

# **New limits on physics beyond the Standard Model in parity- violating electron scattering**

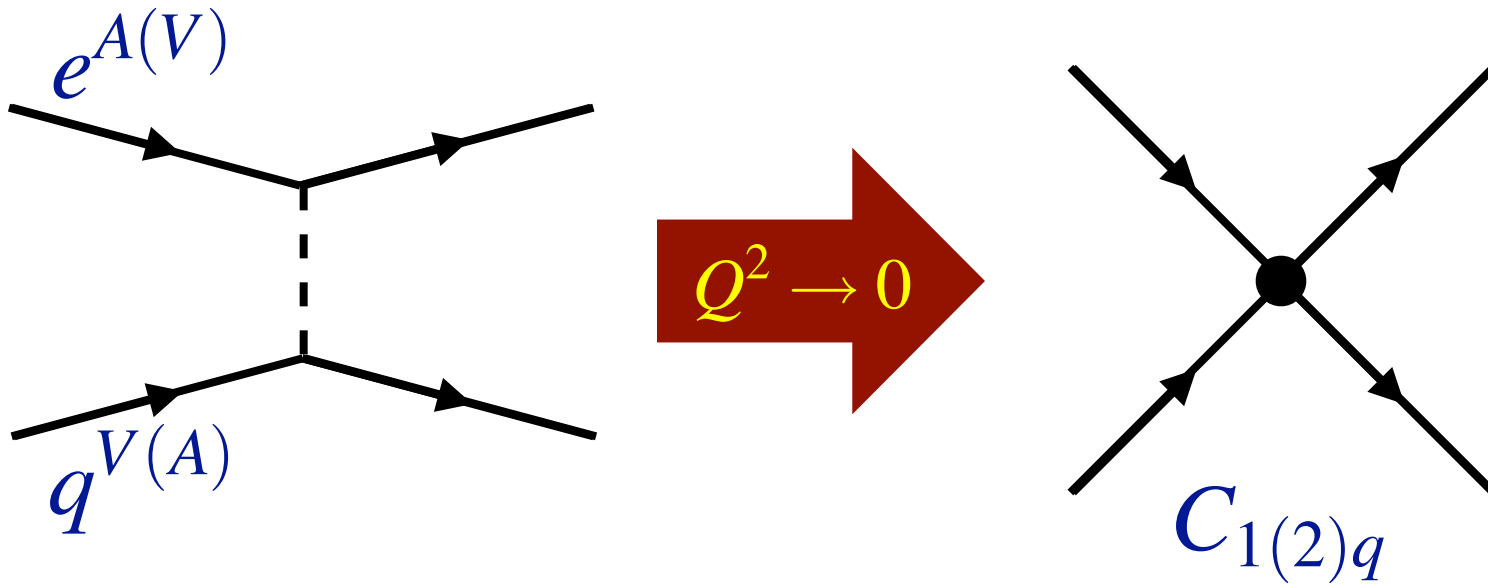
Ross Young

R. Carlini, J. Roche, A. Thomas

# Outline

- Status of PV electron-quark interactions
- Hadronic structure in PVES SM tests
  - Strangeness content of the nucleon
- New experimental limits on low-energy PV electron(A)-quark(V) interactions
- Qweak Experiment

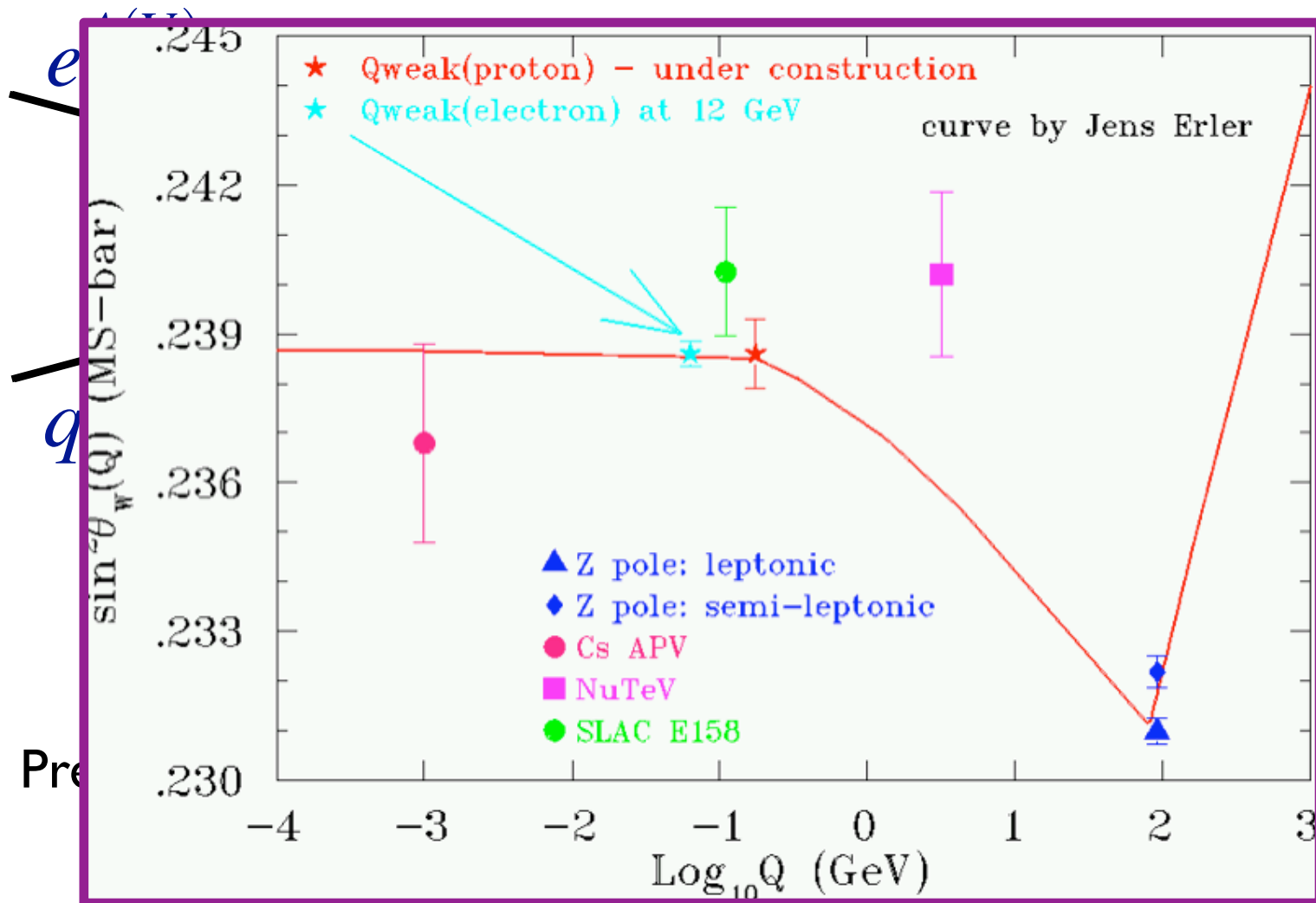
# PV Electron-Quark Couplings



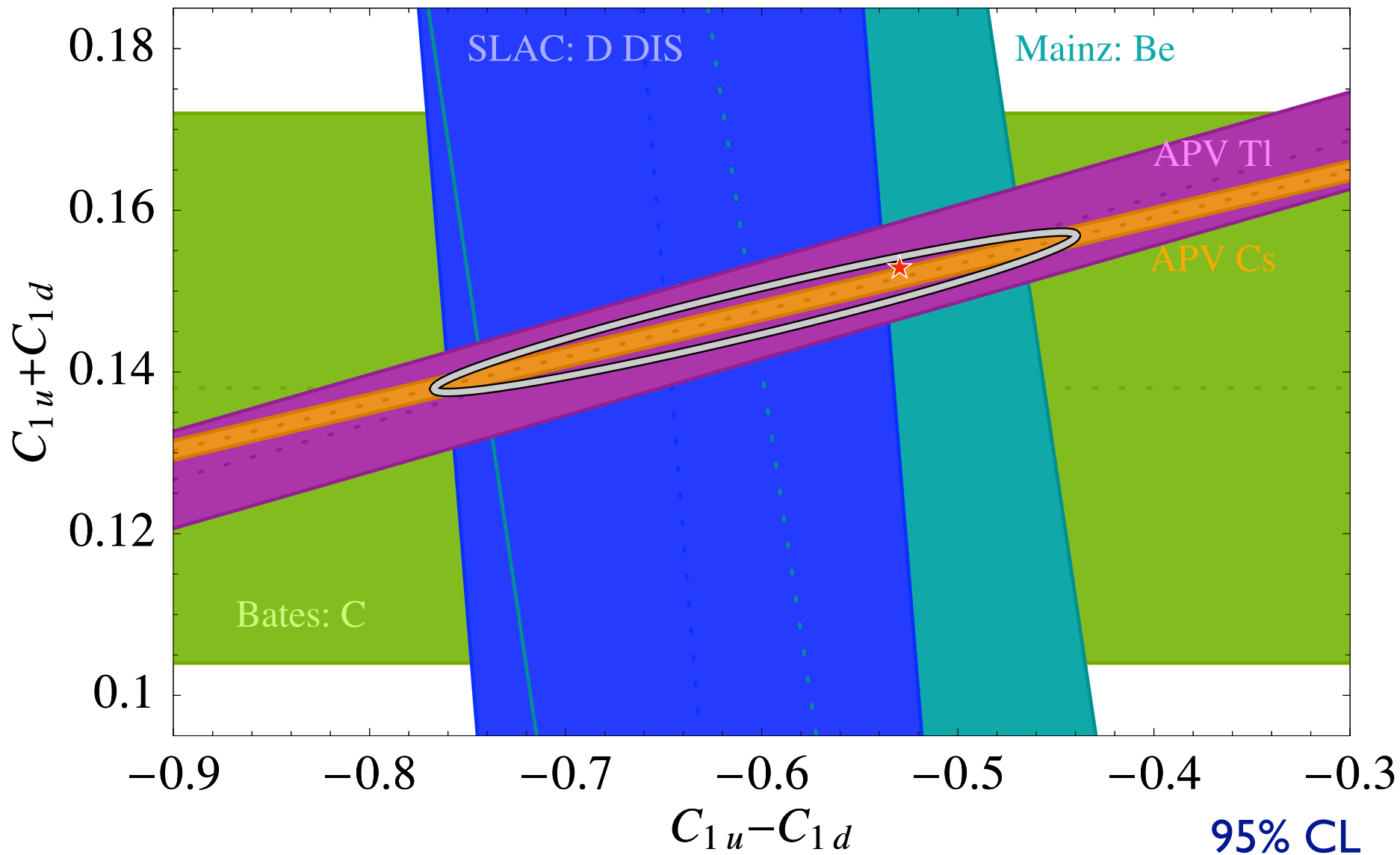
Couplings precisely determined by high-energy measurements and SM scale evolution

Precise low-energy measurements can reveal new beyond the Standard Model physics

# PV Electron-Quark Couplings

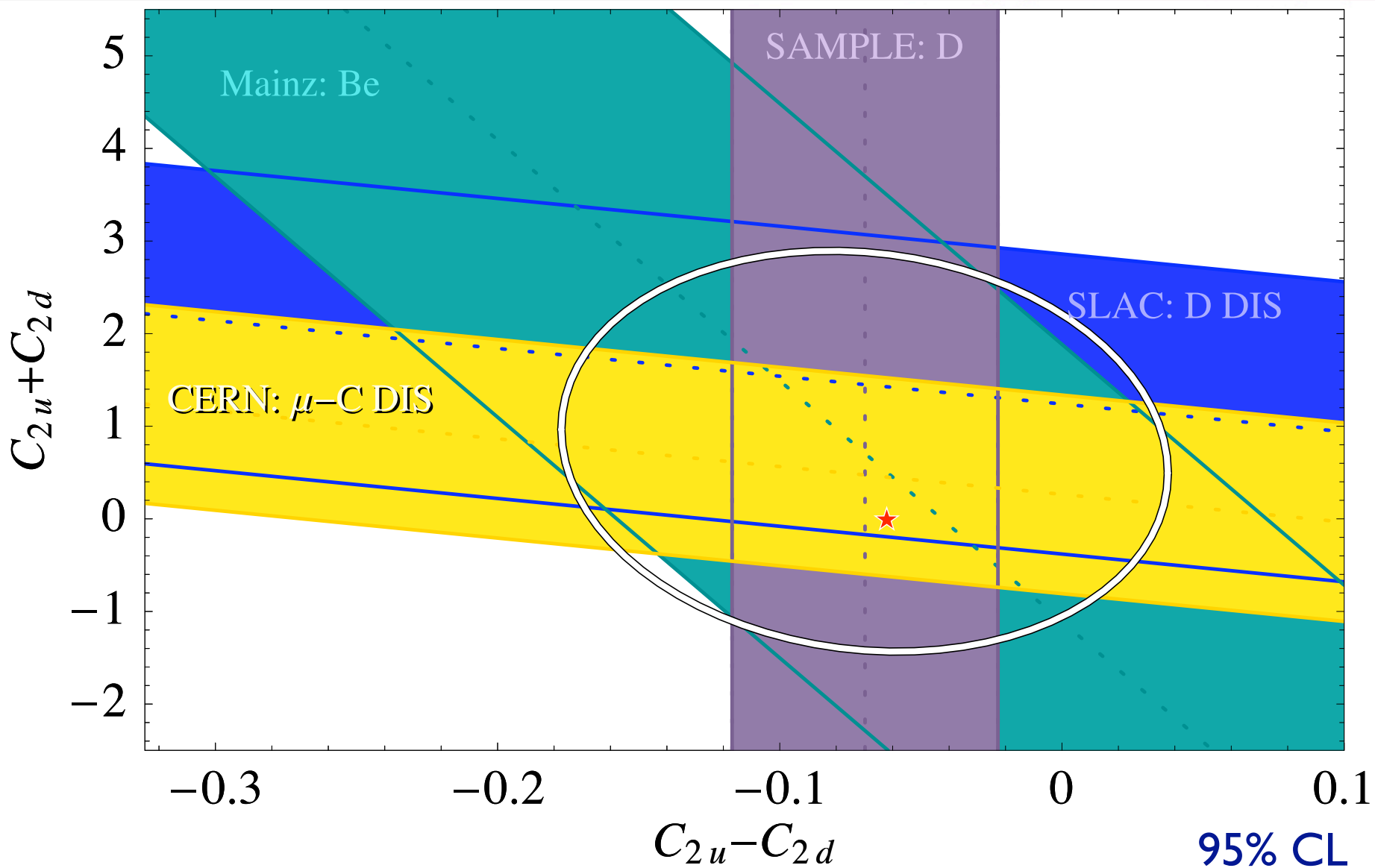


# $C_{1q}$ Couplings



95% CL

# $C_{2q}$ Couplings



95% CL

# Qweak Experiment

- Precise measurement of the proton's weak charge in PVES

$$Q_{\text{weak}}^p = -2(2C_{1u} + C_{1d}) \quad Q^2 = 0.03 \text{ GeV}^2, \theta = 8^\circ$$

- At low energy and small scattering angle:

$$A_{LR} = -\frac{G_\mu Q^2}{4\pi\alpha\sqrt{2}} \left[ Q_{\text{weak}} + \beta_A \tilde{G}_A^p \sqrt{Q^2} + \beta_V Q^2 + \dots \right]$$

$$\beta_A \propto \theta + O(\theta^3)$$

Anapole uncertainty

Strangeness uncertainty

# Strangeness Measurements

- Dedicated measurements to determine strangeness content of nucleon:  
SAMPLE, A4-Mainz, HAPPEX, G0
- Constrain hadronic background for Qweak!

Global fits to all data  $Q^2 < 0.3 \text{ GeV}^2$

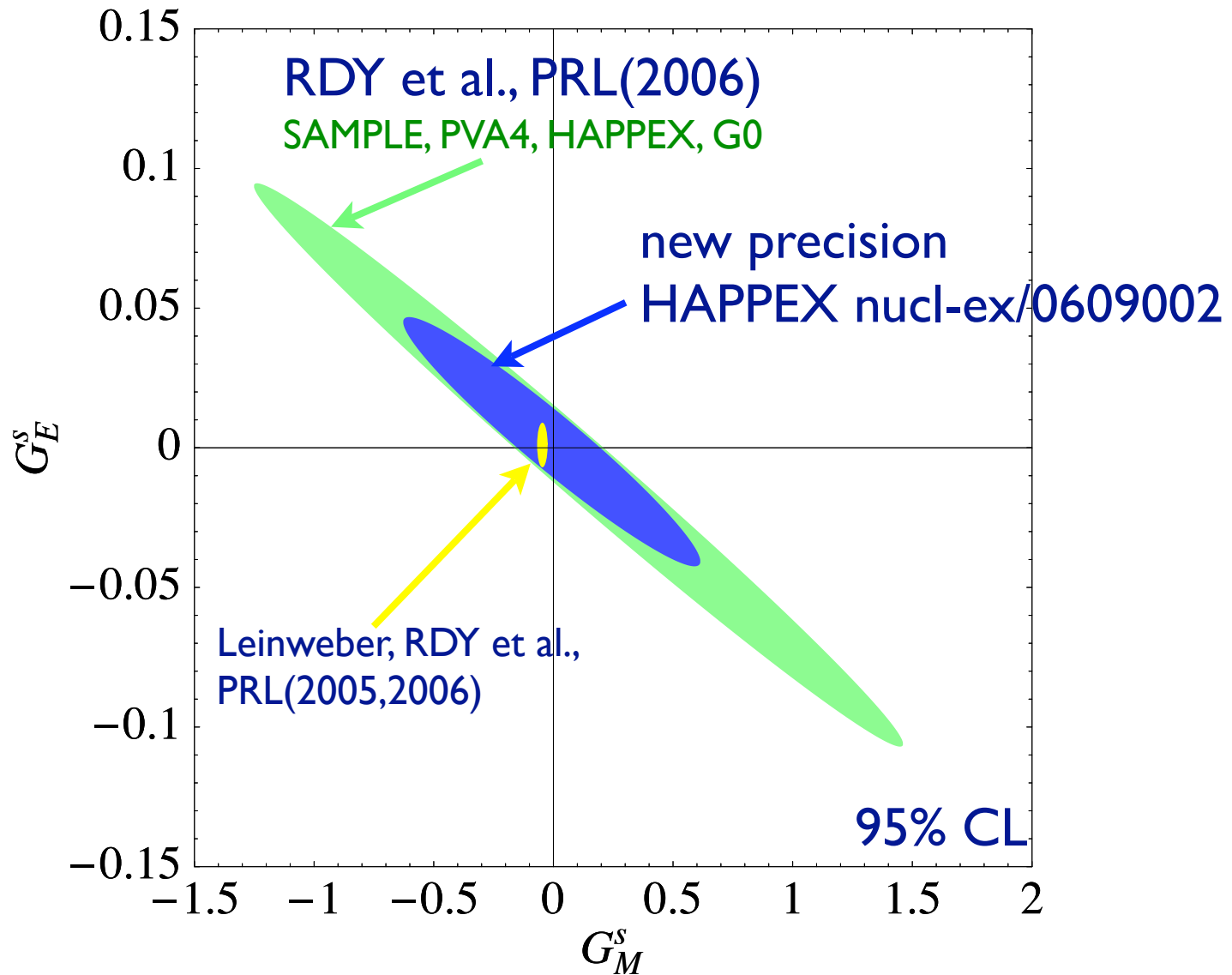
$$G_E^S = \rho_s Q^2 + \rho'_s Q^4 + \dots$$
$$G_M^S = \mu_s + \mu'_s Q^2 + \dots$$

$$\tilde{G}_A^N = \tilde{g}_A^N \left( \frac{1}{1 + Q^2/M_A^2} \right)^2$$

$$\tilde{g}_A^N = (\xi_A^{T=1} g_A \tau_3 + \xi_A^{T=0} a_8 + \xi_A^0 a_s) + (A_{\text{ana}}^{T=1} \tau_3 + A_{\text{ana}}^{T=0})$$



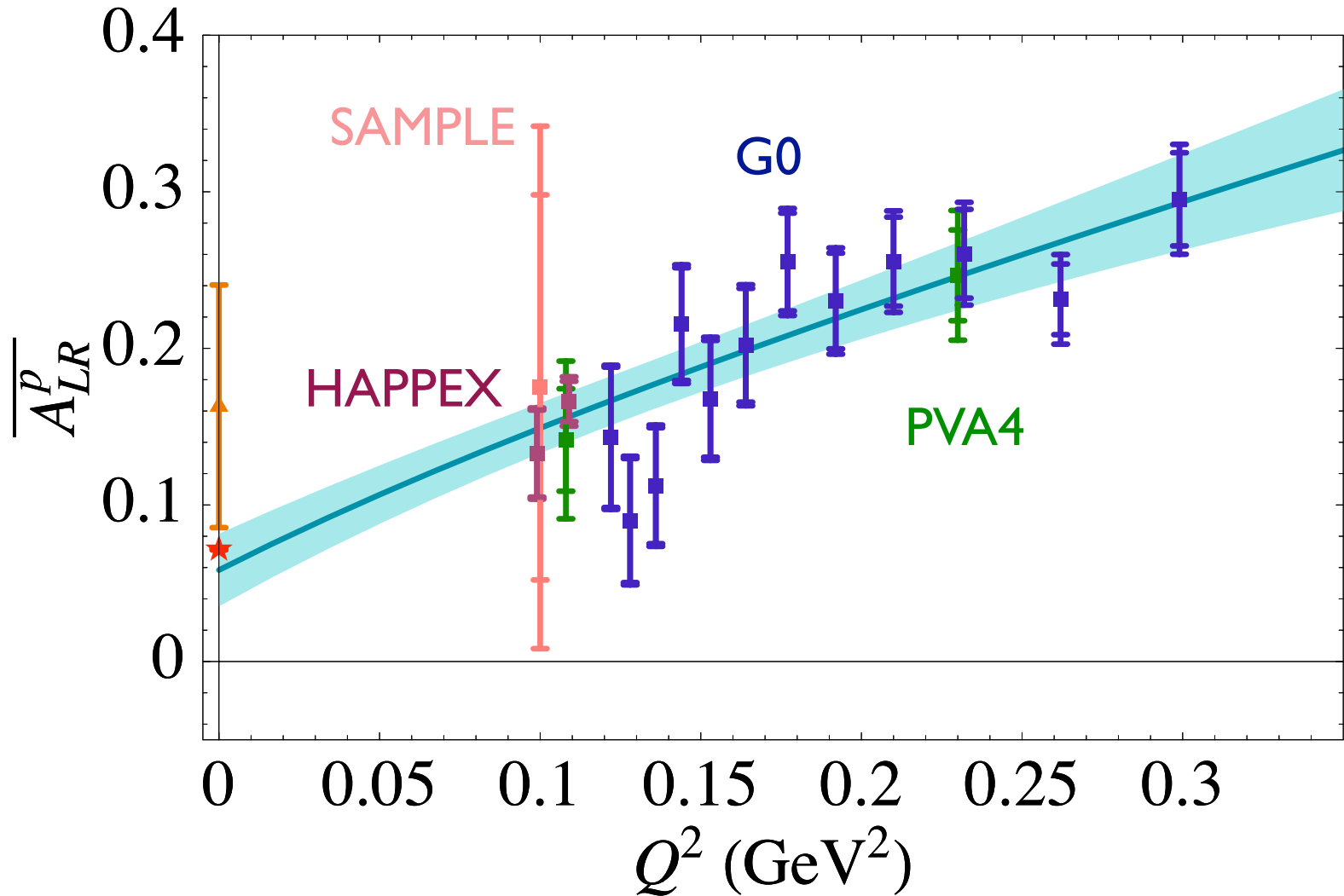
# Strangeness @ $Q^2=0.1 \text{ GeV}^2$



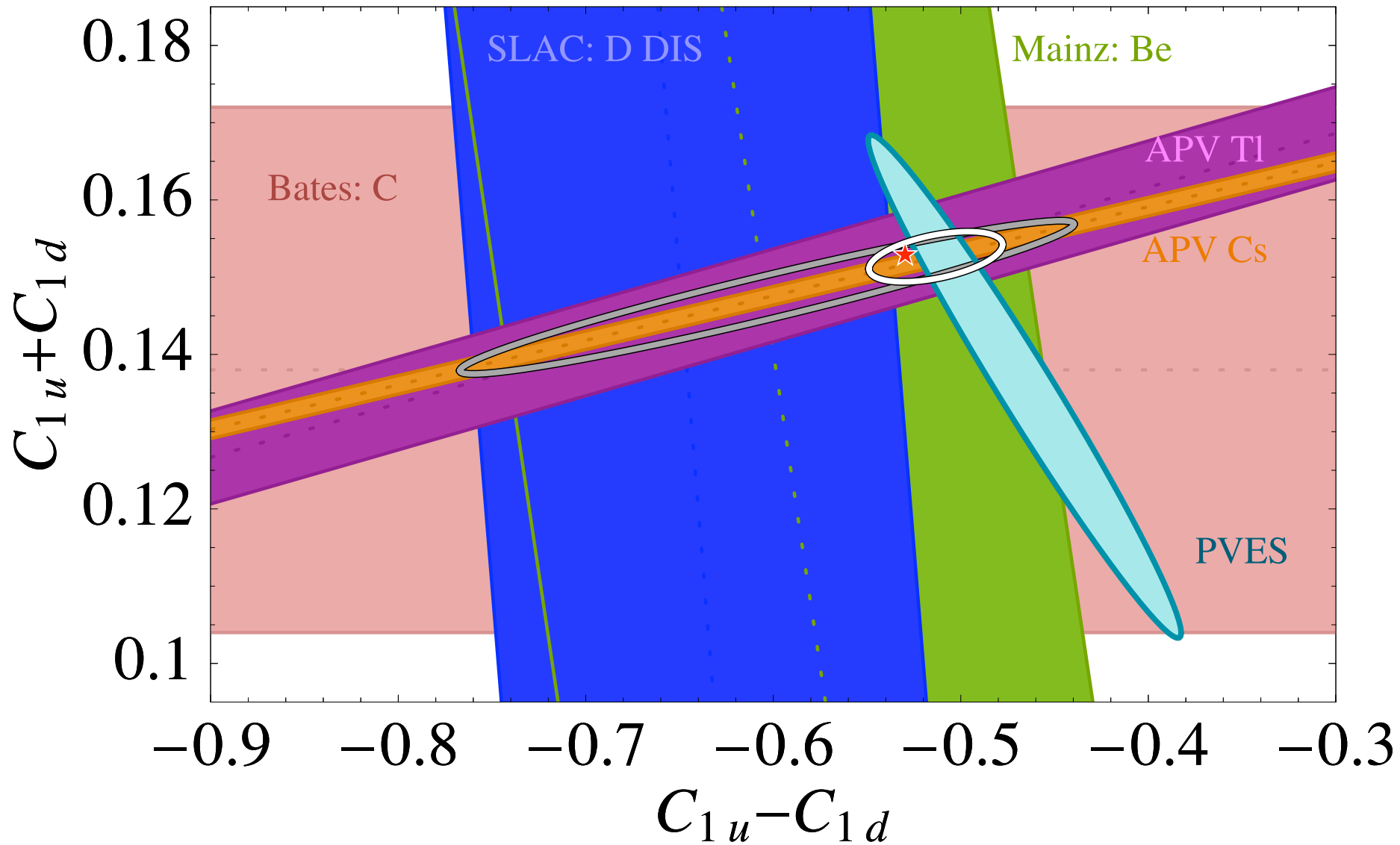
# Electroweak Couplings in PVES

- Without  $Q_{\text{weak}}$  experiment, what are the present limits on  $C_{1q}$ ?
- Repeat global fits with weak charges free – and free hadronic structure

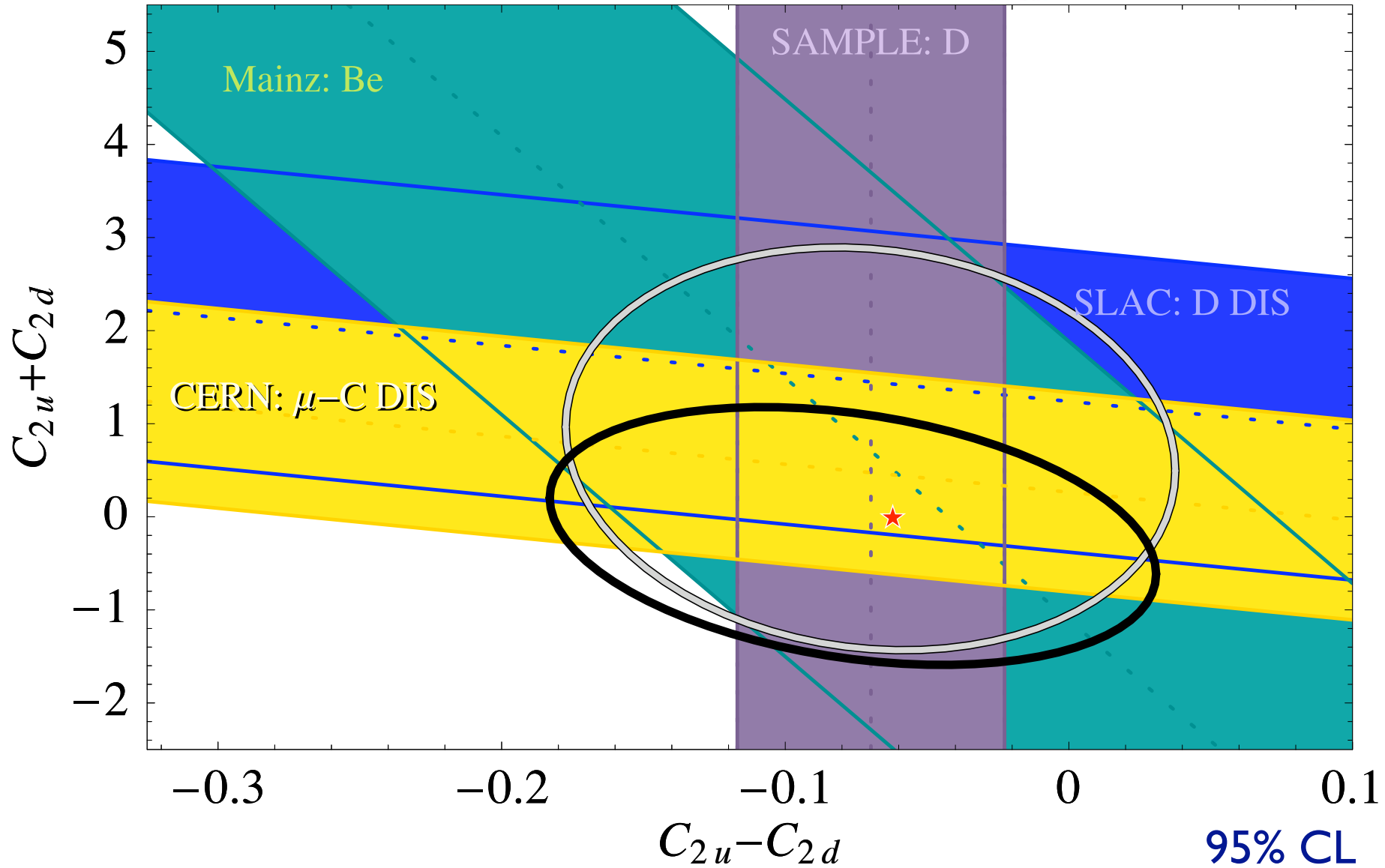
# Proton Weak Charge Extrapolation



# $C_{1q}$ Couplings with PVES



# $C_{2q}$ Couplings with PVES

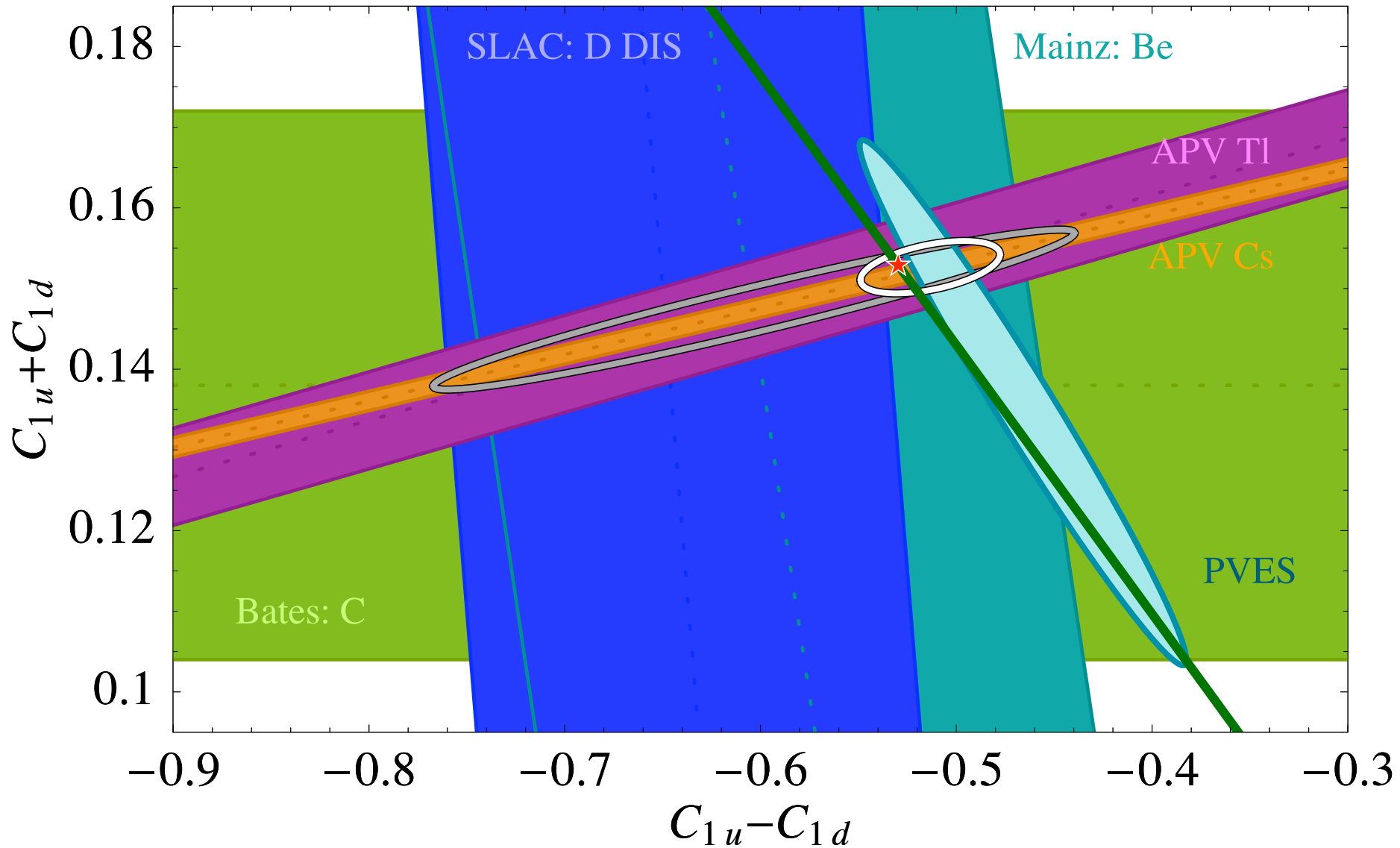


95% CL

# Remarks

- New precision PVES providing critical test of hadronic theory
- Experimental knowledge of electroweak couplings improved by factor  $\sim 5$
- Can now provide model-independent limits on new physics in general isospin parameter space

# The Qweak Measurement!



# Qweak

