Vacuum Box Design and Back Ground Simulation

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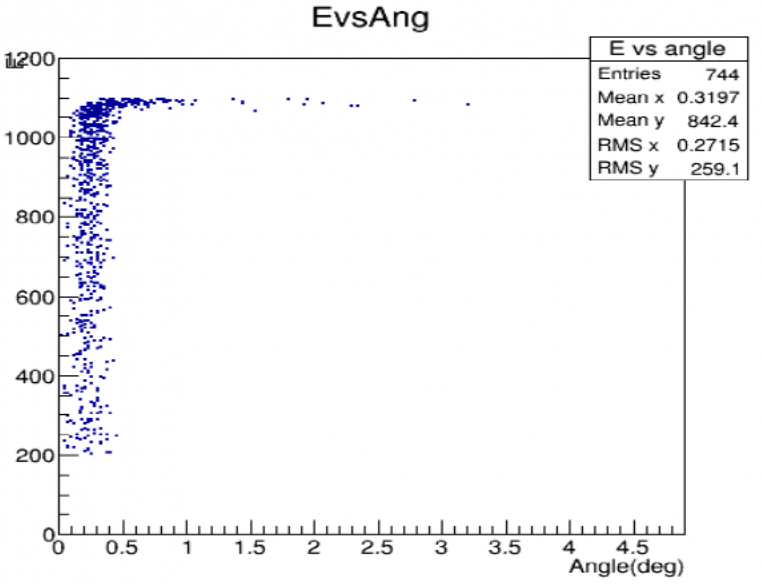
Previous vacuum box simulation



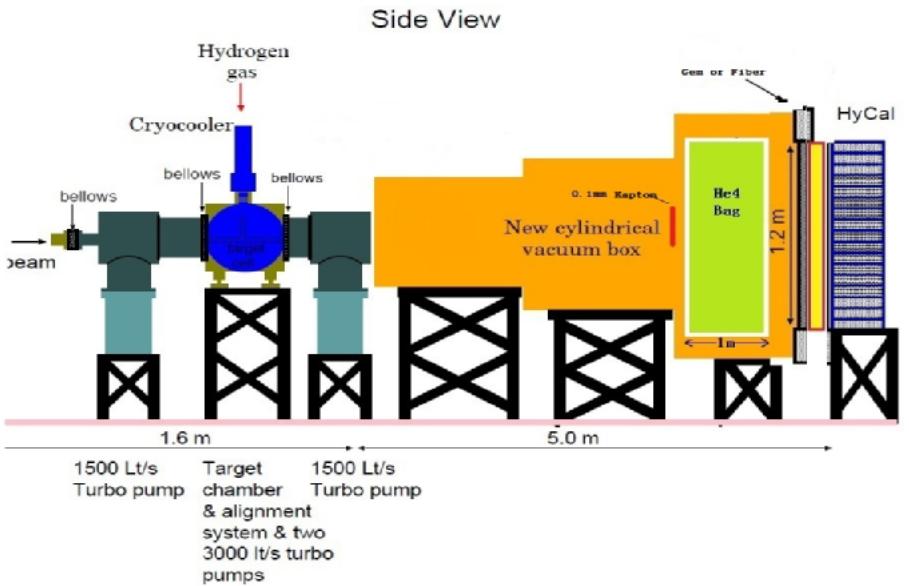
If use 0.2mm Al window, distance 15cm(minmum) , without cut, the events rate on Hycal is about 167 MHz

If apply energy cut E>200MeV. Events rate is about 450 Khz.

But the position detector infront of Hycal can not handle this high rate events.

Two New Design Option for PRad

Design No.1: use Kapton window at the end of 2nd stage vaccum box .
Replace 3rd stage vacuum box with He4 bag



Simulation for design No.1

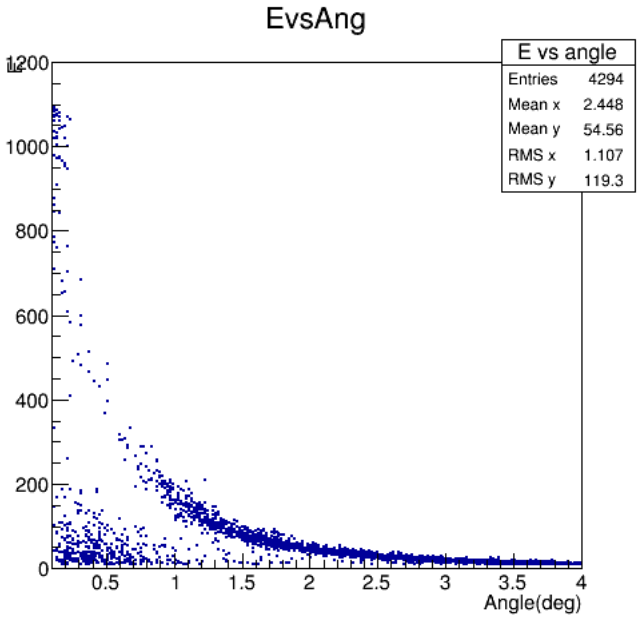
- Try to find the acceptable combination of window thickness and He gas pressure for PRad.

- First try the best situation :

  0.1mm Kapton window with distance 1.2m from Hycal surface , He4 bag pressure - 0 atm(vaccum).

Background rate =

4294*6000M/40M = 644KHz

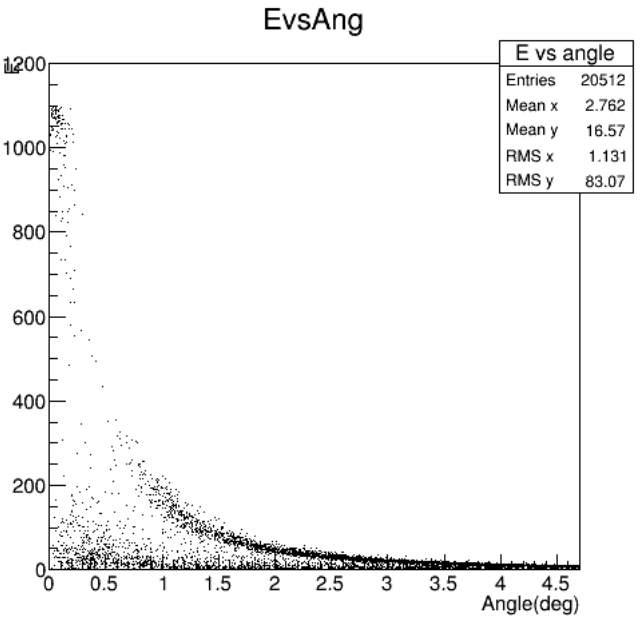


Simulation for design No.1

Than try :

0.1mm Kapton window
+ 0.1 atm He4 gas

Background rate =
20512*6000M/40M =
3.08MHz



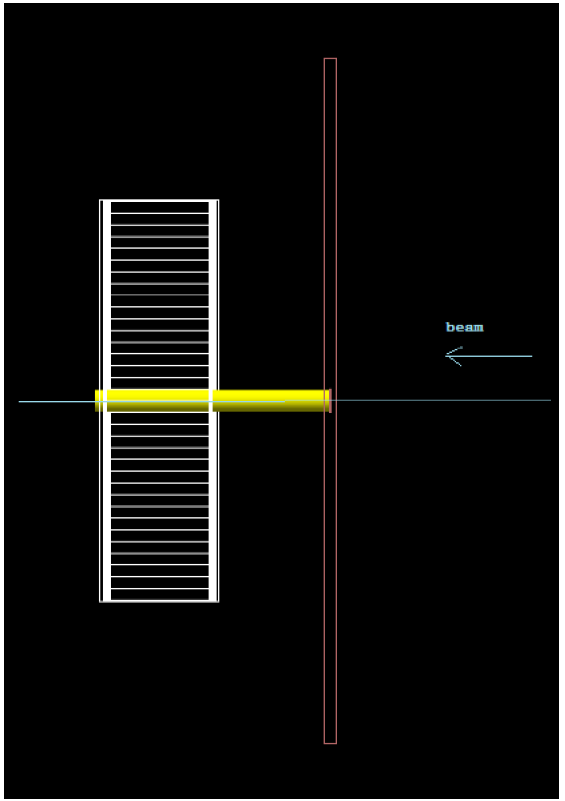
Conclusion

For this design, even most of the back ground are low energy and easy to cut off in Hycal, but 10% atm pressure He4 gas already reach 3MHz level, more pressure will have more back ground.

The position detector (gem or fiber) can not handle this high rate.

So, this is not a good option.

Design No.2



Design No.2 :

Use 1mm Al tube connect to the vaccum box than pass through position detector and Hycal. There will be no window on the beam line.

Simulation for design No.2

In my simulation:

Al tube - 1mm(outer- inner radius), Length 40cm

Vacuum box - 1mm thickness Al , with a hole (4cm diameter) in the centre

Distance from vacuum box to Hycal surface - 20cm

Angle caculation:

Minimun angle : θ = arctan(2cm/520cm) = 0.220deg

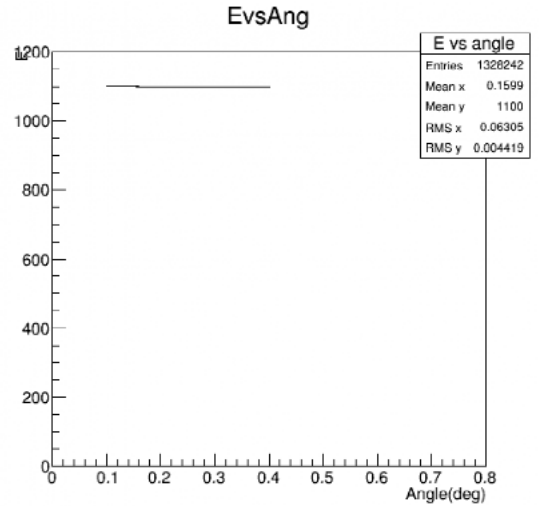
Maxmun angle : Ψ = arctan(2cm/480cm) = 0.239deg

This means any angle less than 0.22deg incident event will not hit the tube, vacuum box or Hycal.

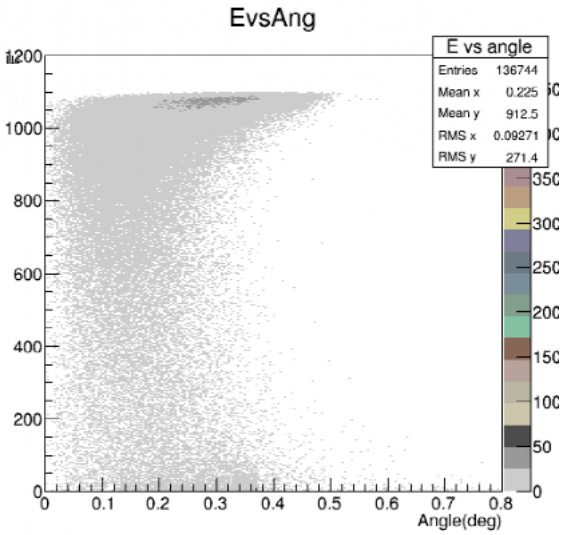
Any angle more than 0.239deg event will not hit the tube but will hit vacuum box and Hycal.

Simulation for design No.2

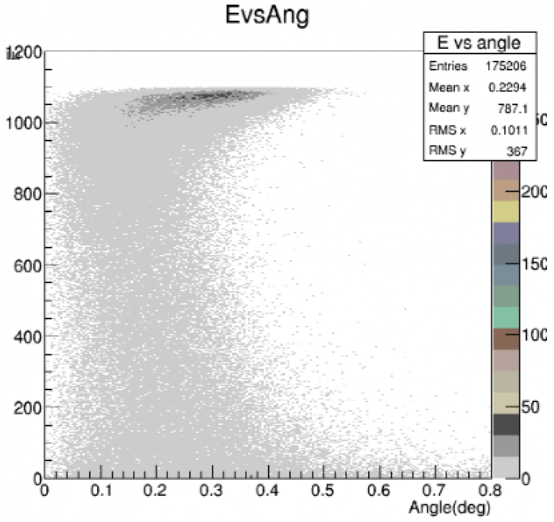
So in the simulation I use 1-h 0.1-0.4deg 1.1 GeV ep events from event generator as incident events, (moller events simulation is on going)



Simulation for design No.2



Left : plot on Hycal without tube



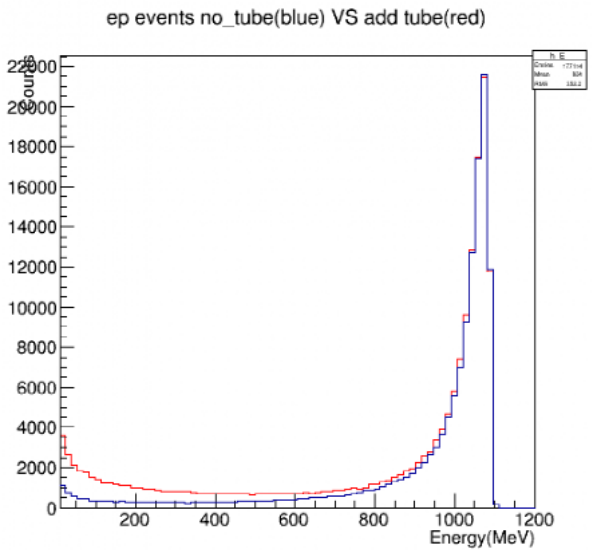
Right : plot on Hycal with the tube

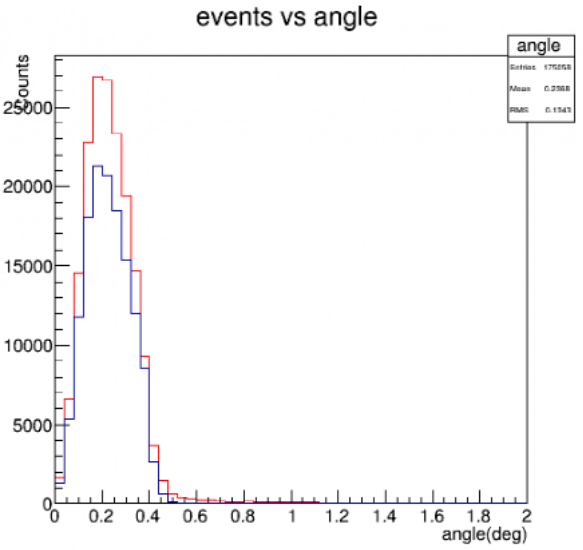
Even without tube, the plot is messy because:

1. some events can not deposit all the energy in Hycal due to the hole of Hycal.
2. some events hit the vacuum box

From the plot we can see that the tube will generate 175206-136744= 38462 additional events

Simulation for design No.2





Left: energy distribution

Right: angle distribution

Conclusion

After adding a tube, will generate ~38000 events for 1 hour beam time.

From the energy distribution, most of these events are at low energy.

From the angle distribution, most of these events stay at the same range because the tube is so close to Hycal.

The events rate(only for ep) is about :

38000/3600s ~~11 events per second

Based on ep simulation, this design seems to work, need to see moller simulation to verify.

Summary

- 0.2mm Al window will not work
- Two new design for PRad
- Design No.1 will have Mhz level back ground which is also not good for position detector.
- Design No.2 will have very low rate back ground and small effect (for ep events, moller events is on-going), because the back ground only comes from the ep and moller events not beam, so it should be only few percent of the signal, the exact number is coming soon.