SPC overview of cold NP

William Detmold, MIT

USQCD All Hands Meeting, Fermilab, MAY 2nd 2015

Nuclear Physics

- NP has a broad program

Phases of QCD Matter	Nucl. Structure & Astrophysics
QCD and Hadron Physics	Fund. Symmetries & Neutrinos

- Existing Facilities: CEBAF @ Jefferson Lab, RHIC @ BNL, ATLAS@ ANL
- Future Facilities
  - Facility for Rare Isotope Beams (FRIB) @ Michigan State
  - ? Electron-Ion Collider (EIC) @ BNL or JLab
  - ?? Ton-scale $0\nu\beta\beta$ decay Experiment

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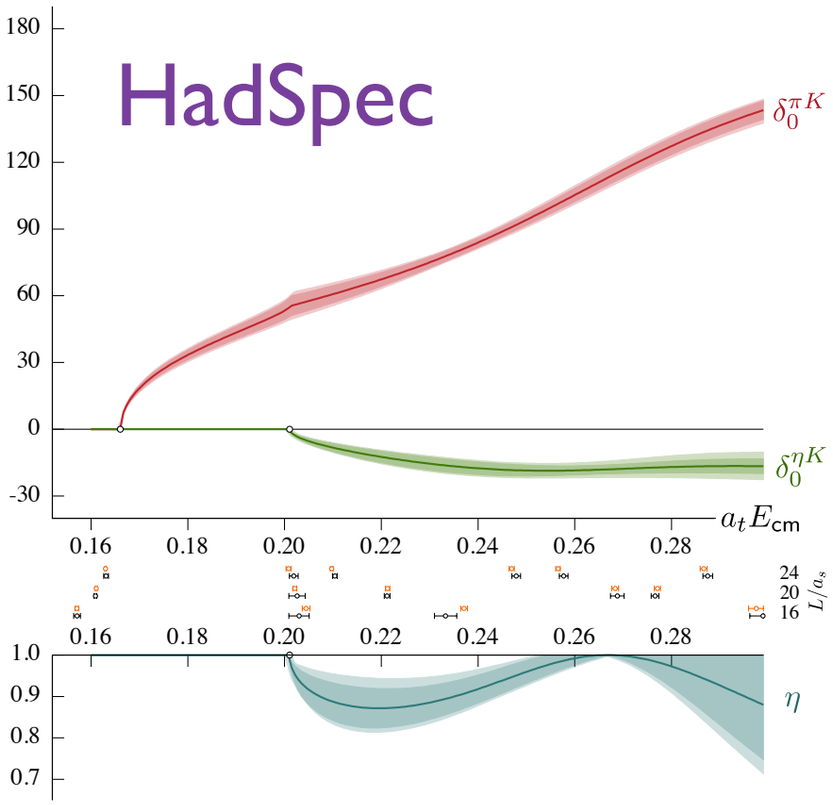
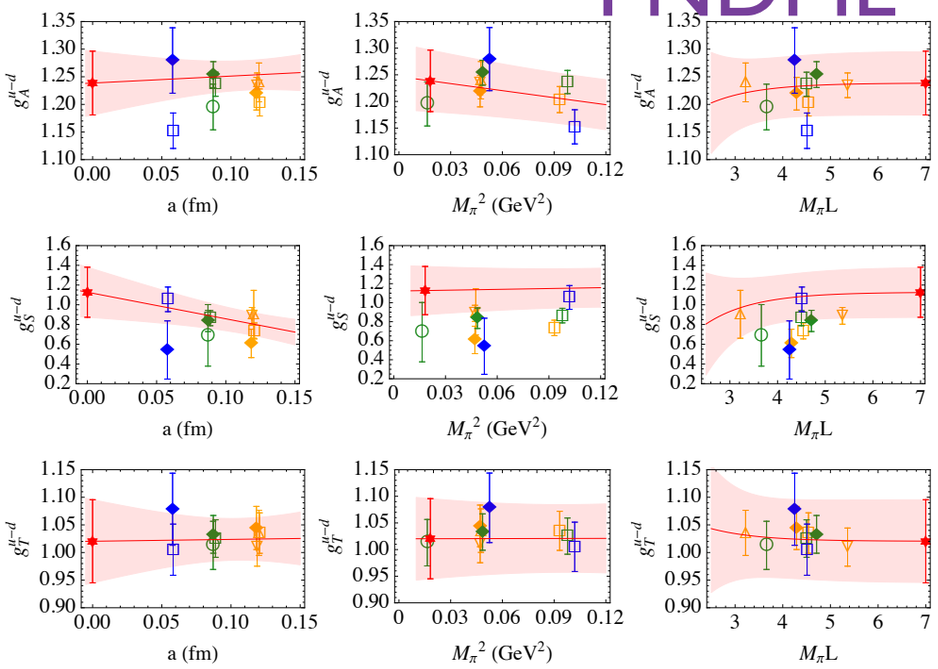
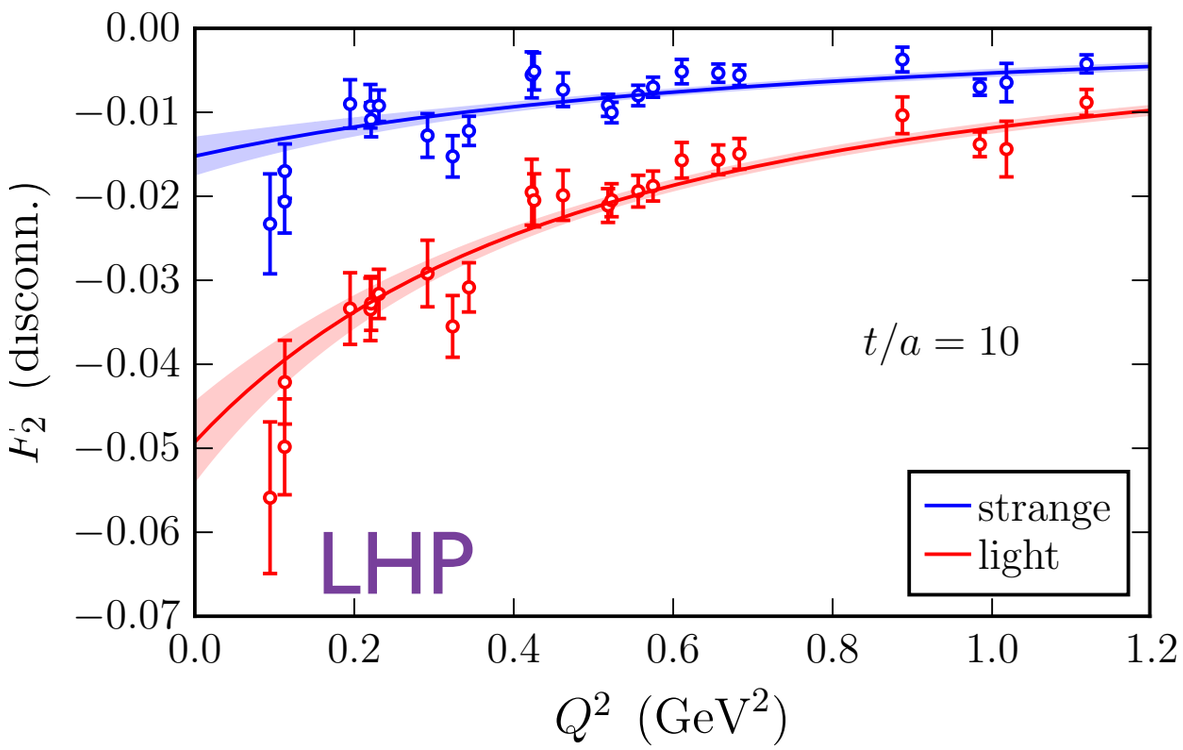
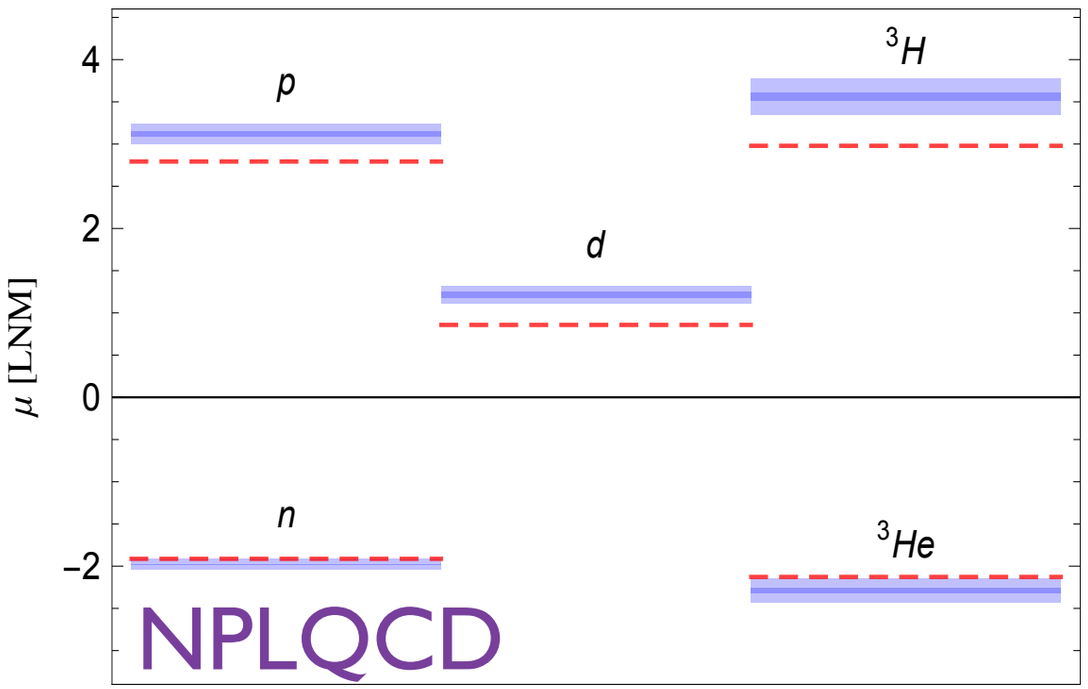
- 2014/5: NSAC long range planning process
  - Updating 2007 LRP
  - Evaluate and prioritise program for next decade
  - 5-day resolution meeting in April, report due in October
- Computational Nuclear Physics Initiative (potentially ~$10M/yr)
  - Lack of capacity computing and workforce in NP
  - Meetings in July 2012, July 2014, 2014 white paper
  - Strong endorsements from all 4 areas of NP
  - Tea leaves: fairing well in LRP

Cold NP Highlights









Cold NP Requests 2014

Edwards	Isotropic Gauge Gen.	100M ORNL 25M+10% ANL
DeTar	Charm Spectroscopy	8.6M CPU
Orginos	Nuclei	85M CPU 40K GPU
Meinel	Disconnected Structure	540K GPU
Richards	Spectroscopy	64M CPU 4.5M GPU
Walker-Loud	~~CP~~ πN, g	37M CPU 7% ANL ZP
Lin	Structure	32M CPU
Liu	Structure	17M ORNL, 6M CPU
Syritsyn	Structure	67M CPU

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Detmold	Nuclei	53M CPU 6.1M GPU
Edwards	Spectroscopy	71M CPU 2.8M GPU
Walker-Loud	~~CP~~ πN, g	10M CPU 2.5M GPU
Lin	Structure	95M CPU
Liu	Structure	39M ORNL, 10M CPU
Syritsyn	Structure	44M CPU
Gupta	Structure	47M CPU
Kronfeld	Structure	30M CPU
Richards	Structure	23M CPU 0.4M GPU
Blum	Chromo-EDM	22M CPU

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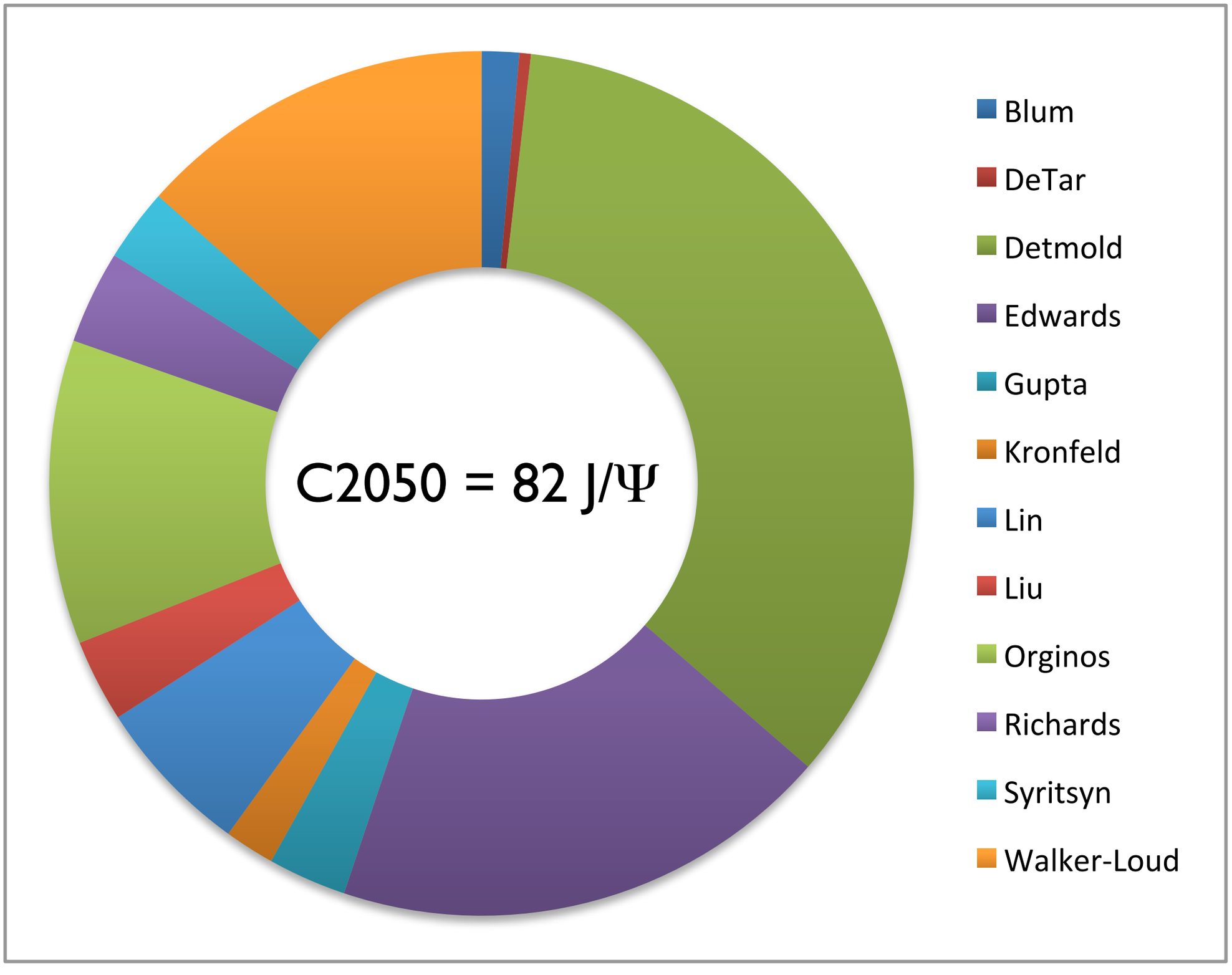
Structure

Cold NP proposals

PI	Title
Tom Blum	Calculation of nucleon electric dipole moments induced by quark chromo-electric dipole moments
Carleton DeTar	Quarkonium Physics: X(3872)
Will Detmold	Lattice QCD Studies of Multi-Neutron Systems and Light Nuclei
Robert Edwards	The Spectrum and Properties of Excited Meson and Baryon States using Anisotropic Clover Lattices
Rajan Gupta	Probing Novel Physics via Precision Calculations of Nucleon Matrix Elements
Andreas Kronfeld	The Nucleon Axial-Vector Form Factor at the Physical Point with the HISQ Ensembles
Huey-Wen Lin	Precision Neutron-Decay Matrix Elements for Fundamental Symmetry
Keh-Fei Liu	Quark and Glue Structure of the Nucleon with Lattice QCD
Kostas Orginos	Dynamical Isotropic-Clover Lattice Production for Hadronic and Nuclear Physics
David Richards	Hadron Structure using Distillation
S. Syritsin	Nucleon Structure Exploration using High Statistics Isotropic Clover Calculations
Andre Walker-Loud	CP Violating pi-N couplings from quark C-EDM operators and other static nucleon matrix elements

Overall Cold NP program



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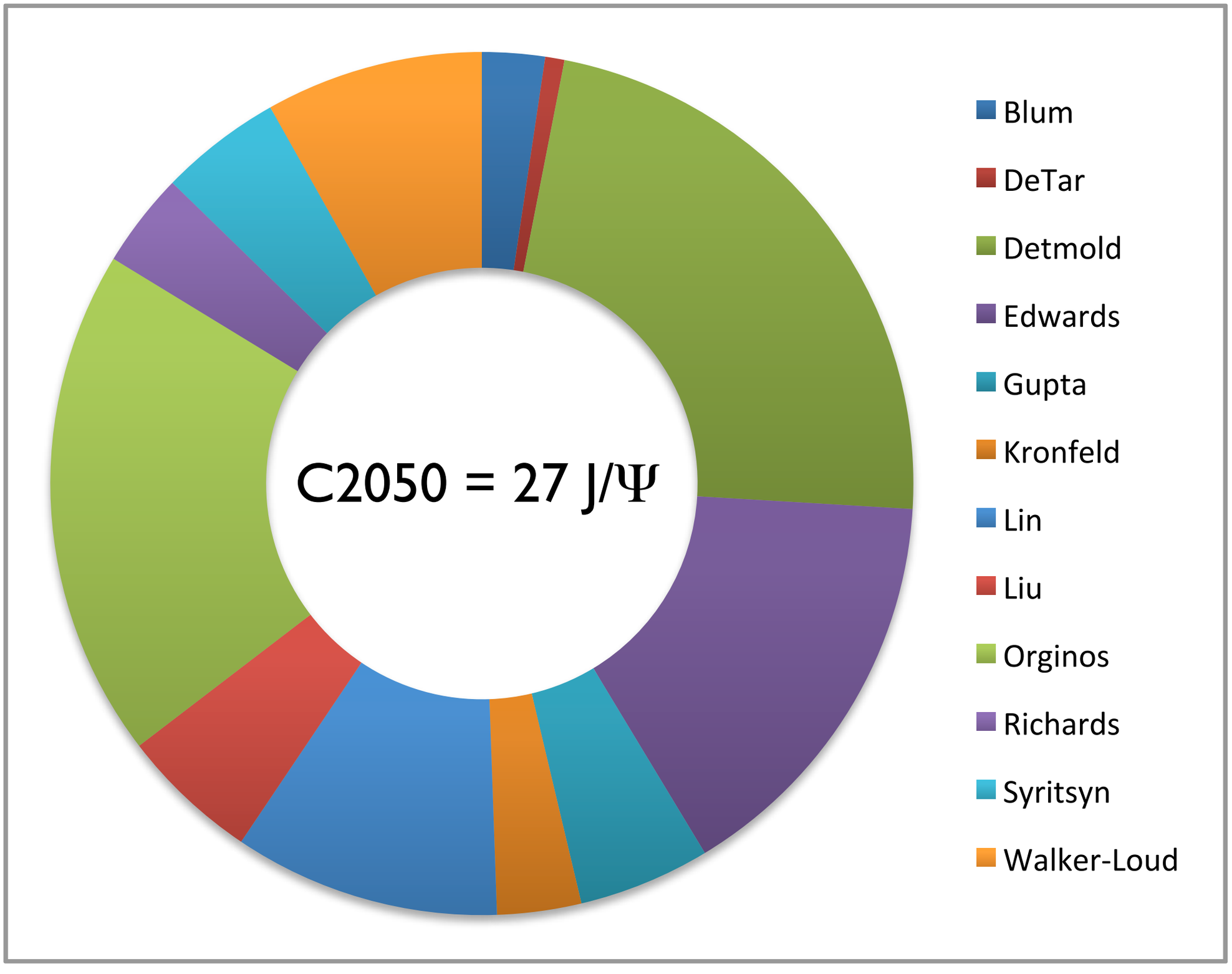


- Edwards: excited state resonance spectroscopy in many channels
  - Coupled channels phase shift extractions
  - Radiative processes
- Detmold: light nuclei (spectrum and properties) and multi-neutron systems
  - Constrain *nnn* interactions and EoS for nuclear astrophysics
  - $m_\pi = 800 \rightarrow 450 \rightarrow 300$ MeV
- DeTar: charm spectroscopy X(3872) state
  - New method to study mixing with open charm states, $L \rightarrow \infty$

Hadron Structure: Physics Coverage

Isoscalar Contributions

Spin decomposition

Valence

CLOVER

HISQ

DWF

Overlap

Liu

SYRITSYN

LIN

TMD PDFs, q(x)

GUPTA

Kronfeld

WALKER-LOUD

BLUM

RICHARDS

Configs

Clover

HISQ

DWF

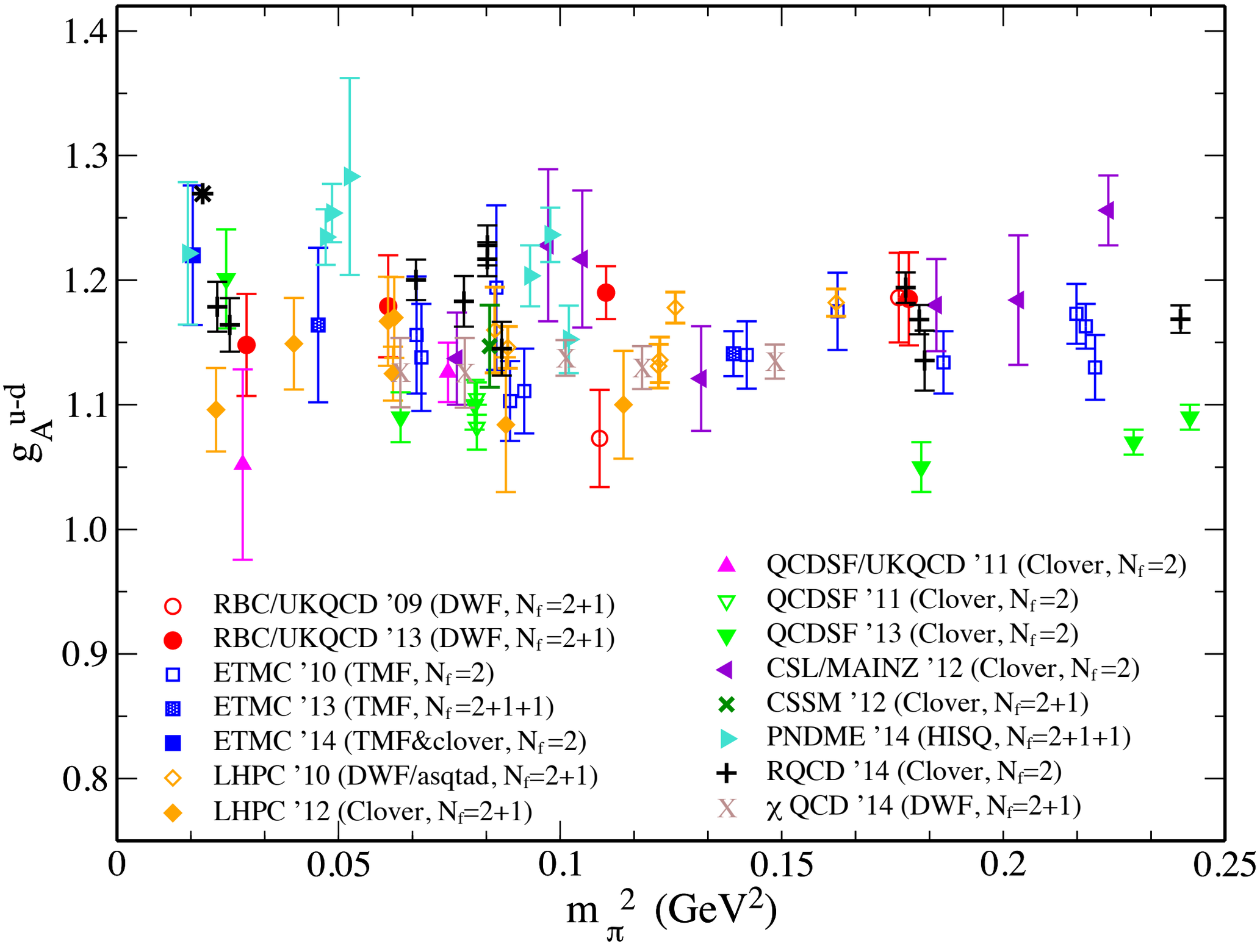
g_A, g_S, g_T, form factors

CPV πN/quark CEDM

Hadron structure

- Why n→∞ proposals on hadron structure?
  - Many interesting physics goals
  - Tough problem (excitations, FV, noise,…)
  - Are we being effective?
  - Divisions in community?
  - Lack of focus and prioritisation?
    Diversity is good, but…
- Should USQCD work together and solve this problem?
  - g_A, <x> have 3% precision goal in USQCD white paper

g_A: Lattice 2014



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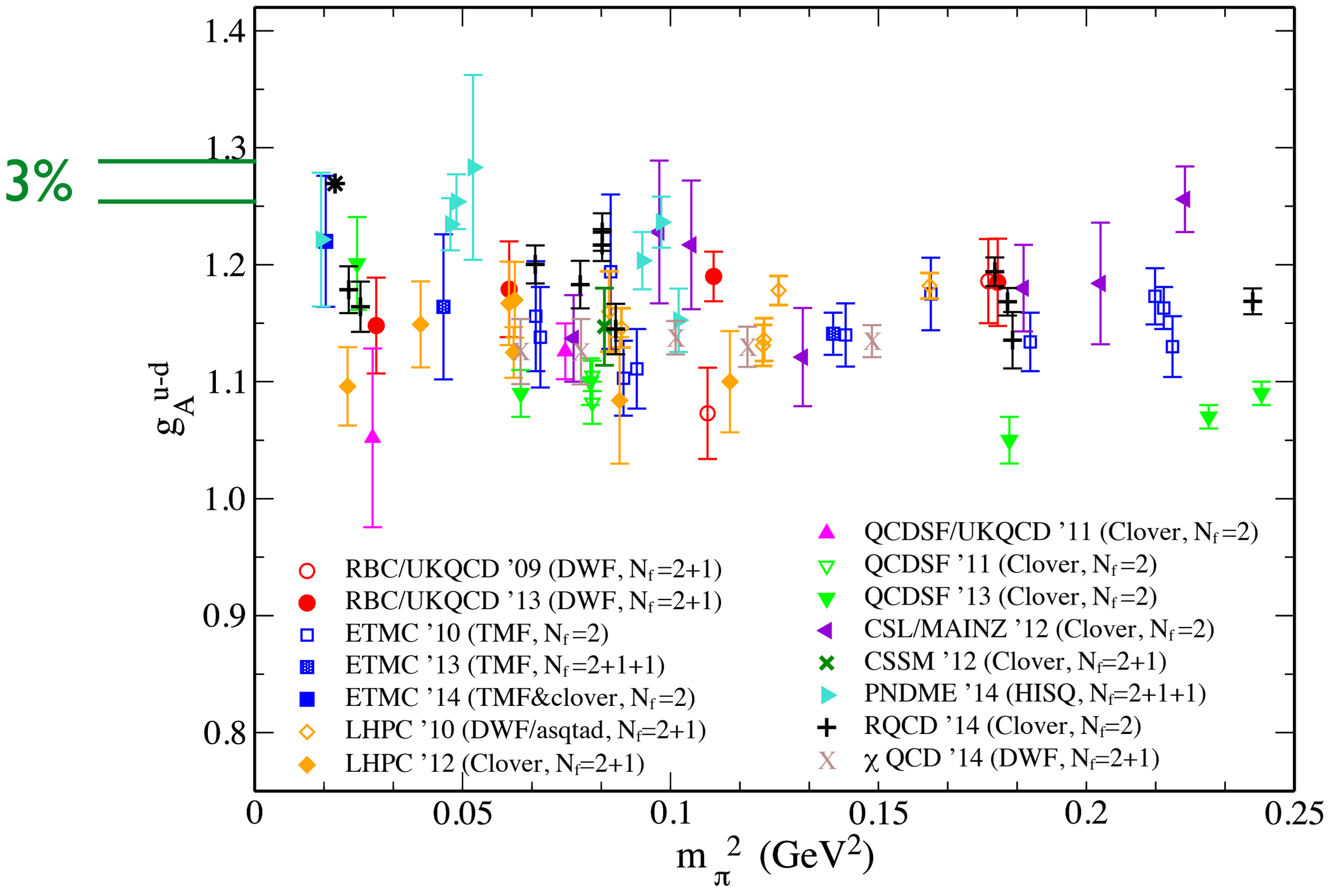

Precision goals

- Historically NP has not focused on the same well quantified precision goals as HEP flavour physics
- Needs to for nucleon matrix elements with new experiments ($\langle r^2 \rangle$, $F_A(q^2)$, UCN, …)
  - Nuclear physics is the new flavour physics
  - Multiple lattice spacings, multiple volumes, multiple t_{sep}
- Requires long-term planning and coherence
  What are the ideal set of calculations to do?
  - DWF, Staggered, Clover?
  - Hadron structure workshop in DC in 2014: broad support for clover fermions
  - Time critical: European groups will finish hadron structure