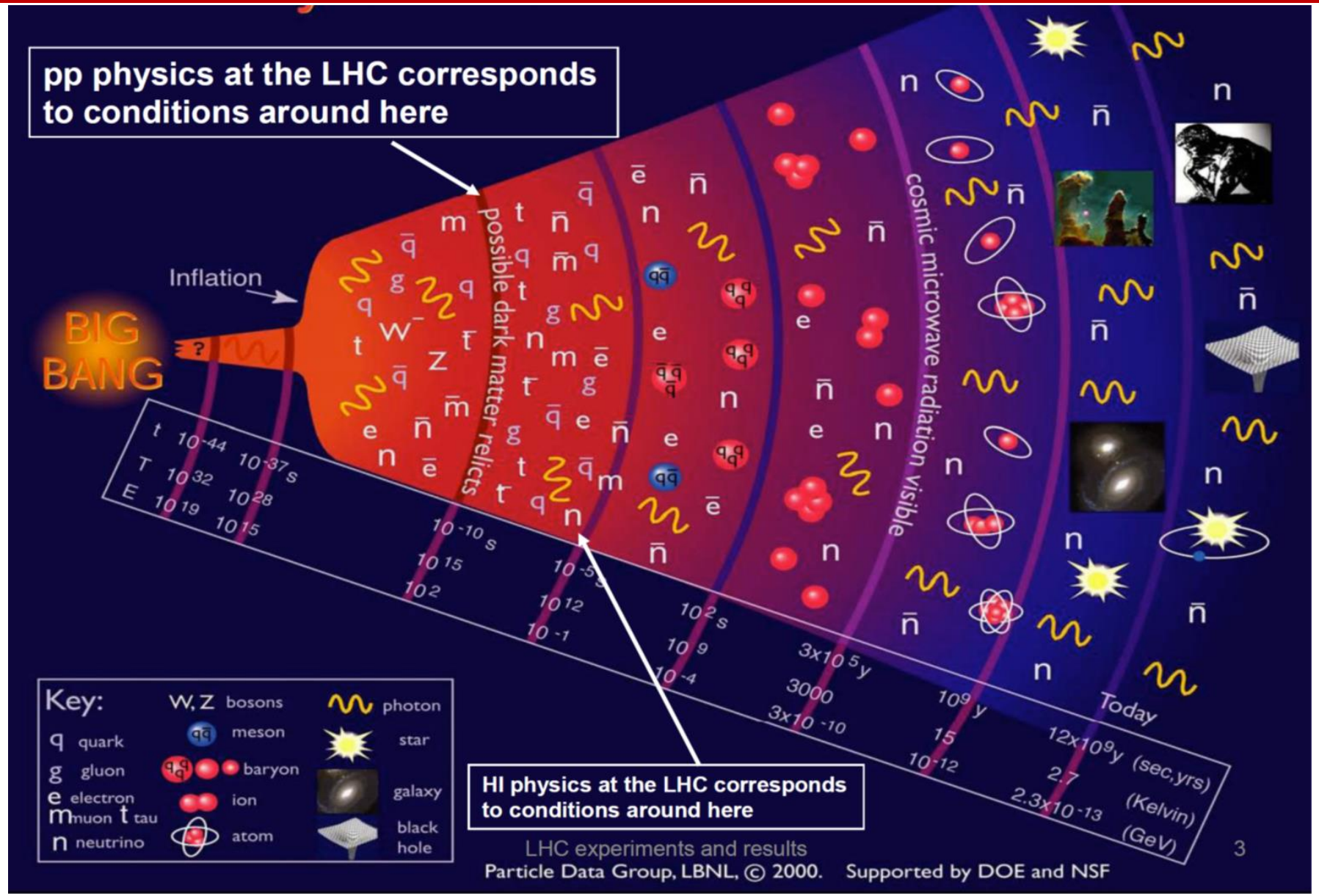
RUN-2 Physics Activities at CMS/LHC

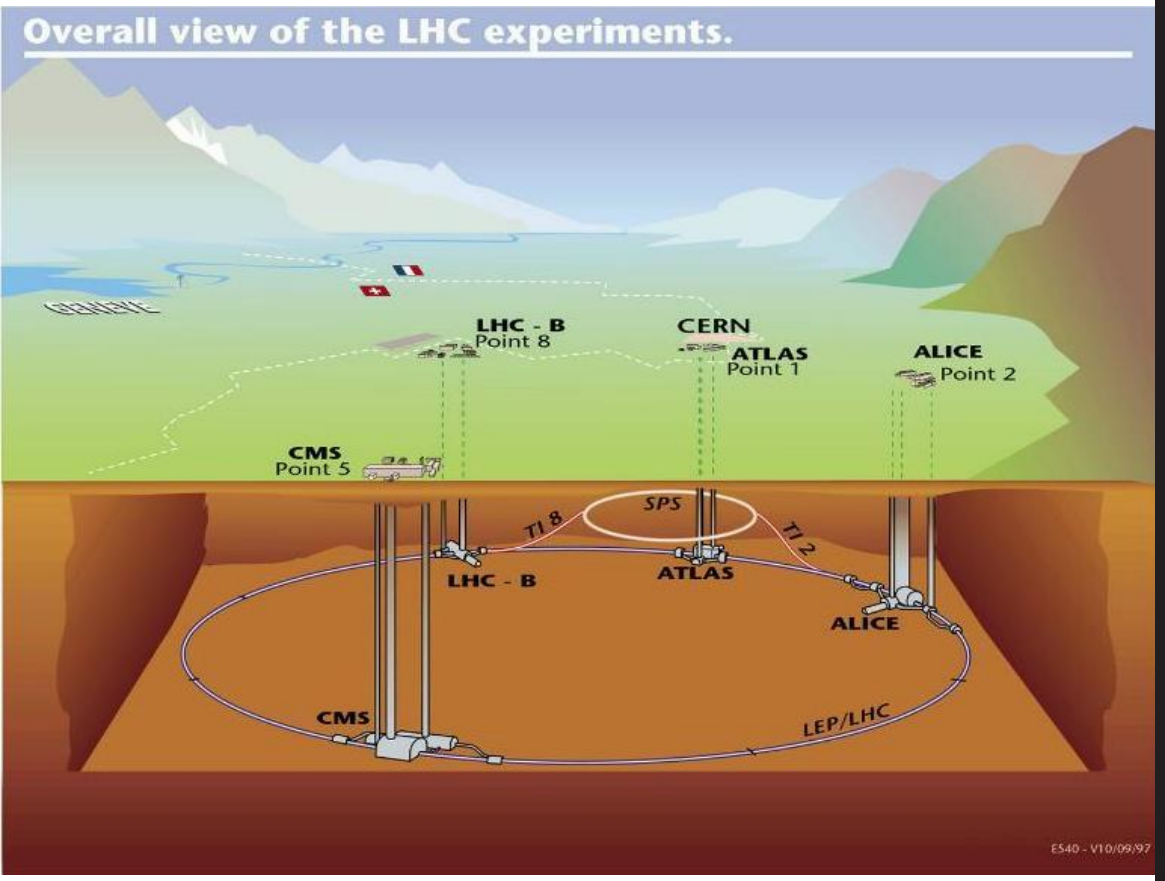
1st Postgraduate Workshop
28 Jan 2020

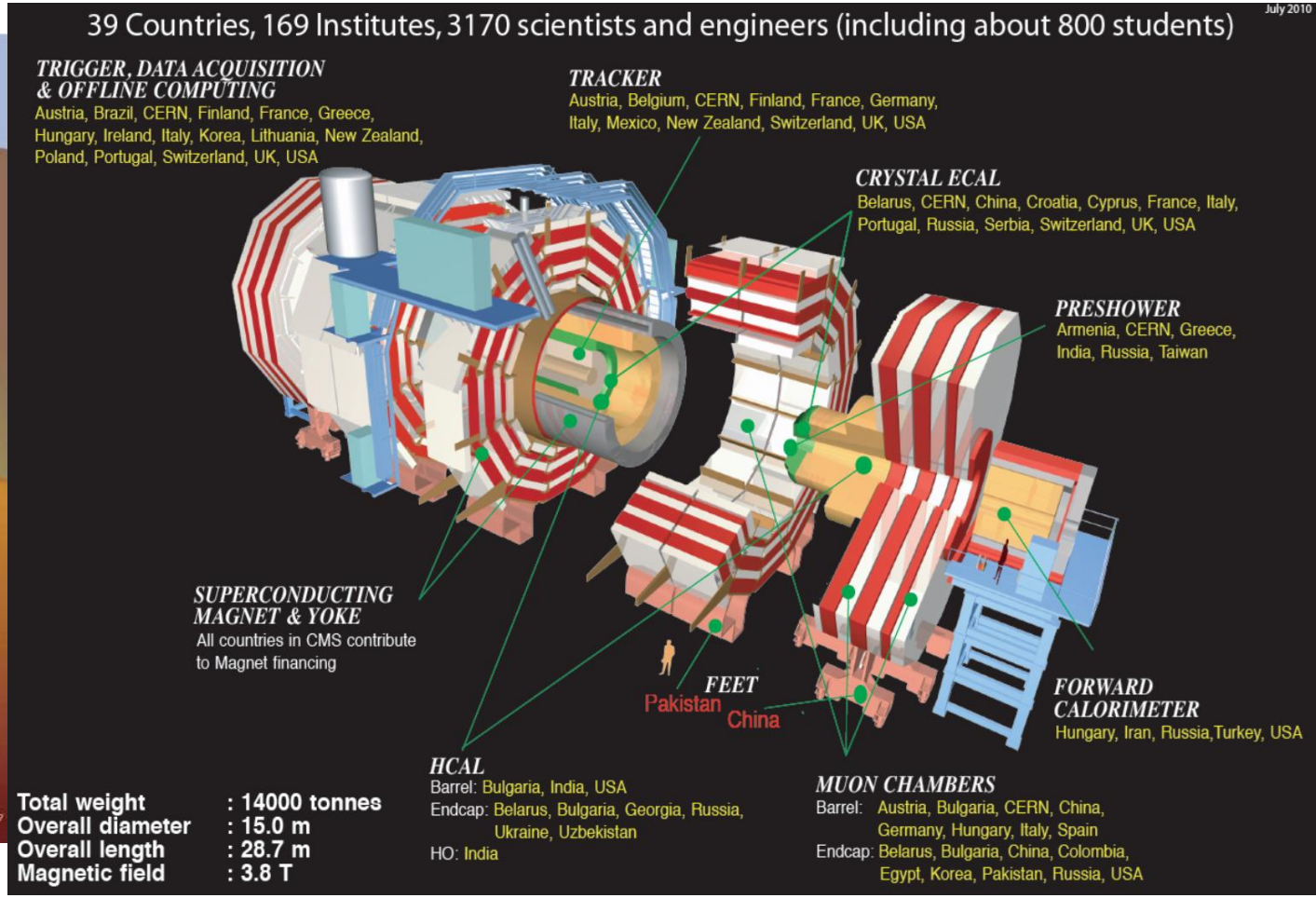
G. Daskalakis

The LHC purpose



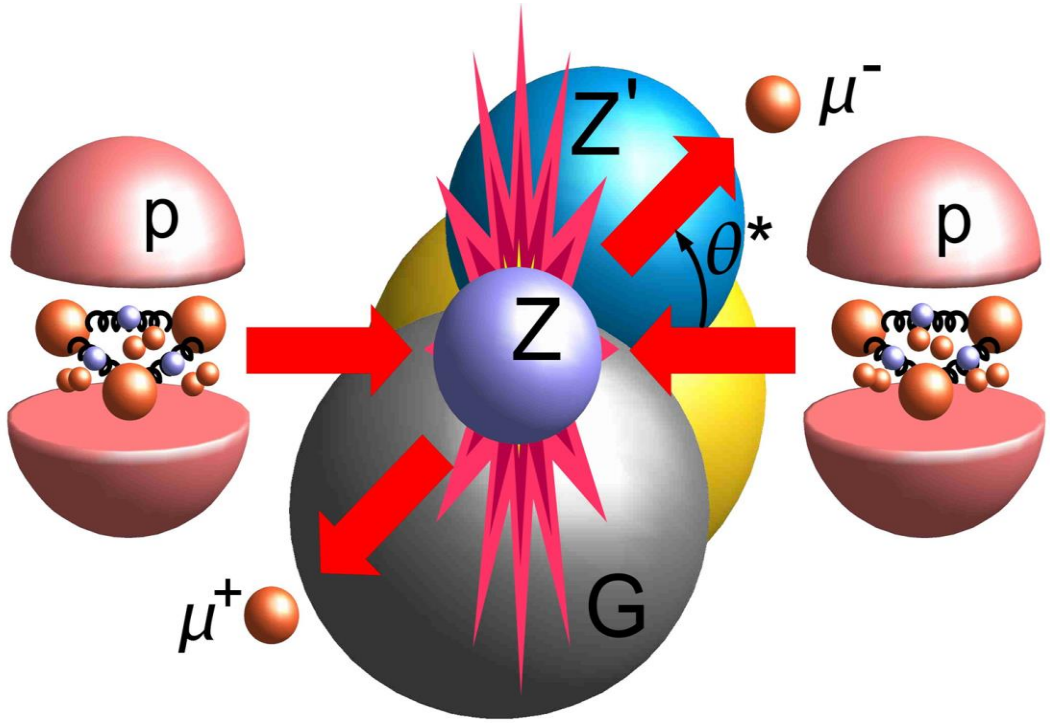
CERN Accelerator & Experiments

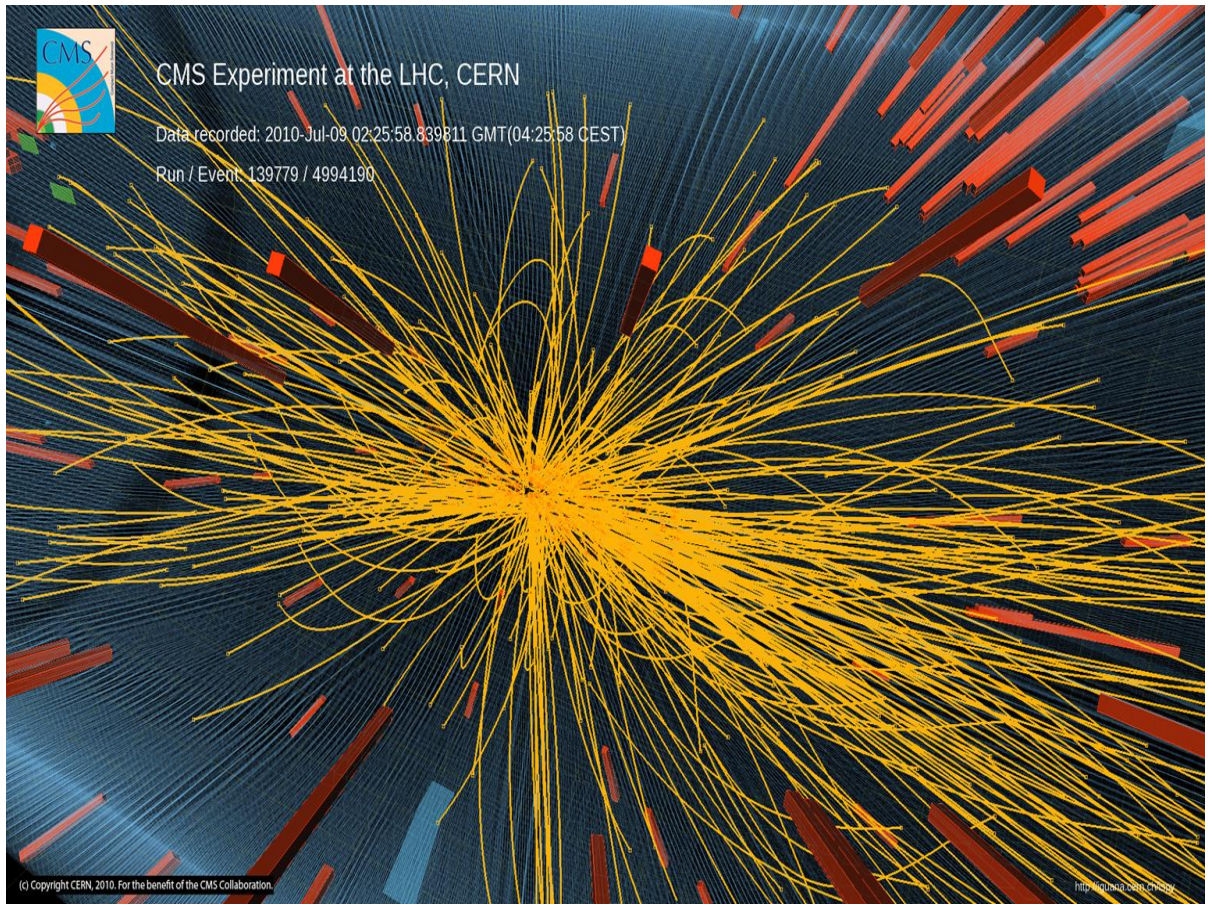




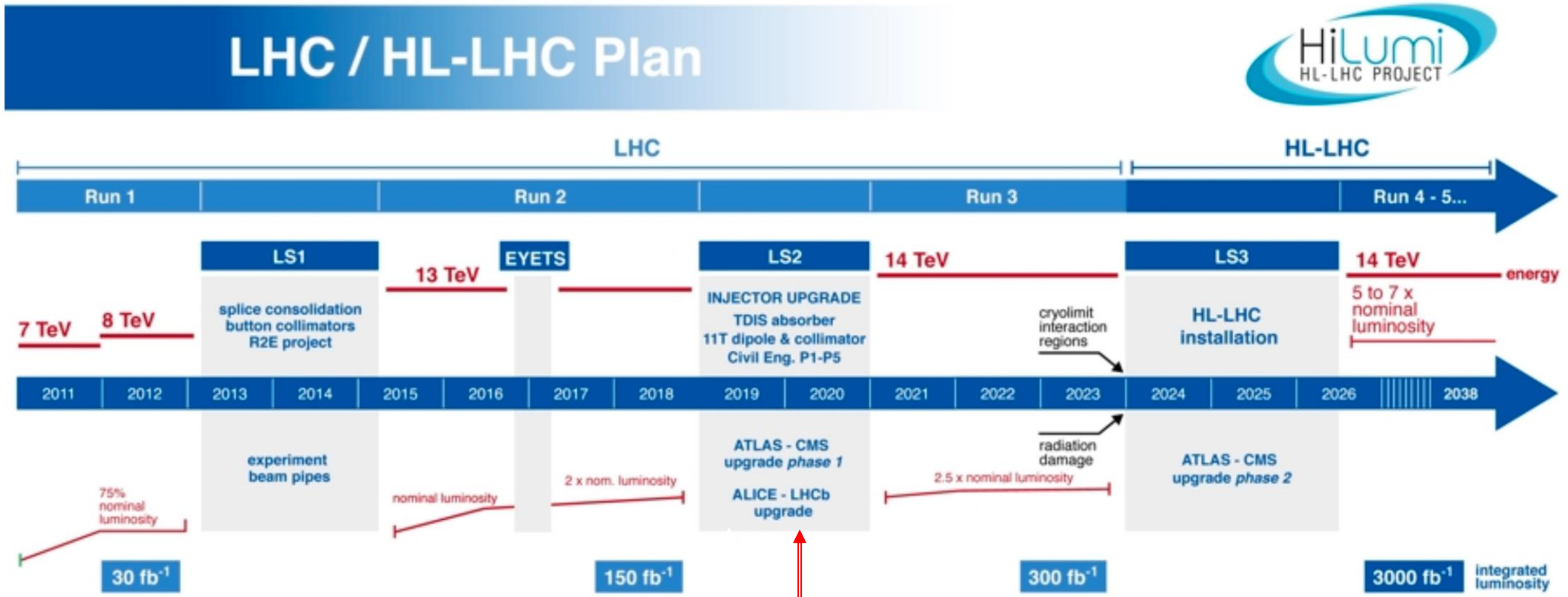
The magic

$$E = mc^2$$





The LHC plan



Run 2
$\langle\mu\rangle \sim 37$
$L \sim 2\times10^{34}$ /cm^2/sec

Run 3
$\langle\mu\rangle \sim 55$
$L \sim 2\times10^{34}$ /cm^2/sec

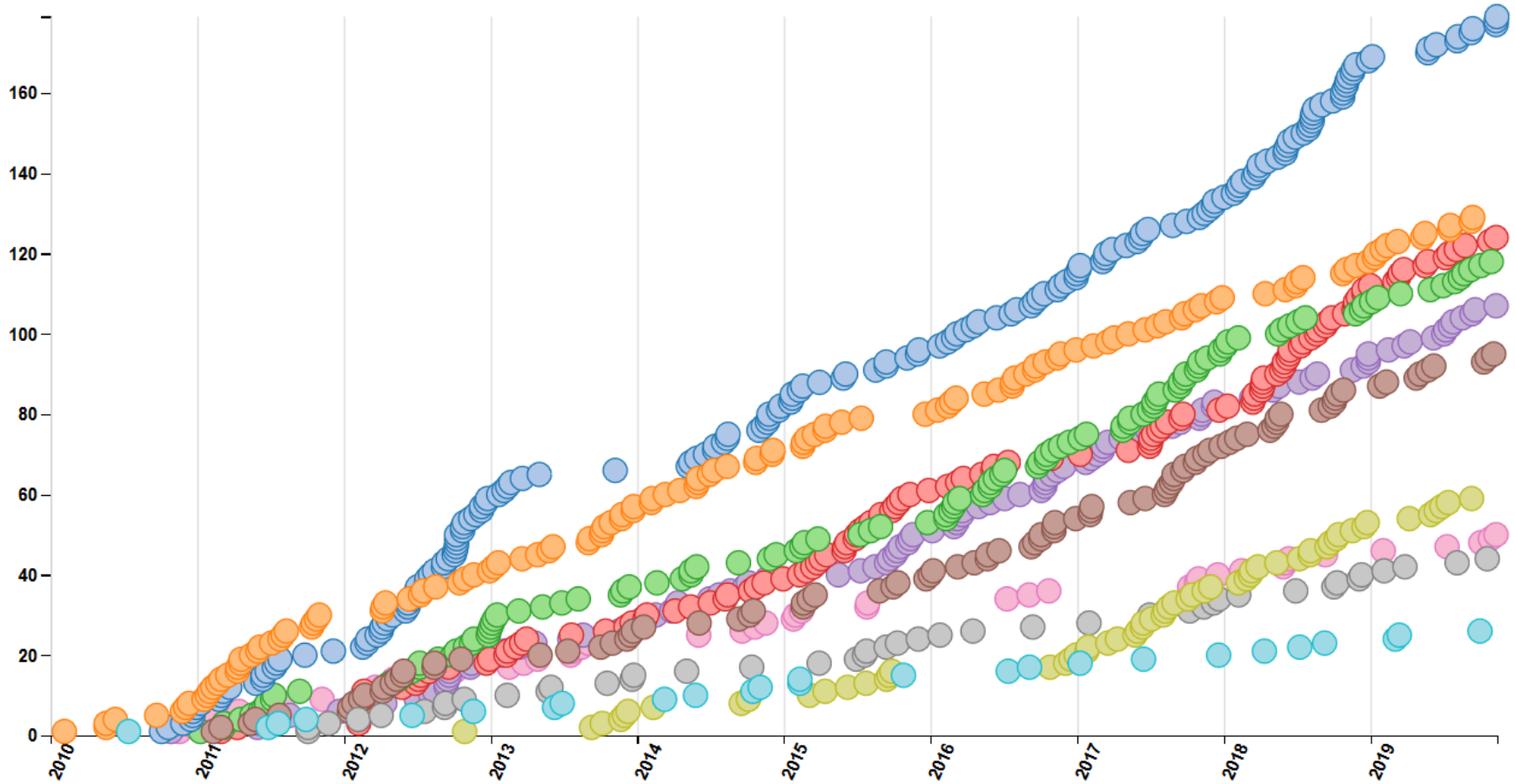
Run 4-5
$\langle\mu\rangle \sim 140\text{-}200$
$L \sim 7.5\times10^{34}$ /cm^2/sec

931 papers from CMS

Show all | Total | Exotica | Standard Model | Supersymmetry | Higgs | Top | Heavy Ions

B and Quarkonia | Forward and Soft QCD | Beyond 2 Generations | Detector Performance

931 collider data papers submitted as of 2019-11-12

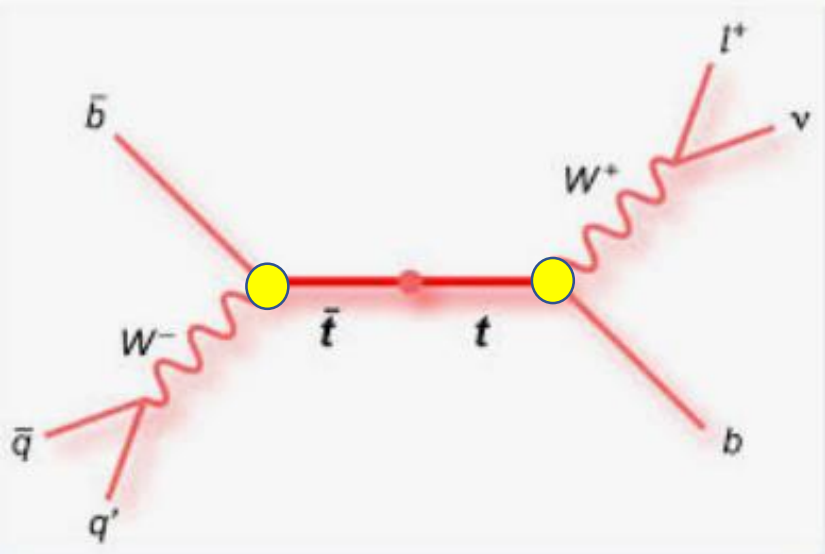


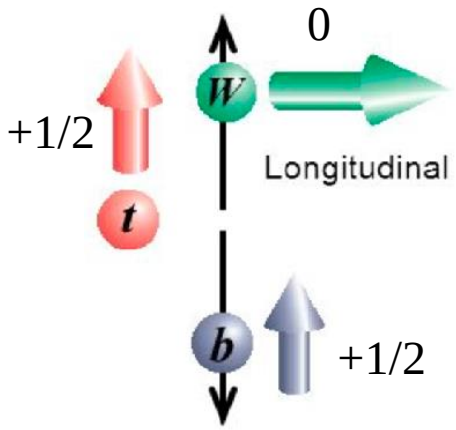
TOP : W helicities from ttbar events

Motivation:

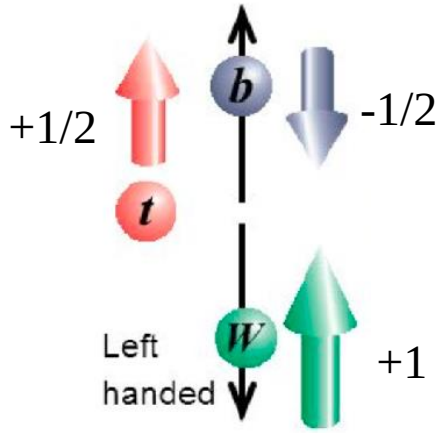
The measurement is sensitive to the Wtb vertex structure;

new physics from anomalous Wtb couplings

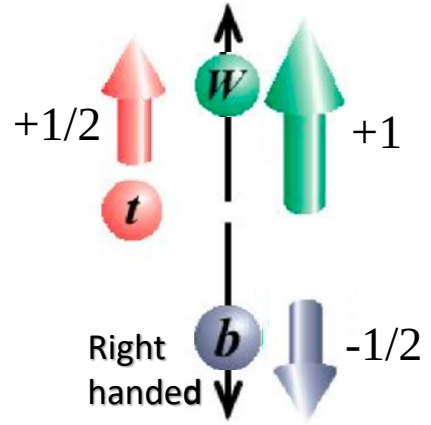




F_0



F_L



F_R

V-A suppressed

CMS (8 TeV)

Phys. Lett. B 762 (2016) 512

F_0 = 0.681 ± 0.012 (stat) ± 0.023 (syst),
F_L = 0.323 ± 0.008 (stat) ± 0.014 (syst), and
F_R = -0.004 ± 0.005 (stat) ± 0.014 (syst)

ATLAS (8 TeV)

Eur. Phys. J. C 77 (2017) 264

F_0 = 0.709 ± 0.019 (stat+syst),
F_L = 0.299 ± 0.015 (stat+syst), and
F_R = -0.008 ± 0.014 (stat+syst)

TOP : W helicities from ttbar events

$$\frac{1}{\Gamma}\frac{d\Gamma}{d\cos\theta} = \frac{3}{8}(1-\cos\theta)^2 \mathbf{F_L} + \frac{3}{8}(1+\cos\theta)^2 \mathbf{F_R} + \frac{3}{4}\sin^2\theta \mathbf{F_0} \ , \quad \theta \equiv \theta^*$$

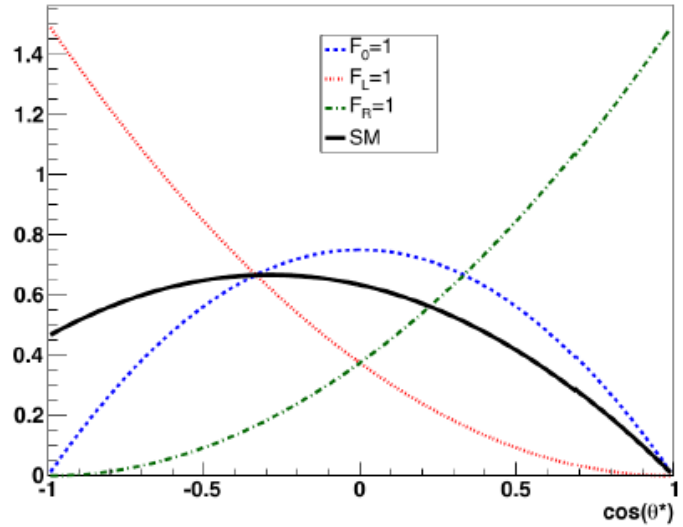
F_0 = 0.687±0.005, F_L = 0.311±0.005, F_R = 0.0017±0.0001
(Phys. Rev. D **81** (2010) 111503) , mt = 172.8 1.3 GeV

Can we do better by changing the 'sensitive variable' ?

- We propose a different approach to extract the W-helicity
  1. $\Delta\Phi(\ell, \text{jet})$
  2. $M_{\ell b}$

Previous Measurements

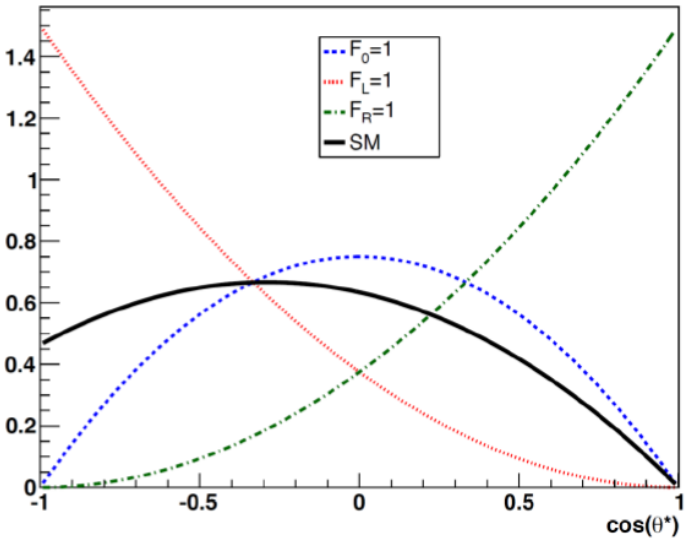
- Based on $\cos(\theta^*)$ $\rightarrow$ Strong discriminant power

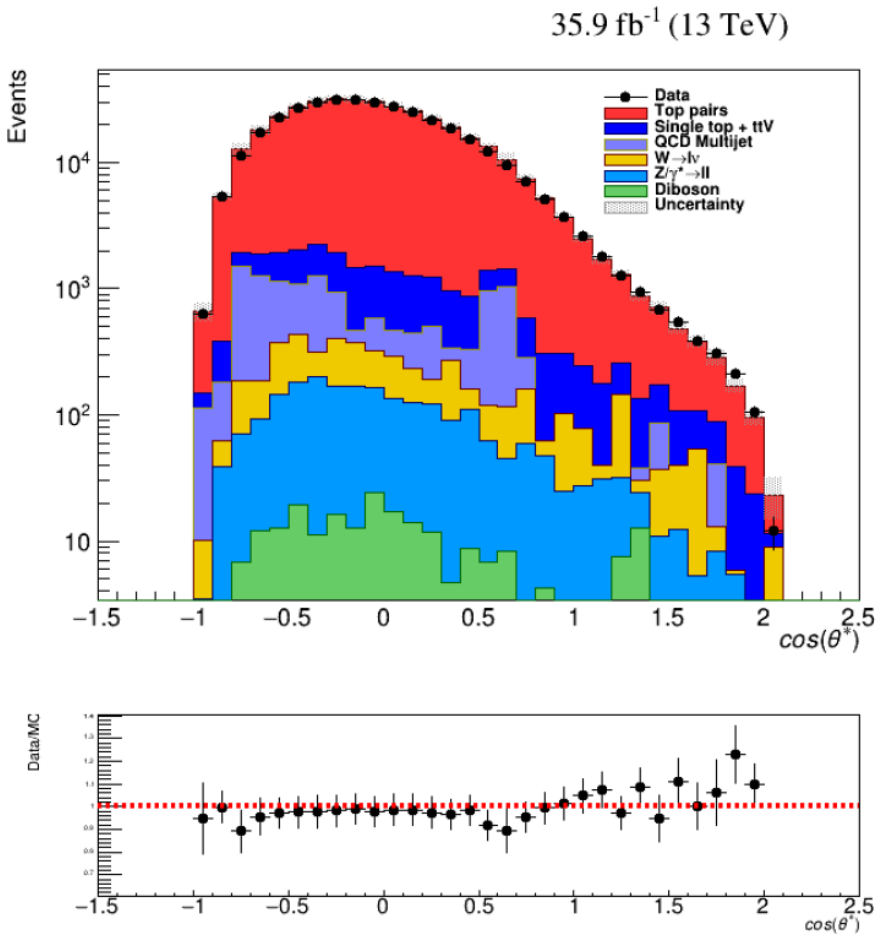


- $\cos(\theta^*)$ needs the reconstruction of the top process ($t\bar{t}$ or single top)
- $t\bar{t}$ kinematic fit introduces a dependency of top mass.

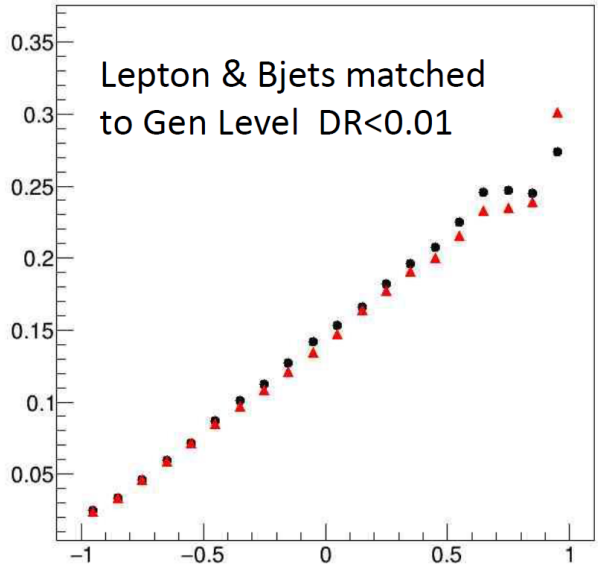
TOP : W helicities from ttbar events

$$cos\theta^{*} = 2\left(\frac{M^{2}_{lb}}{m^{2}_{t} - m^{2}_{W}}\right) - 1$$





The M_{lb} case

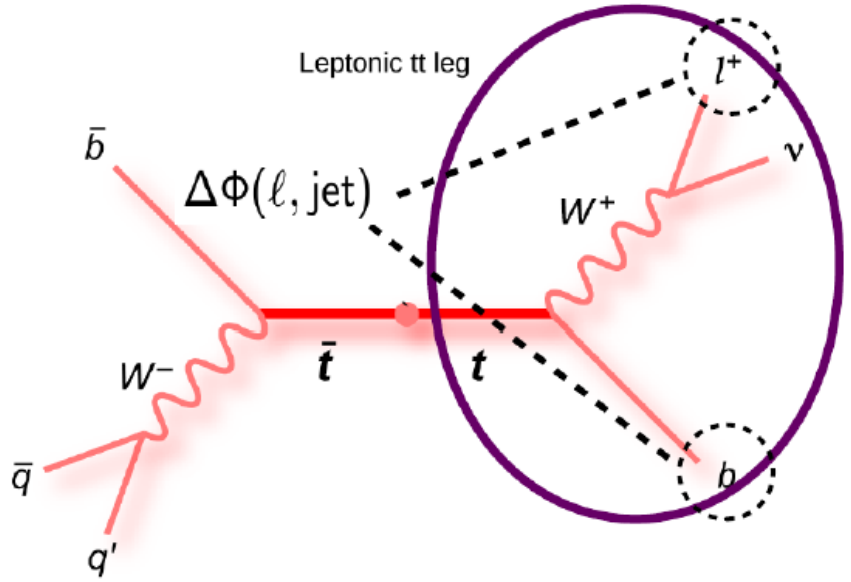


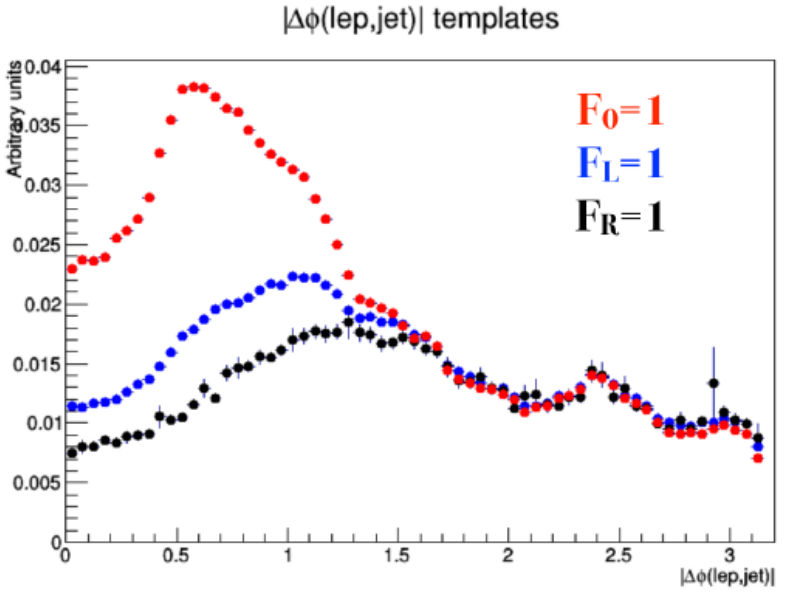
Non uniform resolution versus cos(θ*)

TOP : W helicities from ttbar events

1. Find optimal variable to extract the W-helicity
   - Discriminant power between F_0, F_L and F_R
   - Good resolution
   - different shape for backgrounds
2. $\Delta\Phi(\ell, \text{jet})$

1. Selection of the correct lepton-jet couple
   - Avoid any SM prior
   - Should work in tW/t-channel/$t\bar{t}$ system.
2. The solution: BDT





The $\Delta\varphi$ (l,*jet*) case

W helicities TOPICS

- Measure the W helicities with **different** sensitive variable

  $\cos(\Theta^*)$

  $\Delta\varphi$ (l,jet)

  M_{lb}

- Estimate basic backgrounds with data driven methods (Wjets & QCD)
- Investigate methods to reconstruct the ttbar system

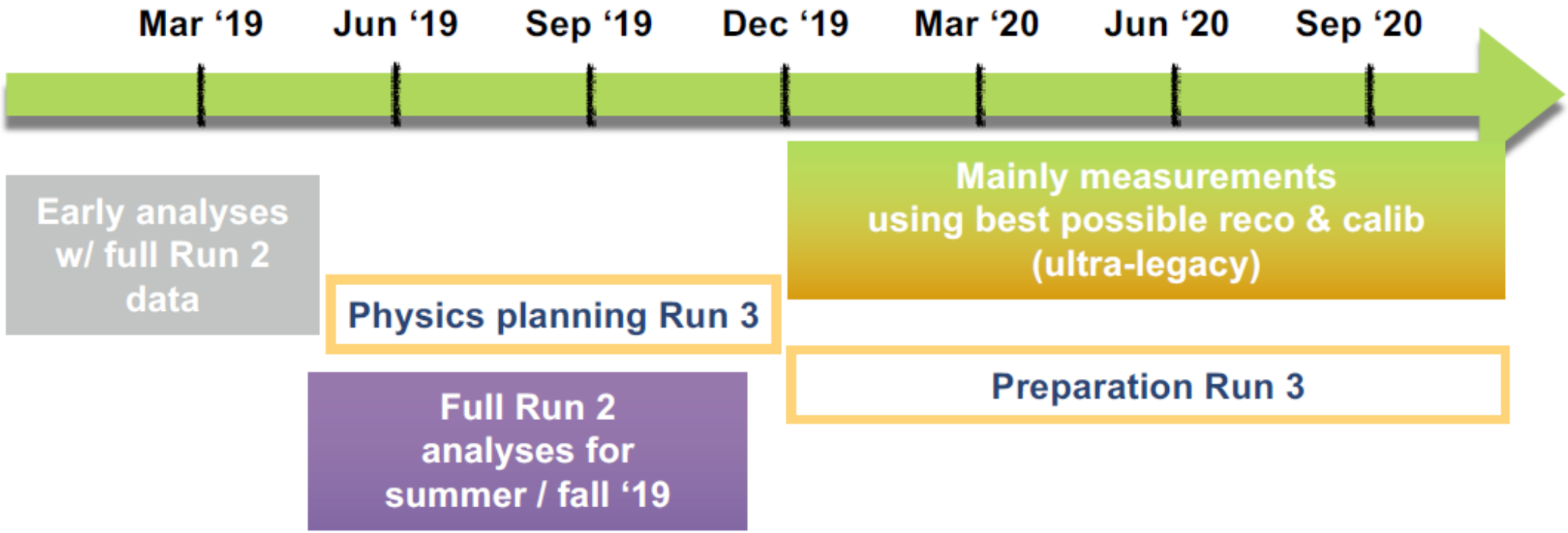
Why should I do it?

- Get in touch with the real **Particle Physics** World
- Analyze **LHC data**
- Search for **New Physics** / Measure the **Standard Model**
- Learn advanced **analysis techniques** & **tools**

What next?

Pursuing parallel activities in three areas:

1. harvest of run 2 results
2. preparation for data taking & analysis in Run 3
3. preparation for HL-LHC



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