Status of the Qweak Experiment

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For the Qweak Collaboration

Hall C Users Meeting

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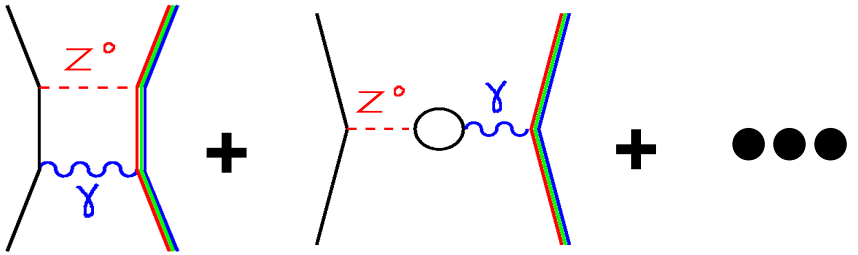
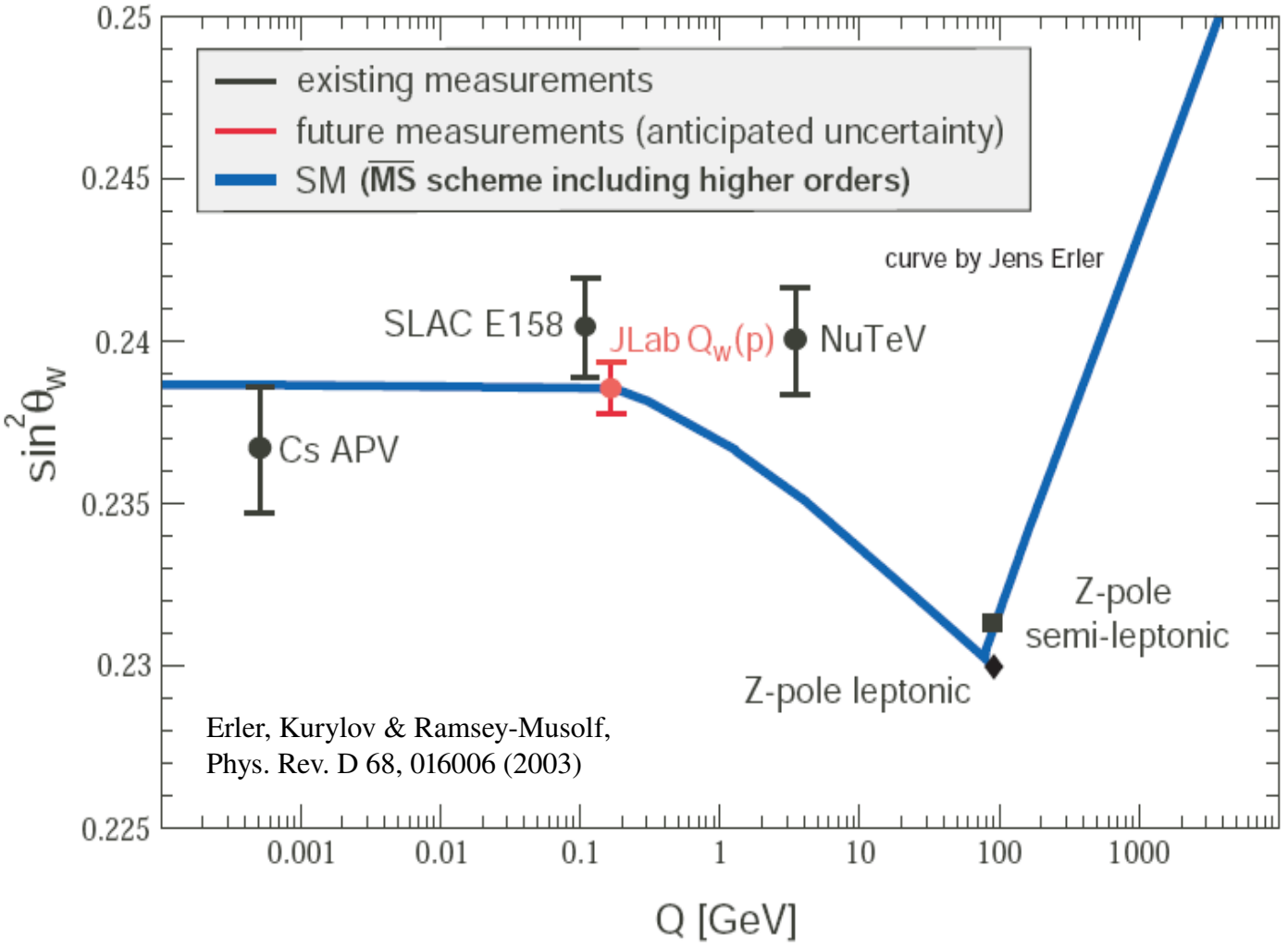
THE GEORGE WASHINGTON UNIVERSITY
WASHINGTON DC

Jefferson Lab

Weak mixing angle

"Running of $\sin^2\theta_W$":





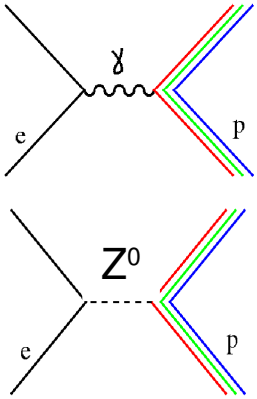
Qweak will measure $\sin^2\theta_W$ at Q^2=0.03 (GeV/c)^2 to 0.3%

$$Q_W^p = 1 - 4\sin^2\theta_W$$

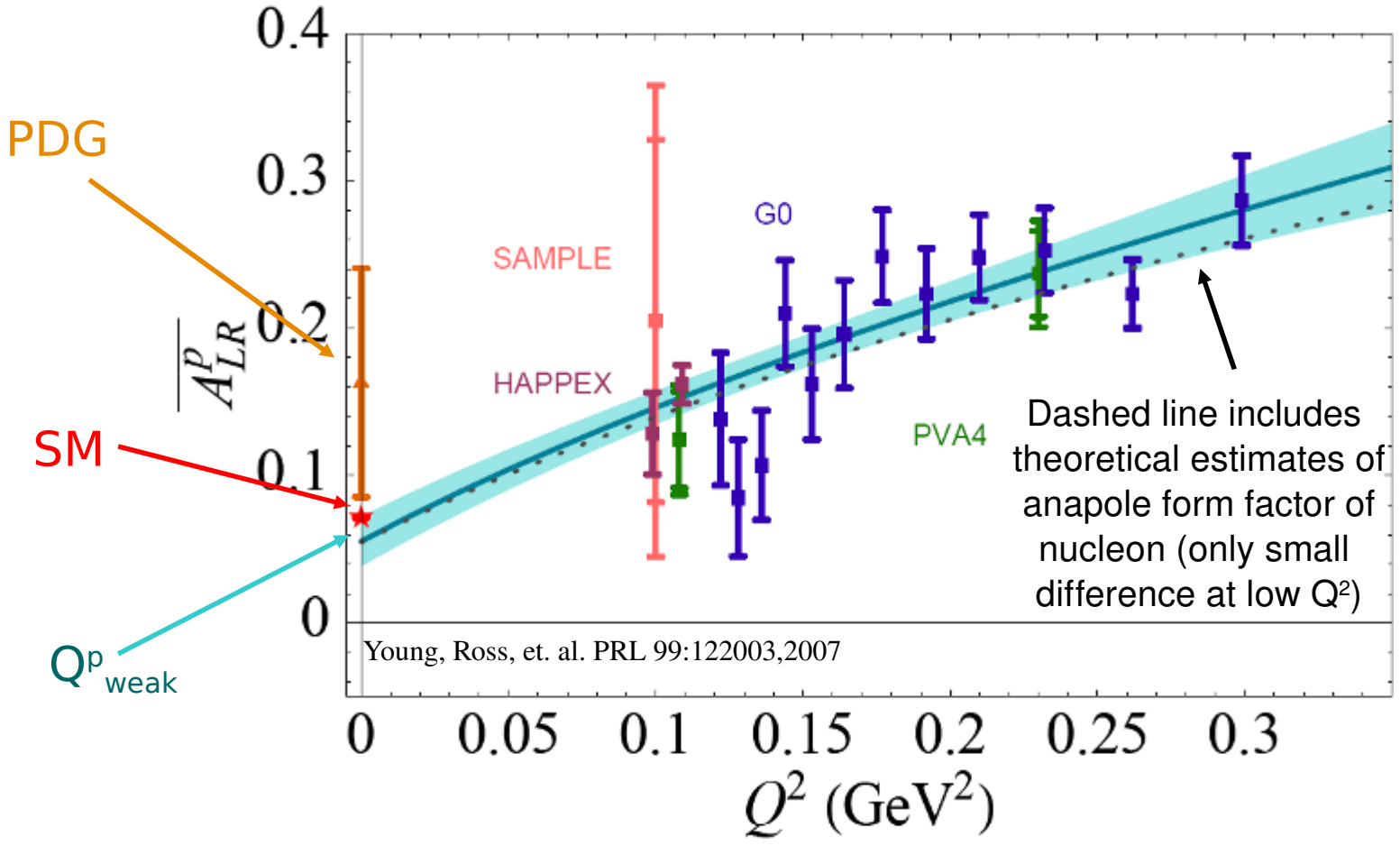
Asymmetry

$$A_{PV} = \frac{\sigma_+ - \sigma_-}{\sigma_+ + \sigma_-} \quad \text{as } Q^2 \to 0, \theta \to 0$$

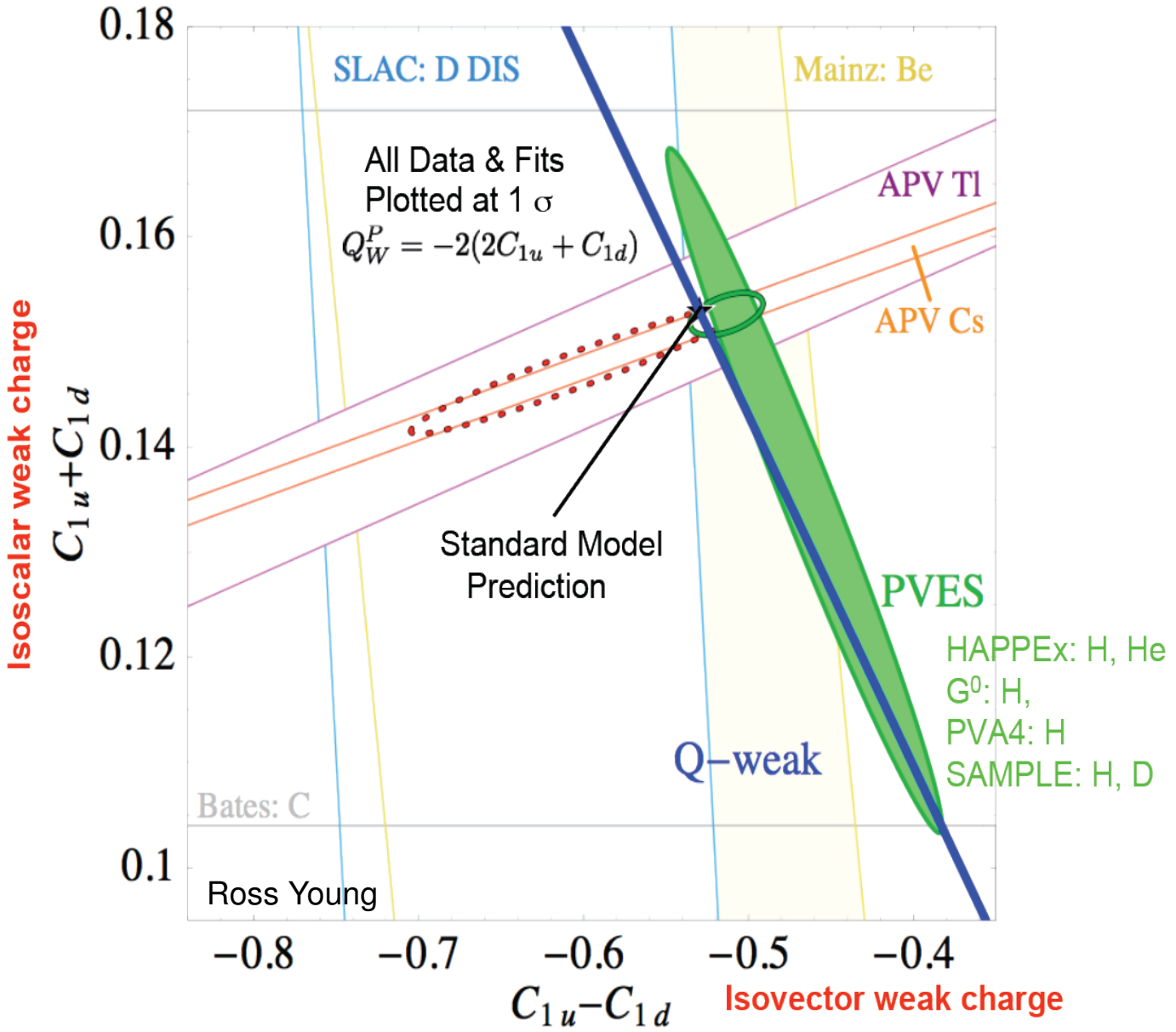
$$A_{PV} \propto Q^p_{weak} Q^2 + B(Q^2)Q^4$$



$$\overline{A^p_{LR}} \simeq Q^p_{weak} + B(Q^2)Q^2 + \ldots$$



Quark Couplings



C_{1u}, (C_{1d}) – weak u (d) quark charge

$$Q_W^p = -2\,(2C_{1u} + C_{1d})$$

measure Q^p_W to 4%

New physics

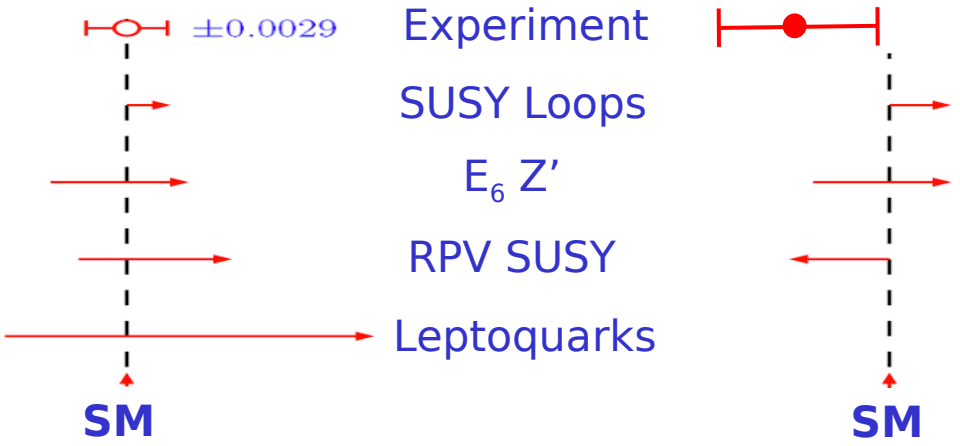
Different experiments sensitive to different extensions

JLab Q_{weak}

$Q^p_w = 0.0716$

SLAC E158 (complete)

$-Q^e_w = 0.0449$



$$\mathcal{L}^{PV}_{e-q} = \mathcal{L}^{PV}_{SM} + \mathcal{L}^{PV}_{New}$$

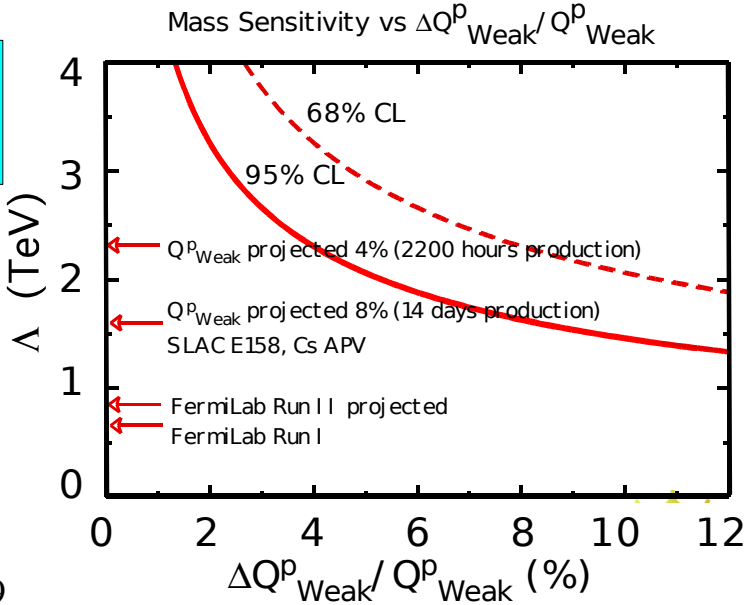
$$= -\frac{G_F}{\sqrt{2}}\bar{e}\gamma_\mu\gamma_5 e \sum_q C_{1q}\bar{q}\gamma^\mu q + \frac{g^2}{4\Lambda^2}\bar{e}\gamma_\mu\gamma_5 e \sum_q h^q_V \bar{q}\gamma^\mu q$$

g : coupling

Λ: mass scale

4% measurement of Q^p_W:

$$\frac{\Lambda}{g} \sim \frac{1}{2\sqrt{\sqrt{2}G_F\left|\Delta Q^p_W\right|}} \approx 2.3\ \text{TeV}$$

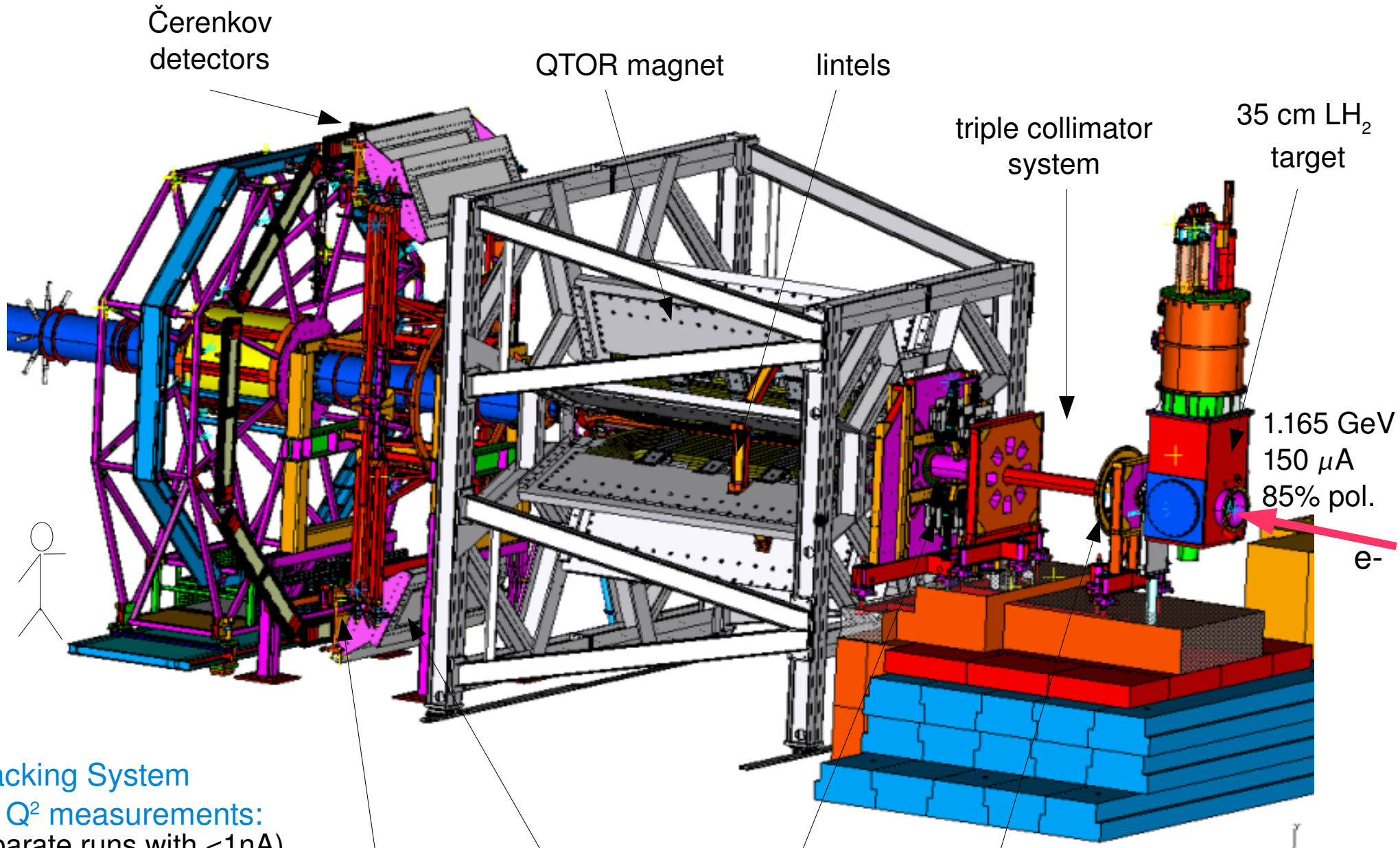


Uncertainties

2% on A_z ≈ 4% on Q^p_W ≈ 0.3% on $\sin^2\theta_W$

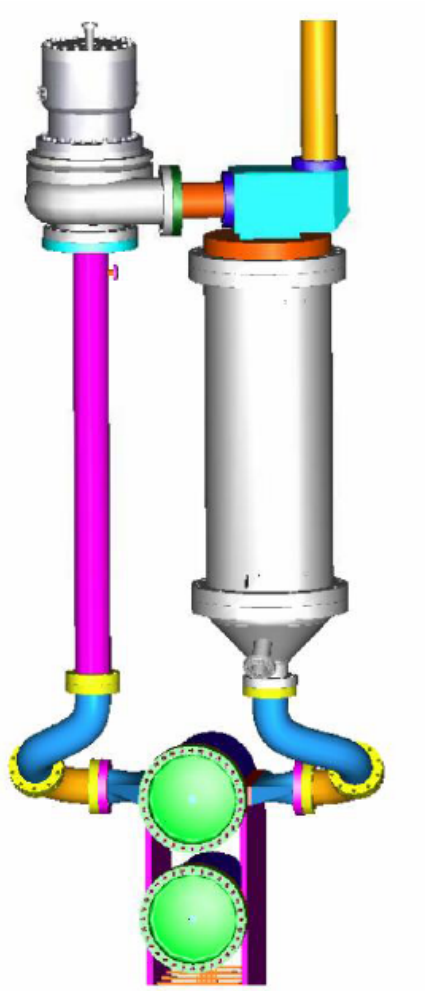
Source of error	Contribution to $\Delta A_{phys}/A_{phys}$	Contribution to $\Delta Q^p_w / Q^p_W$
Counting Statistics	2.1%	3.2%
Hadronic structure	—	1.5%
Beam polarimetry	1.0%	1.5%
Absolute Q^2	0.5%	1.0%
Backgrounds	0.5%	0.7%
Helicity-correlated beam properties	0.5%	0.7%
TOTAL:	2.5%	4.1%

Qweak overview



Tracking System for Q^2 measurements:
(separate runs with <1nA)

Target



- 35 cm long liquid hydrogen: LH_2
- 2.5 kW cooling power required
- He testing this summer

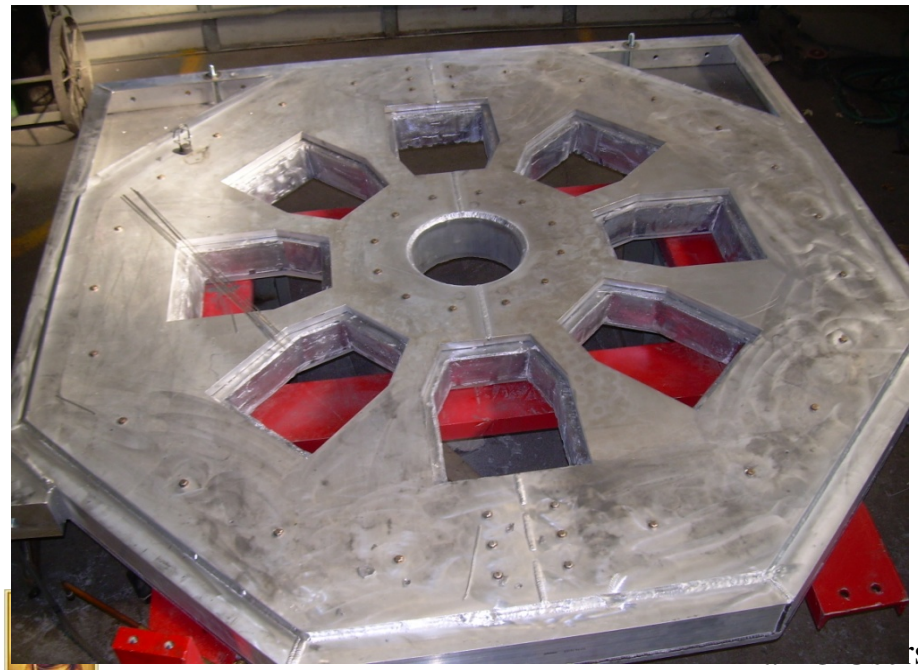
more in upcoming talk...

Collimators

Collimator 1:

Collimator 2 (primary):

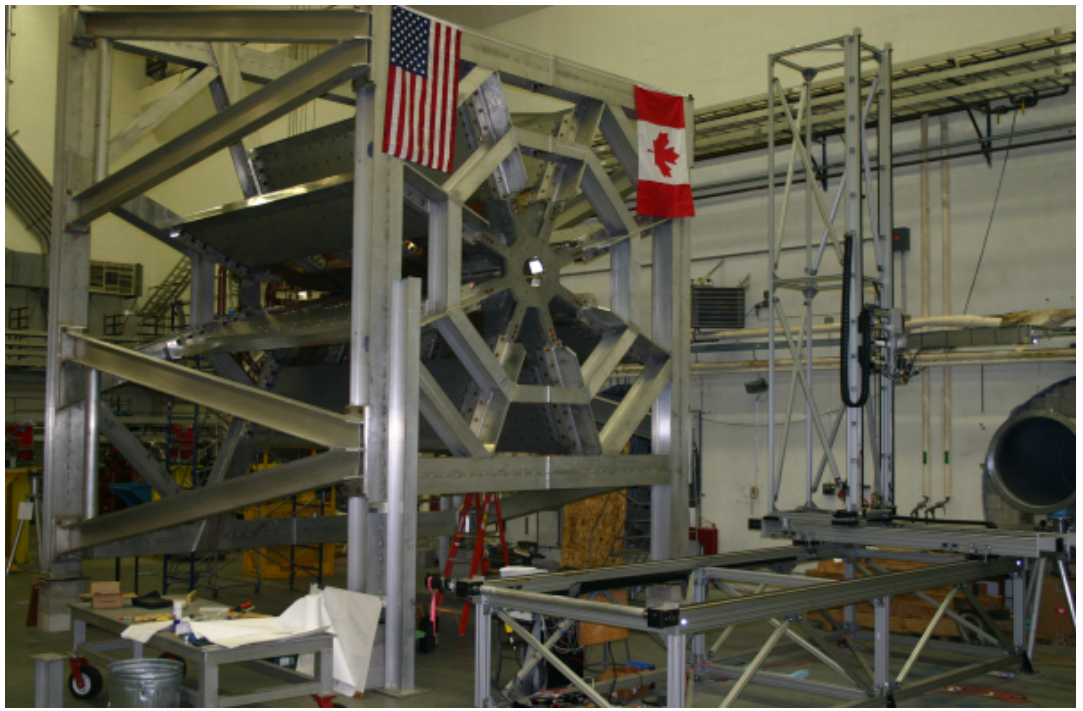
Collimator 3:

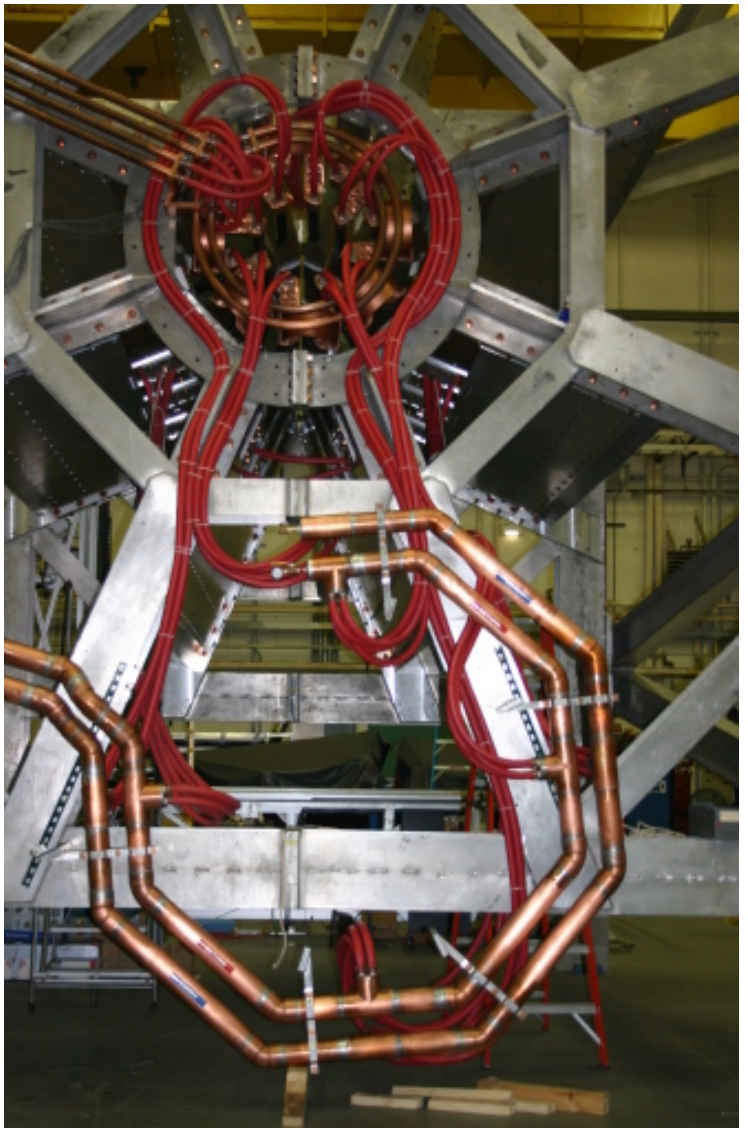


Collimator 3 is already at Jlab

Collimators 1 and 2 are finished and awaiting shipment

QTOR





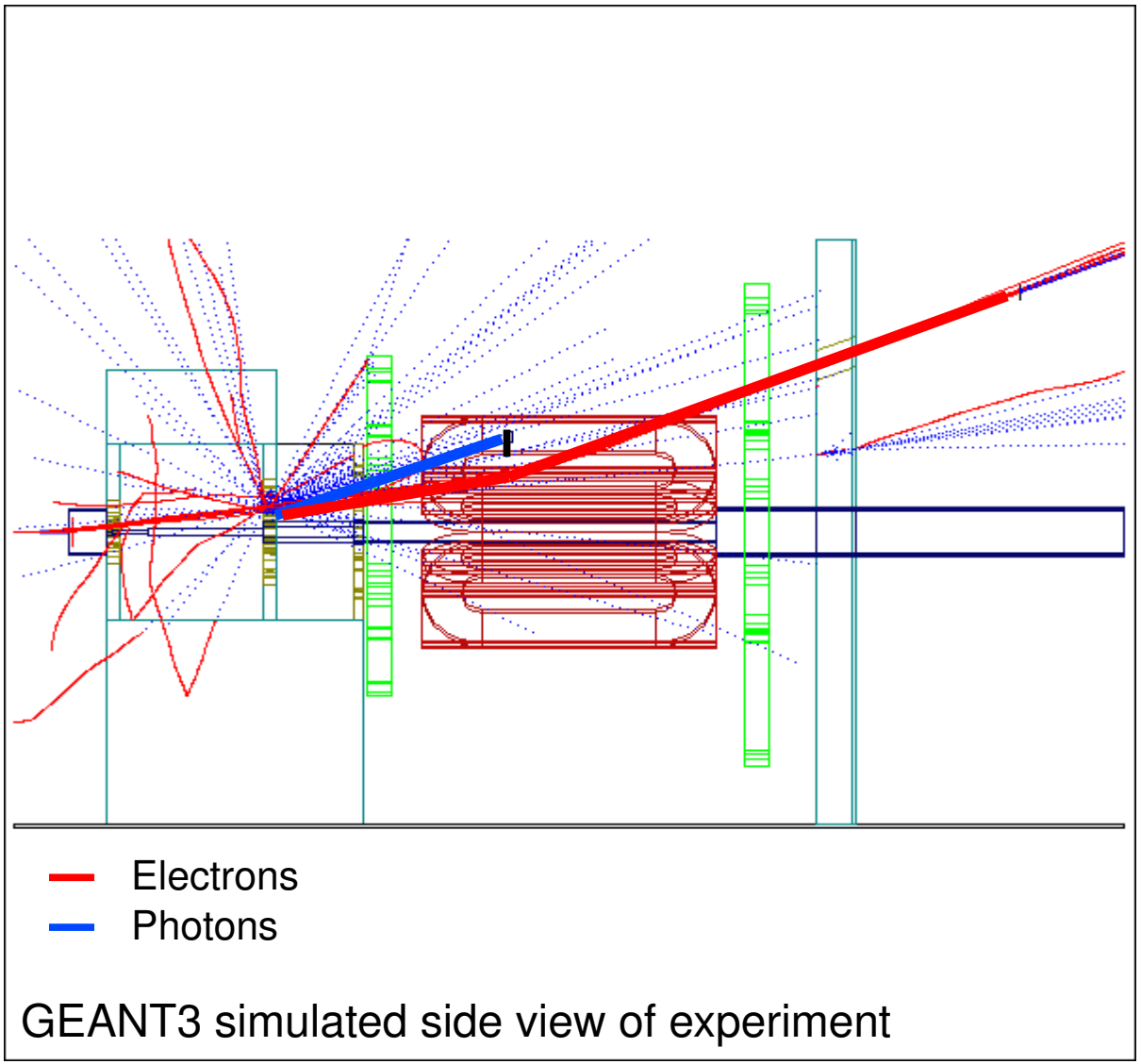
-Magnet was run up to 9500 A
(10% above operating current)

-Magnetic field was mapped at 4000 A
analysis underway

-On schedule to be delivered to JLab end of May

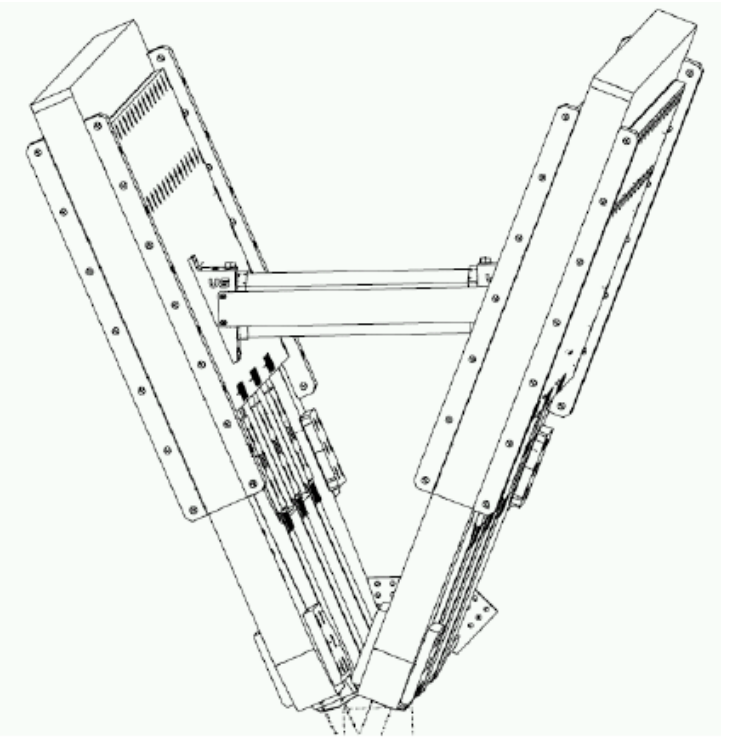
Lintels

Lintels added to block “line of sight” photons from the detector



GEANT3 simulated side view of experiment

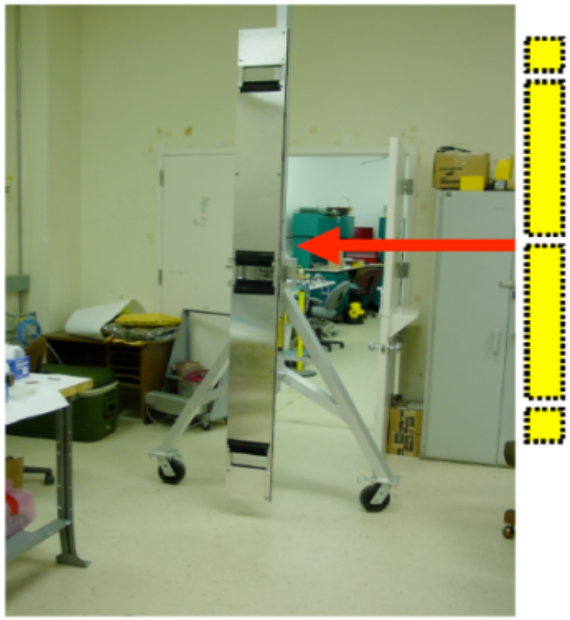
Bracket design complete:



Detectors

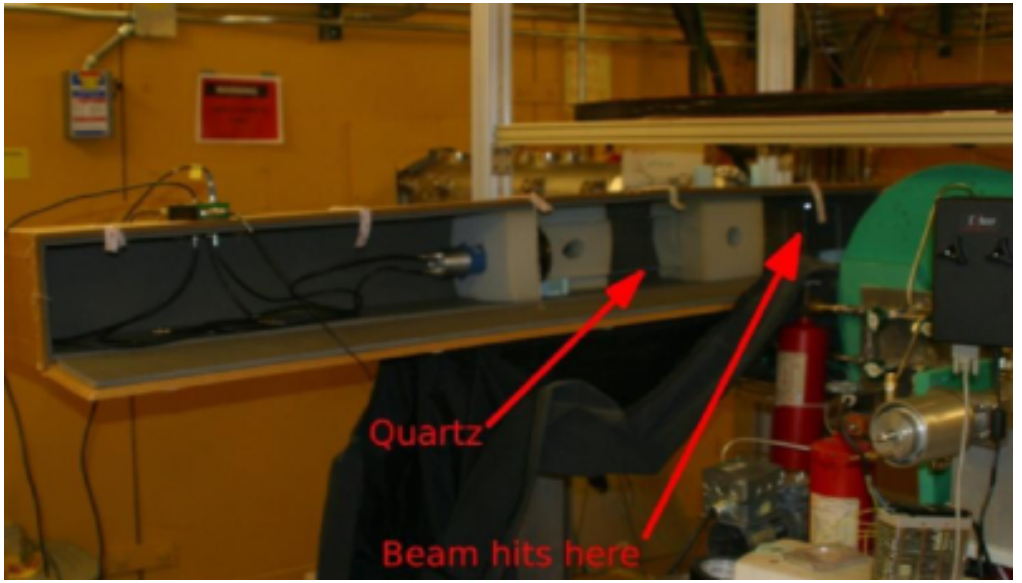
Gluing Jig:

-gluing procedure optimized, gluing underway

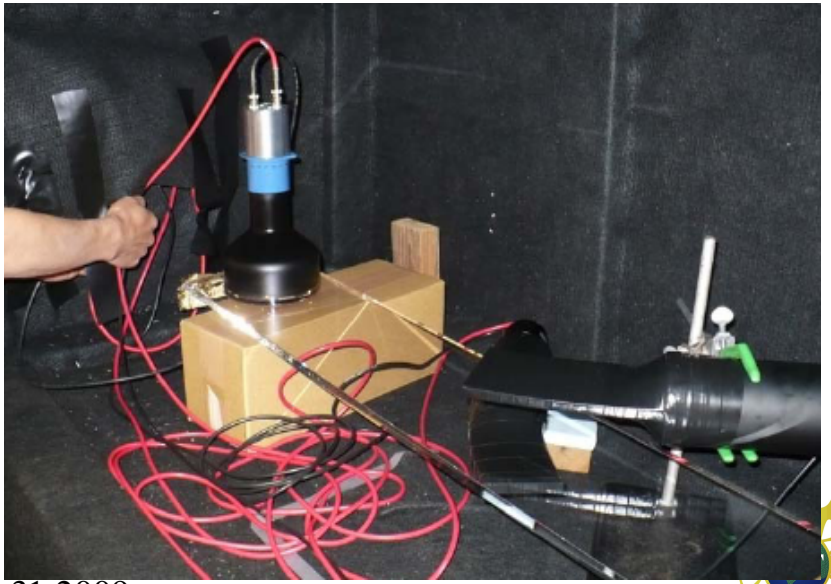


Neutron response function measured at LANSCE:

-data being analyzed

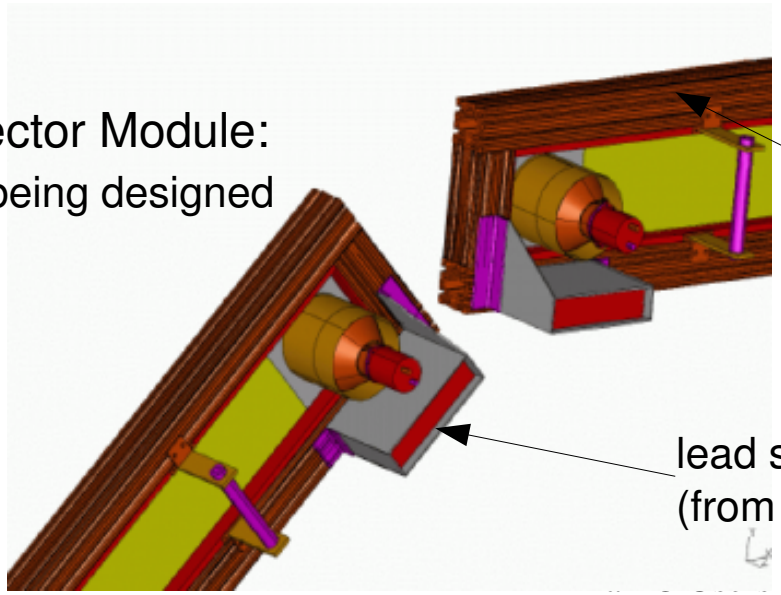


Dark box tests:



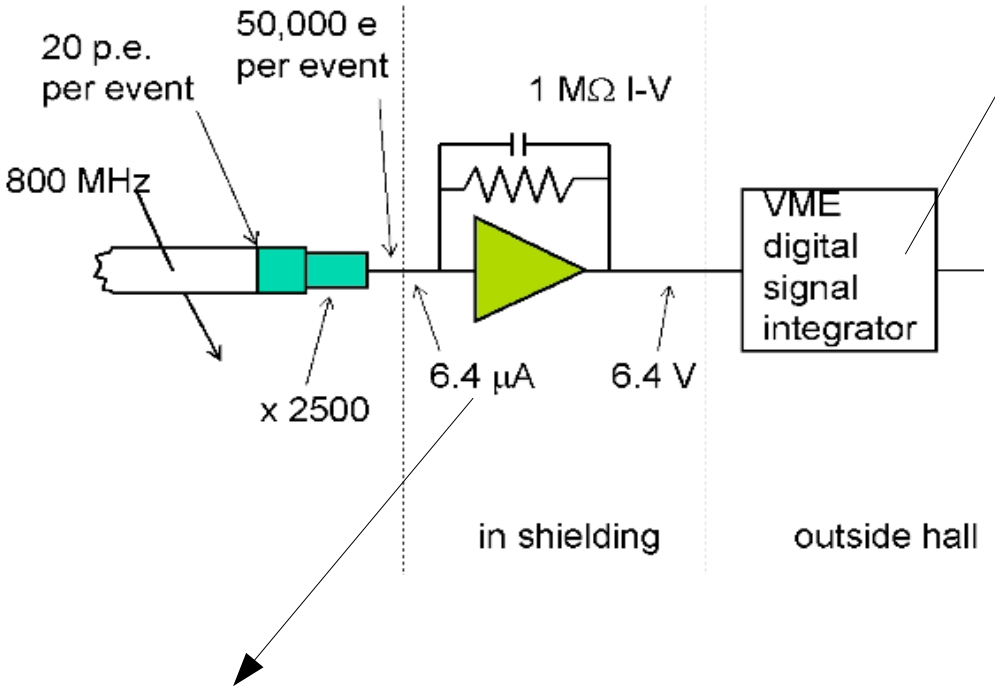
Detector Module:

-being designed

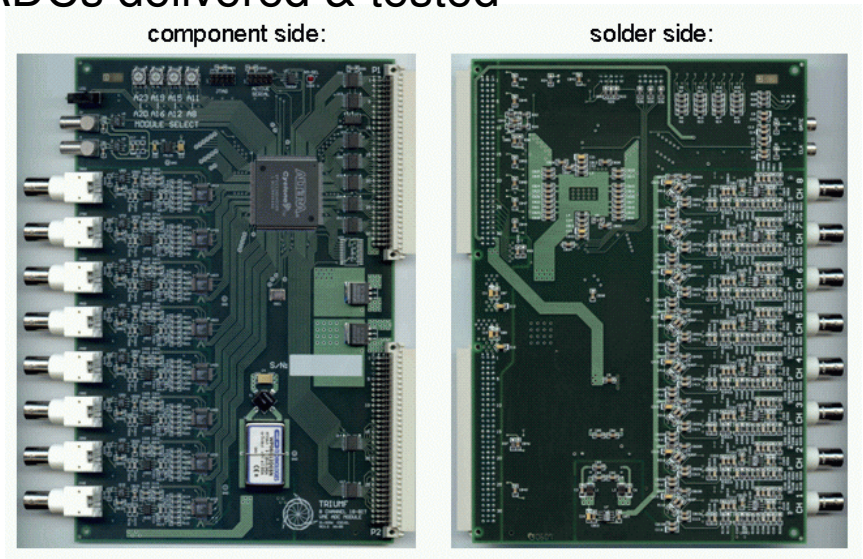


Low-noise electronics

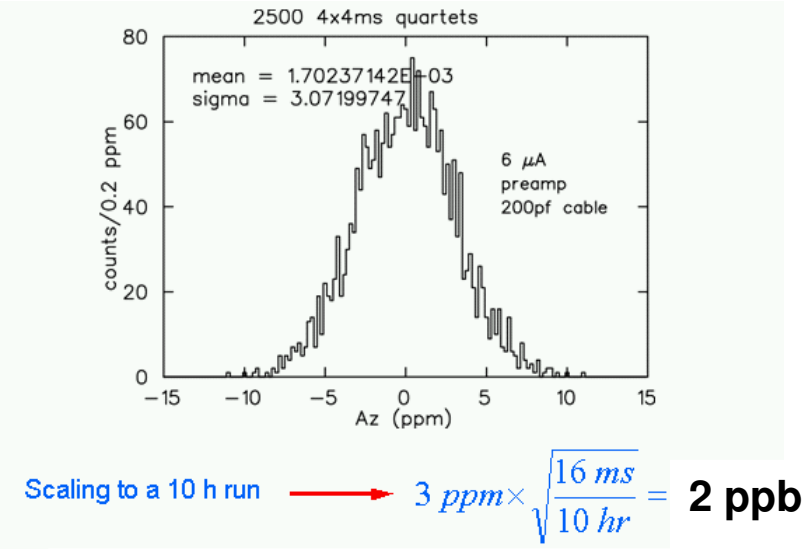
Custom from TRIUMF



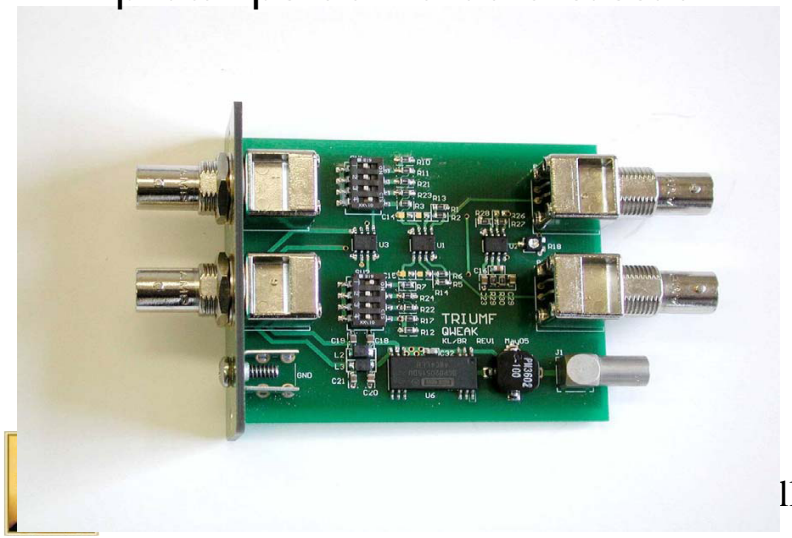
ADCs delivered & tested



Noise test on bench at TRIUMF



I-V preamps delivered & tested



Electronic noise is about 3 orders of magnitude below the counting statistics of electron tracks.

Luminosity monitors

Downstream LUMI's:

-prototype tested in Hall C beamline June 08

-being fabricated

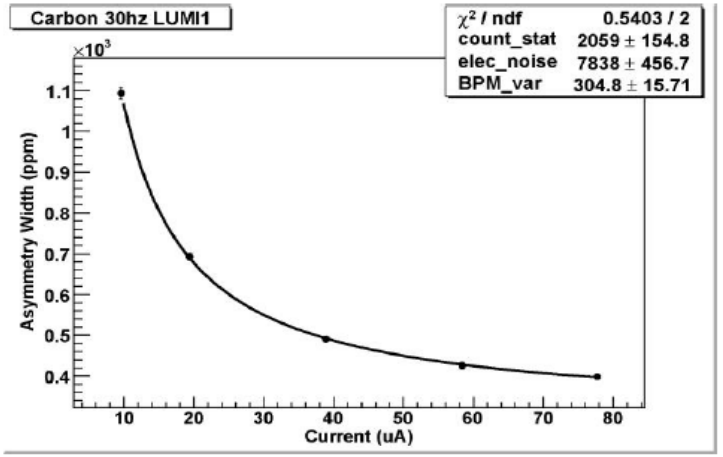
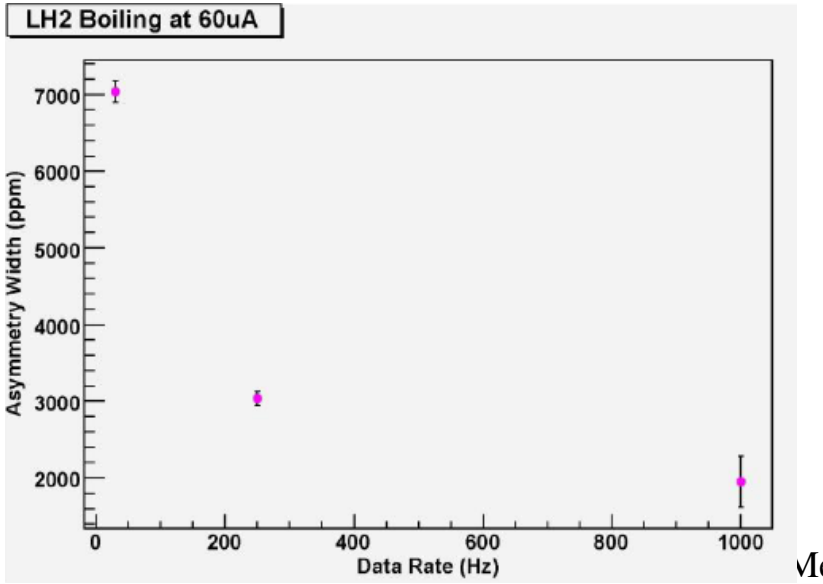
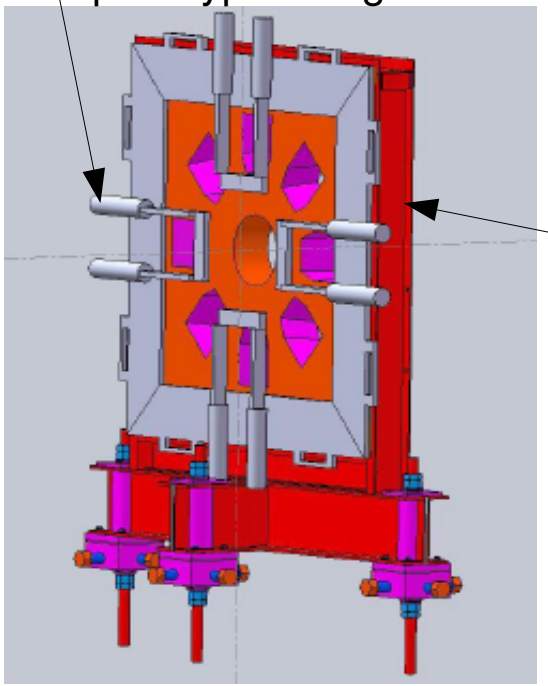


Figure 16 An example of a typical analysis for a carbon target; the solid line is a fit to a model for the asymmetry width that includes counting statistics, electronic noise, and beam parameter fluctuations.



Upstream LUMI's:

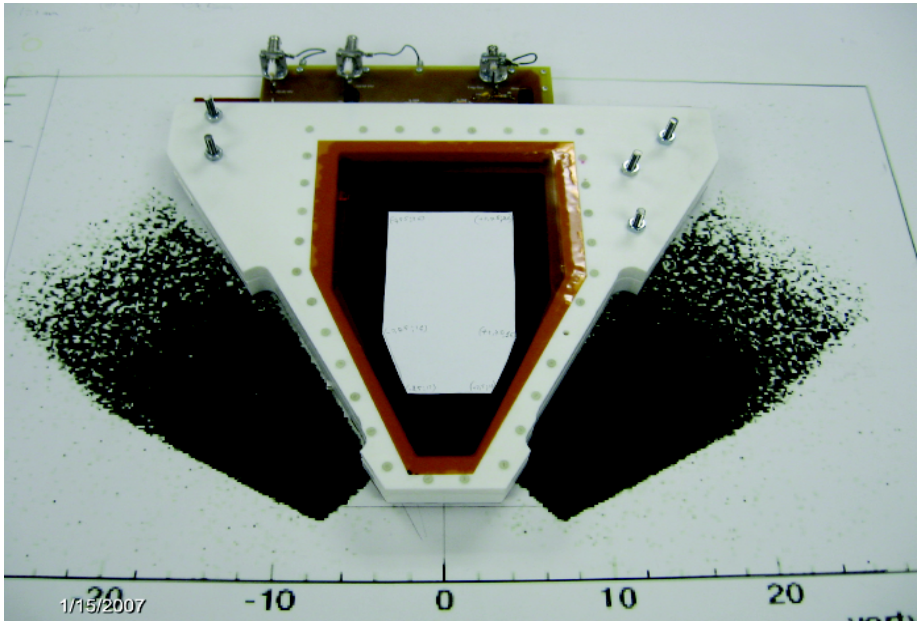
-prototype being tested



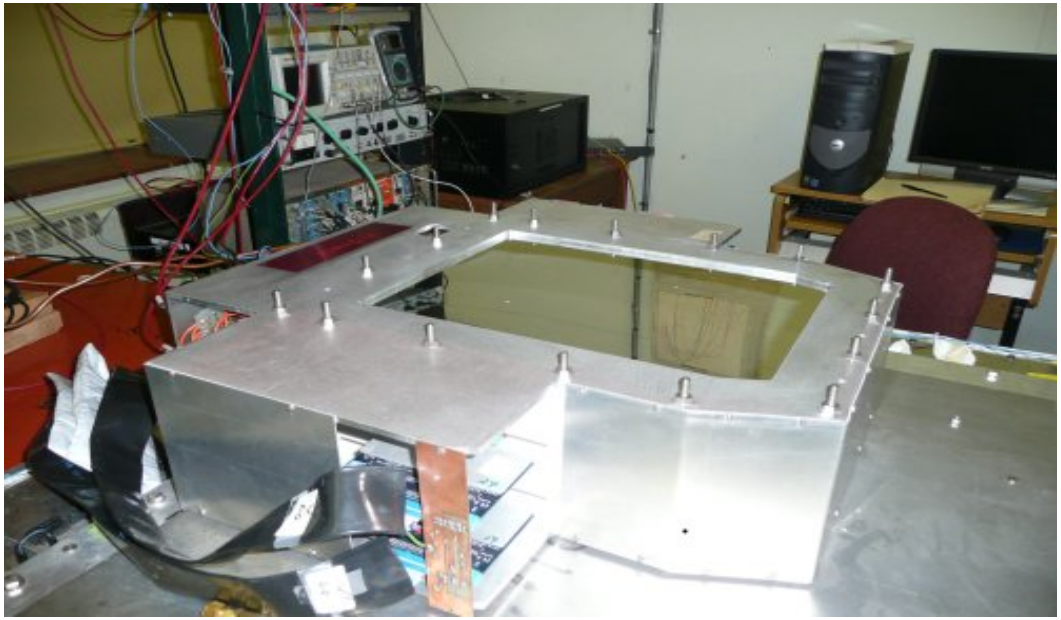
primary coll.

Tracking: RI & RII

Region 1 GEMs: two chambers built



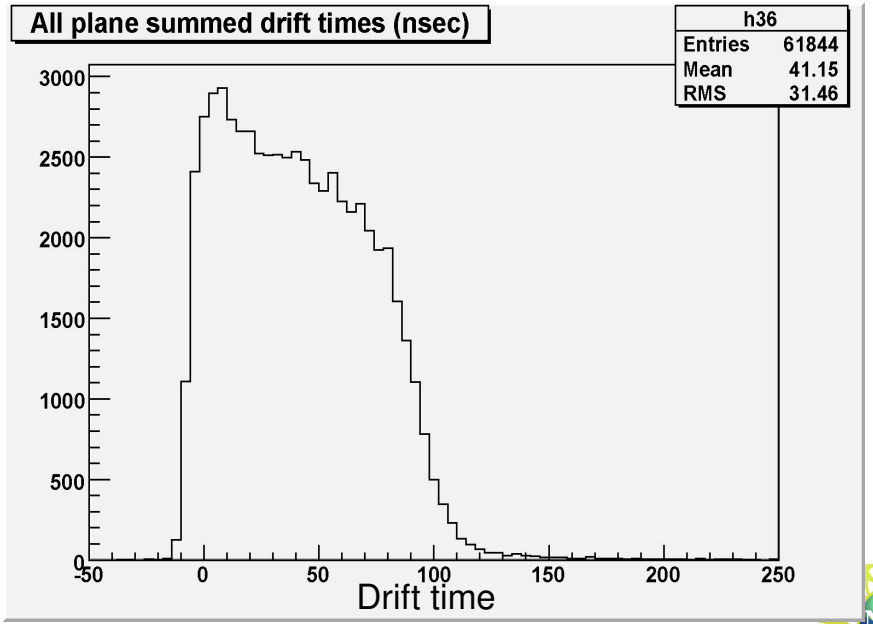
Region 2 HDCs: two chambers built



working on front and back end electronics

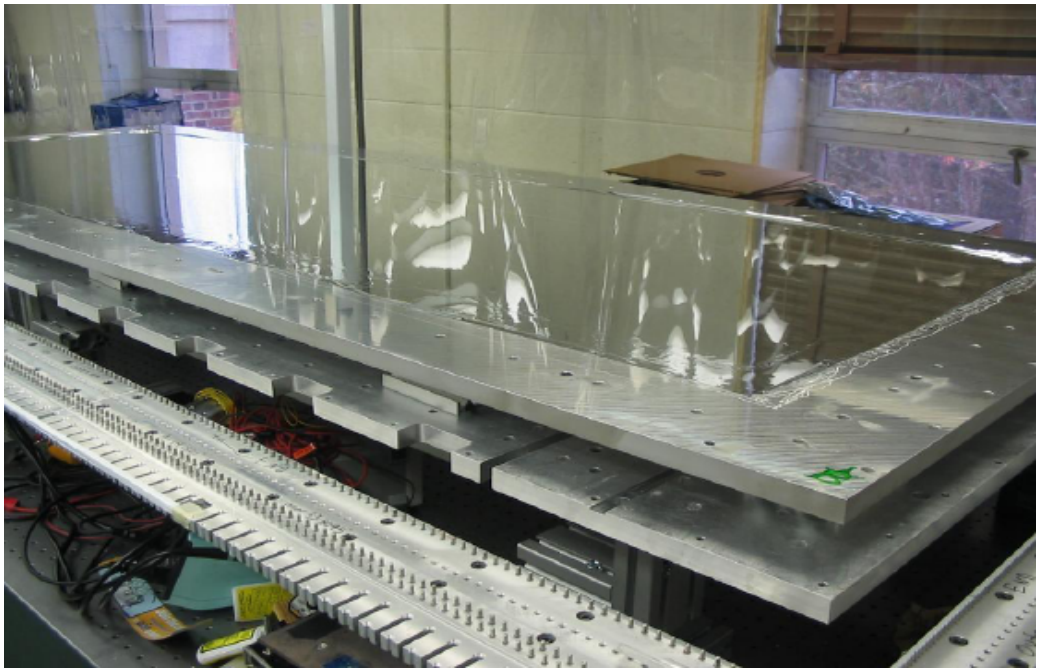
Rotator being tested

Rotator mounting design almost complete

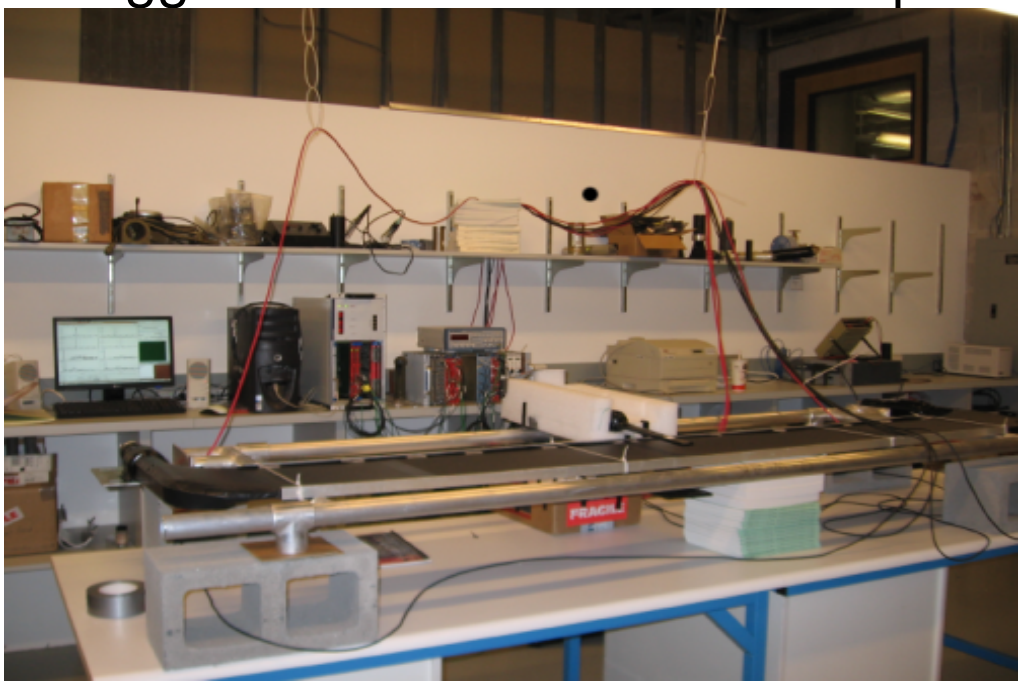


Tracking: RIII

VDCs: First chamber assembled:

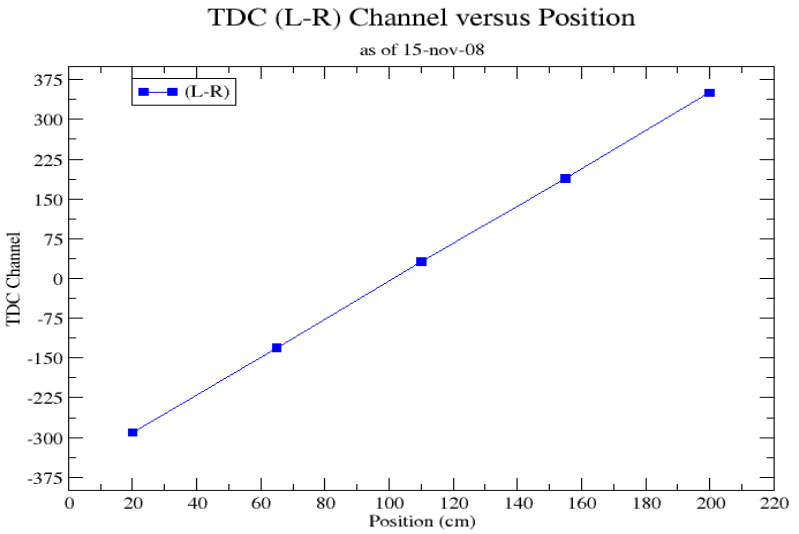


Trigger Scintillators: one is set up



HV testing to begin in February

Rotator: installation in Hall C



Summary

- Physics:
  - Q_{weak} will be the first high-precision measurement of the weak mixing angle at low Q^2
  - First measurement of the weak charge of the proton, Q^p_W
  - Sensitive to new physics at the TeV scale
- Installation Nov 2009
- Start commissioning May 2010, production Oct 2010
- Spending ¾ finished
- Construction and testing well underway

The Qweak Collaboration

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[1]Spokespersons

[2]Project Manager

College of William and Mary, University of Connecticut, Instituto de Fisica, Universidad Nacional Autonoma de Mexico, University of Wisconsin, Hendrex College, Louisiana Tech University, University of Manitoba, Massachusetts Institute of Technology, Thomas Jefferson National Accelerator Facility, Virginia Polytechnic Institute & State University, TRIUMF, University of New Hampshire, Yerevan Physics Institute, Mississippi State University, University of Northern British Columbia, Cockroft Institute of Accelerator Science and Technology, Ohio University, Hampton University, University of Winnipeg, University of Virginia, George Washington University, Syracuse University, Idaho State University, University of Connecticut, Christopher Newport University