Target Studies July 18-23, 2014

I. Effect of Increased Beam Emittance

II. Shielding of the Final Focus Quads

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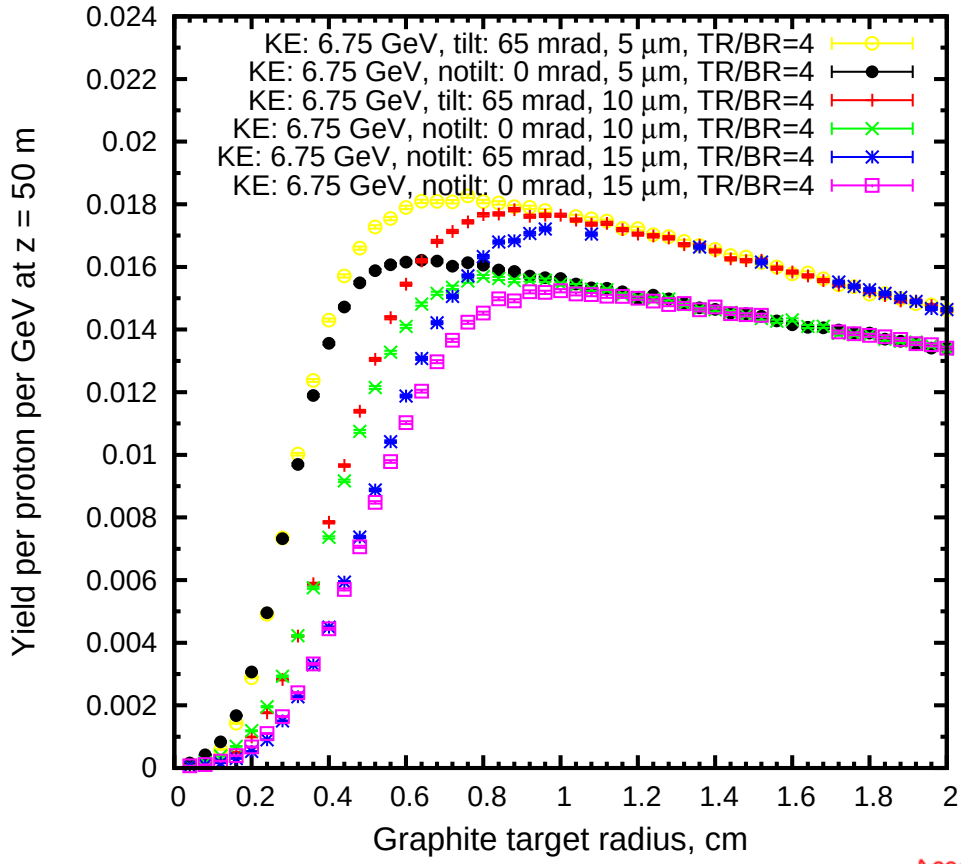
Effect of Increased Beam Emittance (X. Ding)

At 6.75 GeV kinetic energy, beams of nominal geometric transverse emittance = 5 μm may not be possible with powers above 1 MW at 60 Hz rep rate (K. Gollwitzer), due to space-charge emittance blowup.

The longer graphite target (80 cm), compared to 30 cm for a mercury target, may permit use of larger emittance beam with little loss in muon yield.

Optimization via MARS15 indicates only slight loss in yield on tripling the transverse emittance from 5 to 15 μm.

Slightly larger target/beam radius is favored at larger emittance, ⇒ smaller β*,
⇒ Larger beam size in the Final-Focus quads.



Effect of Increased Beam Emittance, II

Scott Berg affirms that we should assume that the Final Focus can deliver a beam with specified rms spot radius and rms divergence to $z = 0$ = center of target.

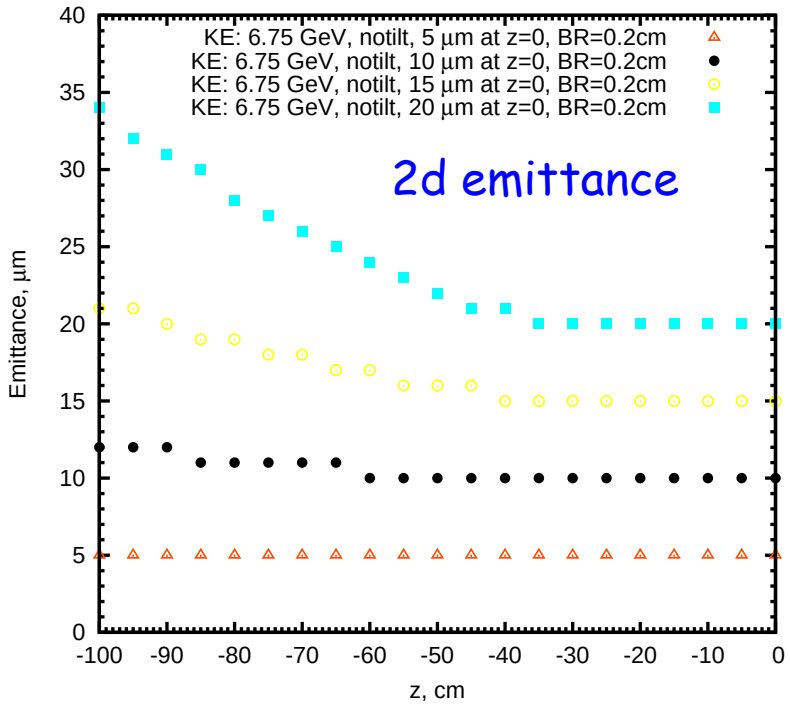
To simulate such a beam, we must launch it at $z < 0$; This is done at $z = -1$ m presently.

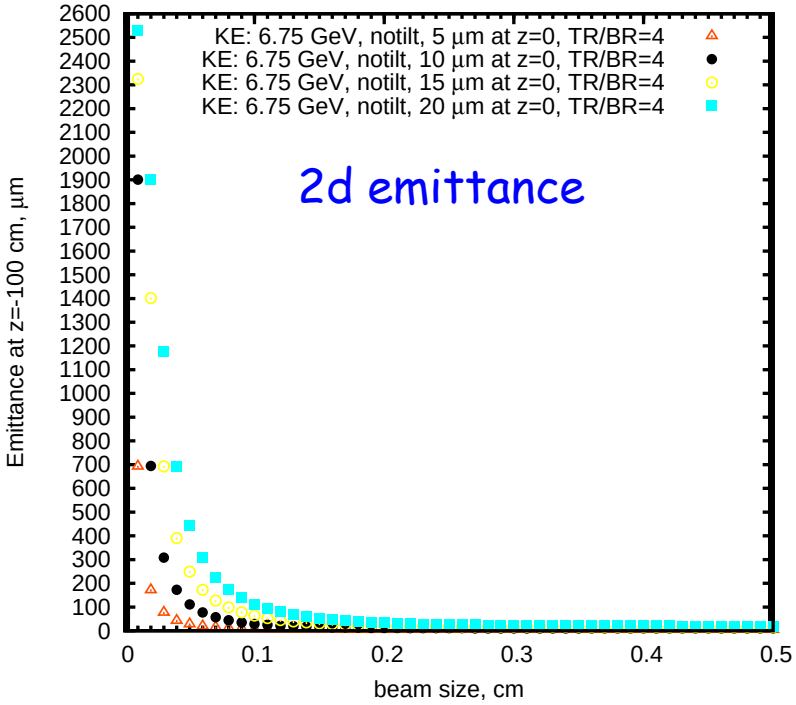
The present algorithm is to generate a beam at $z = 0$ with no target, and "backtrack" to $z = -1$ m, where the beam is characterized by Twiss parameters, and a 2-d rms transverse emittance.

This emittance decreases with z, which is counterintuitive.

Suggestions:

- Use the "backtracked" particles as the input for the MARS simulation.
- Compute the 4-d rms transverse emittance.





Effect of Increased Beam Emittance, III

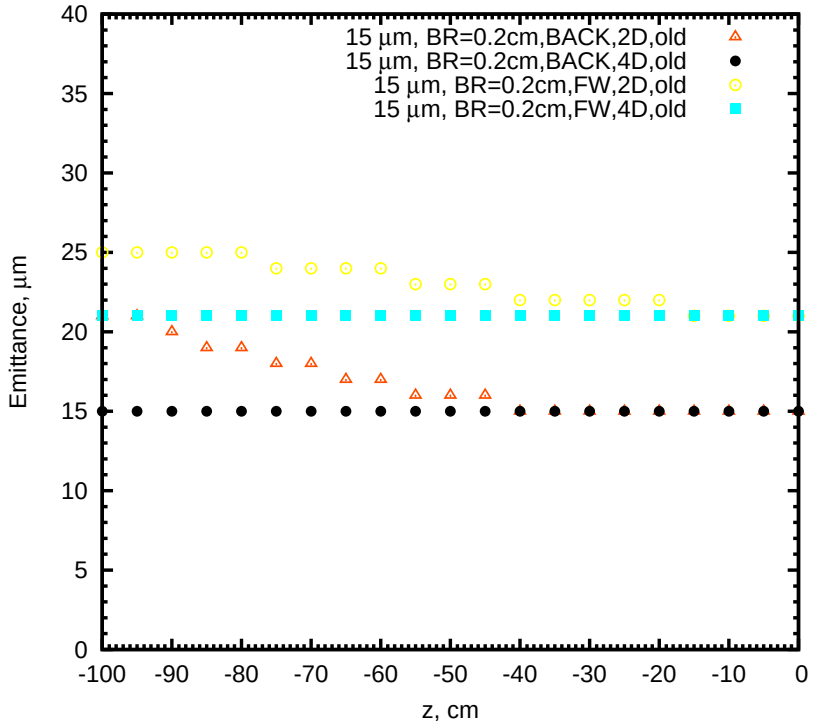
The left plot below shows the 2d and 4d rms transverse emittances computed for the "old" method in which particles generated at $z = 0$ in a 20 T field are backtracked to $z = -1$ m, where Twiss parameters are computed, and used to generate a new beam.

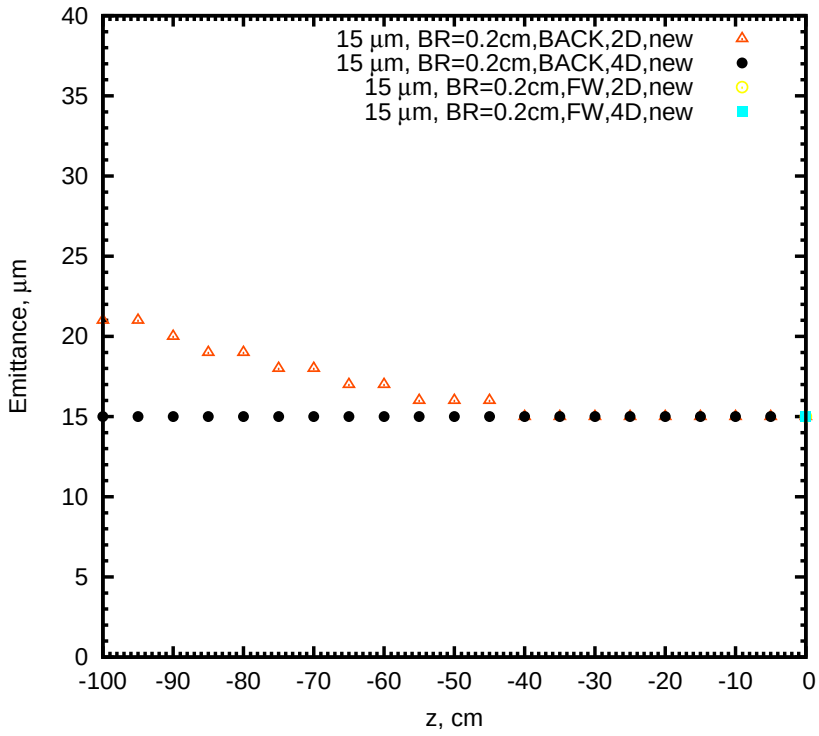
The 4d emittances are independent of z, but that for the beam generated via the Twiss parameters at $z = -1$ m is larger than the original 4d emittance at $z = 0$.

$\Rightarrow$ Old prescription in faulty.

The right plot shows that if the beam generated at $z = -1$ m is just particles backtracked from a beam generated at $z = 0$, then the 4d emittance is well behaved (although the 2d emittance is not).

$\Rightarrow$ Use a beam at $z = -1$ m consisting of particle backtracked from $z = 0$.



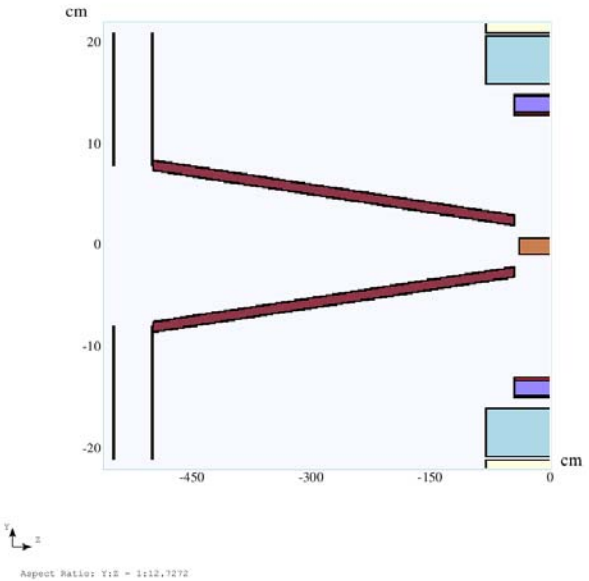


Shielding of the Final Focus Quads (N. Souchlas)

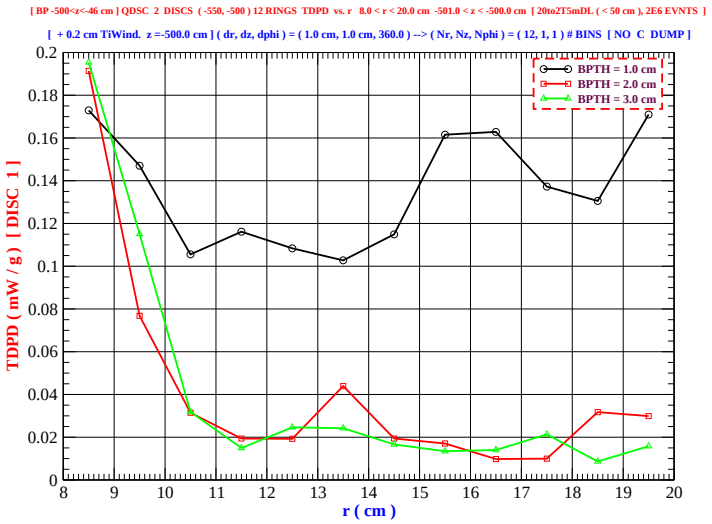
Fringe field of the 20-T Target System solenoid is still 1 T at z = -5 m, the possible location of the last Final-Focus quad, ⇒ Use superconducting quads,

⇒ Must shield against radiation from the target.

Preliminary MARS15 study (for 0 tilt angle of the beam) indicates that a ~ 2-cm-thick SS beampipe provides most of the needed shielding. A small additional shield seems needed to protect the upstream end of the last Final Focus quad.



Downstream end of quad



Upstream end of quad