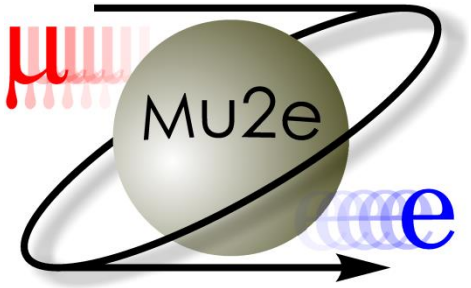
A Triangular Counter Based Cosmic Ray Veto Module

Craig Dukes

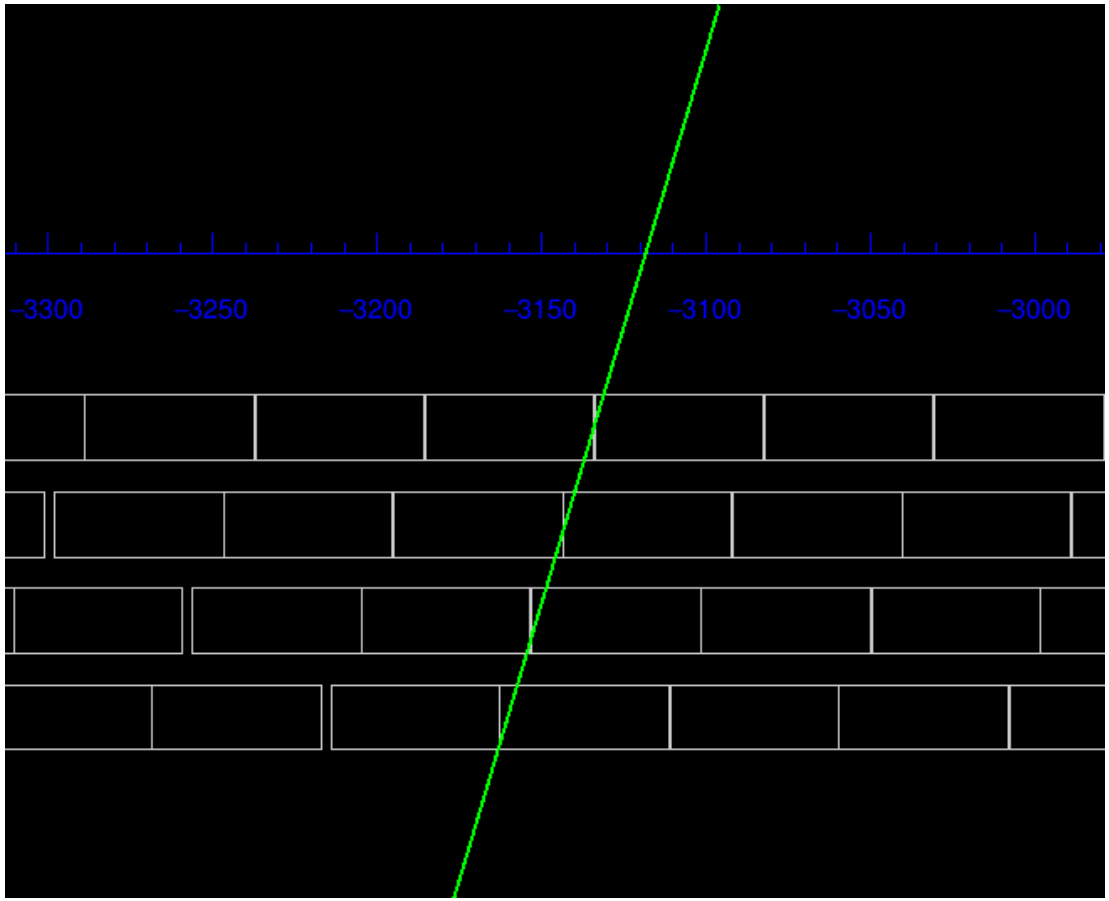
September 23, 2020



Problem with Present Design

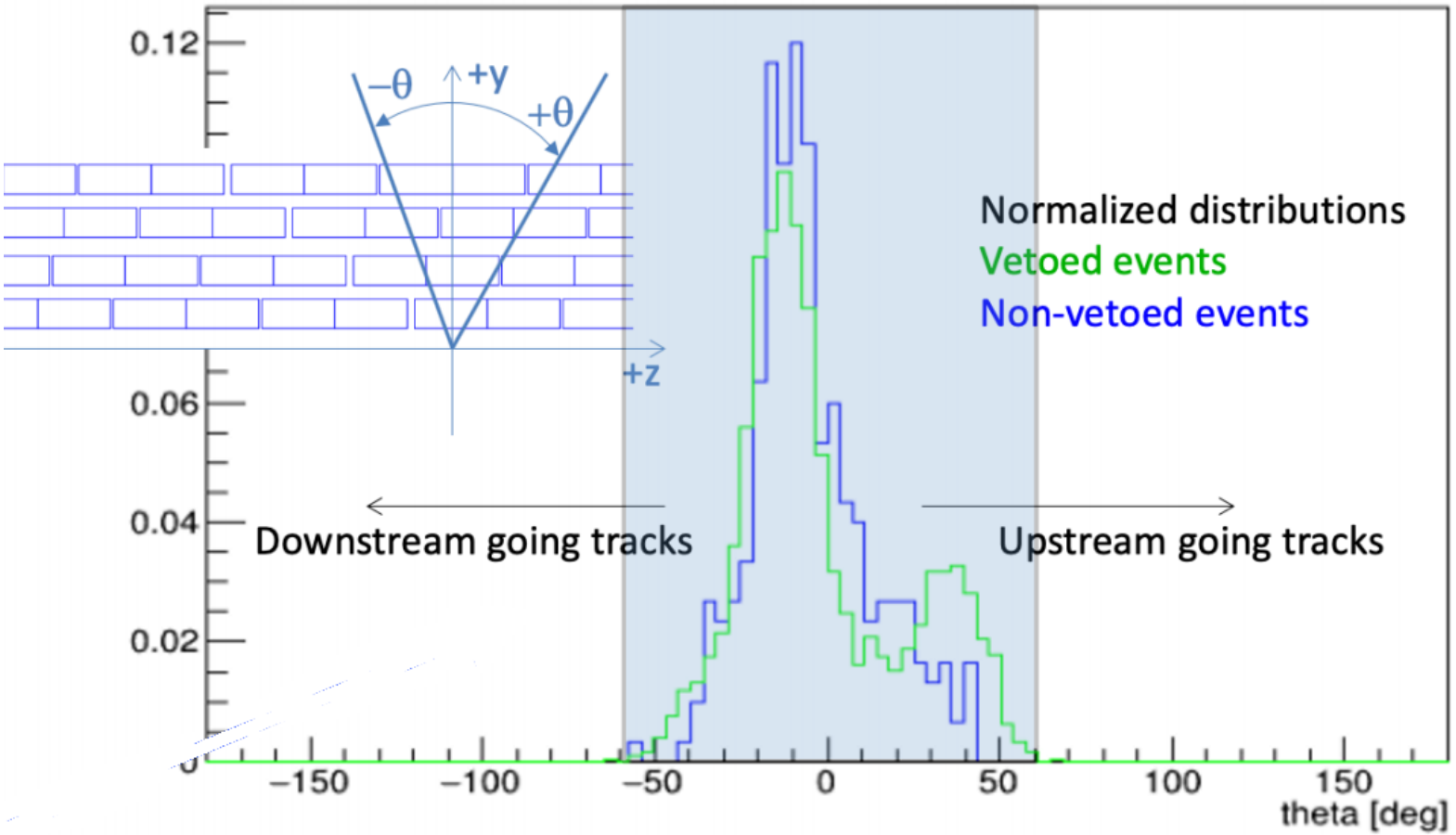
- Yuri Oksuzian and Ben Barton have recently shown that gaps between CRV counters are a major source of inefficiency, and hence backgrounds

A non-vetoed muon impacting a CRV module at the gaps between counters



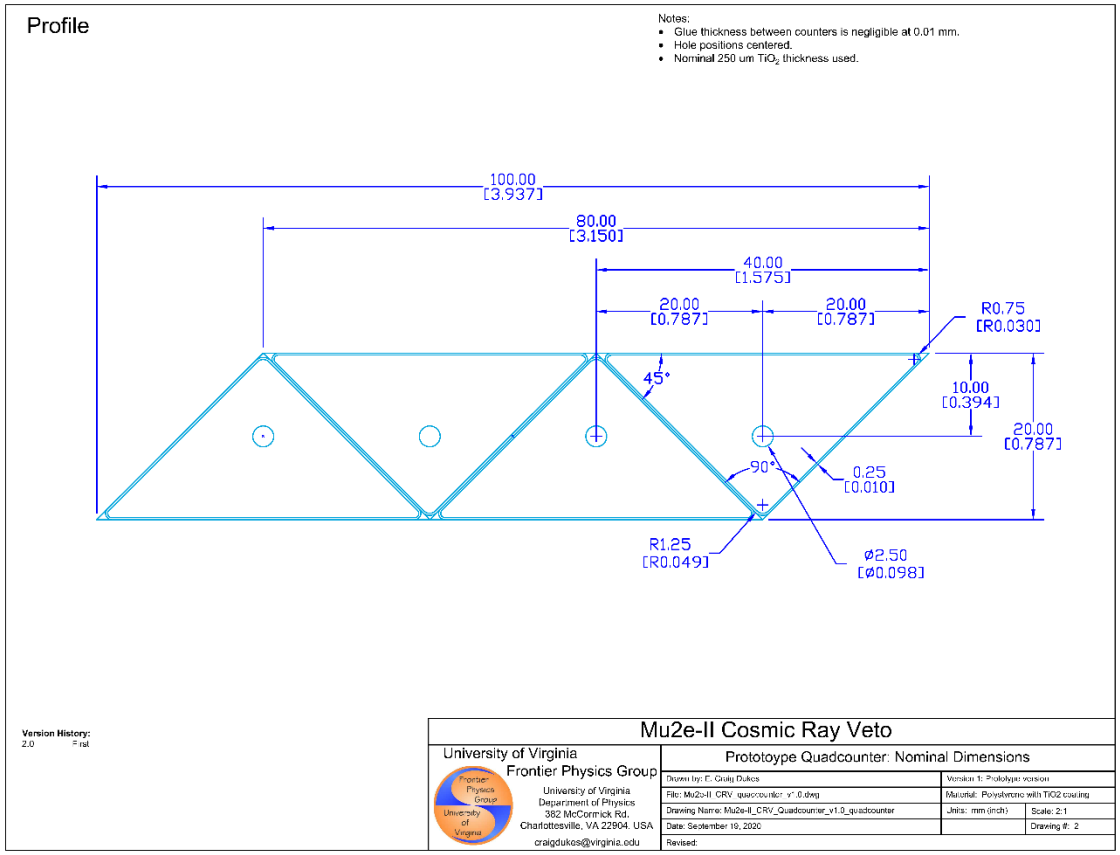
Distribution of Background Creating Muons

- Yuri Oksuzian has shown that almost all background creating muons come from +/-50 degrees from zenith
- He has suggested using triangular extrusions, a la Minerva



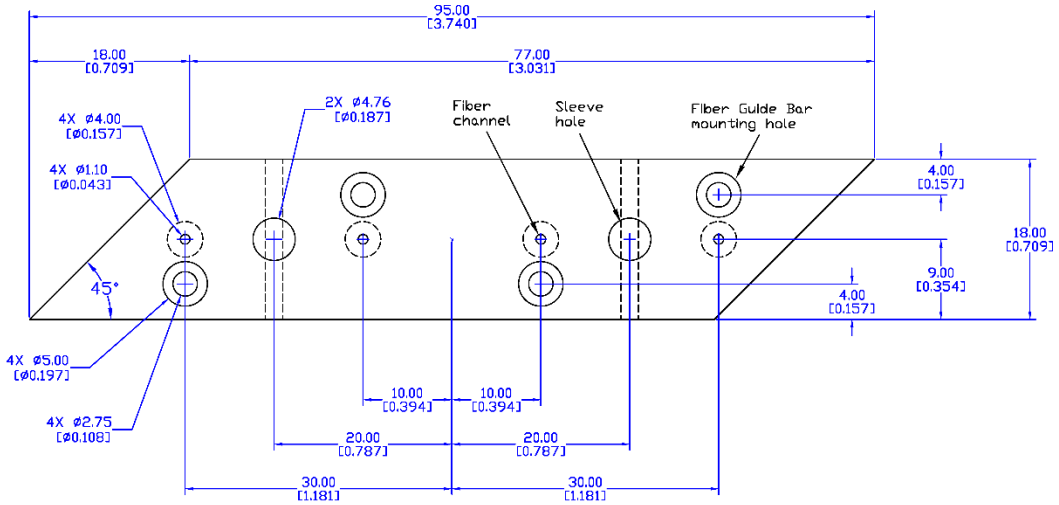
Triangular Counter Design Exercise

- Can we make modules using a much of the Mu2e design as possible?
- Use a right-triangle extrusion that Anna Pla-Dalmau will be extruding this fall using a new die paid for by EGP
- Group them into quadcounters
- This gets us to 45^{o}, not Yuri's 50^{o}, but I don't think this makes much difference

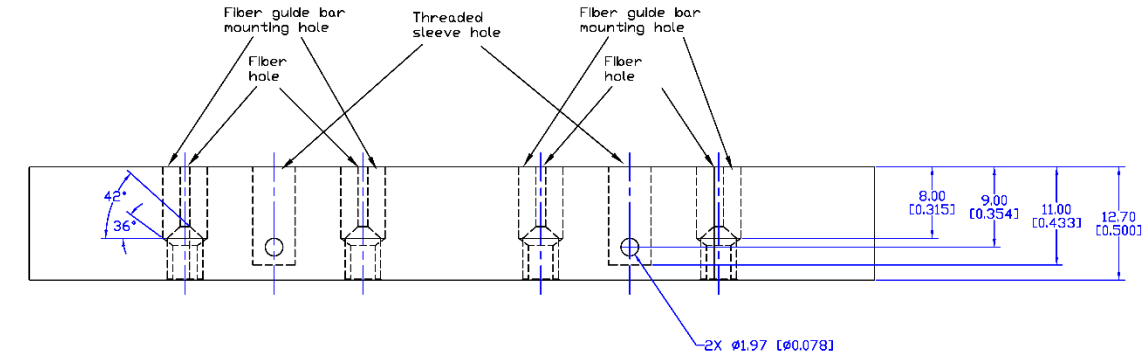


Fiber Guide Bar

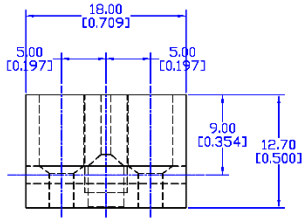
Top View (SiPM Mounting Block side)



Side View



End View



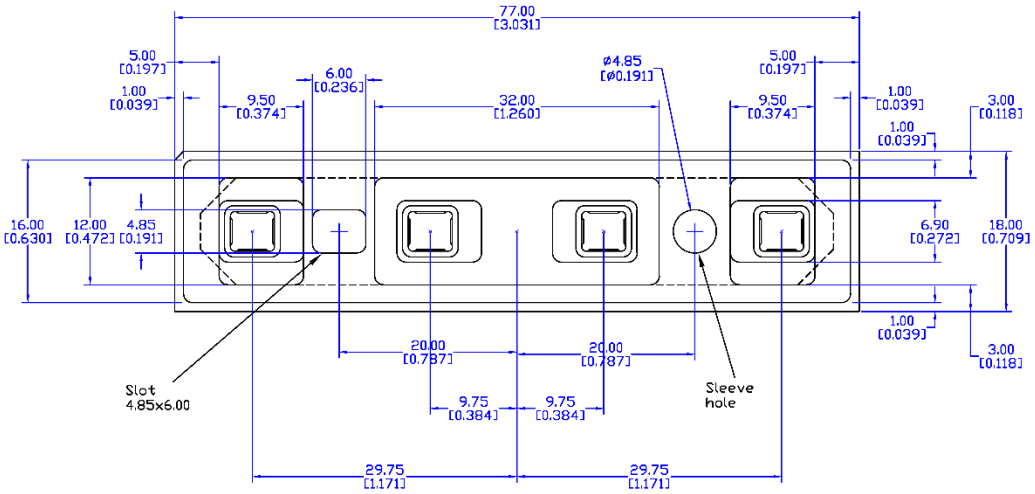
Notes:
1. Tolerances on non-starred dimensions ±0.100 mm (±0.004").
2. Tolerances on starred dimensions: ±0.025 mm (±0.001").
3. Step-down angle not sacred, but should not be less than 25°.
4. Fiber holes for 1.0 mm diameter fibers: 1.10 mm [0.043"].
5. Height of 12.7 mm is before fly cutting.
6. 4 fiber and 2 sleeve holes positioned to ±0.025 mm [0.001"].
7. Threaded sleeve holes size ±0.025 mm [0.001"].
8. Bottom flat to ±0.1 mm [0.004"].

Version History:
1.1 Rectangular counter design.
2.0 Trapezoidal design.

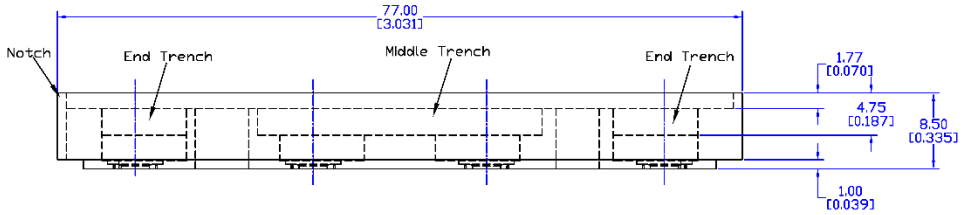
Mu2e-II Cosmic Ray Veto		
University of Virginia Frontier Physics Group University of Virginia Department of Physics 382 McCormick Rd. Charlottesville, VA 22904, USA craigdukes@virginia.edu	Quadcounter Readout Manifold: Fiber Guide Bar	
Drawn by: E. Craig Dukes	Version 1: Trapezoidal design	
File: Mu2e-II_CRV_quadcounter_v1.0.dwg	Material: Acetal	
Drawing Name: Mu2e-II_CRV_Quadcounter_v1.0_FGB	Units: mm [inch]	Scale: 2:1
Date: September 19, 2020	Number needed: 1	Drawing #: 3
Revised:		
Note:		

SiPM Mounting Block

Top View (CMB side)

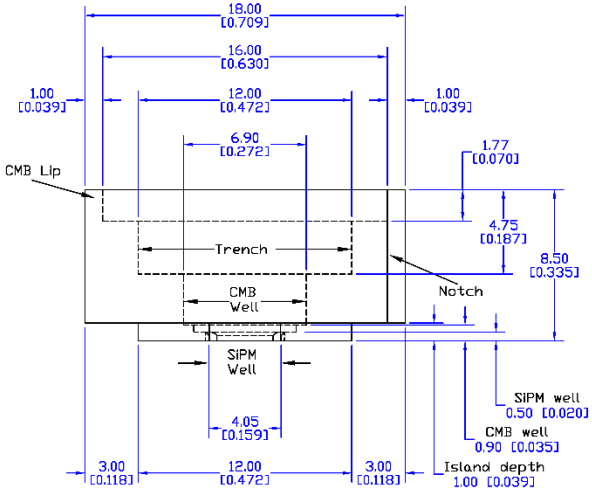


Side View



Make it rectangular to save on fabrication costs

End View



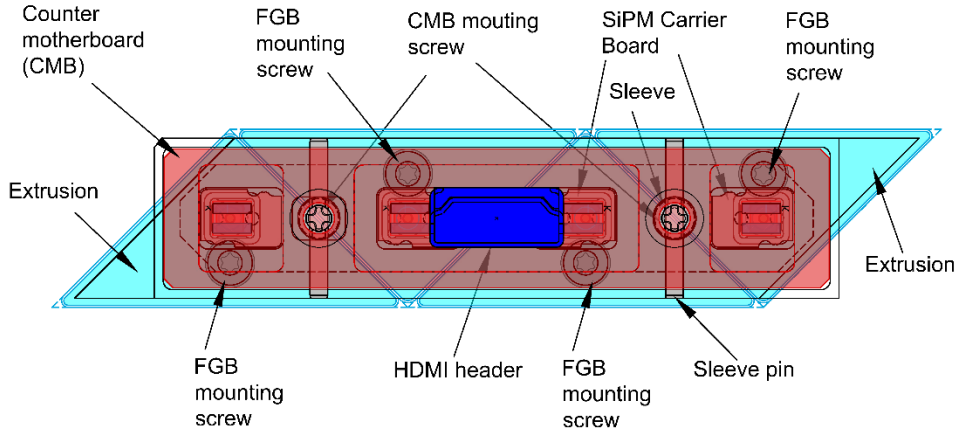
Notes:
1. Up-down symmetric about center, except notch.
2. Remove all burrs and sharp edges.
3. Surfaces in accordance with ANSI B46.1
4. Dimensions and tolerances in accordance with ASME Y14.5M
5. Tolerances on non-starred dimensions: ±0.1 mm [0.004"].
6. Tolerances on starred dimensions: ±0.025 mm [0.001"].
7. Sleeve hole sizes: ±0.025 mm [0.001"].
8. Sleeve hole positions: ±0.025 mm [0.001"].
9. SiPM registration well positions: ±0.025 mm [0.001"].
10. SiPM registration well sizes: ±0.025 mm [0.001"]
11. Bottom flat to ±0.2 mm [0.008"].
12. Opposite the notch end the dowel-pin hole is a rectangular slot 4.85 x 6.00 mm with 1.0 mm fillets.

Version History:
1.0 Rectangular counter design.
2.0 Trapezoidal design.

Mu2e-II Cosmic Ray Veto		
University of Virginia Frontier Physics Group University of Virginia Department of Physics 382 McCormick Rd. Charlottesville, VA 22904, USA craigdukes@virginia.edu	Quadcounter Readout Manifold: SiPM Mounting Block Top	
Drawn by: E. Craig Dukes	Version 1: Trapezoidal Design	
File: Mu2e-II_CRV_quadcounter_v1.0.dwg	Material: Black anodized Al 6061-T6	
Drawing Name: Mu2e-II_CRV_Quadcounter_v1.0_SMB-top	Units: mm [inch]	Scale: 1.2:1; 4:1
Date: September 19, 2020	Number needed: 1	Drawing #: 6
Revised:		
Note:		

Assembled Quadcounter Manifold

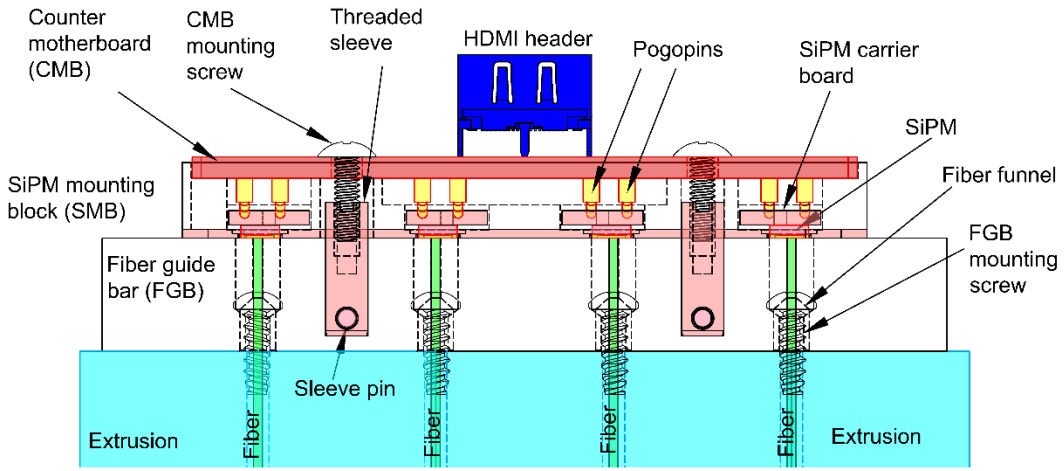
Top View



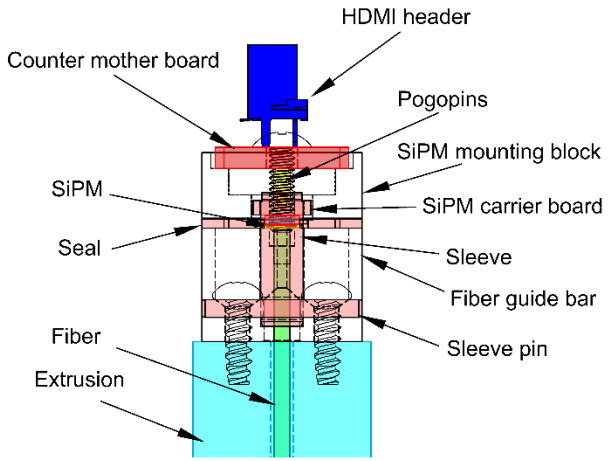
Bill of Materials:

	Item	No.	Manufacturer	Serial No.
1.	Fiber Guide Bar (FGB)	1	Krammes	Internal design
2.	SiPM Mounting Block (SMB)	1	Krammes	Internal design
3.	Seal (40 durometer Poron; $\frac{1}{16}$" - 1.5875 mm)	2	Metro Gasket	Custom design
4.	Sleeve	2	Krammes	Internal design
5.	Pin (M2x16 stainless)	2	McMaster-Carr	91585A231
6.	SiPM Carrier Board (SCB)	4	Hamamatsu	
7.	Extrusions	2	Fermilab NICADD	
8.	Counter Motherboard (CMB)	1	Fermilab electronics	
9.	FGB mounting screws (Torx #4 self-tapping, 3/8" long)	4	McMaster-Carr	99512A216
10.	CMB mounting screws (Phillips 4-40, 3/8" long)	2	McMaster-Carr	91770A108
11.	Gasket [$\frac{1}{4}$" (6.35 mm) wide; $\frac{1}{8}$" (3.175 mm) thick]	1	Metro Gasket	Poron 4701-50-20062

Side View



End View



Version History:
1.0 Rectangular design
2.0 Trapezoidal design

Notes:
1. Symmetric fiber guide bar.
2. CMB can be rotated to reverse orientation of HDMI header.
3. Header carrier board not shown.
4. Seal shown compressed.
5. Distance between CMB bottom and SCB top: 3.63 mm [0.147"]. Range should be: 3.1 to 4.5 mm.
6. SiPM: Hamamatsu S13360-2050-VE.
7. Seal glued to SiPM mounting block bottom.
8. HDMI header position approximate.

Mu2e-II Cosmic Ray Veto

Quadcounter Readout Manifold: Assembly

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Drawn by: E. Craig Dukes	Version 1: Trapezoidal design	
File: Mu2e-II_CRV_quadcounter_v1.0.dwg		
Name: Mu2e-II_CRV_Quadcounter_v1.0_Readout_Manifold_Assembly	Units: mm [inch]	Scale: 2:1
Date: September 20, 2020		Drawing #: 1
Revised:		
Note:		

Comments

- Counters are narrower than the Mu2e counters and hence will suffer lower rates by a factor of a bit more than two
- Better transverse position resolution will reduce the false coincidence rate, and hence deadtime
- A quadcounter can be fabricated quite easily using triangular extrusions of the same depth of the Mu2e CRV extrusions: we intend to do so at UVA at the end of the year
- A new Counter Motherboard is needed: a redesign is simple and cost if modest
- A module design is forthcoming; it will look similar to the Mu2e CRV modules
- Offsets would be most likely not be needed: however, simulations should be done
- Mating this design to the existing Mu2e CRV modules will be difficult to do without creating gaps: either you replace an entire sector, or find a region where a gap is not a problem
- With one fiber per counter redundancy has been lost: electronics must be reliable
- To increase the light yield potting fibers should be explored