# ShowerMax Plans

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(with help from Carlos Bula and Daniel Sluder)

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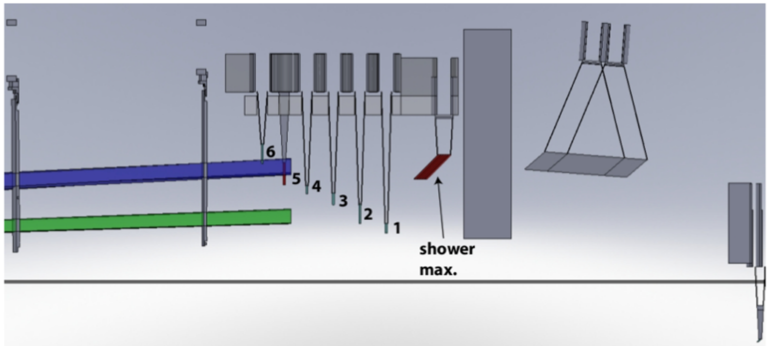
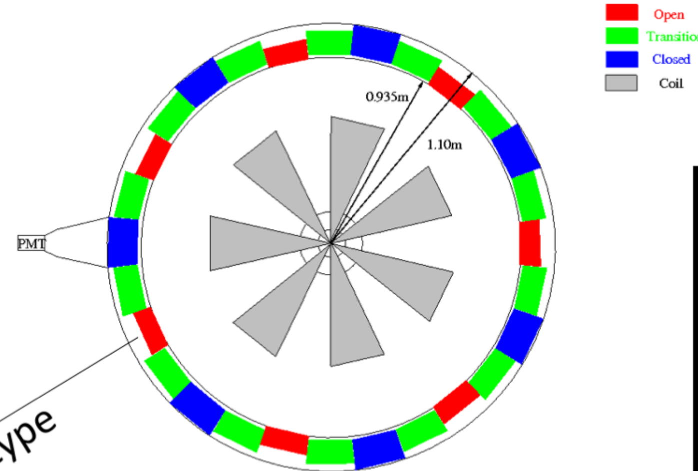
# ShowerMax Plans

## Outline

- What's been done
  - "Baseline" 4-layer sandwich stack - G4 qsim
  - Engineered shop drawings: stack support frame and LG
- What's going on now
  - Yield optimization study of stack configuration - qsim
  - Uniformity studies: PE yield vs. electron hit position - qsim
  - Light Guide prototyping
- Plans for prototyping and SLAC testbeam
- Summary and Future Plans
- Workload distribution with SBU

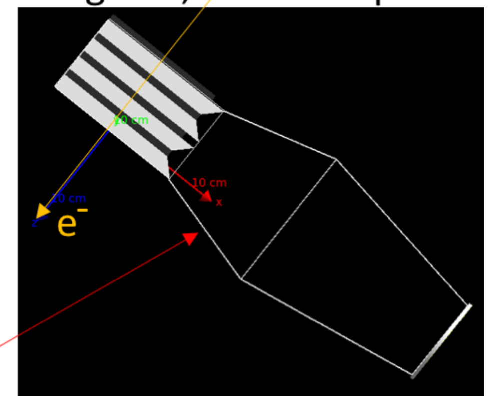
# Baseline Des: 4-layer Stack w/ uniform thicknesses; moderate $




OPEN type

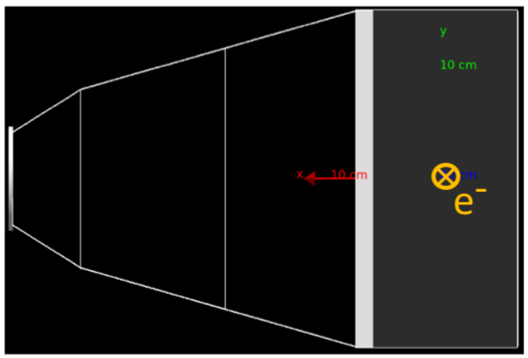
4 layer Stack: 6mm thick tungsten, 12.5mm quartz




Funnel angle and length optimized

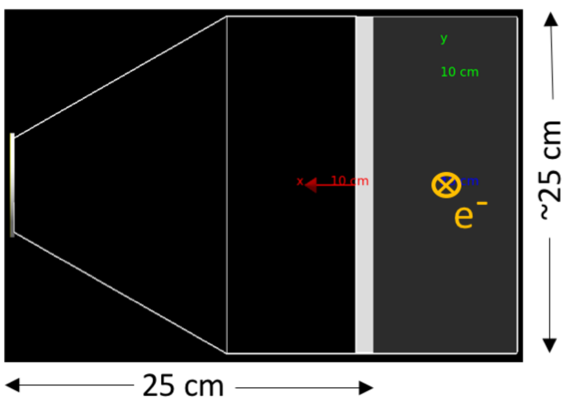
"Baseline" Design

Old "Baseline" LG



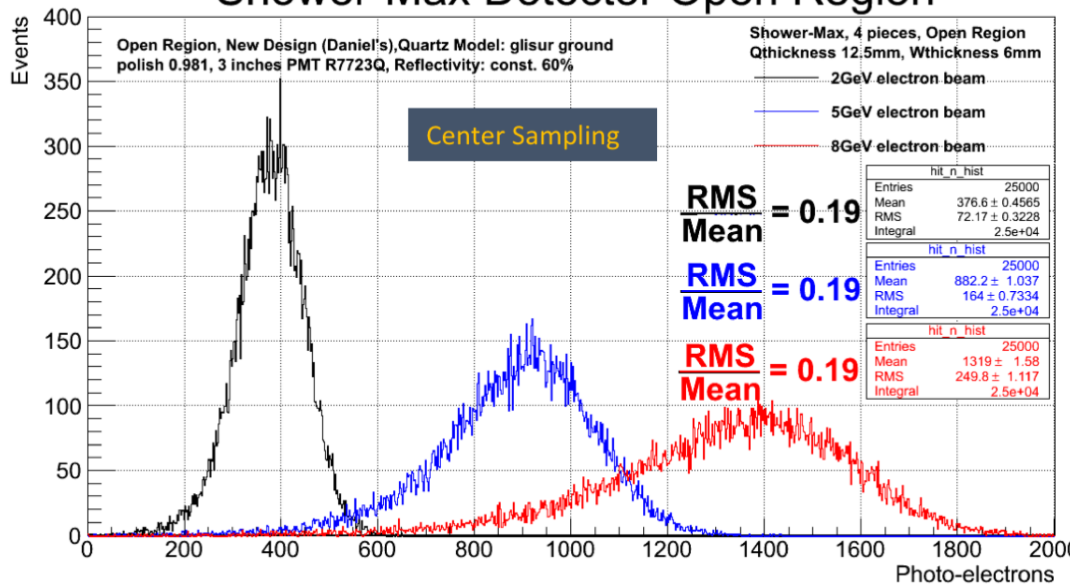

New "Baseline" LG

3inch PMT



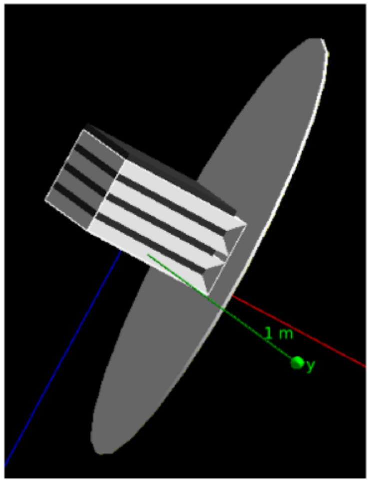

Even more light!

## Photo-Electron Distribution
## Shower-Max Detector Open Region

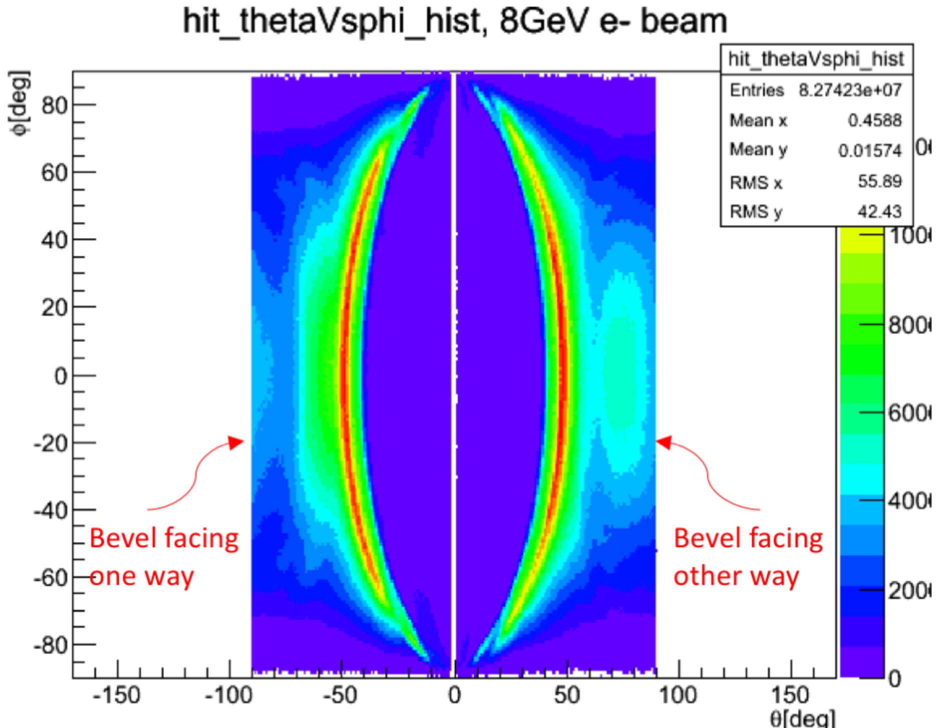


# Optimal Funnel angle and length study

**Light exit angle study for optimizing funnel mirror**

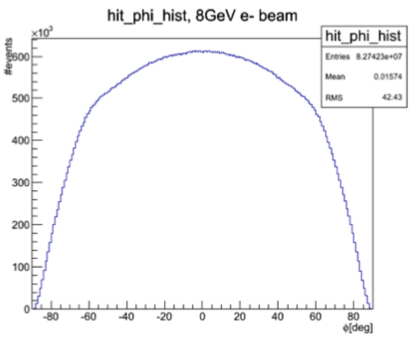


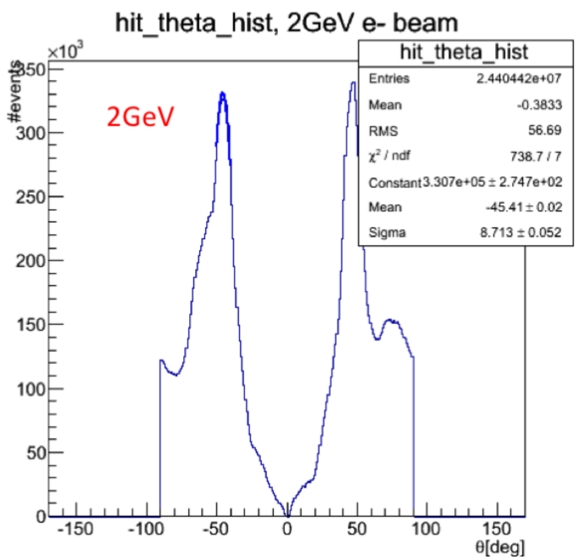

12.5mm quartz, 6mm tungsten, n = 4 layers

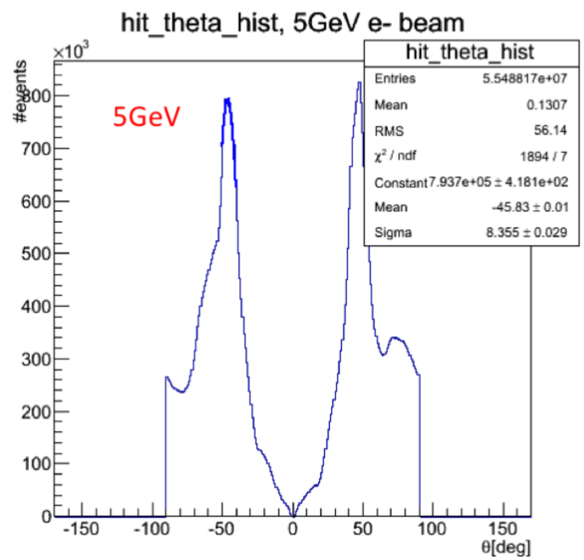


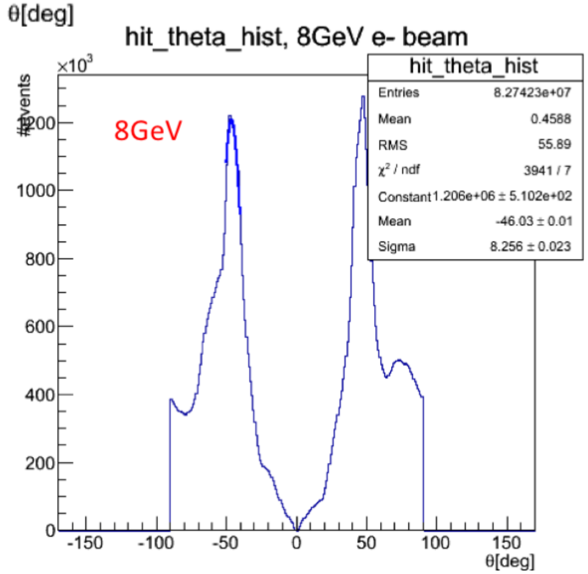

**Results:**

- 2GeV → $\theta_{peak}$ = 45.4°
- 5GeV → $\theta_{peak}$ = 45.8°
- 8GeV → $\theta_{peak}$ = 46.0°



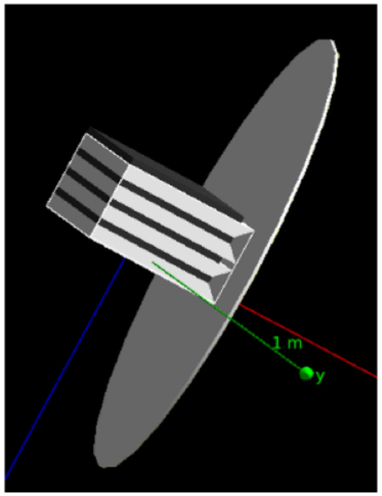



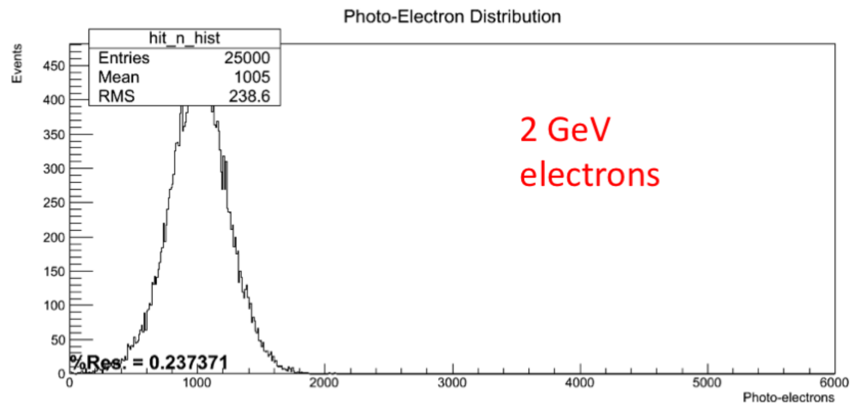



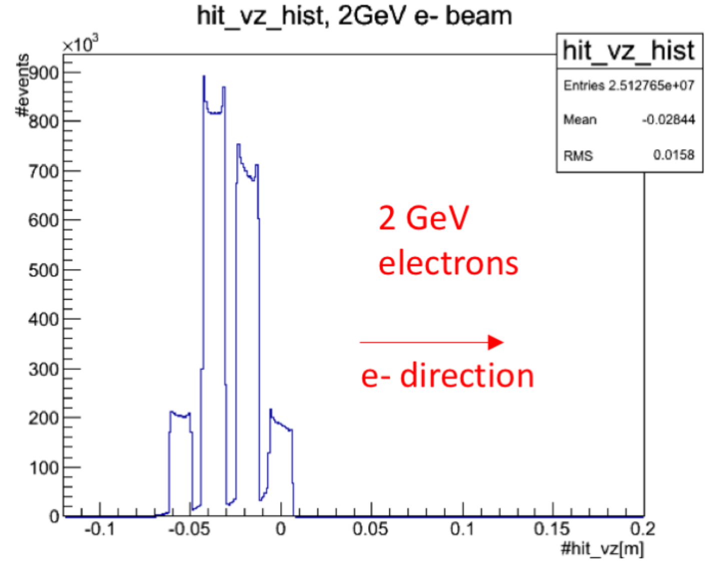
# Which layers give the most light?

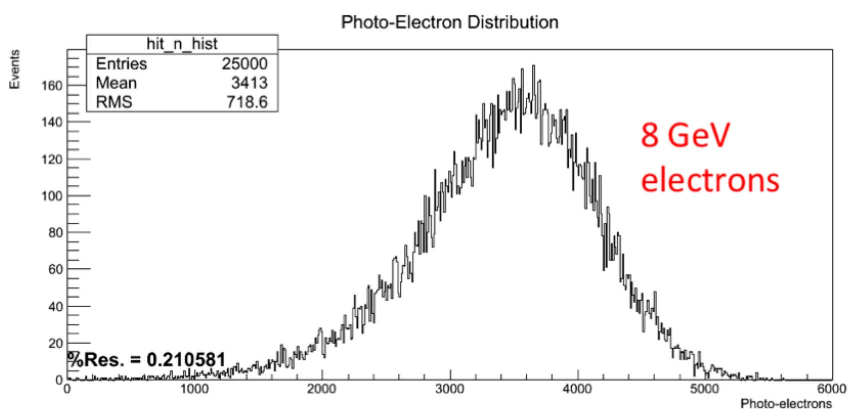
**Light exit study for optimizing No. of layers**

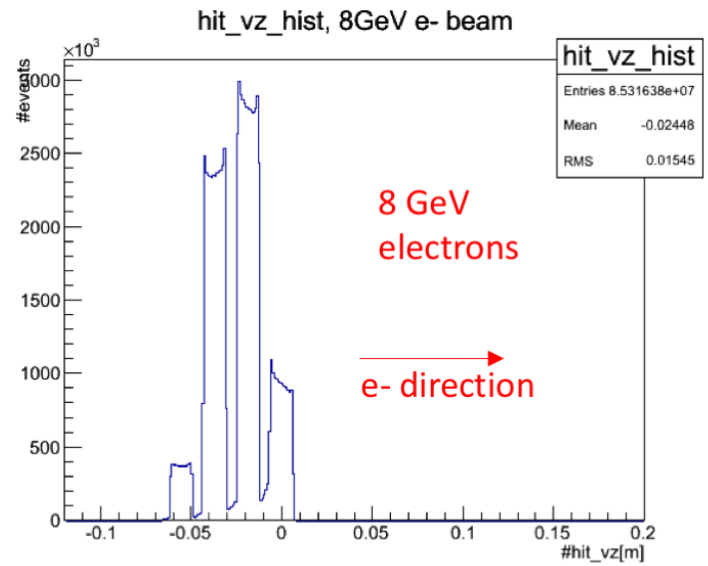



12.5mm quartz, 6mm tungsten, n = 4 layers



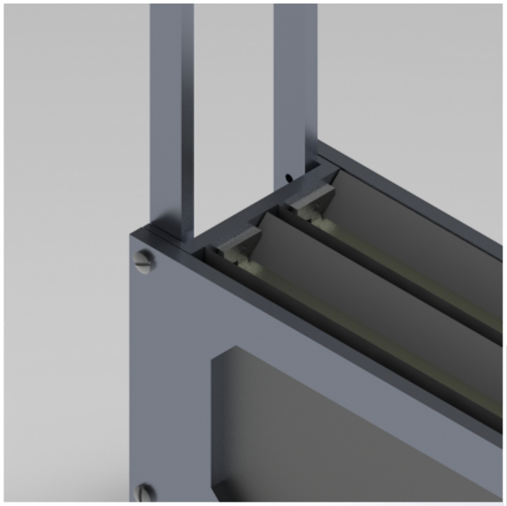



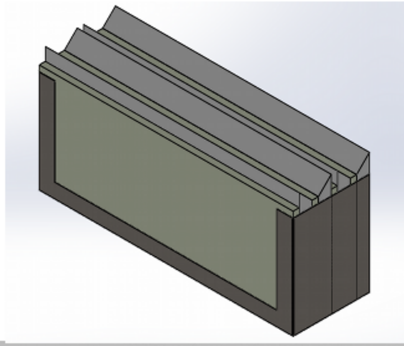



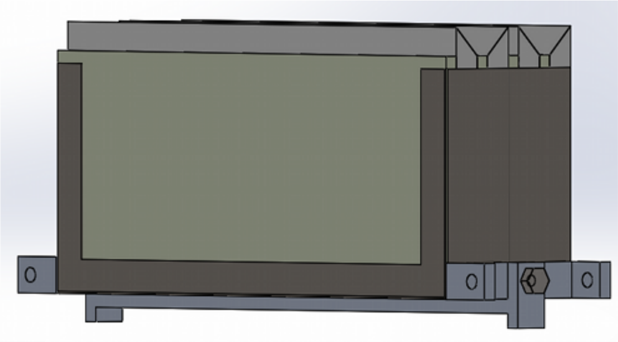

Conclusion:
Most of light yield comes from middle pieces and less from outer pieces – make middle quartz thicker if want more light.
(maybe could remove last layer (n=3))

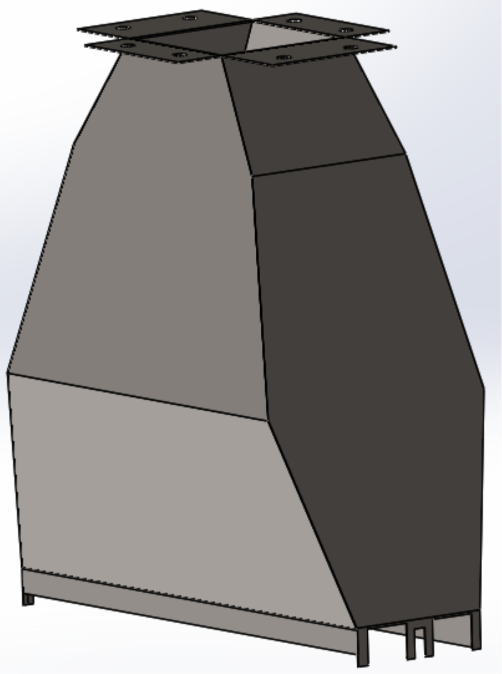
# Prototype stack support structure and LG

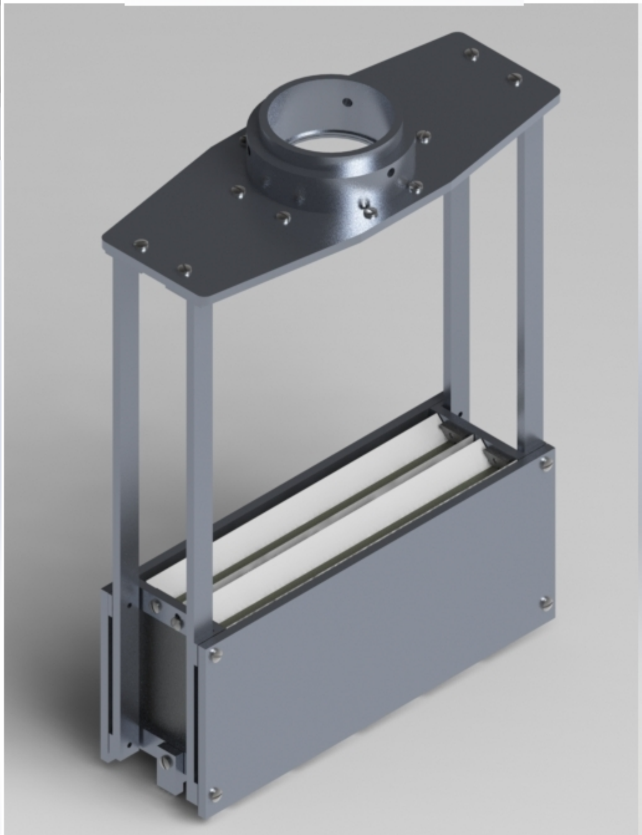
**(CAD and renders by Daniel)**

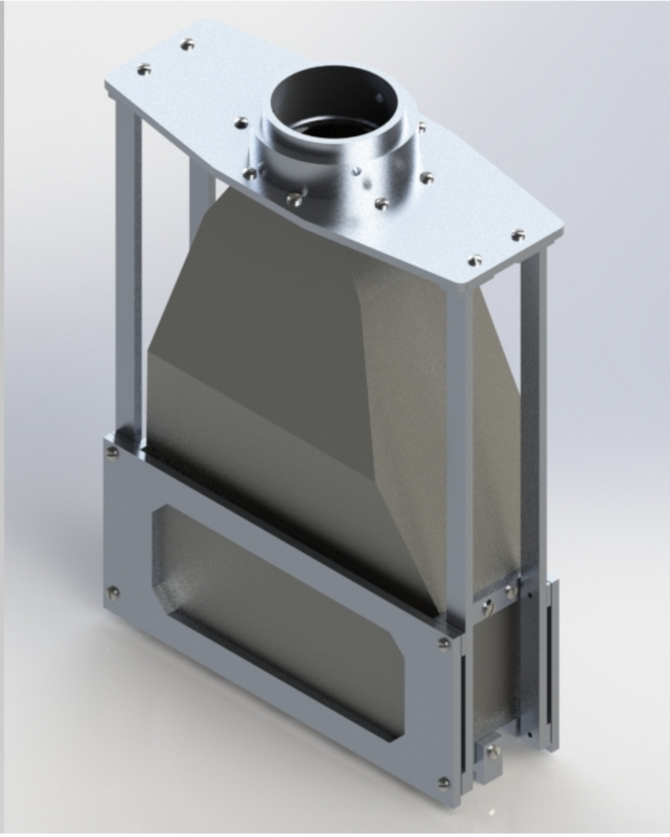






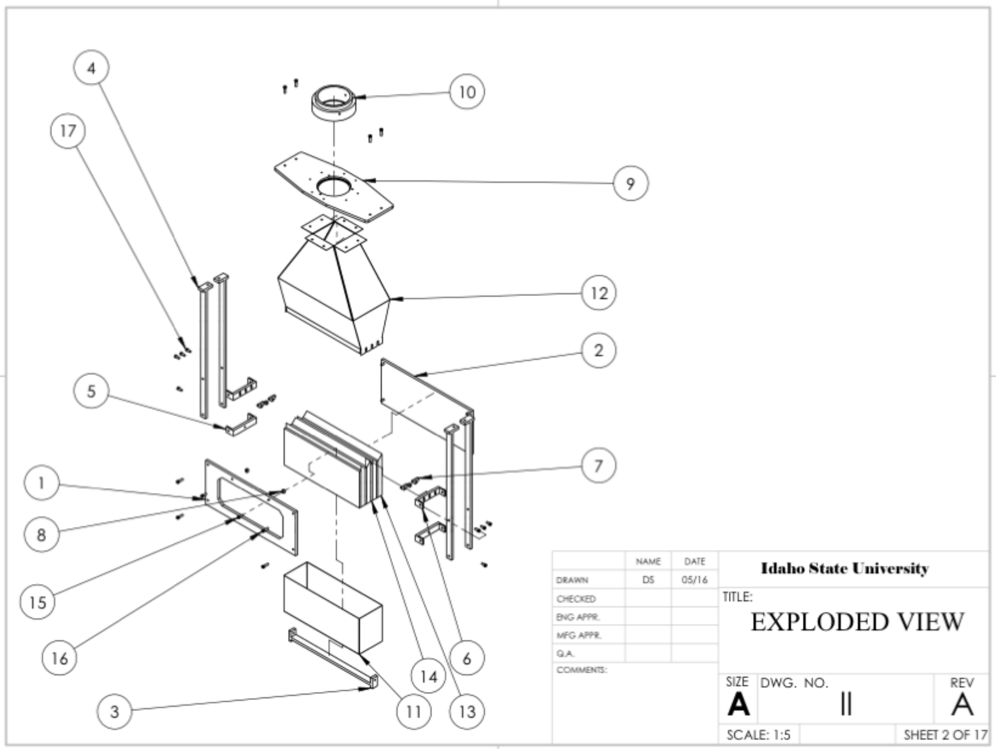




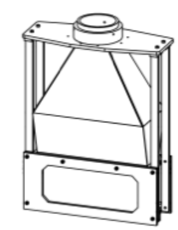


# Engineered machine shop drawings in hand

(Drawings by Daniel)




| # | PART | MATERIAL | QTY. |
|---|---|---|---|
| 1 | Face Plate | 0.25 (1/4) thick 6061-T651 Aluminum Plate | 1 |
| 2 | Back Plate | 0.25 (1/4) thick 6061-T651 Aluminum Plate | 1 |
| 3 | Base Beam | 1/4 x 5/8 6061 Aluminum Flat Bar | 1 |
| 4 | Long Beam | 1/4 x 5/8 6061 Aluminum Flat Bar | 4 |
| 5 | Lower Side Beam | (1/4 x 5/8) AND (1/8 x 5/8) 6061 Aluminum Flat Bar | 2 |
| 6 | Slotted Side Beam | (1/4 x 5/8) AND (1/8 x 5/8) 6061 Aluminum Flat Bar | 2 |
| 7 | Ledge | 3/16 6061 Aluminum | 4 |
| 8 | Ledge-Square | 1/4 6061 Aluminum | 4 |
| 9 | topPlate | 0.25 (1/4) thick 6061-T651 Aluminum Plate | 1 |
| 10 | 3in Ring | 4 OD x .500 wall x 3.00 ID 6061 Aluminum Round Tube | 1 |
| 11 | Suitcase | 0.020 Anolux MIRO-Silver Reflective Aluminium Sheet (Caution: no-scratch mirror surface required) | 1 |
| 12 | LG-StraightUp(recovery) | 0.020 Anolux MIRO-Silver Reflective Aluminium Sheet (Caution: no-scratch mirror surface required) | 1 |
| 13 | 4_pc_Quartz_open | | 4 |
| 14 | 4_pc_Tungsten_open | | 4 |
| 15 | CR-FIMS 0.164-32x0.4375x0.4375-N | | 2 |
| 16 | CR-FIMS 0.164-32x0.5625x0.5625-N | | 12 |
| 17 | CR-FIMS 0.164-32x0.375x0.375-N | | 8 |



Idaho State University

TITLE: BILL OF MATERIALS

SIZE A DWG. NO. III REV A

SCALE: 1:5 SHEET 3 OF 17

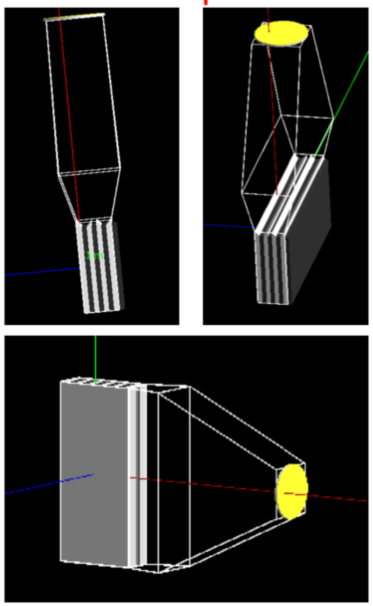
- These are ready to go to the shop or can be modified if needed

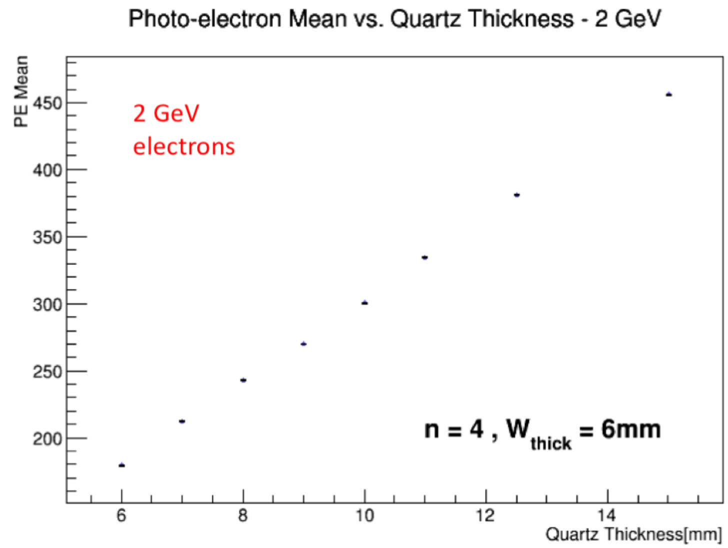
# What's going on now

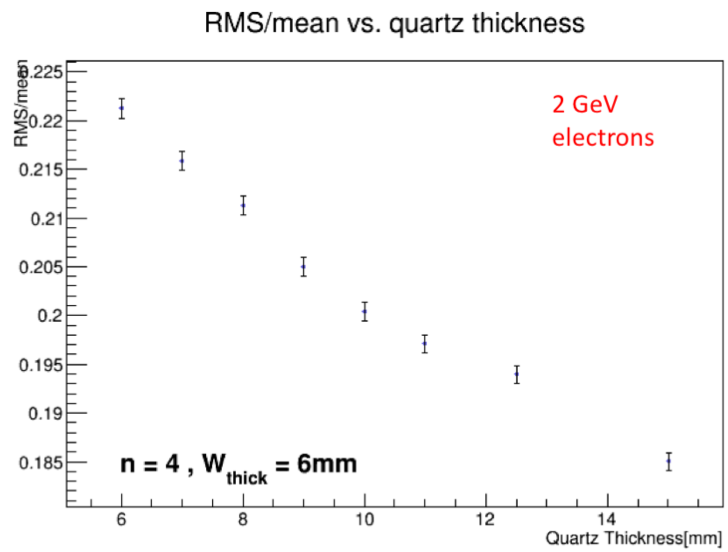
- New grad student Daniel Sluder doing Master's Thesis on Showermax development
  - He's now running G4-qsim on local farm cluster
  - Automated LG code in qsim for variable stack configurations – allowing for optimization studies
- We are now studying effect of quartz thickness on yield. Specifically:
  - we use a 4-layer stack ($n = 4$) with 6mm thick tungsten and variable quartz thickness from 6mm to 15mm
  - Note that all 4 quartz pieces are identical for a given config
- Next we plan to fix the quartz thickness to 6mm and vary the tungsten thickness – the goal here is to explore the cheapest and lowest acceptable PE yield options

# Optimization study1 (2 GeV): 6mm fixed tungsten, variable quartz

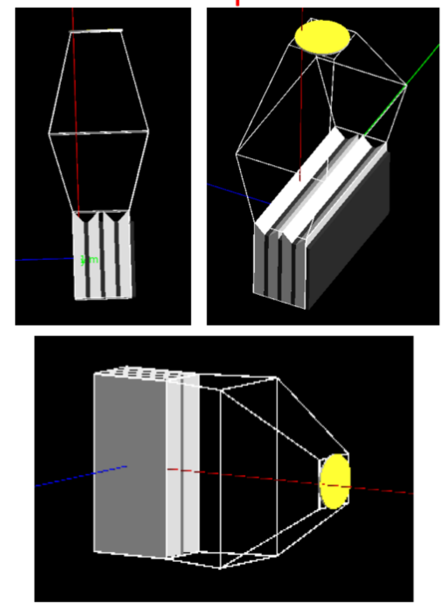
6mm quartz

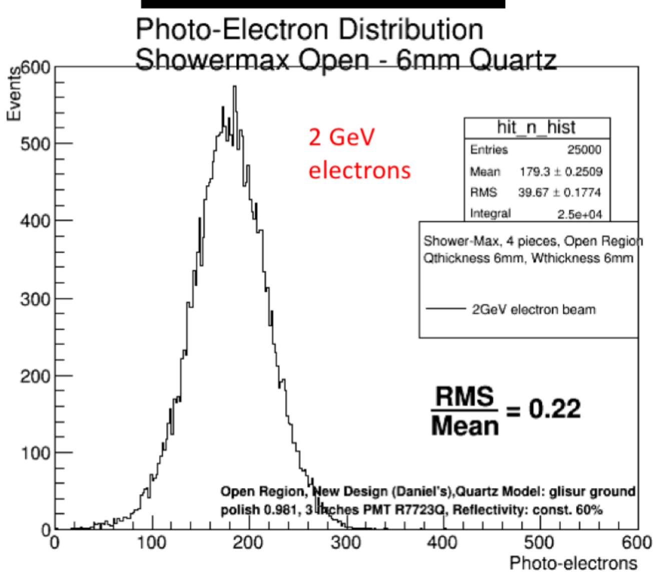


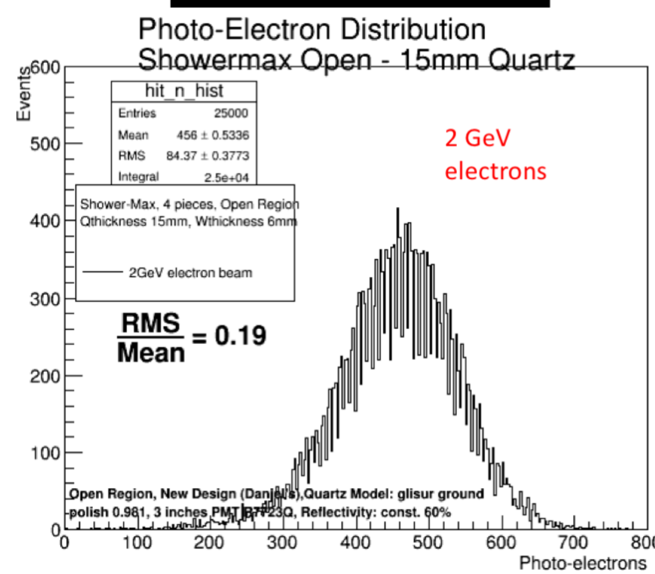



15mm quartz

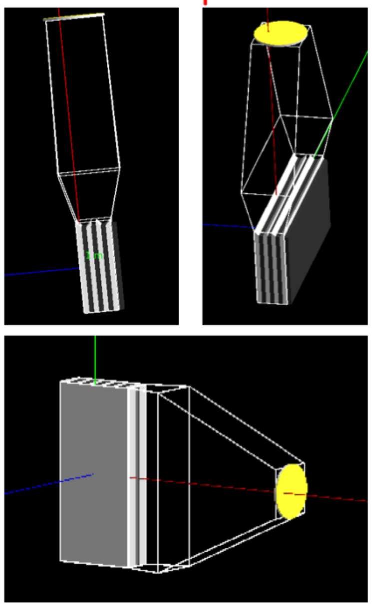


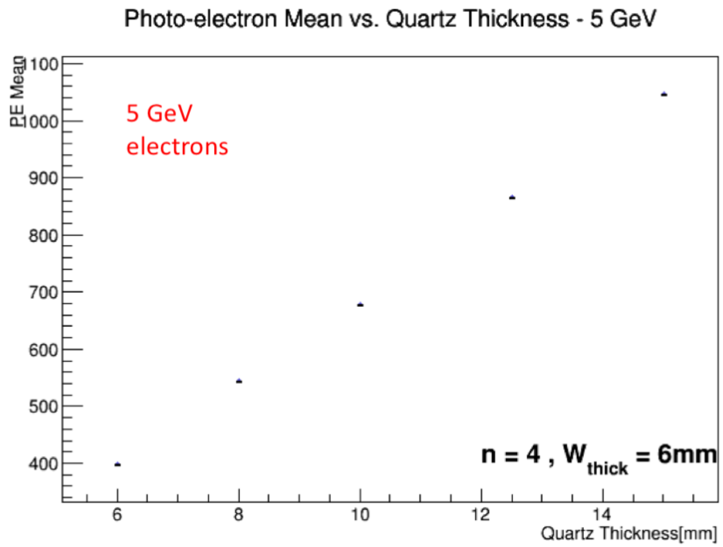


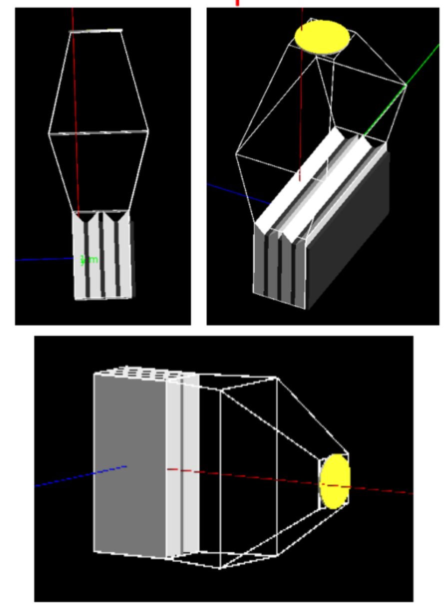
# Optimization study1 (5 GeV): 6mm fixed tungsten, variable quartz

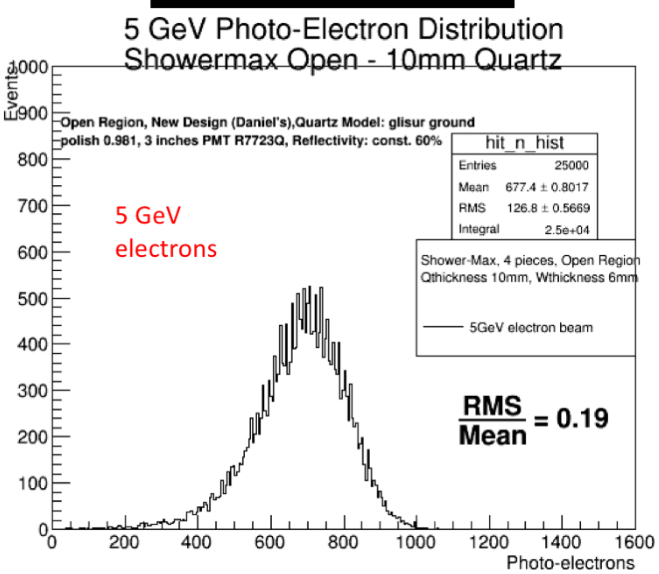
6mm quartz

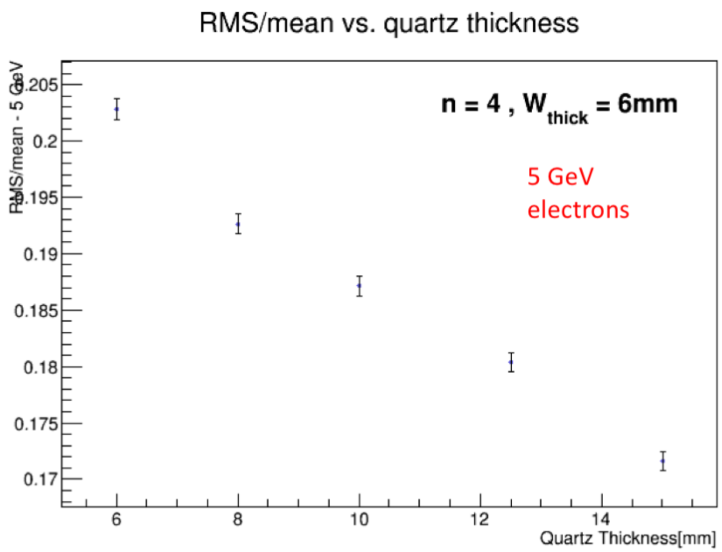


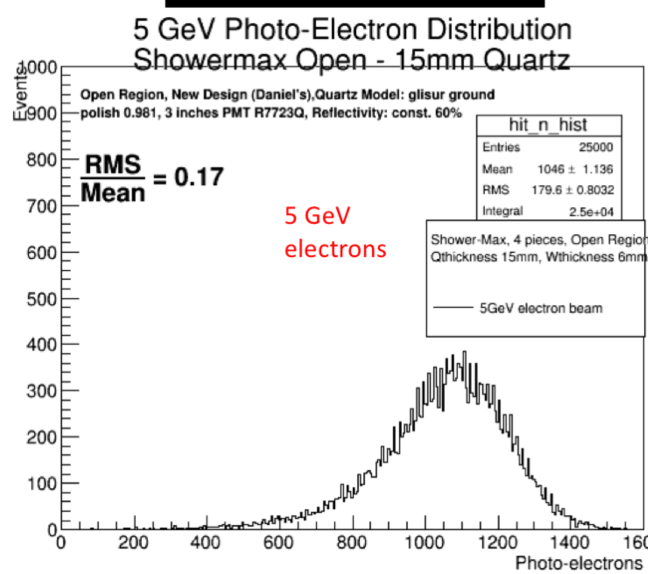



15mm quartz





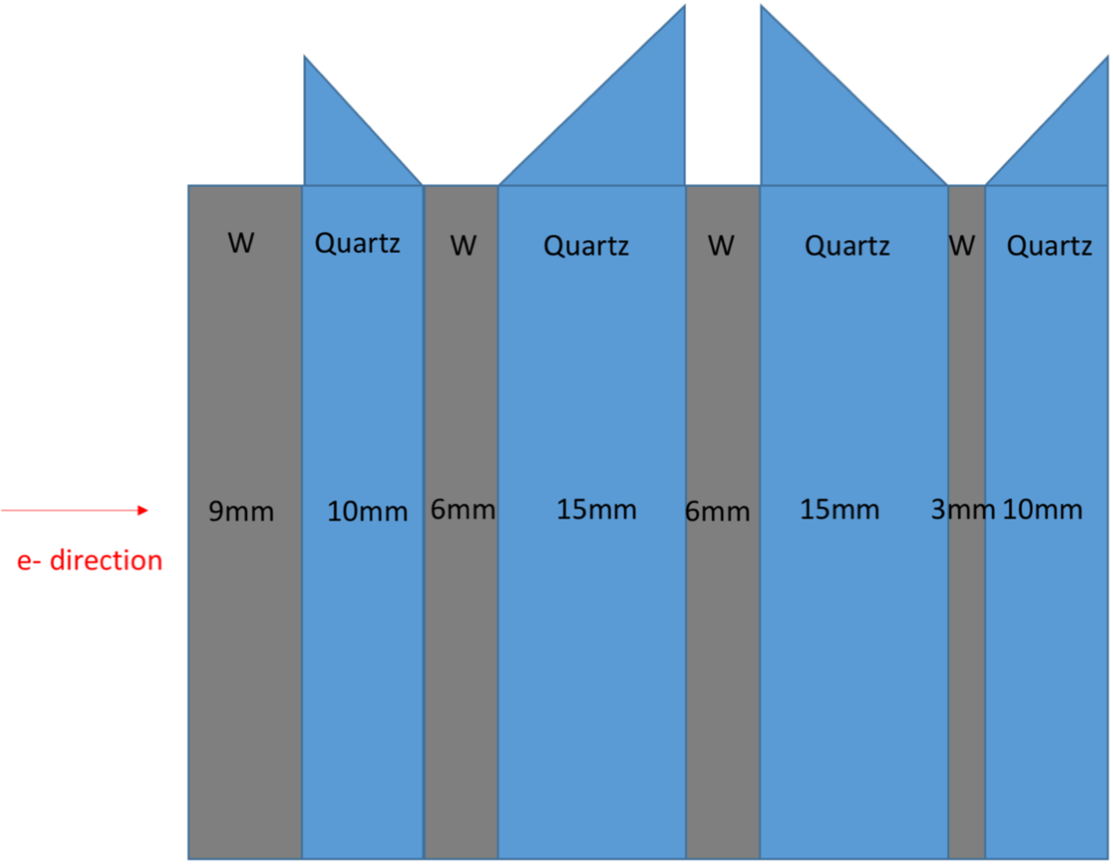



## Comments and plans for Simulation Studies

- 8GeV data is running now and will finish in a couple days
- Farming data is slow: 30 s/event for 2GeV; 120 s/event for 8GeV
  - 25k events take from 8 hrs (2GeV) to 32 hrs (8GeV) using twenty-five 1k-event jobs
  - At the moment we can only run 30 - 50 jobs at a time
- We have started preparing for the next study: variable tungsten and fixed quartz (6mm) thickness (still going with n = 4 layers for now). This is the *minimum* cost & PE yield design study
- Beyond this our plans are to explore the *maximum* PE yield (and cost) design which will potentially use different tungsten and quartz thicknesses for each of the different layers

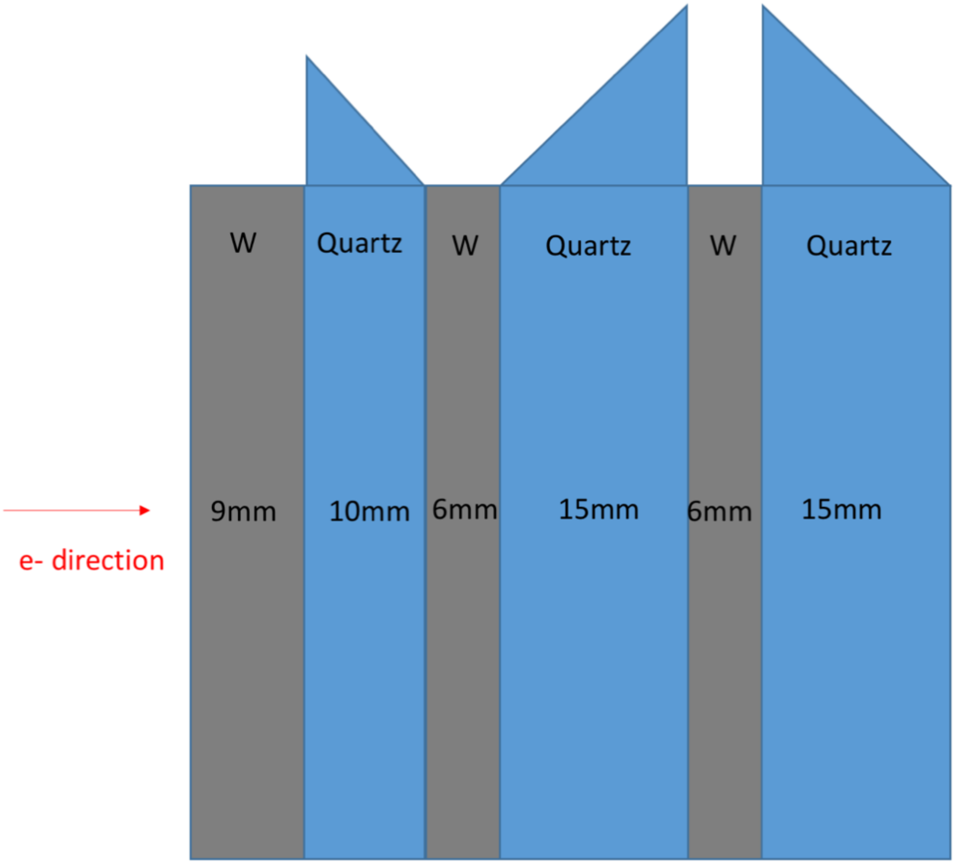
# Maximum PE yield proposed stack configuration

n=4, proposed optimal




Total: 24 mm Tungsten and 50 mm quartz (same as baseline)

n=3, proposed optimal




Total: 21 mm Tungsten and 40 mm quartz (n = 3)

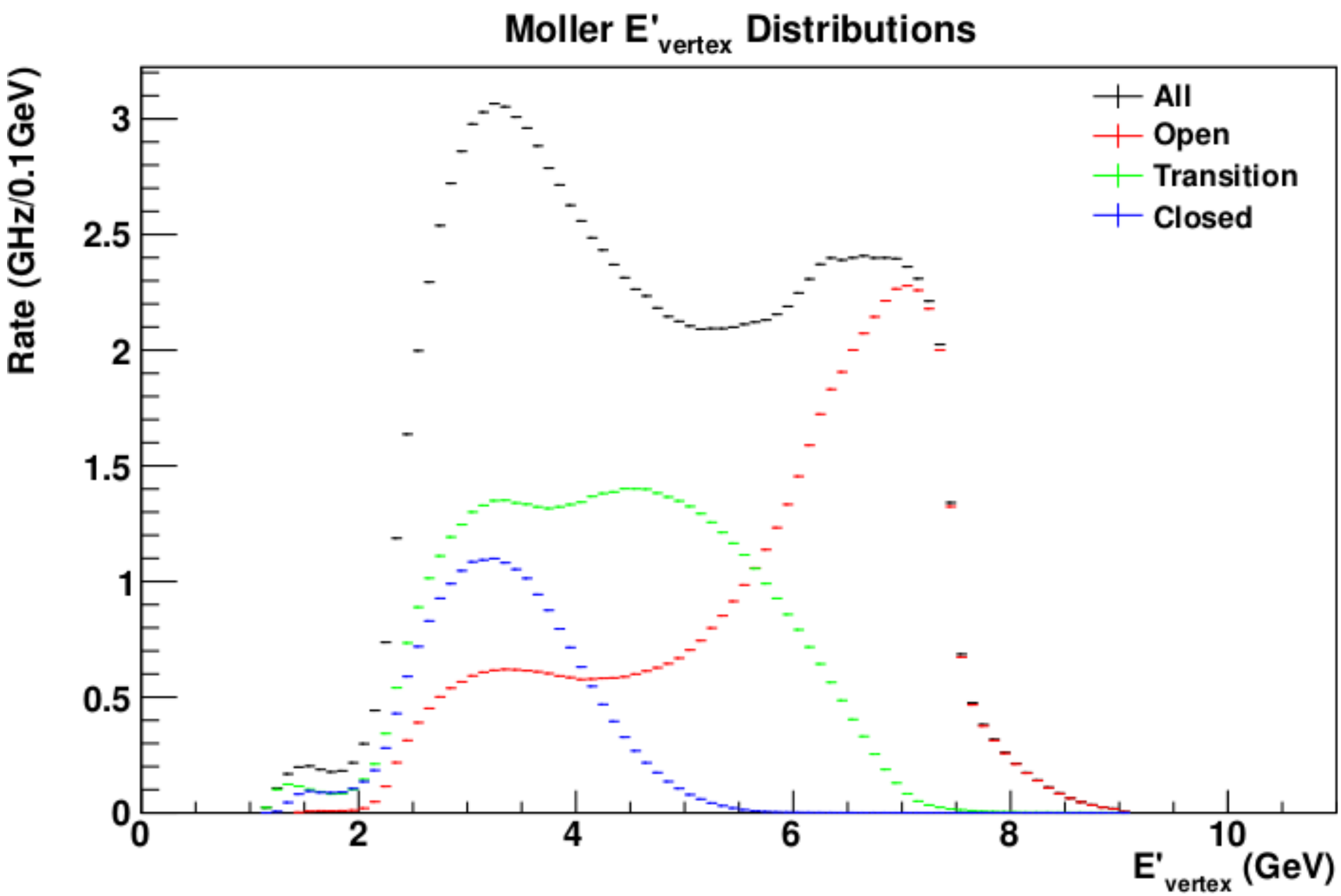
# Plans for prototyping and SLAC testbeam

- Finalize prototype stack configuration by end of year and order quartz and tungsten – typically 6 - 8 week lead-time
- Modify machine drawings for new stack and LG and send to shop – typically 2 - 4 weeks
- Assemble prototype by mid March 2017
- SLAC testbeam: Many questions:
  - When?
  - DAQ/trigger and HV? Mounting? Need 3" PMT.
- Would like to build 2 prototypes? for cross-talk studies. I can try to scrounge up some funds to make this happen

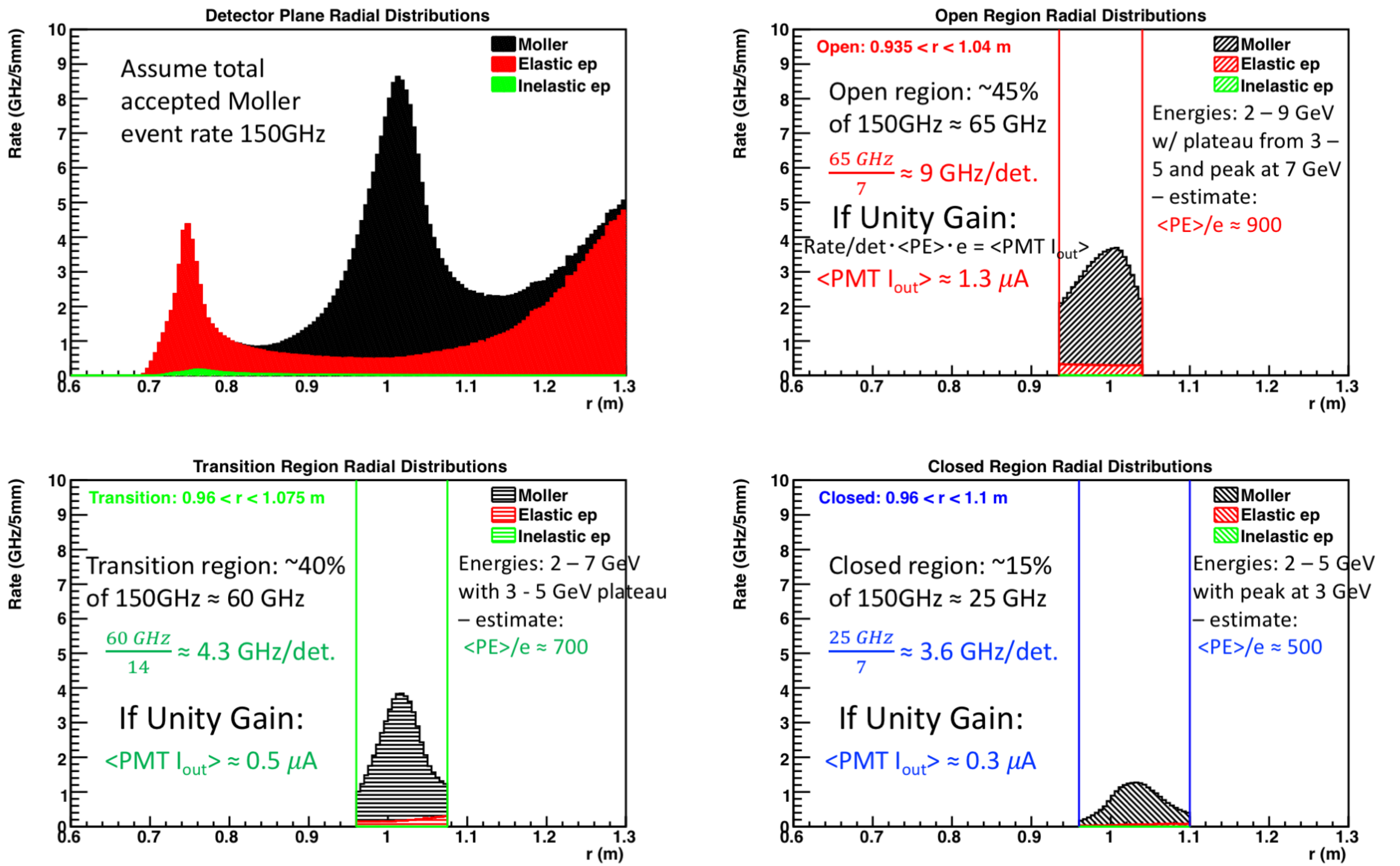
# Summary and Future Plans

- Need to decide which direction to pursue for stack configuration: Minimum, moderate, or max PE yield design?
  - Connected to this question is issue of unity gain operation during integration mode? This seems feasible – still looking into it
  - Do we want to consider having different stack designs for the three types of detectors: Open, closed, transition?
- Need to study PE yield uniformity across face of detector
- Need to incorporate LG reflectivity lookup tables (using 60%)
- Would like to sample realistic electron energy distributions for each region: Open, closed, and transition (instead of just 2, 5 and 8GeV) see next slide
- Incident angle dependence? Probably not much, but check.

# Energy Dists for Open, Closed, and Transition



# Unity Gain operation with Baseline design?




- Could be possible to use conventional 3” pmts with electronic switching between unity gain base (integrating mode) and high gain base (counting mode)

# Workload distribution with SBU

- Showermax optical simulations are very time consuming
  - As simulation becomes more realistic (with proper energy and position sampling along with reflectivity lookup), it will take even longer to generate events
  - Need more powerful cluster and could use more manpower to farm and analyze the jobs – *SBU student*
- Need to incorporate realistic energy, position, and reflectivity sampling into “qsim-stack” – *SBU student*
- *SBU student* could also do optimal funnel angle and uniformity studies for chosen stack configurations
- In general, would be nice to have outside group look over and use our qsim stack code – double check for bugs/problems and improve the code

# Ring of staggered Open prototypes