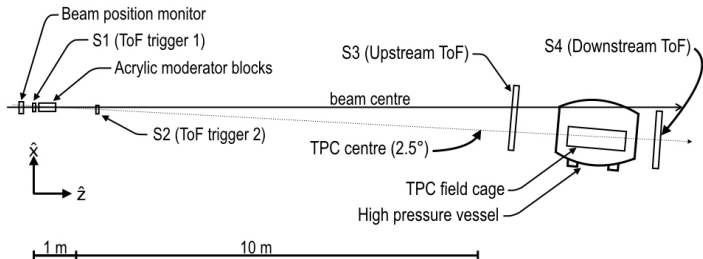# MC geometry studies

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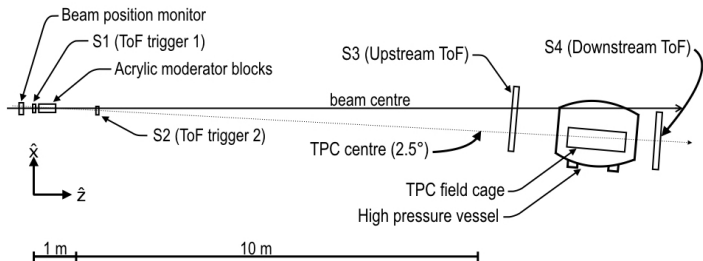
February 24, 2020

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A reminder

- I have been trying to track down the source of the discrepancy between the data and MC
- As part of this, have been trying to check the MC is as realistic as possible

A reminder

- In the MC protons are propagated from $S3$ through the vessel and to $S4$
- The direction and momenta of these particles are drawn from the measured $S3$ distributions
- The vessel is represented as an argon-filled cylinder with a hollow ellipsoid at each end (the doors)

MC comparison with survey data

- Previously, I thought I had checked the positions within the MC and found them all to be correct (to a reasonable precision)
- On the next few slides I'll show histograms of the true MC particle positions within various detectors as a function of off-axis angle
- The coordinate system is centred on $S1$ and the nominal beam axis is at $\theta = \phi = 0$
- If you imagine these plots as being from a 'beam's eye view' they are flipped in θ due to the coordinates used in the survey
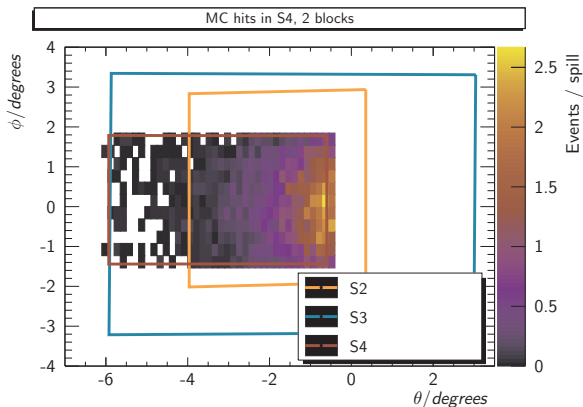
MC hits in S3
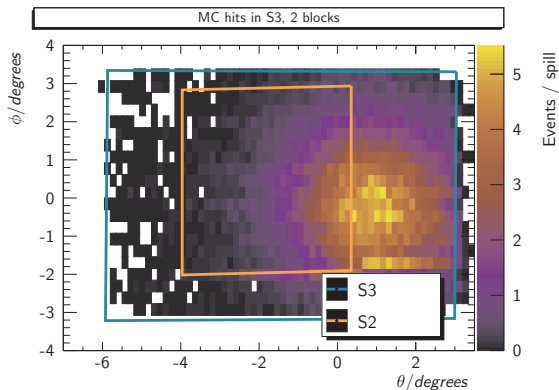
- The lines are based upon the survey data
- We see that nearly all of the MC S3 hits fall within the surveyed data
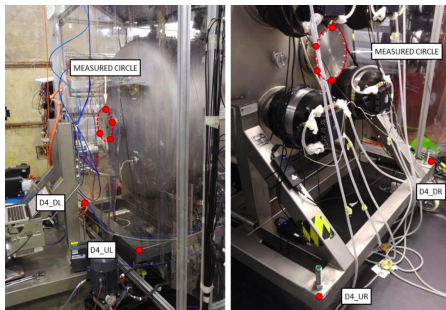
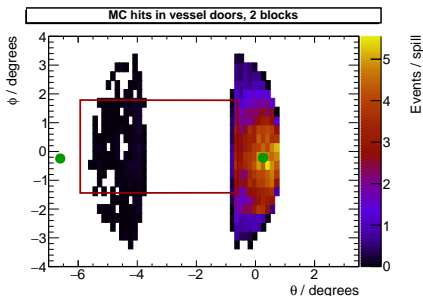# MC hits in *S3* (with an *S2* trigger)
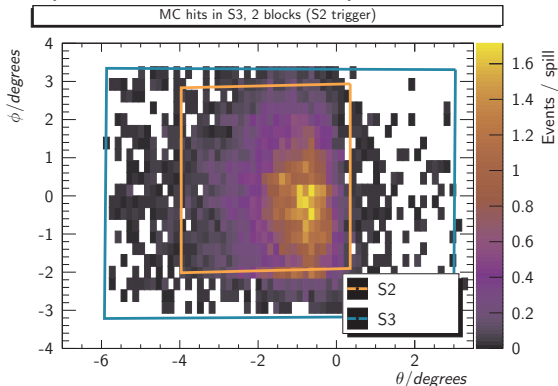
- As expected, once we require *S2* trigger, MC hits mainly fall within shadow of *S2*

MC hits in *S4*

- Looking at the same distributions for *S4*, we see that the MC falls pretty much within the measured points
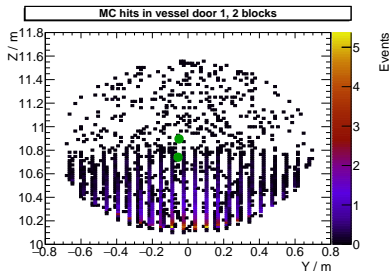
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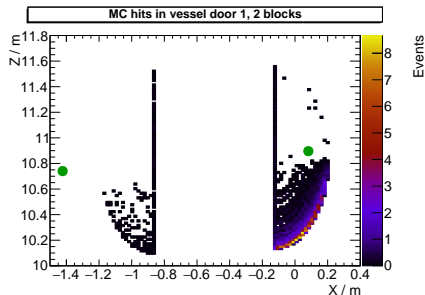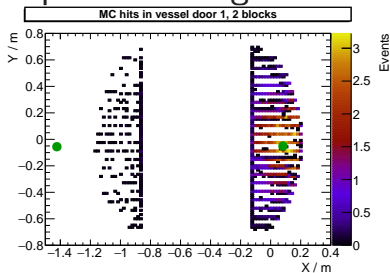# MC hits in vessel doors

- However, for the doors there appears to be an offset between the data and the MC
- The green points are the measured points on the doors on the flanges (labelled 'Measured circle' in picture)
- There appears to be an offset between the MC positions of the doors and their measured positions
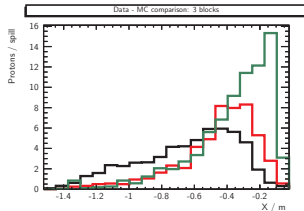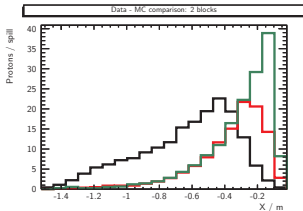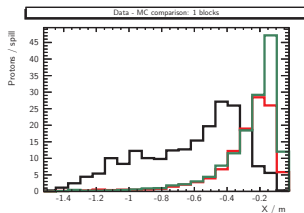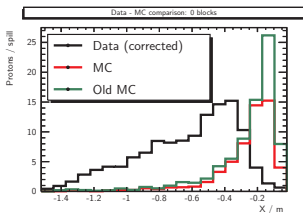
Hit positions in global coordinates

- Measured points in green
- Offset appears to be mainly in X
- Vessel also needed to be rotated
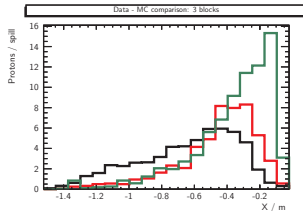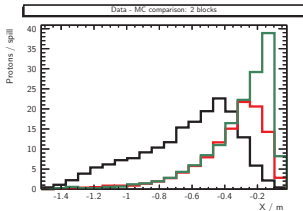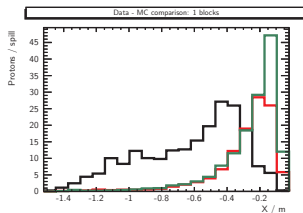
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Changes made to MC

- Vessel needed to be shifted by $(-0.1796, -0.04165, -0.0108)$ m and rotated by $5.91°$
- Also discovered that $S4$ had a rotation that was slightly off
- Thanks to Toby for implementing these changes

Effects on MC distributions

- The interesting part of all this is the effect it has on the distributions in $S4$

Effects on MC distributions
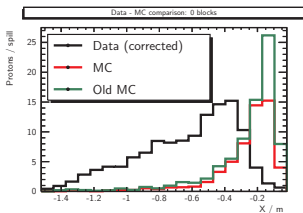
- We lose the sharp peaks we had on the beam side edge of $S4$, with our MC now resembling our data more

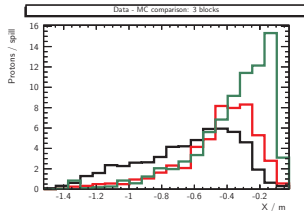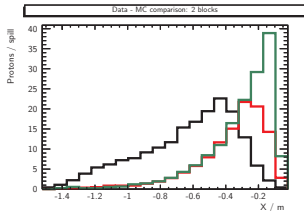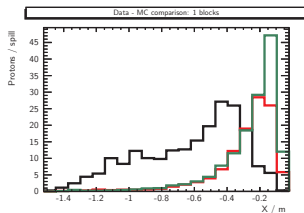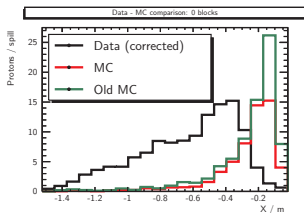# Effects on MC distributions

- The data and MC distributions look to be offset by ∼ 20 cm but this could be a resolution effect

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Effects on $S3/S4$ proton ratios

N. blocks	$(S3/S4)_{Data}$	$(S3/S4)_{MC}$	Data/MC
0	0.0621	0.0281 ± 0.0008	2.21
1	0.1265	0.0680 ± 0.0011	1.86
2	0.1352	0.0861 ± 0.0013	1.57
3	0.0599	0.0582 ± 0.0019	1.03
4	0.1118	0.0149 ± 0.0004	7.5

- Errors on MC ratio are stats only
- Errors on data are likely of a similar magnitude. 3 block sample is the only one that is consistent between data & MC
- However, factor of ~ 2 agreement is quite good given simplicity of MC model
- 4 block: We are down at very low proton kinetic energies and susceptible to any slight changes to material in beam line

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Conclusion

- An offset was found in the vessel position relative to other beamline object within the proton MC
- Once corrected the $S4_{MC}$ proton spatial distributions look much more like the data
- Ratios of protons in $S3$ and $S4$ range from factor of 2 out to consistent (excluding 4 block)