Pion capture and magnetic field tapering

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Thanks to Pavel Snopok for his help with the lattice file!

Pion capture and B-field tapering

Aim for the study:

- Is the ST2 layout the optimal one?

- Study alternative solenoid and B-field tapering configurations

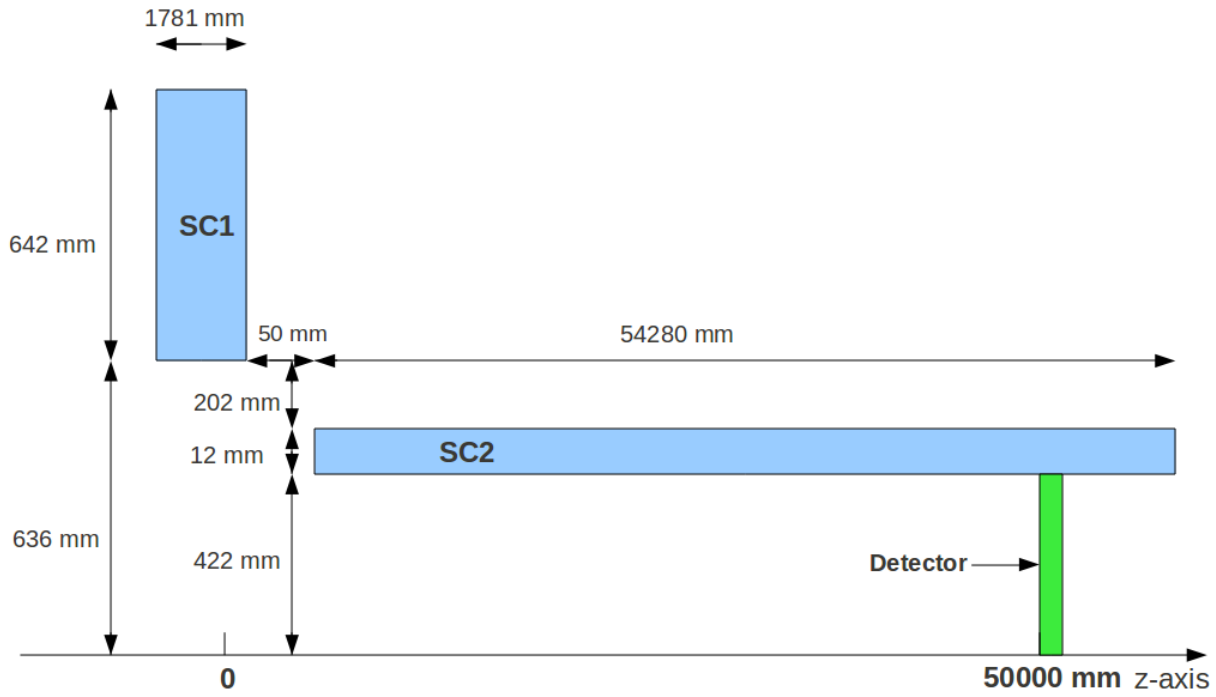
- Stay with particle tracking, not (yet) studies on energy deposition and radiation

Scenarios studied (G4BL-simulations)

	Magnetic field (Radius, Length)			
ST2 setup	13 solenoid setup			
2 solenoid setup	20T (R=636 mm, L=1781 mm)	1.5T (R=422 mm, L=54280 mm)		
3 solenoid setup	20T (R=636 mm, L=1781 mm)	1.5 T (R=700 mm, L=6372 mm)	1.5T (R=422 mm, L=46280 mm)	
Some of the setups have 3 resistive solenoids added between the first solenoid and the target				
Cu-solenoid 1		R=178 mm	L=749mm	
Cu-solenoid 2		R=231 mm	L=877 mm	
Cu-solenoid 3		R=353 mm	L=1073 mm	

2 solenoids setup

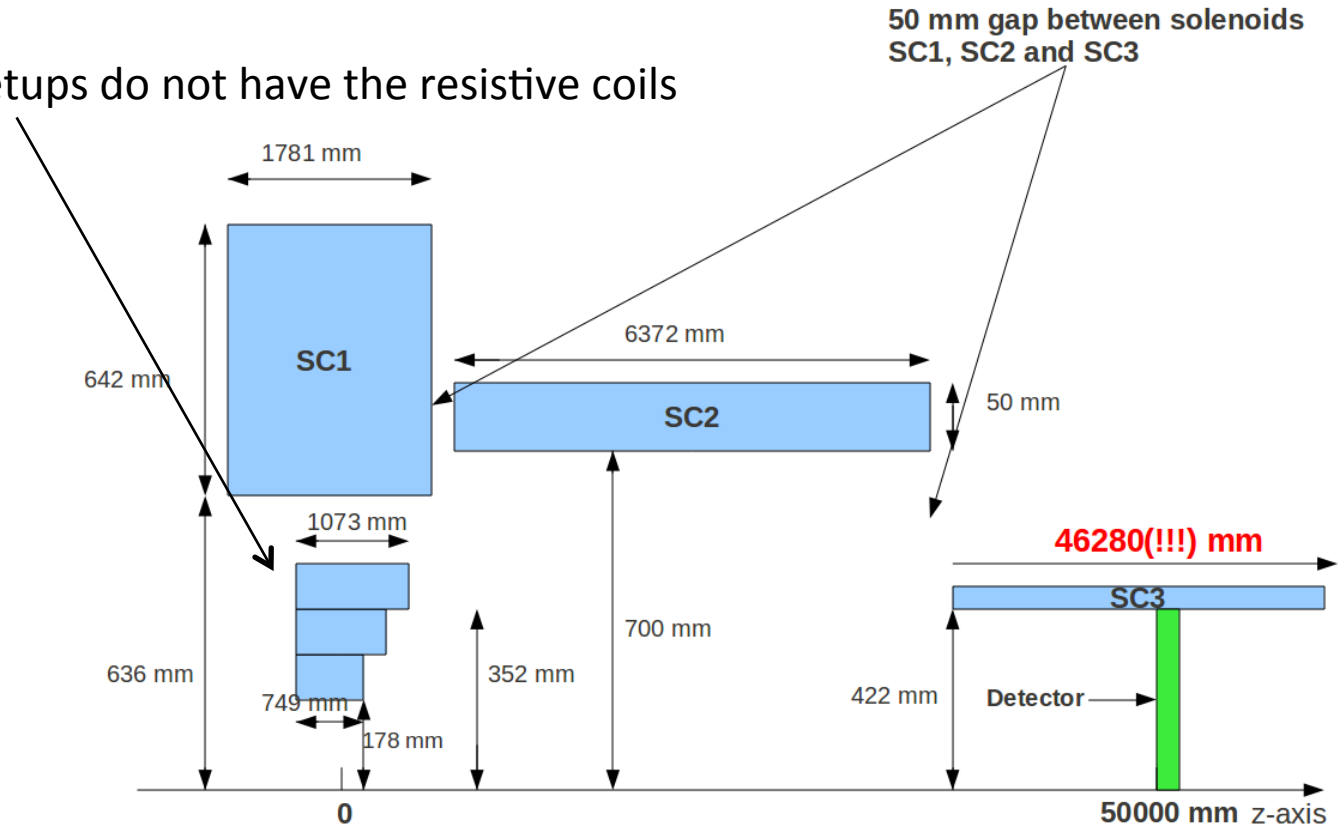
20T solenoid followed by a long 1.5T solenoid



3 solenoids + 3 Cu solenoids

20T solenoid followed by a two 1.5 solenoids but at different radii

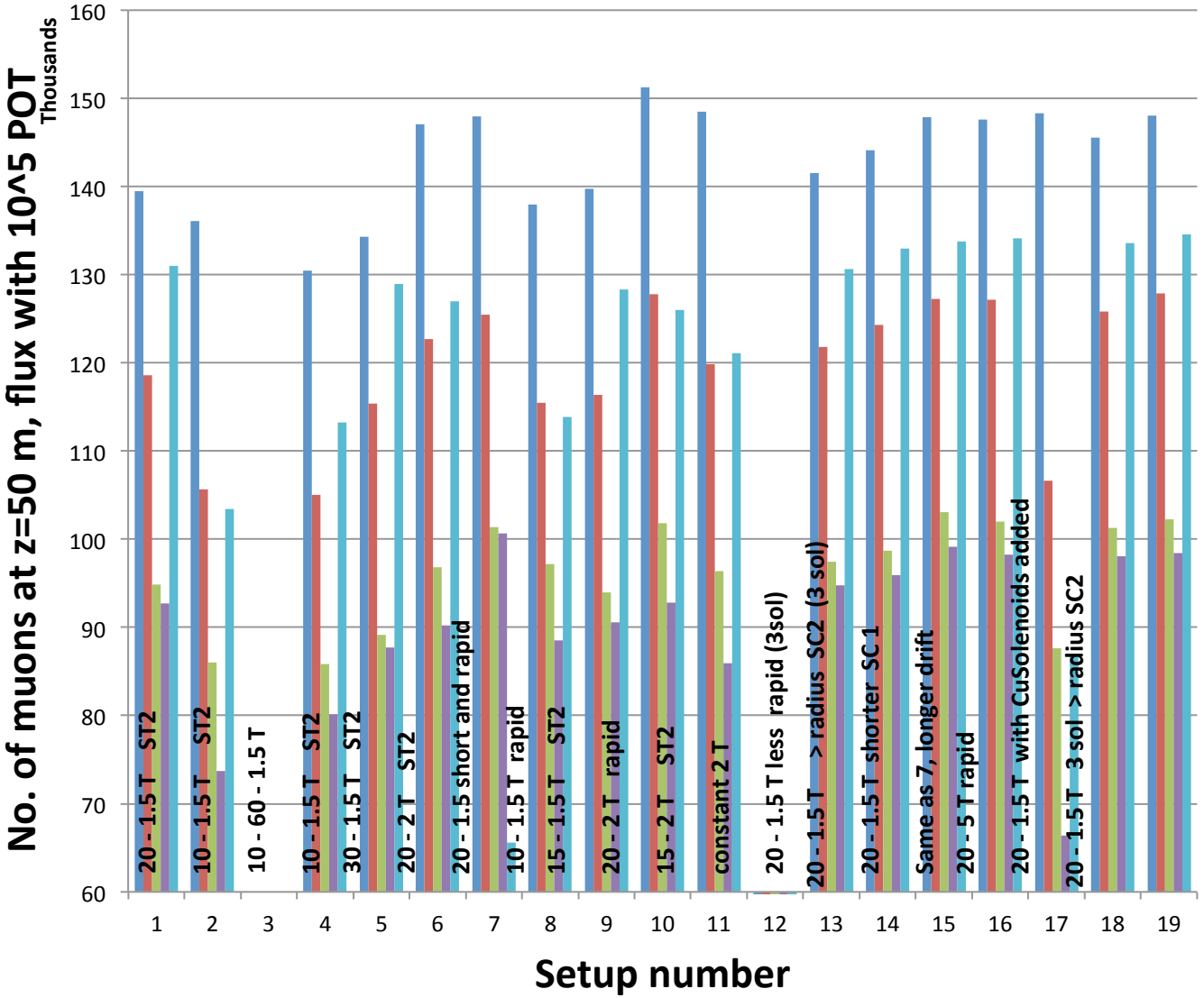
All the setups do not have the resistive coils



Target and beam

- Mercury target cylinder
  - L=30 cm
  - R=0.5 cm
  - Centered at z=0
  - Rotated 100mrad
- 10 GeV beam energy
  - slope of 67mrad

Comparisons, muon flux at z= 50m with 10^5 POT



Acceptance cuts:

- 450>Pz>50, t<300,Pt<150
- 400>Pz>100, t<250, Pt<100
- 300>pz>100, t<250, Pt<100
- 300>pz>100,t<250,Pt<70
- 500>pz>100,300>t>100,Pt<70

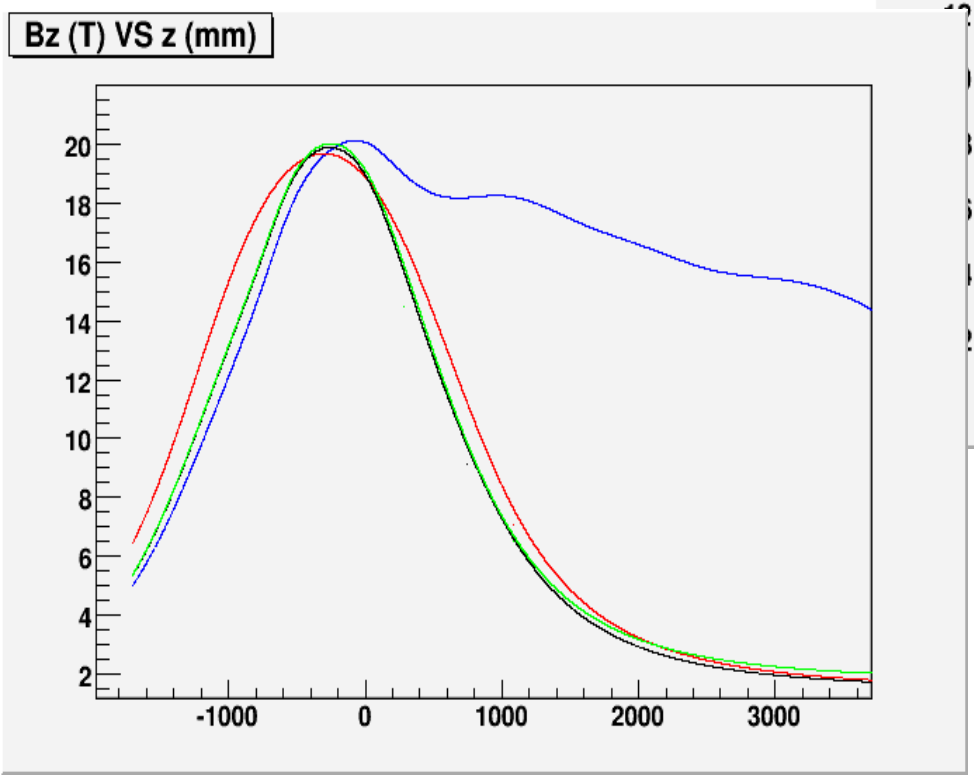
Units:
pz=[Mev/c]
pT=[MeV/c]
t=[ns]

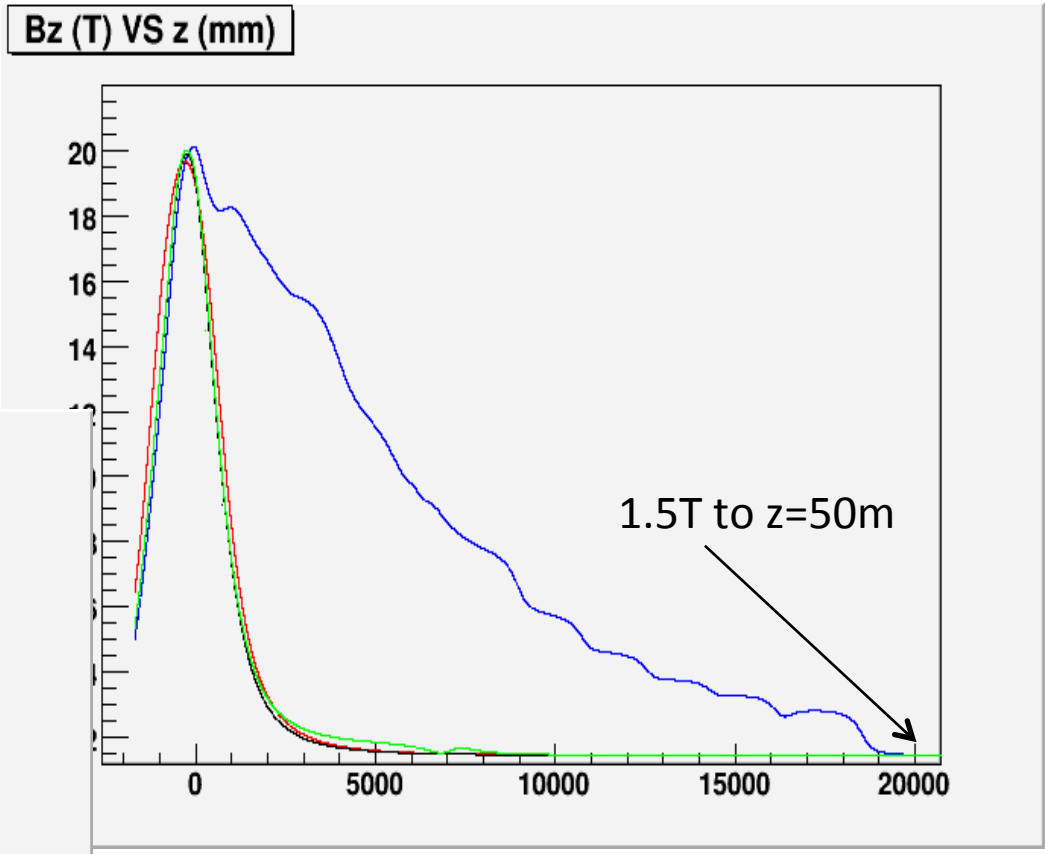
Some observations

- The layout with a higher magnetic field in the drift section, “lose” a lot of particles when applying acceptance cuts
- 20 Tesla field around the target seems to give the best results
- The three best layouts are chosen and compared to the ST2 setup

Magnetic field tapering

Blue	**ST2 setup**
Red	2 solenoids (rapid)
Black	2 solenoids and 3 Cu-Solenoids (rapid)
Green	3 solenoids and 3 Cu-solenoids (rapid)



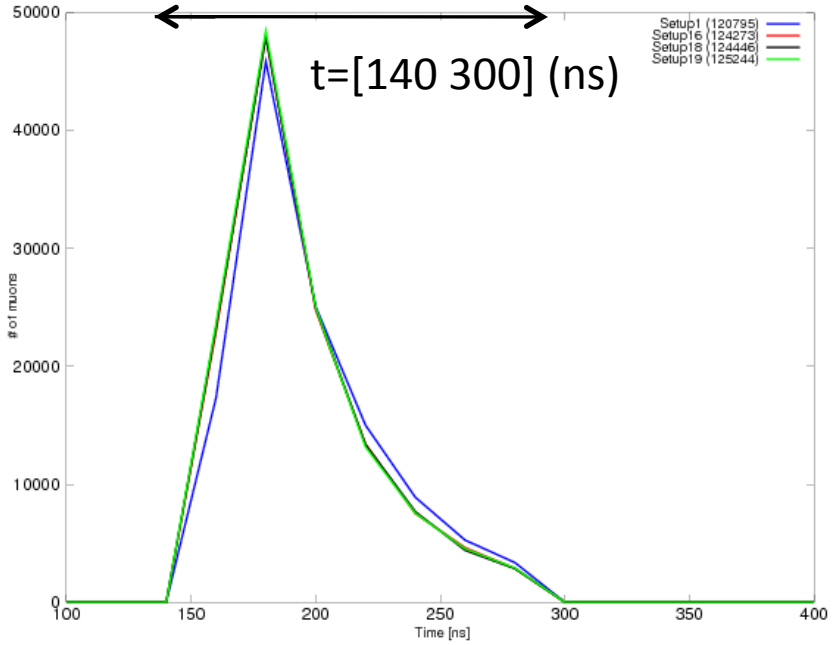


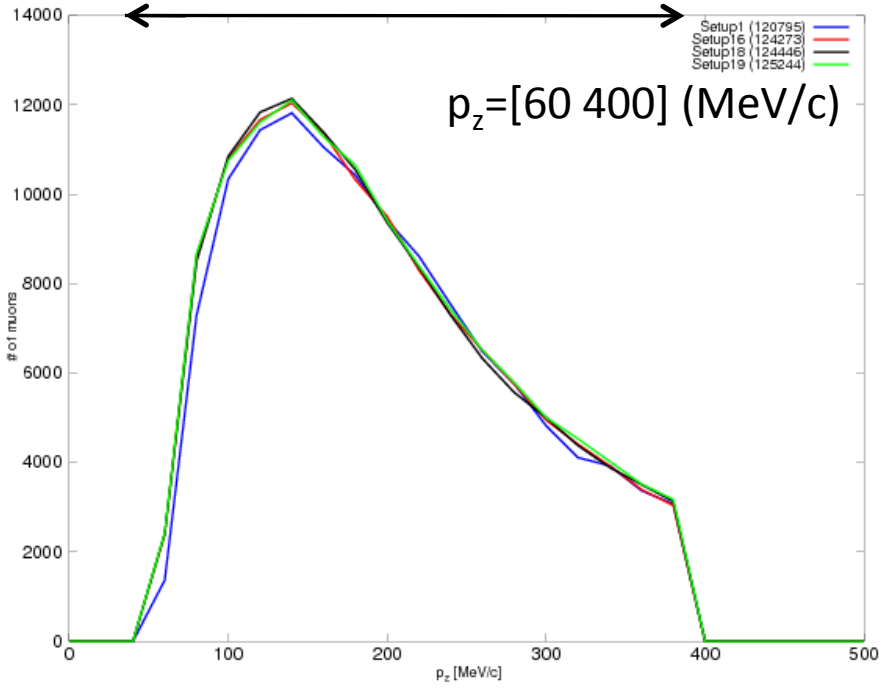
Study on acceptance cuts

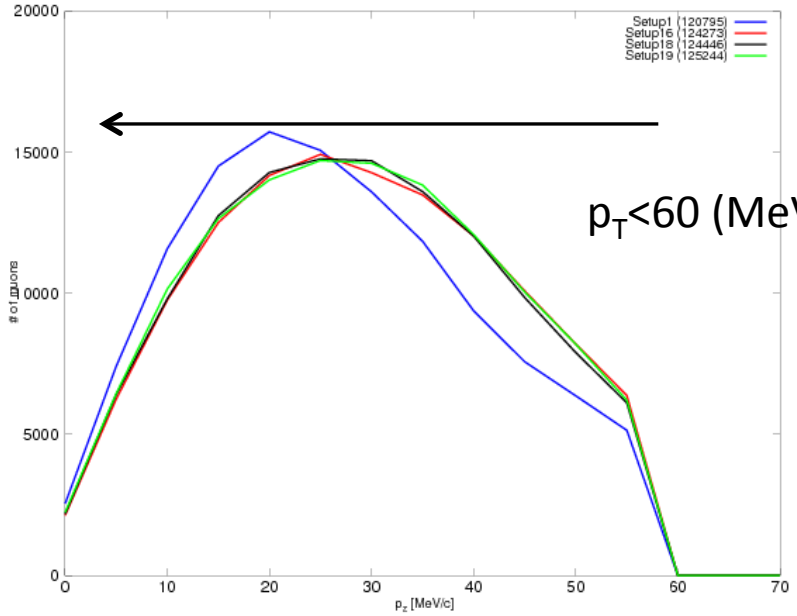
- Used lattice made by Pavel Snopok (Thanks!)

- The ecalc9f routine used to find the accepted particles after the cooling (L=273.1 m), then these “survivors” are tracked back to the end of the drift section (z=50m) to find the corresponding momentum, time and position distribution

Ecalc9f cuts	
$100<p_z<300$ [MeV/c]	$A_{\|\|}<30$ [mm]
$p_T<150$ [MeV/c]	$A_T<150$ [mm]



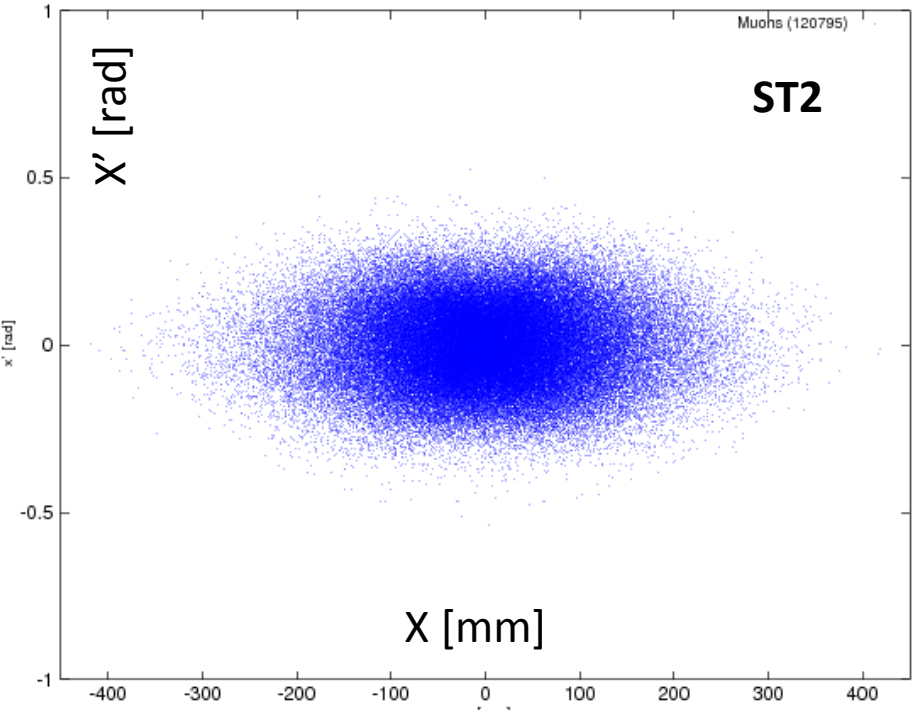


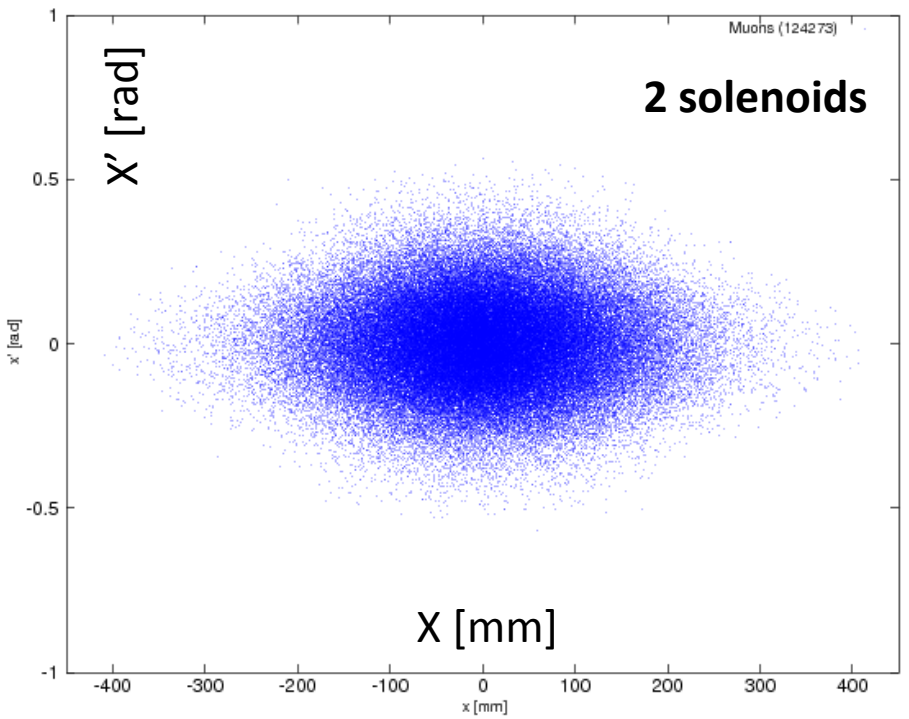


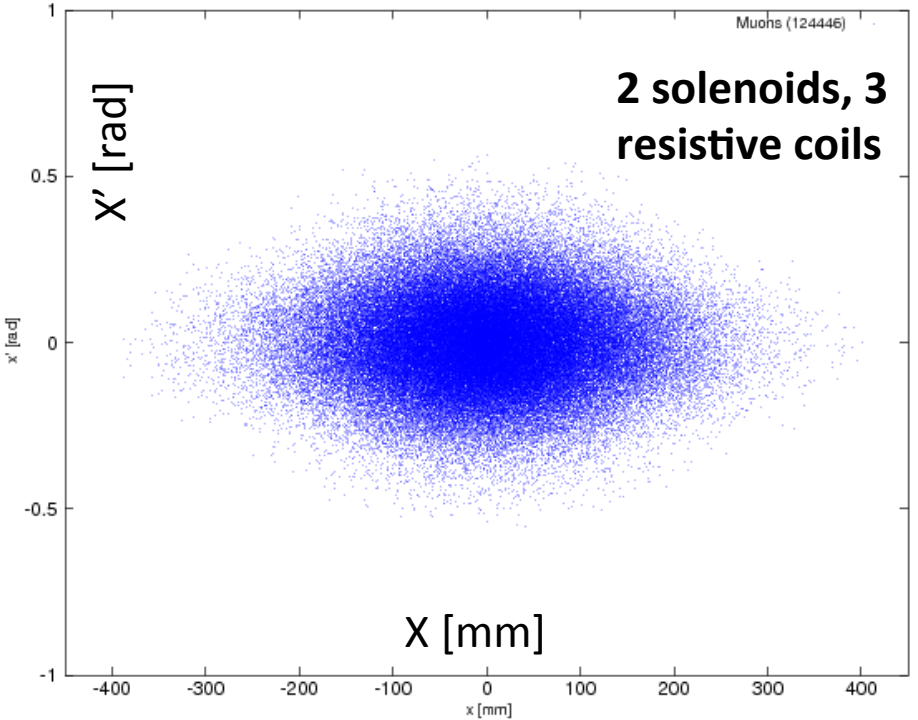
Setup
ST2
2 solenoids
2 solenoids, 3 resistive solenoids
3 solenoids 3 resistive solenoids

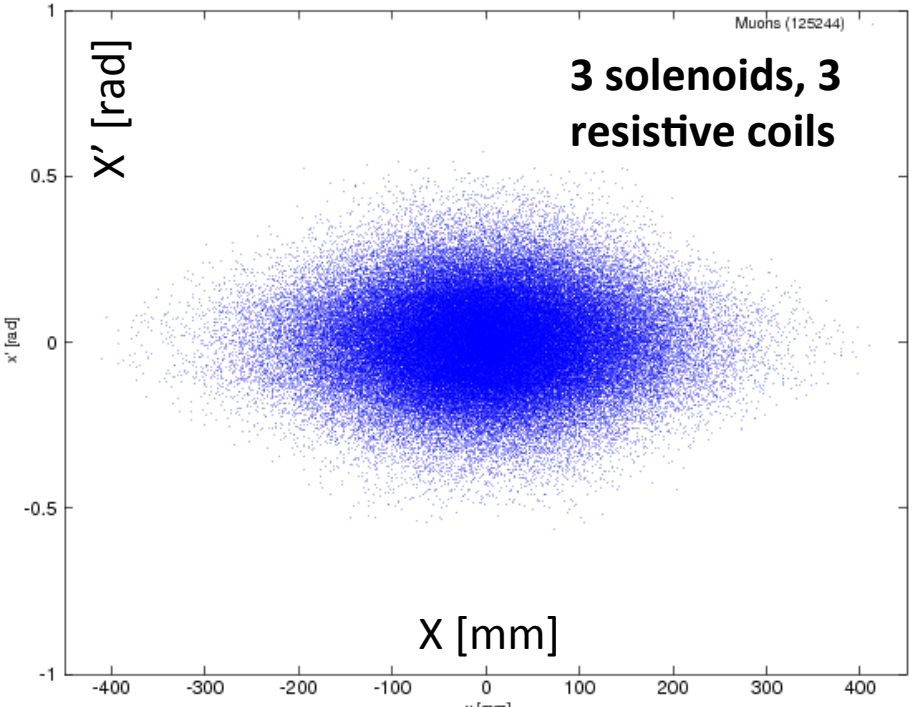
Cuts

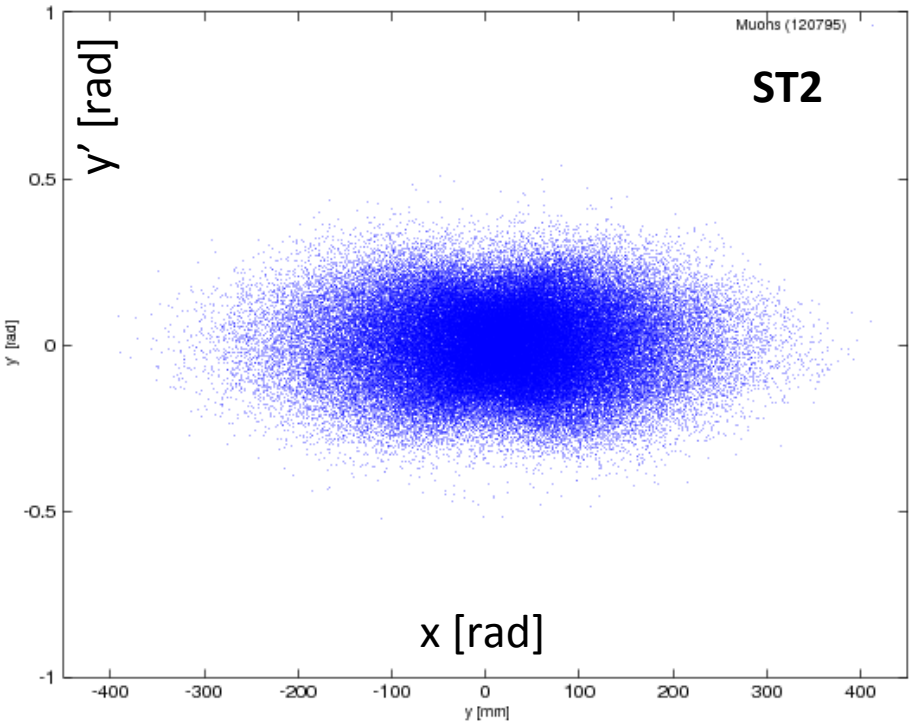
- pz=[60 400] (MeV/c),
- pT<60 (MeV/c),
- t=[140 300] (ns)

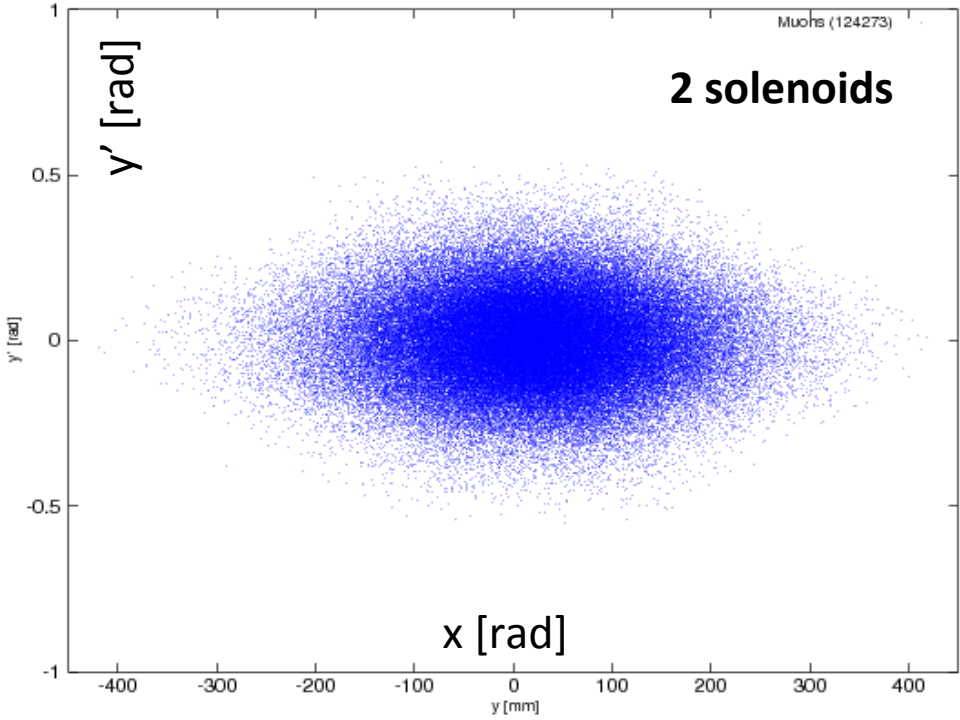

Muons (120795)
ST2
X' [rad]
X [mm]

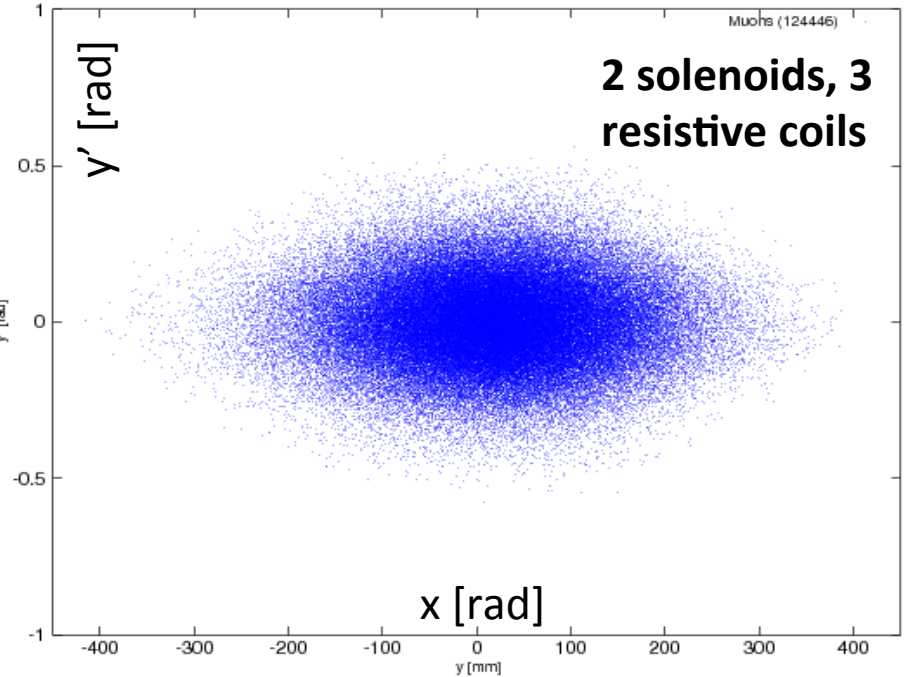

Muons (124273)
2 solenoids
X' [rad]
X [mm]

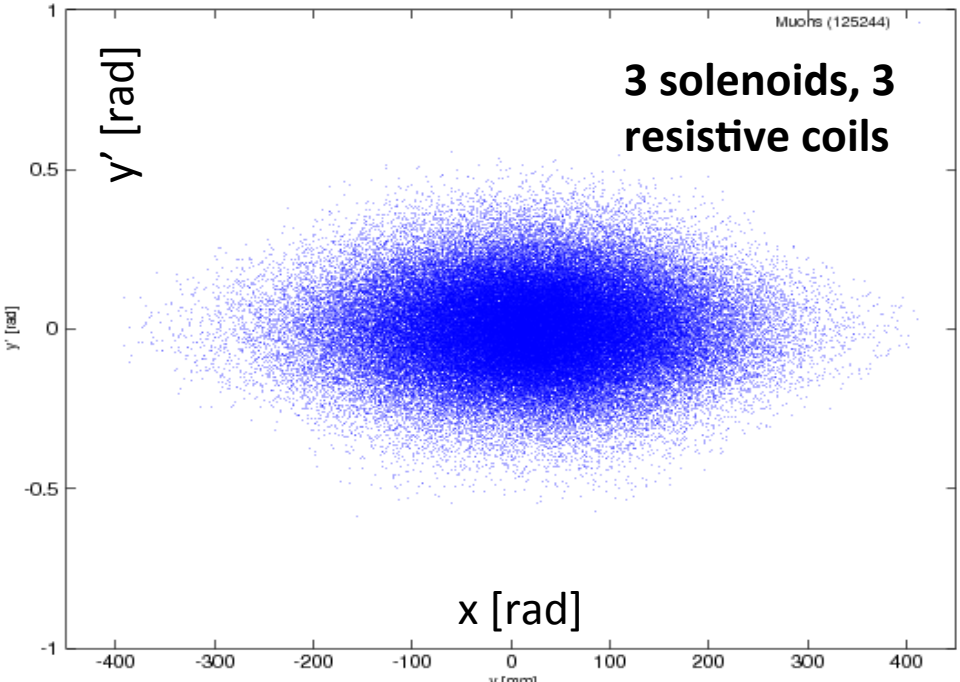

Muons (124446)
2 solenoids, 3 resistive coils
X' [rad]
X [mm]


Muons (125244)
3 solenoids, 3 resistive coils
X' [rad]
X [mm]


Muons (120795)
ST2
y' [rad]
x [rad]
y [mm]


Muons (124273)
2 solenoids
y' [rad]
x [rad]
y [mm]


Muons (124446)
2 solenoids, 3 resistive coils
y' [rad]
x [rad]
y [mm]


Muons (125244)
3 solenoids, 3 resistive coils
y' [rad]
x [rad]
y [mm]

Summary

- A longer tapering is not necessarily better for capturing pions/muons
- The 2/3 solenoid setup is as good or even better than the ST2 setup

Setup	Flux, no cuts	Flux, w/acceptance Cut
ST2	179070	120795
2 solenoids	185307	124273
2 solenoids, 3 resistive solenoids	182118	124446
3 solenoids 3 resistive solenoids	188028	125244

Further work

- Sensitivity to acceptance cuts
- Study of other setups
- Study the impact of rapidly decreasing B-field on the beam-target
  - The target interaction lengths for the proton beam may be slightly different in the setups, due to the different magnetic field and bending of the beam, check how this can impact the results.
- Other ideas?
- Thanks!!