Tracker Choice:
Ground Rules and Process

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MICE TRACKING QUESTIONS

1) What effect does RF noise have on the tracking system? How do tracking devices with conductors behave near RF cavities. A cosmic ray telescope made with PWCs might be able to do this at FNAL's Lab G. Numerous small PWCs used to be employed in monitoring FNAL's fixed target beamlines. The idea is to get some initial data quickly. It is said that the CAMAC crates in Lab G have to be covered with copper foil to work.

2) What effect do electrons from RF have on the tracker? What occupancy levels does this lead to? How does this effect ganging fiber tracker channels together?

3) What is the multiple scattering introduced by the tracking system for 200 MeV/c muons? Whatever RF shielding the tracking system needs should be included.

4) What is the momentum resolution?
It only has to be good enough.

5) Has the system been shown to work either in an experiment or as a proto-type? Has whatever is new been shown to work?

6) What is the estimated cost of the system?
What are the prospects for funding?

7) How hard is it to run the detector and are people available to keep the detector going for at least for as many tracks as MICE needs to record?

Tracker technology choice

Common technical criteria

i. Sensitivity to cavity-generated X-ray background:
Sensitivity of sensitive material (scintillating fibre or gas) to X-rays and spurious electrons. Rate and characteristic signal must be measured, using a common cavity (Lab G at Fermilab ideal as fibre measurements already done there).
Acceptable performance of pattern recognition and track fit to levels of background significantly in excess of expectation must be demonstrated. A common simulation of beam and background must be used. The effect of integration time must be included. Note that conversions in the support structures (end plates, support tubes) must be simulated.

ii. Sensitivity of off -detector electronics to RF noise:
Measure 805 MHz component on 60 Hz mains outside Lab G area at Fermilab.
Develop filter strategy.

iii. Position resolution:
Demonstrate required point resolution.
What is the multiple scattering introduced by the tracking system for 200 MeV/c muons? Whatever RF shielding the tracking system needs should be included.

iv. What is the momentum resolution?

v. Has the system been shown to work either in an experiment or as a prototype?

vi. Safety:
Issue is that RAL safety review must accept that operation of devices in the neighbourhood of the liquid hydrogen is safe. This must be done before a decision is made.

Common: cost and schedule

vii. Cost:
A cost breakdown must be prepared in reasonable detail including an analysis of the principle risks in the purchasing and supply.

viii. What are the prospects of funding?

ix. Schedule:
A schedule with appropriate detail including key milestones must be prepared. Prototyping and quality control issues should be addressed and an indication of critical path given.

Common: maintenance and operation

x. How hard is it to run the tracking system? What are the people available to keep the detector going for at least as many tracks as MICE needs to record?

SciFi specific criteria

xi. Alignment and stability:
Relative alignment of five stations must be sufficiently precise and both reproducible and stable. The required precision should be demonstrated through construction of an appropriate prototype.

xii. Assembly of components:
By manufacture of appropriate prototypes the feasibility of component manufacture and assembly must be demonstrated.

xiii. Optical cross-talk between scintillating fibres:
Demonstrate that this is reduced to an acceptable level (or eliminated) for at least one of scintillator formulation.

xiv. Light yield (efficiency):
By measurements on the single-station prototype, show that the light yield is high enough to provide the necessary point efficiency.

xv. Noise:
By measurements on the single-station prototype, show that the noise is low enough not to interfere with the tracking performance.

xvi. Demonstrate performance of the multiplexing scheme:
By construction and operation of appropriate prototypes, demonstrate that the proposed multiplexing scheme meets requirements. By simulation demonstrate that the pattern-recognition performance in the presence of background and inefficiency is acceptable.

xvii. Update the simulation with measured parameters and demonstrate adequate performance of the full system (detectors and reconstruction software).

TPG specific criteria

xviii. Sensitivity of detector and on-detector electronics to RF noise (pick-up):
By measurements on an appropriate prototype in front of the Lab G cavity, show that pick-up of RF and other electrical noise is acceptably low.

xix. Alignment and stability:
Estimate alignment precision required (field cage with respect to magnetic field axis). By construction of appropriate prototypes, show that the required tolerance can be achieved.

xx. Electric/magnetic field uniformity:
Estimate the degree of electric and magnetic field uniformity required for the TPC performance to be maintained. Demonstrate that the required tolerance can be achieved.

xxi. Performance of He based gas mix:
Measure characteristics of proposed gas mixture (drift velocity , Lorentz angle, amplification) in an appropriate prototype.

xxii. Track length of X-ray-induced delta rays in drift volume:
Measure the path length of X-ray induced delta rays in an appropriate prototype. Simulate as appropriate in G4MICE simulation of TPG and demonstrate that pattern recognition and track fit performs adequately.

xxiii. Full simulation and reconstruction within G4MICE.

xxiv. Cross talk:
By construction of appropriate prototype, demonstrate that this is not a problem in the proposed electronics.

xxv. Effects of X-rays and secondary electrons on GEMs:
By exposing a suitable prototype to the X-rays produced in the Lab G cavity, measure the effect of X-rays on the GEMS. Implement simulation of the effect of X-rays on the GEMS in G4MICE and demonstrate that he performance of the pattern recognition is adequate.

xxvi. Calibration of time-to-distance in situ:
Demonstrate procedure by which time-to-distance relation can be determined in situ during data taking.