost efficient way to design the detector.

In this note, I want to question the usefulness of the pad layers and to propose that at least one of the pad layers can be eliminated; perhaps the pads on IST2.

The Strip layer gives excellent resolution in one dimension. If we build a system with two detectors and the strips are rotated by 90 degrees in one of the detectors, versus the other, then it is possible to achieve very good pointing resolution on the HFT. The area pointed to by the IST detectors will be approximately symmetric, too. Figures one and two show a simulation with 3.8 cm long strips (i.e. no pads) that have 60 micron spacing between the strips. With this system, it is possible to define a search radius on the surface of the HFT that is 200 microns by 500 microns for Kaons at 750 MeV/c. (This is essentially the same result you get if you include the pad layers.)




Figures 1 and 2: R-Phi and Z pointing resolution (respectively) for two IST detectors pointing at the HFT. The IST detectors are located at radii of 17 and 12 cm.

The single track efficiencies in the HFT can be calculated from these pointing resolution numbers if we provide additional input for the event multiplicity, luminosity, and HFT integration time. Under the fairly conservative assumptions listed at the end of this document (i.e. high rate RHIC II Au-Au running), the single track efficiencies are quite reasonable and are shown in Figure three.

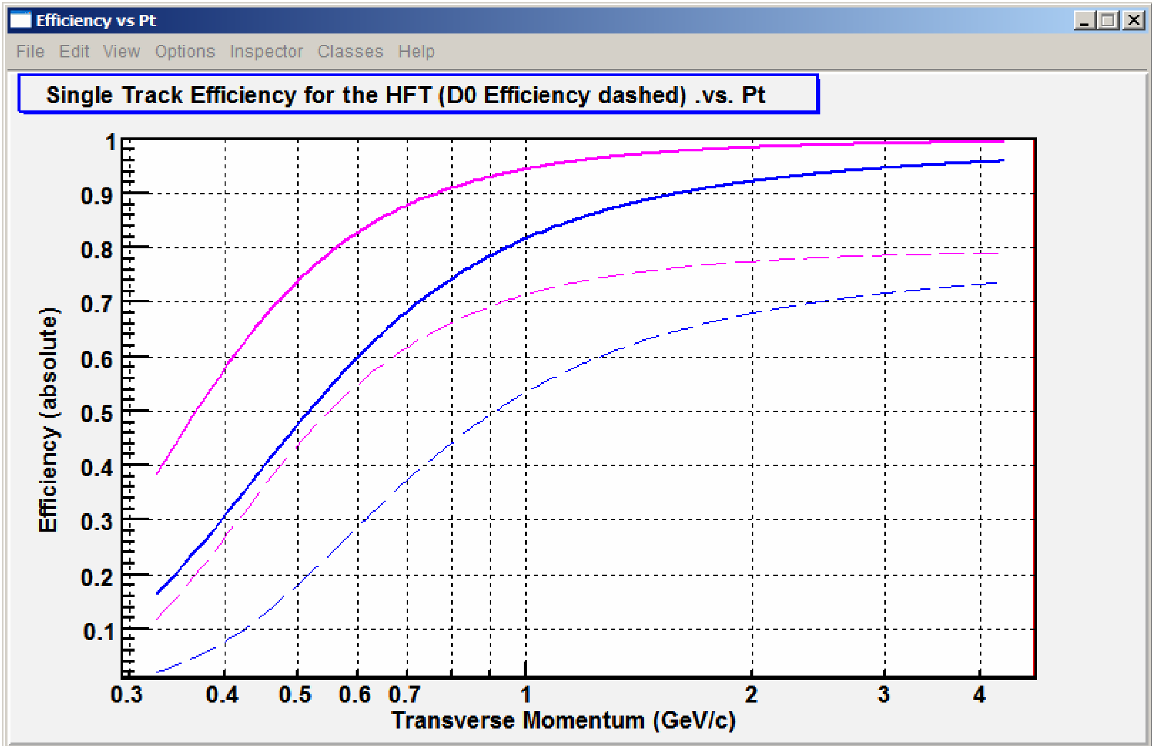



Figure 3: The solid blue line shows the efficiency for finding a kaon in both layers of the HFT. The dashed line represents the square of the solid line (times 0.8 to displace the curves) and is a very crude estimate of the D0 track finding efficiency. The magenta line shows the improvement that can be had by 'hot roding' the tracking algorithm by using Victor and Howard's chi-square hit finding algorithm plus improving the detector resolutions by 1/root(12).

In summary, the two IST detectors working together provide excellent results but the pad layers don't contribute to the performance of the system in terms of resolution and efficiency.

Up to this point, I have ignored ambiguous (or ghost) hits.

The purpose of the pads is to decrease the occupancy on the strip layers of the IST. The pads define a virtual cell that is no wider than a strip and is 20 times shorter. In principle, this improves the performance of the tracking system. However, this improvement comes in association with an increased number of ambiguous hits (aka ghosts) due to the projective nature of the pads and strip layers. The relative rate of ambiguous hits can be quite high if the IST layers are pushed too close-in towards the vertex. See:

http://rnc.lbl.gov/~jhthomas/public/HFT/ISTat12cm.pdf

Are the pads necessary? The proposed pads are very large ( 1.2 x 1.9 mm ). However, the pads only deliver millimeter scale resolution while the TPC+SSD does an equivalent or better job of tracking and therefore is more able to resolve the hits on the strips than the pads can do. This is especially true if the strips lie in a direction that is transverse to the direction of the strips in the SSD. Even the TPC acting alone does a better job of resolving the hits on the strips than the pads can do. Thus, I conclude that we don't need the pads.

If you want to say that the pads provide an unambiguous determination of the hit location (because the TPC suffers distortions and other systematic effects) then I might agree. However, in that case, I don't think we need more than one layers of pads in the system. A pad layer with each set of IST strips is not essential and the outer layer of pads is even redundant with the function of the SSD.

Thus, it may be possible to eliminate the pads in IST2. This would save a lot of money and reduce the total radiation length budget for the tracking system.

Parameters used in these calculations:

```
#define        Mass                     0.540       // Mass of the test particle in
#define        BFIELD                   0.5         // Tesla  (test data taken at 0.25
#define        AvgRapidity              0.5         // Avg rapidity, MCS calc is a
#define        Luminosity               1.e28       // Luminosity of the beam (RHIC I ==
#define        Sigma                    15.0        // Size of the interaction diamond
#define        dNdEta                   170         // Multiplicity per unit Eta  (AuAu
#define        CrossSection             10          // Cross section for event under
#define        IntegrationTime          0.2         // Integration time for HFT chips (
#define        BackgroundMultiplier     4.0         // Increase multiplicity in detector
#define        SiScaleFactor            1.0         // For scaling Si pad sizes.  (eg
#define        EfficiencySearchFlag     0           // Define search method. ChiSquare =

// Most likely Detector parameters you may want to tune are in the block starting here:

#define        VtxResolution            0.3000      // cm  Test data wants 3 mm vertex
#define        VtxResolutionZ           0.3000      // cm  Test data wants 3 mm vertex

#define        NewVtxResolution         0.0300      // cm  NewVertex to study effect of a
#define        NewVtxResolutionZ        0.0300      // cm  NewVertex to study effect of a

#define        RefitVtxResolution       0.0030      // cm  Refit Vertex to study effect
#define        RefitVtxResolutionZ      0.0030      // cm  Refit Vertex to study effect

#define        BeamPipe1Resolution      RIDICULOUS  // Beampipe is not active as a

#define        Hft1Resolution           0.0030      // cm  30 x 30   micron pixels
#define        Hft1ResolutionZ          0.0030      // cm  30 x 30   micron pixels

#define        Hft2Resolution           0.0030      // cm  30 x 30   micron pixels
#define        Hft2ResolutionZ          0.0030      // cm  30 x 30   micron pixels

#define        BeamPipe2Resolution      RIDICULOUS  // Beampipe is not active as a

#define        HpdResolution            0.0050      // cm  50 x 425  micron pixels ...
#define        HpdResolutionZ           0.0425      // cm  50 x 425  micron pixels ...

#define        Ist1Resolution           0.0060      // cm  60 x 1920 micron pixels ... Z
#define        Ist1ResolutionZ          0.1920      // cm  60 x 1920 micron pixels ...
//#define        Ist1Resolution           0.1920      // cm  60 x 1920 micron pixels ...
//#define        Ist1ResolutionZ          0.0060      // cm  60 x 1920 micron pixels ...

//#define        Ist2Resolution           0.0060      // cm  60 x 1920 micron pixels ...
//#define        Ist2ResolutionZ          0.1920      // cm  60 x 1920 micron pixels ...
#define        Ist2Resolution           0.1920      // cm  60 x 1920 micron pixels ...
#define        Ist2ResolutionZ          0.0060      // cm  60 x 1920 micron pixels ...

#define        SsdResolution            0.0095      // cm  95 x 4200  microns double
#define        SsdResolutionZ           0.2700      // cm  95 x 4200  microns double
```

```
#define        IFCResolution            RIDICULOUS  // IFC is not active as a detector

#define        TpcResolution            0.0575      // cm  600 x 1500 microns ...Test
#define        TpcResolutionZ           0.1500      // cm  600 x 1500 microns ...Test

// End of 'most likely' block, but there are more parameters, below.

#define        VtxIndex                 0
#define        BeamPipe1Index           1
#define        Hft1Index                2
#define        Hft2Index                3
#define        BeamPipe2Index           4
#define        HpdIndex                 5
#define        Ist1Index                6
#define        Ist2Index                7
#define        SsdIndex                 8
#define        IFCIndex                 9
#define        TpcIndex                 10
#define        VtxThickness             0.0000  // % Radiation Lengths
#define        BeamPipe1Thickness       0.0015  // % Radiation Lengths (as in 0.01 == 1%)
#define        Hft1Thickness            0.0028  // % Radiation Lengths (0.0028 new 0.0036
#define        Hft2Thickness            0.0028  // % Radiation Lengths (0.0028 new 0.0036
#define        BeamPipe2Thickness       0.0015  // % Radiation Lengths
#define        HpdThickness             0.0100  // % Radiation Lengths
#define        Ist1Thickness            0.0150  // % Radiation Lengths
#define        Ist2Thickness            0.0150  // % Radiation Lengths
#define        SsdThickness             0.0100  // % Radiation Lengths
#define        IFCThickness             0.0052  // % Radiation Lengths
#define        TpcAvgThickness          0.00026 // % Radiation Lengths ... Average per
#define        VtxRadius                0.0     // cm
#define        BeamPipe1Radius          2.05    // cm (2.05 new 1.50 old)
#define        Hft1Radius               2.50    // cm (2.5  new 1.55 old)
#define        Hft2Radius               7.00    // cm (7.0  new 5.00 old)
#define        BeamPipe2Radius          8.55    // cm (8.55 new 6.05 old)
#define        HpdRadius                9.2     // cm (9.2  HPD,6.0  SVT)
#define        Ist1Radius              12.0     // cm (12.0 IST,10.0 SVT, option 9.5 IST)
#define        Ist2Radius              17.0     // cm (17.0 IST,14.0 SVT)
#define        SsdRadius               23.0     // cm
#define        IFCRadius               47.25    // cm  Middle-Radius of the IFC ... its
#define        TpcInnerRadialPitch1     4.8     // cm
#define        TpcInnerRadialPitch8     5.2     // cm
#define        TpcOuterRadialPitch      2.0     // cm
#define        TpcInnerPadWidth         0.285   // cm
#define        TpcOuterPadWidth         0.620   // cm
#define        InnerRows1               8
#define        InnerRows8               5
#define        InnerRows               (InnerRows1+InnerRows8)
#define        OuterRows               32
#define        TpcRows                 (InnerRows1 + InnerRows8 + OuterRows)
#define        RowOneRadius            60.0     // cm
#define        RowEightRadius          93.6     // cm
#define        RowFourteenRadius      127.195   // cm
```