Study of Neutron Rates at the CRV for 1 and 3 GeV Proton Beam

Mu2e-II Working Group at CSS2013

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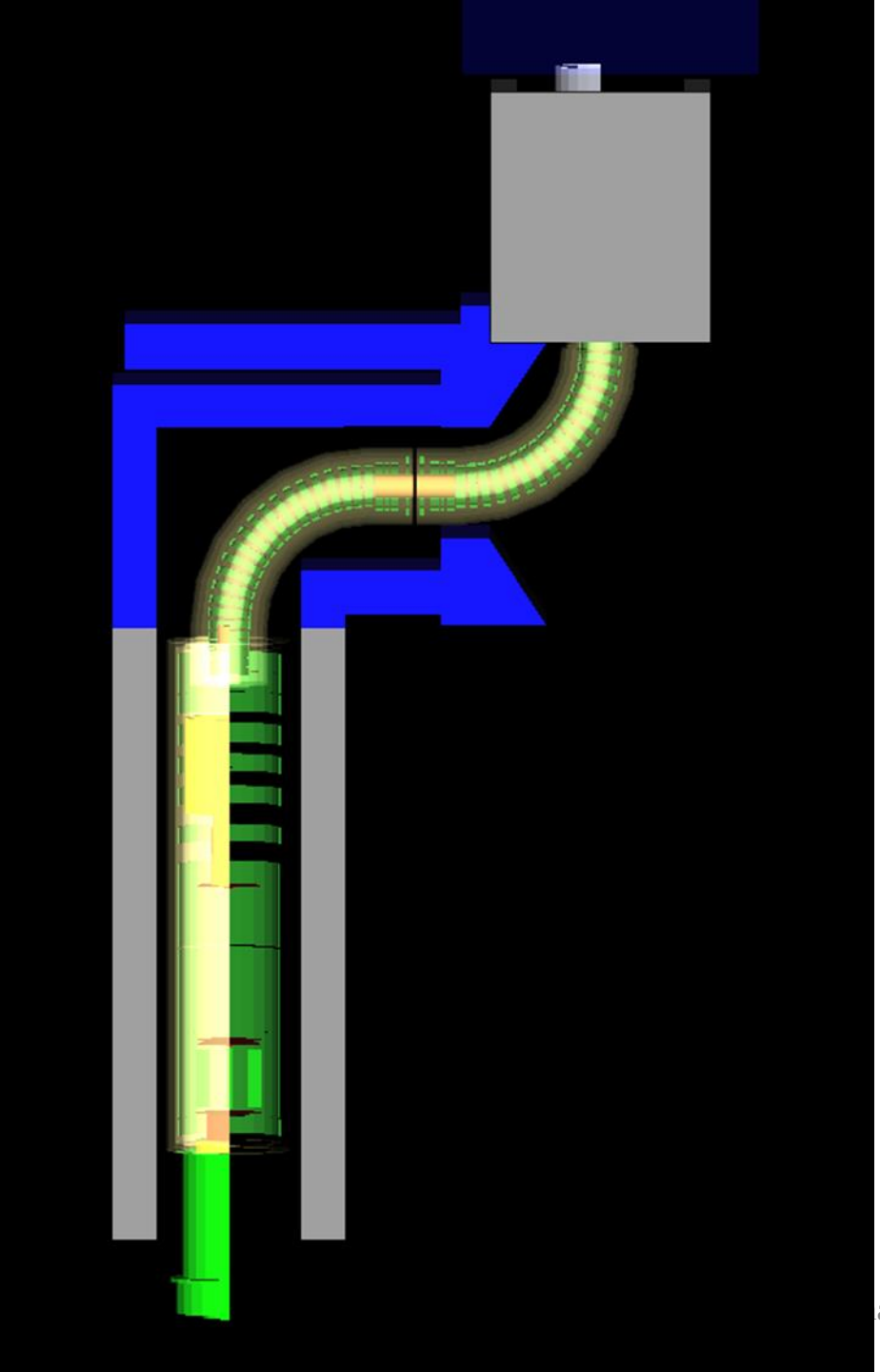
This Talk

- Uses current snapshot of shielding configuration for Mu2E "Geometry 13"
- Generate "PS_only" files for 1 and 3 GeV and compare them to 8 GeV.
  PS_only = neutrons produced at the primary target which intersect a virtual detector at the downstream end of the PS extended to the TS
- Count neutrons at various regions in the Cosmic Ray Veto system
- Compare 1, 3, 8 GeV rates normalized to number of stopping muons
- Only comment on "beam" produced sources and shielding implications.
  Beam=particles transported through TS into DS

Simulation Details

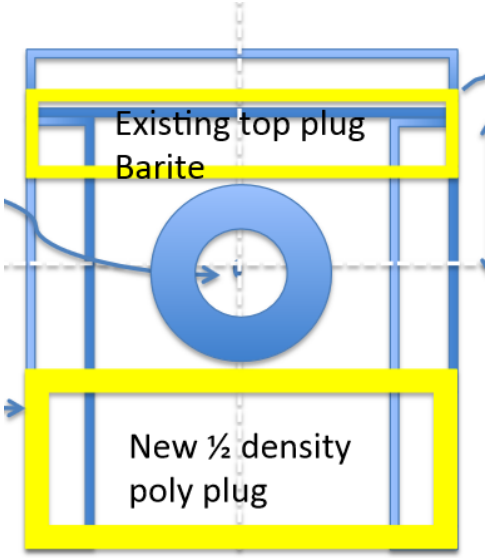
- Use g4bl V2.12, geant4 v09-05-patch-01, QGSP_BERT_HP
- Generate PS_only files of neutrons for 1M POT
- Use these 200 times (with different seeds) to transport to CRV counters → 200M POT
- Count neutrons in CRV layer 1 and layer 3 (they are not identical) and then take their average

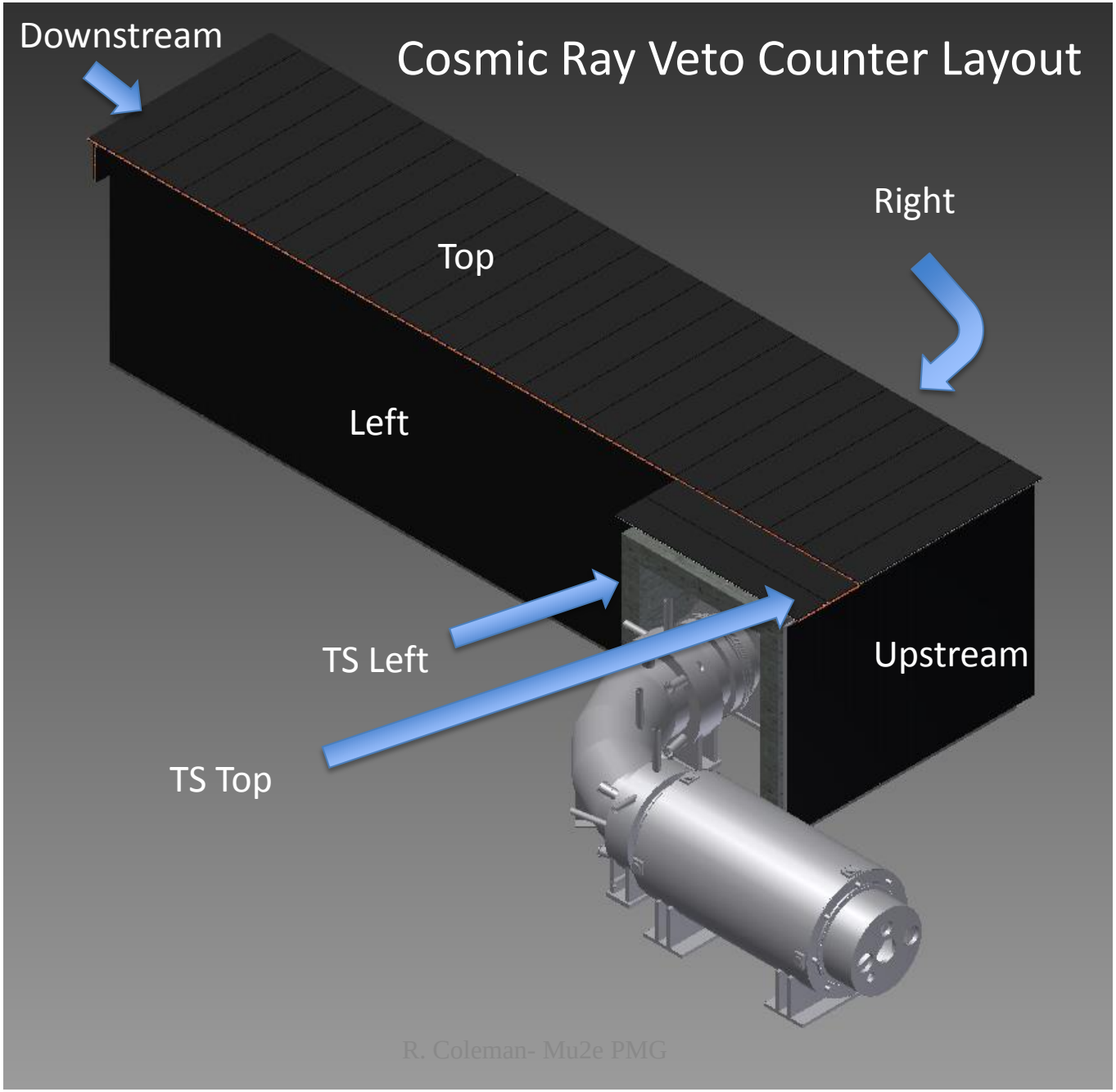


Geometry #13

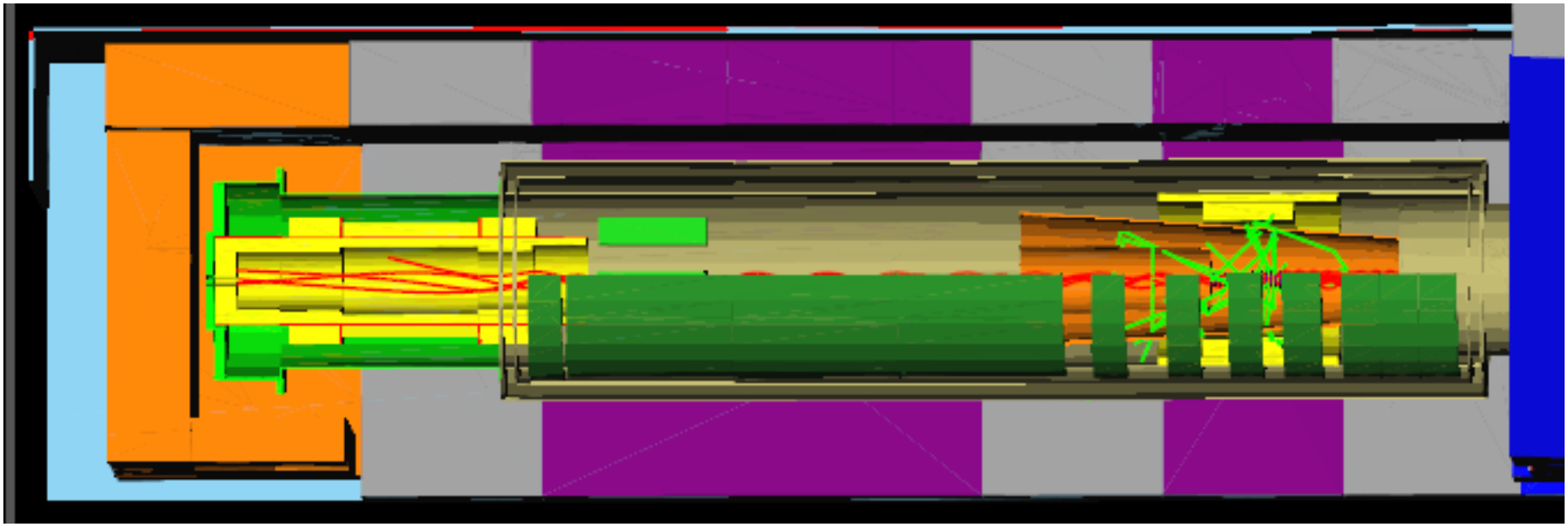
2x walls,
Barite around TS

Insert half-density poly plug at TS entrance
below beam , density= 0.465
(maybe poly beads in bags stuffed in TS stand)




Cosmic Ray Veto Counter Layout
Downstream
Top
Right
Left
TS Left
Upstream
TS Top

Geometry13: DS Region



- HDPE Inner Neutron Shield (in yellow)
- Inner and outer proton absorber (in orange)
- CRV concrete (in grey and purple) 36” thick → studies underway with barite concrete
- End cap concrete (in orange) 36” thick → studies underway with barite
- Muon Beam Stop HDPE(yellow) and stainless steel (red)
- No shielding material between DS cryostat and concrete and no additional material (Pb, B-poly) on concrete walls

July 2013 Snapshot of n CRV rates at 8 GeV

Beam Source File - 786 M incident protons

CRV Neutrons	Geometry 13	
DS-Top	3248	2379
DS-R	2912	130
DS-L	2839	1040
DS-Rear	571	0
TS-L	1329	923
TS-Top	1521	2002
TS-R or DS-Upstream	1638	4901

PS Only Source File - 60M incident protons

CRV Neutrons	Geometry 13	
		PS*13
DS-Top	183	2379
DS-R	10	130
DS-L	80	1040
DS-Rear	0	0
TS-L	71	923
TS-Top	154	2002
TS-R or DS-Upstream	377	4901

Beam Source = (mostly) charged particles transported through TS to DS → neutrons produced by interactions and mu/pi captures in TS, stopping target, and Muon Beam Stop

PS_Only Multiply by 13 to compare to Beam Source

All DS CRV counters dominated by Beam. TS both Beam and PS. Still working on shielding especially in PS/TS region

Beam vs PS_only sources at 1 and 3 GeV

- The rate of backgrounds from beam sources will ~scale with the number of stopping muons → will need either/both additional shielding in the DS region and change in CRV design (e.g. extra layer). Not addressed today
- PS-produced neutrons decrease as energy lowered from 8 to 3 or 1 GeV. But so do number of stopped muons. Look at relative CRV rate from PS_only to number of stopped muons

CRV PS_only Neutron rates – raw values

- 200M POT → # CRV neutrons (average of layer 1 and 3)
- DS-upstream = TS-right

Proton E CRV region	1 GeV # neutrons	3 GeV # neutrons	8 GeV # neutrons
DS-downstrm	0	0	2
DS-right	1	33	72
DS-top	27	154	567
DS-left	29	86	234
DS-upstrm	41	596	1634
TS-top	15	201	642
TS-right	34	104	292

CRV PS_only Neutron rates – normalized values

- 200M POT → # CRV neutrons (average of layer 1 and 3)
- All DS=DS-down+DS-R+DS-top+DS-L
- All TS=DS-upstrm+TS-top+TS-L

Proton Energy	**1 GeV**	**3 GeV**	**8 GeV**
#CRV/stopped muon :	*10^-3	*10^-3	*10^-3
All DS	1.0	1.0	1.4
All TS	1.6	3.3	4.0
#stopped muons/POT	0.00014	0.00067	0.00161

Conclusions

- Lower proton energies (1 and 3 GeV) give fewer neutrons from the production target in CRV counters
- But the reduction in neutron rate is close to the reduction in the number of stopped muons for 1 and 3 GeV protons → background rates per stopped muon are similar for different proton energies with only a slight improvement at 1 GeV
- Will need to add shielding or modify CRV design for running at 1 and 3 GeV