T-577 Testbeam Run Setup and Goals

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T-577 Beam Request

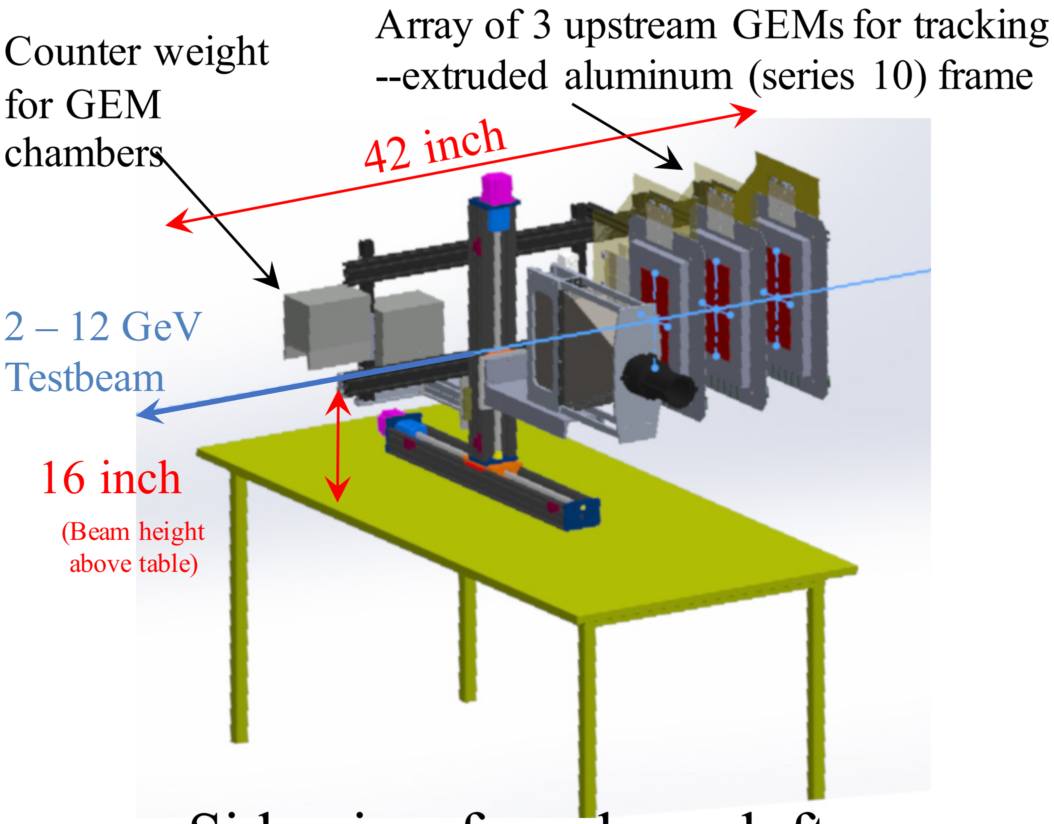
- We would like secondary, single-event mode electron beam. Ideally we want one electron at a time, but understand we'll get a Poisson distribution—so sometimes 1, 2 or possibly 3.

- Beam spot size ideally is pin-point but we're prepared for golf or baseball size spots…
  - Our detectors have position and angle sensitivity to incident electron and so we have GEM tracking chambers to get trajectories.

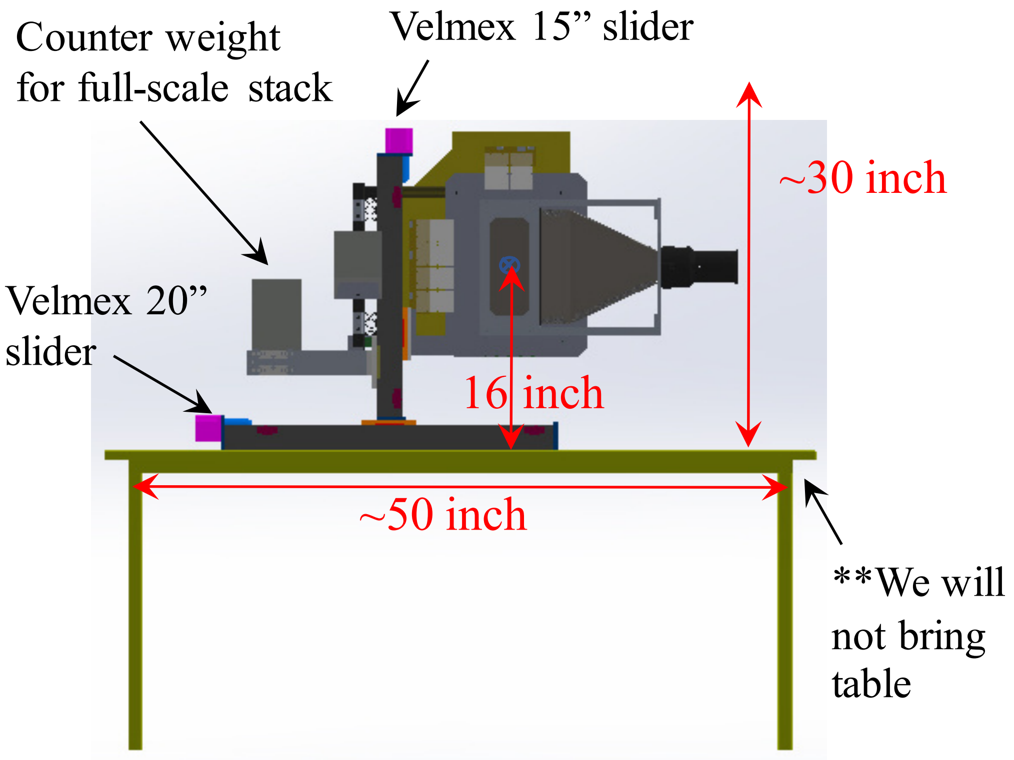
- Beam energies should be 3, 5.5, and 8 GeV for roughly 1/3 of the time each. How long does it take to change energy?

- We have our own remote controllable motion system to move all our beamline components out of beam for any potential tuning or higher than single-event mode currents.

T-577 Beamline Setup



Side view from beamleft



View from downstream

T-577 General Run Plan

- Start with commissioning of trigger, timing and DAQ setup using nominal beam; also exercise motion system and find edges of detector active area (alignment position).

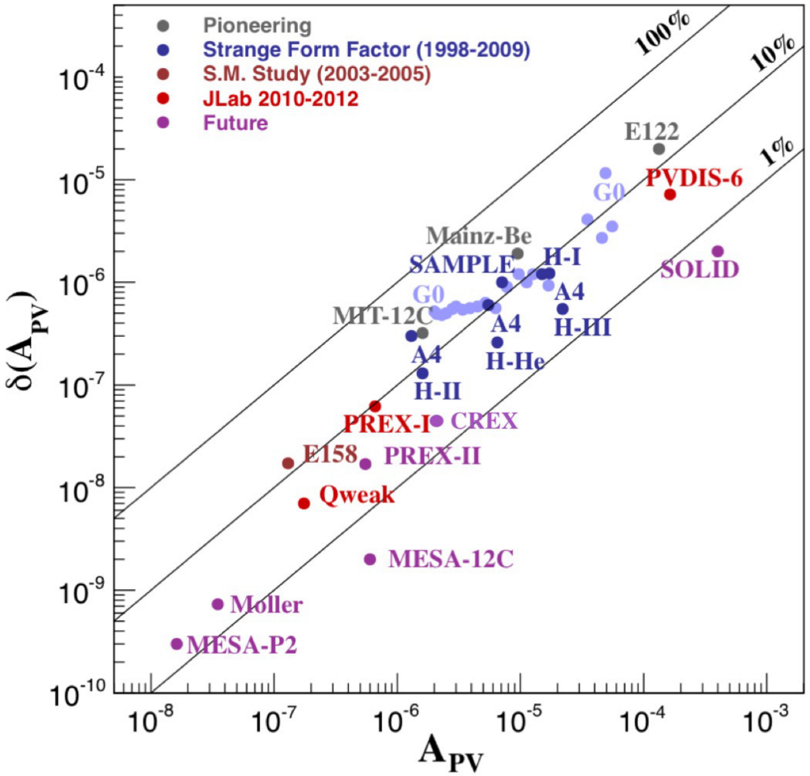
- Main programs: Test "full-scale" and "benchmarking" MOLLER ShowerMax detectors: examine light yield and resolution uniformity over the face of detectors
  - For full-scale testing, accesses are expected around every 4 – 5 hours if we are running smoothly
  - For the benchmarking detector there will be more frequent (and ~quick) accesses around every 1 – 2 hours.
  - The two above studies are expected to take ~4 days of beamtime at 12 hours per day.

- Secondary programs involve testing thin quartz detectors for MOLLER and PREX-II/CREX. This uses same beamline setup and will have accesses every few hours to swap in new detectors, but we really only need a minimal set of measurements for these and not the full scans

3 Decades of Technical Progress

photocathodes, polarimetry, high power cryotargets, nanometer beam stability, precision beam diagnostics, low noise electronics, rad-hard dets

PVeS Experiment Summary



1st generation

2nd generation

3rd generation

4th generation

E122 – 1st PVES Expt (late 70's at SLAC)

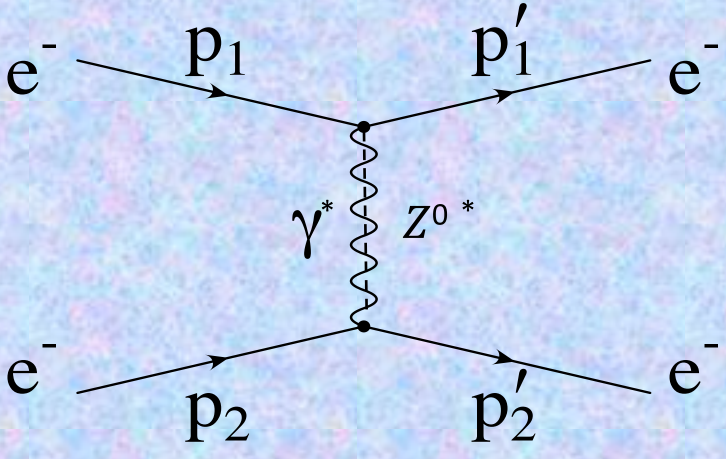
Mainz & MIT-Bates in mid 80's

JLab program launched in mid 90's

E158 at SLAC meas PV Møller scattering

- Parity-violating electron scattering has become a precision tool

The MOLLER Project at Jefferson Lab:



***M**easurement*

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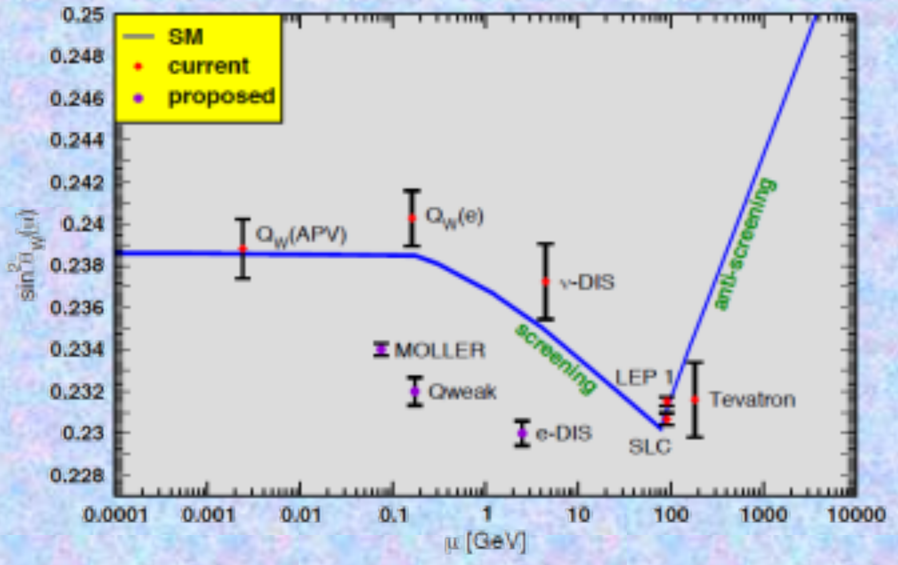
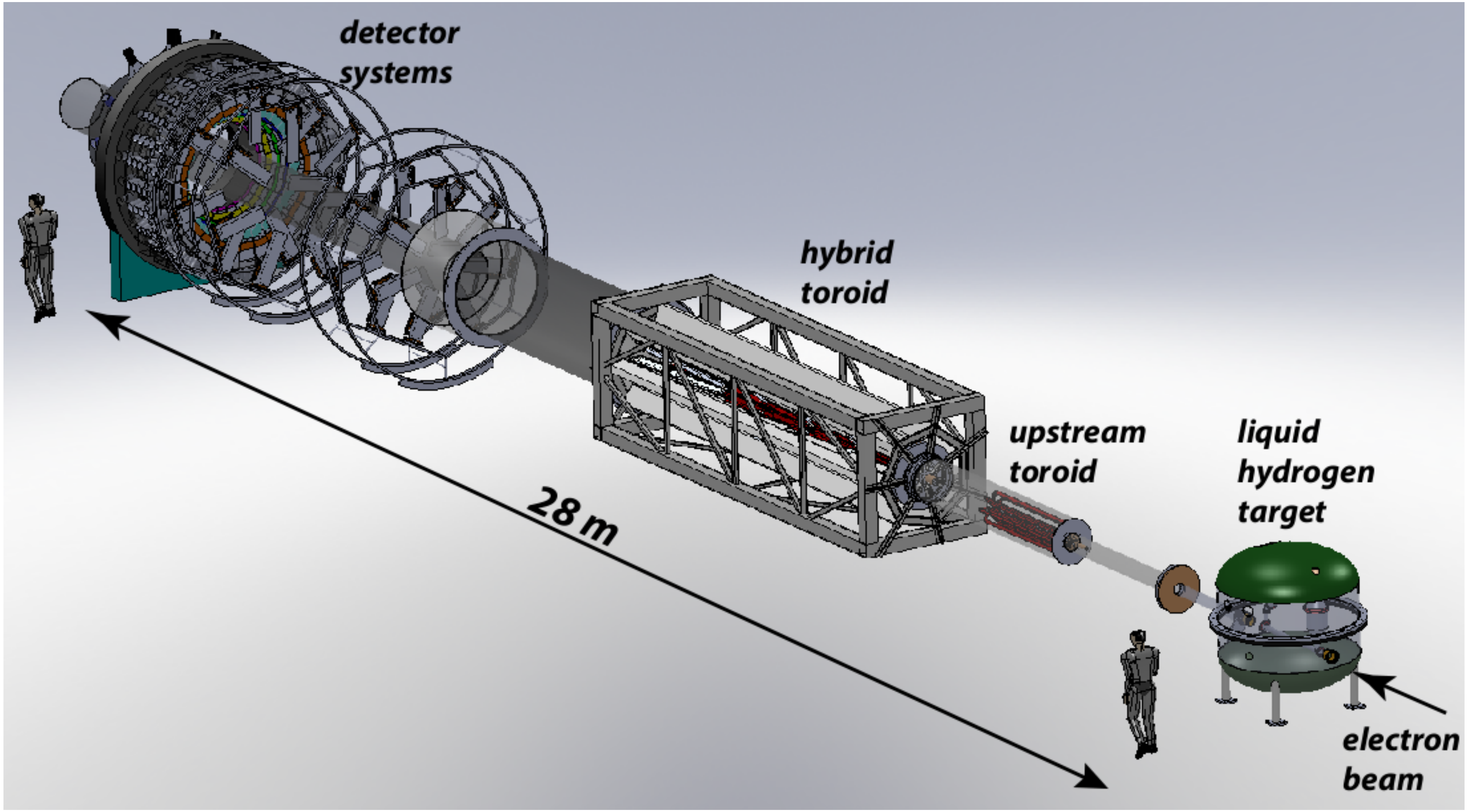
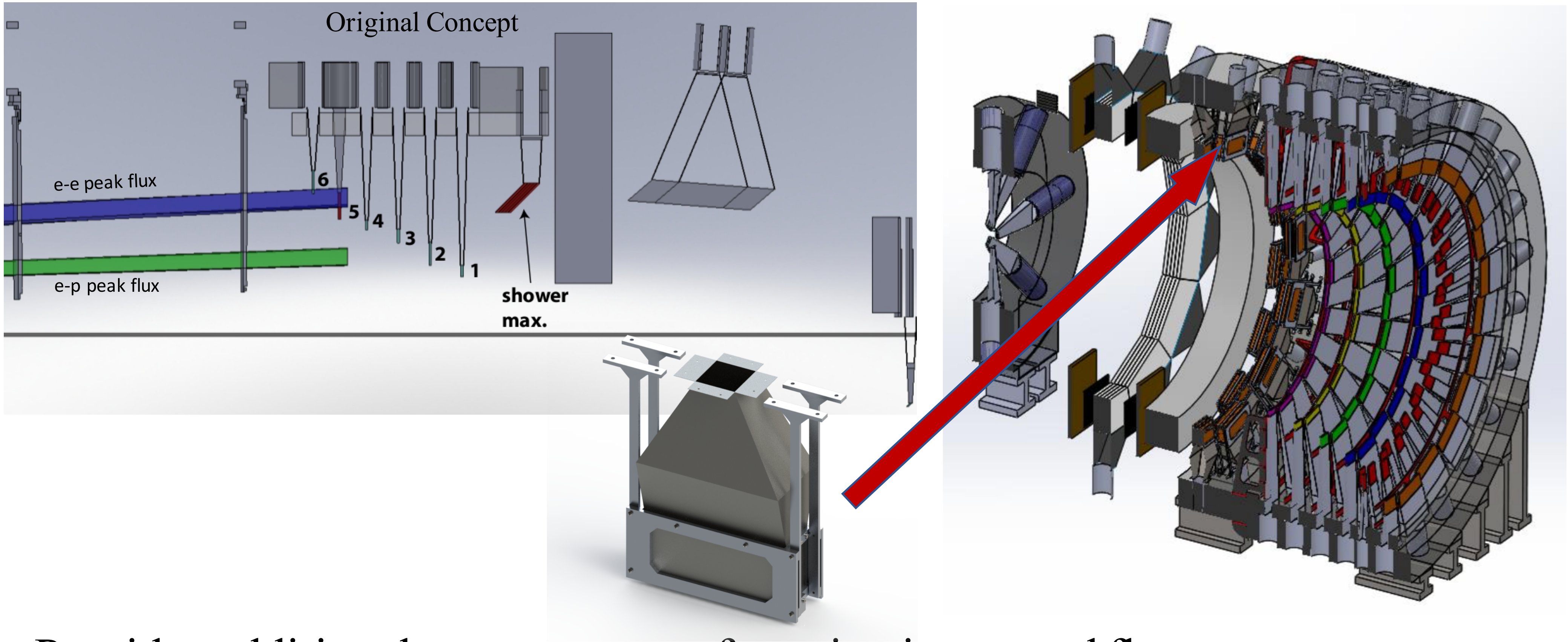
***R**eaction*



MOLLER Apparatus at Jefferson Lab Hall A



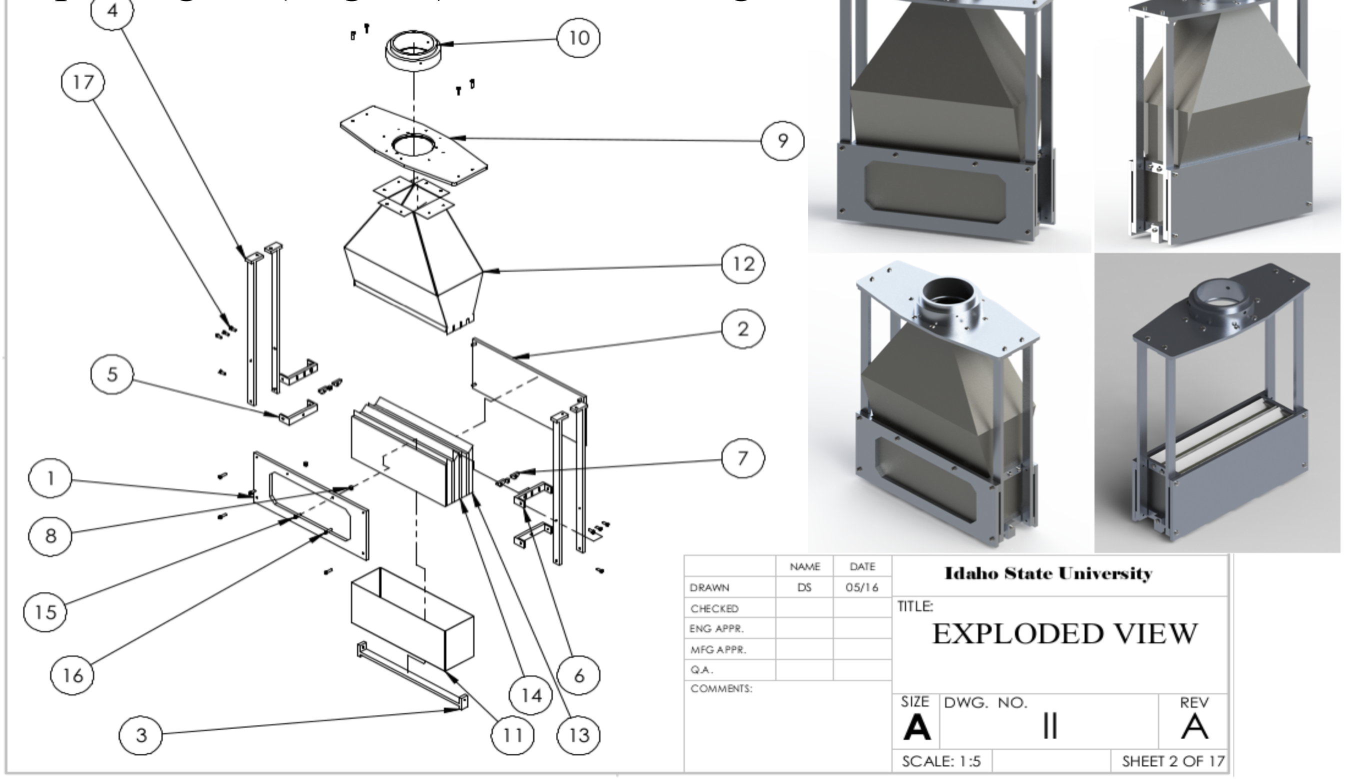
ShowerMax Detector Motivation

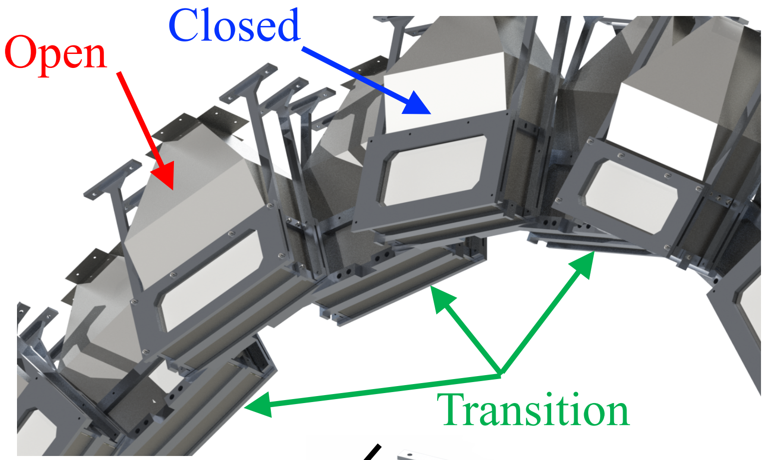


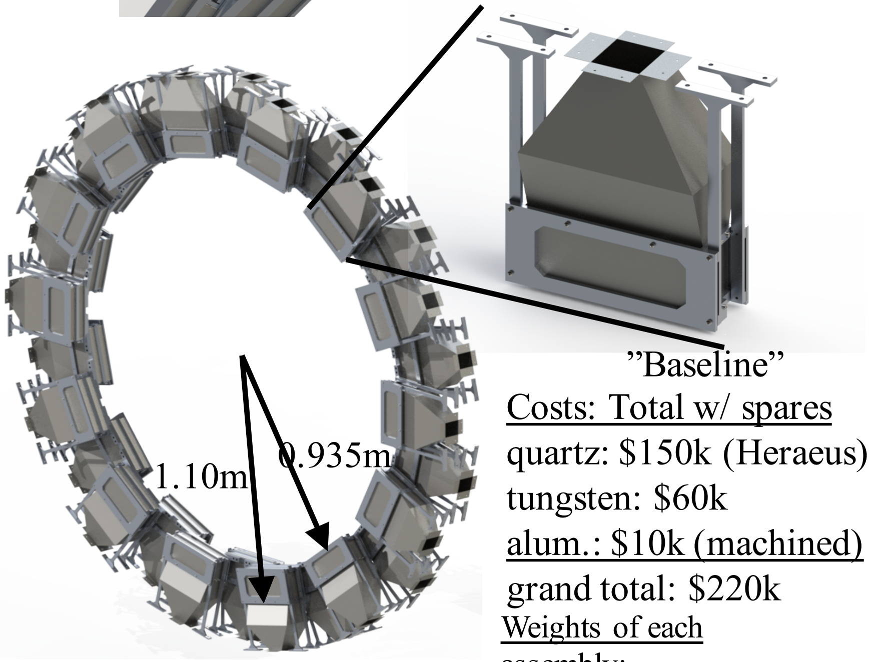
- Provides additional measurement of e-e ring integrated flux
- Weights flux by energy $\Longrightarrow$ less sensitive to low energy and hadronic backgrounds
- Will also operate in tracking mode to give additional handle on background (pion) identification – gives MIP-like signal
- Should have good resolution over full energy range ($\frac{\sigma}{\langle n \rangle} \lesssim 25\%$), long term stability and be radiation hard

Baseline ShowerMax Design and Ring Concept

Open region (original) Baseline Design







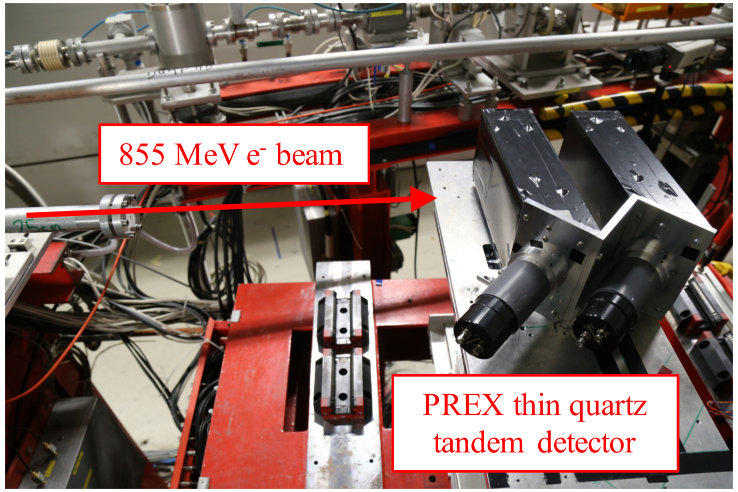
- Engineered shop drawings for full-scale prototypes in hand
- ***PLANS***: Finalized prototype Stack designs last fall and ordered prototype quartz in Nov 2017, construct in winter/spring 2018 and test in summer/fall using 2 - 10 GeV electron SLAC testbeam
- Shower-max ring design concept: staggered in $\hat{z}$ with reinforced struts and brackets. 28 detectors in ring: 7 Open, 7 Closed, and 14 Transition

<u>Costs: Total w/ spares</u>
quartz: $150k (Heraeus)
tungsten: $60k
<u>alum.: $10k (machined)</u>
grand total: $220k

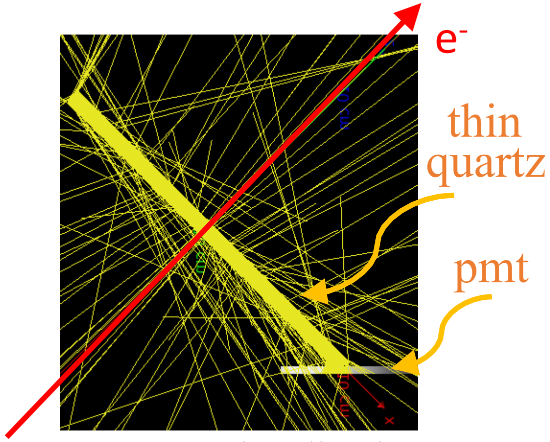
<u>Weights of each assembly:</u>
Open: 39.7 lbs.
Transition: 42.5 lbs.
Closed: 50.8 lbs.
ring weight: 1230 lbs.

Benchmarking G4 Optical Monte Carlo with Testbeam Data

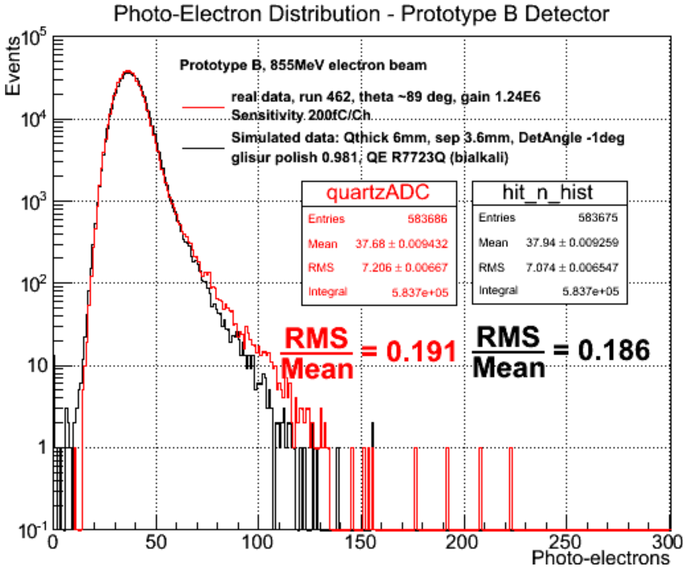
- Quartz optical G4 properties benchmarked at MAMI: Glisur ground polish parameter ~0.981



MAMI testbeam with PREX detector



G4 event visualization for PREX detector



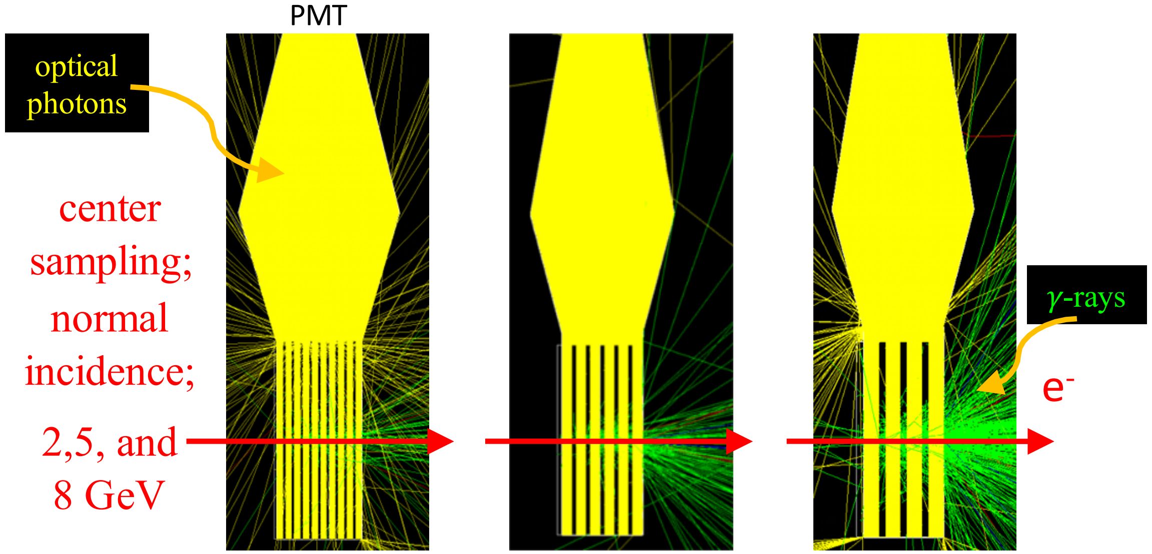
PE dists: *Real data* vs. *Sim data*

- Stack configuration MC study:

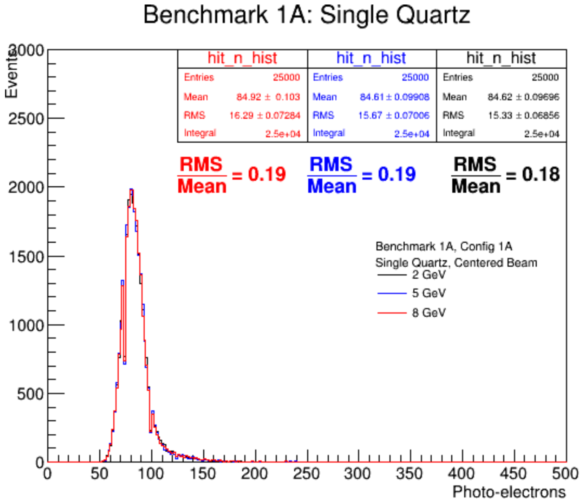
❖ Stack thicknesses all same (9.5 X_0)
❖ 2, 5, and 8 GeV incident electrons
❖ PE dists generated using tuned polish parameter and 60% LG reflectivity

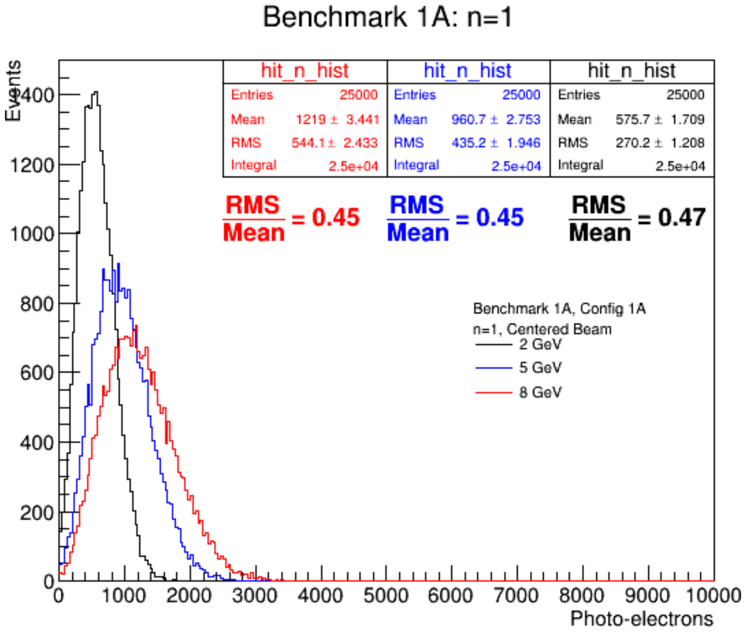
Conclusion:

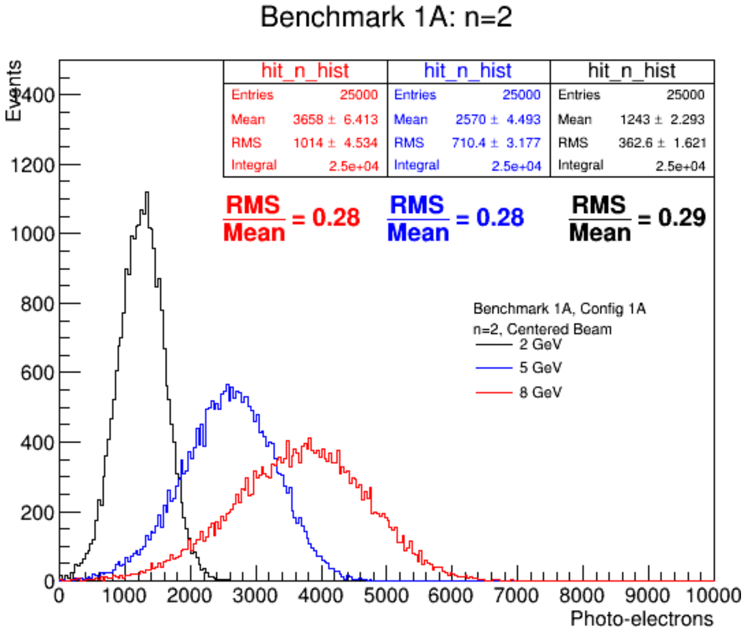
4-layer gives comparable performance to 10-layer
(and is easier and cheaper to build)



Shower-max event visualizations







- •Benchmarking PE yields are incredibly high for n =1 to 4
- •Will use 3” ET PMTs: 9305QKB
- •May use ND filters with 1, 10, 25, 50, and 80% transmission