SPC Summary

BSM - Energy Frontier
USQCD proposals, 2017

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BSM within USQCD

Almost all HEP -USQCD effort is related to BSM physics

What falls in the BSM - Intensity Frontier category?

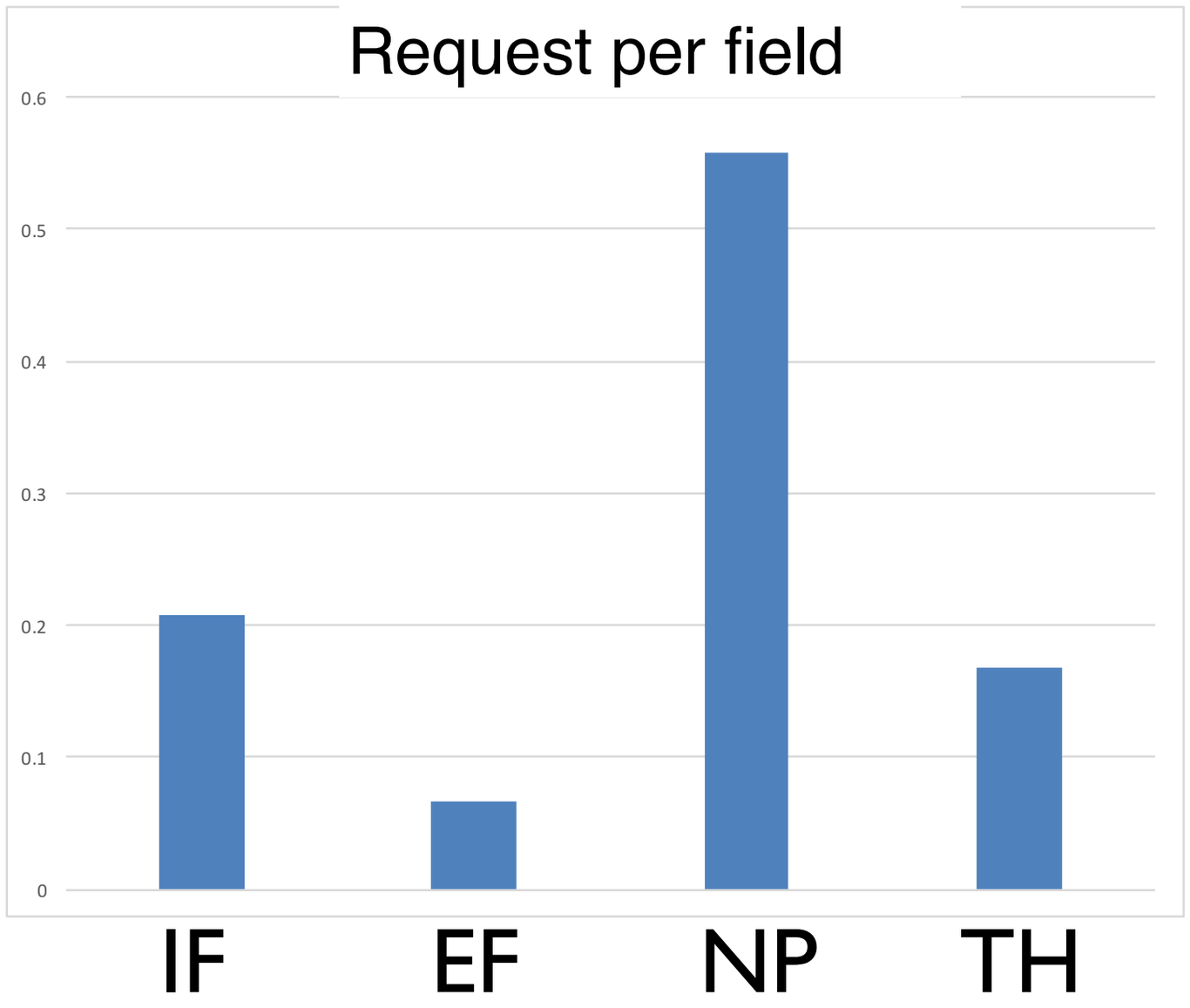
- Strongly coupled models that are BSM candidates
  - Dilaton - like Higgs ✓
  - pNGB - like Higgs ✓
  - models where walking is tunable ✓
  - models with partial compositeness ✓
  - models with 4-fermion interactions
  - .....
- Dark matter from strongly coupled models ✓
- Nuclear physics of strongly coupled systems ✓
- Investigations of general conformal systems
  - boundary of conformal window ✓
  - anomalous dimensions ✓
  - ....
- SUSY & AdS/CFT correspondance ✓
- .....

These topics are intertwined

✓ by USQCD

BSM within USQCD

Relatively small effort: 6.5% of all requests,



Total:(J-psi hrs)

IF: 21%

EF: 6.5 %

NP: 56 %

Th: 16.5 %

BSM within USQCD

Goal:

understand the (general) properties of models that could describe BSM physics

Synergies:

- Pheno community :

  predictions for non-perturbative quantities like

  - hadron spectrum in near-conformal or walking theories
  - anomalous dimensions relevant for mass generation
  -

- Lattice community :

  BSM models are QCD - variants. BSM projects contribute

  - HMC code testing/development (SUSY, Grid code for MDW, staggered w/FUEL)
  - Measurement techniques (disconnected spectrum, spectrum with gradient flow - mixed action studies, step scaling / β function calculations)
  - Most collaborations will share codes & configurations

2017 USQCD BSM proposals:

Higgs is dilaton-like state

- J. Kuti /LHColl : 2 flavor sextet model — 80.4M Jpsi

Higgs is pNGB

- E. Neil : pNGB with fermions in 2 different representations — 6.1M Jpsi
- O. Witzel /LSD coll : 4+6 flavors — 24.4M Jpsi

Conformal FP

- C. Rebbi : Step scaling function and universality with MDW — 14.8M Jpsi

Lattice SUSY

- S. Catterall/ Syracuse & RSI group: ongoing investigations that even string theorists care about — 18M Jpsi

Incite projects:

- LHColl : sextet
- LSD : 8 flavors, 4+4 flavors (staggered), 4+6 MDW
- SUSY (see J. Giedt's talk)

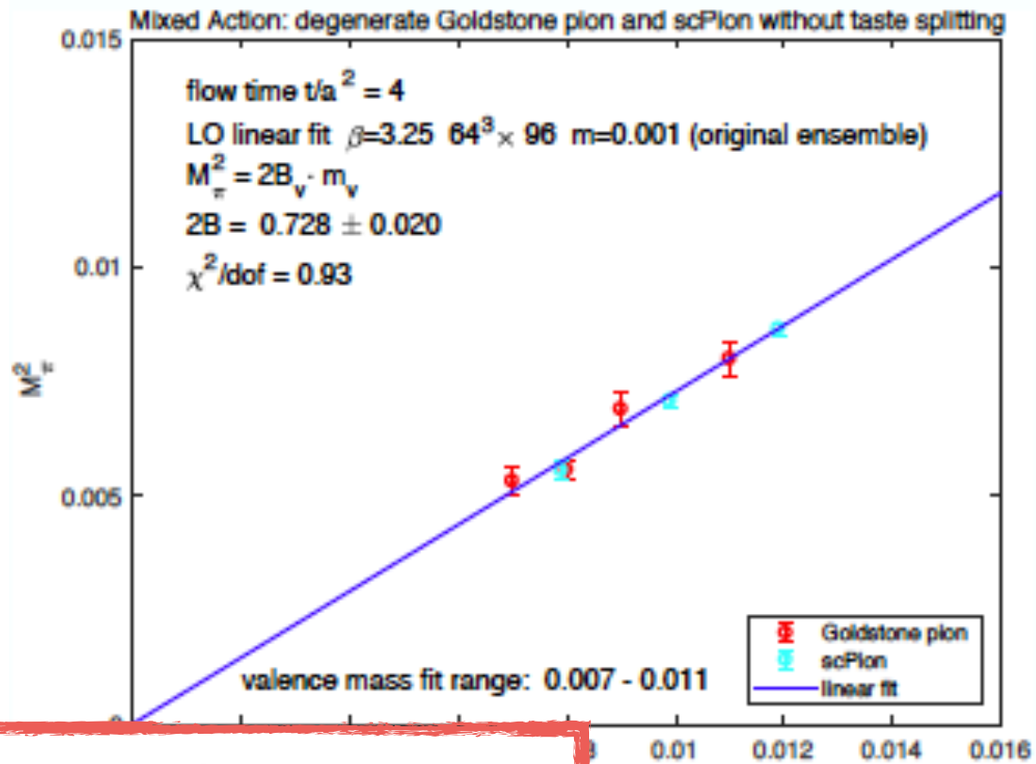
J. Kuti/LHColl: The composite Higgs with new lattice BSM

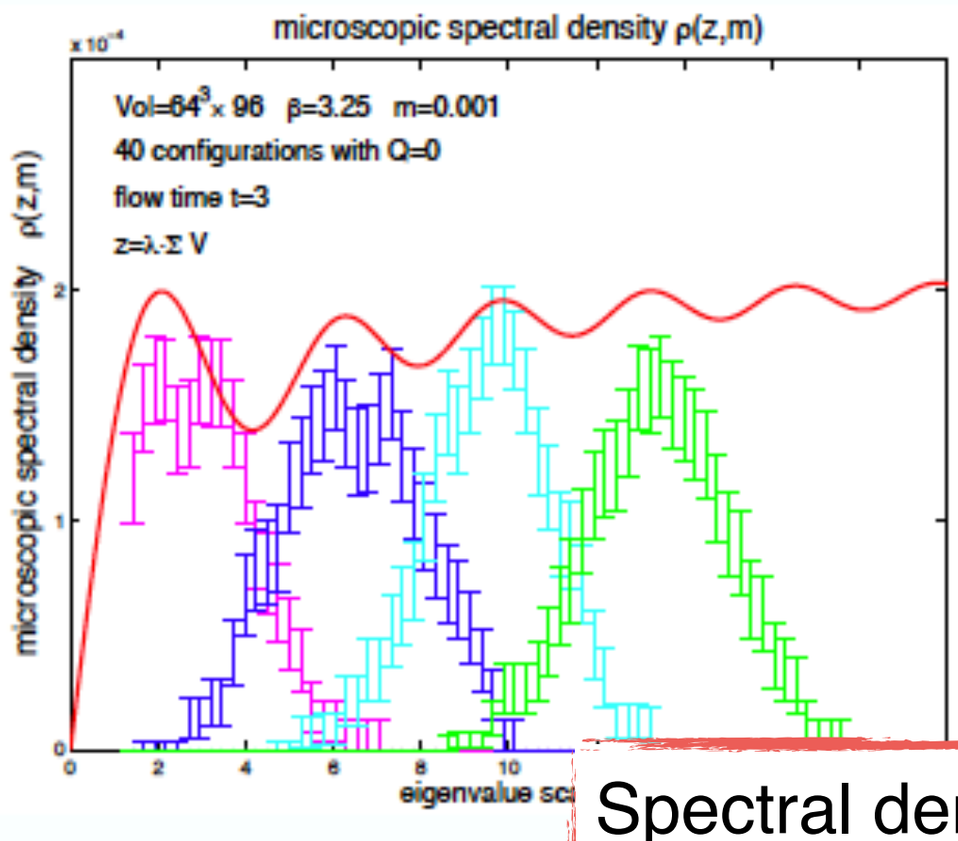
- 80.4M Jpsi on GPU

- 2-flavor SU(3) sextet model is candidate BSM with
  - only 3 Goldstone pions
  - light Higgs as 0^{++} sigma state

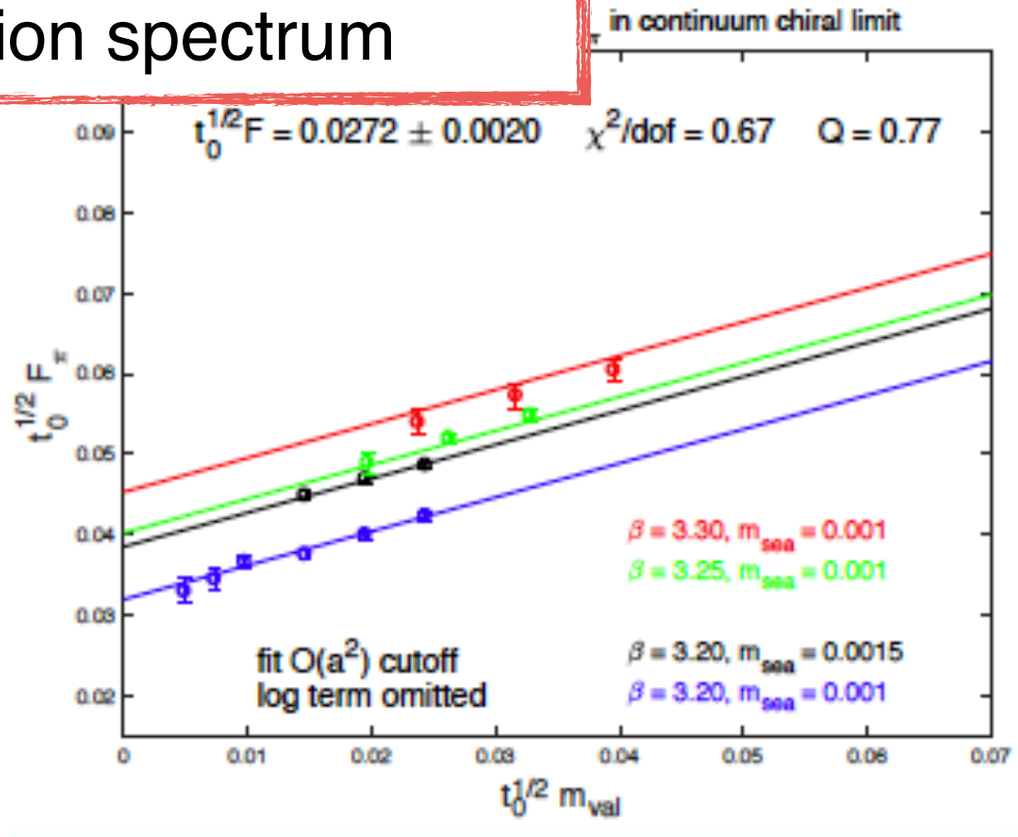
- On-going project; Configurations are generated with Incite & other time; Request is for capacity computing on GPU for measurements
  - RG β function
  - η-prime through topology - gradient flow
  - mass anomalous dimension (close to 1)
  - spectrum both in ε and p-regime; many on gradient-flowed configurations (mixed action)

J. Kuti/LHColl: The composite Higgs with new lattice BSM

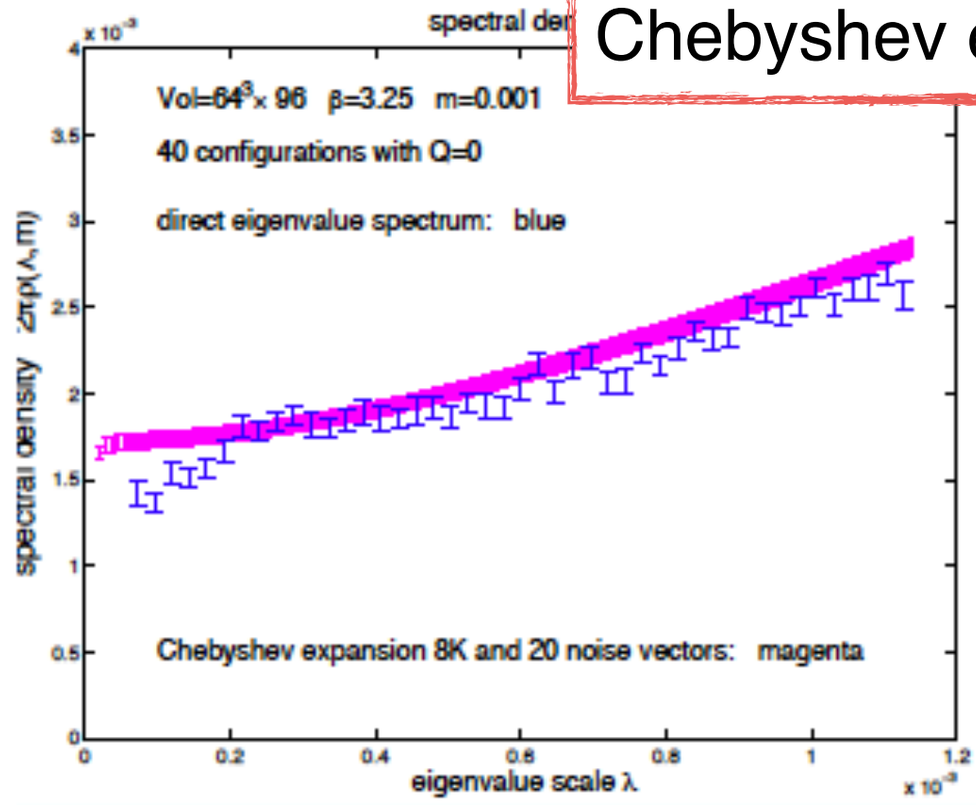




Gradient flow mixed action spectrum



Spectral density from Chebyshev expansion



1) https://arxiv.org/abs/1312.5330

E.Neil: Composite Higgs on the Lattice

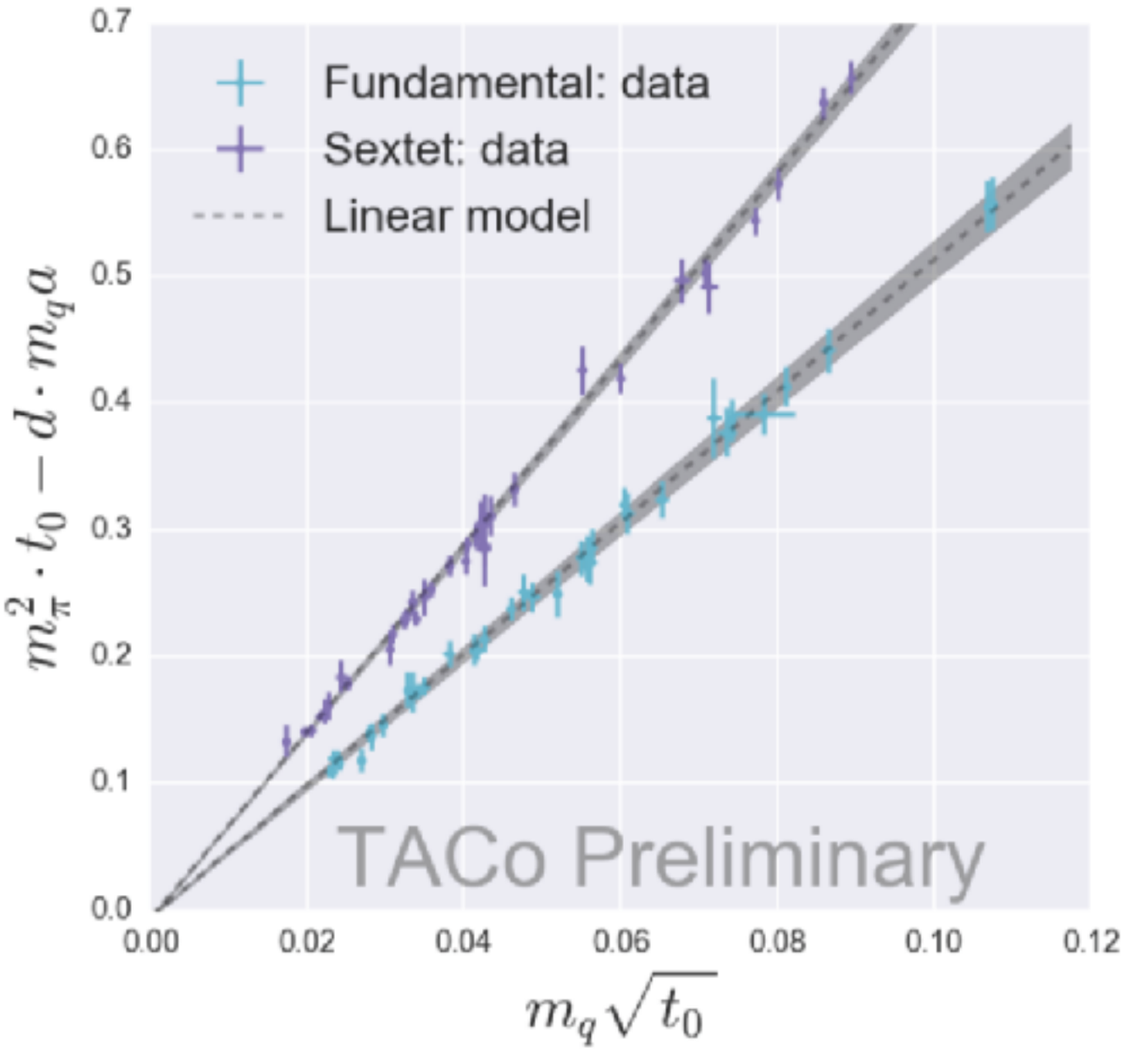
- 6.1M Jpsi, clusters

- First lattice efforts pursuing “composite PNGB Higgs” by Tel Aviv/Colorado

- Higgs boson appears as an exact Goldstone of chiral symmetry breaking; interactions w/EW, top quark generate usual Higgs potential.

- UV completions of such models (mostly) classified by Ferretti and Karateev[1]; simplest model is SU(4) w/ fermions in 4 and 6 irreps

- Initial lattice studies underway (right): meson spectroscopy tests chiPT with two irreps. Future results: finite-T, Higgs potential, top partner decay…



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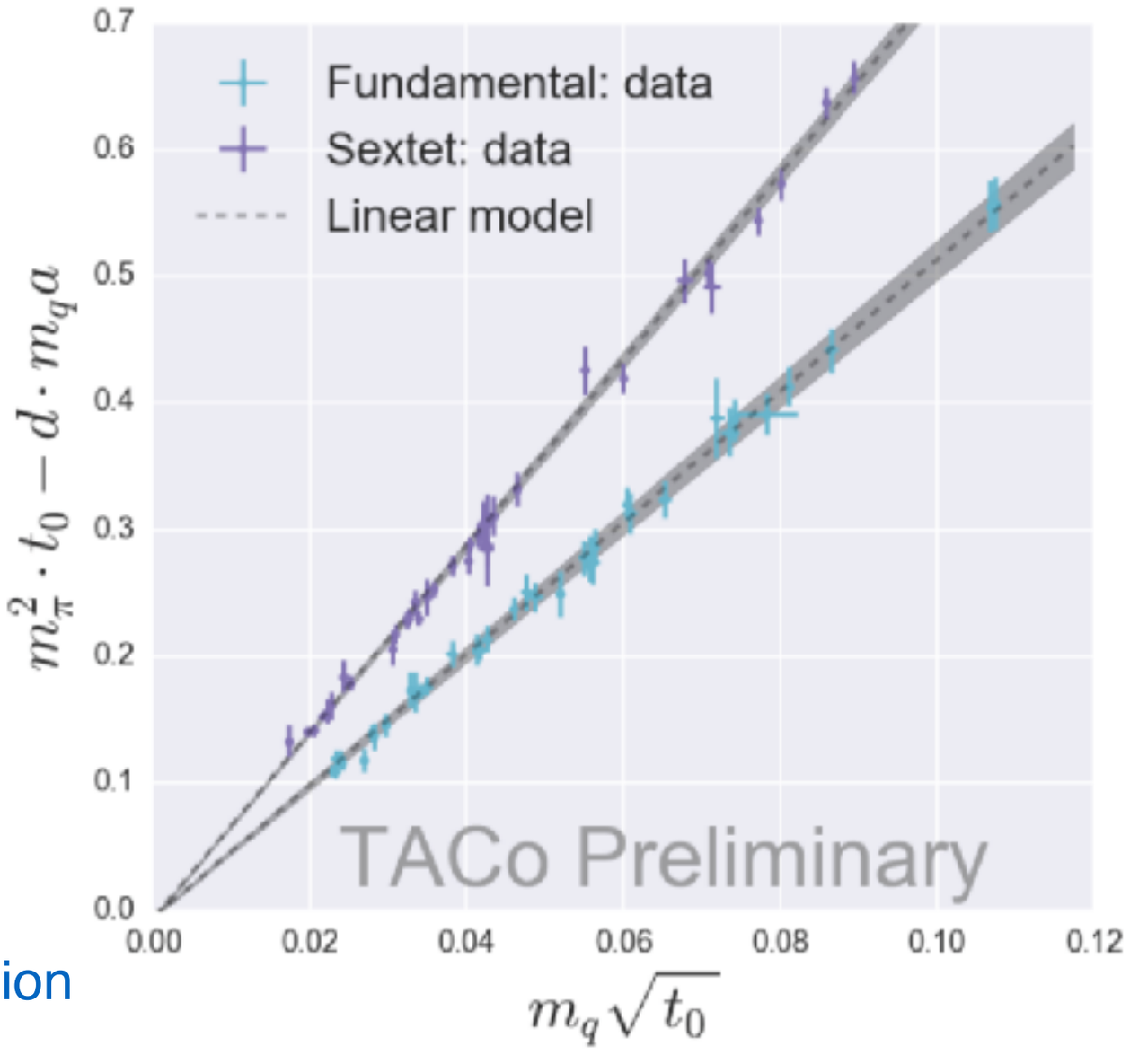
- This model is not near an IRFP.
  It is not expected to show walking or even large anomalous dimensions - those properties should come form a UV completion



O. Witzel/LSD : 4+6 flavors with DWF

New

▸ 24.4M Jpsi, KNL

Most BSM systems require large scale separation between IR & UV ("need walking")

Mass split systems with m_ℓ light and m_h heavy flavors achieve this

- the scale separation is tunable by m_h
- UV spectrum is governed by a conformal fixed point of m_ℓ+m_h flavors
  - hyperscaling and high level predictability
- IR is chirally broken with m_ℓ light flavors

Previous study of 4 light + 8 heavy flavors verified these principles

New proposal: study 4 light + 6 heavy flavors with DWF

- closer to the conformal window
- correct chiral symmetry is important at the conformal FP that governs the UV behavior
- use the GRID code for configuration generation

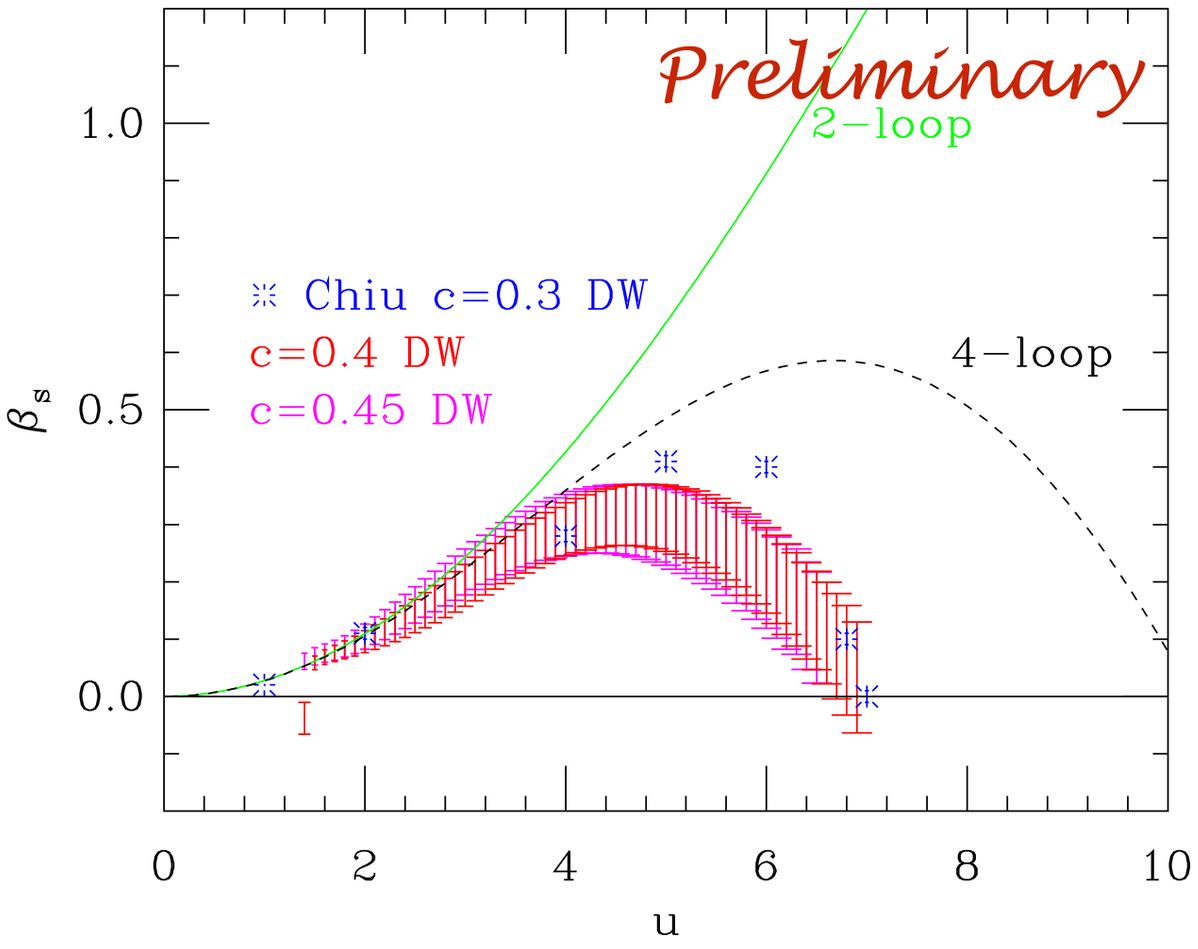
C. Rebbi: Step scaling study of 10 and 12 flavors with DWF

- 14.8M Jpsi
  cluster or KNL

New

Goal:

- Investigate the parameter range of 10 flavors in preparation for the 4+6 study
- Study universality of fermion actions at conformal FP with 12 flavors



Step scaling function with N_f=10 suggesting the existence of an IRFP in agreement with Chiu'16

BSM within USQCD

- Small but active community

- There are several new/developing projects, methods
  Waiting for more participants and projects!