Measurement of the weak neutral form-factor of the proton at high momentum transfer.

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I. Strange Form Factor

Elastic form factors describe the deviation of the corss section from that of a point-like target.

$$\frac{d\sigma}{d\Omega} = \left(\frac{d\sigma}{d\Omega}\right)_0 \left(\frac{G_E^2 + \tau G_M^2}{1+\tau} + 2\tau G_M^2 \tan^2\frac{\theta}{2}\right)$$

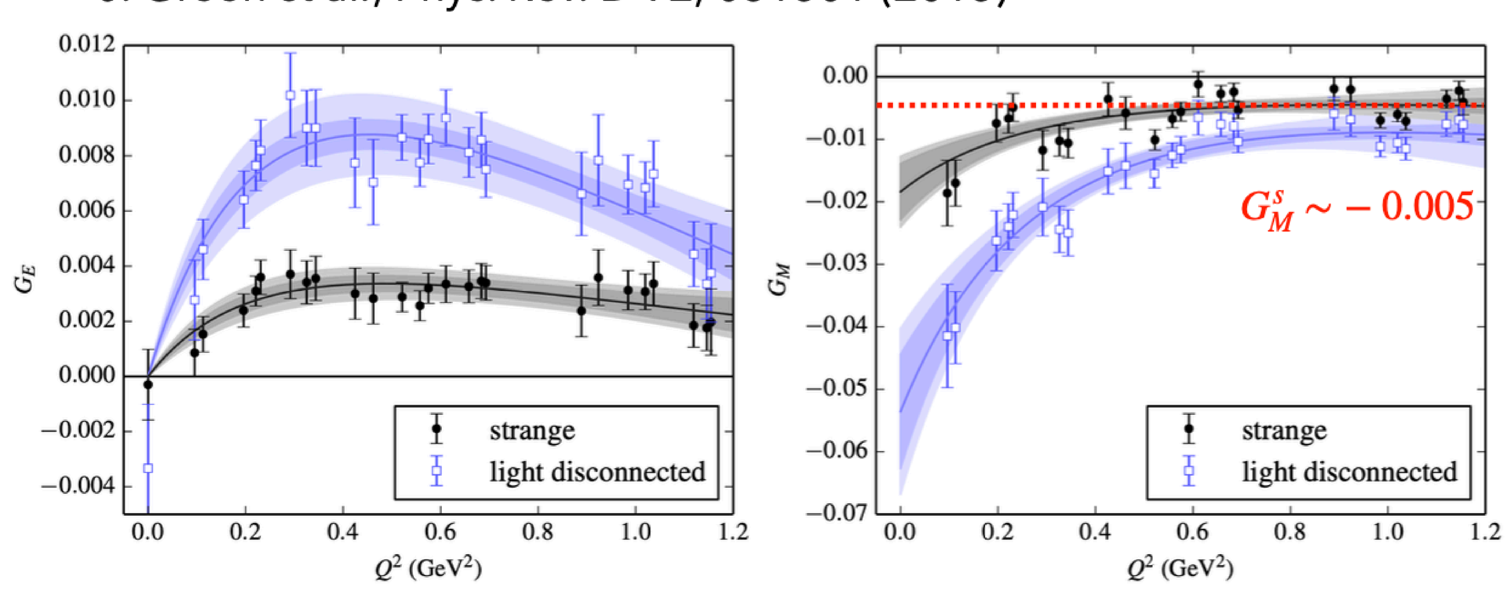
At low Q^2, G_E and G_M are the Fourier transforms of the charge and magnetization distributions. At high Q^2, transition to perturbatively dominated mechanisms and other degrees of freedom become important. The most common charge symmetry breaking is from strange quark contribution.

$$G_E^p = \frac{2}{3}G_E^{u,p} - \frac{1}{3}G_E^{d,p}; \qquad G_E^p = \frac{2}{3}G_E^{u,p} - \frac{1}{3}G_E^{d,p} - \frac{1}{3}G_E^s$$

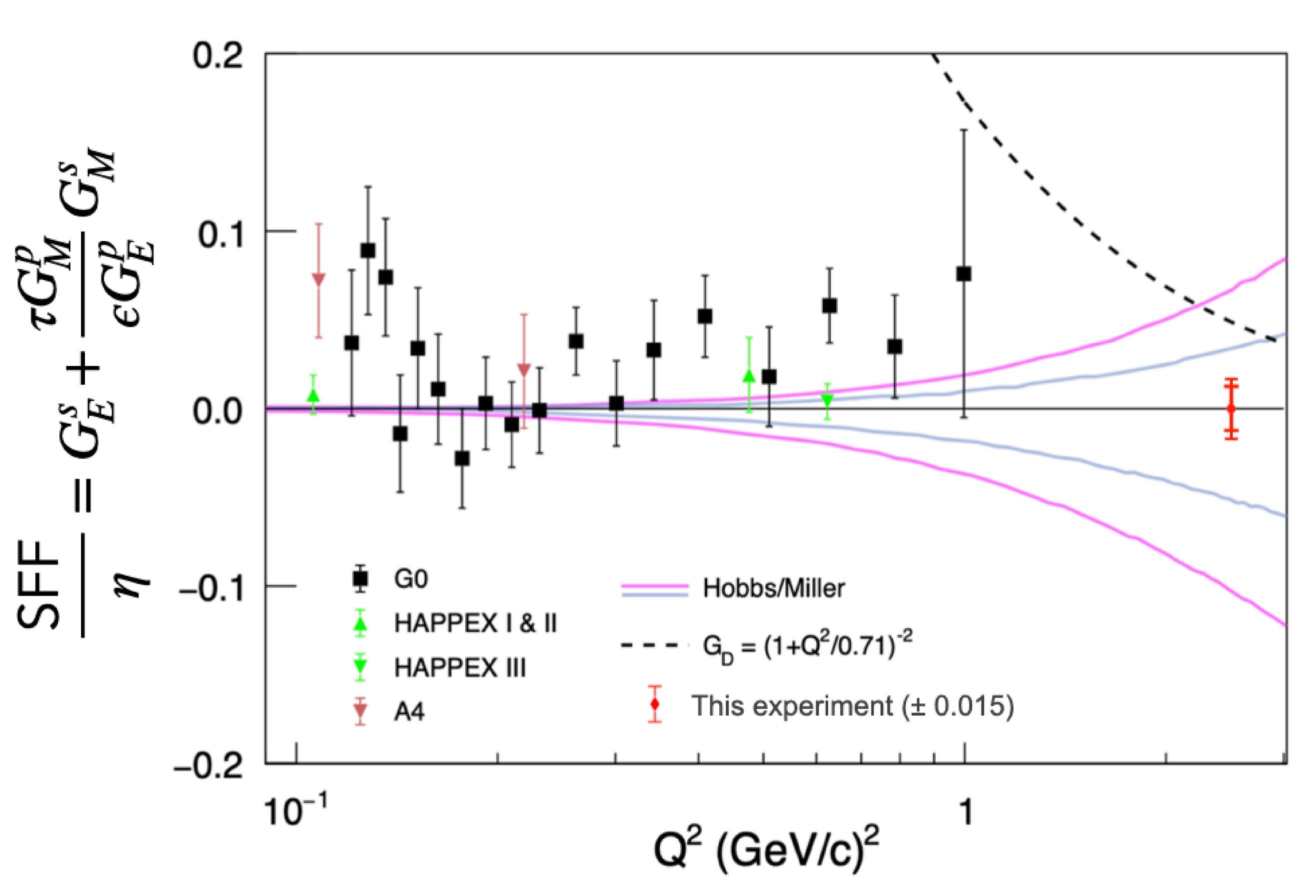
$$G_E^n = \frac{2}{3}G_E^{u,n} - \frac{1}{3}G_E^{d,n}; \qquad G_E^n = \frac{2}{3}G_E^{u,n} - \frac{1}{3}G_E^{d,n} - \frac{1}{3}G_E^s$$

Charge symmetry is assumed for the form factors. But this can broken! One way is to have a non-zero strange form-factor, which breaks the "2 equations and 2 unknowns" system The weak form factor provides a third linear combination. For example: lattice results do not rule out large contributions from strange-quark form factors.

J. Green *et al.*, Phys. Rev. D 92, 031501 (2015)

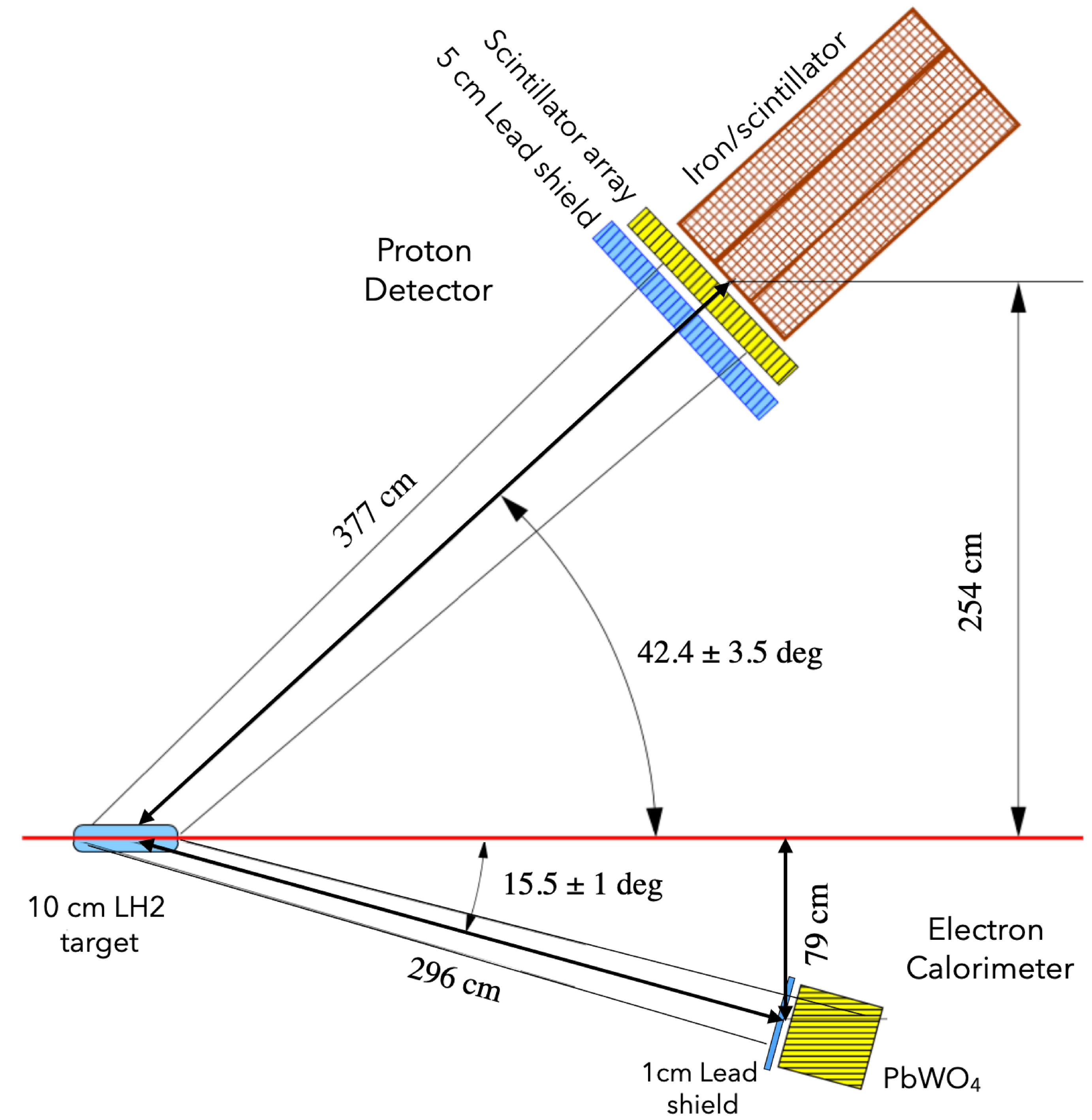


II. Projected Result



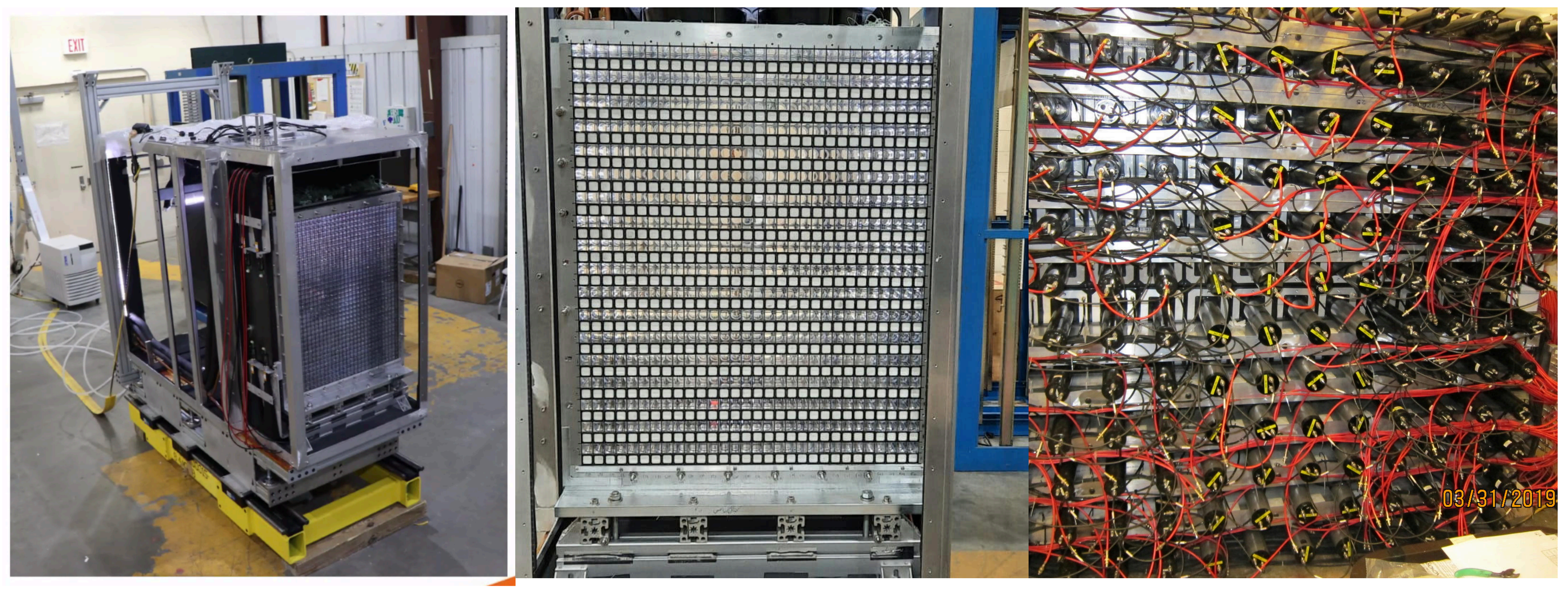
At high Q^2 the measurement is projected to reach very high precision, which can be compared to the uncertainty in the fit of existing data at low-Q^2 (Hobbs-Miller).

III. The experiment



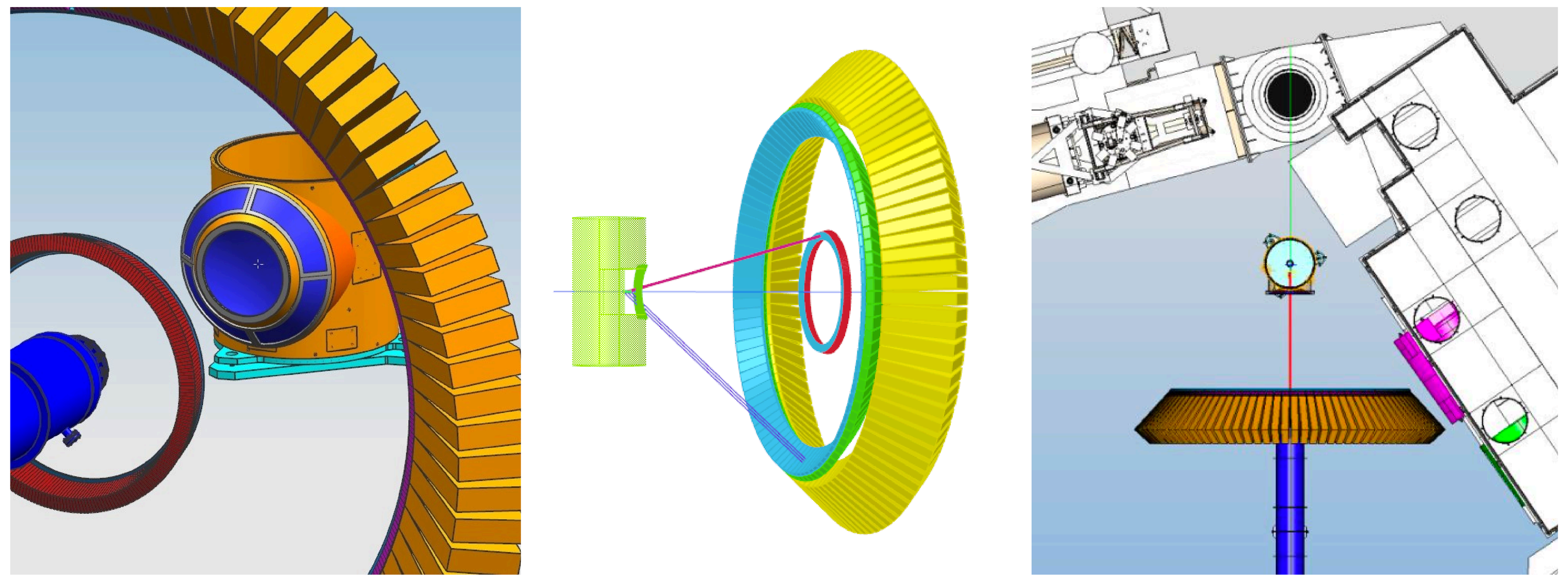
Identify elastic kinematics with electron-proton coincidence

- Angular e-p correlation
- High resolution calorimeter for electron and proton trigger separately
- Scintillator array on proton arm, to improve position resolution
- 6.6 GeV beam energy
- electron at 15.5 degrees, proton at 42.4 degrees
- APV = 150 ppm, 4% precision goal, so 3×10^{10} elastic scattering events
- L =1.7×10^{38} $mm^{-2}s^{-1}$, 10 cm LH2 target and 65 μA beam current
- Full azimuthal coverage, 42 msr



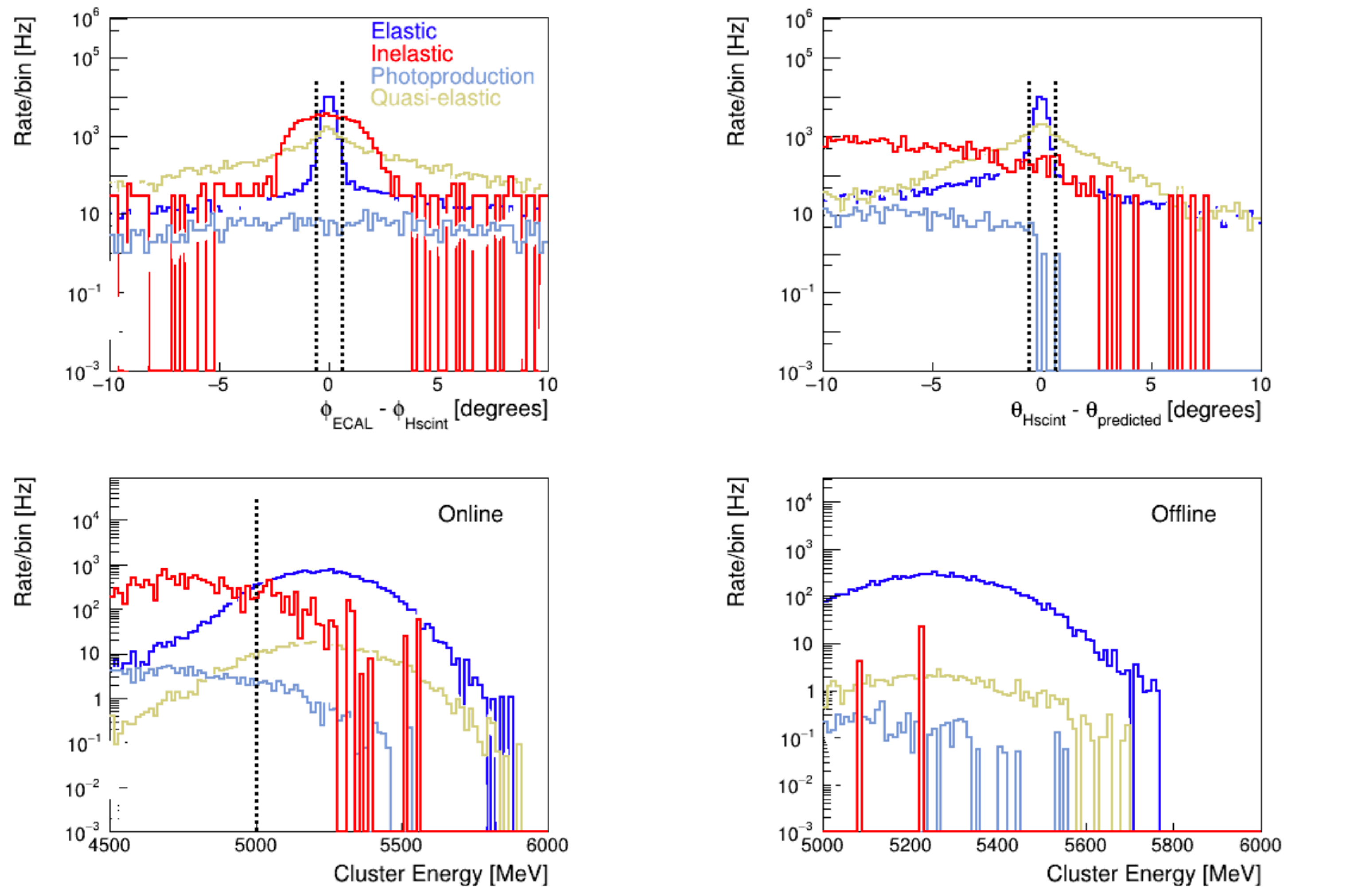
Reconfigure NPS calorimeter and HCal.

IV. Configuration in HALL-C



V. Background

Geant4 simulation is used to model the target and the caloriemeters.



Online: ECAL vs HCAL coincidence, loose time and geometric cut
Offline: tighten geometric cut with pixel hodoscope and ECAL cluster center
Exclude inelastic background to ~0.2%

Fraction of total by event type	offline
Elastic scattering	0.989
Inelastic (pin electro-production	0.002
Quasi-elastic scattering(target windows)	0.008
π^0 photo-production	0.001

"Sideband" analyses will help verify QE and inelastic asymmetries.

VI. Next Step - Beam Test

- Test elastic identification and background rate and exxclusion.
- 50μA on 15cm Hydrogen target at 6.6GeV, about 2kHz into detector.
- SHMS at 15.5 degree, prototype proton detector at 42.4 deg
- FADC readout in spectrometer DAQ.
- Pixel array of 20 small scintillators with MA-PMT readout + 2x2 SBS HCAL blocks.

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