Brief Update on the PRad-II Proposal

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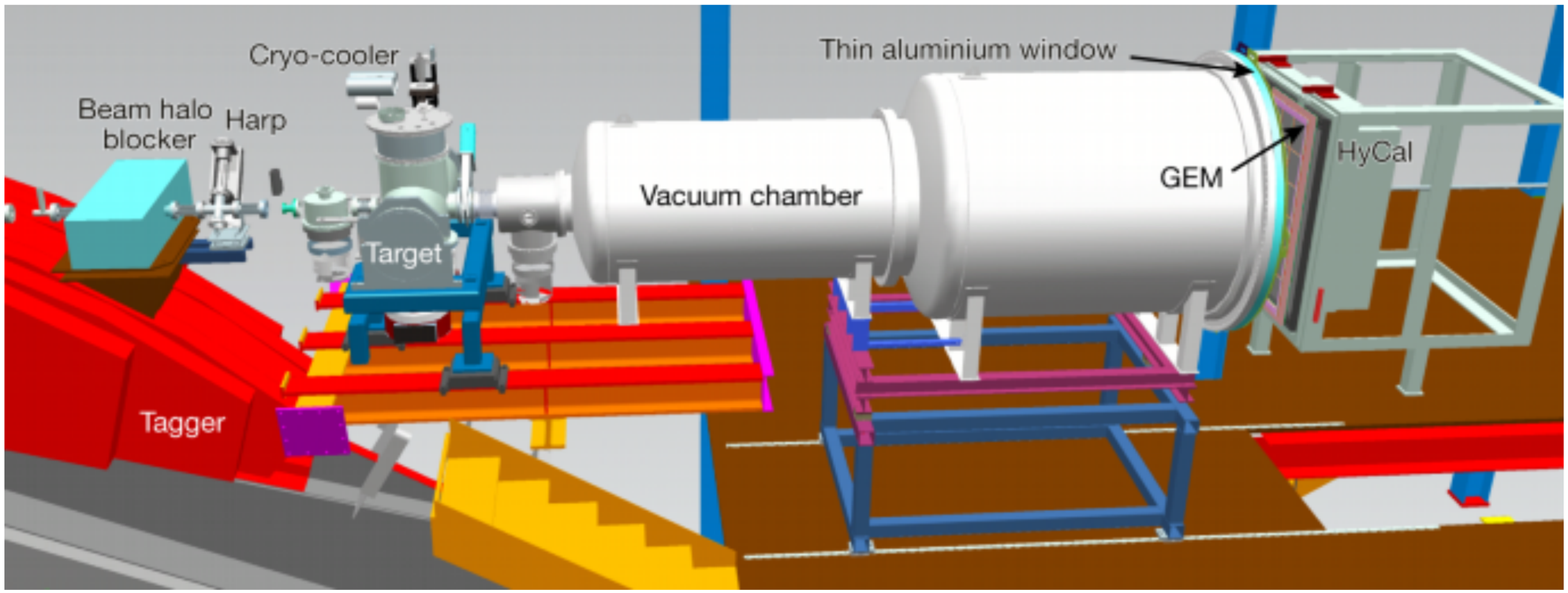
PRadius

PRad-II C1 Review

March 12, 2021



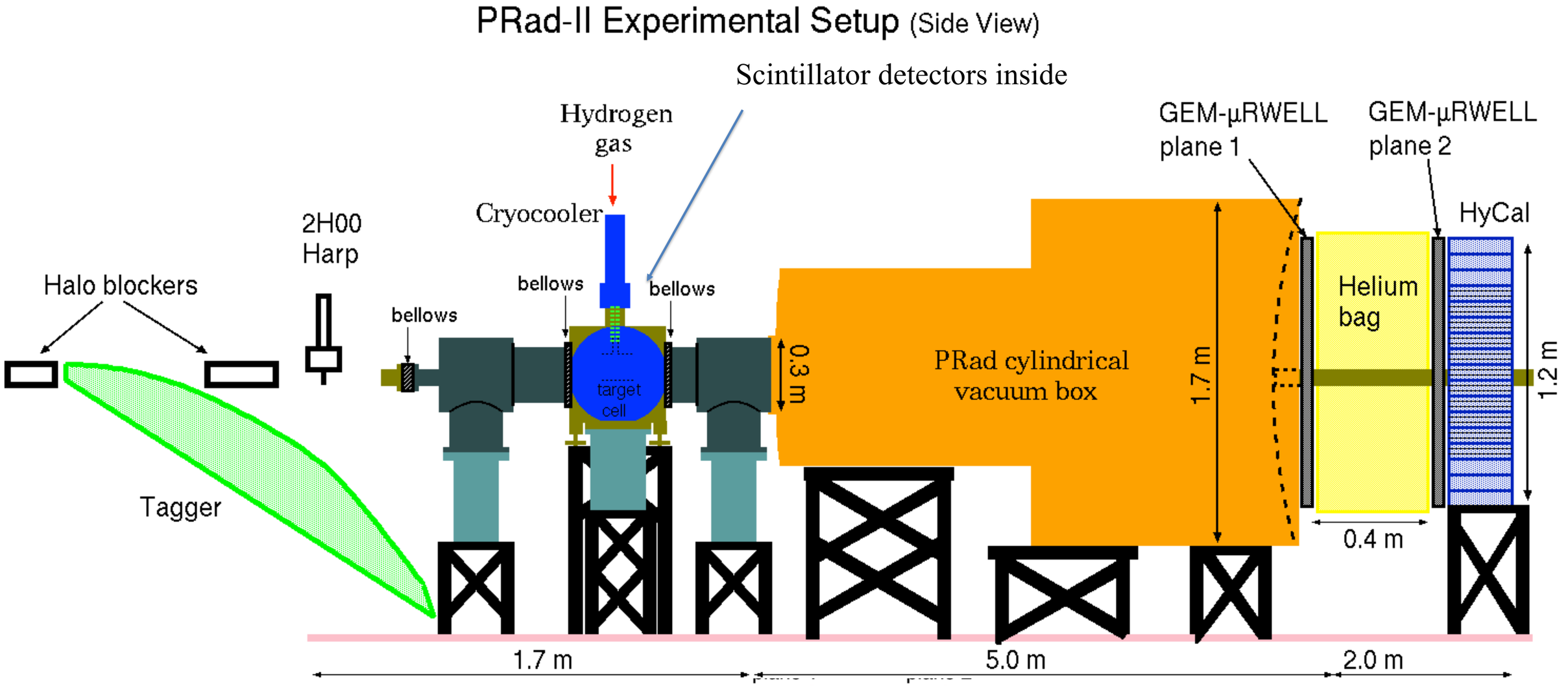
Overview of PRad-II

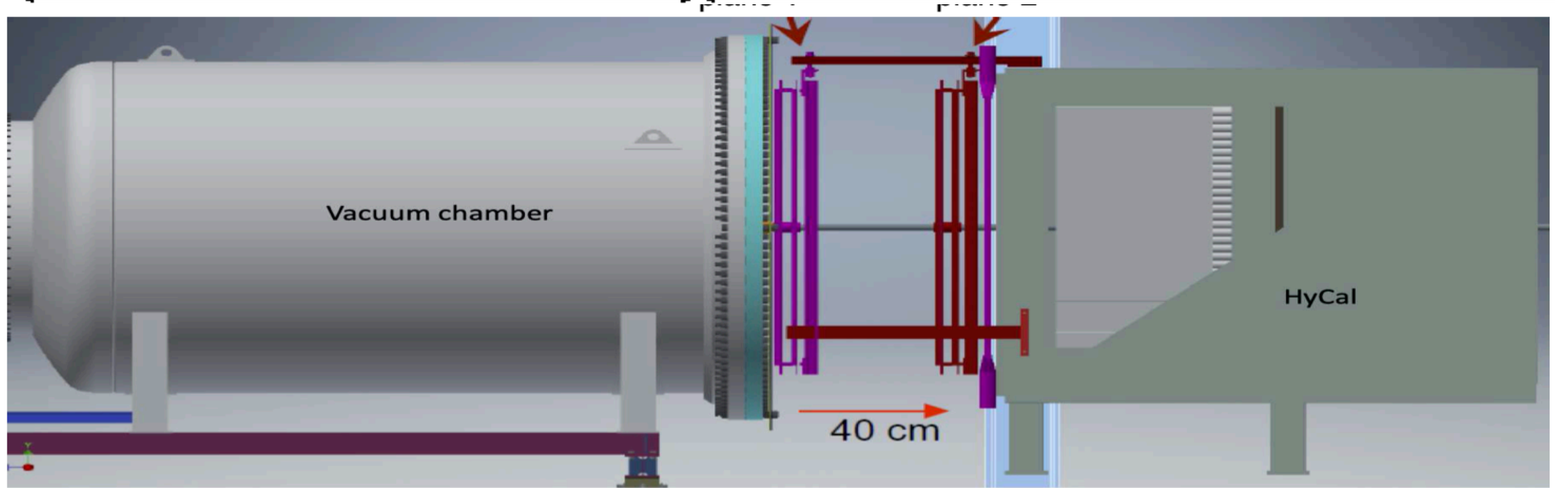
- **PRad-II goal – Reduce the uncertainty of the r_p by a factor of 3.8!**

- **Upgrades and Improvements from PRad**
  - Improving tracking capability by adding a second plane of tracking detector
  - Upgrading HyCal to all $PbWO_4$ modules to improve uniformity, resolutions and suppress inelastic contamination
  - Improve DAQ rate by converting to FADC based readout
  - Suppressing beamline background
    - Improving vacuum
    - Adding second beam halo blocker upstream of the tagger
    - Reducing statistical uncertainties by a factor of 4 compared with PRad
    - Improve radiative correction calculations by going to NNL order

- **PRad-II will reach an unprecedented low values of Q^2 : 4×10^{-5} $(GeV/c)^2$**
  - Adding new rectangular cross shaped scintillator detectors to separate Moller from ep electrons in scattering angular range of 0.5^0- 0.8^0
  - Three beam energies: 0.7, 1.4 and 2.1 GeV – **0.7 GeV is critical to reach Q^2 value of 4×10^{-5} $(GeV/c)^2$**

PRad-II Experimental Setup





PRoton Radius

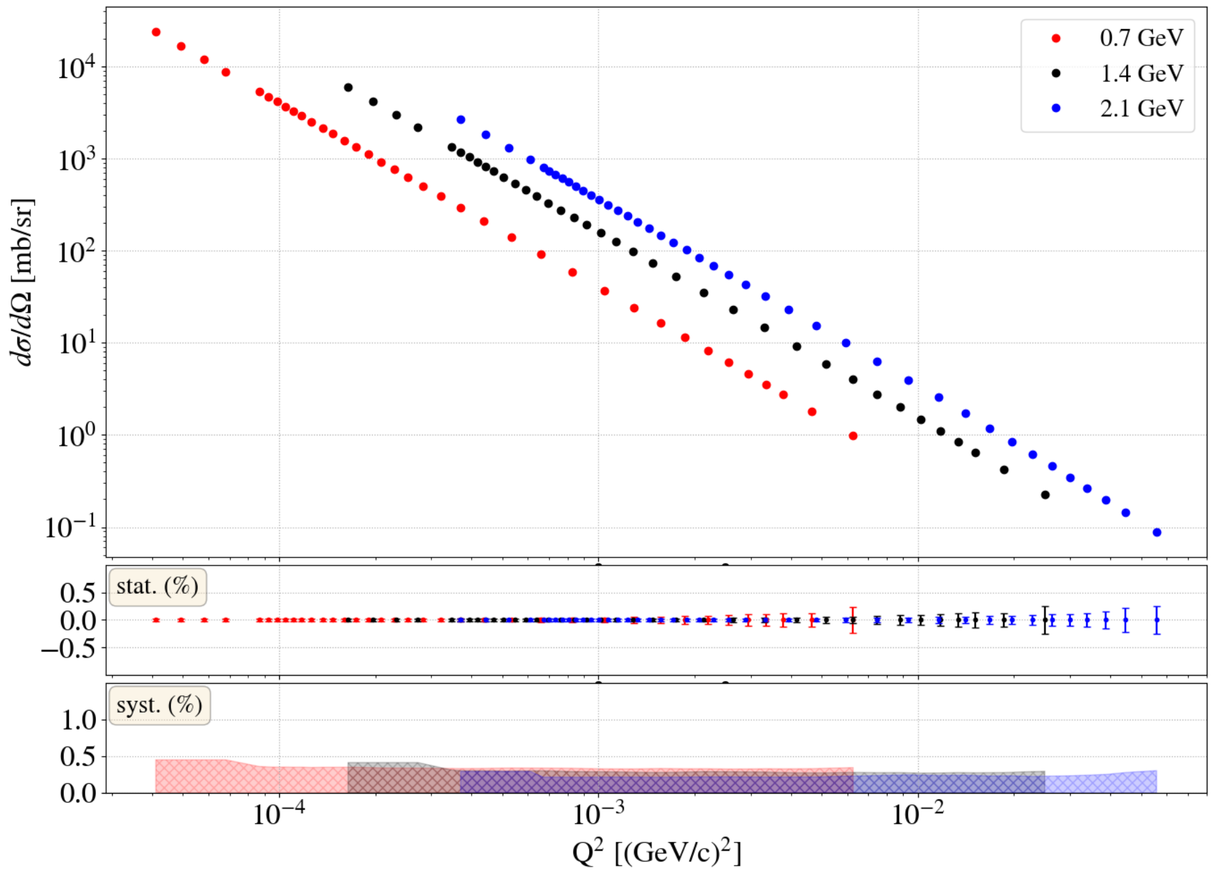
Improvement from PRad to PRad-II

Item	PRad δr_p [fm]	PRad-II δr_p [fm]	Result of
Stat. uncertainty	0.0075	0.0017	**More beam time and higher DAQ rate**
GEM efficiency	0.0042	0.0008	**2nd tracking detector**
Acceptance	0.0026	0.0002	**2nd tracking detector**
Beam energy related	0.0022	0.0002	**2nd tracking detector**
Event selection	0.0070	0.0027	**2nd tracking + HyCal upgrade**
HyCal response	0.0029	Negligible	**HyCal upgrade**
Beam background	0.0039	0.0016	**Better vacuum 2nd halo blocker vertex res. (2nd tracking)**
Radiative correction	0.0069	0.0004	**Improved calc.**
Inelastic ep	0.0009	Negligible	**Upgraded HyCal**
G_M^p parameterization	0.0006	0.0005	**---**
Total syst. uncertainty	0.0115	0.0032	
Total uncertainty	**0.0137**	**0.0036**	

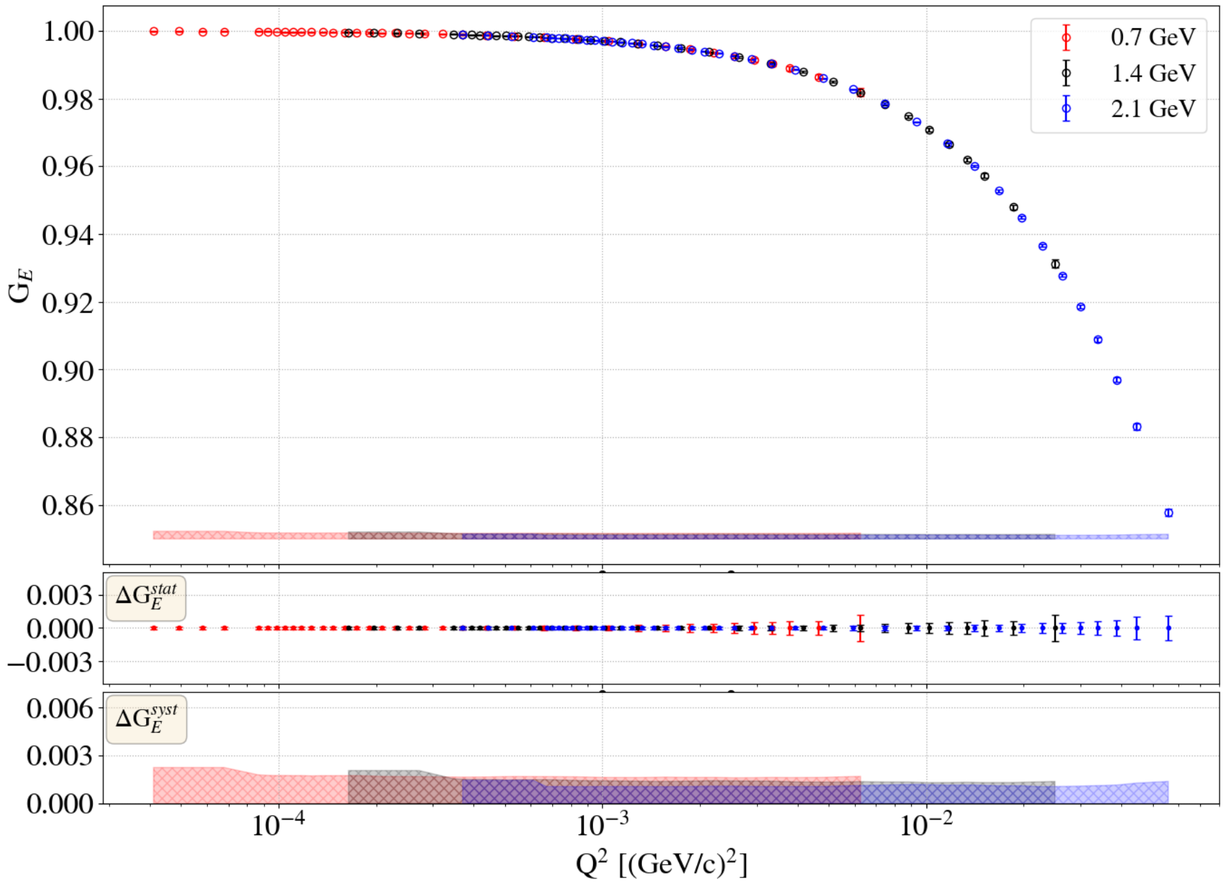
A factor of 3.8 improvement !

Projections for PRad-II

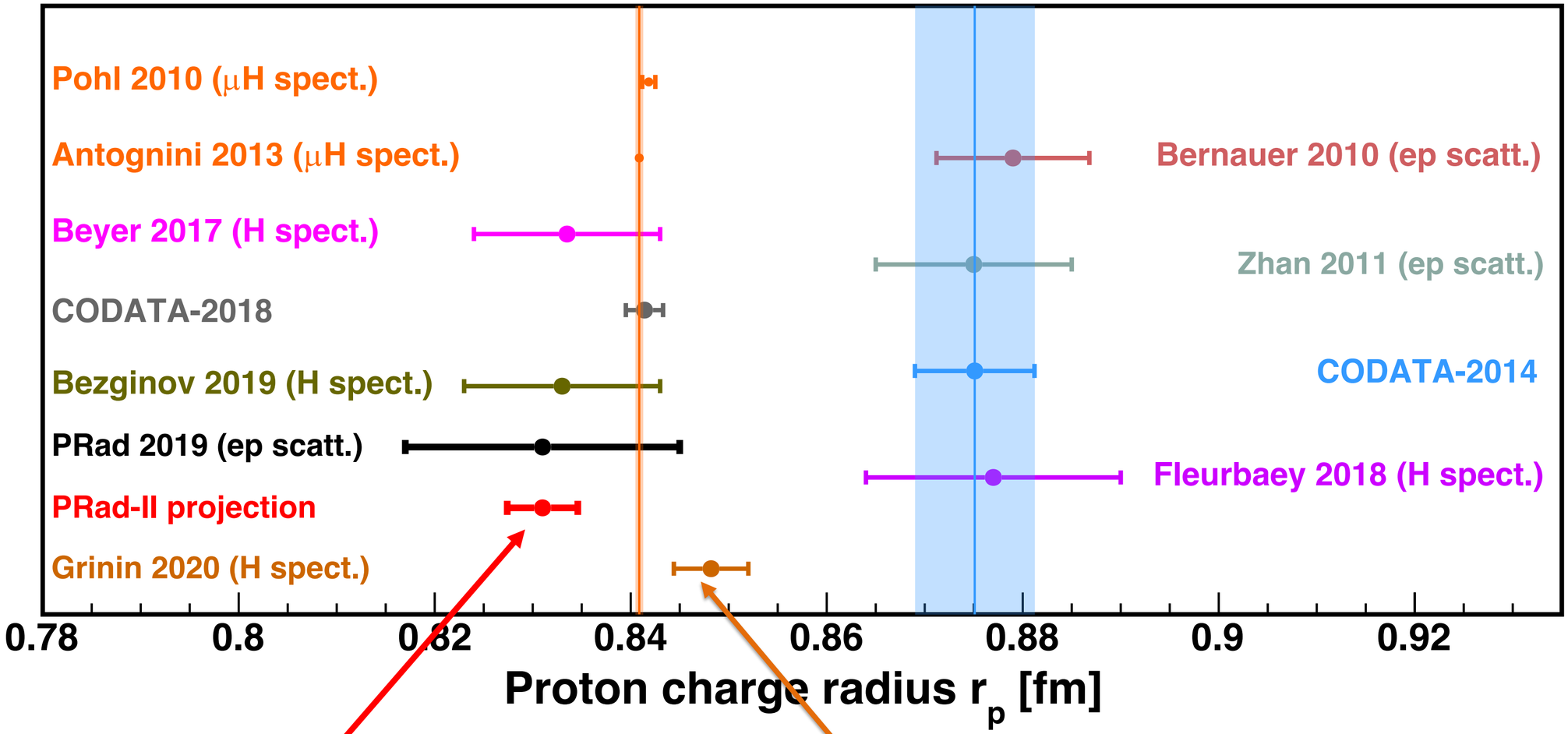
Differential Cross section



Electric form factor



Projections for PRad-II



- **PRad-II: total uncertainty 0.0036 fm**

- **Latest result from ordinary hydrogen spectroscopy since PAC C1 approval:**

$r_p = 0.8482 \pm 0.0038$ fm
Grinin *et al*., Science **370**, 1061 (2020)