Theory Summary For Working Group 6: Spin and 3D Structure

Ted Rogers, with Oleg Eyser and Bakur Parsamyan

DIS 2019, Turin Italy

Areas of Progress

- ≈ 32 theory presentations

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  - PDFs ✔
  - TMD PDFs (transverse momentum dependent distributions) ✔
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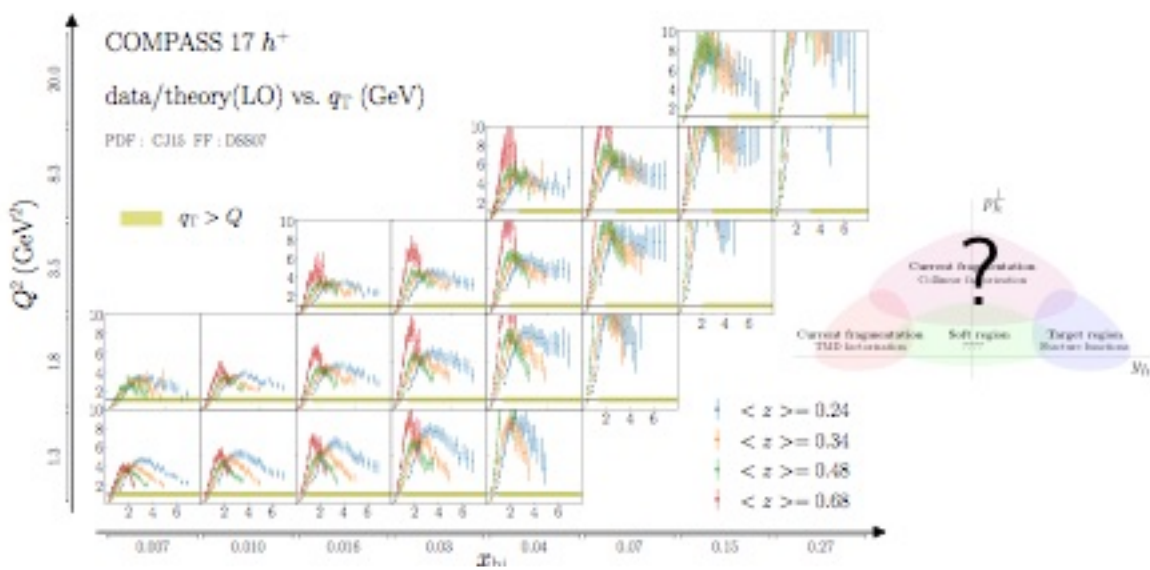
- Theoretical Refinements ✔
- Extraction and Pheno ✔

Semi-Inclusive DIS

- Description of large q_T:

N. Sato



  – Higher orders? Refine fragmentation function fits?

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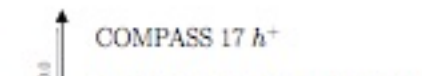
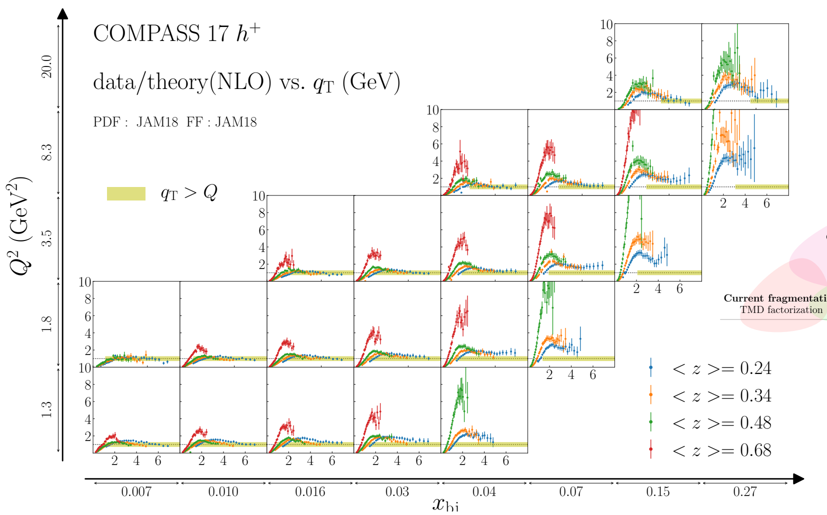
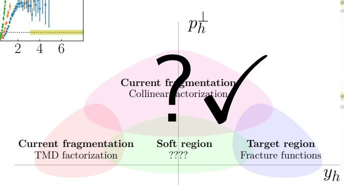
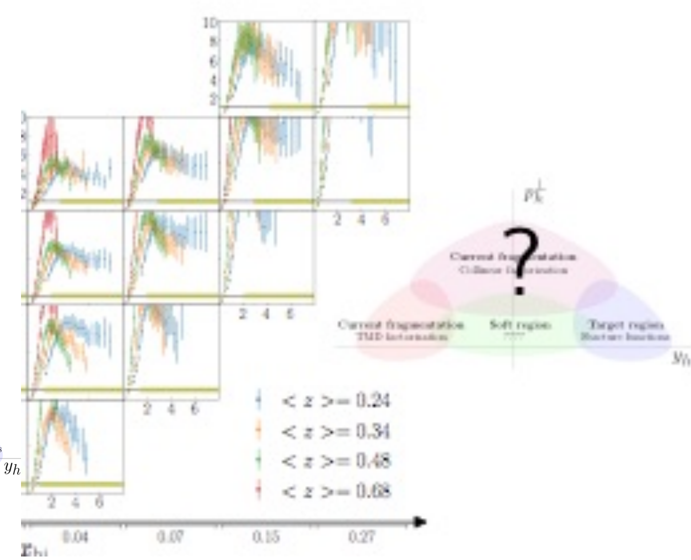
FO @ NLO (JAM18)









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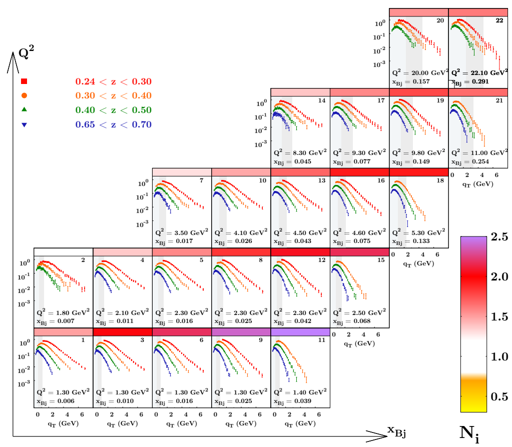
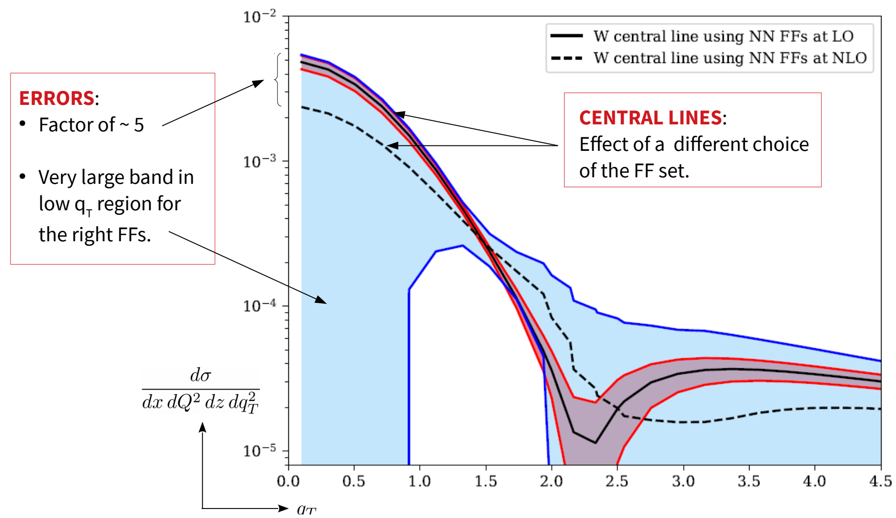


J. Gonzalez-Hernandez

Tension with normalization.

- Improved knowledge of FFs needed?

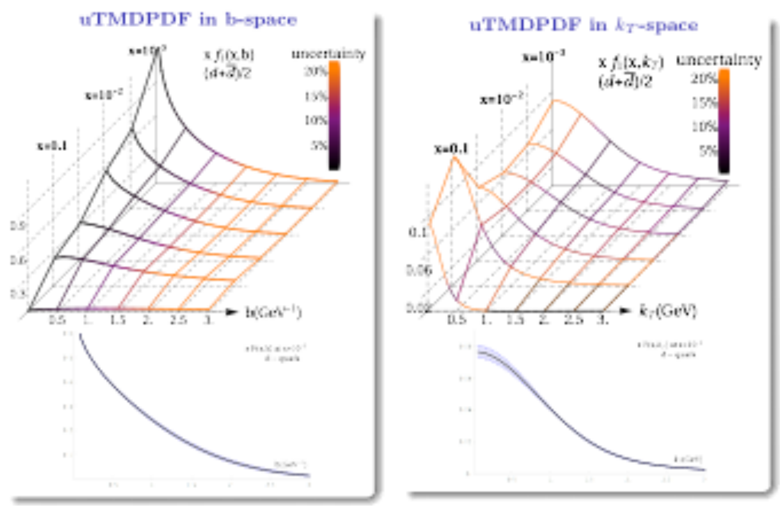
A. Simonelli



Drell-Yan

- TMD PDF fits with large amount of data:

A. Vladimirov



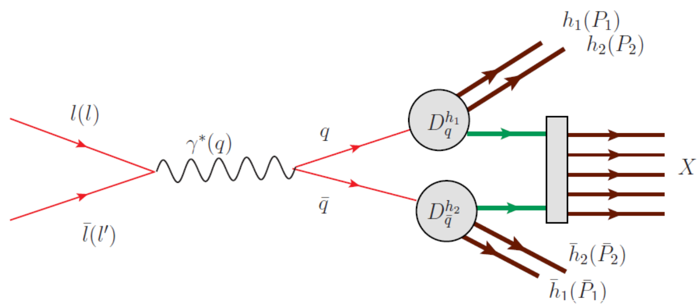
- New tools:

repository:
https://github.com/VladimirovAlexey/artemide-public

- Many tools now for TMD physics, with high orders in all parts.

Fragmentation Functions

- New ways of constraining fragmentation and hadronization dynamics:



A. Kotzinian

- Sum rules for quarks into unpolarized hadrons, up to twist-3
  - (only thing missing for twist-4: full FF-TMD analysis)

$$\sum_{h\,S_h}\int dz\, z D_1^h(z) = 1$$
Collins-Soper

NEW $$\sum_{h\,S_h}\int dz M_h E^h(z) = M_j$$ NEW $$\sum_{h\,S_h}\int dz M_h \tilde{E}^h(z) = M_j - m_{q0} = m_q^{corr}$$

NEW $$\sum_{h\,S_h}\int dz M_h H^h(z) = 0$$ $$\sum_{h\,S_h}\int dz M_h \tilde{H}^h(z) = 0$$
Diehl-Sapeta

fully dynamical quantities

$$\sum_{h\,S_h}\int dz\, z M_h H_1^{\perp\,(1)\,h}(z) = 0$$
Schaefer-Teryaev

NEW $$\sum_{h\,S_h}\int dz M_h^2 D^{\perp\,(1)\,h}(z) = 0$$ NEW $$\sum_{h\,S_h}\int dz M_h^2 \tilde{D}^{\perp\,(1)\,h}(z) = -\frac{1}{2}\langle P_\perp^2/z\rangle$$

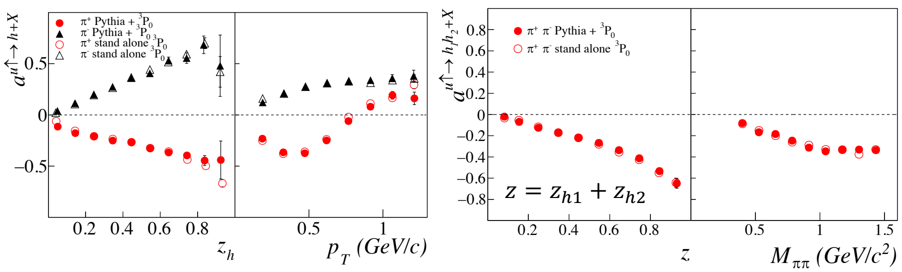
NEW $$\sum_{h\,S_h}\int dz M_h^2 G^{\perp\,(1)\,h}(z) = 0$$ NEW $$\sum_{h\,S_h}\int dz M_h^2 \tilde{G}^{\perp\,(1)\,h}(z) = 0\ .$$

A. Accardi

Hadronization

- Progress in incorporating polarization in Monte Carlo simulations

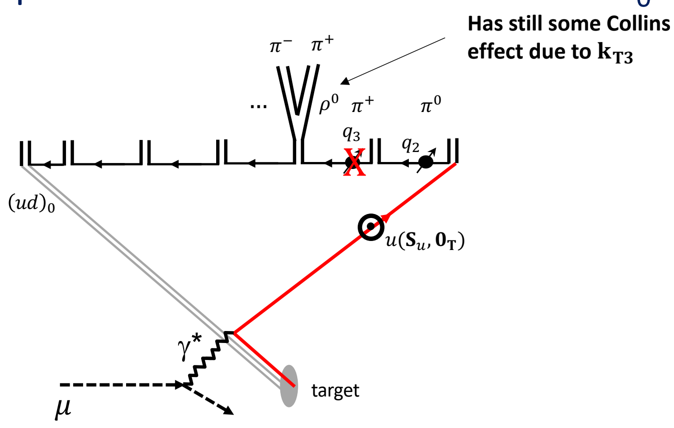
Comparison between Pythia + $^3P_0$ and stand alone $^3P_0$:
Collins and di-hadron analysing powers



$p_T > 0.1\ GeV/c$ $\quad$ $z_h > 0.2$ $\quad$ $z_{hi} > 0.1,\quad R_T > 0.07\ (\frac{GeV}{c})$

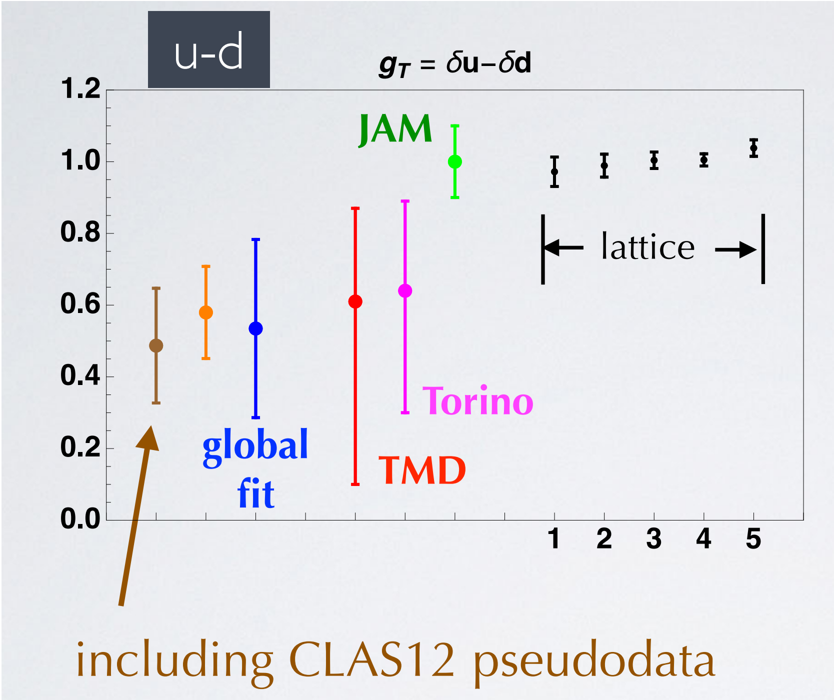
A. Kerbizi

A different option for the final state in PYTHIA + $^3P_0$



Proton Tensor Charge

- Tension?



M. Radici

Progress in Large TM Sivers

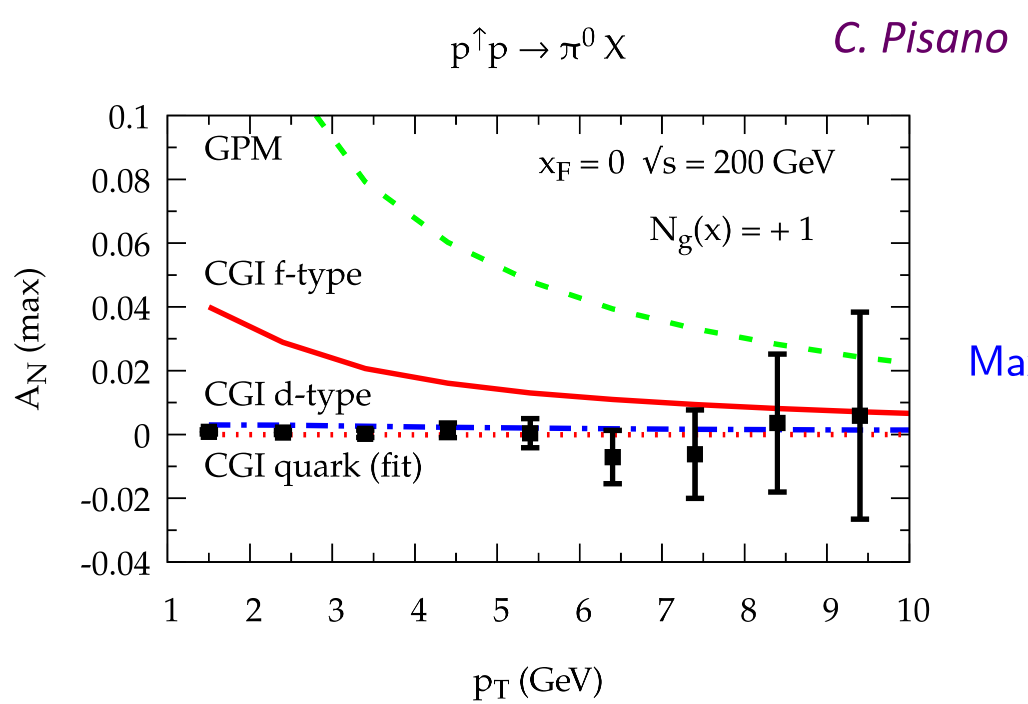
- Polarization dependent results important for fully global TMD pheno program:

$$f^{\perp}_{1T;q\leftarrow h;\mathrm{DY}}(x,\vec{b};\mu,\zeta) = \pi T(-x,0,x) + \pi a_s(\mu)\Big\{ -2\mathbf{L}_\mu P\otimes T + C_F\left(-\mathbf{L}_\mu^2 + 2\mathbf{l}_\zeta \mathbf{L}_\mu + 3\mathbf{L}_\mu - \frac{\pi^2}{6}\right) T(-x,0,x)$$
$$+\int d\xi \int_0^1 dy\delta(x-y\xi)\Big[\left(C_F - \frac{C_A}{2}\right)2\bar{y}\, T(-\xi,0,\xi) + \frac{3y\bar{y}}{2}\frac{G_+(-\xi,0,\xi)+G_-(-\xi,0,\xi)}{\xi}\Big]\Big\}$$
$$+O(a_s^2) + O(\vec{b}^2)$$

I. Scimemi

Tests of Process Dependence

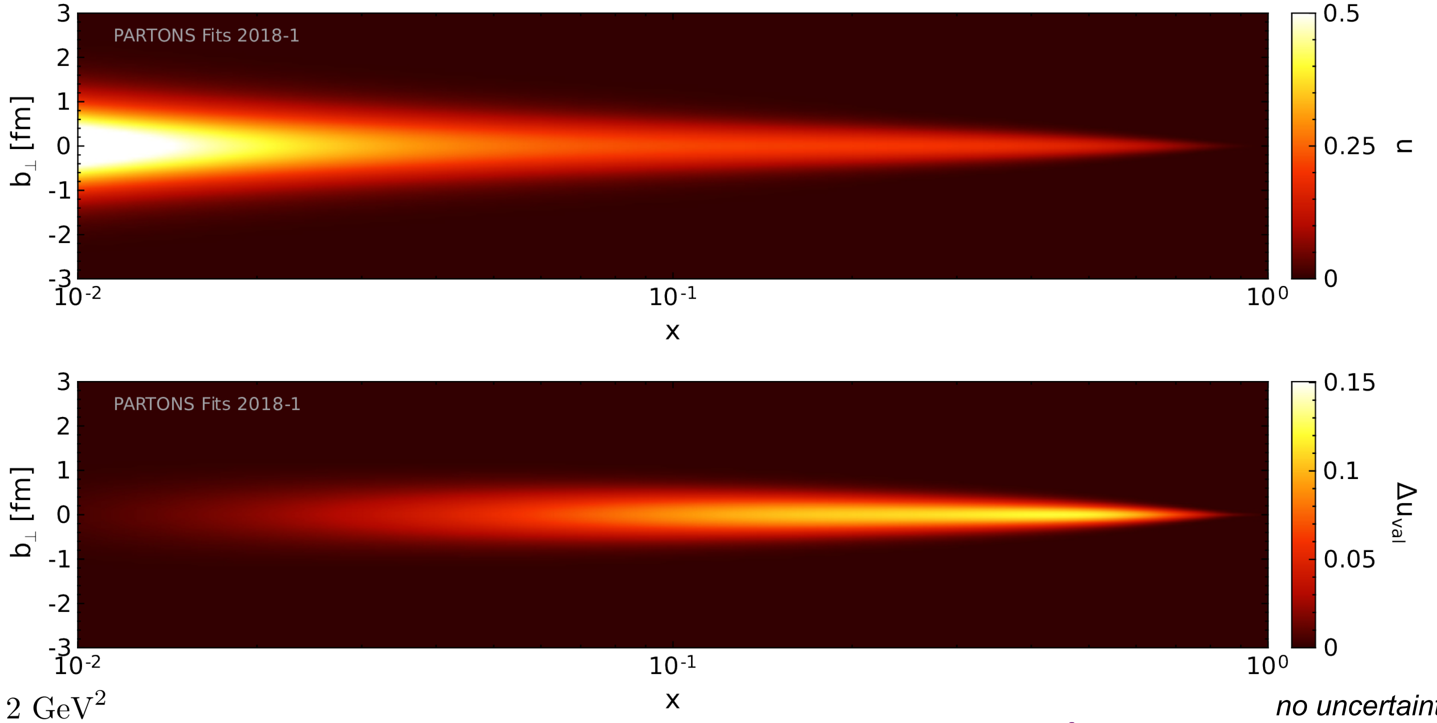
- Gluon Sivers function at RHIC



Maximized GSFs ($N_g = +1$)

GPDs and Exclusive Processes

Nucleon tomography:



$Q^2 = 2\ \mathrm{GeV}^2$

no uncertainties!

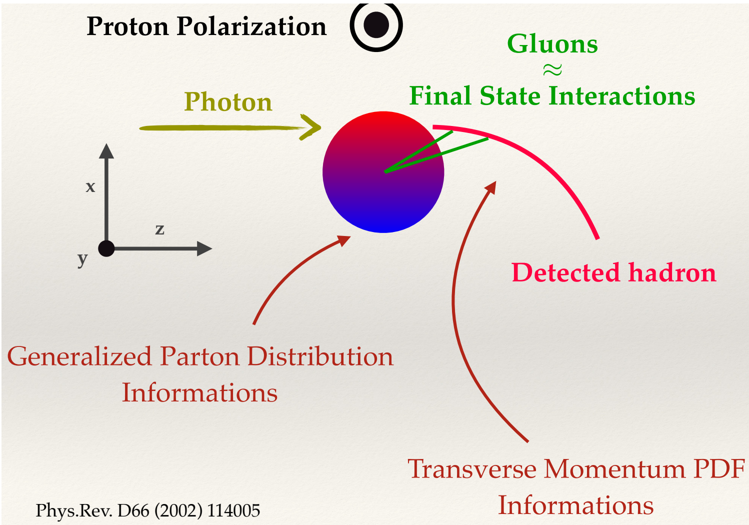
P. Sznajder

H. Moutarde, P. S., J. Wagner "*Border and skewness functions from a leading order fit to DVCS data*" Eur. Phys. J. C78 (2018) 11, 890

Goal: global extraction of Compton Form Factors (CFFs) from DVCS data using LO/LT formalism

Analysis done within PARTONS framework

Complications with Lensing Relation



Model studies are useful to get insight on complex physics phenomena

Model-dependent relations between distributions can be useful

But they should not be extrapolated to different models

S. Rodini

Summary of Summary

- Interesting results and progress with phenomenology.

- Interesting sources of tension.

- Apologies for all talks that I missed!