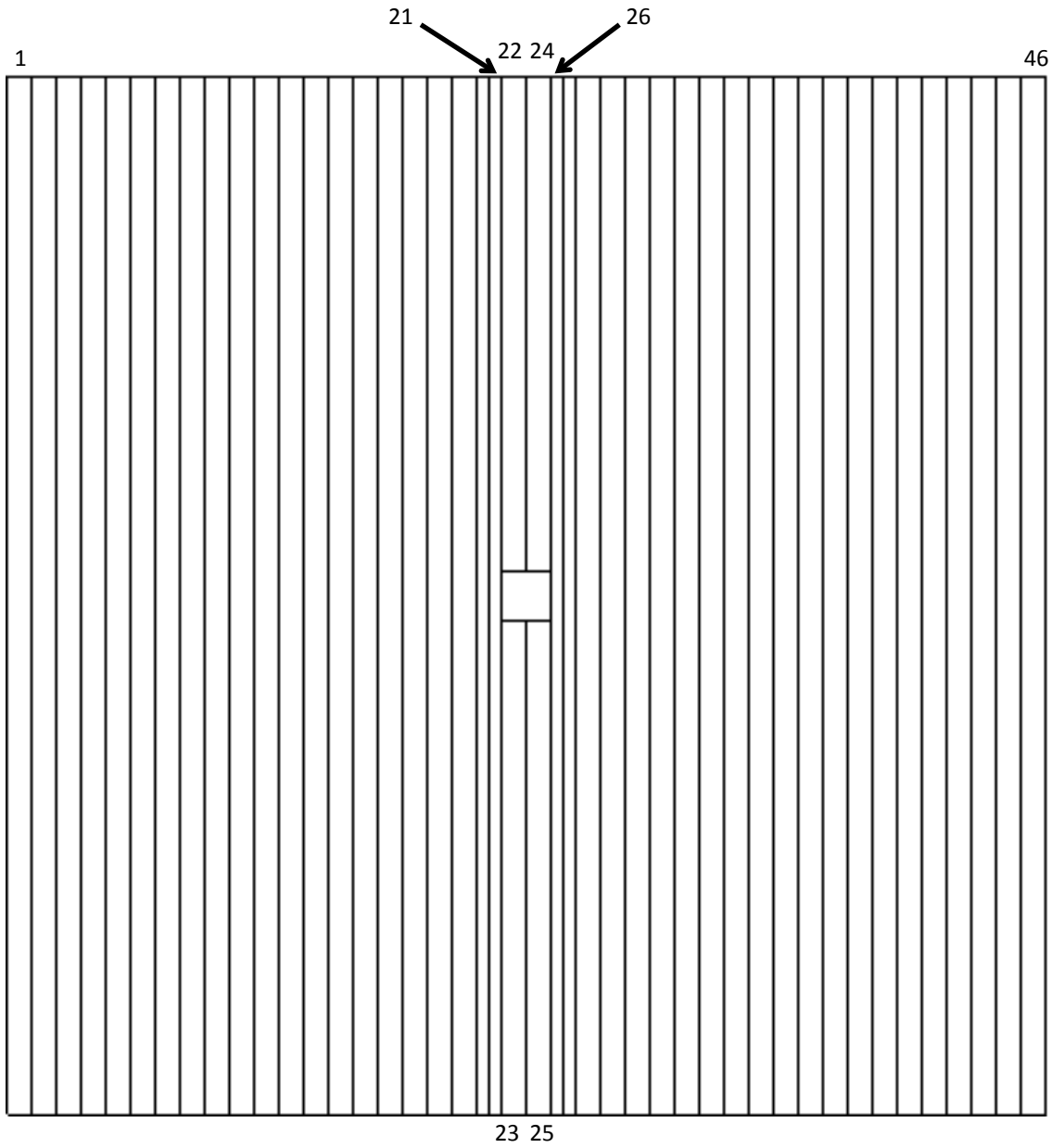
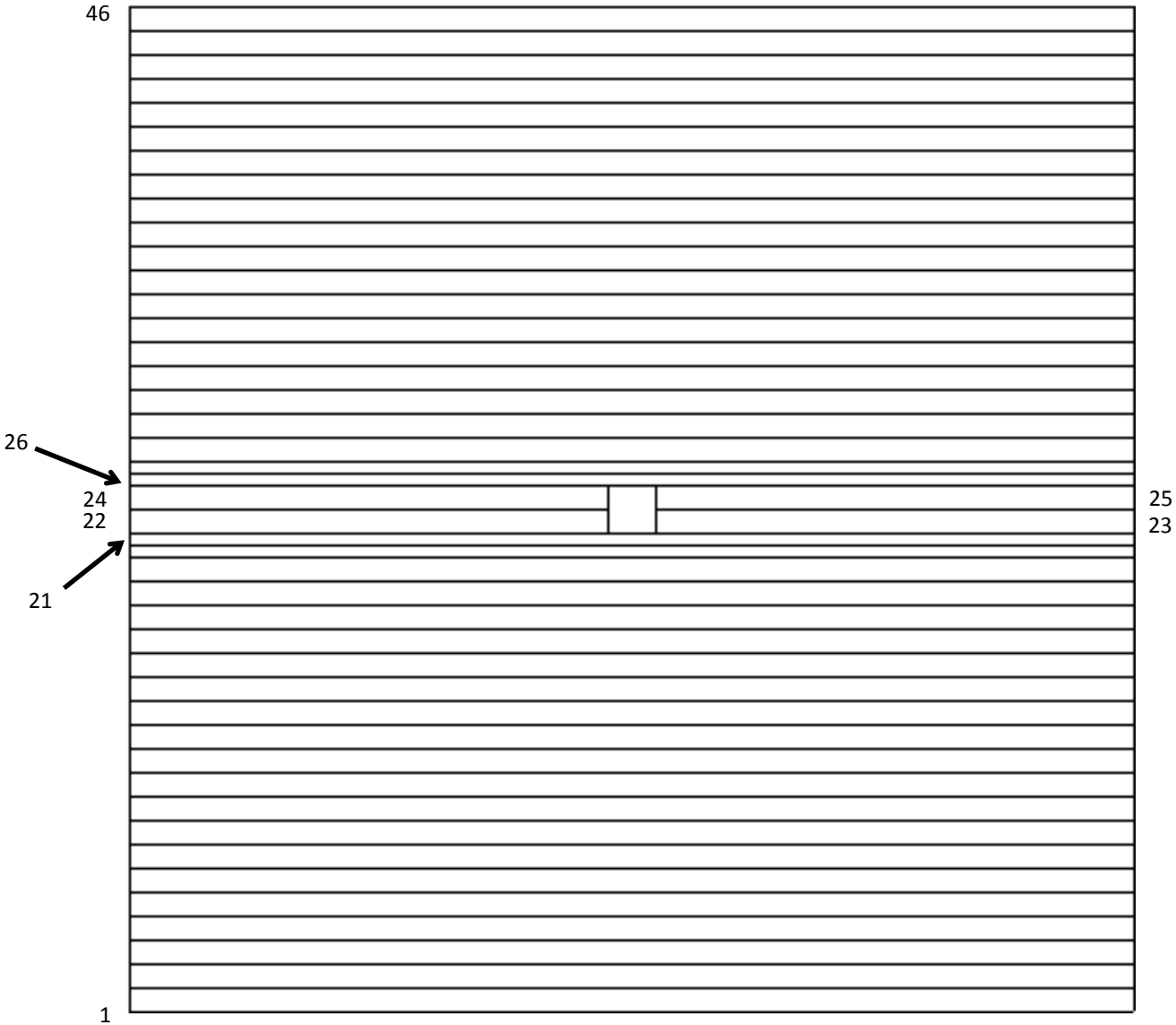
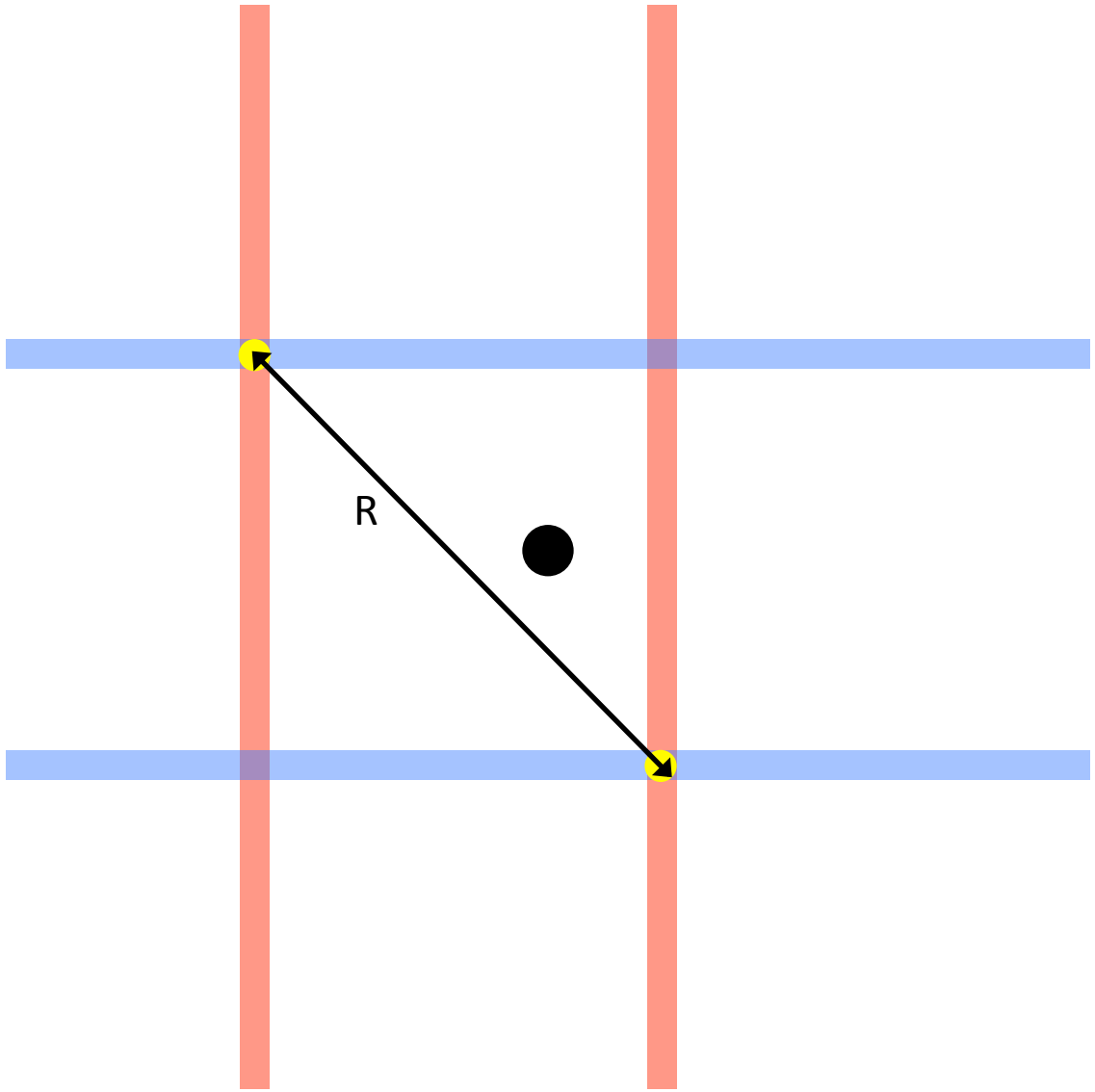
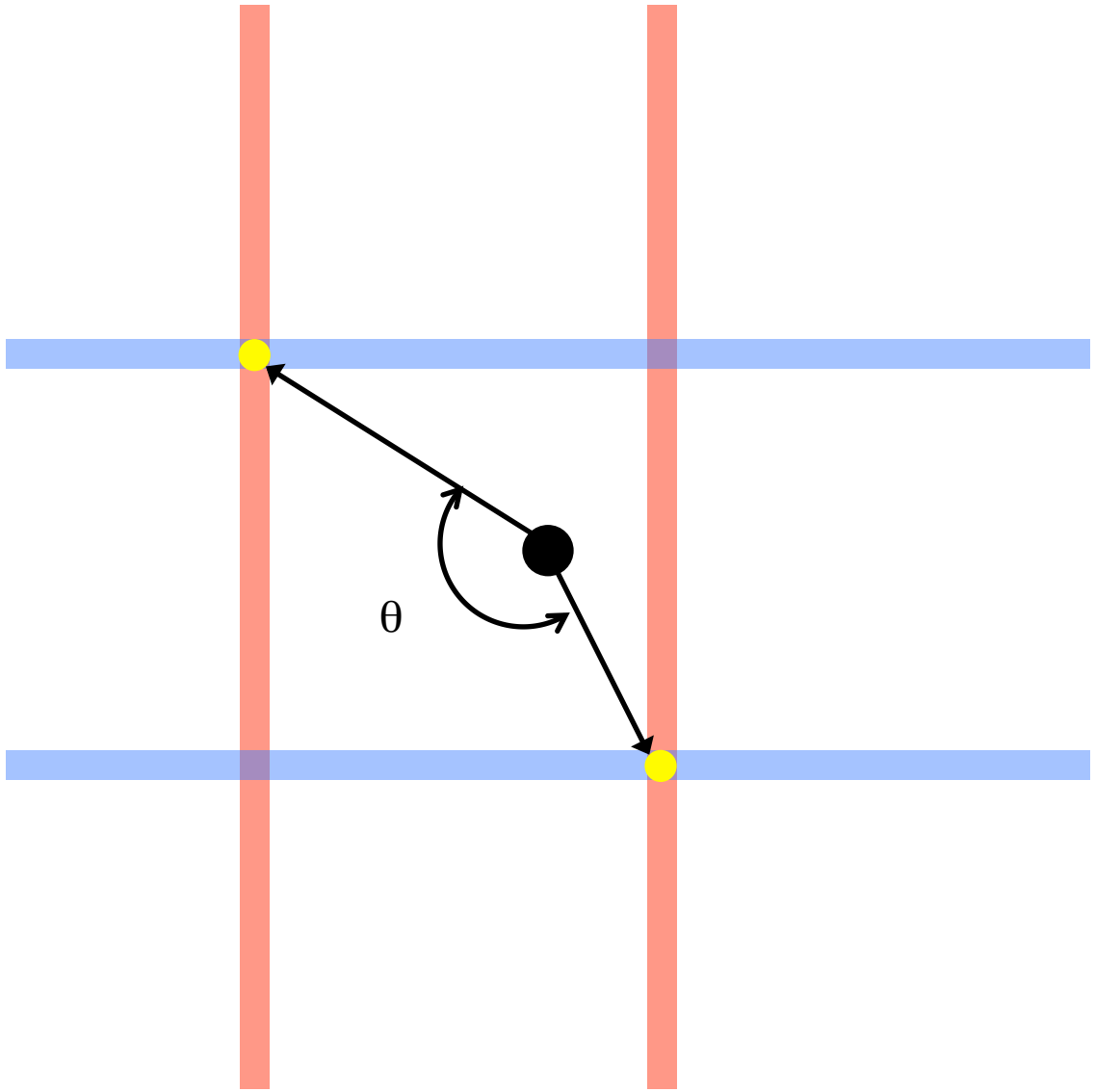
Using the TOF for Triggering the CPP Experiment

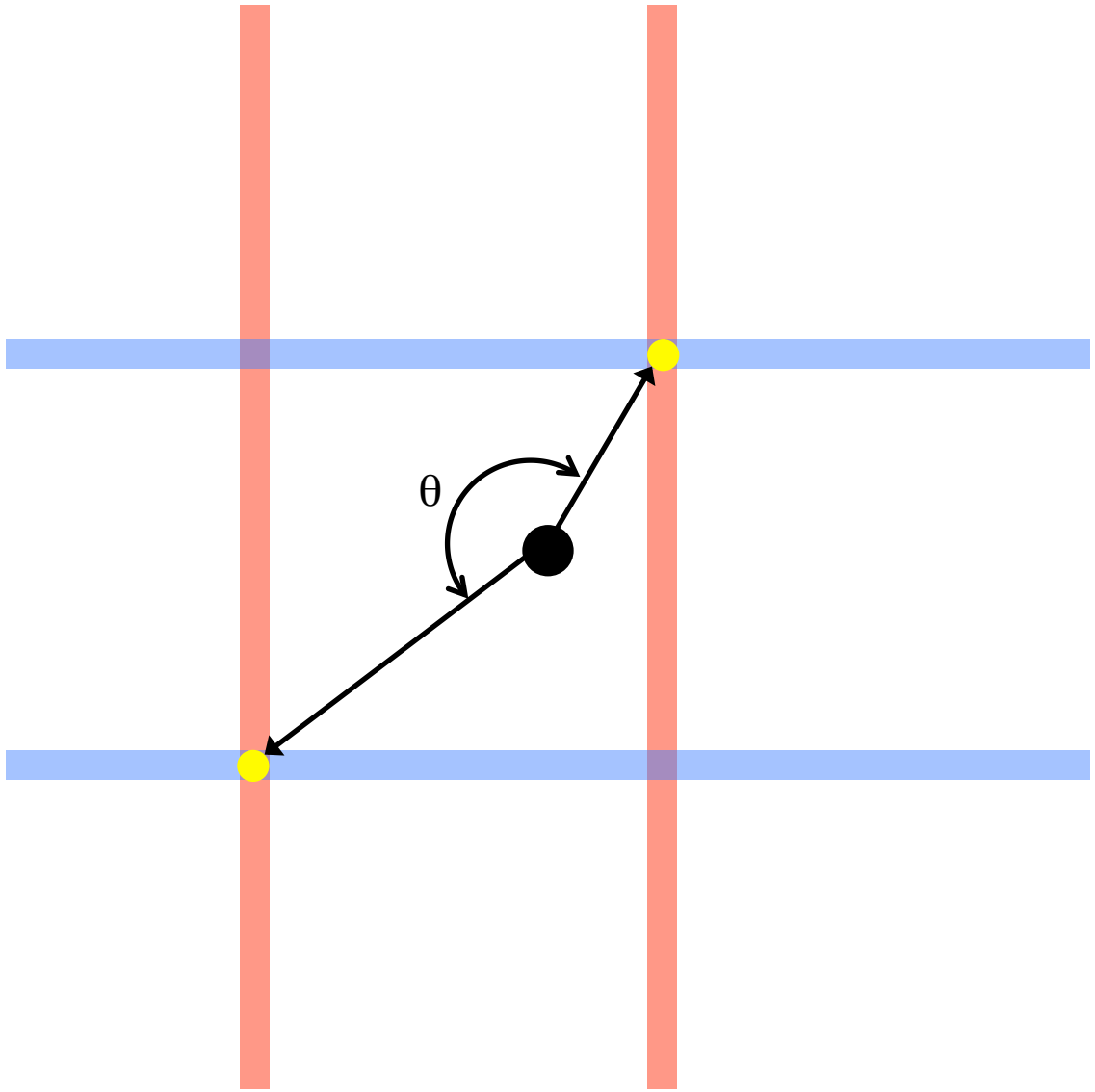
From April 8, 2016

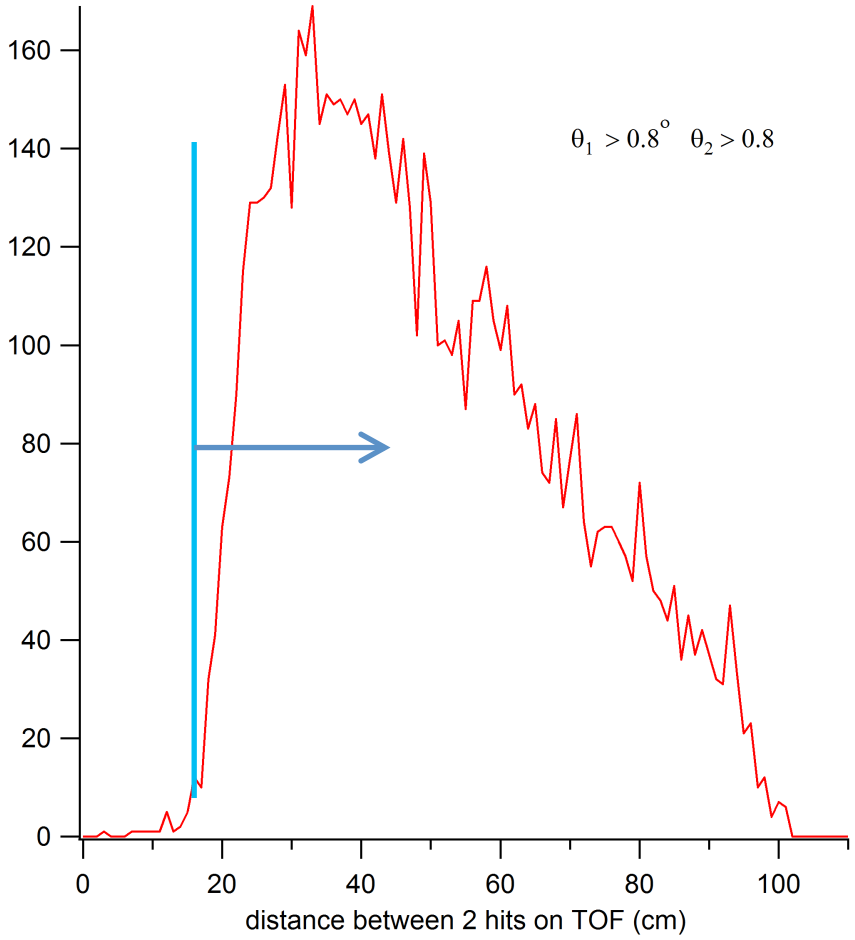

21
26
1
22 24
46
23 25

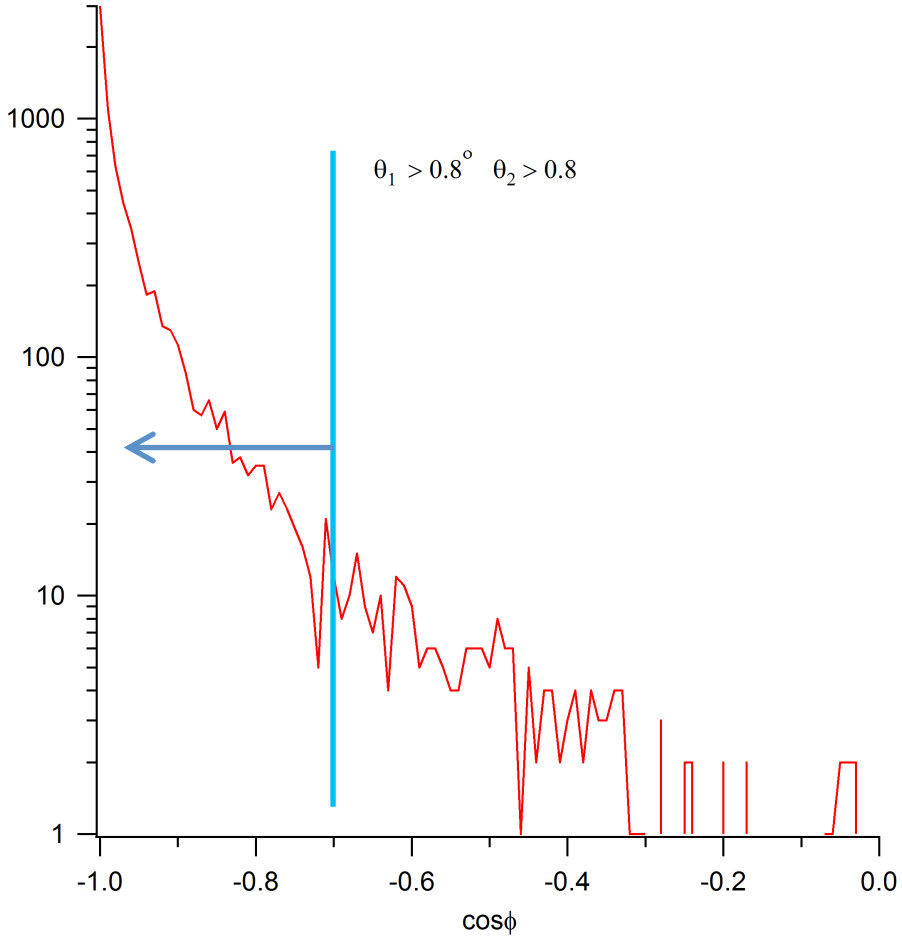

46
26
24
22
25
23
21
1


R


θ


θ


160
140
120
100
80
60
40
20
0
0
20
40
60
80
100
distance between 2 hits on TOF (cm)
$\theta_1 > 0.8^\circ$ $\theta_2 > 0.8$


1000
100
10
1
-1.0
-0.8
-0.6
-0.4
-0.2
0.0
cosϕ
$\theta_1 > 0.8^\circ$ $\theta_2 > 0.8$

The accidental rate between the i^{th} and j^{th} paddles is given by:

$$Acc(x_i, x_j) = R(x_i)R(x_j)\Delta t$$

Calculate how much of the rate $Acc(x_i,x_j)$ satisfies acceptance requirements:

1. Two paddles in the front array fire, and two paddles in the back array fire
2. R > 18 cm
3. cos θ < -0.7
4. Exclude a range of central paddles from the trigger

Let $\varepsilon(x_i,x_j)$ = fraction of $Acc(x_i,x_j)$ that satisfies these requirements.

To find $\varepsilon(x_i,x_j)$, need to know the rate as a function of x and y. Postulate that:

$$Rate(x,y) = \frac{A_1}{2\pi\sigma_1^2} e^{-(x^2+y^2)/(2\sigma_1^2)} + \frac{A_2}{2\pi\sigma_2^2} e^{-(x^2+y^2)/(2\sigma_2^2)} + B$$

Then the rate in paddle x_i is given by:

$$R(x_i) = \int_{-L/2}^{L/2} Rate(x_i, y)dy = \frac{A_1}{\sigma_1\sqrt{2\pi}} e^{-x^2/(2\sigma_1^2)} + \frac{A_2}{\sigma_2\sqrt{2\pi}} e^{-x^2/(2\sigma_2^2)} + BL$$

Fit TOF data with the form above.

TOF rates with solenoid on, 3.4 mm collimator

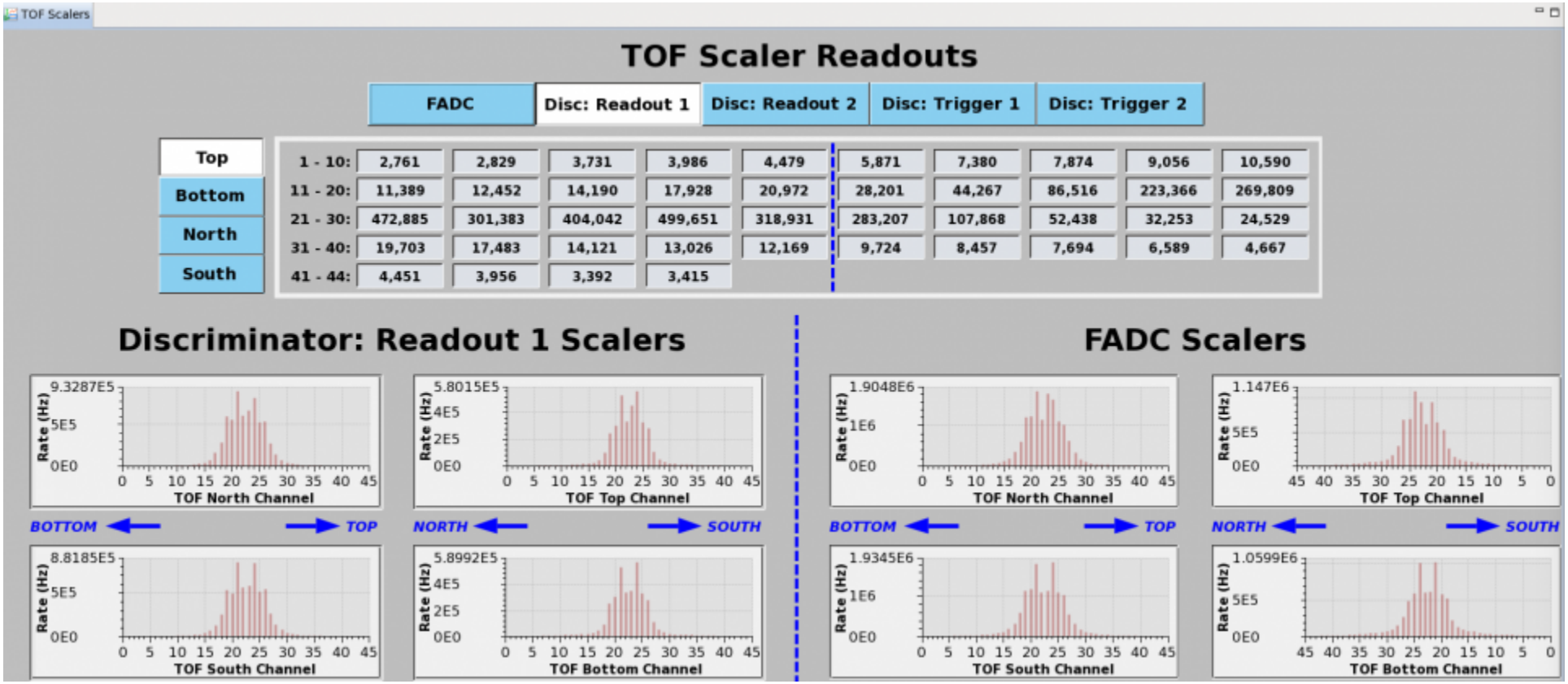
Lognumber 3393177. Submitted by Elton on Tue, 03/29/2016 - 08:28.

Logbooks: HDLOG HDTOF

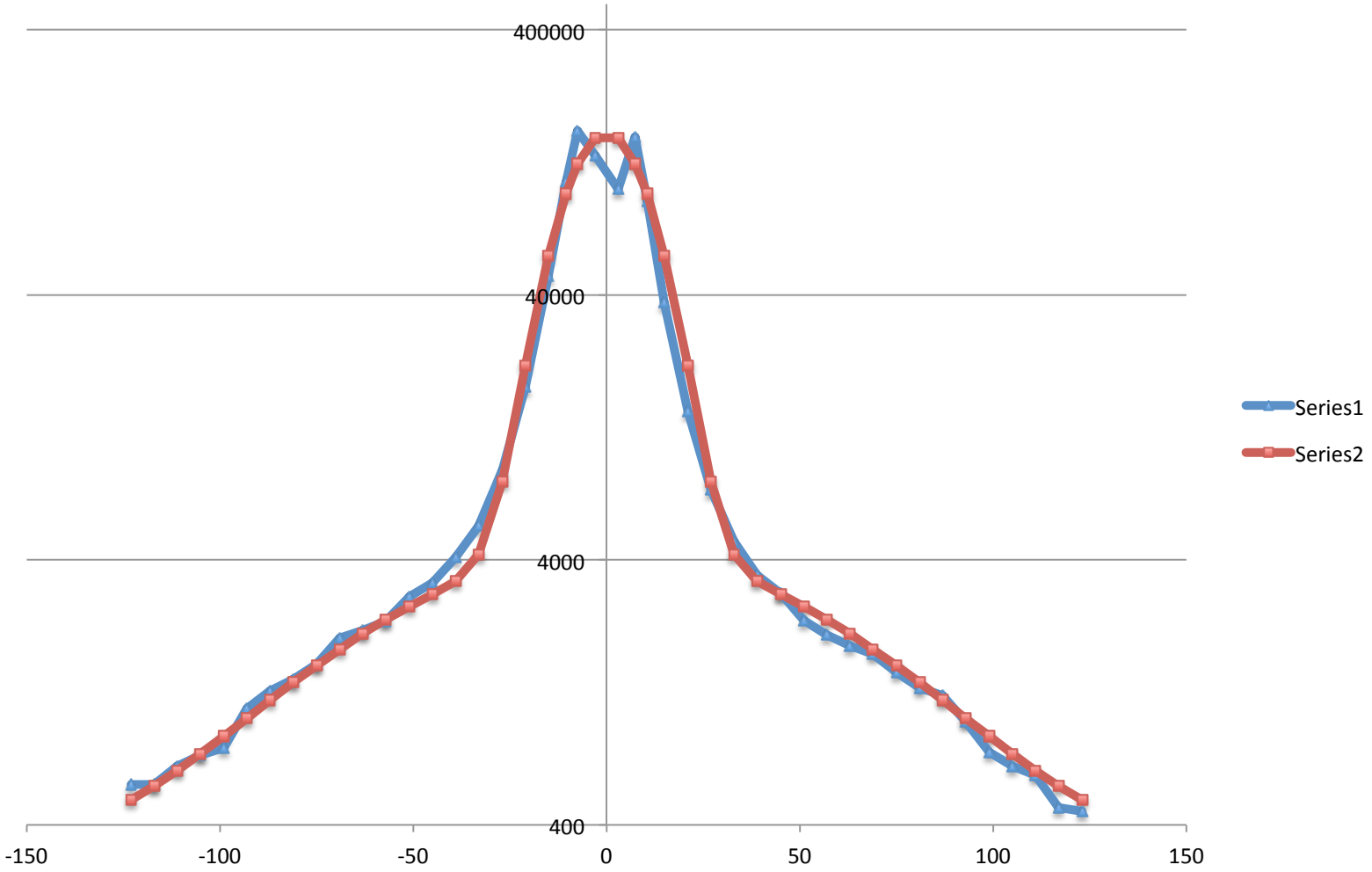
References: 3392794 - TOF rates with solenoid off

Nominal running with amorphous radiator, 3.4 mm collimator, 200 nA beam

TOF scaler rates are about 1 MHz. We need to check the threshold and compare to trigger thresholds.



Fitted TOF rates:



- For a given x_i, draw y from the fitted probability distribution

$$Rate(x,y) = \frac{A_1}{2\pi\sigma_1^2} e^{-(x^2+y^2)/(2\sigma_1^2)} + \frac{A_2}{2\pi\sigma_2^2} e^{-(x^2+y^2)/(2\sigma_2^2)} + B$$

- Calculate $\varepsilon(x_i,x_j)$ by testing many events

- Total rate is given by: $$Rate = \frac{1}{2}\sum_{i\neq j} Acc(x_i,x_j)\varepsilon(x_i,x_j)$$

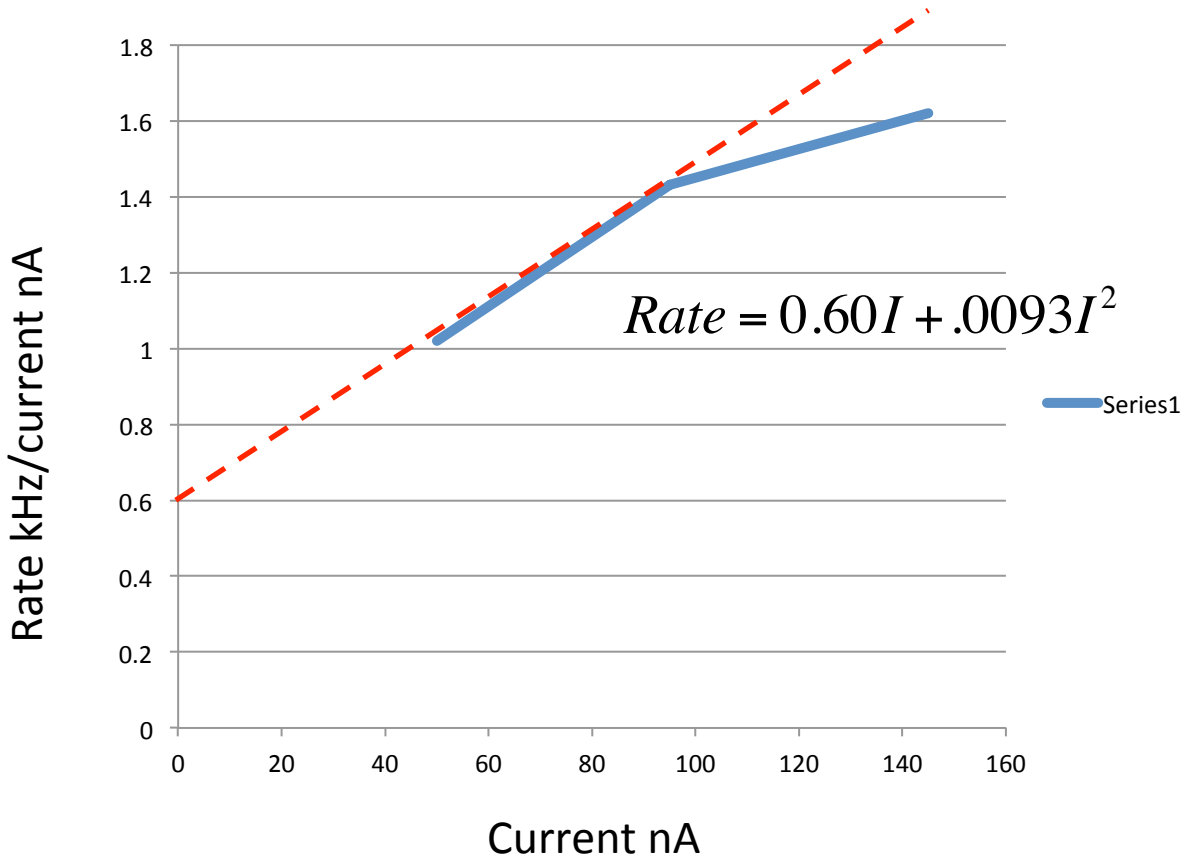
200 nA
Amorphous radiator
3.4 mm collimator
20 ns coincidence window
Unknown scintillator thresholds

Vertical paddles turned off	Horizontal paddles turned off	R cut (cm)	Cos min	Cos max	Rate (kHz)
none	none	none	none	none	146
none	none	18	-0.9	0.0	57
22,23,24,25	22,23,24,25	none	none	none	23
22,25	22,25	none	none	none	70.3
22,25	22,25	none	-0.9	0.0	32.8
22,25	22,25	18	none	none	53.1
22,25	22,25	18,	-0.9	0.0	29.8
22,25	22,25	none	-1.0	0.0	40.4
21,26	21,26	none	none	none	61
21,26	21,26	none	-0.9	0.0	32.5

From Ilya's and Sasha's beam test:

TOF trigger rates vs beam current and TOF threshold. Reduction factor with applied offline cuts

Beam current	50nA	95nA	145nA
DAQ rate	51kHz	136kHz	235/191/157kHz 30/60/90mV
At least 2 hits in each plane (cumulative with the cuts below)	90%	89%	88%
2 TOF reconstructions	94%	90%	87%
2 TOF reconstructions R>18cm	61%	57%	55%
2 TOF reconstructions out of 18x18cm center	80%	75%	73%
2 TOF reconstructions out of 18x18cm center R>18cm	47%	44%	42%



- Rate is dominated by linear current effect up to 65 nA.
- Beyond 65 nA the rate is dominated by quadratic current effect.

Tentative conclusions:

- At currents below about 65 nA the rate is mostly from track pairs, … presumably e^+e^- pairs?
- At currents above about 65 nA the rate is mostly from accidental coincidences between paddles in the front TOF array. Presumably these hits are e^+ and e^-

Questions:

- Can we run with a coincidence window of 20 ns or lower in the triggering to suppress the quadratic current background?
- We don't need to read out CDC, BCAL or START counter. Does this allow for a higher trigger rate?
- What's the highest trigger rate that we can run at?
- Need to understand the difference in trigger rates between running amorphous on hydrogen and coherent bremsstrahlung on Pb (or other high Z) target pulled back.
    - The difference in trigger rate between hydrogen and Pb targets should be difference in radiation length
    - What's the difference in trigger rate between 1/k Brem. distribution, and a coherent peaked distribution?
    - What's the effect of pulling the target back? If have a 18 x 18 cm^2 hole in the TOF and then pull the target back to Z=1 cm, are we just undoing the "good" obtained from the larger hole in the TOF?