M13 *TWIST* Beam Development Studies

Documentation can be found on the Beams Study Group Bulletin Board at
http://stoney.phys.ualberta.ca/ e614/Projects/E614-S2/00016/index.html.

Properties to be measured:

- total intensity (normalized to proton beam current)
- particle momentum distribution
- four-dimensional emittance (x, y, dx, dy)

Some or all of these properties must be measured as a function of different beam line variables.

Measurements at different momenta

Some properties are most easily measured with a detector arrangement limited to higher momentum (*e.g.* 90 MeV/c).

- *TWIST* beam tune – establish low depolarization tune of J. Doornbos
- beam element settings – sensitivity to magnet variations
- beam emittance – sensitivity to jaw and slit variations
- momentum acceptance – indirect only

Where possible, confirmation of the above properties at surface muon momentum should be attempted, with a detector arrangement that is less affected by multiple scattering. Additionally, other properties can only be obtained near 29.7 MeV/c.

- surface muon beam shape and position
- cloud muon properties, including polarization
- BL1A proton beam steering sensitivity
- solenoid fringe field effects
- production target differences

Detector arrangement for 90 MeV/c

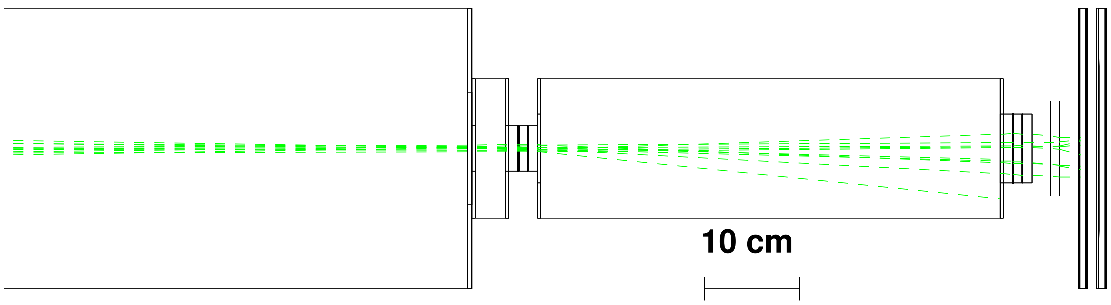

Figure 1: Possible arrangement for high momentum beam size and emittance estimation using two separated chambers (FC1 is 5 cm, FC2 is 7 cm) and scintillators for particle identification. The simulated tracks entering from the left demonstrate the significant multiple scattering of a surface muon beam with realistic emittance, focused at FC1.

Why 90 MeV/c?

GEANT simulations were made at three momenta for a "perfect" beam (zero size and divergence) passing through a realistic set of materials. The materials are:

- 76.2 μm mylar
- 10 cm He
- fast chamber (FC) with
  - 30 mm CF_4/isobutane (80/20)
  - 6 mylar foils, each 6.35 μm thickness
  - 2 anode planes (x and y), each of 12.7 μm diameter W wires, 0.762 mm spacing
- 50 cm He

Momentum ($\times 29.79$ MeV/c)	1.0	2.0	3.0
into FC1			
x (cm, rms)	0.256	0.07	0.04
dx (mr, rms)	26.5	7.4	4.1
exiting FC1			
x (cm, rms)	0.332	0.09	0.05
dx (mr, rms)	47.4	13.0	6.5
at 50 cm from FC1			
x (cm, rms)	2.49	0.70	0.37
dx (mr, rms)	48.1	13.2	6.8

Table 1: Simulation results

Emittance measurements at 90 MeV/c

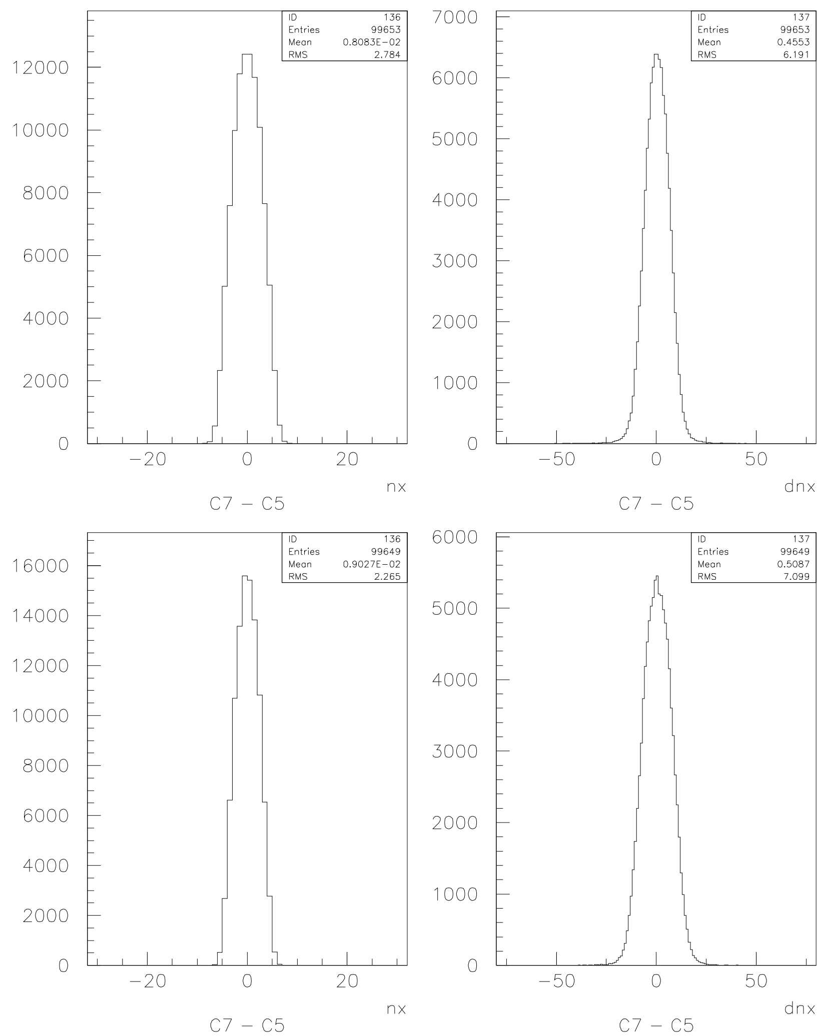

Figure 2: Comparison of fast chamber distributions for the setup of Fig. 1 at three times surface muon momentum. The top left is the x wire distribution in FC1 (64 wires, $\sim$ 5 cm) and the top right is the wire location difference between FC2 (96 wires, $\sim$ 7 cm) and FC1, which gives the beam divergence, for beam half widths of 5 mm and 16 mrad. The lower two pictures are equivalent measurements for beam half widths of 4 mm and 20 mrad.

Detector arrangement for 29.7 MeV/c

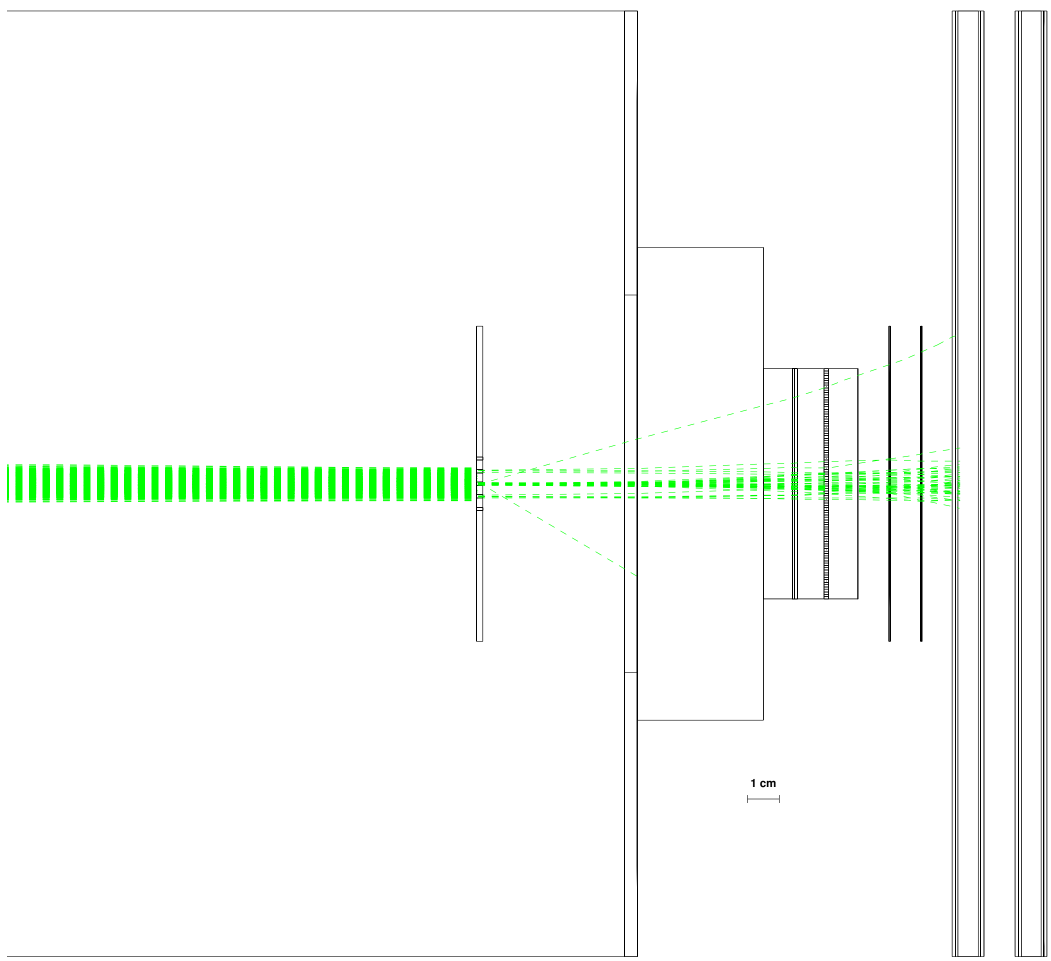

Figure 3: Possible arrangement for low momentum beam size and emittance estimation using a multiple-hole (sieve) collimator in vacuum, one fast wire chamber, and scintillators for particle identification.

Sieve collimator distributions at 29.7 MeV/c

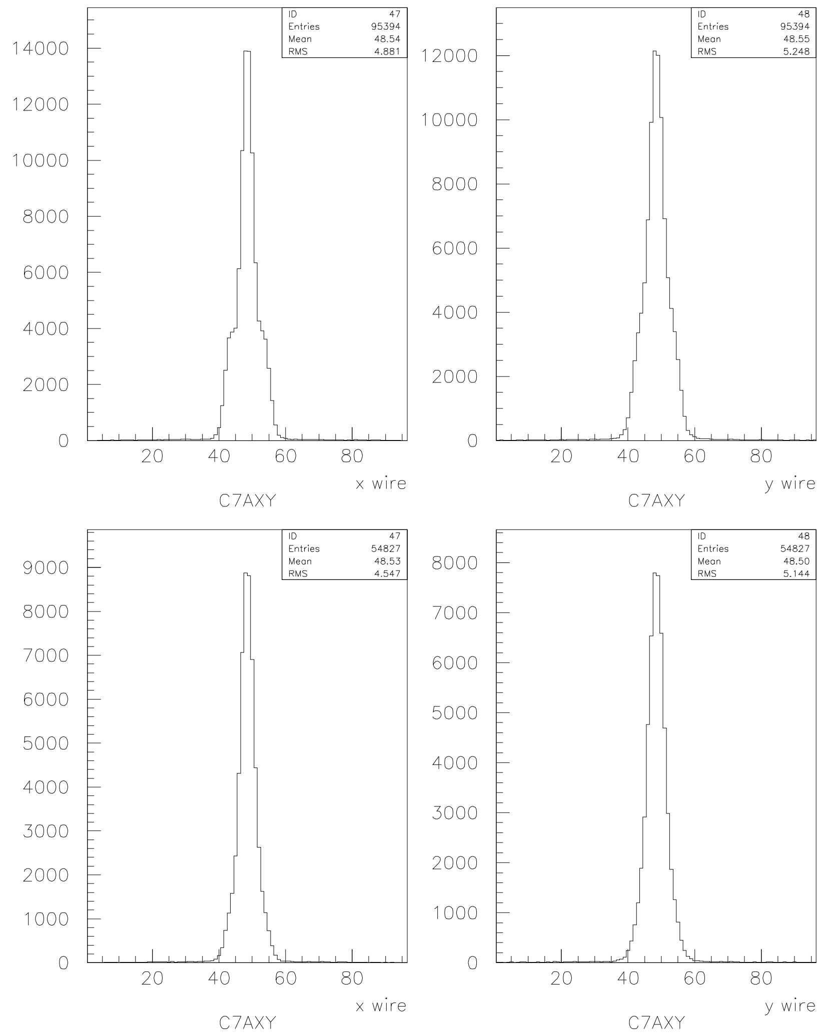

Figure 4: Comparison of fast chamber distributions for the setup of Fig. 3 at surface muon momentum. The top left is the x wire distribution in FC1 (64 wires, ~ 5 cm) and the top right is the y distribution, for beam half widths of 5 mm and 16 mrad. The lower two pictures are equivalent measurements for beam half widths of 4 mm and 20 mrad, showing the differences to be expected in this measurement. In both cases, only the center and four nearest neighbor holes of the square array collimator are hit with the beam.

Resources necessary for October 2000

- Y slit at M13 F2
- working fast chambers (7 cm and 5 cm), including PCOS interfaces and readout
  $\Rightarrow$ bench testing
  $\Rightarrow$ careful alignment to "beam axis"
- thin scintillators (250 or 375 μm, 10 cm ϕ)
- thin beam window on 6" mating flange (75 μm by 10 cm ϕ, or re-entrant design?)
- mating flanges for fast chambers to 6" beam tube flange
- various beam tube extensions

Summary

- Assuming fast chambers work, measurements at 90 MeV/c should be efficient and informative.
- Success of sieve collimator emittance estimates is not assured. There should be a better way:
  - ▷ remotely controlled $x - y$ slits rather than sieve collimator
  - ▷ TEC