

First stage of transverse merge

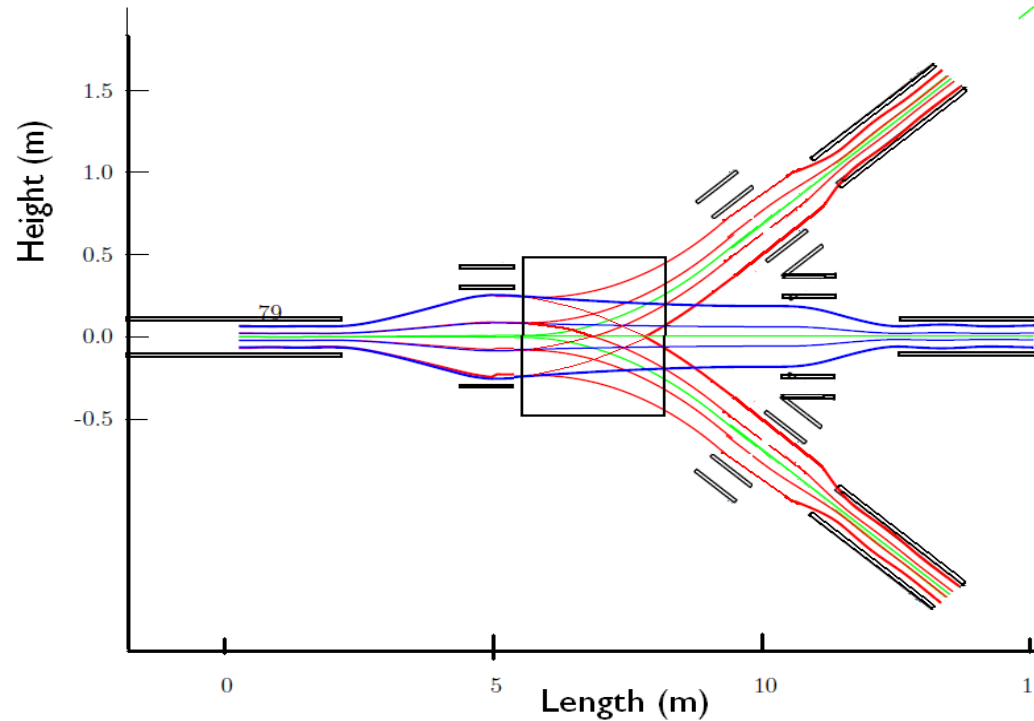
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UC Riverside

Nov. 05, 2013

Bob's scheme

1. Kick 6 bunches into 6 channels
2. Use solenoid lens to Keep the emittance low
3. Use trombones to lead the bunches to different channels



Beam parameters

 Use beam after longitudinal merge





 $P=212.7\text{MeV}/c$, $dp=8.9\text{MeV}/c$

 $\sigma_Z = 13.4\text{ cm}$





 $\sigma_X=\sigma_Y=2.6\text{ cm}$

 $\sigma_X'=\sigma_Y'=0.03$


No kicker first

-  Optimize the solenoids without the kicker
-  2 solenoids lens or 4 ?
-  Use bucking coils to stop fringe fields
-  Try to get lowest emittance at the trombone

Optimizer

-  Propagate the Courant-Snyder parameters through the channel
-  Chose beam momentum from 188-212 MeV/c
-  Calculate a $\chi^2 = \sigma(\alpha^2 + (\beta(\text{beam}) - \beta(\text{cs})) / \beta(\text{cs}))$
-  Change solenoids strengths and positions to minimize χ^2

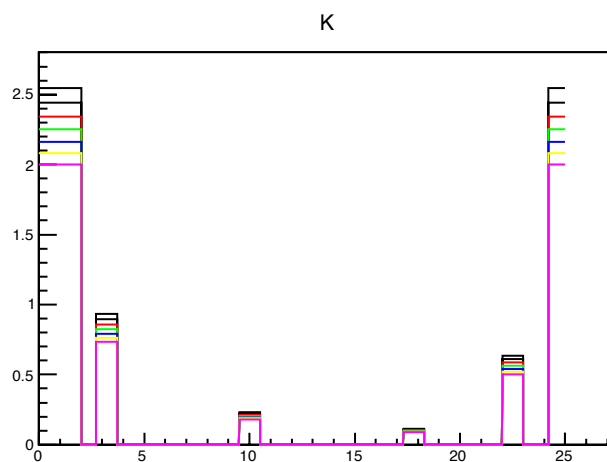
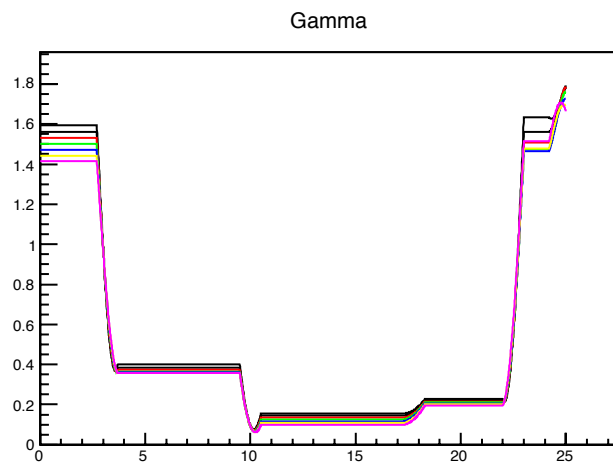
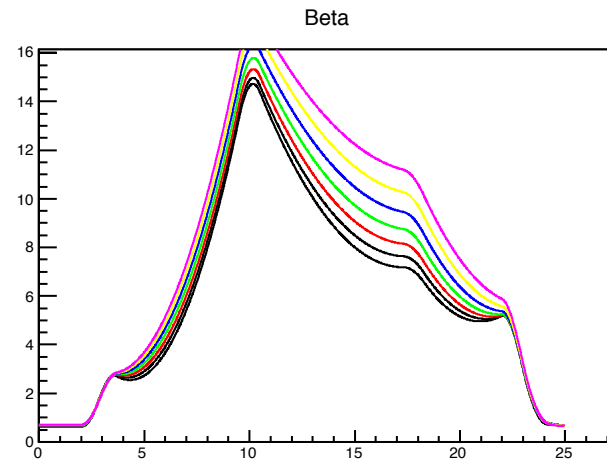
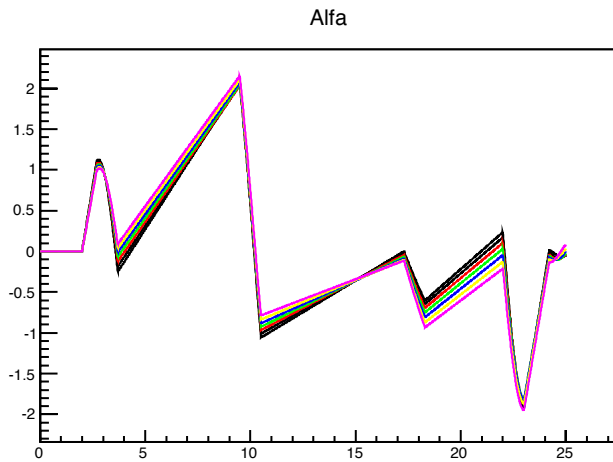
Difficulties

 Computing time: propagating the parameters to 25m long channel with 1 cm accuracy need ~ 1s. Fully optimize 5 solenoids together impossible (need 100 days)

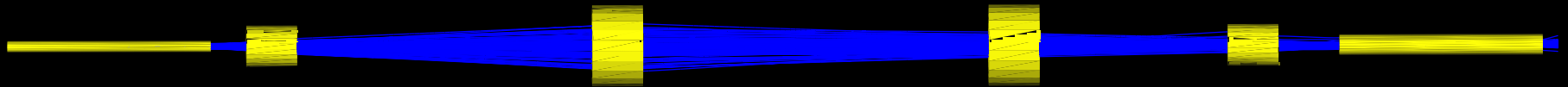
 Can only use ideal field strength in the optimizer. Error should be corrected by hand

Optimized (center 4 solenoids)

$\alpha=0.083$, $\beta=0.68$



4 solenoids

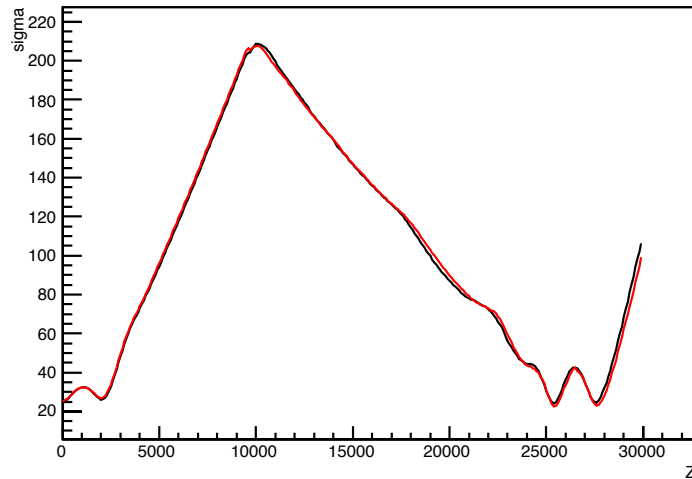


Strength: $B_1 = 1.21\text{T}$, $B_2 = 0.6\text{ T}$, $B_3 = 0.42$
 T , $B_4 = 1\text{ T}$

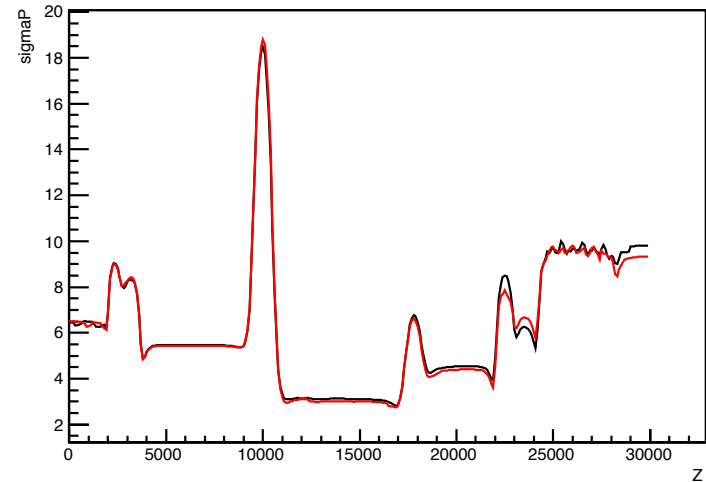
Position: $P_1 = 2.7\text{ m}$, $P_2 = 9.5\text{ m}$, $P_3 =$
 17.3 m , $P_4 = 22\text{ m}$

Transverse emit: 1.5mm->2.4mm

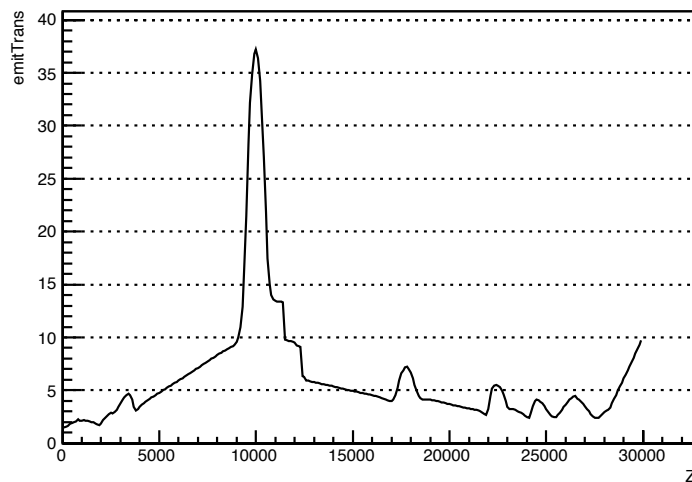
XZ black & YZ red



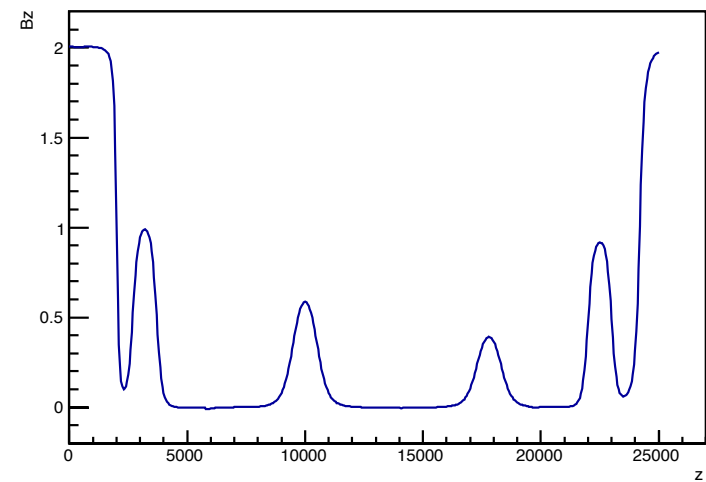
PxZ black & PyZ red



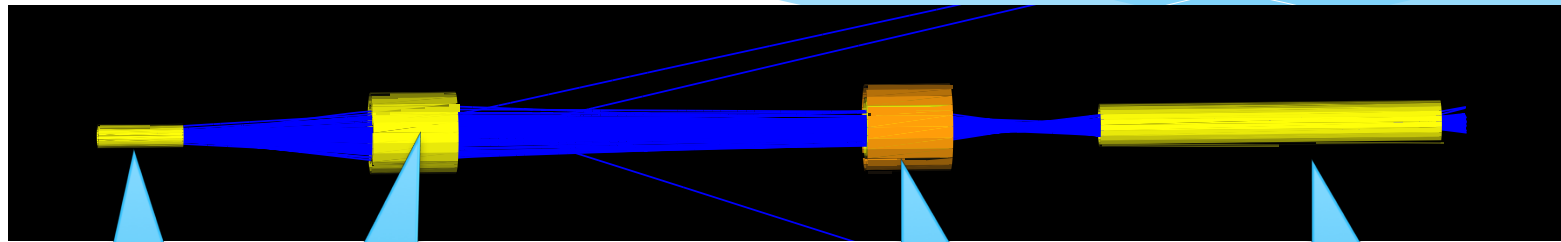
emitTransZ



Bz:z {x==0&&y==0}



2 focusing solenoids



Incoming
from
previous
merge

Focusing lens
1

Focusing lens
2

Will be
trombones

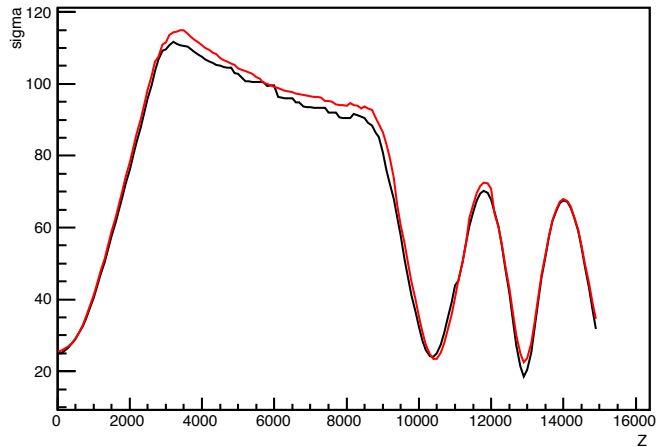
$B_1=1T$, $B_2=1.2T$

$L_1=L_2=1m$

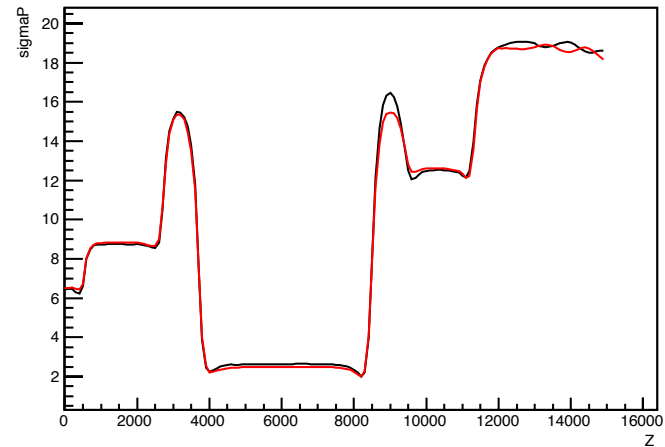
Gaps: 2.2m, 4.8m, 1.75m

Transverse emit: 1.5 mm \rightarrow 2.8 mm

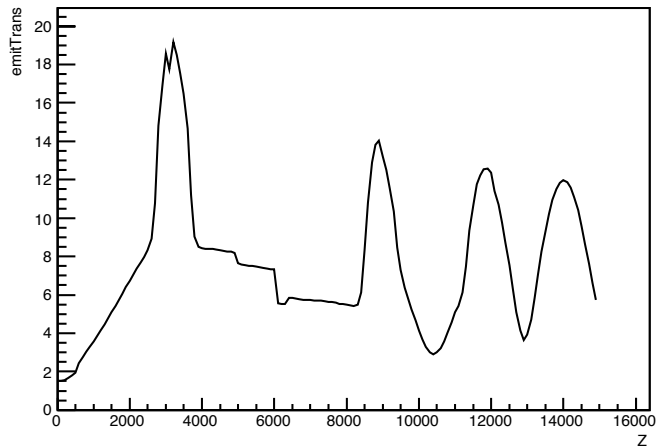
XZ black & YZ red



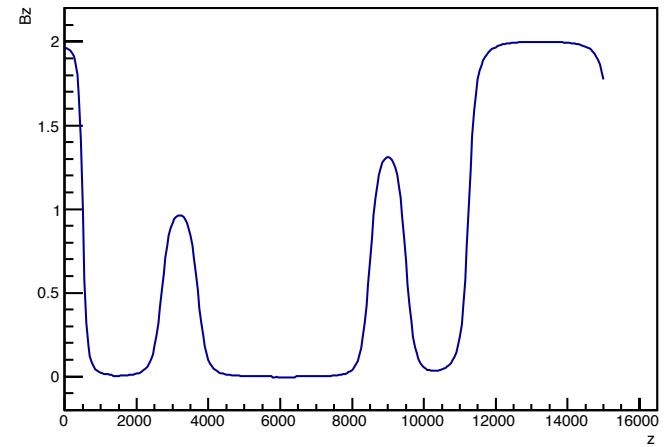
PxZ black & PyZ red



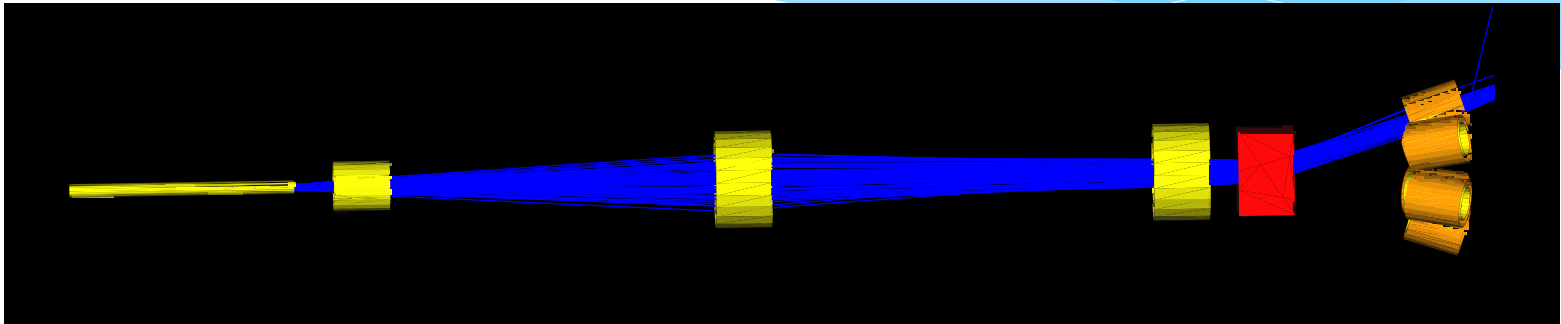
emitTransZ



Bz:z {x==0&&y==0}



Kicker on (4 solenoids)

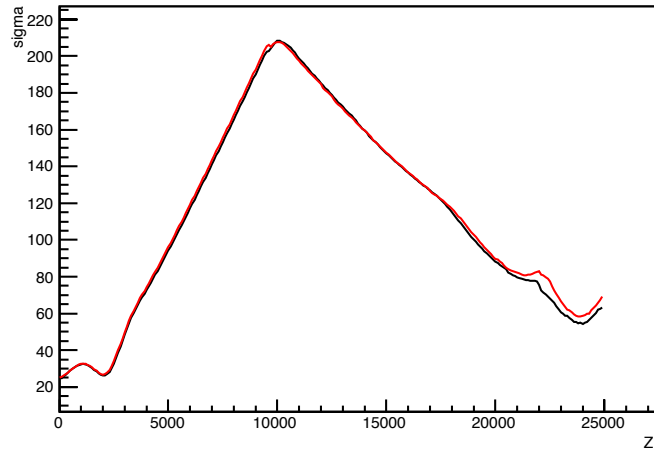


Kicker $B=0.22$ T, $L=1$ m

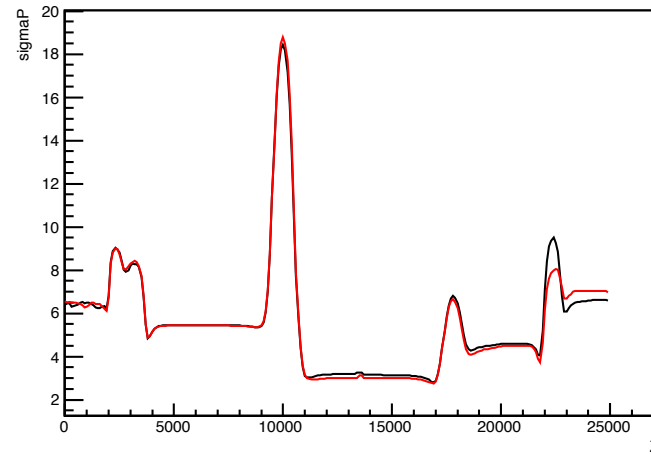
Short and strong kicker, because of space limit

Transverse emit: 1.5mm->4mm

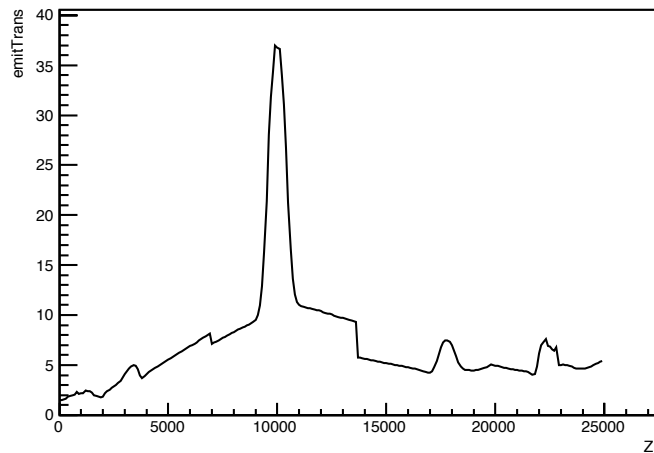
XZ black & YZ red



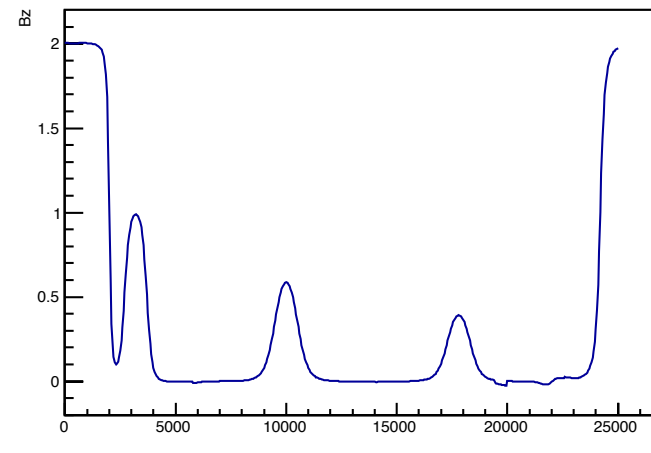
PxZ black & PyZ red



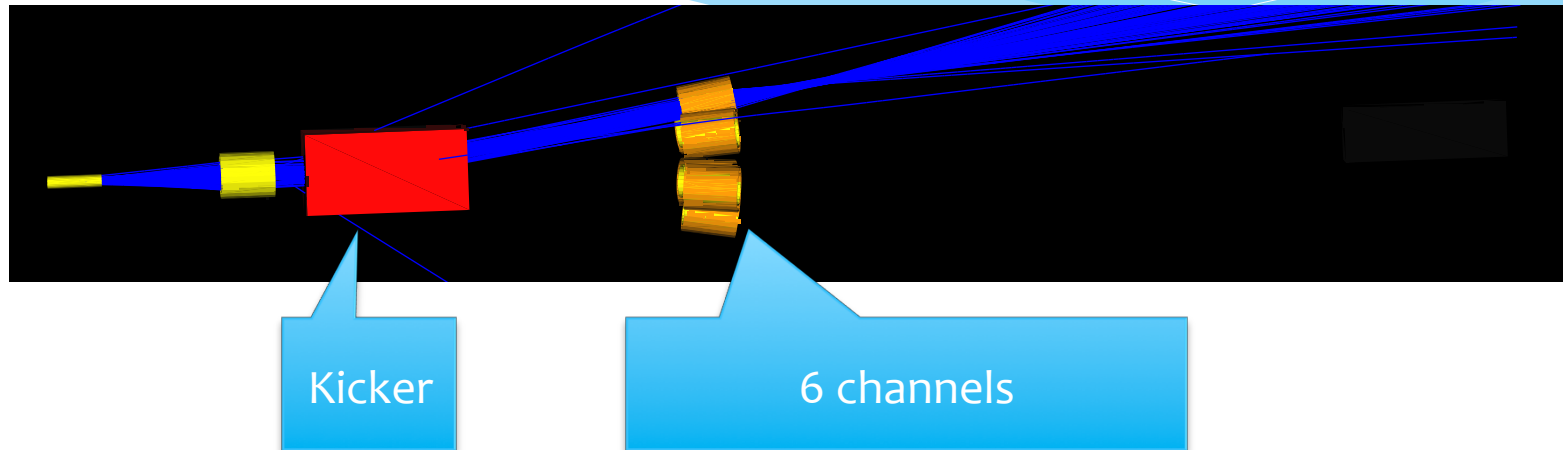
emitTransZ



Bz:z {x==0&y==0}



Kicker on (2 solenoids)

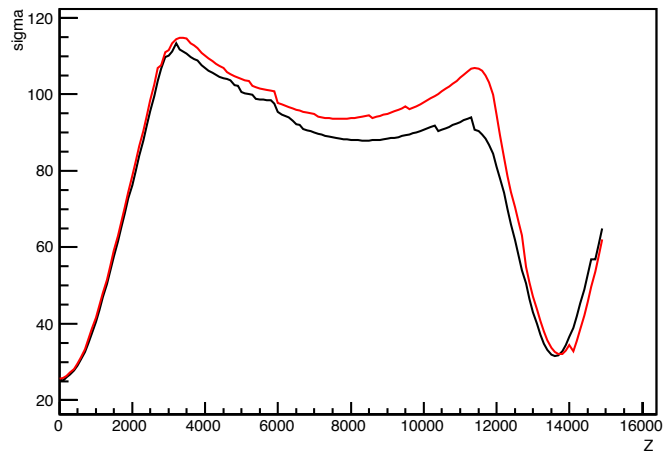


6 solenoids are set close to each other to keep less bent

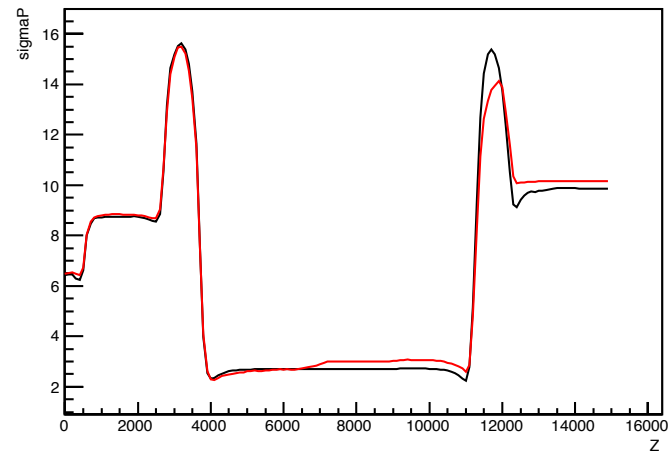
Kicker strength is decided by the required bending.
Here $B=0.05$ T, $L=3$ m

Transverse emit 1.5mm->3.2mm

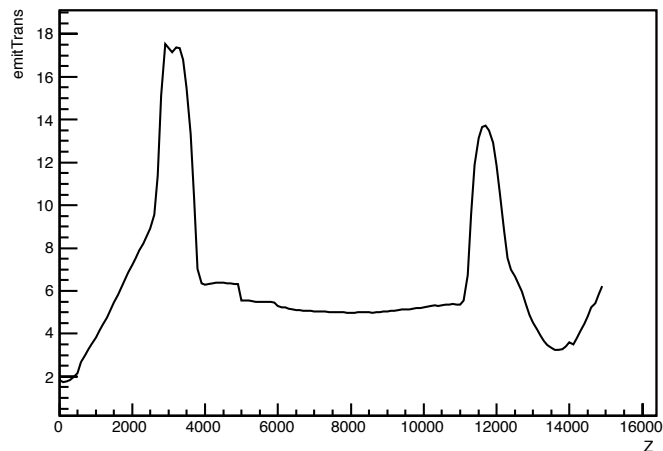
XZ black & YZ red



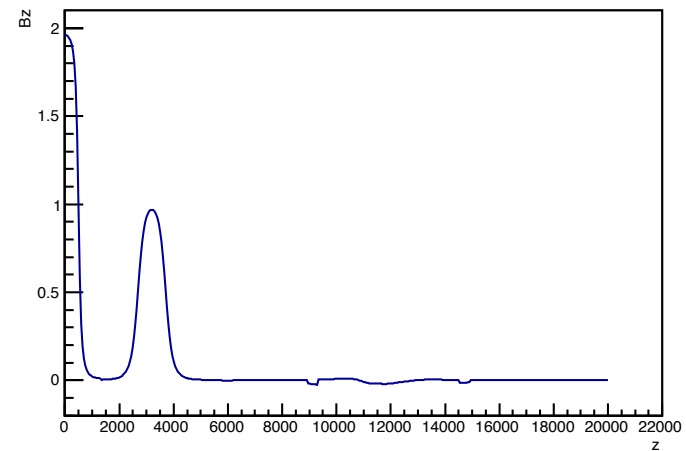
PxZ black & PyZ red



emitTransZ



Bz:z {x==0&&y==0}



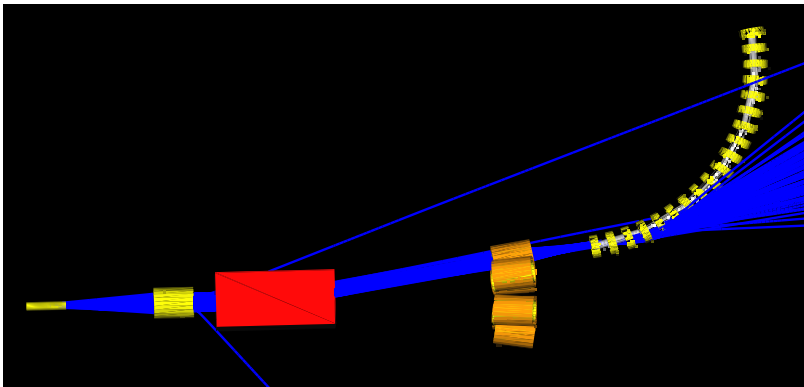
summary

- Without the kicker, 4 solenoids have better focusing
- For space problem, 4 solenoids need stronger kicker field, resulting in larger emittance increase
- The best focusing reached:
 - Beta from 25mm to 35mm
 - Emittance from 1.5mm to 3.2mm

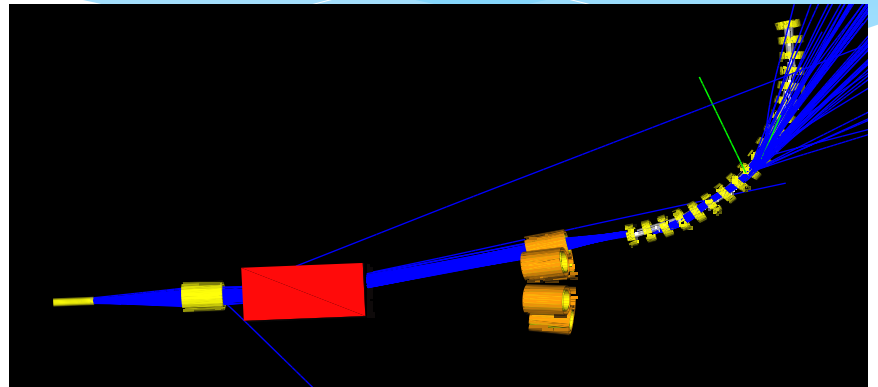
The kicker caused the major emittance increase!

Another difficulty

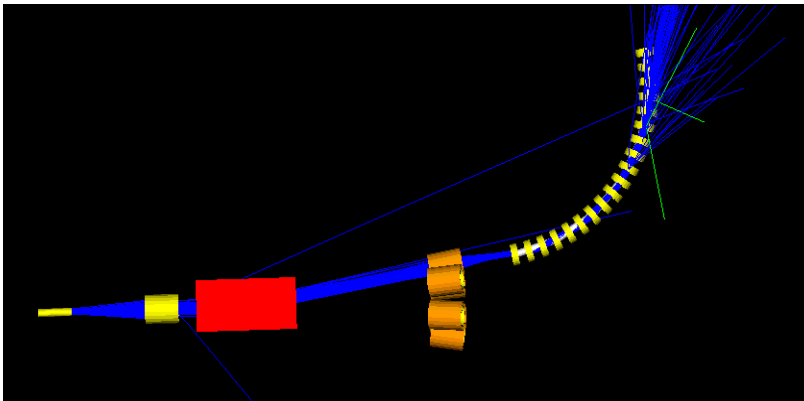
2T



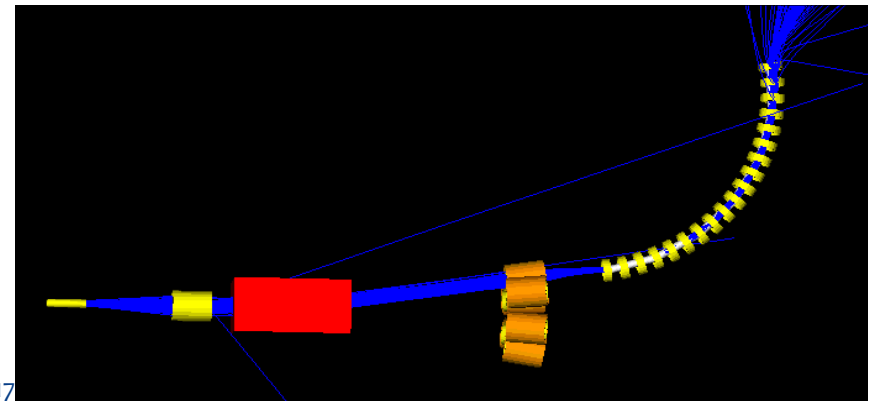
4T



6T



10T



Chicane?