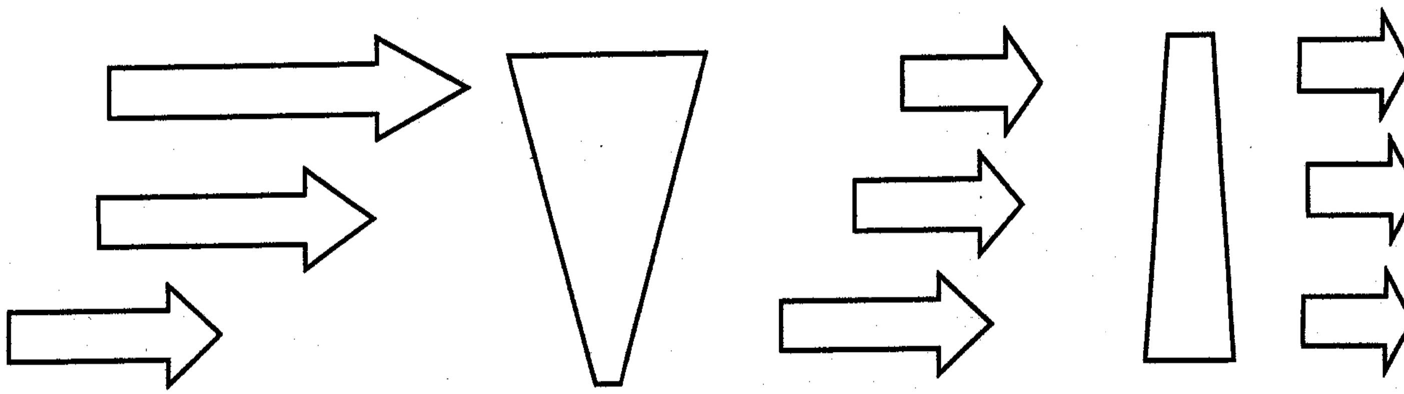
Bruce King

Longitudinal focusing w/o rf

The idea ...



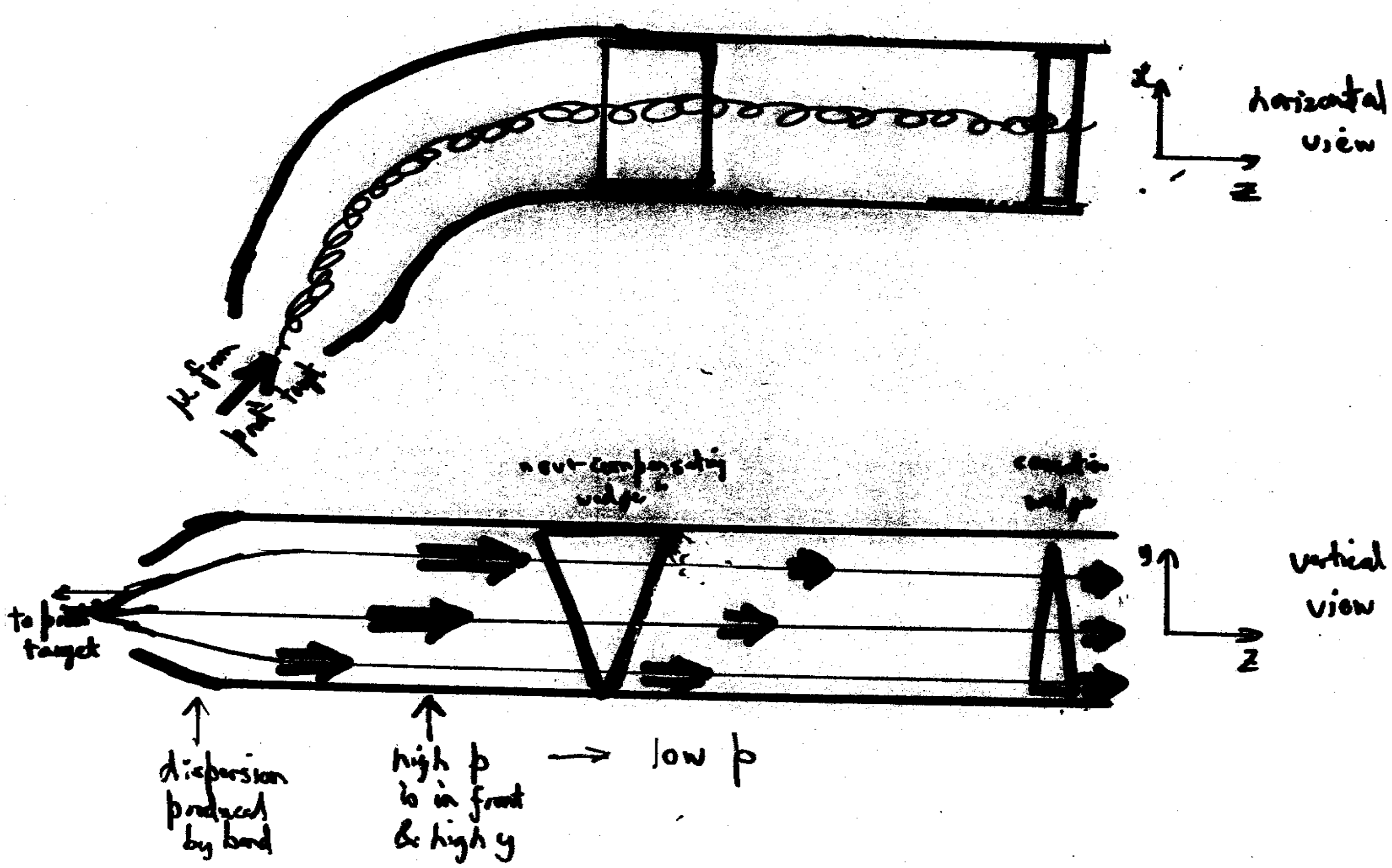
lower energy muons lag behind in a dispersive channel

an overcompensating wedge inverts momentum deviations

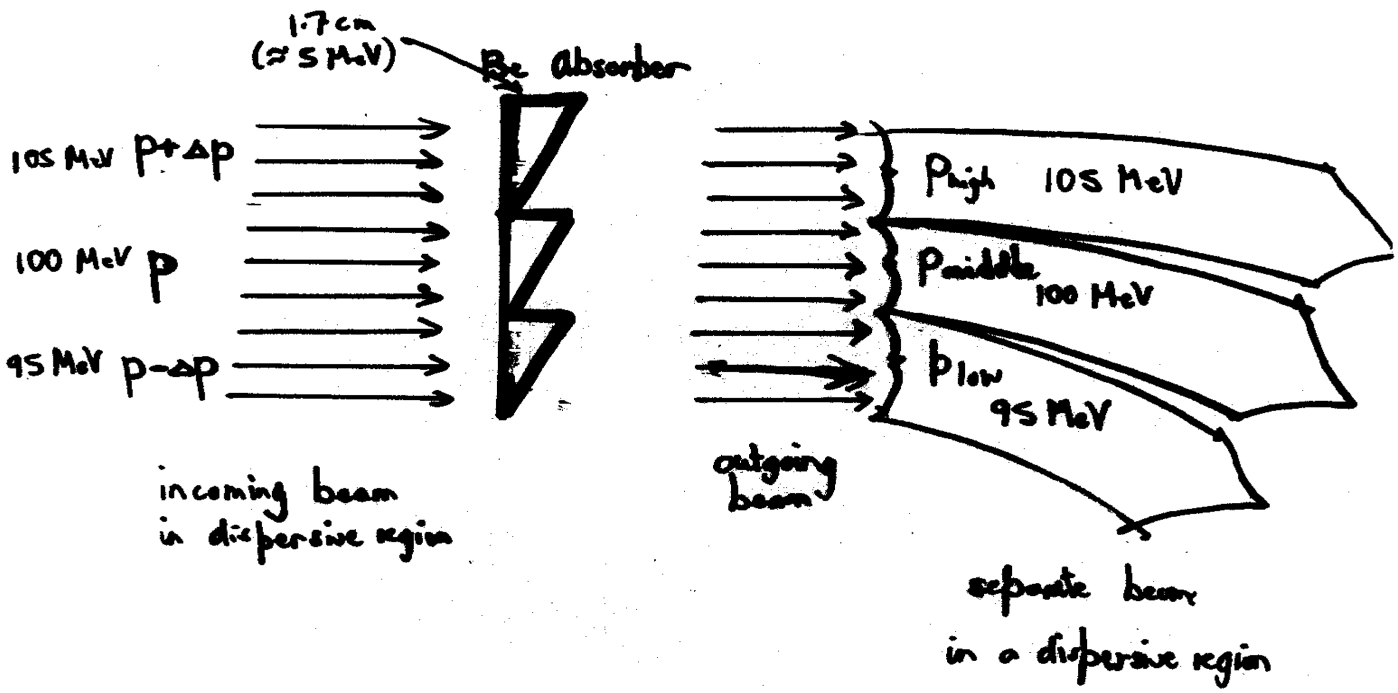
the now higher p muons catch up

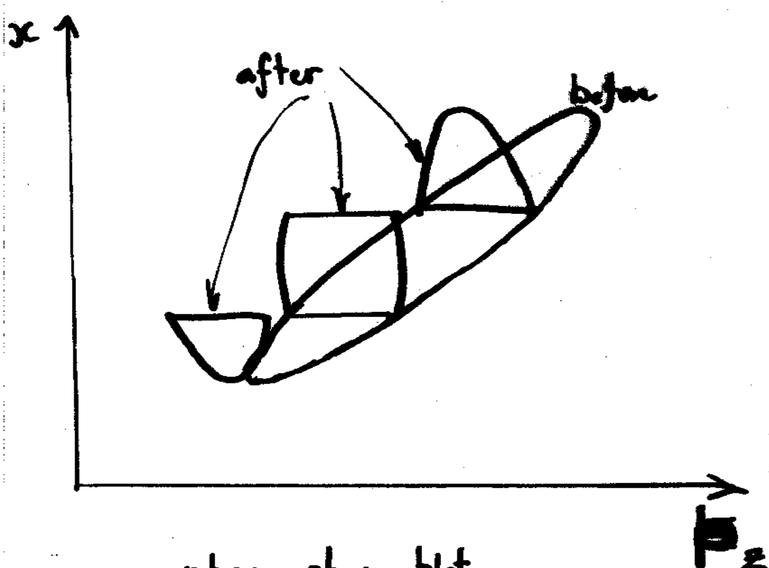
a correction wedge equalizes the momenta where all muons are abreast

μ Phase Rotation w/o r.f.



Sawtooth Absorbers ...
The Idea



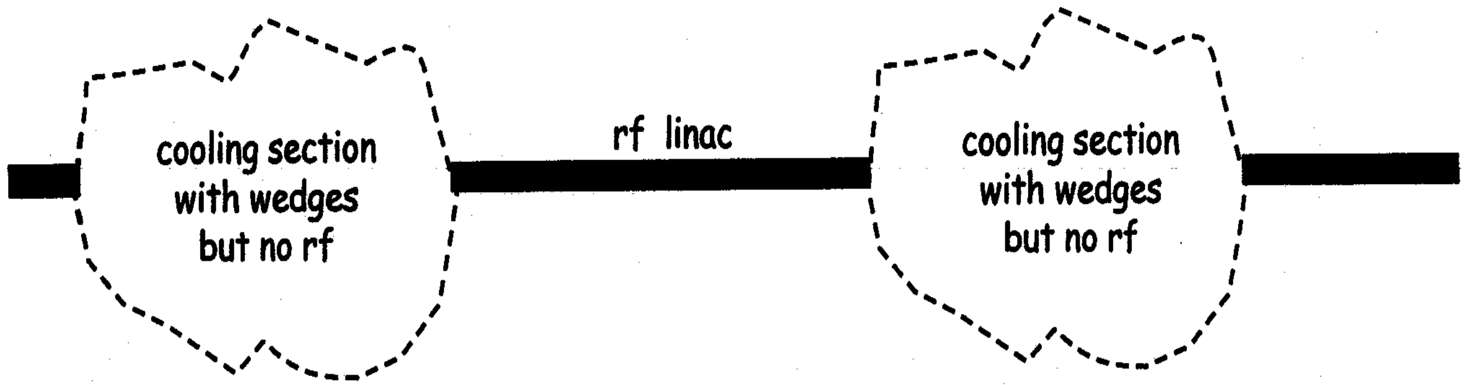


<u>phase space plot</u>

Partition the phase space

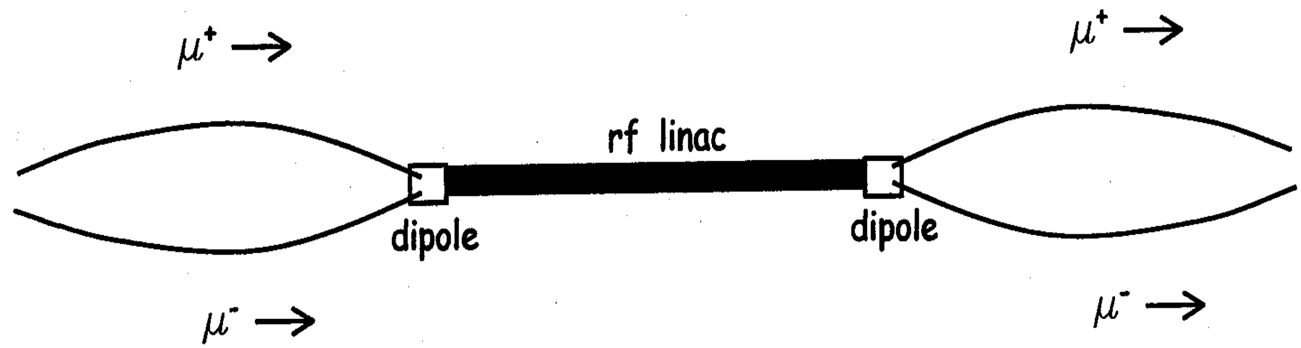
$\Rightarrow$ cooler μ bunches !!

A bonus: beam manipulation with wedges might allow the separation of cooling sections from re-acceleration sections



This would have advantages in engineering simplicity. It would also allow new cost saving strategies in different parts of the cooling channel ...

In the earlier cooling stages ...

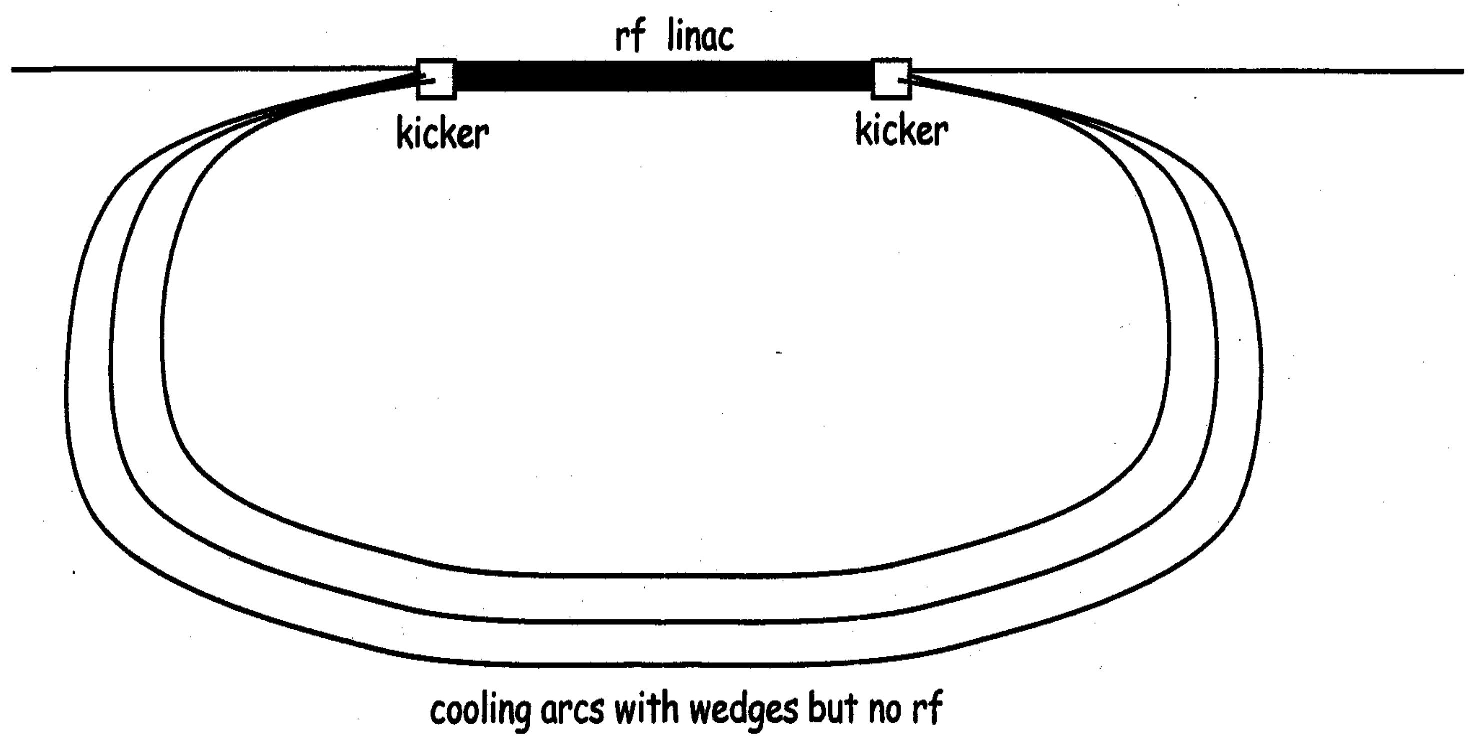


Both muon signs can share the same rf even when the beam emittance is too big for a recirculating scheme

=> possible large cost savings

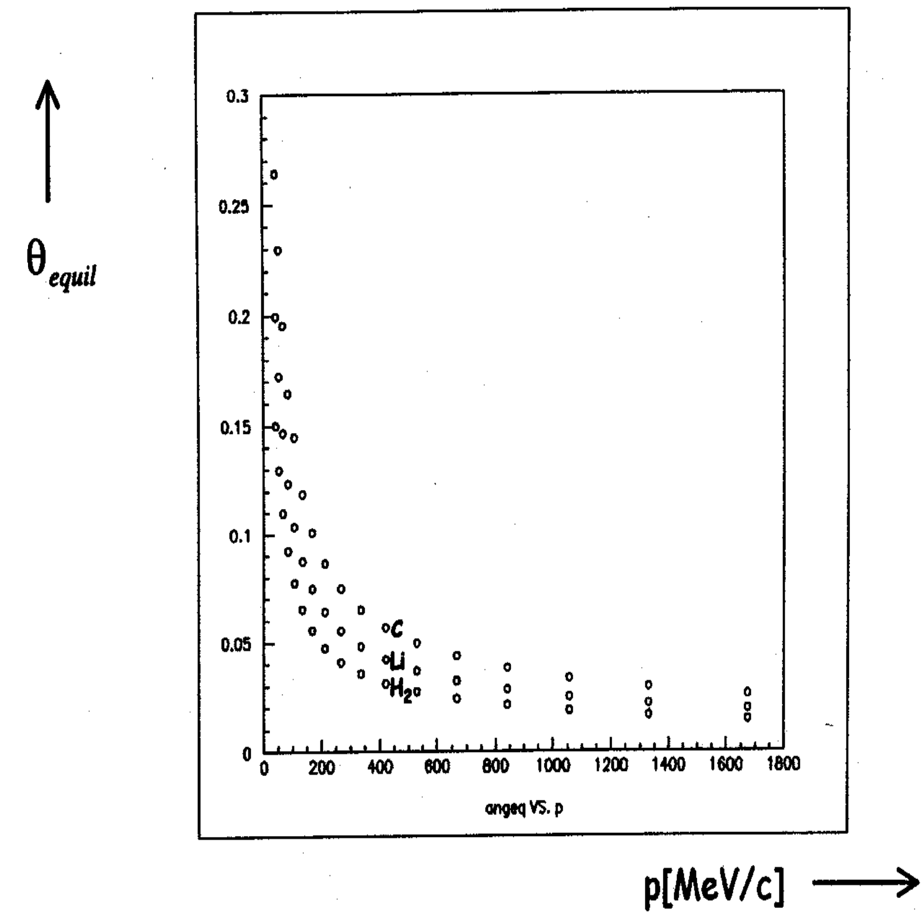
In the later cooling stages ...

Option for a recirculating linac => allows cooling over a large dynamic range using the same rf => could be very economical.



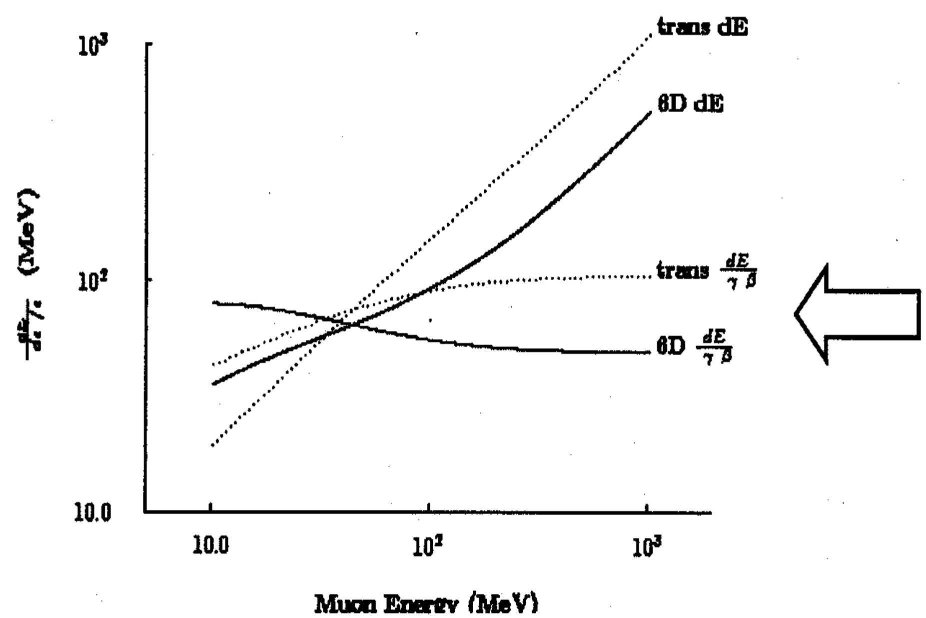
Note that the kicker should be more feasible with more rf in the linac and at higher p because the longer transit time allows the field to change more slowly.

a bigger advantage for higher p ...



$\theta_{equil} \propto 1/\sqrt{p}$ for ultrarelativistic muons => <u>expect easier optics at higher p</u>

Decays during cooling ~indep. of p



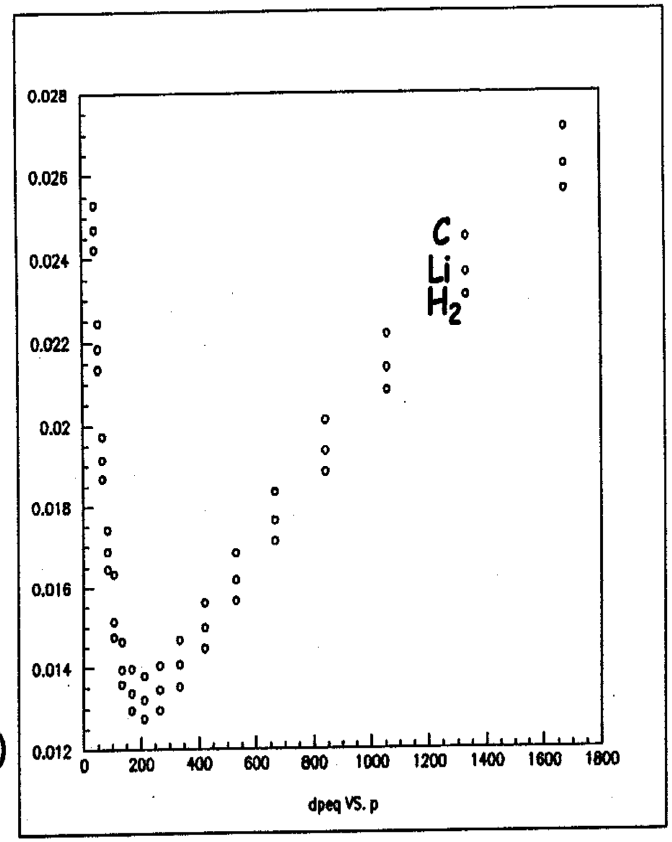
Plot from Bob Palmer's lecture notes, lecture 6, p13

However, packing fraction of absorber will decrease at very low emittances due to need for progressively lower β^*. Is exacerbated by hourglass effect i.e. absorber can't be much longer than β^*. Exceptions are lithium lenses and long solenoids, where the low $\beta^*$is maintained.

Equilibrium delp/p vs. p

$$\left.\frac{\sigma_{pz}}{p}\right|_{equil}$$

(note offset 0)



p[MeV/c]

Can see that, roughly $\left.\frac{\sigma_{pz}}{p}\right|_{equil} \propto \sqrt{p}$ for ultrarelativistic muons -- disfavors higher p but scaling not too bad

Why delp/p varies roughly as sqrt(p)

$\left.\frac{\sigma_{pz}}{p}\right|_{equil}$ is reached when fractional transverse cooling rate ~= fractional mom. heating

$$\frac{2}{\sigma_x}\frac{d\sigma_x}{dz} \approx \frac{1}{\sigma_{pz}}\frac{d\sigma_{pz}}{dz}$$

<u>approximations used</u>:

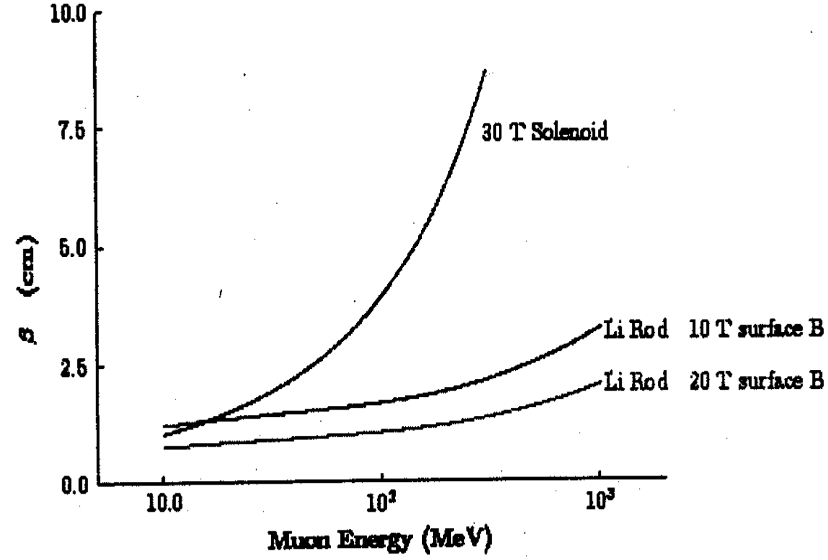
paraxial: $p \sim p_z$ and $\vartheta \ll 1$

ultrarel.: $\gamma \sim p \sim E$, $\beta = 1$

$$\Rightarrow \frac{2}{p} \propto \frac{1}{\sigma_{pz}}\frac{\gamma^2}{\sigma_{pz}} \sim \left(\frac{p}{\sigma_{pz}}\right)^2$$

$$\boxed{\Rightarrow \left.\frac{\sigma_{pz}}{p}\right|_{equil} \propto \sqrt{p}}$$

β^* for Li Rods & Solenoids vs. p



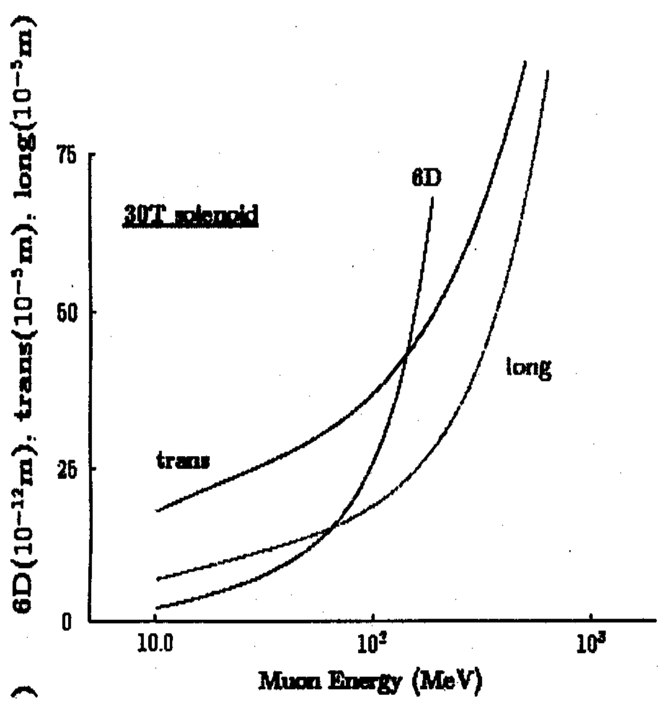
(Plot from Bob Palmer's lecture notes, lecture 6, p16)

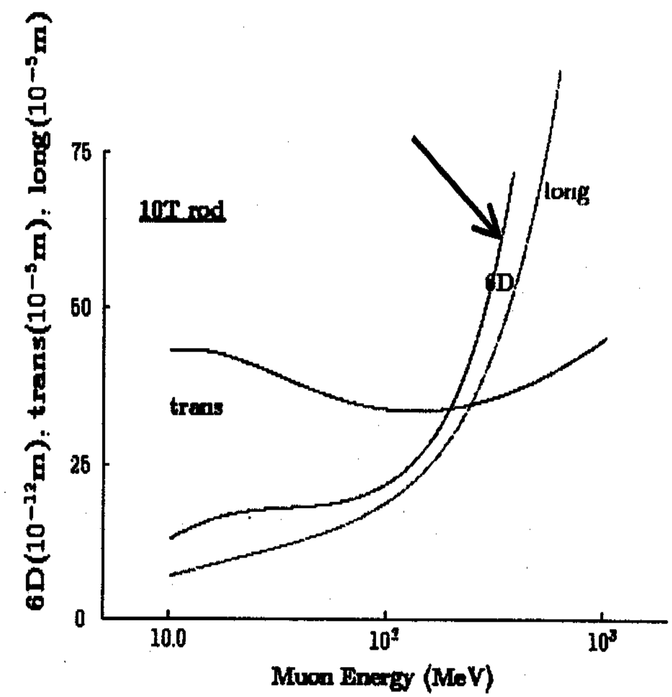
Solenoids favor lower p more strongly than do Li rods & conventional FODO lattices.

Can also get focus to small β^* with conventional FODO lattices. Quote from Snowmass book: "A cooling channel inside a FODO lattice should be a suitable arrangement for a higher momentum muon beam, although this has not been studied in detail."

⇦ worth looking at FODO lattices

Minimum emittances vs. p





Plots from Bob Palmer's lecture notes, lecture 6, p17.

Implies might still want to let the final cooling stage drop down to low momenta, in either a rod or a solenoid.