$SU(2)_C$ with N_f=2 fundamental Dirac flavours

- SU(2) gauge theory with N_f = 2 Dirac fermions in the fundamental representation.

$$\mathcal{L} = -\tfrac{1}{4}F^a_{\mu\nu}F^{a\mu\nu} + i\overline{U}\gamma^\mu D_\mu U + i\overline{D}\gamma^\mu D_\mu D + \tfrac{m}{2}Q^T(-i\sigma^2)C\,EQ + \tfrac{m}{2}\left(Q^T(-i\sigma^2)C\,EQ\right)^\dagger$$

- Pseudo-real irrep of SU(2): **global flavour symmetry is upgraded to SU(4)** :

$$Q \equiv \begin{pmatrix} U_L \\ D_L \\ \widetilde{U}_L \\ \widetilde{D}_L \end{pmatrix} \equiv \begin{pmatrix} U_L \\ D_L \\ -i\sigma_2 C\bar{u}_R^T \\ -i\sigma_2 C\bar{d}_R^T \end{pmatrix}, \quad E = \begin{pmatrix} 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \\ -1 & 0 & 0 & 0 \\ 0 & -1 & 0 & 0 \end{pmatrix}$$

- Chiral symmetry breaking pattern : ***SU(4) -> Sp(4)*** ***(SO(6) -> SO(5))***

→ **5 Goldtone bosons**

EW embedding

[G. Cacciapaglia & F. Sannino, JHEP 1404,111 (2014)]

- $Q_L = (U_L, D_L)$: $SU(2)_L$ doublet with hypercharge 0
- $\tilde{U}_L, \tilde{D}_L$: $SU(2)_L$ singlet with hypercharge $\pm 1/2$

- Two interesting alignments of the condensate :

$\Sigma_H \equiv E = \begin{pmatrix} 0 & 1 \\ -1 & 0 \end{pmatrix}$: break EW symmetry $\qquad \Sigma_B \equiv \begin{pmatrix} i\sigma_2 & 0 \\ 0 & -i\sigma_2 \end{pmatrix}$: does not break EW

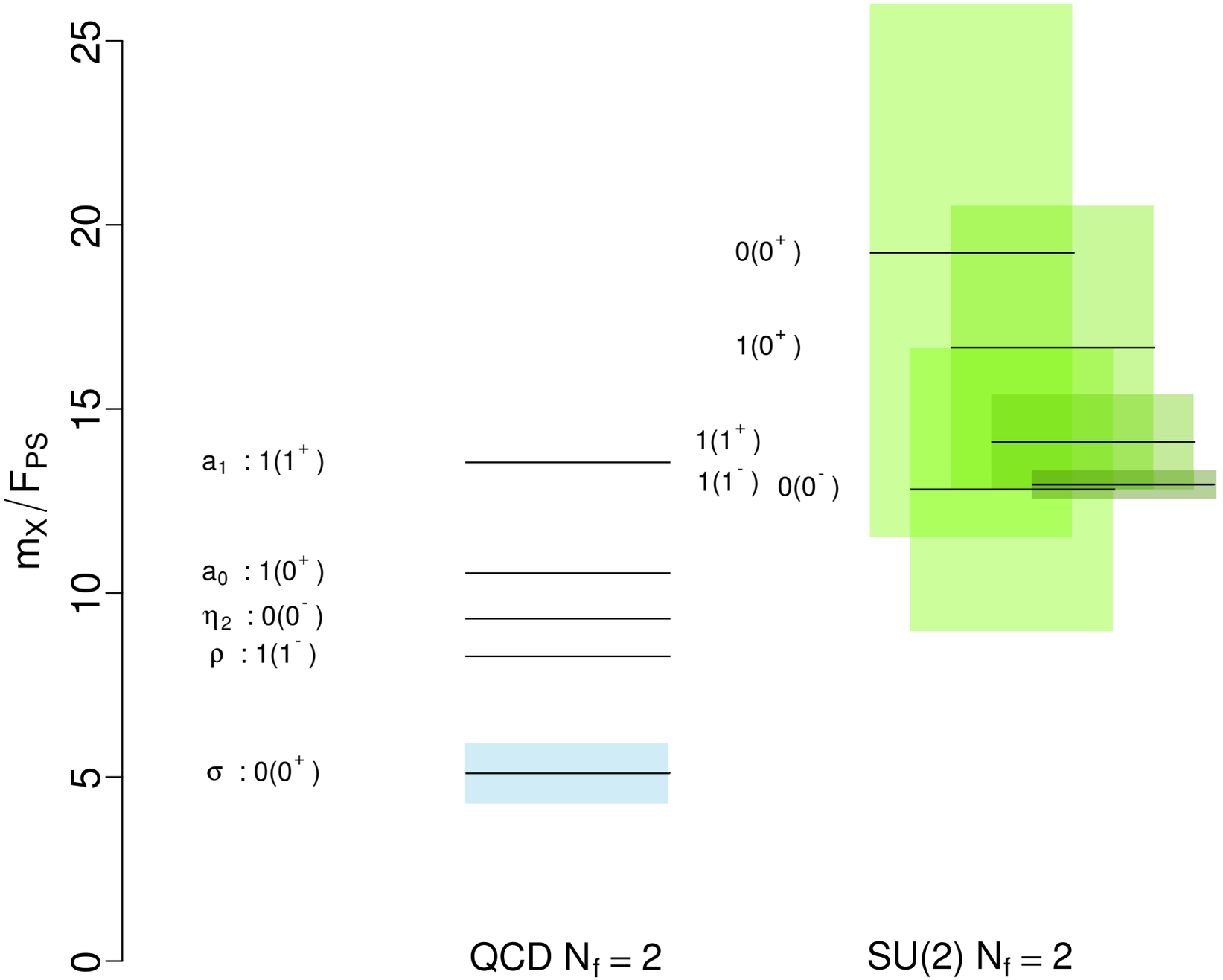
- General case :

$$\Sigma_0 = \cos\theta\ \Sigma_B + \sin\theta\ \Sigma_H$$

- Two limit cases :
  - $\theta = 0$: EW does not break : composite Higgs limit
  - $\theta = \pi/2$: EW breaks + DM candidate : technicolor limit
- at LO : $m_W^2 = 2\, g\ (F_{PS}\ \sin\theta)^2$

The model interpolates between TC and CH

Summary and comparison with N_C=3



- Shifted upward compared to QCD ?

R. Arthur, VD, A. Hietanen, C. Pica, F. Sannino [arXiv:1607.06654]
R. Arthur, VD, A. Hietanen, C. Pica, F. Sannino [arXiv:1602.06559]

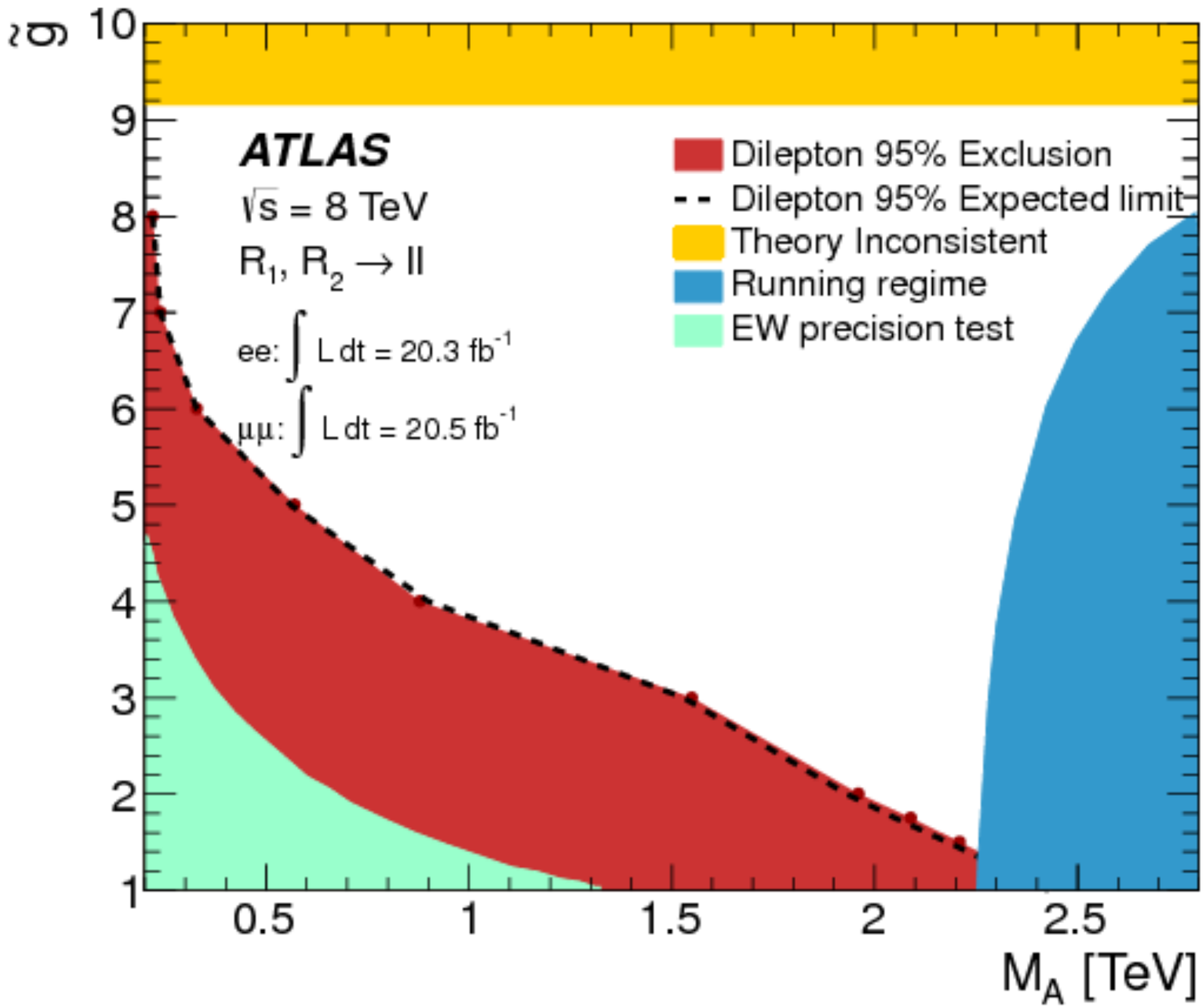
Beyond the spectrum.

- Phenomenology considerations:
  - Properties of resonances related to searches at the LHC
  - Contribution to EW boson scattering? In the CH limit, is the scattering length more relevant ?
  - Is it useful to constrain the timelike form factor ?
  - Other resonances ?

- Theoretical interest:
  - How does the coupling changes with the underlying theory
  - Is the KSRF relation satisfied ?

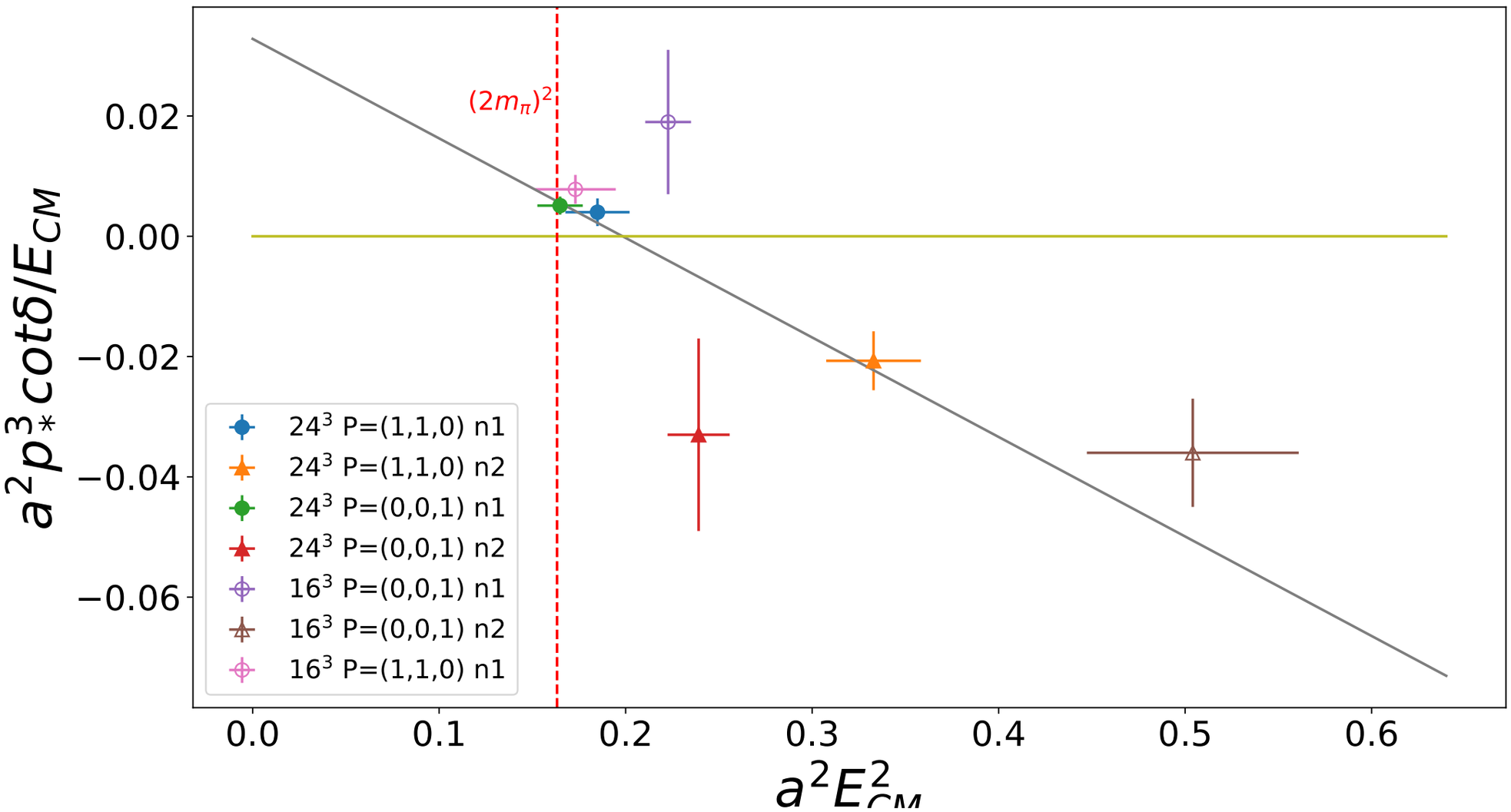
Constraints on resonances@LHC

"Search for high-mass dilepton resonances in pp collisions at s√=8 TeV with the ATLAS detector", ATLAS collaboration, [arXiv: 1405.4123], Phys. Rev. D90 (2014) 5, 052005



Phase shift: GB scattering (vector meson channel)

T. Janowski, C. Pica, S. Prelovsek, VD, to appear.



Preliminary

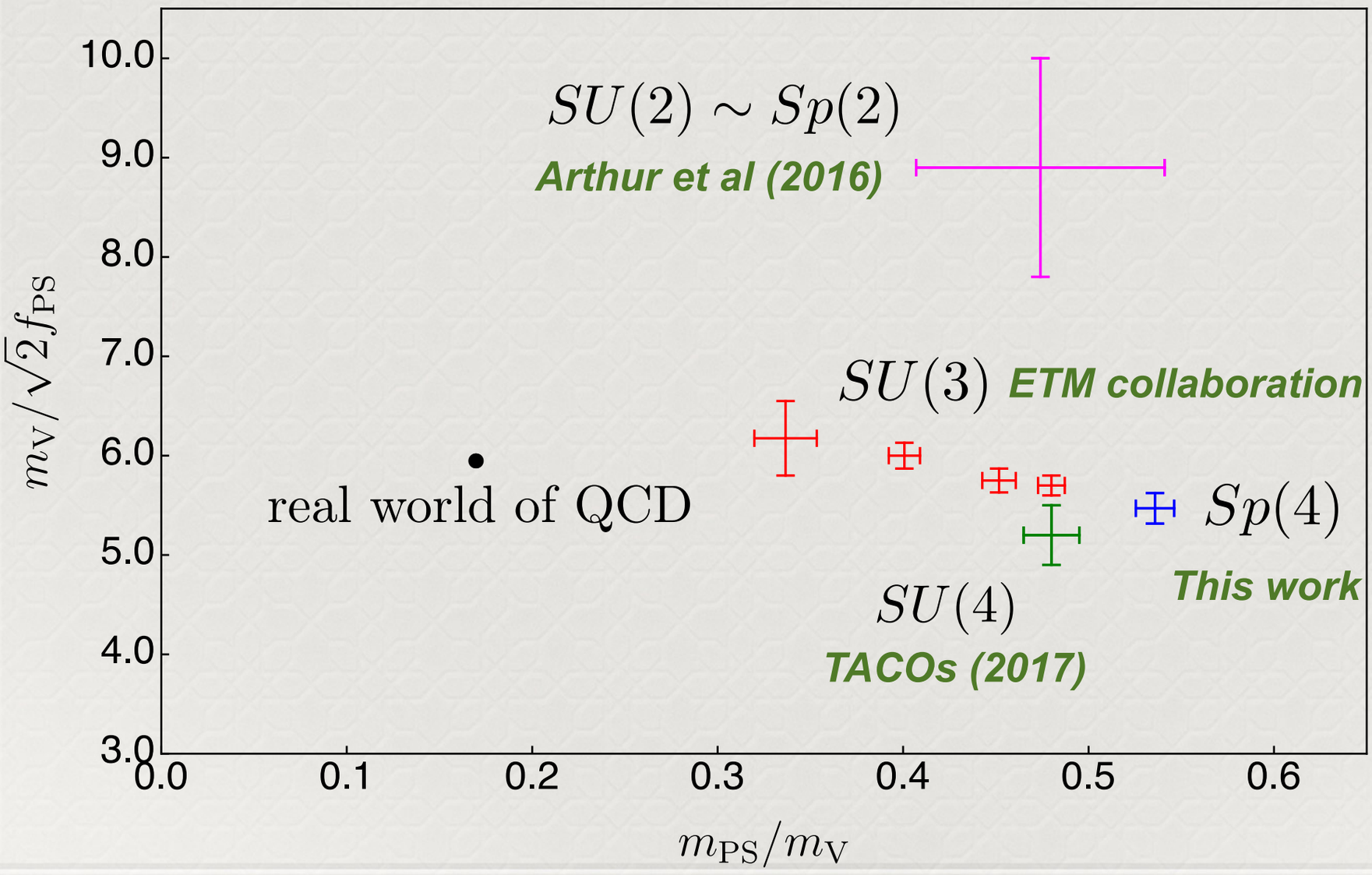
$$g_{\rho\pi\pi} = 10.7(23)$$

$$aM_\rho = 0.445(95) \qquad am_\rho^{\text{naive}} = 0.444(9)$$

Comparison with other gauge groups

- The hypothesis vector meson dominance leads to the KSRF relation *Kowarabayashi & Suzuki (1966)* *Riazuddin & Fayyazuddin (1966)*

$$g_{VPP} = \frac{m_{\rm V}}{\sqrt{2} f_{\rm PS}}$$



Large Nc argument:

$$f_{\rm PS} \sim \sqrt{N_c}$$

From Lee, Bennett, Piai, Lucini, Hong, Lin, Vadacchino, Lattice 2019.