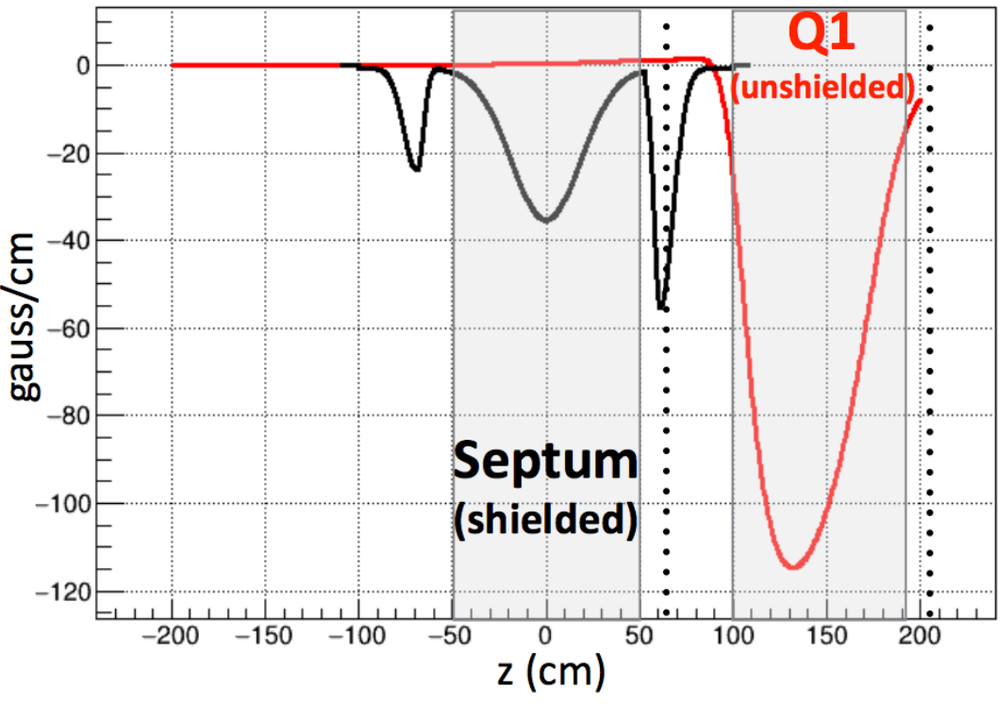
PREX Magnetic Modeling

work done by Jay Benesch

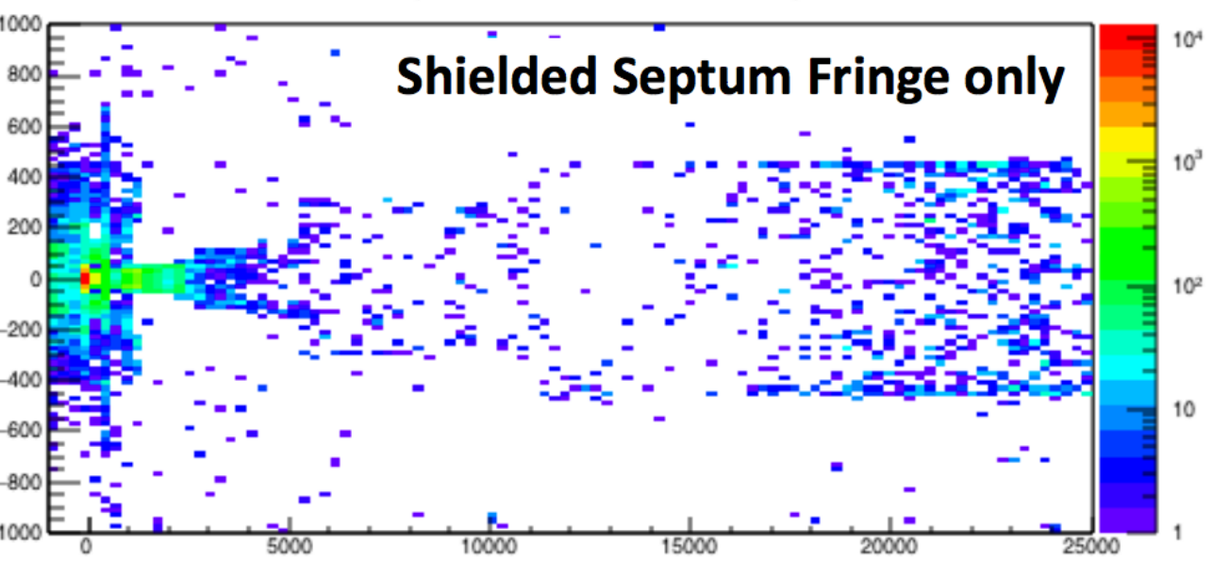
ERR Q1 status

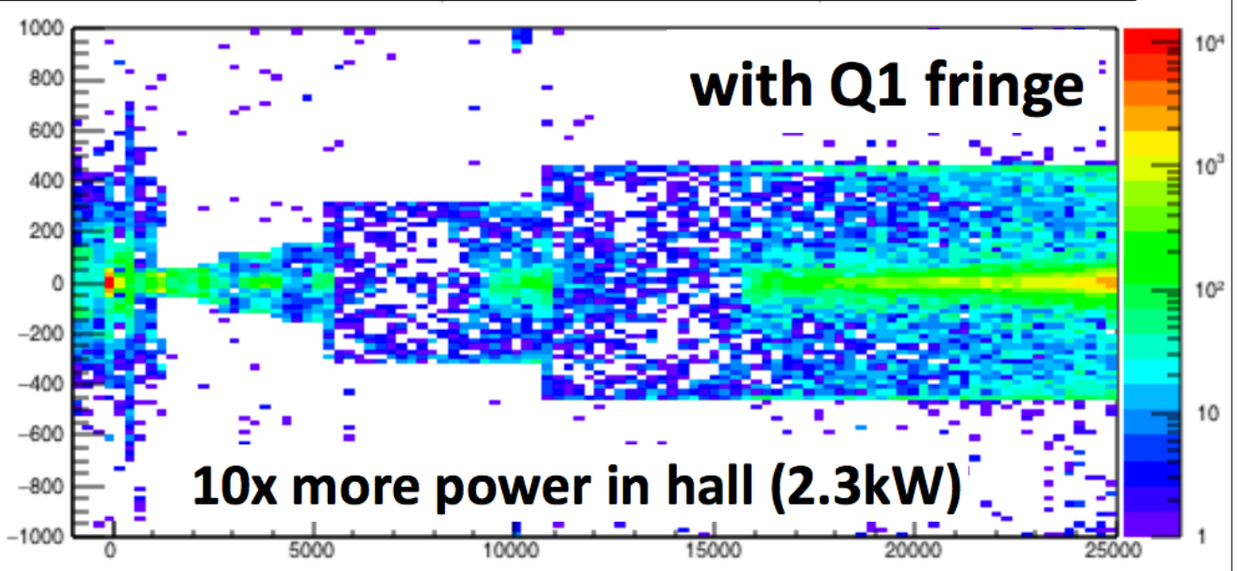


- The field we estimated had a large effect on radiation levels inside the hall (making PREX2 reach PREX1 levels)
- There were 2 problems with the setup:
  - The magnitude of the fringe was a factor of 2 too large
  - The sign of the field was wrong

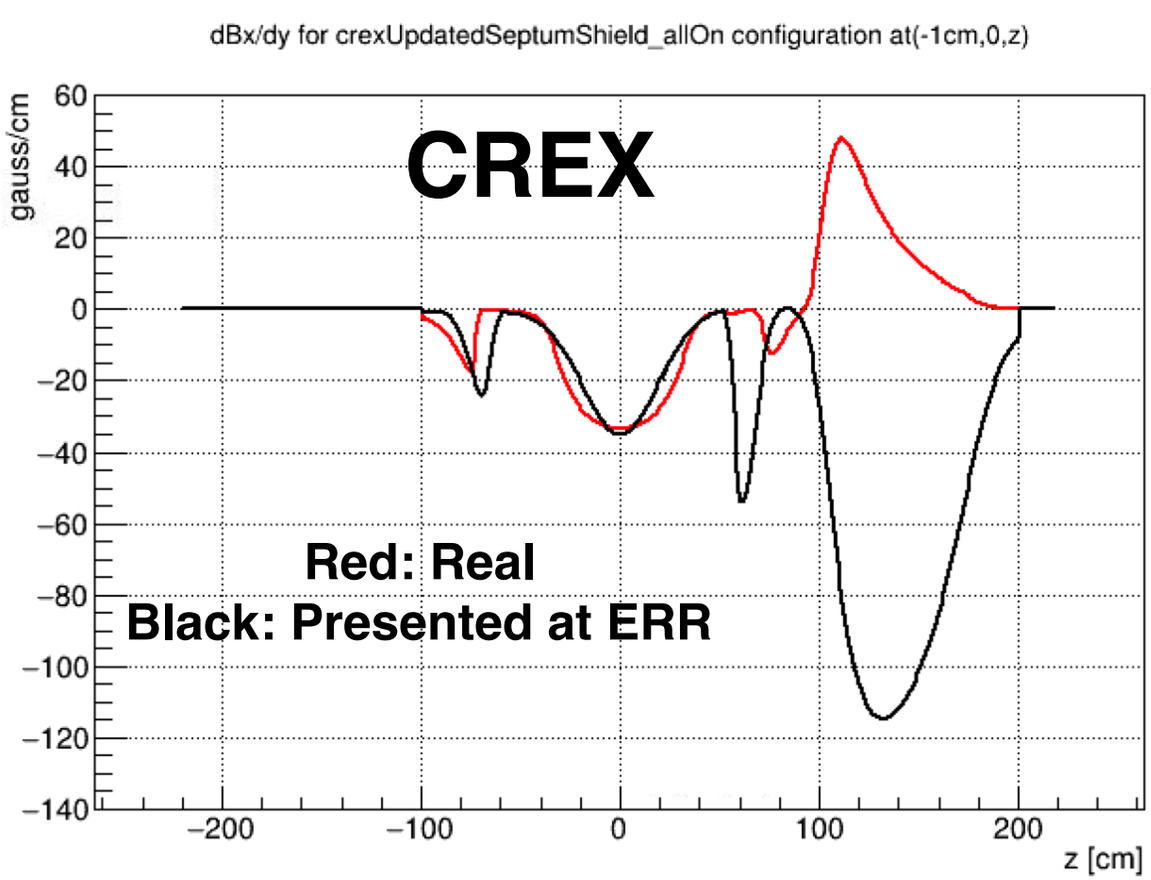
1MeV n_{eq} / cm^2

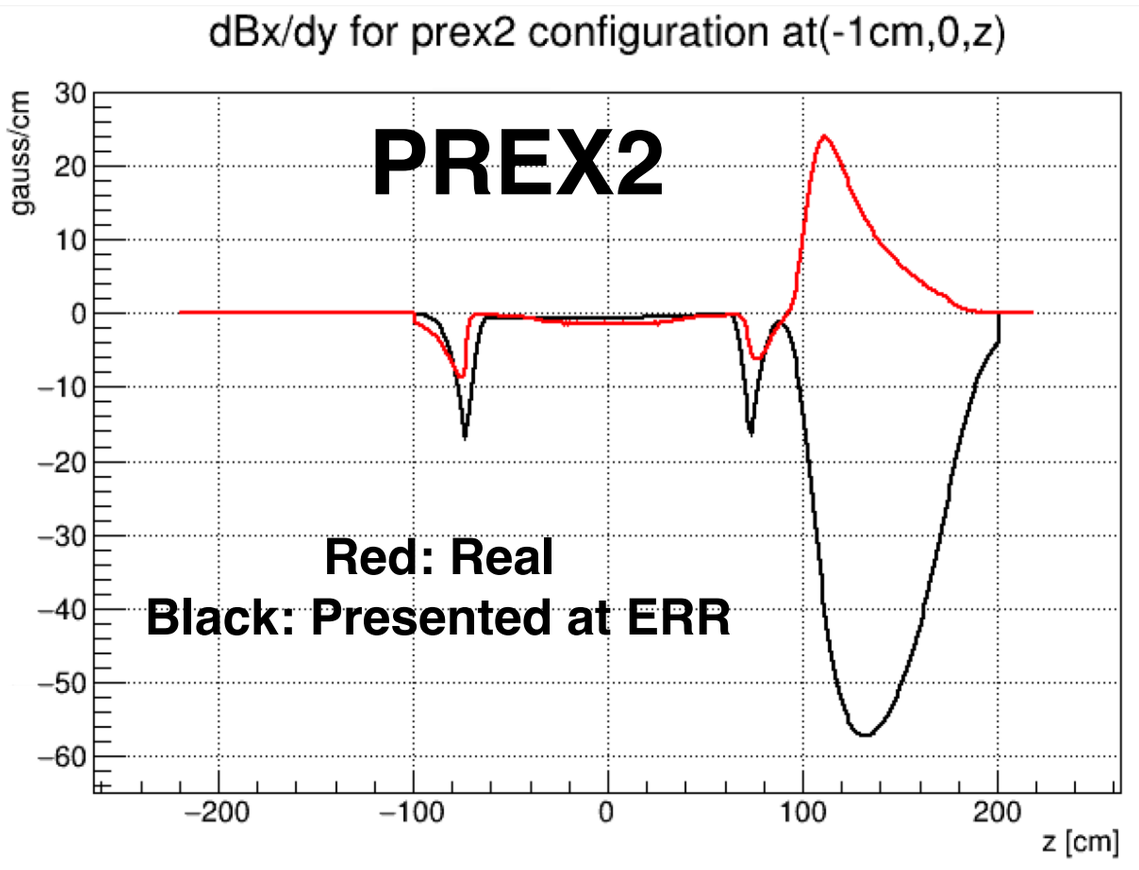
HRS power supply	PREX-I	PREX-II	CREX	PREX-II +Q1 fringe	CREX +Q1 fringe	PREX-II Q1/noQ1	CREX Q1/noQ1
total	**2.3E+11**	**2.1E+10**	**3.6E+10**	**3.3E+11**	**4.2E+11**	16	11.7





Fringe fields

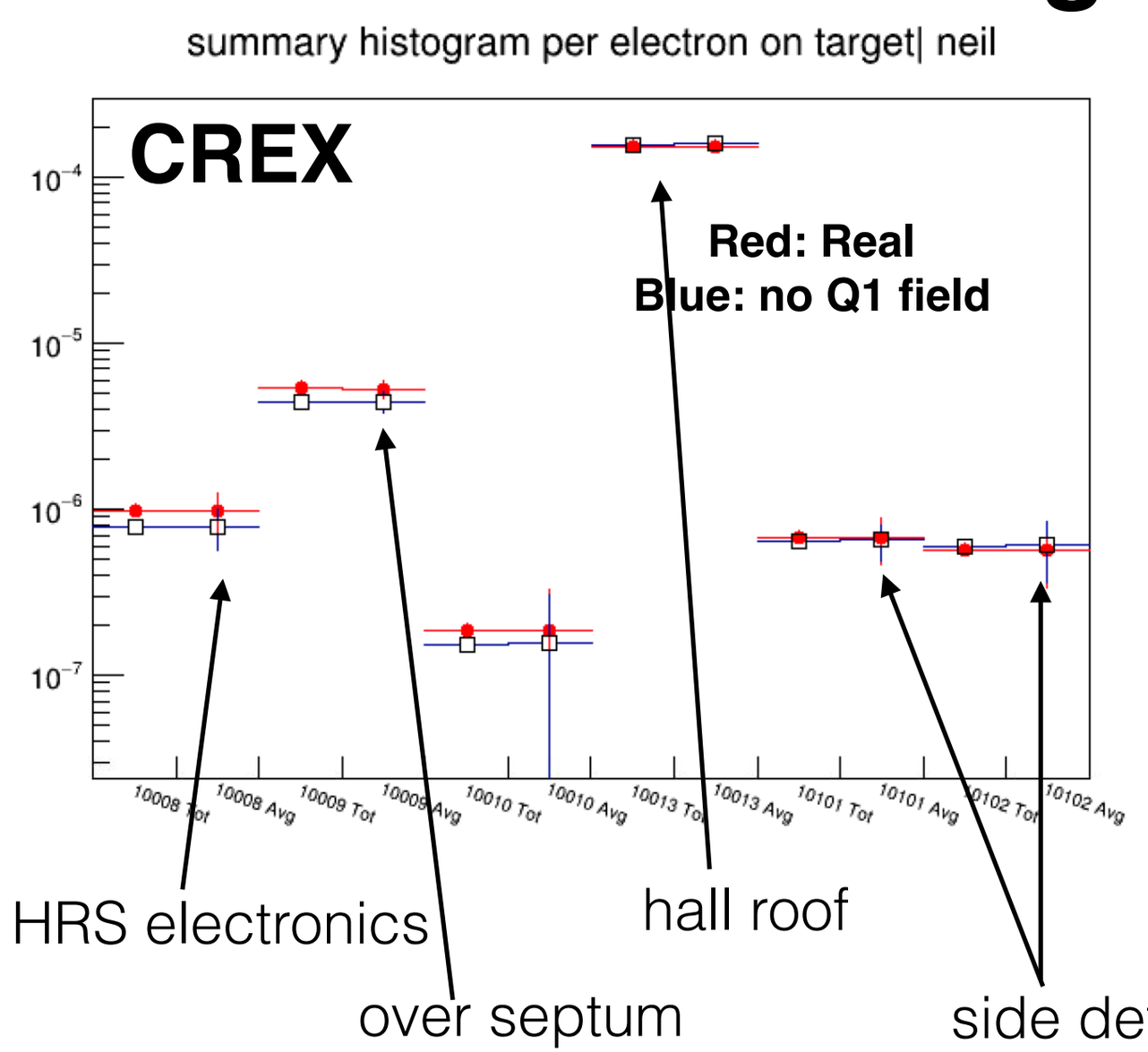


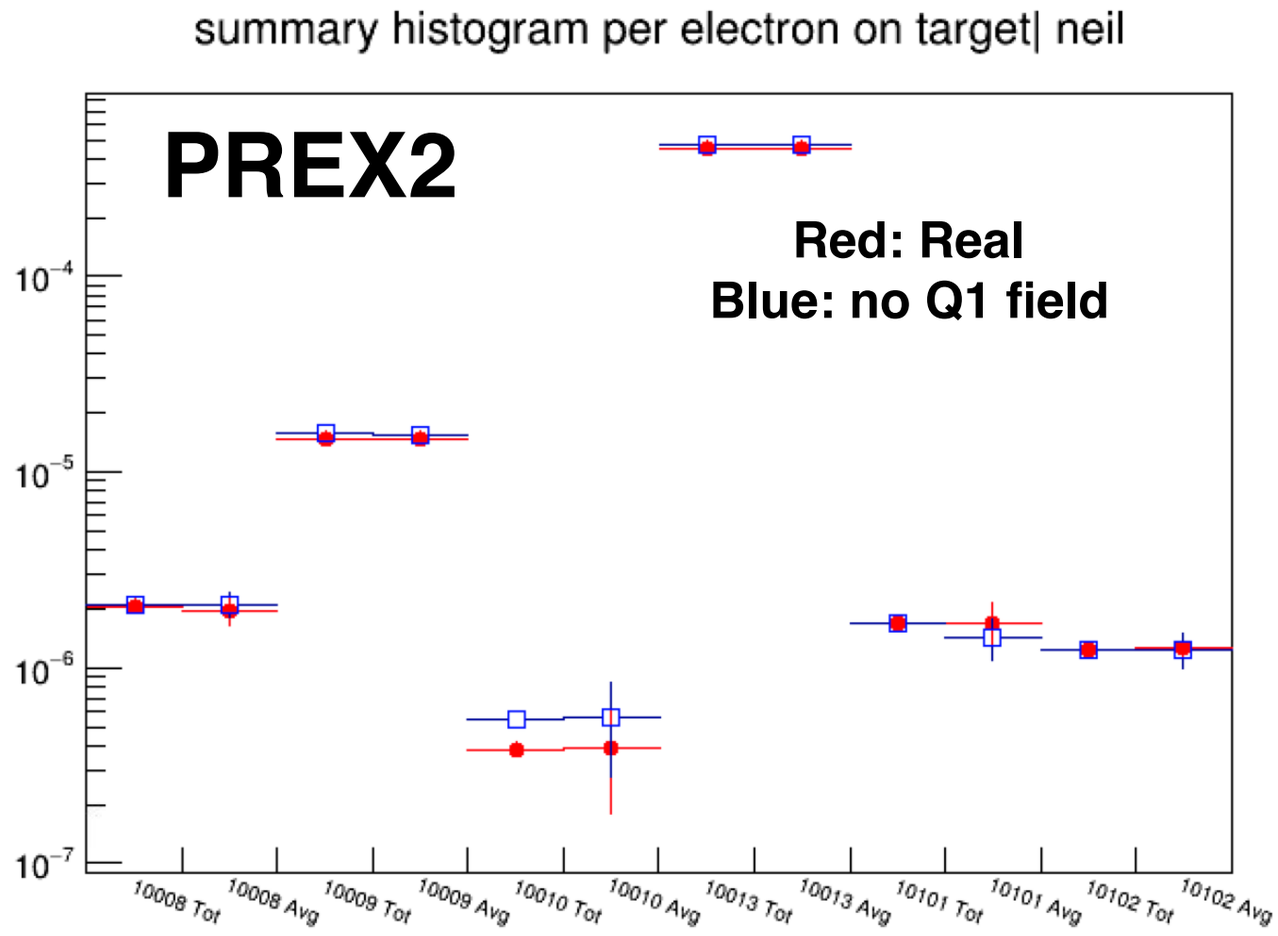


- Jay implemented a realistic septum beam pipe and now we have the whole fringe field around the beam pipe through both Septum and Q1

- The effect of opposite sign quad fields is not as simple as convergent-divergent pair of lenses (but it's a good first approximation)

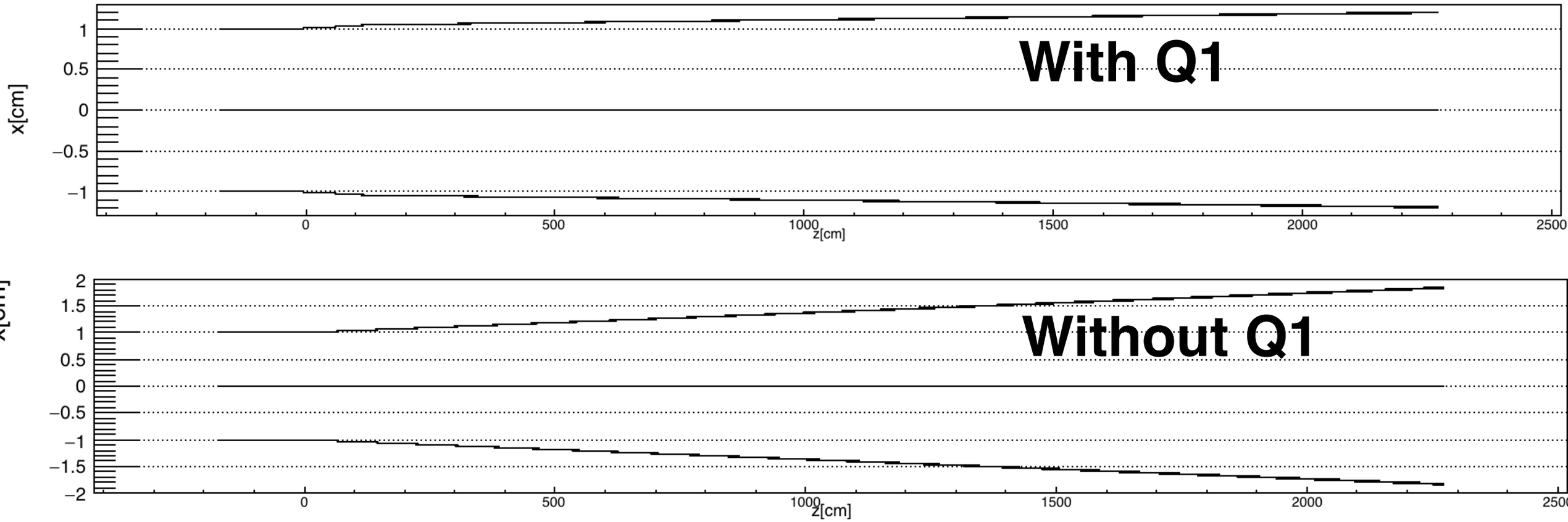
Fringe fields





- If we look at the different detectors we have in the radiation simulation through the hall we can see that:
  - For CREX the Q1 fringe might help
  - For PREX the Q1 fringe does not seem to have any effect (or a slightly increased radiation field)

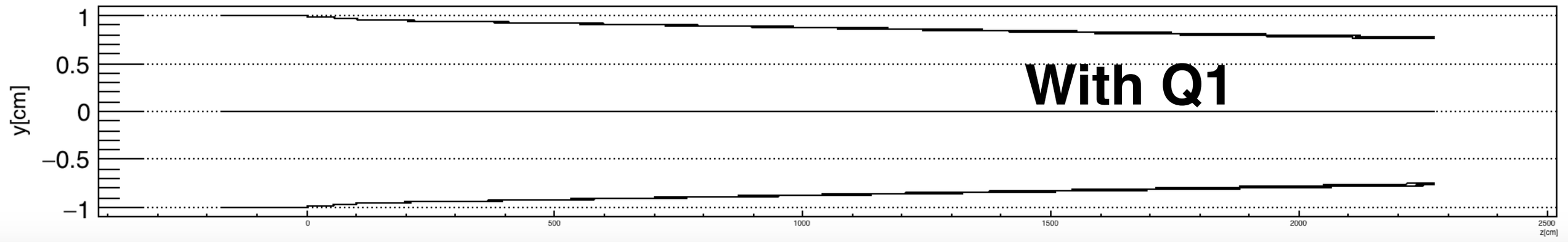
Beam transport - CREX

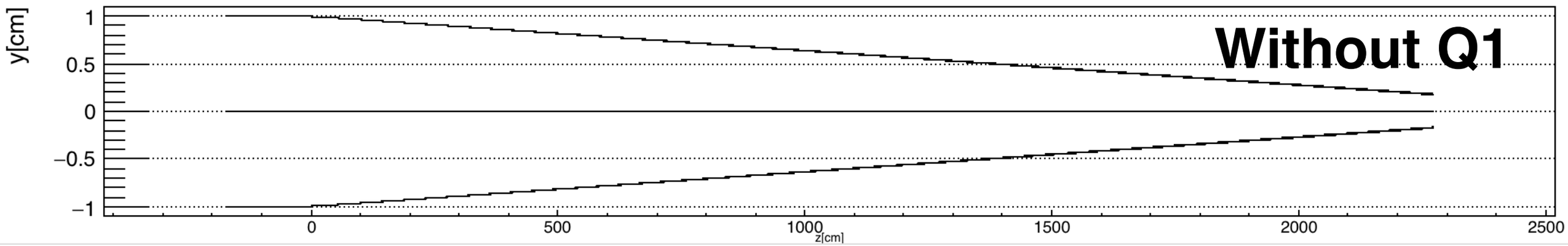


- Jay produced trajectories in TOSCA in a grid (1x1cm) at the target and propagated them through the fields all the way to the dump tunnel

  - the x “beam spot” decreases with the Q1 fringe field from 1.9 -> 1.2

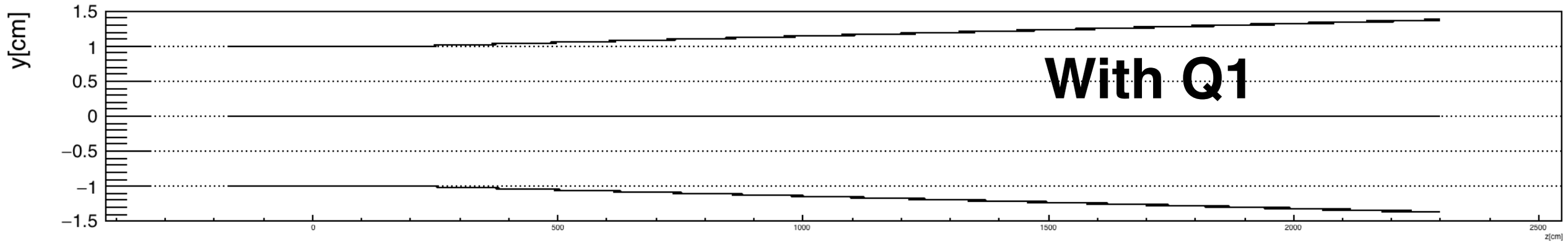
Beam transport - CREX

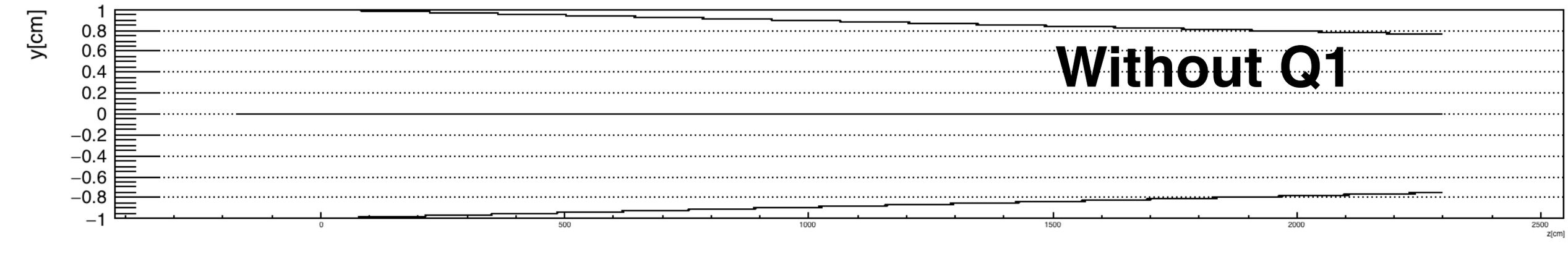




- Jay produced trajectories in TOSCA in a grid (1x1cm) at the target and propagated them through the fields all the way to the dump tunnel
  - the y “beam spot” increases with the Q1 fringe field from 0.2 -> 0.8

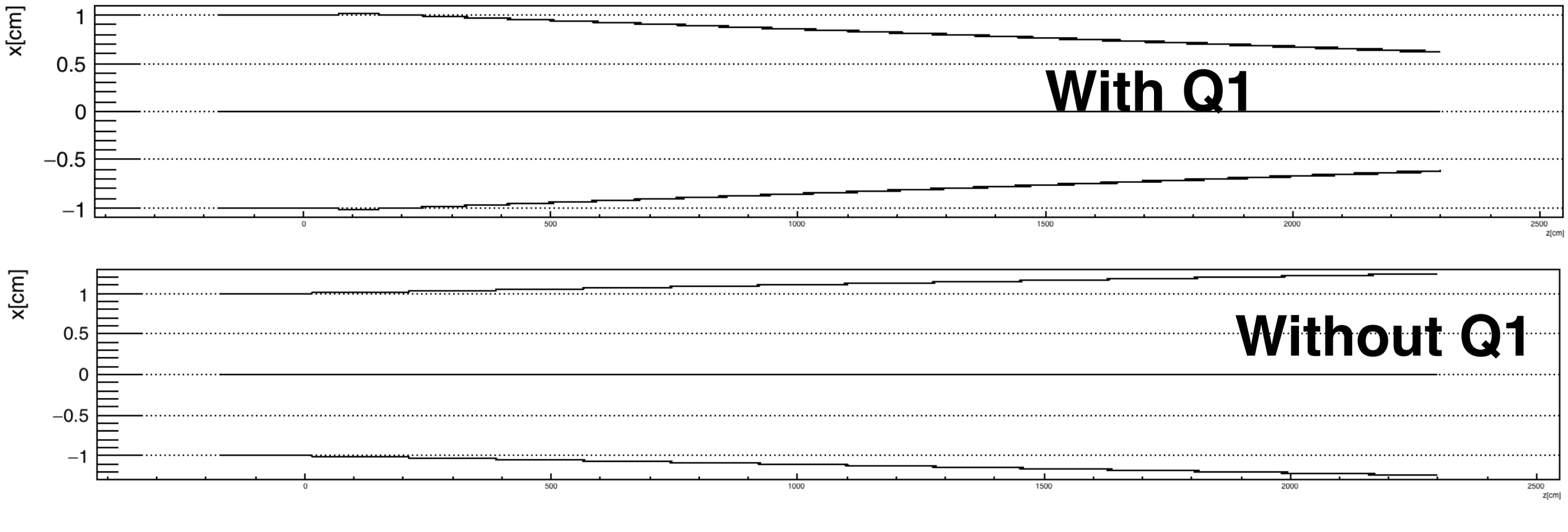
Beam transport - PREX





- Jay produced trajectories in TOSCA in a grid (1x1cm) at the target and propagated them through the fields all the way to the dump tunnel
  - the y “beam spot” increases with the Q1 fringe field from 0.8 -> 1.4

Beam transport - PREX



- Jay produced trajectories in TOSCA in a grid (1x1cm) at the target and propagated them through the fields all the way to the dump tunnel

  - the x “beam spot” decreases with the Q1 fringe field from 1.2 -> 0.6

Beam transport

	PREX wi	PREX wo	CREX wi	CREX wo
y	1.4	0.8	0.8	0.2
x	0.6	1.2	1.2	1.9

- This is just a rough analysis but it does not see that leaving the Q1 fringe field in will be a huge disruption for beam transport to the dump

Conclusions

- In terms or radiation the Q1 fringe field might actually be useful (in particular for CREX)

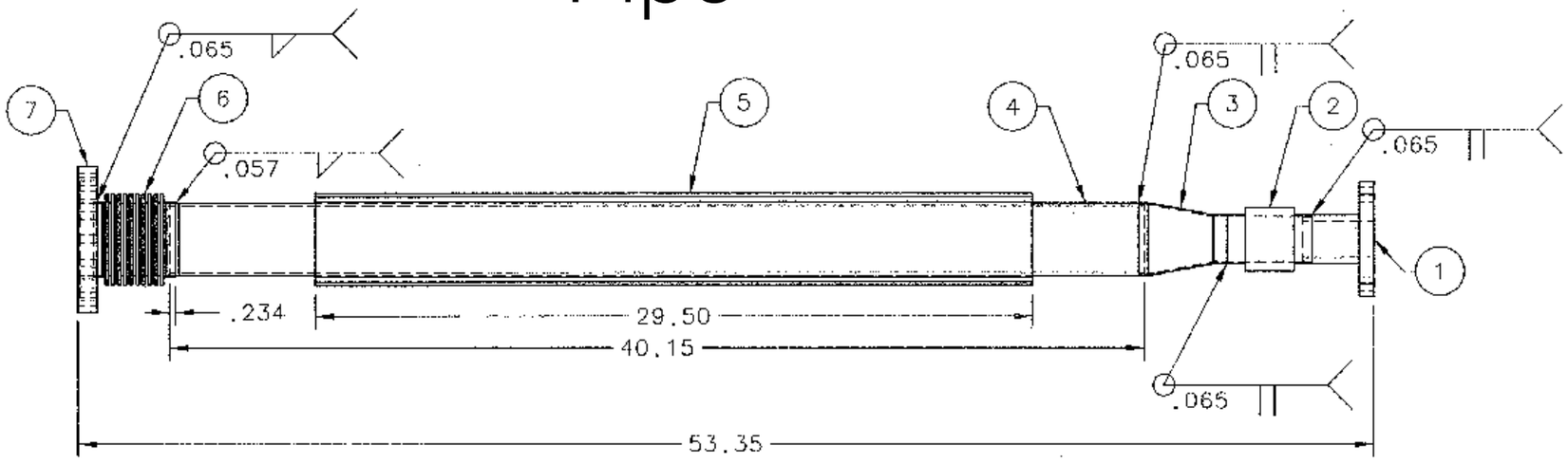
- Seems beam transport will be ok with Q1 fringe

- We still need to evaluate the beam transport with only one Q1 turned on (Jay is working on it)

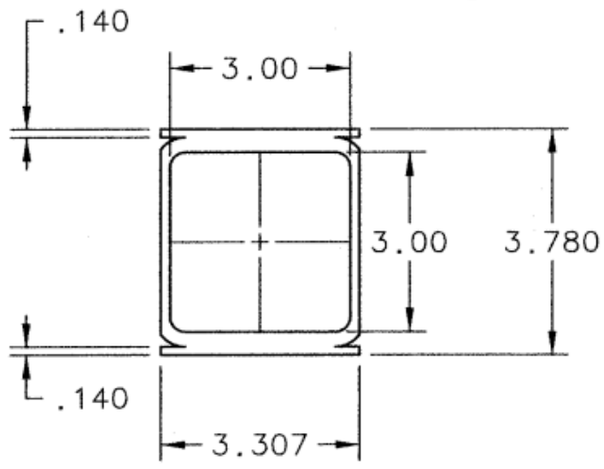
Backup

Septum beam pipe

Pipe



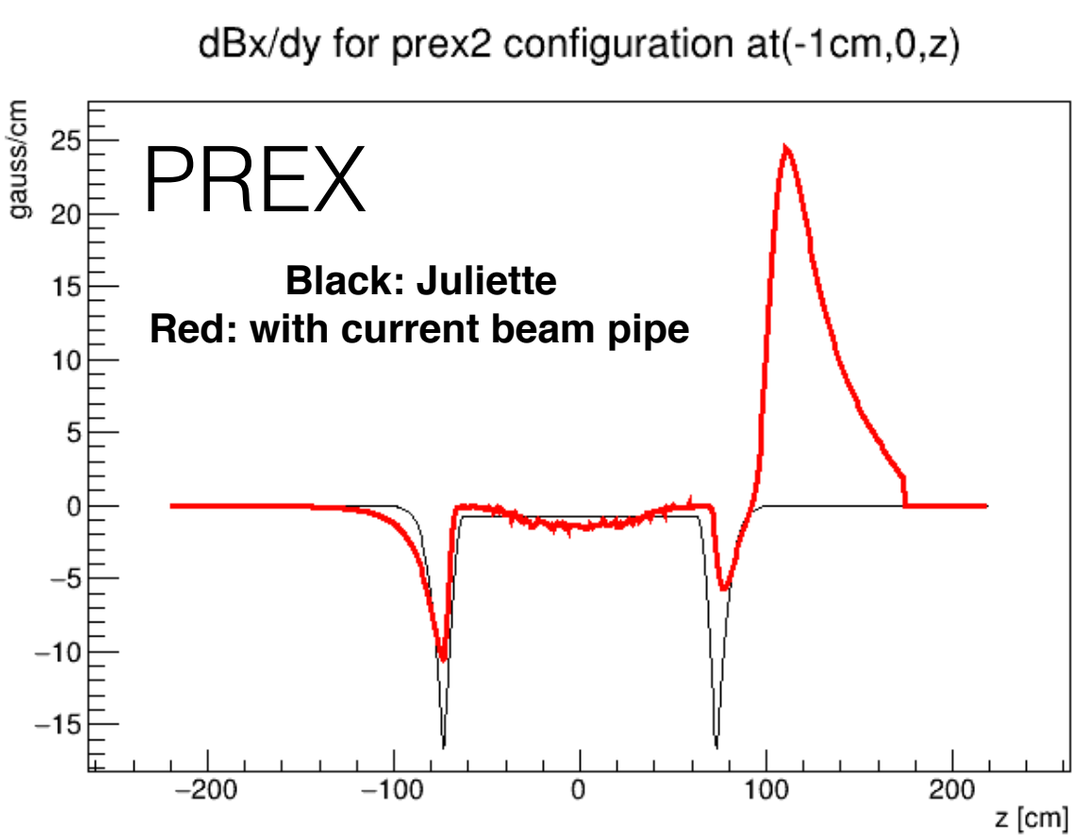
Shielding

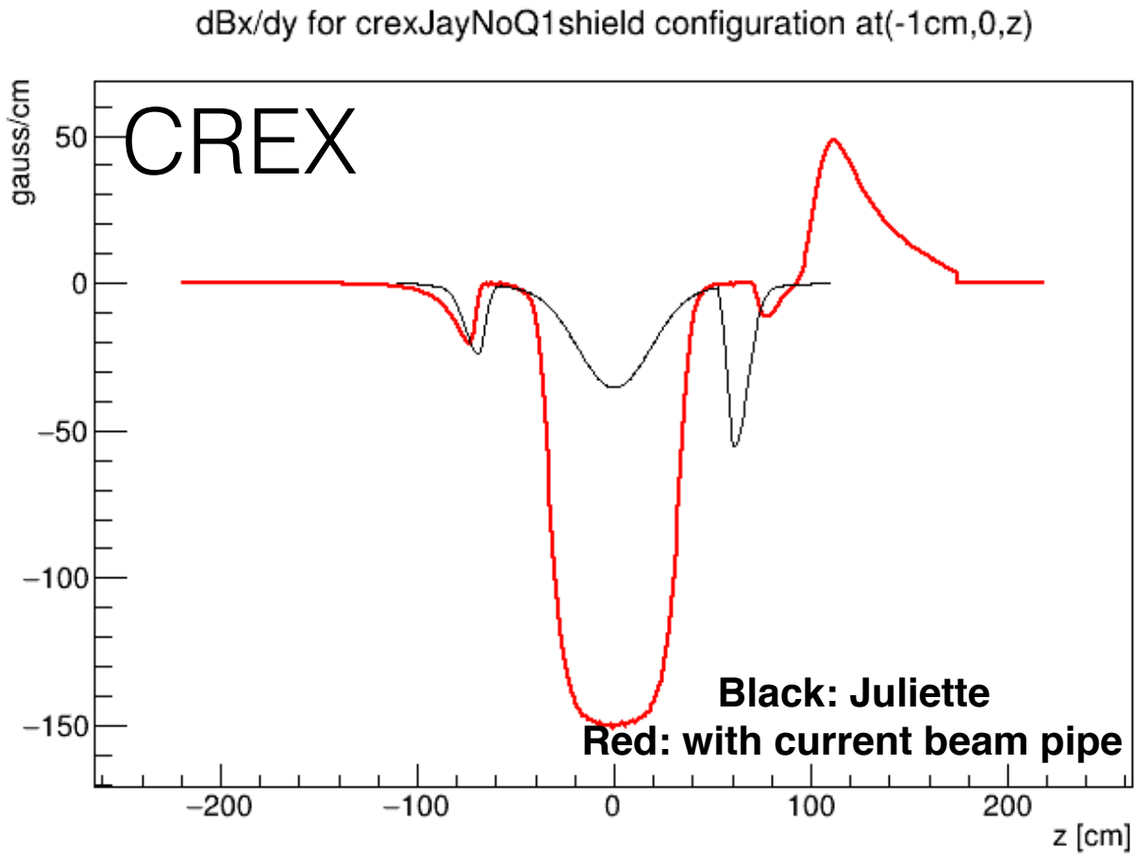


- Jay started working with the model Juliette and Iris provided

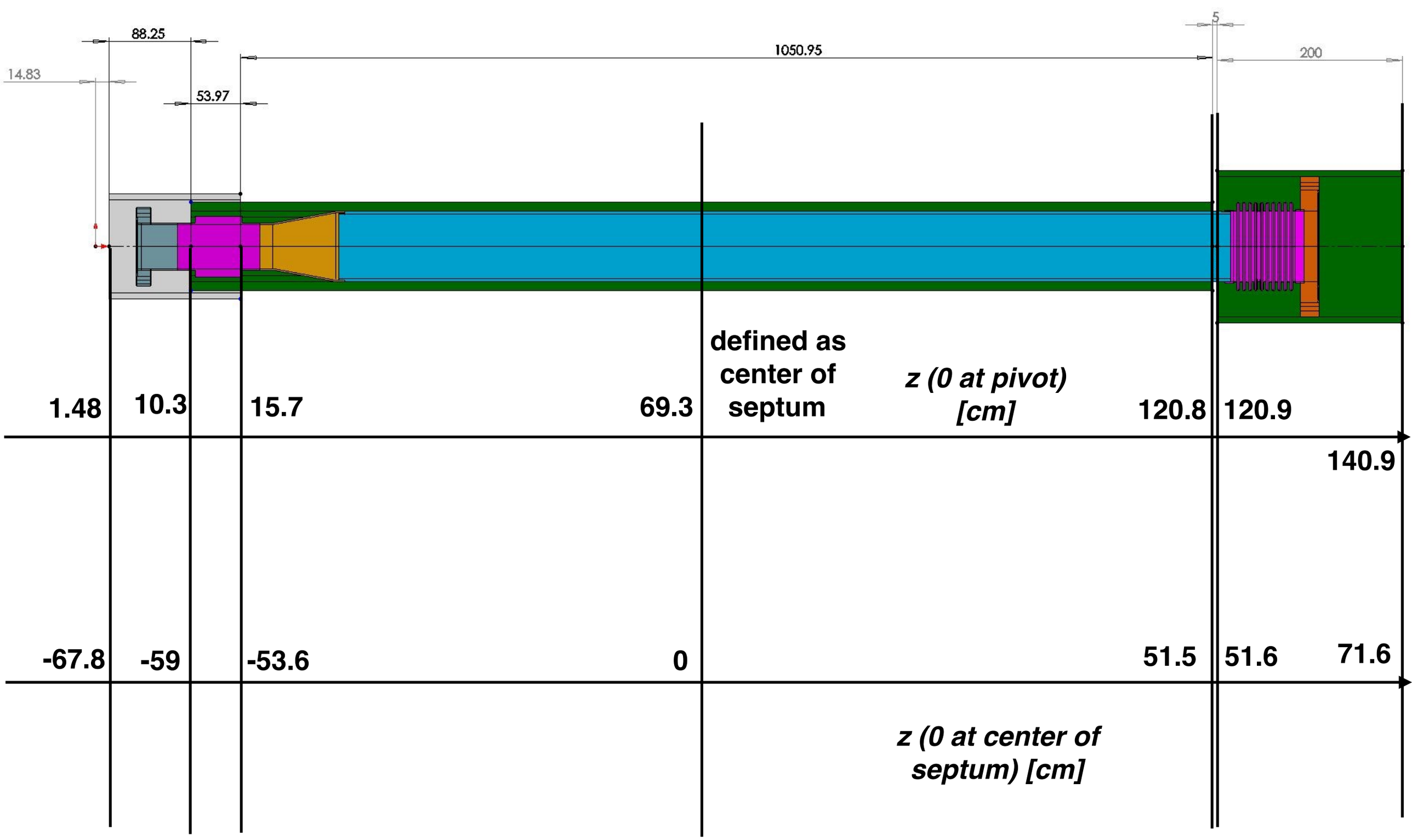
- The beam pipe through the septum in the configuration that ran for PREX1 (and is available now) has:
  - The shielding (# 5) is in actuality longer - 43.5”
  - The shielding box is made out of carbon steel and the openings at the top and bottom are filled in with weld
  - The pipe itself is made out of stainless steel

B fringe field from current setup





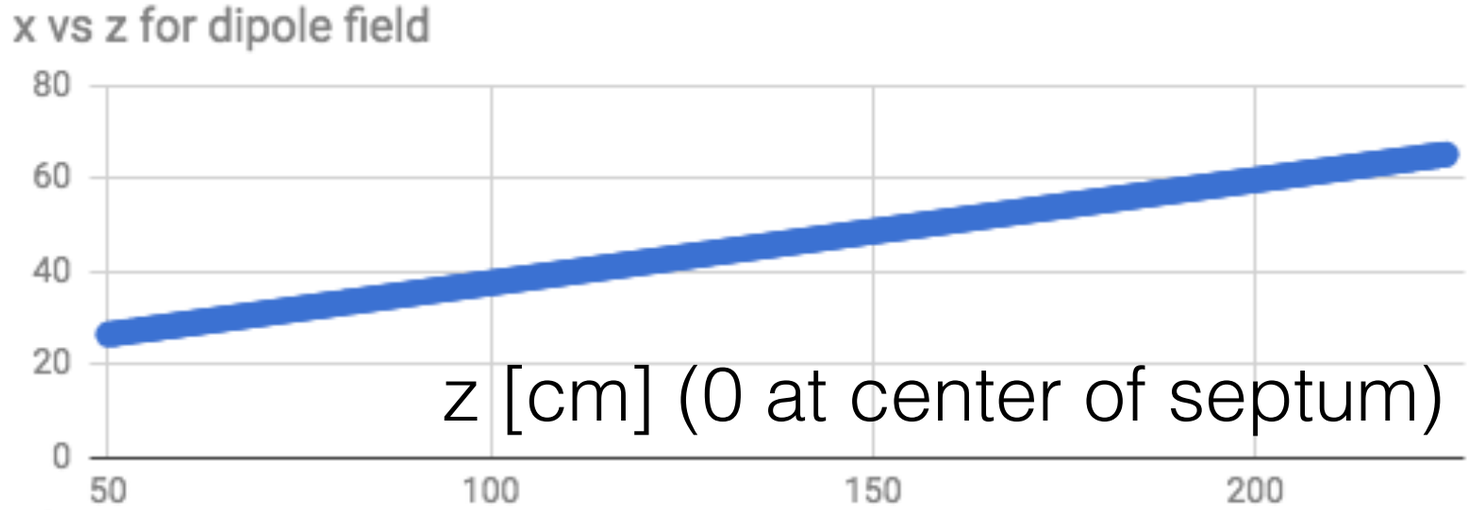
- Note that Juliette never got a fringe field for the Q1s
- The fringe field in the CREX case is probably unmanageable (radiation wise) if we keep the current setup
- Juliette must have already replaced the stainless steel pipe in her simulation with carbon-steel
- Jay has models running now with updated configuration

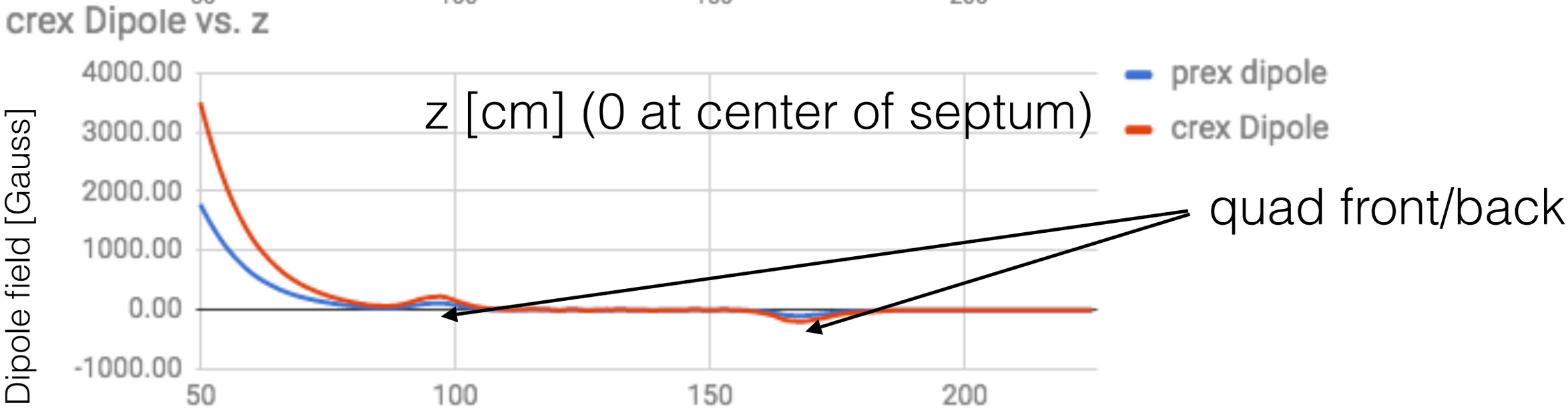

88.25
14.83
53.97
1050.95
5
200
1.48
10.3
15.7
69.3
defined as center of septum
z (0 at pivot) [cm]
120.8
120.9
140.9
-67.8
-59
-53.6
0
51.5
51.6
71.6
z (0 at center of septum) [cm]

Changes needed to the beam pipe

- Minimal changes:
  - the beampipe 3''OD 0.124'' thickness should be **carbon-steel** Z[-53.6, 51.6]. The rest should be left out because that is where we will have stainless steel bellows.
  - the rectangular carbon-steel box around the beampipe should extends Z[-59, 51.6] — already in place
  - the US carbon-steel plates with 0.25'' thickness should extend between Z[-67.8, -53.6] **— have to be designed and manufactured**
  - the DS carbon-steel plates with 0.25'' thickness should extend between Z[51.6, 71.6]**— have to be designed and manufactured**
- Alternative solution:
  - Take two carbon steel rectangular cross section beams (of the correct size) and drill a semi-circular cavity
  - Weld the two pieces together and connect to bellows at either end

Dipole field along signal particle path





- Jay's calculations show that there is a significant dipole field along the path of the particles being scattered into the HRS

- These are calculations made by Jay and provided to us in a spreadsheet of multipoles (the large

- These are with the updated septum beam pipe (the field around 50 is due to the fringe of the septum interacting with the iron in the Q1)s