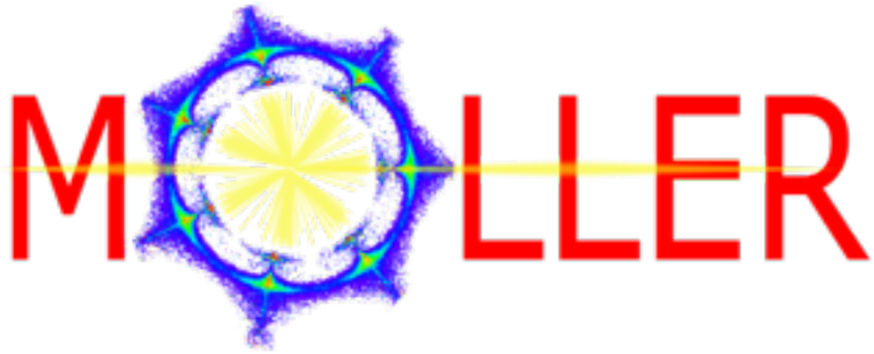


Status Update

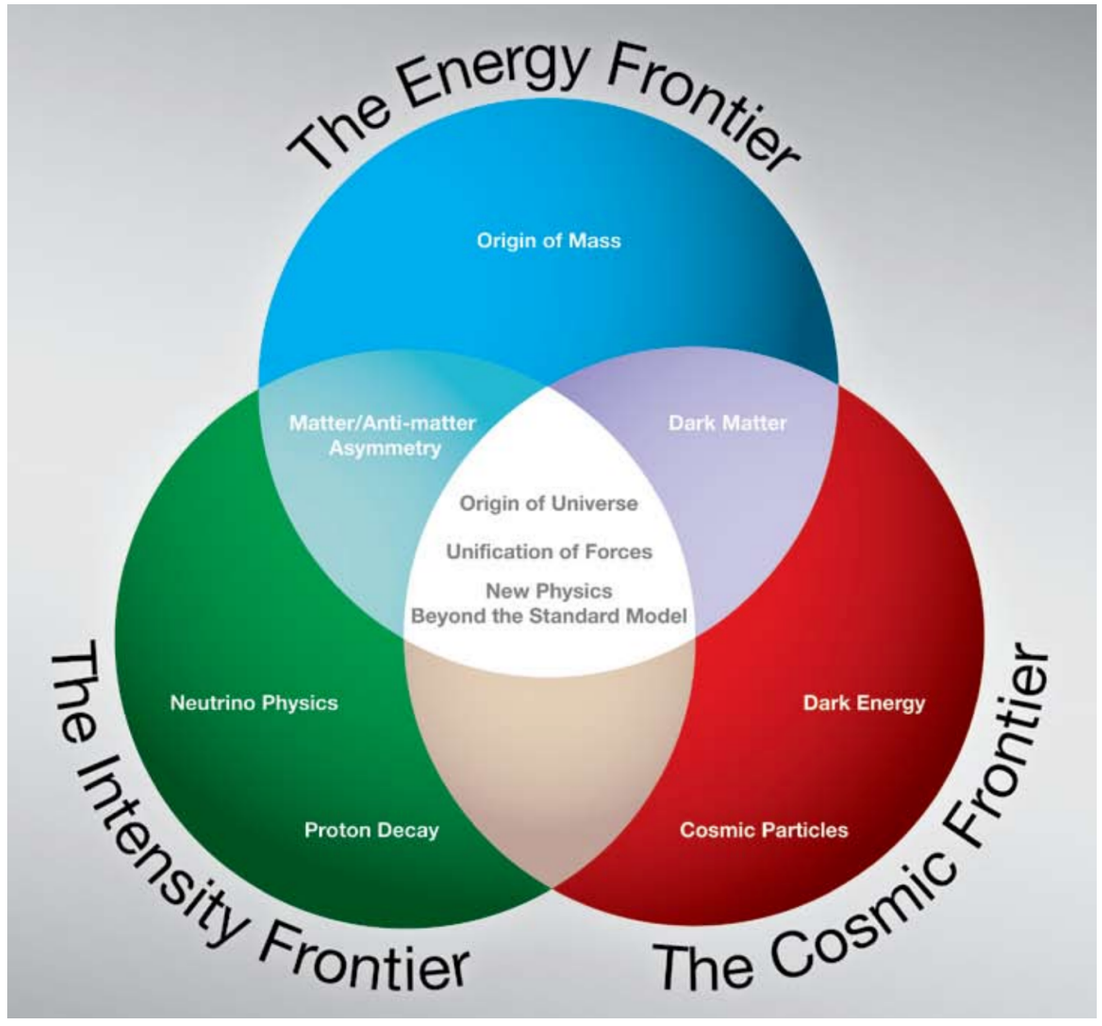
Ciprian Gal
University of Virginia

Why MOLLER?

- Complementary to direct searches for physical processes that explain some of the inconsistencies in the SM, indirect searches provide cross checks and new insights

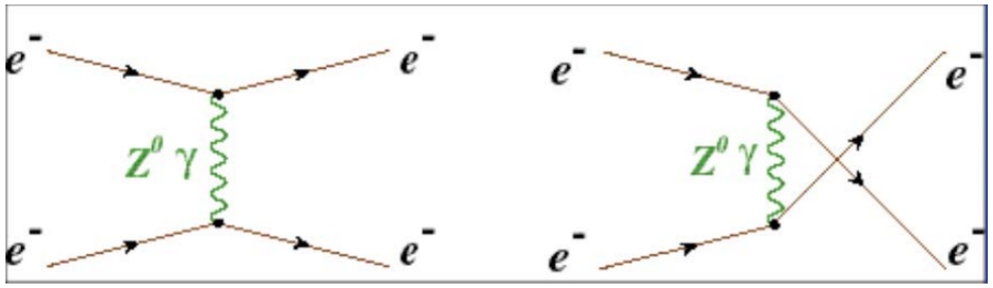
- Any anomaly seen at the LHC will require crucial input for the properties of the new particles from sensitive probes like MOLLER or *g*-2

- Moreover MOLLER surveys a phase space that will not be directly accessible at colliders



https://science.energy.gov/~/media/hep/pdf/files/pdfs/p5_report_06022008.pdf

Weak neutral current vector charge



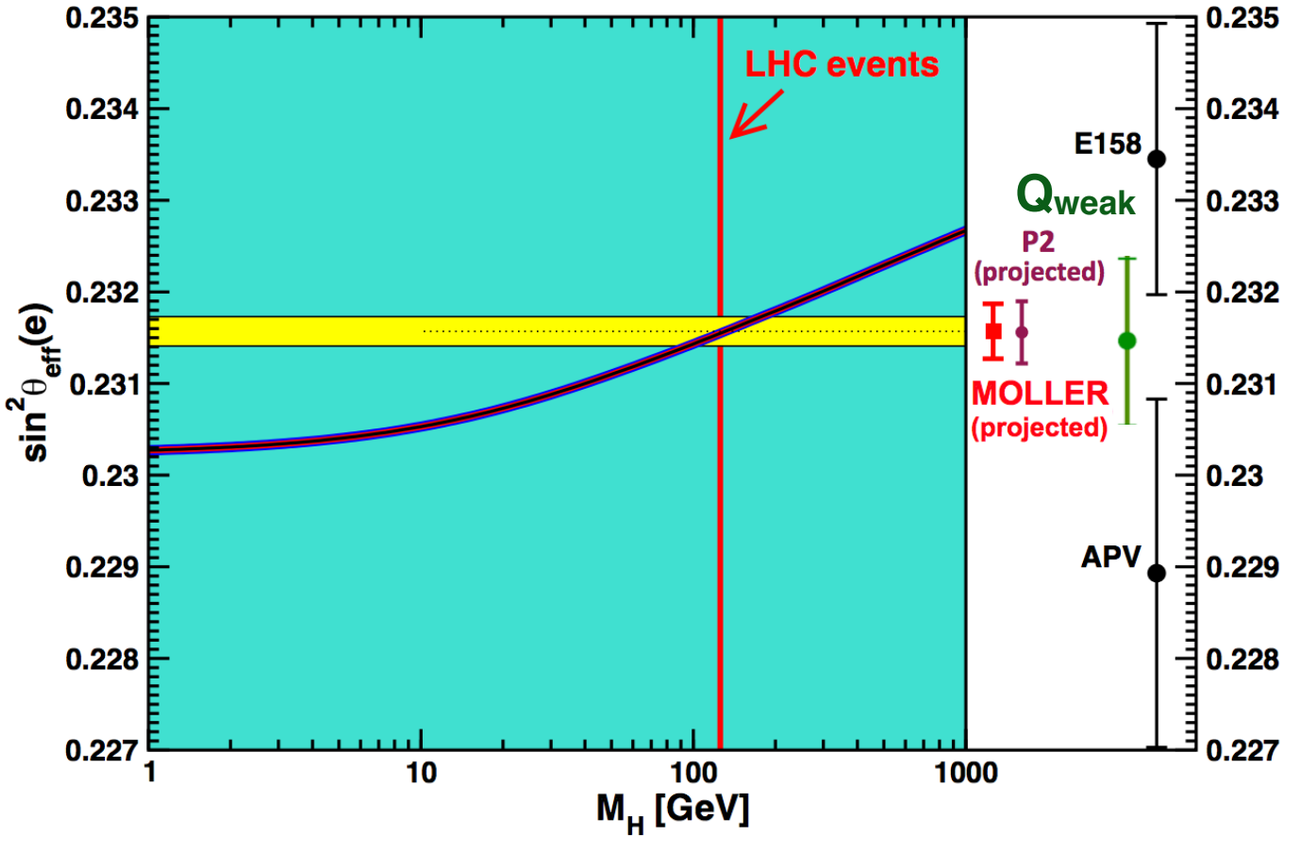
$$A_{PV} = \frac{\sigma_R - \sigma_L}{\sigma_R + \sigma_L} \sim \frac{\gamma \quad Z^0}{\left| \gamma \right|^2} \propto \frac{|\mathcal{M}_Z|}{|\mathcal{M}_\gamma|}$$

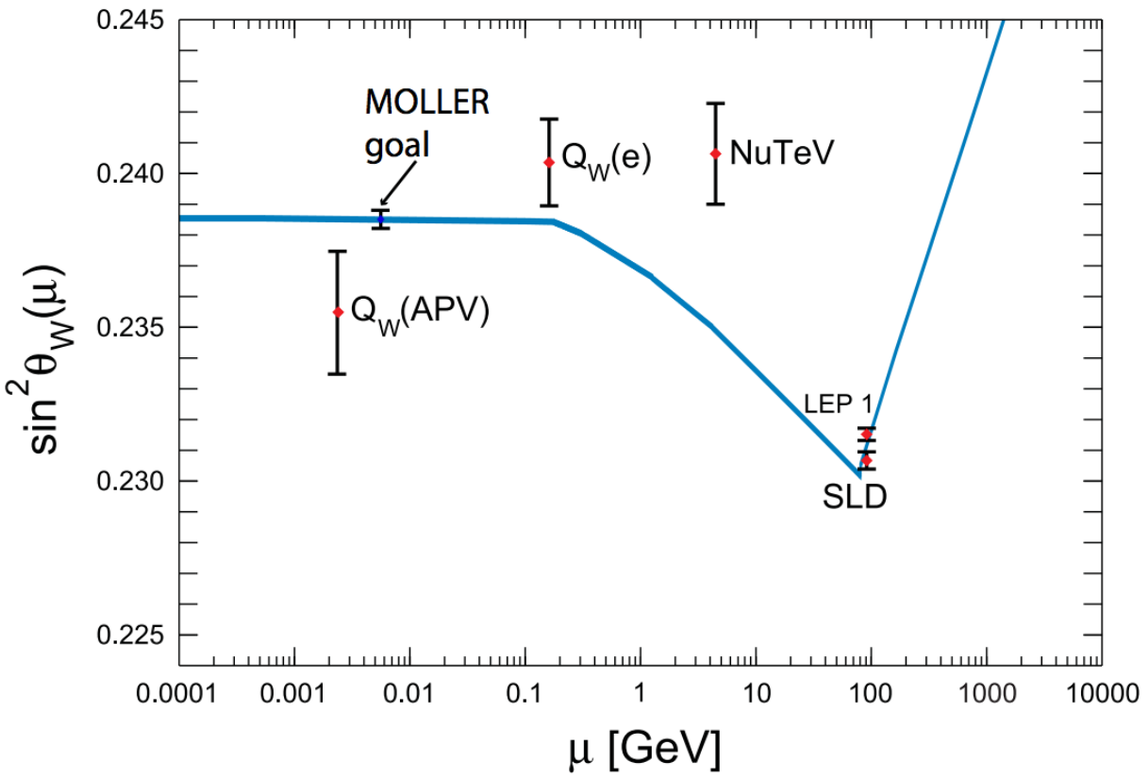
- With the discovery of the 126 GeV Higgs SM boson, the parity-violating asymmetry in Møller scattering is predicted at the <1% level
- Suppression of the weak neutral current vector coupling provides an enhanced sensitivity to new physics
  - most sensitive probe of new flavor and CP-conserving neutrons current interactions over the next decade

	EM Charge	WNC Vector Charge
u	$+\frac{2}{3}$	$1 - \frac{8}{3}\sin^2\theta_W$
d	$-\frac{1}{3}$	$-1 + \frac{4}{3}\sin^2\theta_W$
$p = 2u + d$	$+1$	$1 - 4\sin^2\theta_W$
$n = u + 2d$	0	-1
e	-1	$-(1 - 4\sin^2\theta_W)$

*tree level. Radiative corrections from one loop and higher are being evaluated and expected to provide ~1-2% corrections to the measured PV asymmetry

Weak mixing angle

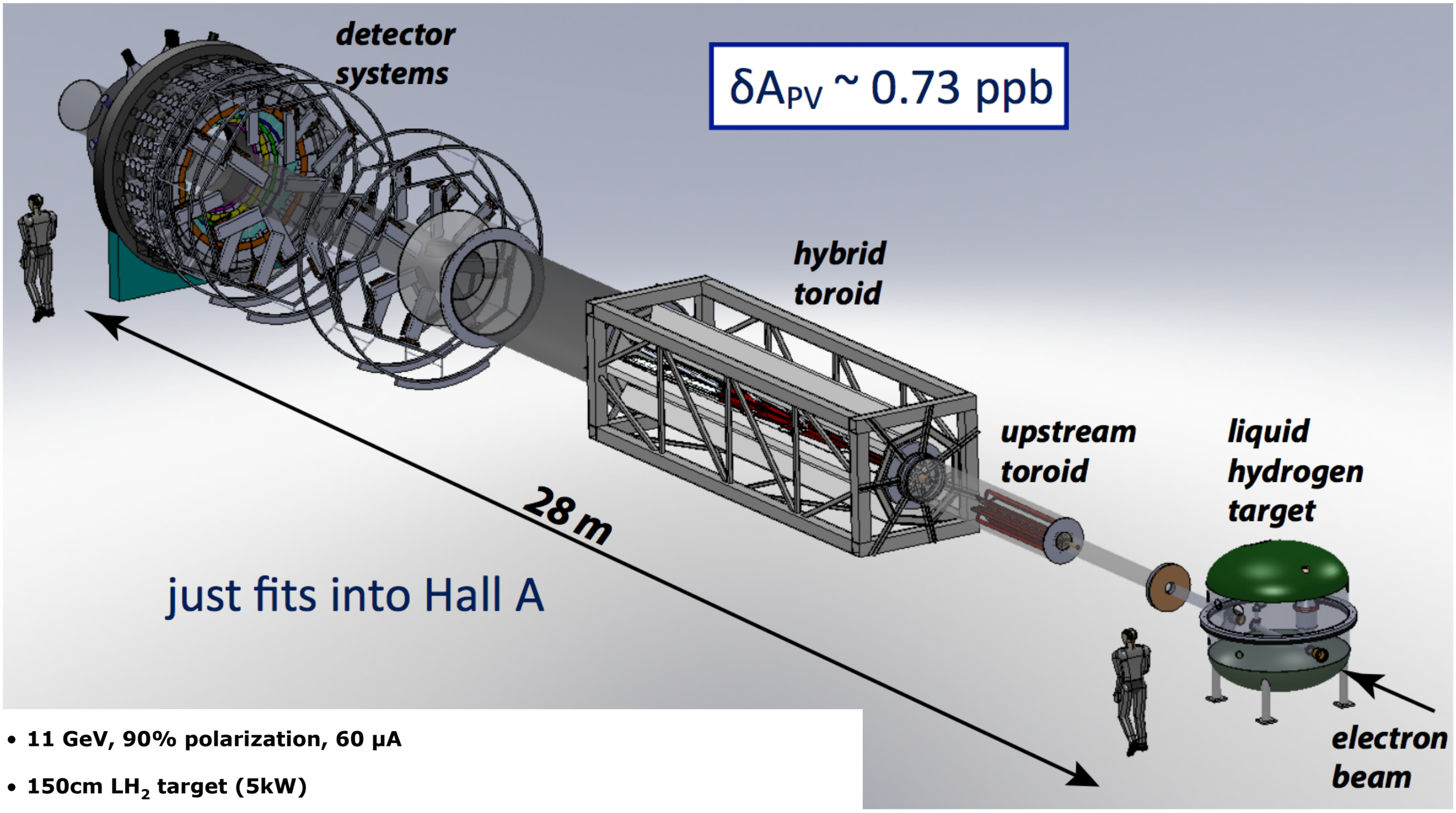




- The determination of the weak mixing angle from the MOLLER experiment will be on par with the best collider determination at the Z-pole (~0.1% precision)

- The low energy measurement constrains dark-Z models that predict mixing between the SM Z_0 and a dark sector Z_d

Basic experimental design



- **11 GeV, 90% polarization, 60 μA**
- **150cm LH_2 target (5kW)**
- **Novel toroidal spectrometer**
- **Segmented integrating detectors + counting detectors (for background)**

Project

- After successful CD-0 review the project is still in a “paused” state
- The collaboration is hard at work improving the design of the detector, shielding, spectrometer, and target
- Our main working groups are very active with an emphasis on dealing with recommendations from previous reviews
- Beginning to think about getting support from NSF and NSERC
- Important progress to obtain future TRIUMF support (Manitoba)
- Lab Management is helping us with project management organization

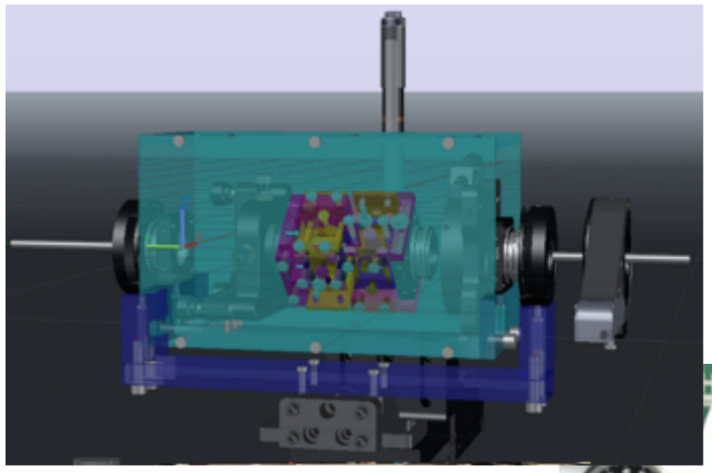
Spectrometer update

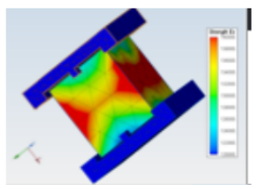
- A test coil has been constructed (final acceptance at Vendor by end of Jan 2018)
- Tests plan is in place to characterize and stress the coil
- Series of simulation studies needed to evaluate radiation load on coils is underway
- TOSCA field simulations are being produced to evaluate spectrometer construction tolerances, fringe fields and effects from environmental variations

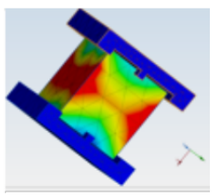
Polarized Source

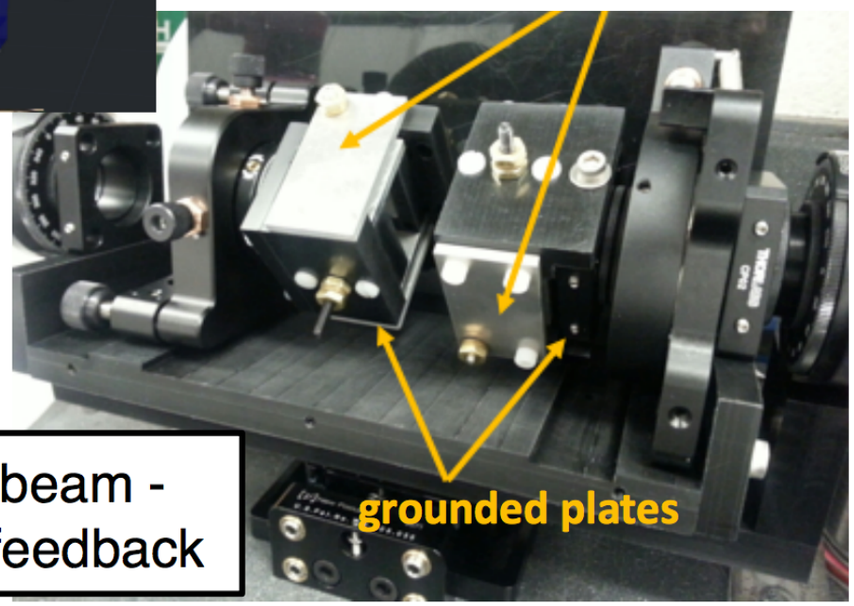
MOLLER requires a 2kHz helicity flip with a 10 μs settle time (Qweak: 1kHz, 60 μs)

RTP upgrade (UVa):









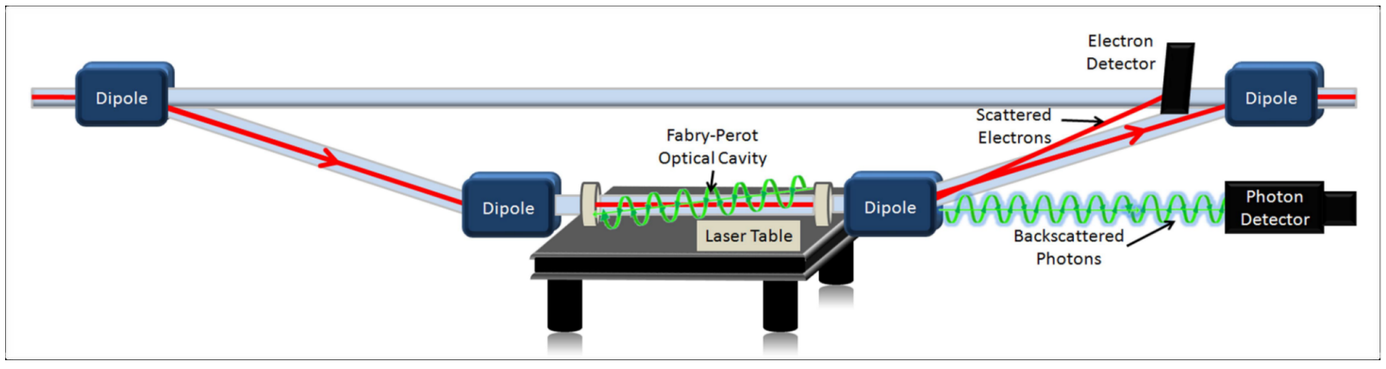
E-field gradient steers beam - use effect for position feedback

- The beam requirements for MOLLER will need a polarized source upgrade
- Caryn Palatchi and Kent Paschke at UVa have conducted several successful beam tests replacing the KD*P cell with a RTP cell
  - electron beam helicity correlated position differences on the order of 100 nm were reached, with clear path towards improvement
- Further studies are scheduled for April 2018 to characterize the properties of this new setup

Polarimetry

Compton:

- The Compton has successfully been tested during the DVCS Fall 2016 run
- Currently more work is needed for the laser table in order to get the system locking
- The photon detector works, with plans to upgrade the DAQ system
- Plans under way to recover functionality or replace electron detector



MOLLER:

- The new target ladder designed and built at Temple has been extensively tested and is on track to provide fine angle controls
- Kerr effect studies are under way lead by Stony Brook

- A Geant4 based simulation is being developed and tested against old Geant3 simulation package

Beam monitoring

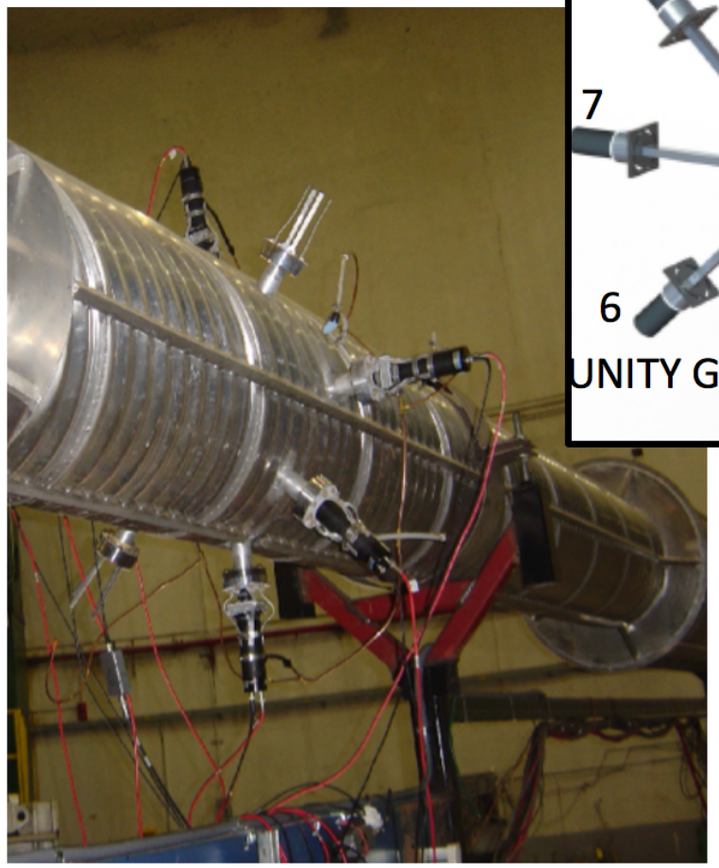
- Dustin McNulty (Idaho State) constructed and installed Small Angle Monitors in the Hall A beam line

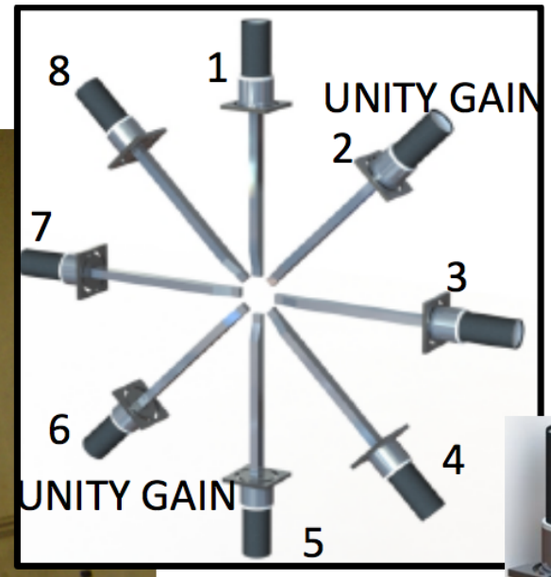
- These detectors were used parasitically during the DVCS/Gmp run to test and characterize our current beam charge monitors

  - Analysis is underway

- Further characterization will need specific conditions (solid target) and higher currents and helicity flip rates

- Plans are being developed to implement new beam monitoring techniques at LBNL (Yury Kolomensky)

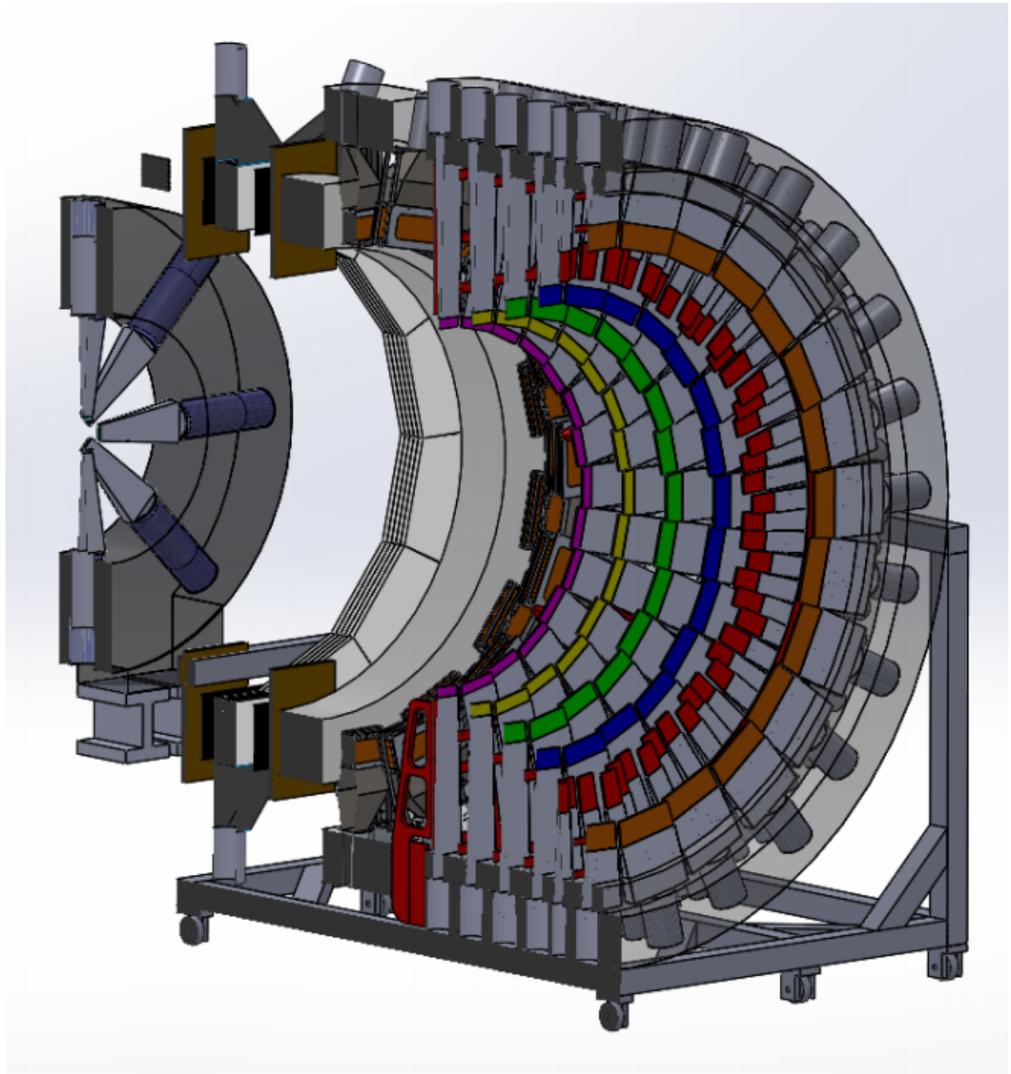




- 8 quartz detectors with light guides placed around beam line downstream of pivot
- Symmetric design helps disentangle beam position and angle HCBP's
- For large dynamic range, mix 'n matched

Detectors

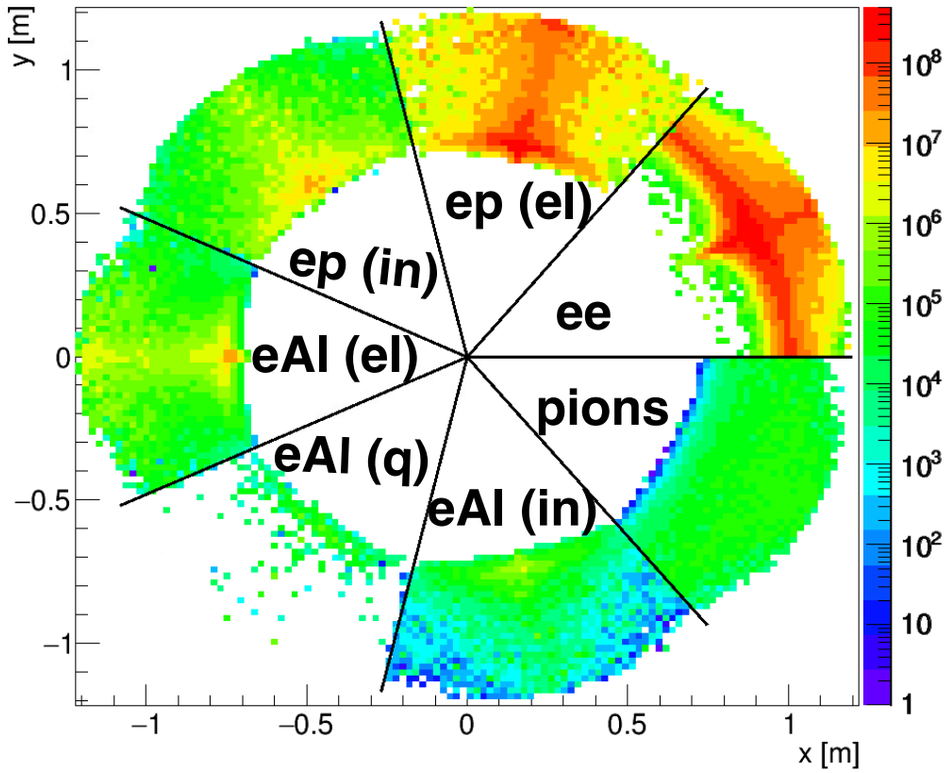
- We have a pretty well established detector geometry and mechanical design (SBU)
  - several beam tests have been performed to ensure we will have the necessary quality
  - working on mechanical supports and assembly
- Shower max detectors have already been prototyped (including mechanical assembly) and tested with the Mainz beam (ISU)
- Radiation exposure and hardness tests are being drawn up and prototype is being constructed (ISU)
- Pion detectors are being developed to directly measure this contribution to our experiment (W&M)



Simulations

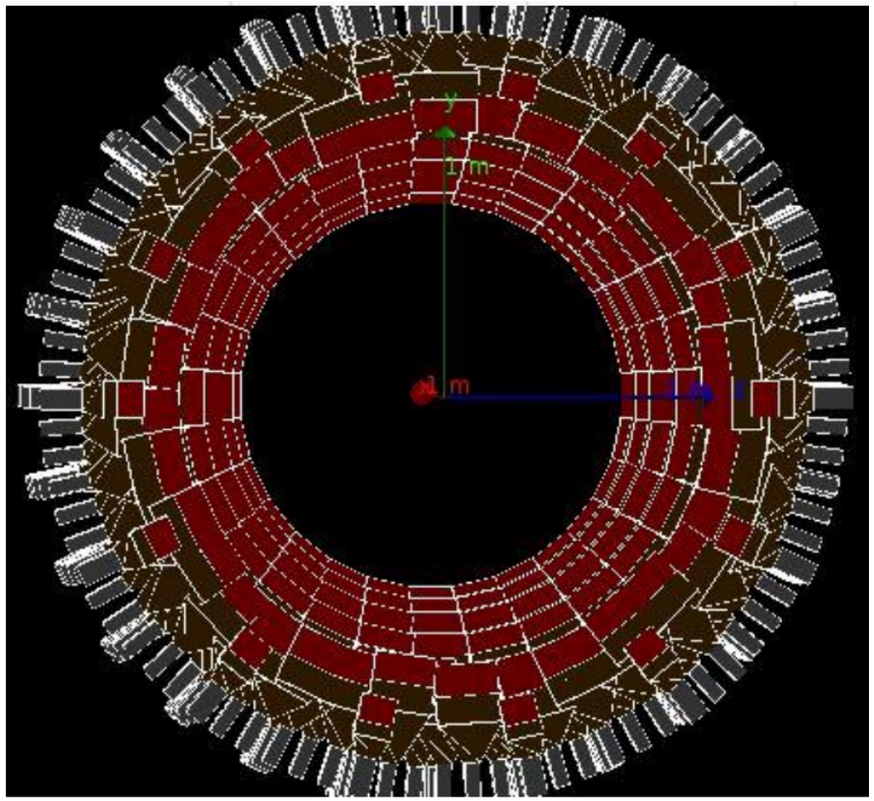
- From our previous review we have received a list of simulation topics that we are expected to tackle for our future reviews

- Using already developed background and signal extraction methods we are optimizing the geometrical coverage of our quartz detectors (UVa)



- We are evaluating contributions from non-standard background (re-scattering, slit-scattering etc.) (Manitoba)

- We plan to look at possible transverse analyzing power effects to evaluate systematics offsets (UVa)



Summary

- The MOLLER experiment will provide invaluable information for BSM physics in the next decade
- Our collaboration is making good progress on all fronts towards realization of the technical aspects needed to stage this experiment