What can we learn from a snapshot of SHMS Rates?

(while it was serving as the hadron arm in C(e,e'p) at 3-pass)

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2/1/18

v2 Feb 1 corrections in red, in body and below.

I just quickly checked the 5-pass xscaler hodo rates. No big change from 3-pass. The S1X rate is similar, near 1 MHz. The other hodo rates are 10%-20% higher, so the z-dependent fall off of the hodo rates is not as steep. DD said the S/B is expected to be lower at 5-pass, so HODO 3 out of 4 could be dirtier.

v3 Feb 2 looked at single paddle rates and realized that "S1X" is probably the OR rather than the AND

Motivation and Overview

In hadron detection, where we often use a 3 out of 4 hodoscope trigger, the triggers can be significantly contaminated with accidental coincidences from soft backgrounds.

This is not an insurmountable problem since we have a large number of offline cuts available. But it does makes it harder to find quickly find small signals and to measure the tracking efficiency, especially in the single-arm detection of hadrons.

The SHMS is brand-new, and its bend angle is small, so it's important to see if there are unexpected problems.

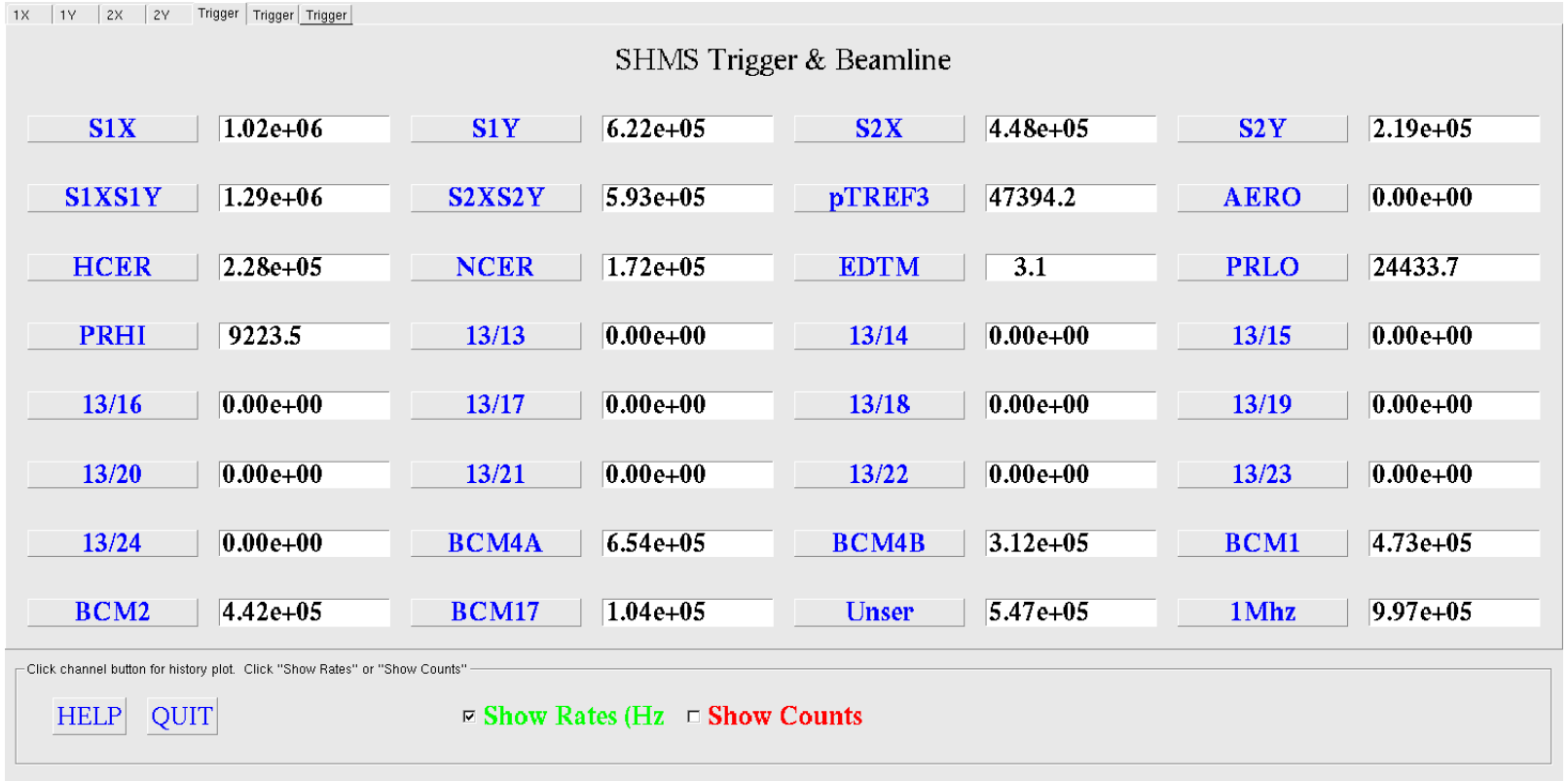
The xscalers information on the following slides is from the 3-pass, SHMS setting for the CT experiment. These data should be a low S/B challenge for the SHMS:

- the relatively high Q2 ensures a small QF e+p signal, and

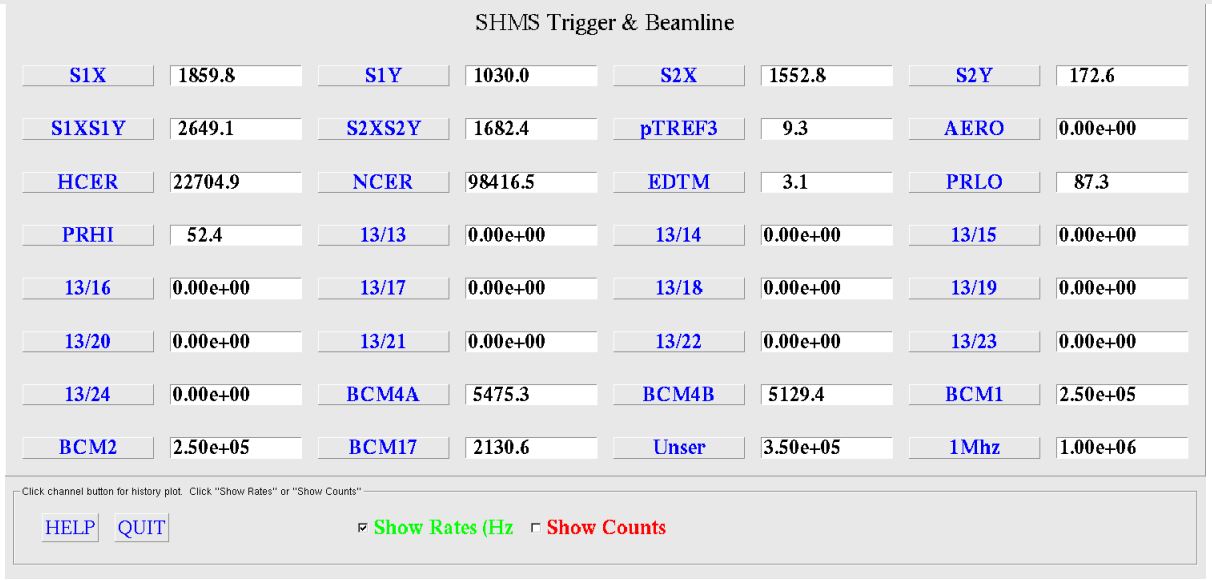
- the combination of thick carbon target, downstream beamline, and a beam current of 50 muA should provide large soft photon and neutron backgrounds.

https://logbooks.jlab.org/entry/3522729

Beam on



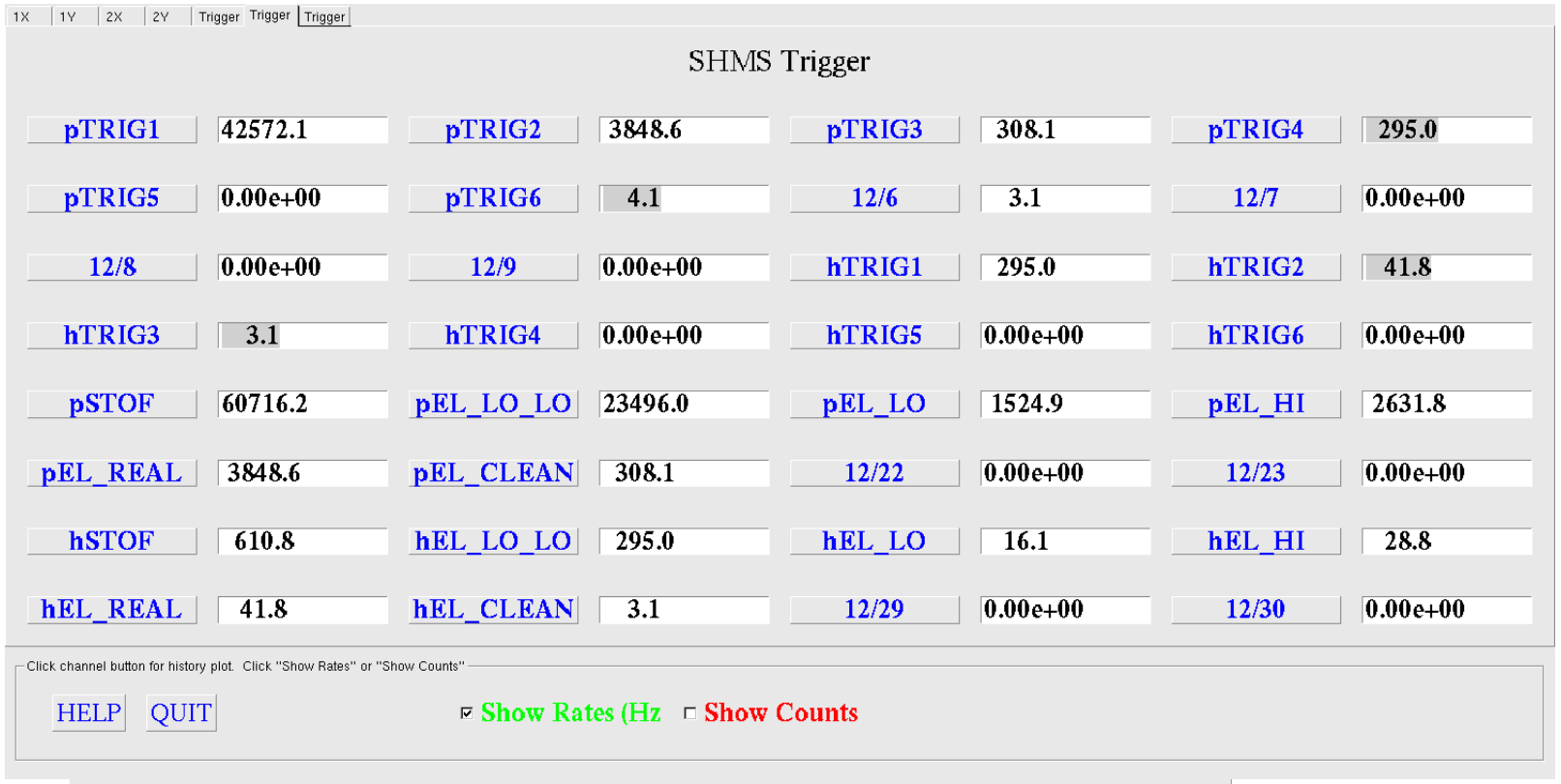
Beam off

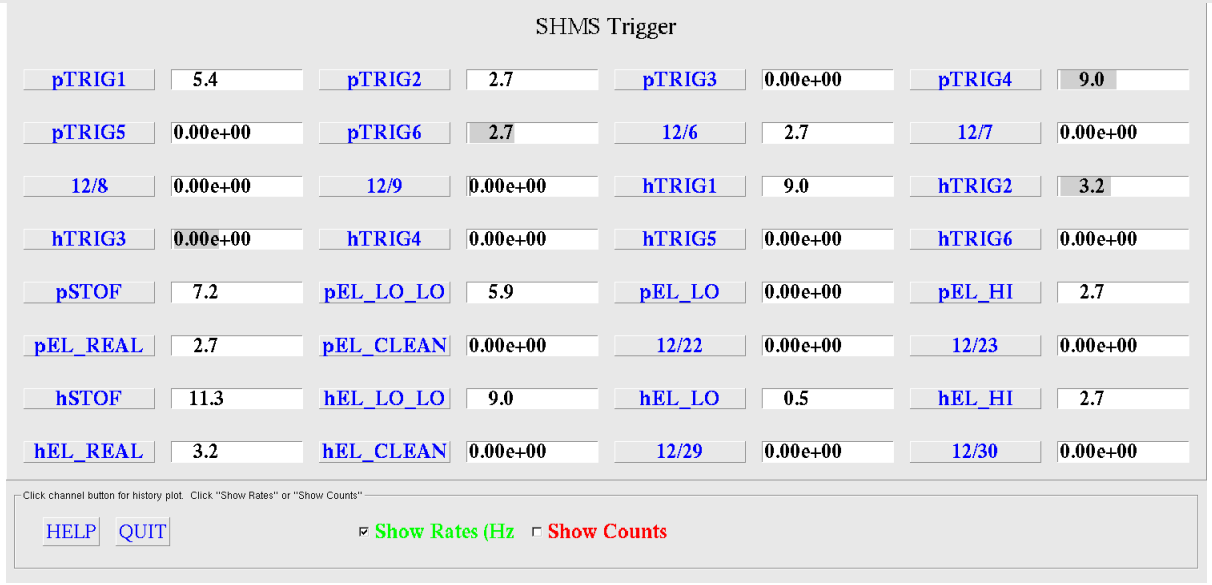


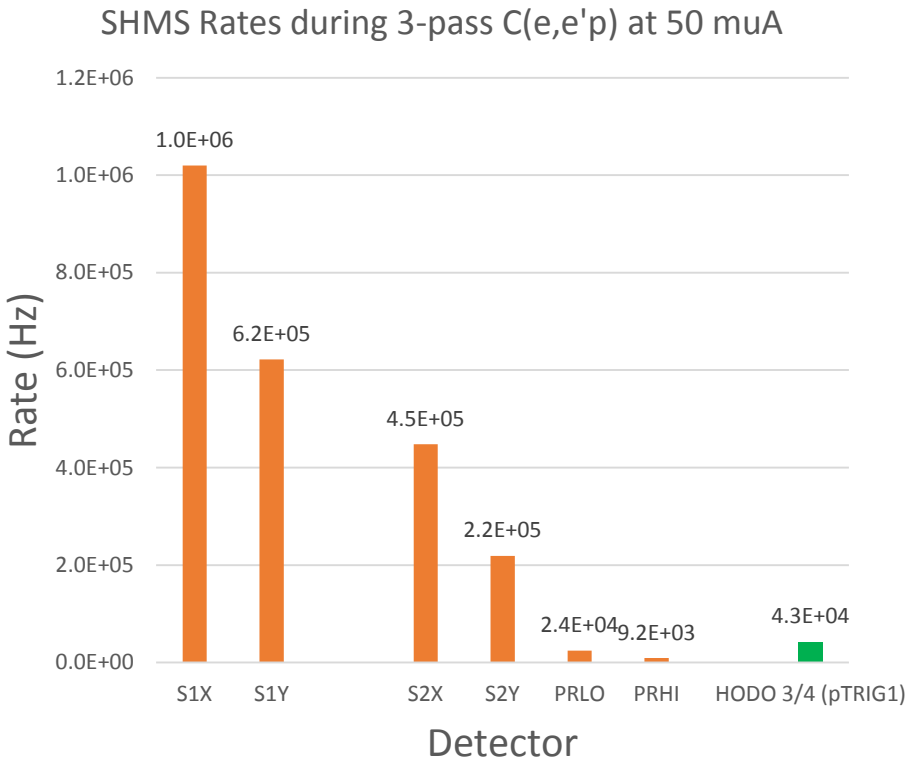
I think I can safely ignore these beam off scaler rates. But I noticed:

- S2Y is nice and quiet.
- NCER rate is quite high with beam off.
- HCER looks quieter . (It was noted in the meeting that both Cerenkovs have 4 pmt's, so the rates are apples to apples.)

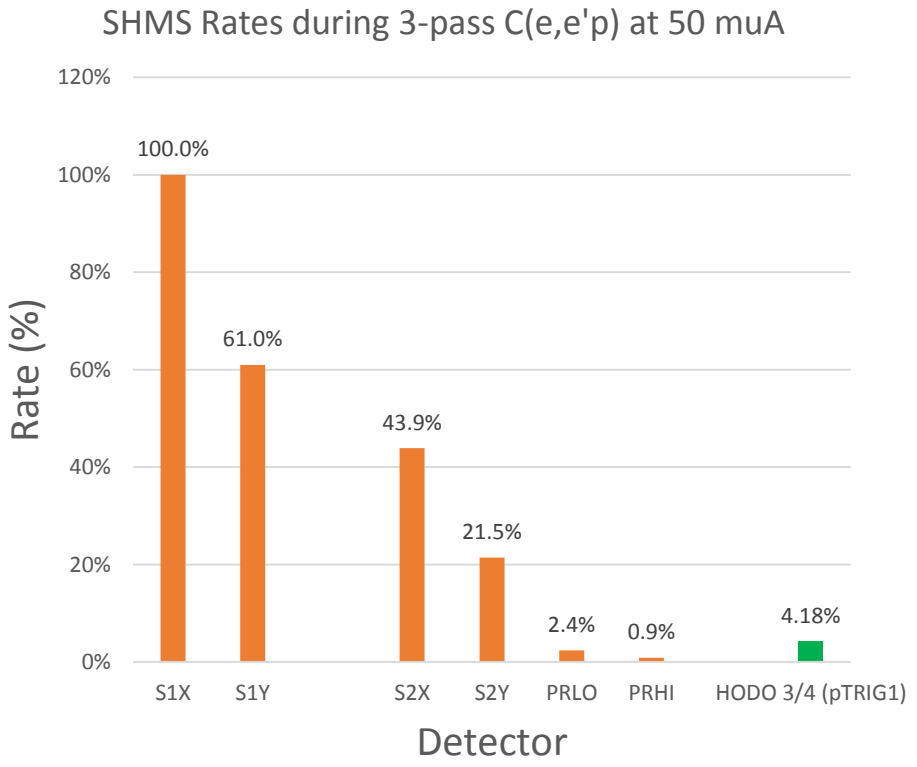
I don't know if this is their usual dark rates, or activation due to the carbon target.


1X 1Y 2X 2Y Trigger Trigger Trigger
SHMS Trigger
pTRIG1 42572.1 pTRIG2 3848.6 pTRIG3 308.1 pTRIG4 295.0
pTRIG5 0.00e+00 pTRIG6 4.1 12/6 3.1 12/7 0.00e+00
12/8 0.00e+00 12/9 0.00e+00 hTRIG1 295.0 hTRIG2 41.8
hTRIG3 3.1 hTRIG4 0.00e+00 hTRIG5 0.00e+00 hTRIG6 0.00e+00
pSTOF 60716.2 pEL_LO_LO 23496.0 pEL_LO 1524.9 pEL_HI 2631.8
pEL_REAL 3848.6 pEL_CLEAN 308.1 12/22 0.00e+00 12/23 0.00e+00
hSTOF 610.8 hEL_LO_LO 295.0 hEL_LO 16.1 hEL_HI 28.8
hEL_REAL 41.8 hEL_CLEAN 3.1 12/29 0.00e+00 12/30 0.00e+00
Click channel button for history plot. Click "Show Rates" or "Show Counts"
HELP QUIT
Show Rates (Hz
Show Counts


SHMS Trigger
pTRIG1 5.4 pTRIG2 2.7 pTRIG3 0.00e+00 pTRIG4 9.0
pTRIG5 0.00e+00 pTRIG6 2.7 12/6 2.7 12/7 0.00e+00
12/8 0.00e+00 12/9 0.00e+00 hTRIG1 9.0 hTRIG2 3.2
hTRIG3 0.00e+00 hTRIG4 0.00e+00 hTRIG5 0.00e+00 hTRIG6 0.00e+00
pSTOF 7.2 pEL_LO_LO 5.9 pEL_LO 0.00e+00 pEL_HI 2.7
pEL_REAL 2.7 pEL_CLEAN 0.00e+00 12/22 0.00e+00 12/23 0.00e+00
hSTOF 11.3 hEL_LO_LO 9.0 hEL_LO 0.5 hEL_HI 2.7
hEL_REAL 3.2 hEL_CLEAN 0.00e+00 12/29 0.00e+00 12/30 0.00e+00
Click channel button for history plot. Click "Show Rates" or "Show Counts"
HELP QUIT
Show Rates (Hz
Show Counts



Same plot as on left, but expressed as percentages of S1X rate:



Takeaway:

- The S1X rate was ~ 1 MHz .
- Most of the hodoscope paddle rate is background (ie, it is 0.5 to 1.5 orders of magnitude larger than the HODO 3 out of 4 rate).
- The hodo background drops as one gets away from the dipole exit.
- The above is not completely unexpected, but the steep increase toward S1X is a surprise. It raises questions about S1X pmt lifetime and whether we'll be making significant corrections for electronic deadtime.

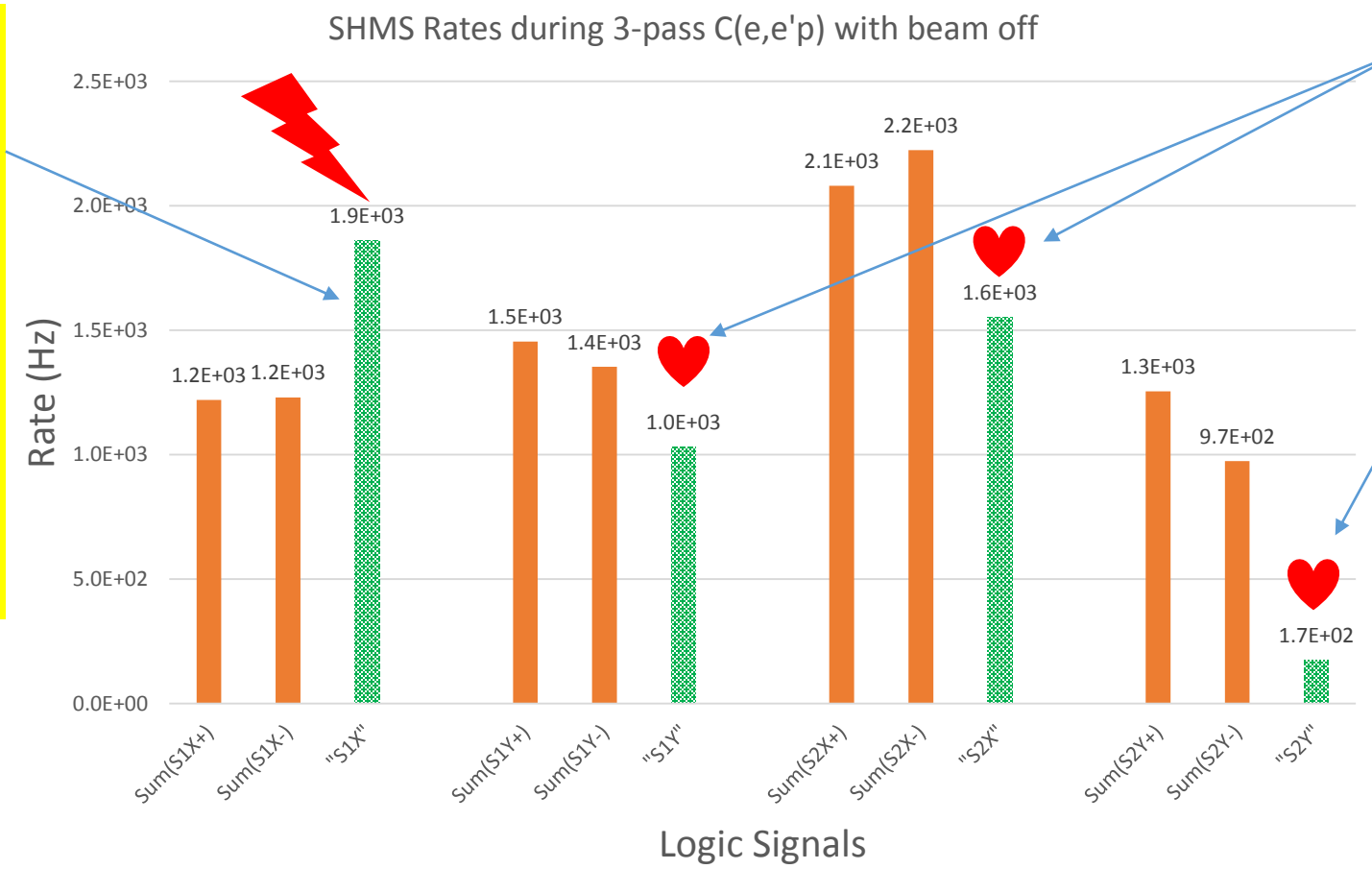
Check on Paddle Hit Definition **Sum(+) .AND. SUM(-)**
(beam off to ensure stable results)

It's not possible for Sum(S1X+).AND.Sum(S1X-) to be larger than either input.

This xscaler signal may be Sum(S1X+).OR.Sum(S1X-).

I don't know if this propagates into the hodo triggers (it shouldn't hurt the data), or if it is an isolated wiring issue.

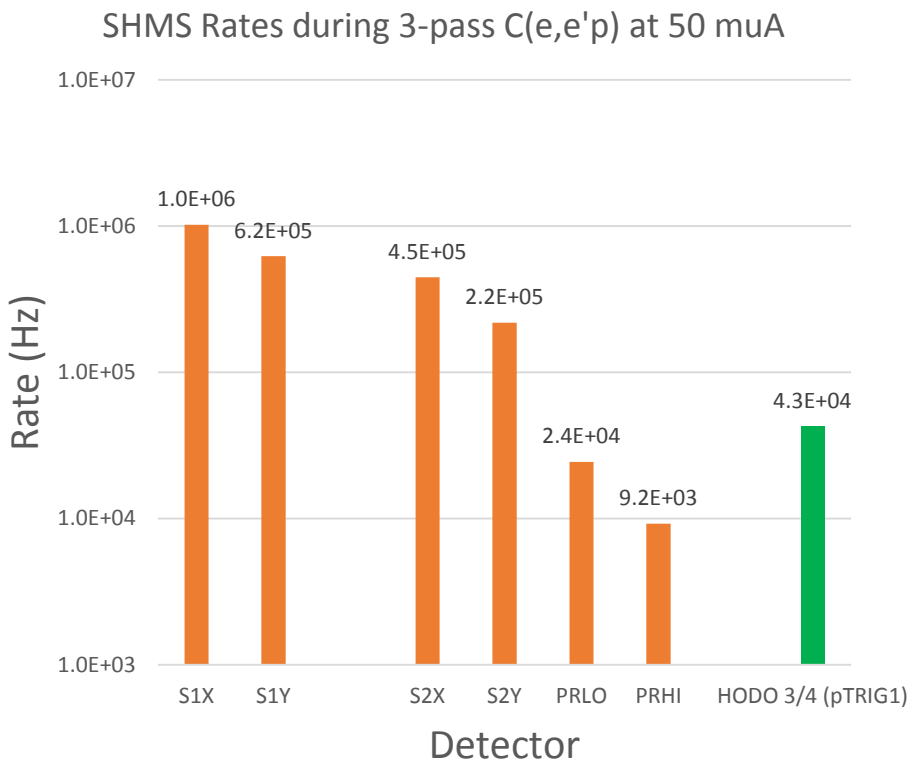
I think this S1X issue is why I couldn't make sense of Mark Jone's KPP scaler results at https://logbooks.jlab.org/entry/3470325



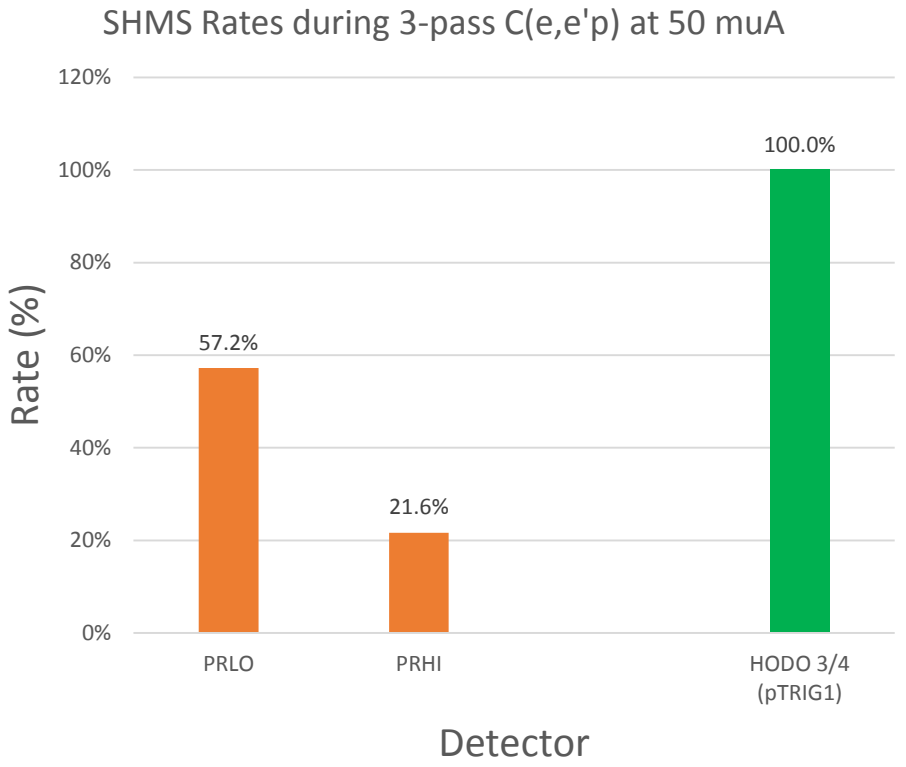
The bkg rate in the scints typically fires both pmts.

The quartz tube rates are not low, just their coincidence. The rate is probably dominated by uncorrelated spe hits.

Same plot on a log scale to emphasize the lower and cleaner rates.



The lower and cleaner rates, normalized to the HODO 3 out of 4 rate.



Takeaway:

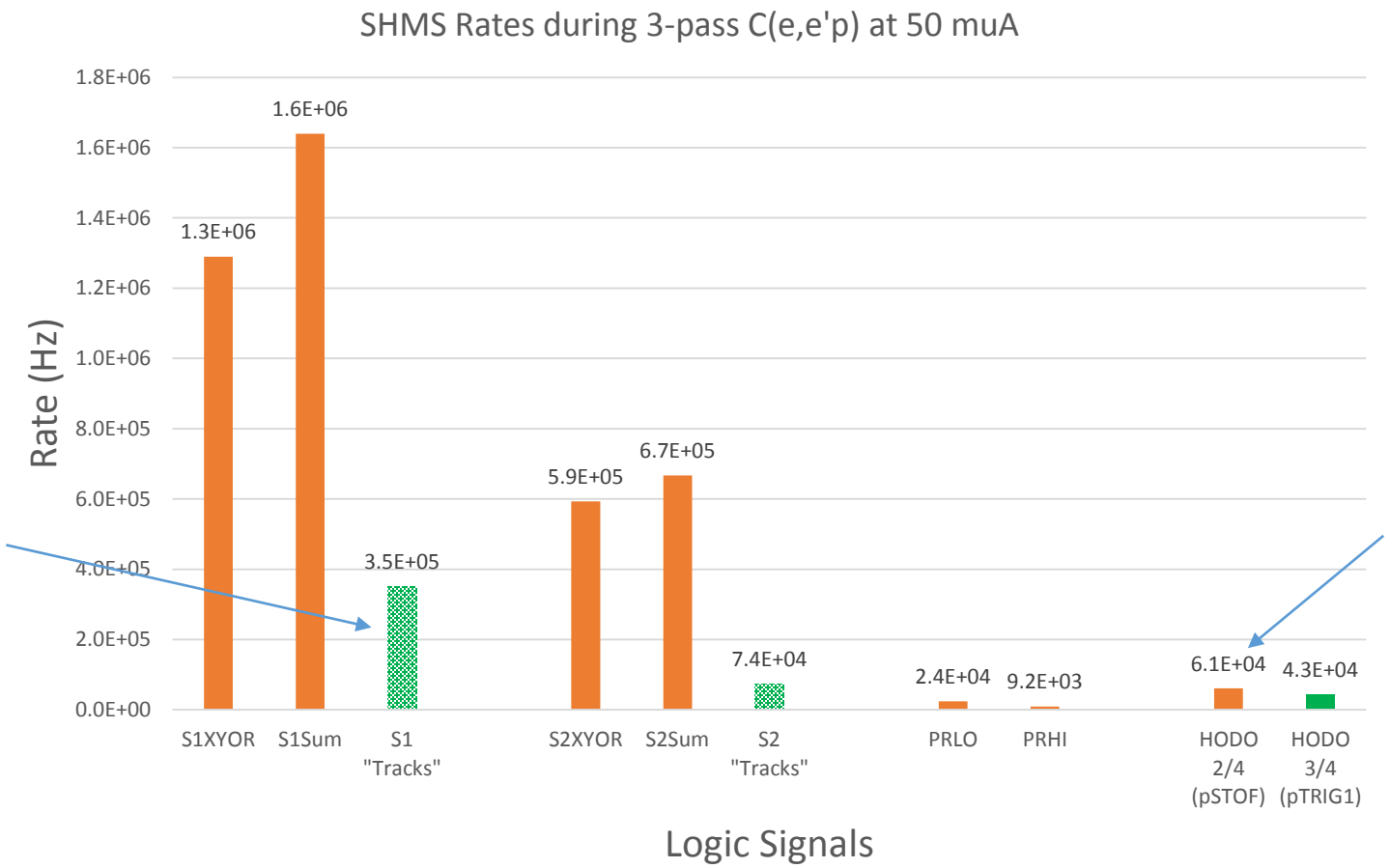
- The HODO 3 out of 4 rate is not far from the sum of PRLO and PRHI. (Remember, these tracks are mostly pi+ and protons, and there may still be some accidentals in the hodo trigger.)

An optimistic interpretation of the above is:

- The HODO 3 out of 4 is a not-too-dirty estimate of the rate of tracks in the acceptance, and
- low threshold calorimeter information is efficient enough to use in a robust, single-arm wire chamber efficiency for hadrons.

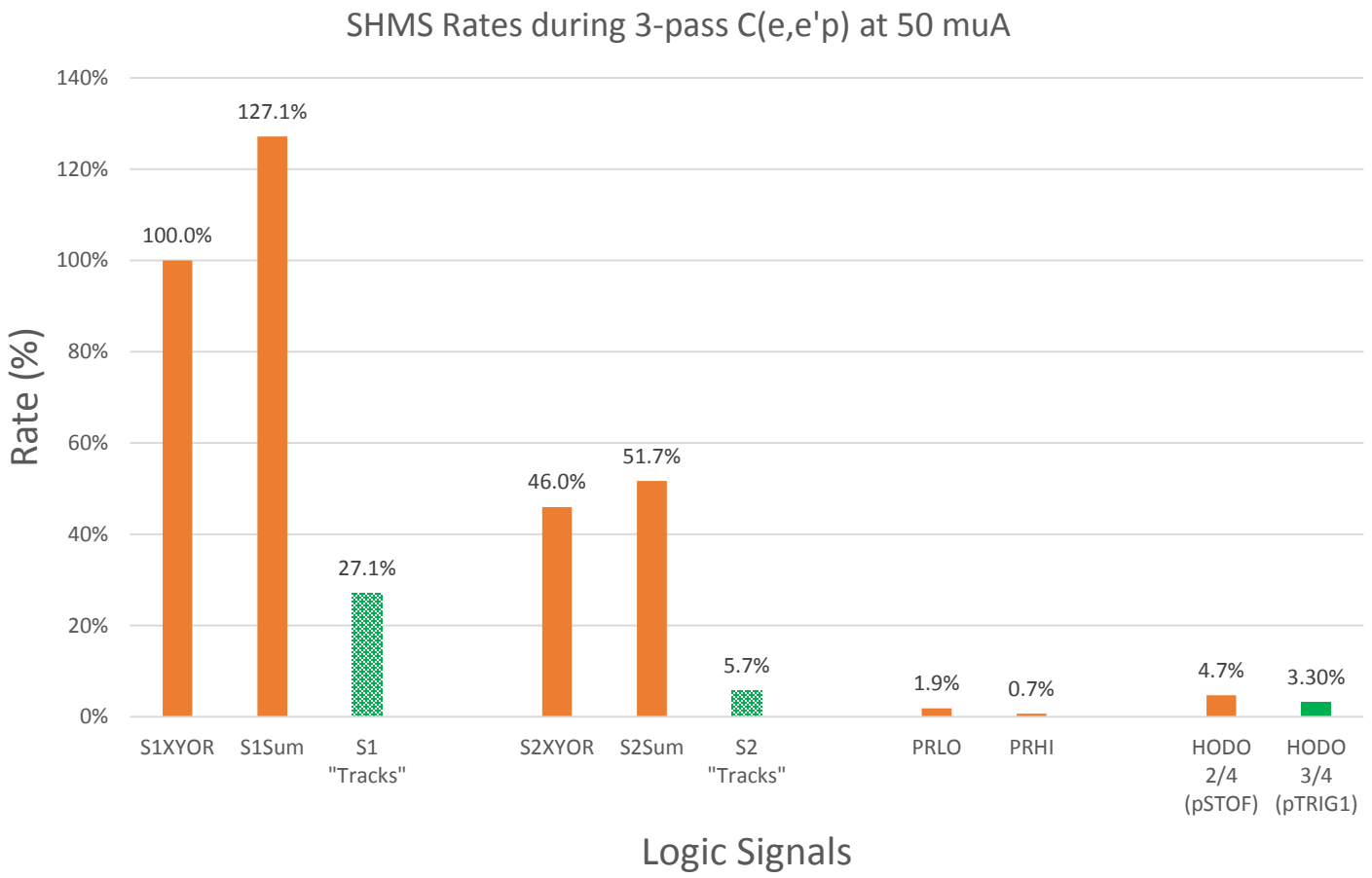
Now emphasizing more of the logical signals:

I infer a local track rate from (S1X+S1Y) – (S1X.or.S1Y), etc.

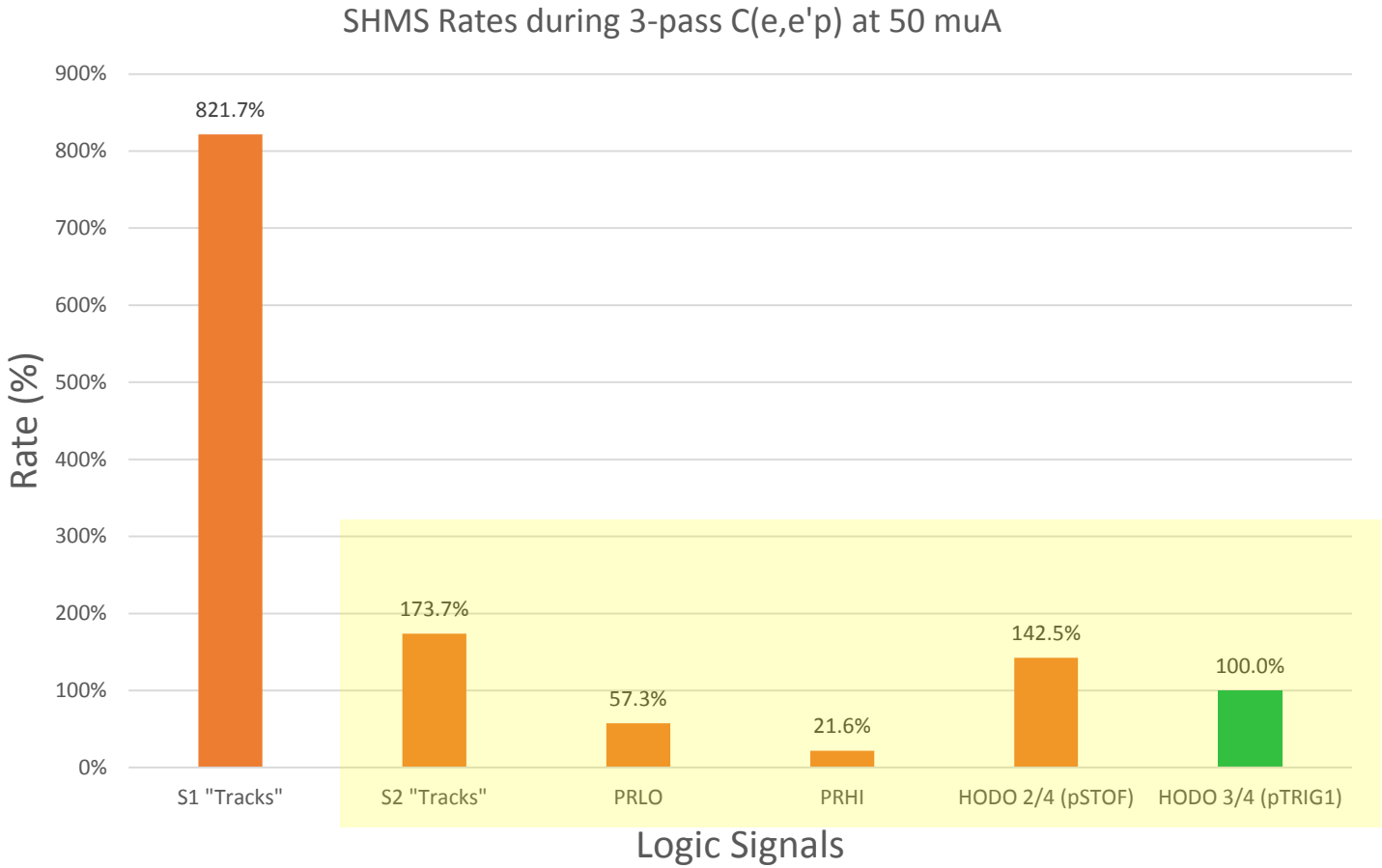


I added HODO 2 out of 4.

Same plot as on previous page, but normalized to S1X.or.S1Y rate.

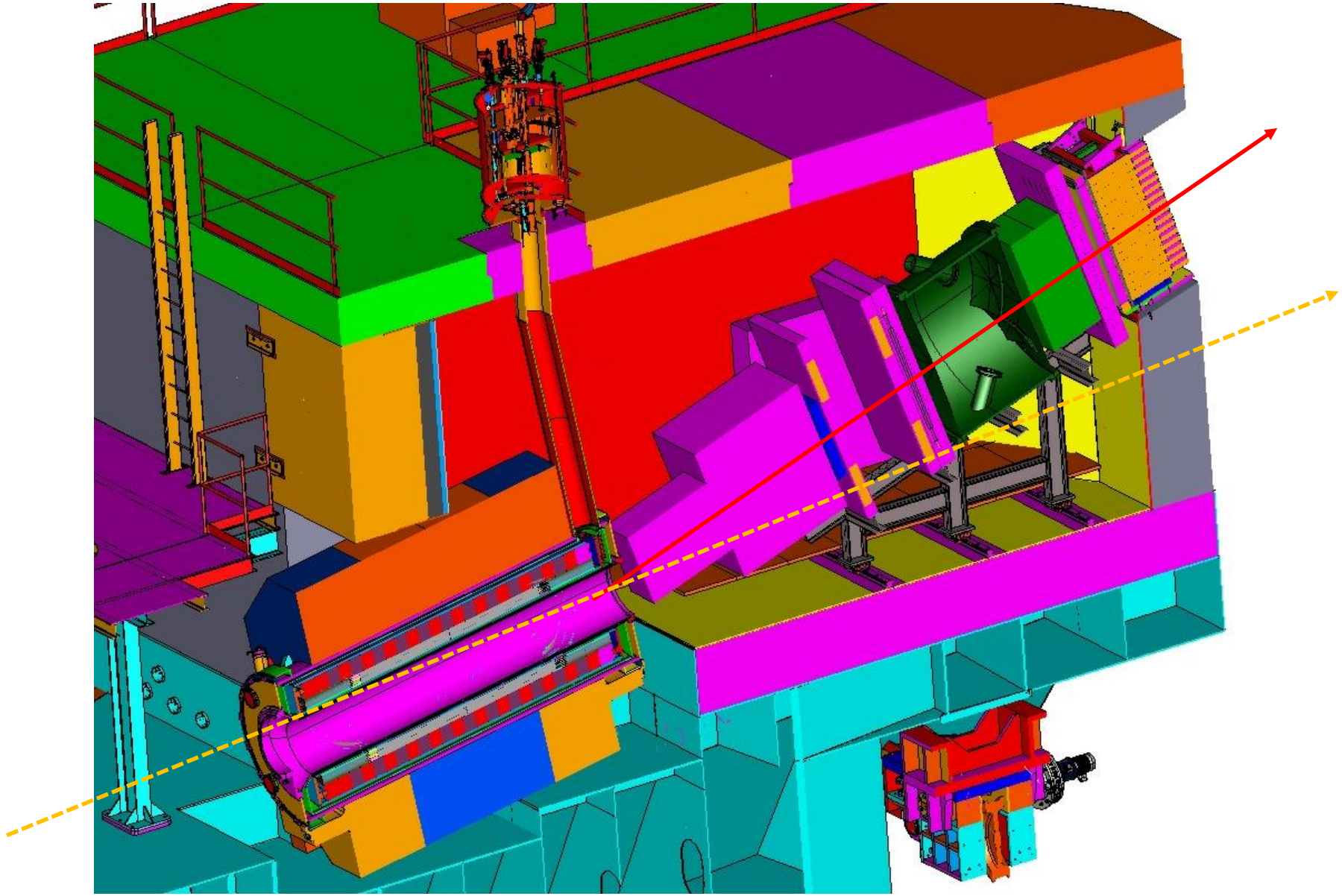


Emphasizing the rates naively with the potential to be associated with a good track:



Takeaway:

- Most of the inferred track rate in S1 doesn't make it to S2. Either the bkg tracks in the S1 region are too soft, or too large an angle.
  (I think the fact that "S1X" is an OR rather than an AND doesn't change this conclusion. But it complicates things.)
- By contrast, the majority of the inferred track rate at S2 does show up in the HODO triggers. They are mostly in the acceptance, and clearly hard enough to fire at least one S1 counter.
- The HODO 2 out of 4 looks promising: its rate is only ~40% larger than the 3 out of 4.
- Without additional cuts on HODO 3 out of 4, I would conservatively assume it has O(10)% accidentals.



Summary

Hodo rates were O(1) MHz near the SHMS dipole exit. The background appears to be a soft and/or highly angled.

The high rate in S1X appears to be due to its being an OR rather than the intended AND.
The correct S1X rate may be 20%-30% lower.

Only roughly 5% of the rate in S1 is due to tracks in the acceptance. This is actually not so unusual. What is surprising is how the background grows exponentially as one draws near the dipole exit.

It won't look so steep with the correct S1X rate.

We need to think about whether we're OK wrt electronic deadtime and PMT lifetime in S1.

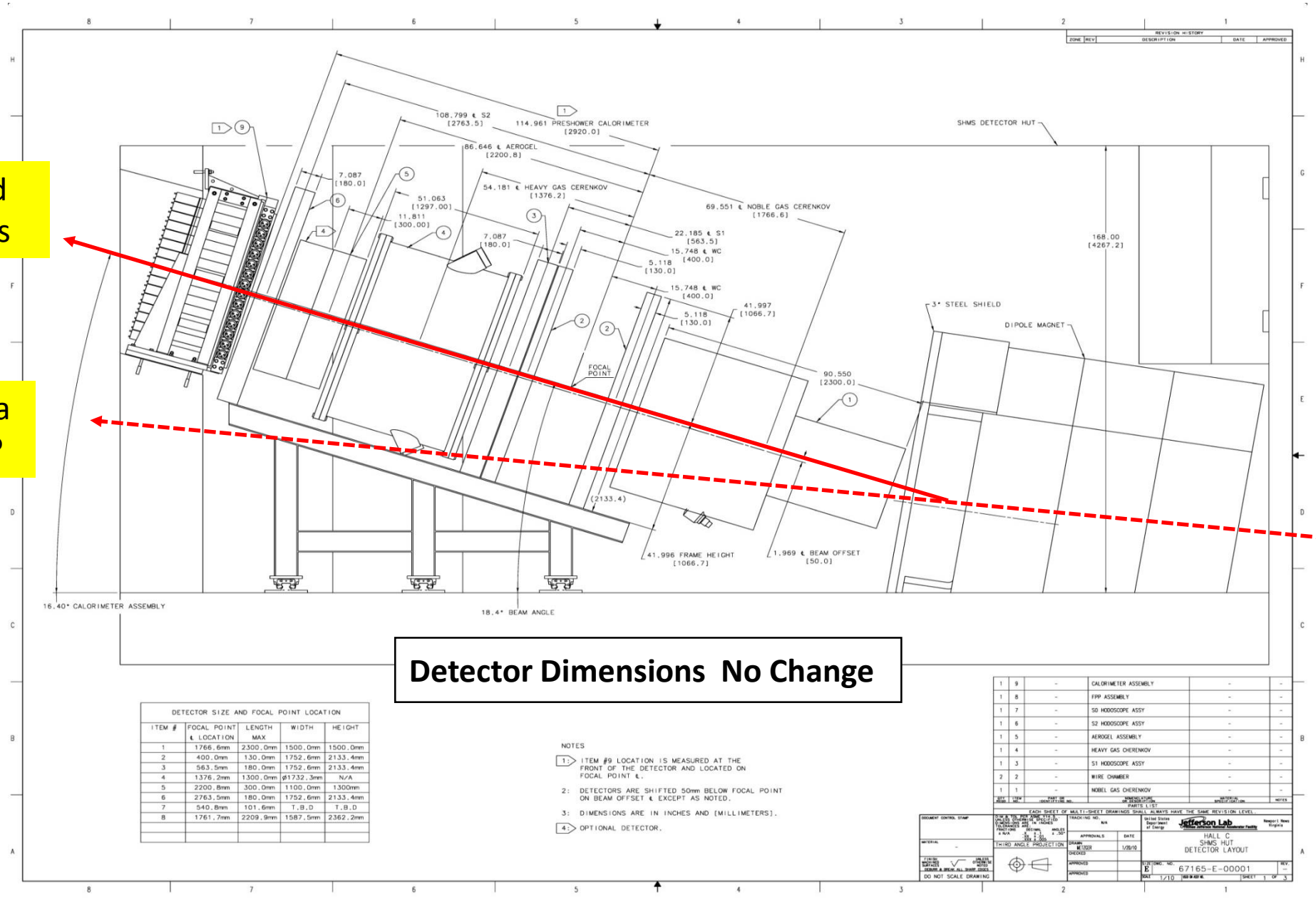
Still a question, but the correct S1X rate will be smaller.

It looks like there's often enough energy in the calorimeter from a typical hadron (eg, in PRLO) to help clean up the HODO 3 out of 4 triggers to help determine an accurate tracking efficiency. (A loose beta cut could should also help remove uncorrelated hits in the hodoscopes.) Just remember: we can't use cut quantities that use SHMS wire chamber information.

backups

Good tracks

Gamma Beam?



Detector Dimensions No Change

DETECTOR SIZE AND FOCAL POINT LOCATION

ITEM #	FOCAL POINT ℄ LOCATION	LENGTH MAX	WIDTH	HEIGHT
1	1766.6mm	2300.0mm	1500.0mm	1500.0mm
2	400.0mm	130.0mm	1752.6mm	2133.4mm
3	563.5mm	180.0mm	1752.6mm	2133.4mm
4	1376.2mm	1300.0mm	ø1732.3mm	N/A
5	2200.8mm	300.0mm	1100.0mm	1300mm
6	2763.5mm	180.0mm	1752.6mm	2133.4mm
7	540.8mm	101.6mm	T.B.D	T.B.D
8	1761.7mm	2209.9mm	1587.5mm	2362.2mm

NOTES

1: ITEM #9 LOCATION IS MEASURED AT THE FRONT OF THE DETECTOR AND LOCATED ON FOCAL POINT ℄.

2: DETECTORS ARE SHIFTED 50mm BELOW FOCAL POINT ON BEAM OFFSET ℄ EXCEPT AS NOTED.

3: DIMENSIONS ARE IN INCHES AND [MILLIMETERS].

4: OPTIONAL DETECTOR.

1	9	-	CALORIMETER ASSEMBLY	-	-
1	8	-	FPP ASSEMBLY	-	-
1	7	-	S0 HODOSCOPE ASSY	-	-
1	6	-	S2 HODOSCOPE ASSY	-	-
1	5	-	AEROGEL ASSEMBLY	-	-
1	4	-	HEAVY GAS CHERENKOV	-	-
1	3	-	S1 HODOSCOPE ASSY	-	-
2	2	-	WIRE CHAMBER	-	-
1	1	-	NOBEL GAS CHERENKOV	-	-

PARTS LIST

EACH SHEET OF MULTI-SHEET DRAWINGS SHALL ALWAYS HAVE THE SAME REVISION LEVEL

THIRD ANGLE PROJECTION

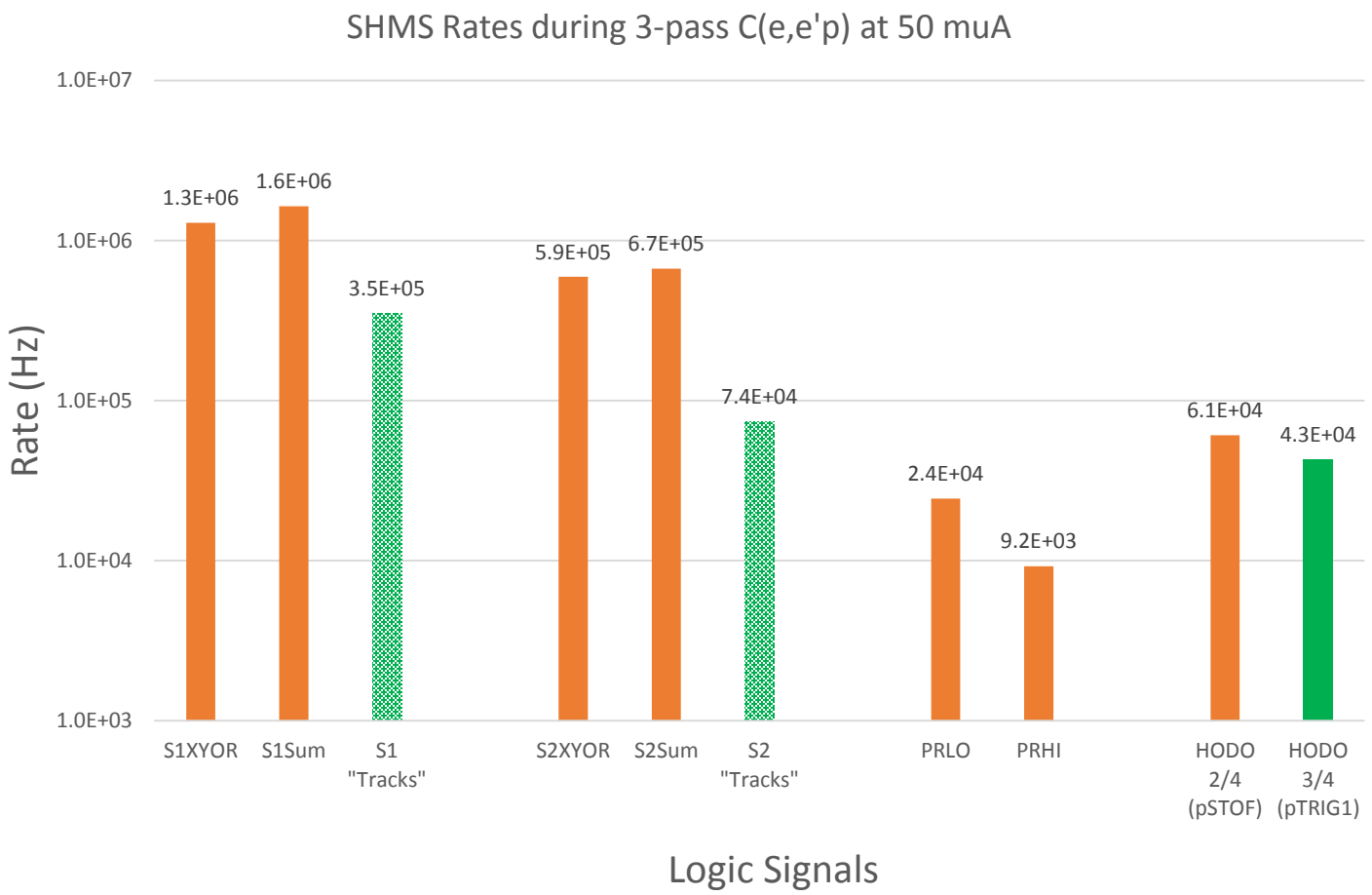
DO NOT SCALE DRAWING

Jefferson Lab — Newport News, Virginia

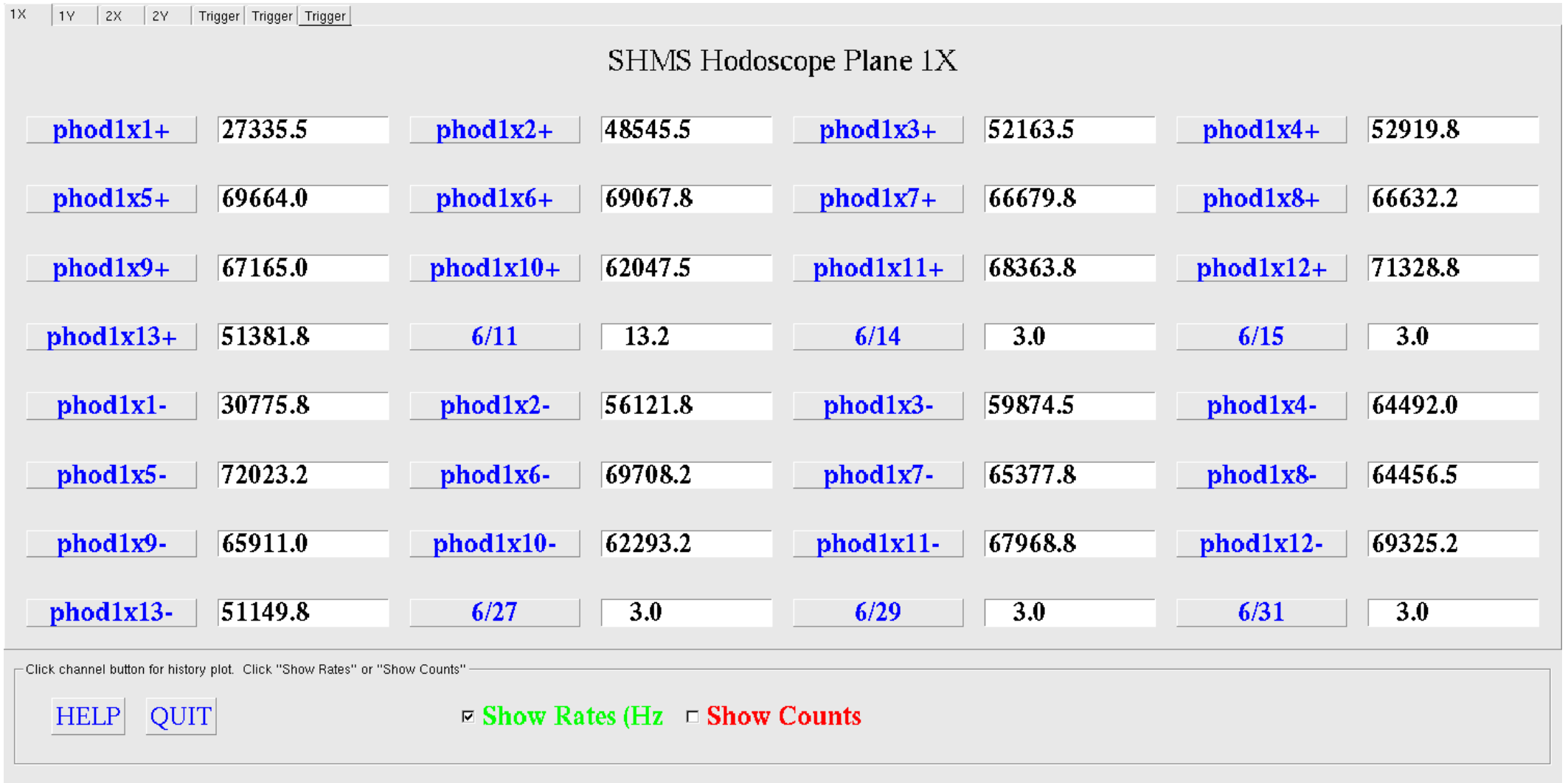
HALL C
SHMS HUT
DETECTOR LAYOUT

67165-E-00001

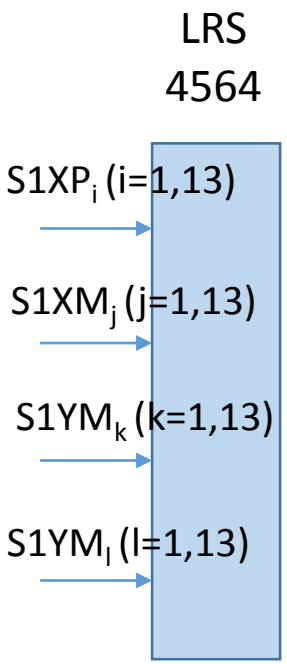
Log scale


SHMS Rates during 3-pass C(e,e'p) at 50 muA
1.0E+07
1.0E+06
1.0E+05
1.0E+04
1.0E+03
Rate (Hz)
1.3E+06
1.6E+06
3.5E+05
5.9E+05
6.7E+05
7.4E+04
2.4E+04
9.2E+03
6.1E+04
4.3E+04
S1XYOR
S1Sum
S1 "Tracks"
S2XYOR
S2Sum
S2 "Tracks"
PRLO
PRHI
HODO 2/4 (pSTOF)
HODO 3/4 (pTRIG1)
Logic Signals

I didn’t bother to histograms rates for individual paddles. The rate varies only a factor of ~2.5 from the super-elastic(?) side of S1 on the bottom (eg, phod1x1+) to the inelastic side on the top (phod1x13+).



Guess at SHMS S1 Logic Outputs from LRS 4564



Output Channel	Logical Output	Relatively Short, Unambiguous Name	PMT Multiplicity Required for Output	Comments
1	S1XP	S1XP	1	
2	S1XM	S1XM	1	
3	S1YP	S1YP	1	
4	S1YM	S1YM	1	
5	S1XP*S1XM	S1X	2/2	In use
6	S1YP*S1YM	S1Y	2/2	In use
7	S1XP+S1XM	S1XOR	1/2	
8	S1YP+S1YM	S1YOR	1/2	
9	S1XP*S1XM*S1YP*S1YM	S1(4/4)	4/4	
10	S1XP+S1XM+S1YP+S1YM	S1(1/4)	1/4	
11	(S1XP+S1XM)*(S1YP+S1YM)	S1XOR*S1YOR	2/4	
12	(S1XP*S1XM)+(S1YP*S1YM)	S1X+S1Y	2/4	In use as "S1"

???

NEED TO CONFIRM ORDER OF PLUS VS MINUS