MITP Summer School

New Physics on Trial at LHC Run II

Flavor anomalies: SM strikes back (?)

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based on JHEP 1606 (2016) 116 (arXiv:1512.07157)

in collaboration with:

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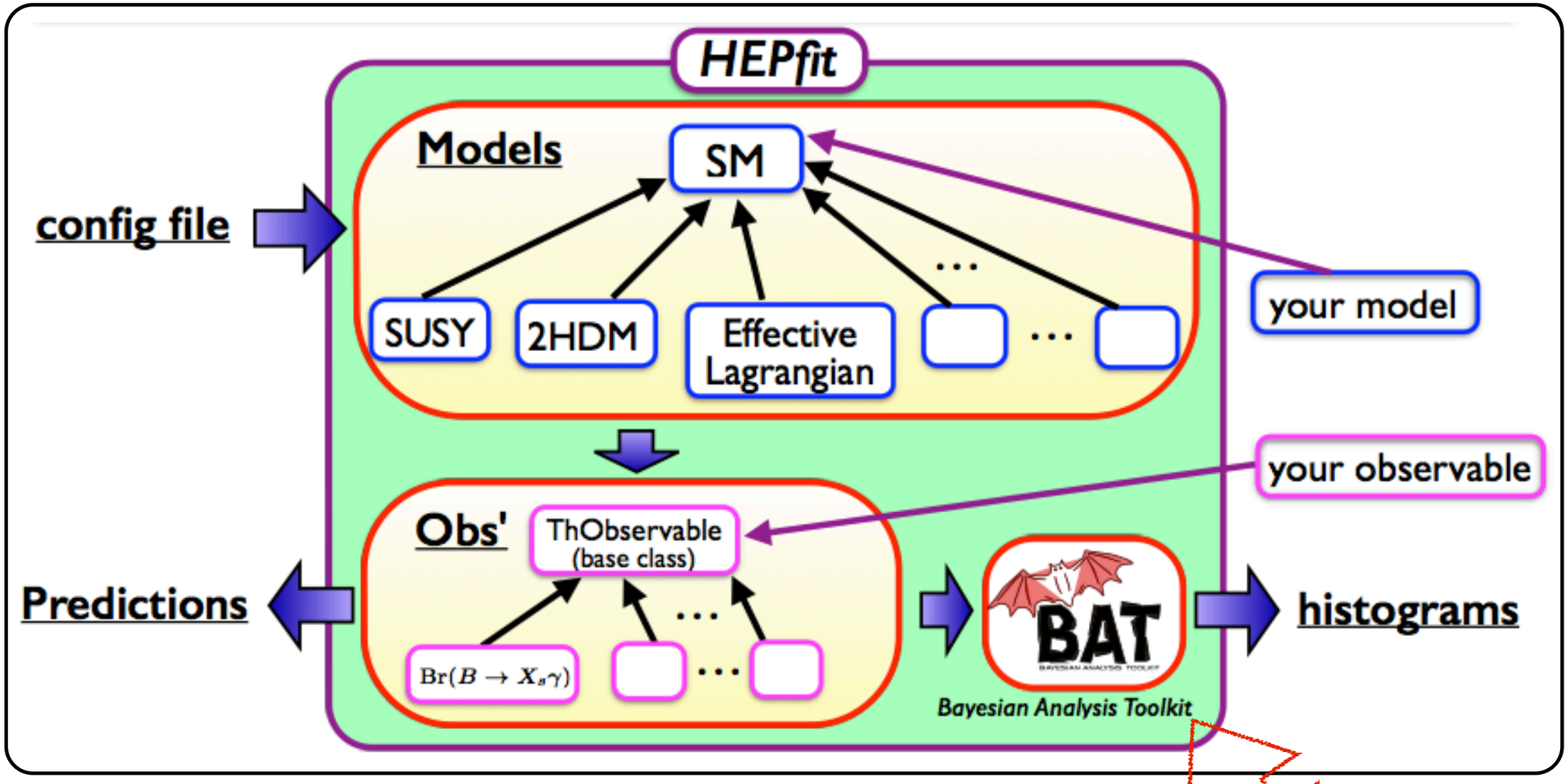
HEPfit : a new tool for SM physics & Beyond



HEPfit v1.0 release candidate

available @ http://hepfit.roma1.infn.it/

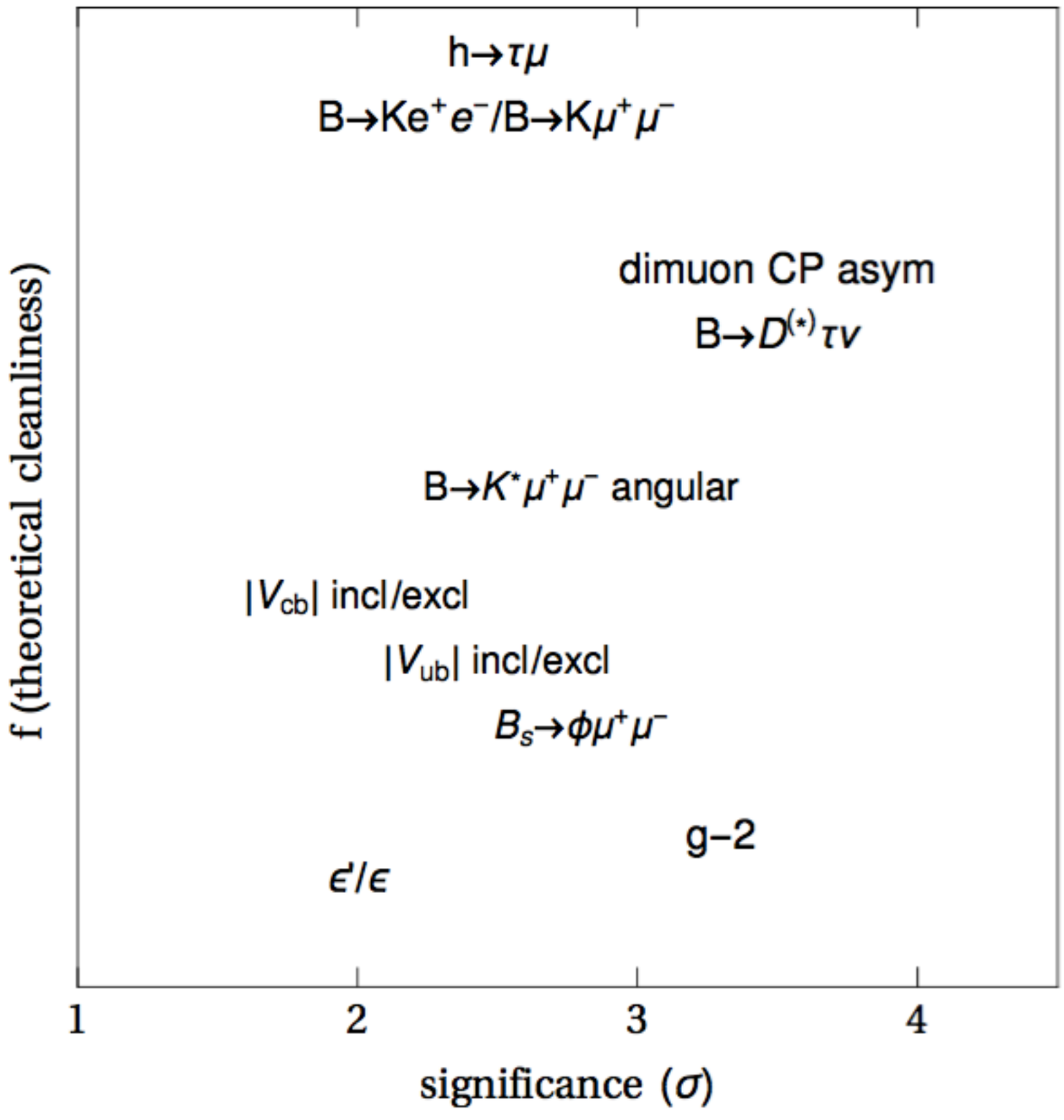
detailed Doxygen documentation of the code (user manual coming out soon!)

$$P(\lambda|D) \propto P(D|\lambda)\, P_0(\lambda)$$

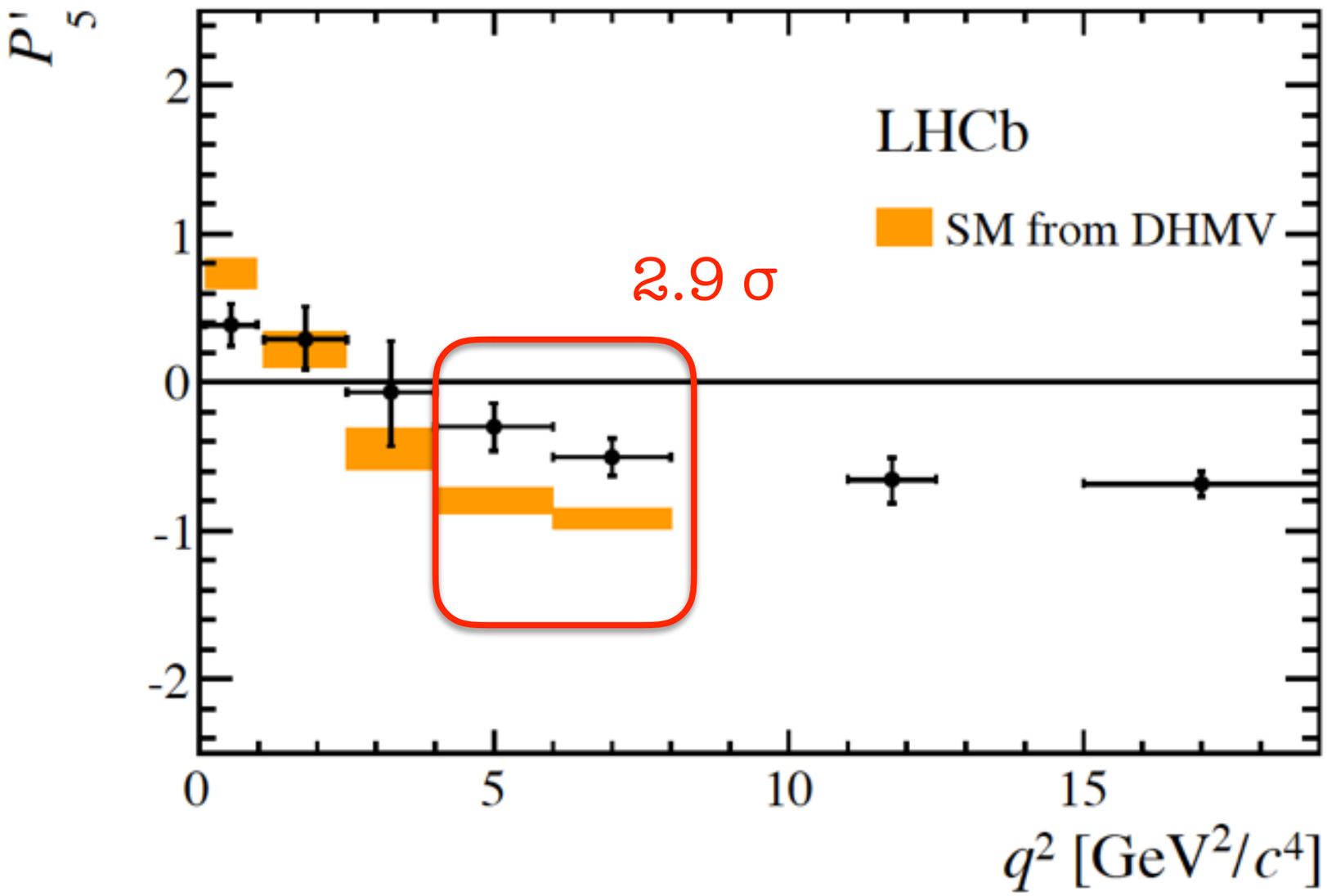
λ posterior — likelihood — λ prior

Developer version available @ https://github.com/silvest/HEPfit

Flavour anomalies



The B → K*μμ anomaly



LHCb
arXiv:1512.04442

Is NP the responsible for this anomaly? Many think so…

F.Beaujean et al. arXiv:1310.2478 W.Altmannshofer, D.M.Straub arXiv:1411.3161 S. Descotes-Genon et al. arXiv:1510.04239 T.Hurt et al. arXiv:1603.00865 A.Karan et al. arXiv:1603.04355 …

The aim of our work

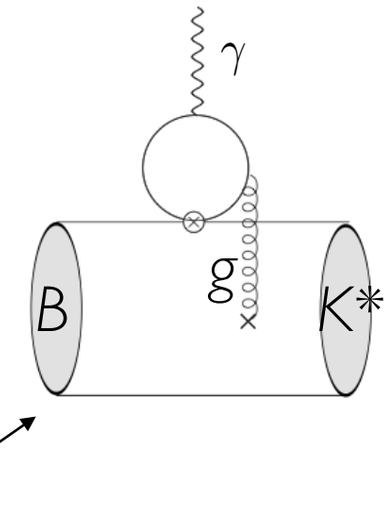
*Can we be **sure** that this anomaly **is due to NP**, or there is still a **chance that SM can reproduce** the experimental results? Is it even legit to ask…? **YES!***

On the theoretical side, we still don't know how to properly take into account non-perturbative hadronic contributions in the whole phenomenological region

The large- recoil region in HEPfit

$$\mathcal{H}_{\rm eff}^{\Delta B=1} = \mathcal{H}_{\rm eff}^{\rm sl} + \mathcal{H}_{\rm eff}^{\rm had}$$

- *7 Form Factors from LCSRs/Lattice*
- *Hard gluon exchanges from QCD factorization*



- *Soft gluon exchanges ($c\bar{c}$ loops) from LCSR (single emission only!)*

Each additional soft-gluon *exchange is* **suppressed** *by a factor* $1/(q^2 - 4m_c^2)$ *hence this approximations holds* **only for very low** q^2 *and worsens at higher* q^2 **breaking down exactly where the "anomaly bins" sit**

$$H_V(\lambda) \propto C_9 V_{L\lambda} + \frac{2m_b m_B}{q^2} C_7 T_{L\lambda} - 16\pi^2 m_B^2 h_\lambda$$

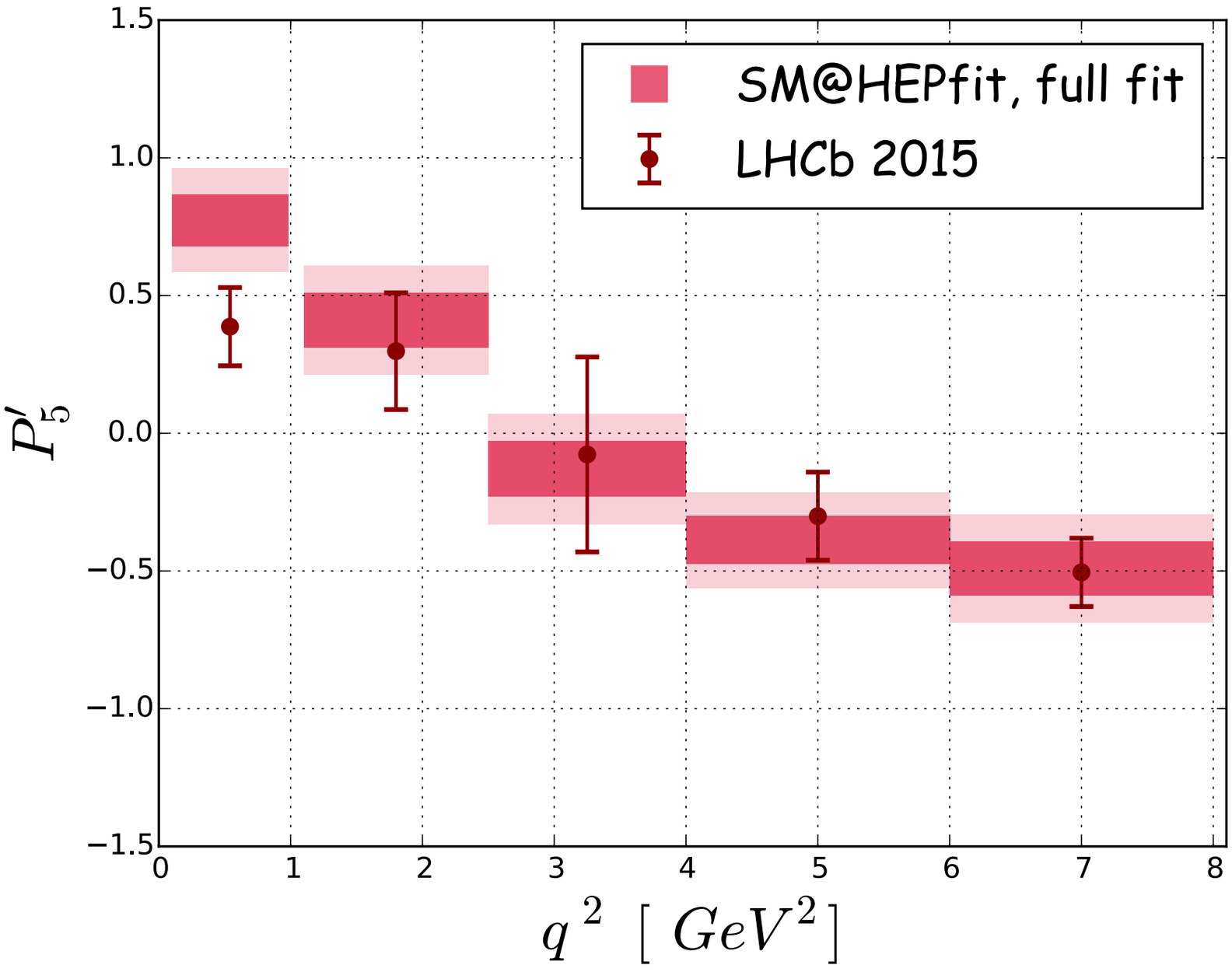
$$h_\lambda(q^2) = \frac{1}{q^2} h_\lambda^{(0)} + h_\lambda^{(1)} + h_\lambda^{(2)} q^2$$

The SM@HEPfit analysis, case 1

soft-gluon constraint applied **only for $q^2 \lesssim 1$ GeV^2**

⟶ *what happens to P'_5 anomaly?*

⟶ *what info can we extract on h_λ?*

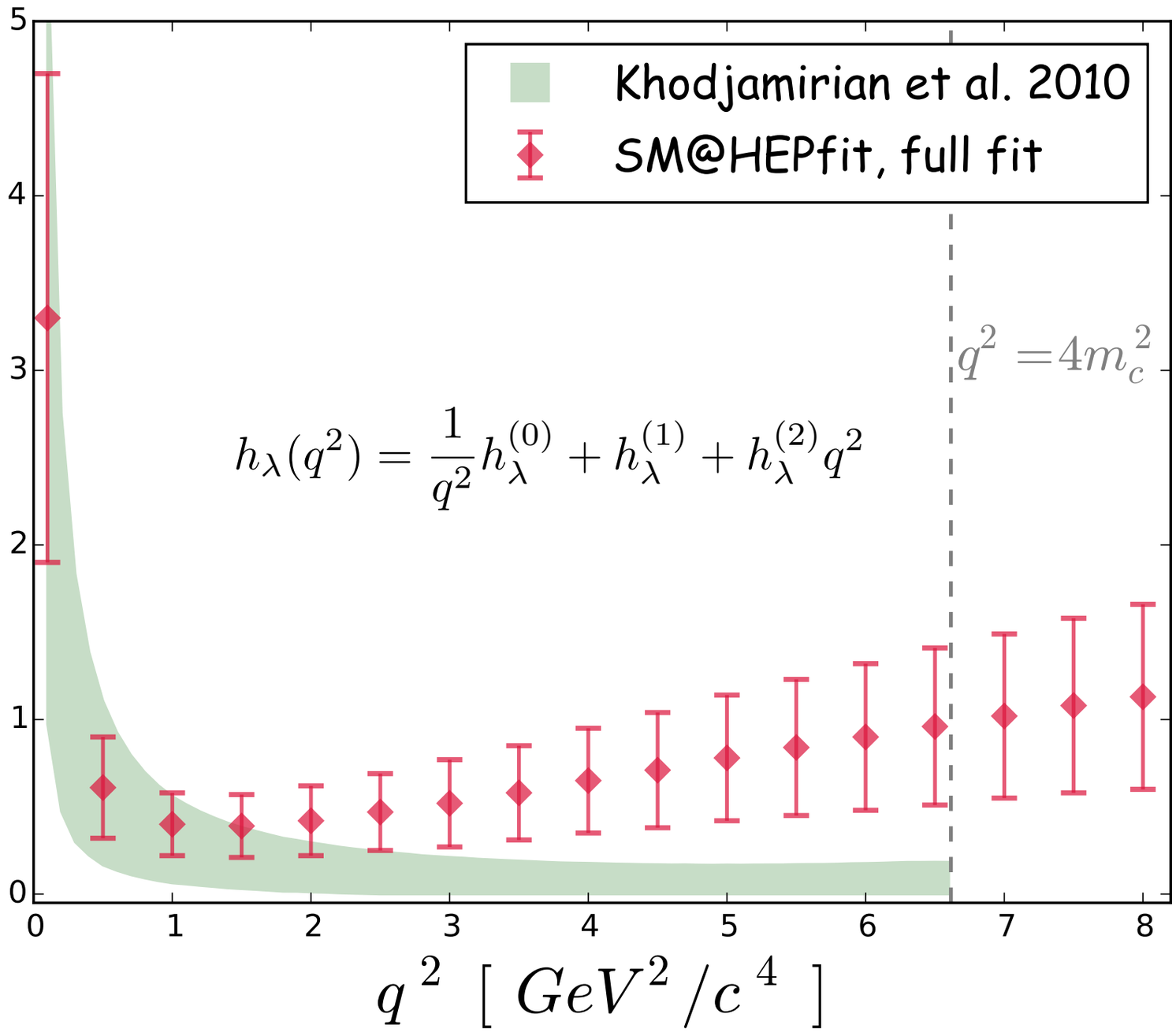


No anomalies in P'$_5$ …!

All observables in good agreement with data

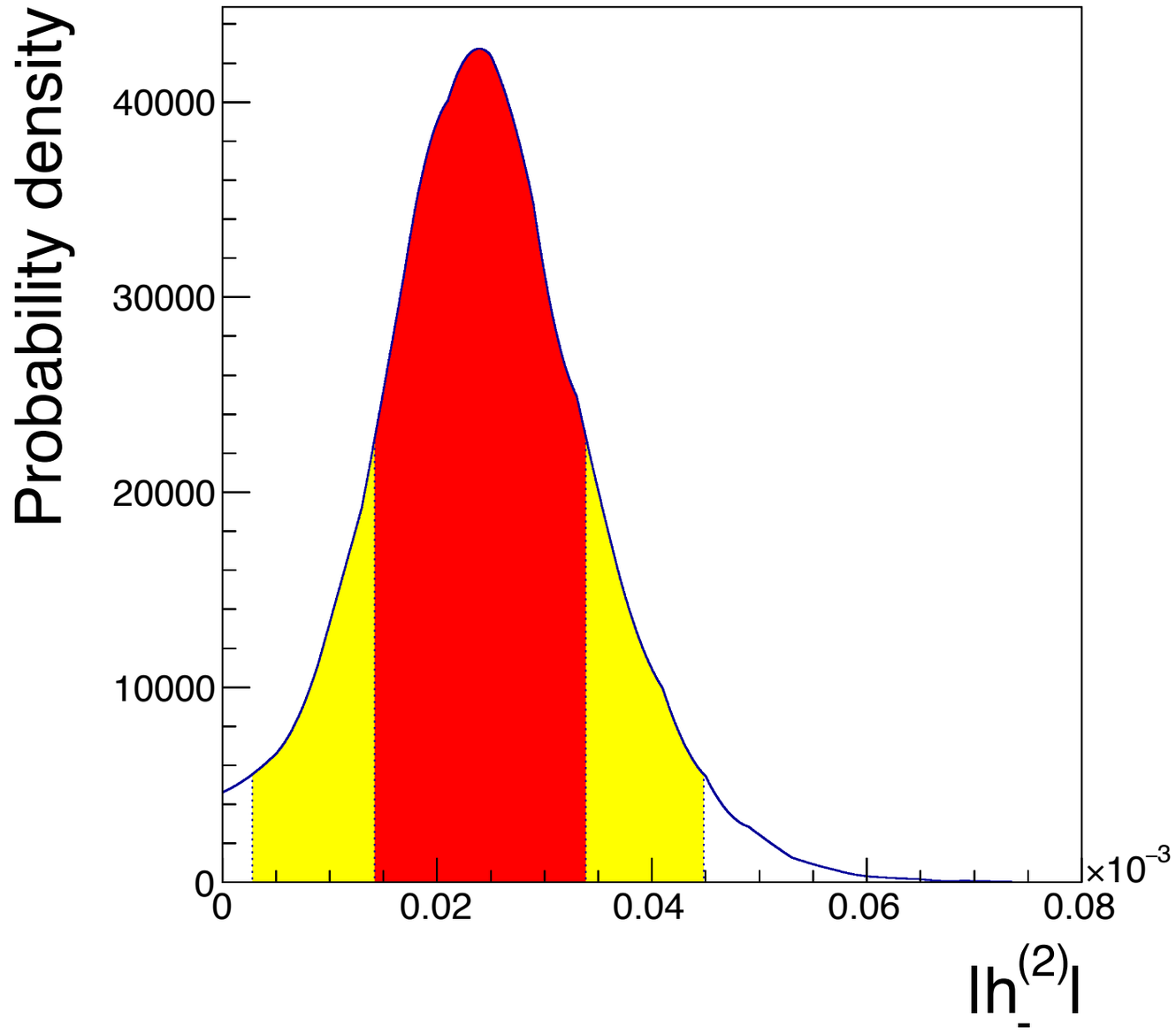
EXTRACTING THE NON-PERTURBATIVE HADRONIC CONTRIBUTION

linear combinations of h_λ



NP contribution in C_7 and/or C_9 cannot reproduce such a q^2 behavior

RESULTS FOR THE HADRONIC PARAMETERS h_Λ



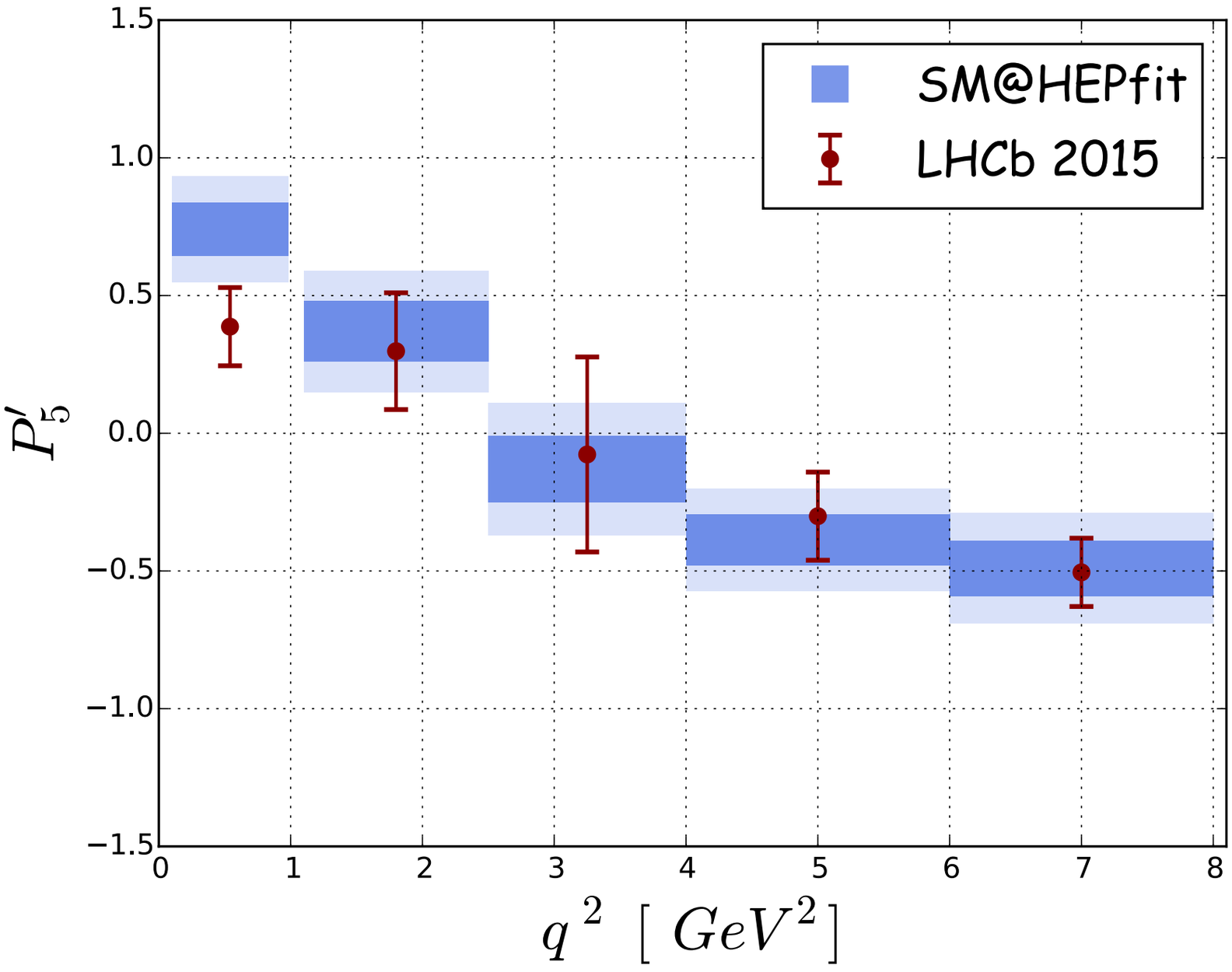
$|h_-^{(2)}|$ *differs from zero* **at more than 95.45% probability,**
thus **disfavouring** *the interpretation of the hadronic correction*
as **NP contributions in C_7 and/or C_9**

The SM@HEPfit analysis, case II

no soft-gluon constraint applied

⟶ *what happens to P'_5 anomaly?*

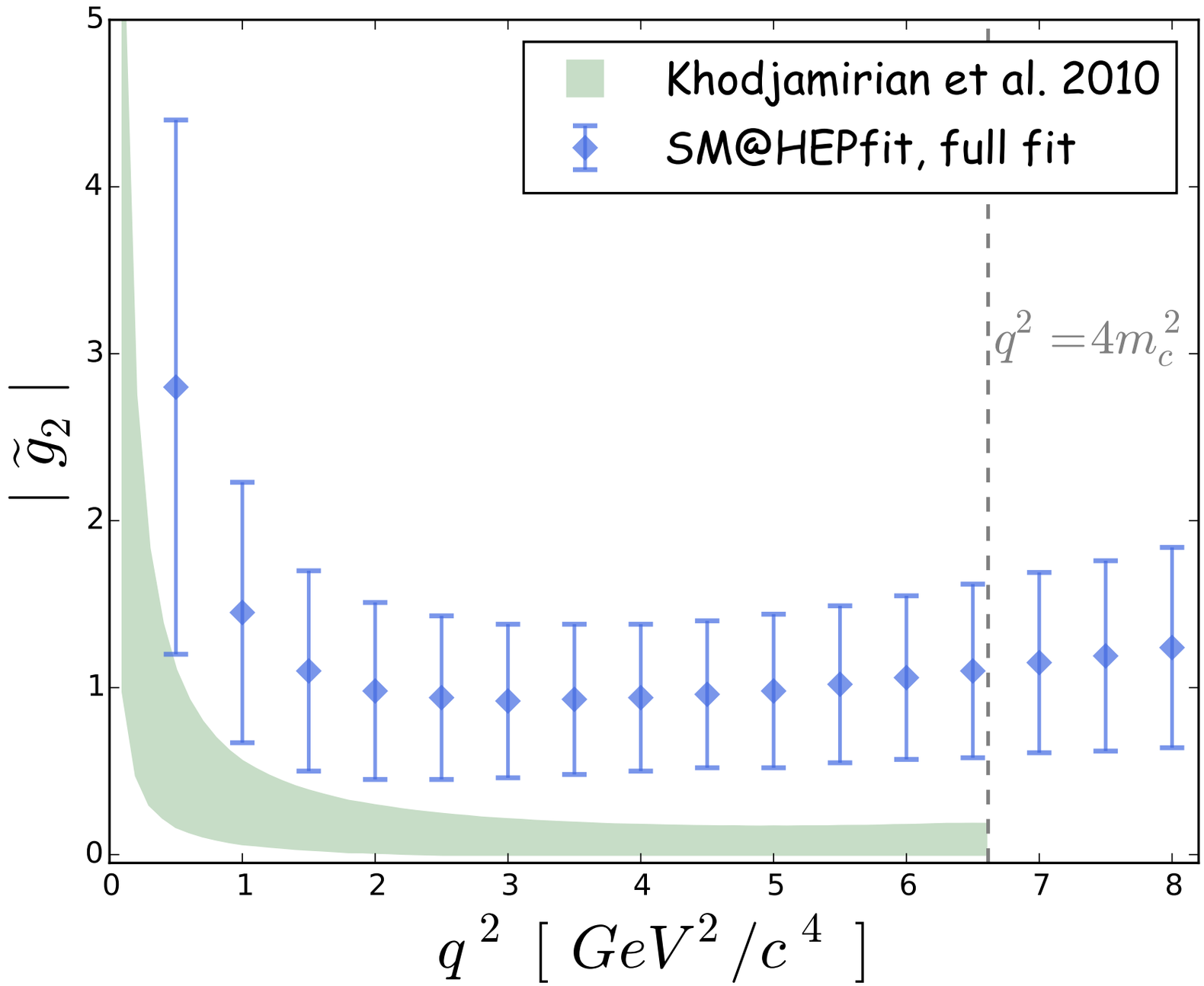
⟶ *what info can we extract on h_λ?*



Still no anomalies in P'$_5$ …!

All observables in good agreement with data

EXTRACTING (again) THE NON-PERTURBATIVE HADRONIC CONTRIBUTION



No firm conclusions on q^2 behavior, it could be just NP…!

FINAL REMARK

*Looking at this channel alone, there is **no way** to prove the presence of NP right now!*

***We need to pay attention!** Sometimes (poor control of) **SM** can be the reason why anomalies raise, while sometimes it's **not even possibile to disentangle NP** contributions **from SM** ones…*

*We're all in a **desperate** look for NP, but we have to be honest with ourselves and realize that sometimes might just be **SM striking back!***