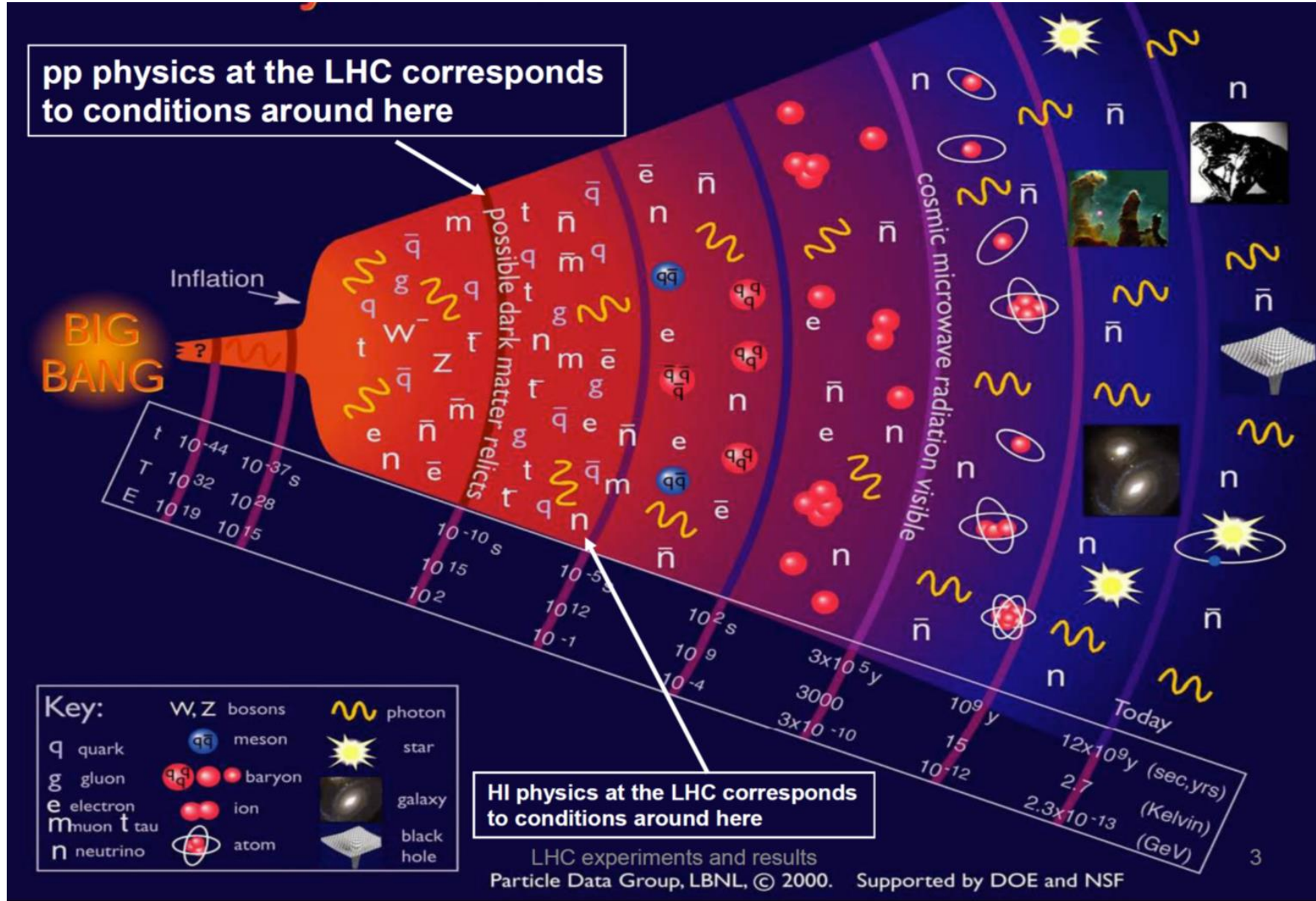


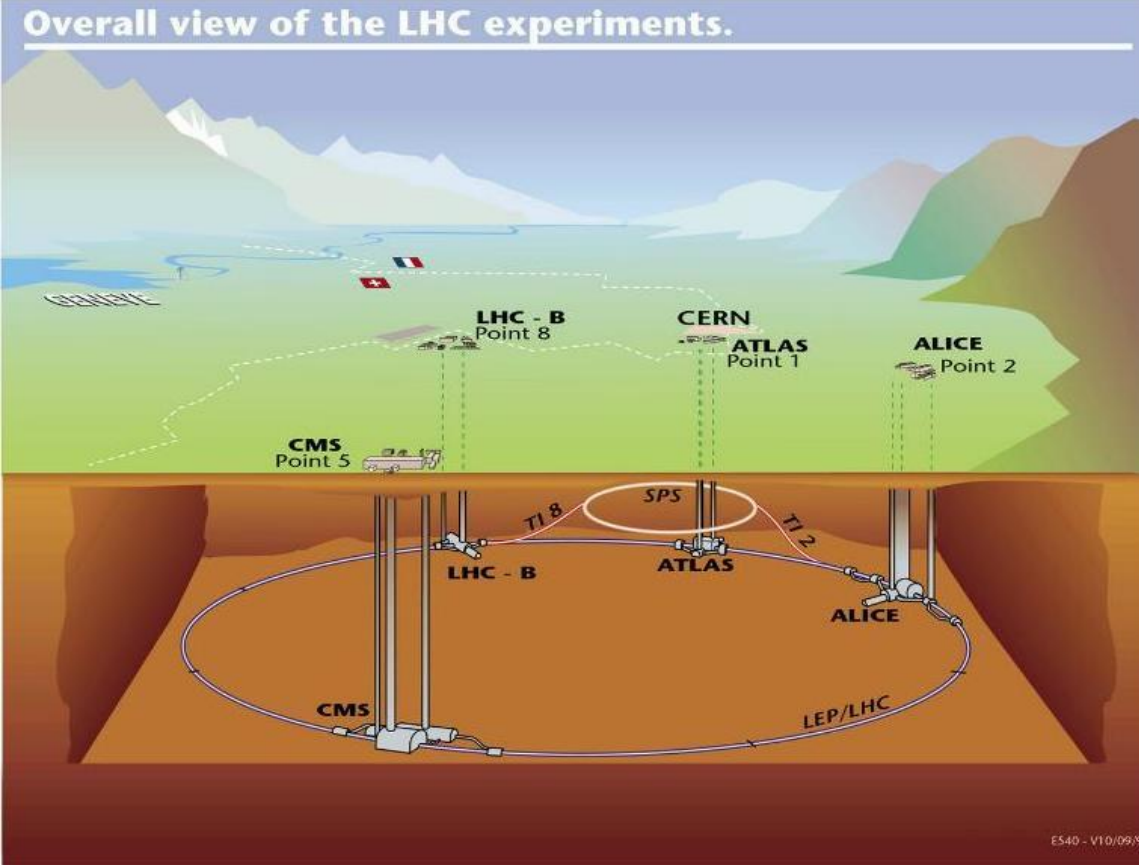
RUN-2 Physics Activities
at
CMS/LHC

1st Postgraduate Workshop
28 Jan 2020

G. Daskalakis

The LHC purpose





39 Countries, 169 Institutes, 3170 scientists and engineers (including about 800 students) July 2010

TRIGGER, DATA ACQUISITION & OFFLINE COMPUTING
Austria, Brazil, CERN, Finland, France, Greece, Hungary, Ireland, Italy, Korea, Lithuania, New Zealand, Poland, Portugal, Switzerland, UK, USA

TRACKER
Austria, Belgium, CERN, Finland, France, Germany, Italy, Mexico, New Zealand, Switzerland, UK, USA

CRYSTAL ECAL
Belarus, CERN, China, Croatia, Cyprus, France, Italy, Portugal, Russia, Serbia, Switzerland, UK, USA

PRESHOWER
Armenia, CERN, Greece, India, Russia, Taiwan

FORWARD CALORIMETER
Hungary, Iran, Russia, Turkey, USA

FEET
Pakistan, China

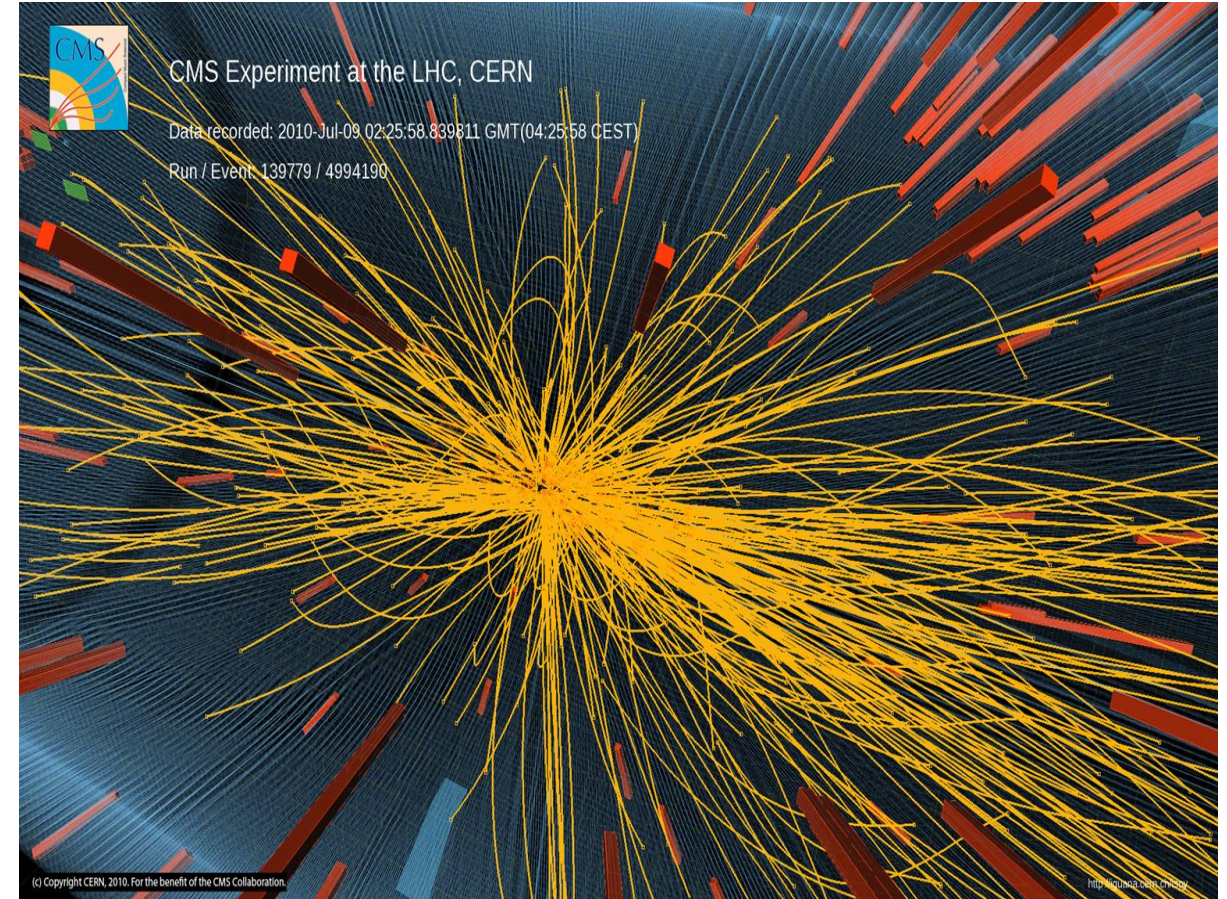
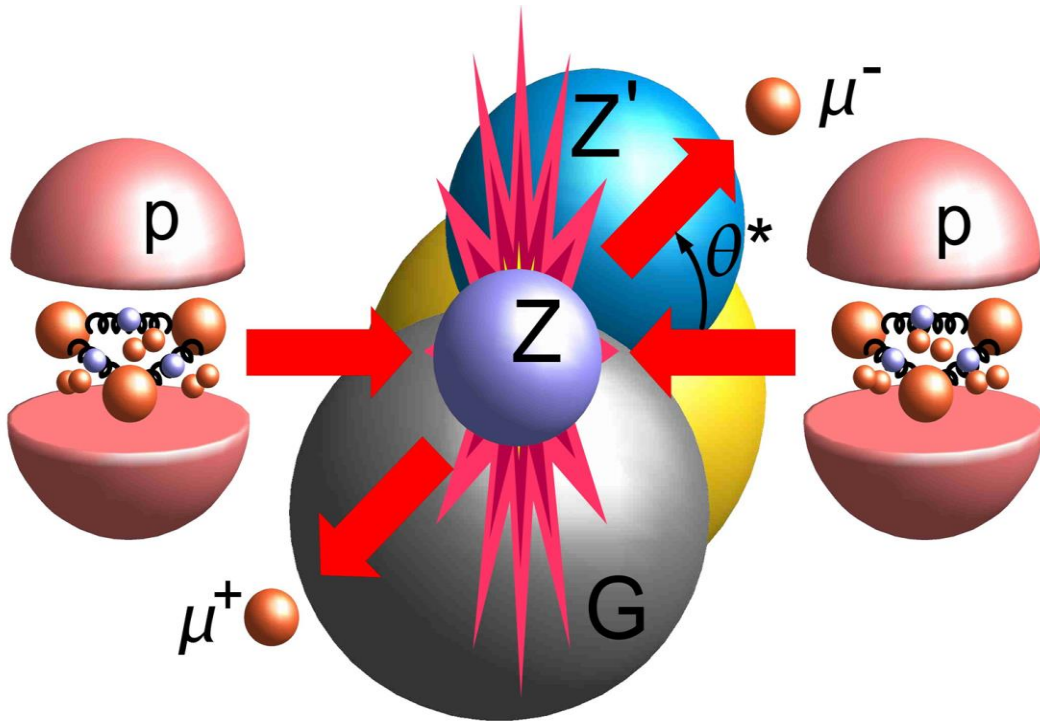
MUON CHAMBERS
Barrel: Austria, Bulgaria, CERN, China, Germany, Hungary, Italy, Spain
Endcap: Belarus, Bulgaria, China, Colombia, Egypt, Korea, Pakistan, Russia, USA

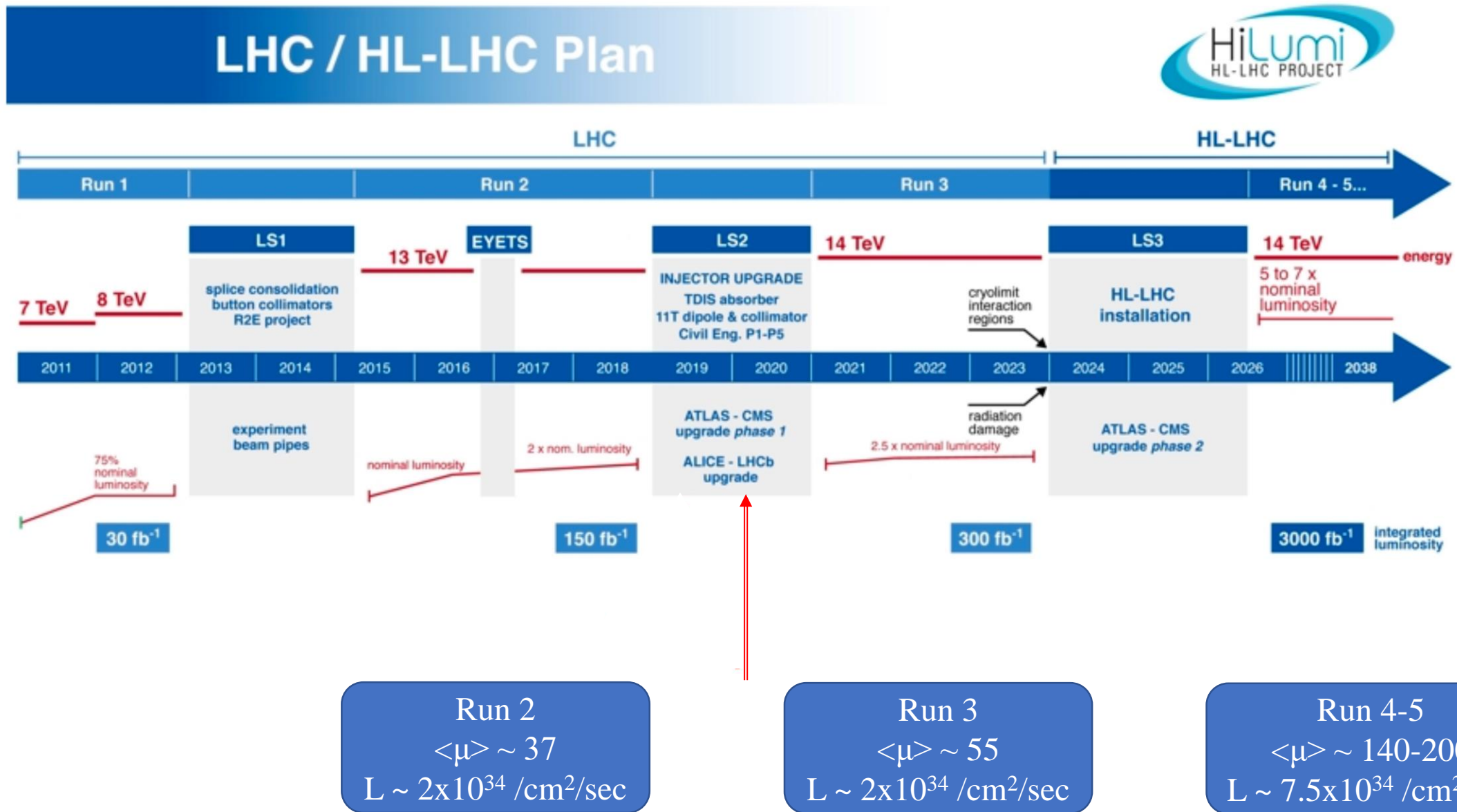
HCAL
Barrel: Bulgaria, India, USA
Endcap: Belarus, Bulgaria, Georgia, Russia, Ukraine, Uzbekistan
HO: India

SUPERCONDUCTING MAGNET & YOKE
All countries in CMS contribute to Magnet financing

Total weight : 14000 tonnes
Overall diameter : 15.0 m
Overall length : 28.7 m
Magnetic field : 3.8 T

$$E = mc^2$$

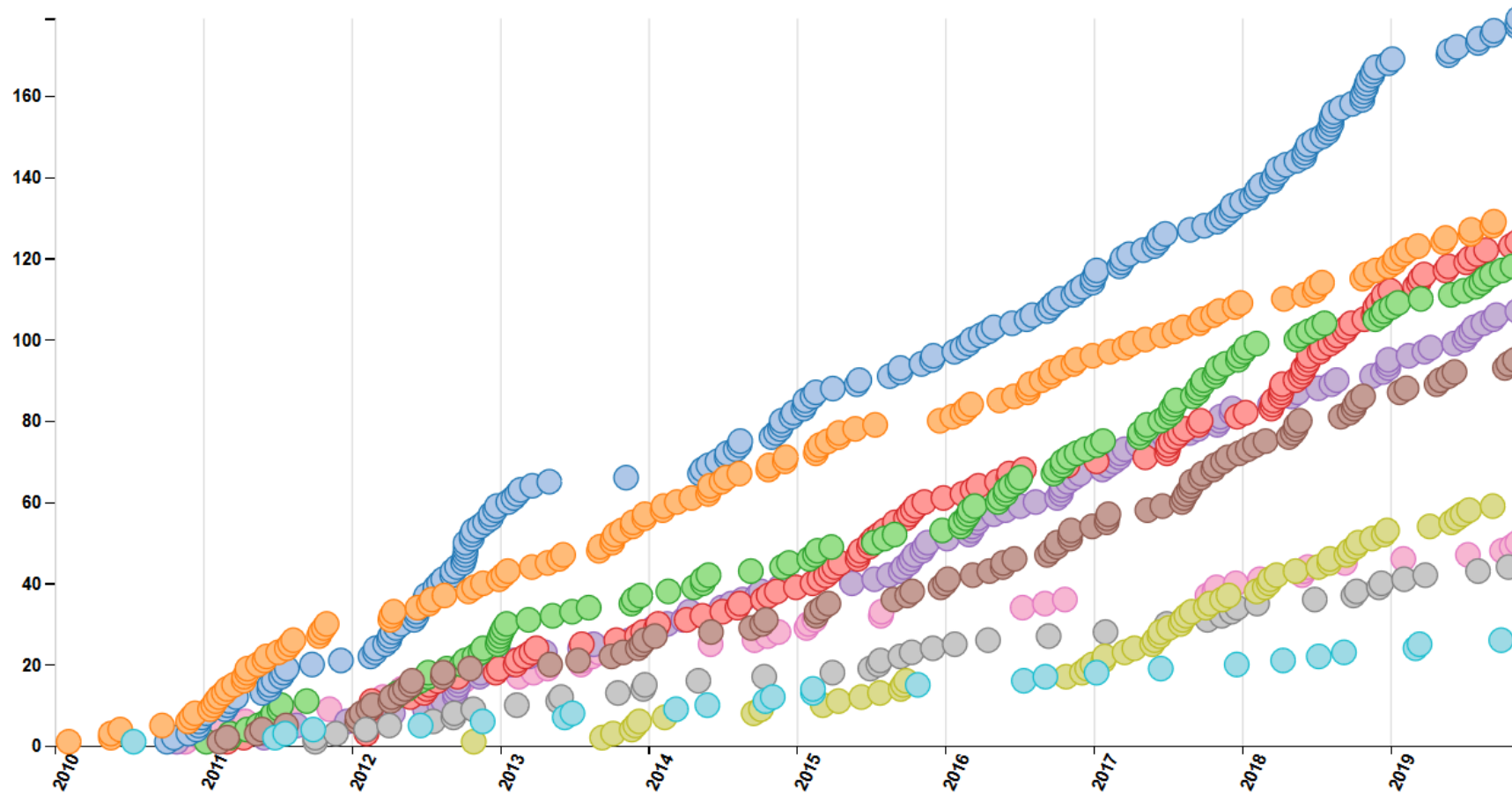




931 papers from CMS

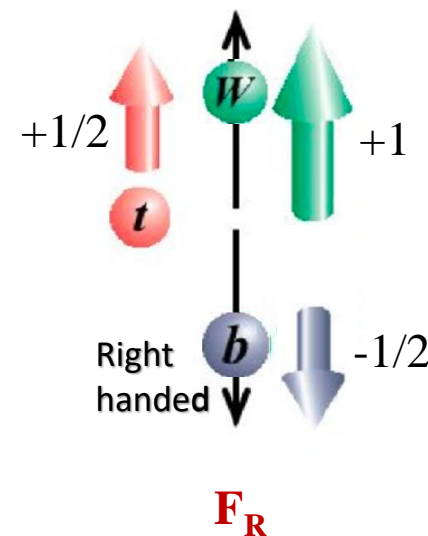
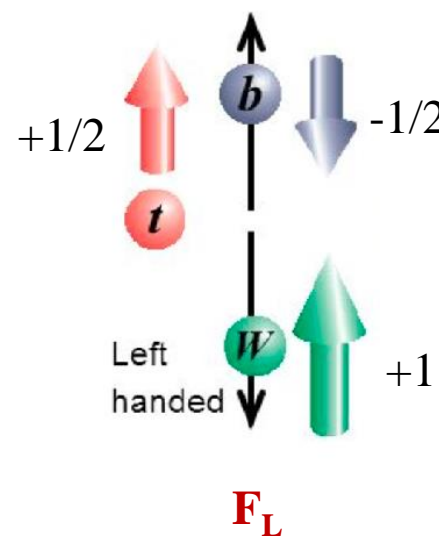
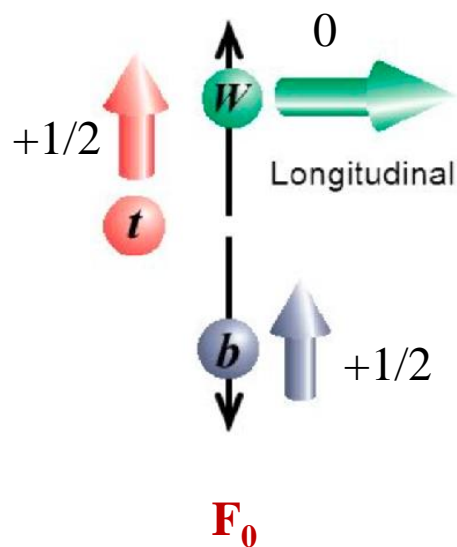
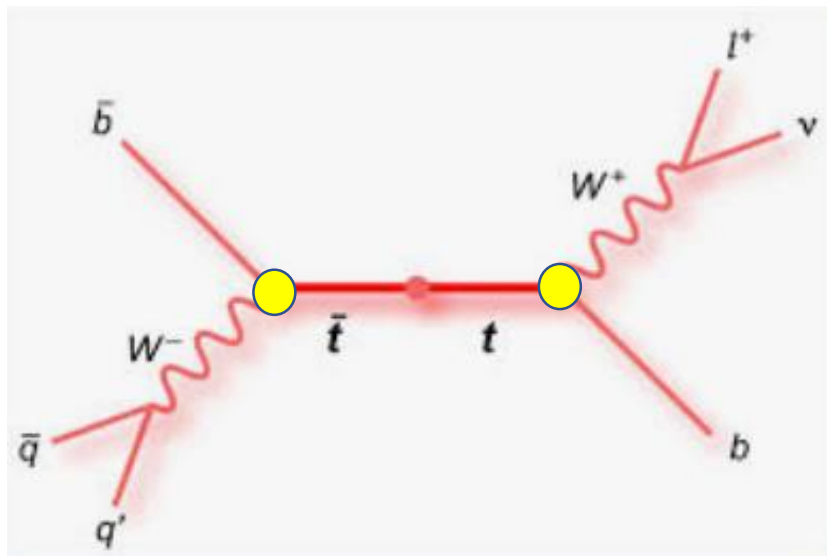
- Show all
- Total
- Exotica
- Standard Model
- Supersymmetry
- Higgs
- Top
- Heavy Ions
- B and Quarkonia
- Forward and Soft QCD
- Beyond 2 Generations
- Detector Performance

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



Motivation:

The measurement is sensitive to the Wtb vertex structure;
new physics from anomalous Wtb couplings



V-A suppressed

CMS (8 TeV)

Phys. Lett. B 762 (2016) 512

$$F_0 = 0.681 \pm 0.012 \text{ (stat)} \pm 0.023 \text{ (syst)},$$

$$F_L = 0.323 \pm 0.008 \text{ (stat)} \pm 0.014 \text{ (syst)}, \text{ and}$$

$$F_R = -0.004 \pm 0.005 \text{ (stat)} \pm 0.014 \text{ (syst)}$$

ATLAS (8 TeV)

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

$$F_0 = 0.709 \pm 0.019 \text{ (stat+syst)},$$

$$F_L = 0.299 \pm 0.015 \text{ (stat+syst)}, \text{ and}$$

$$F_R = -0.008 \pm 0.014 \text{ (stat+syst)}$$

$$\frac{1}{\Gamma} \frac{d\Gamma}{d\cos\theta} = \frac{3}{8} (1 - \cos\theta)^2 \mathbf{F}_L + \frac{3}{8} (1 + \cos\theta)^2 \mathbf{F}_R + \frac{3}{4} \sin^2\theta \mathbf{F}_0, \quad \theta \equiv \theta^*$$

$$F_0 = 0.687 \pm 0.005, \quad F_L = 0.311 \pm 0.005, \quad F_R = 0.0017 \pm 0.0001$$

(Phys. Rev. D **81** (2010) 111503), $m_t = 172.8 \pm 1.3$ GeV

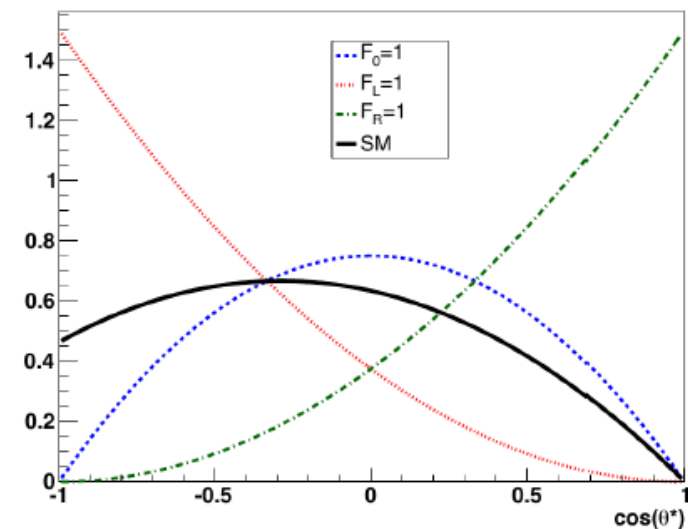
Can we do better by changing the ‘sensitive variable’ ?

- We propose a different approach to extract the W-helicity

- 1 $\Delta\Phi(\ell, \text{jet})$
- 2 $M_{\ell b}$

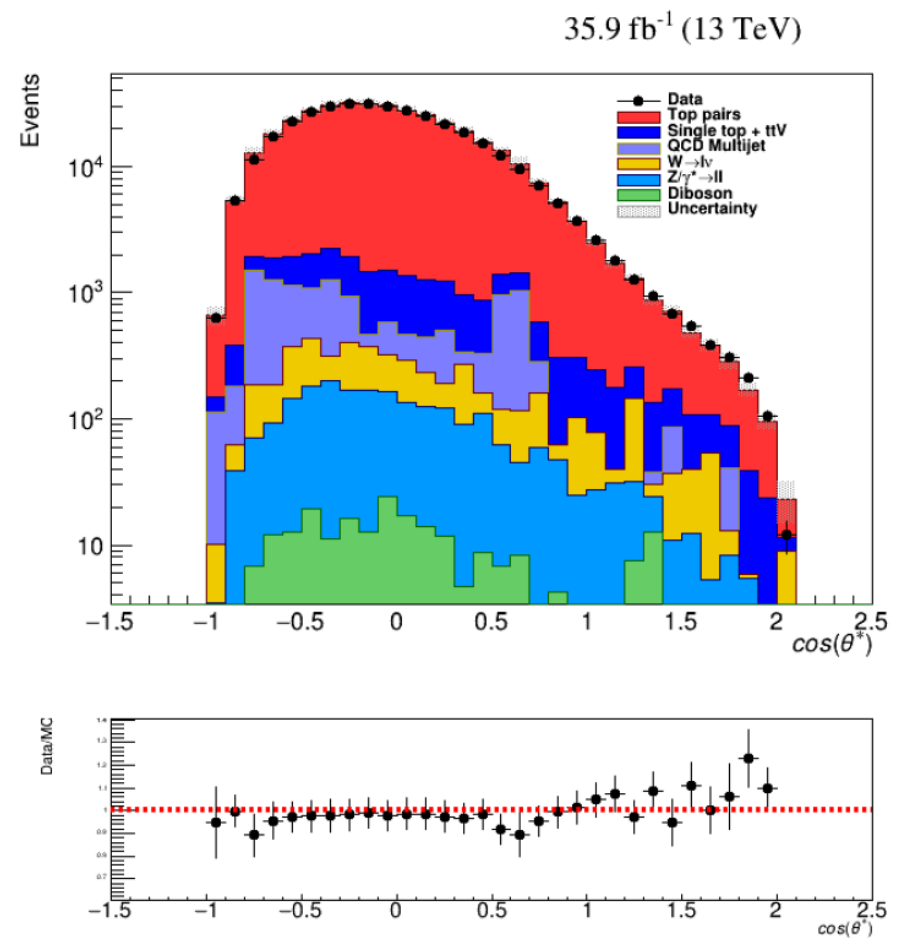
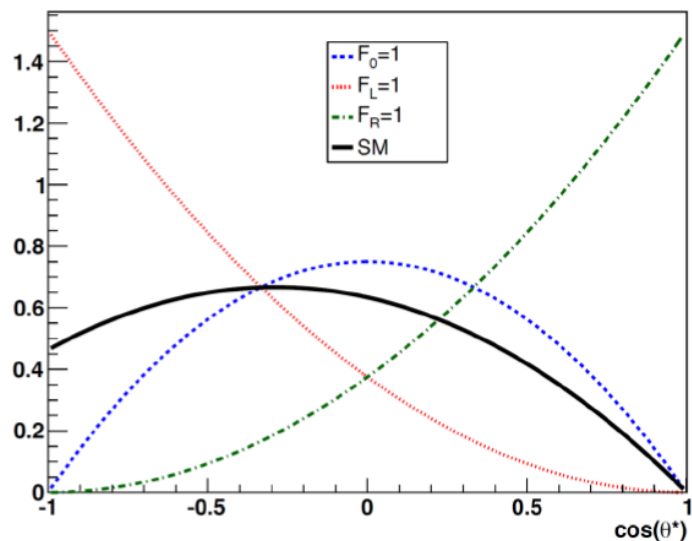
Previous Measurements

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

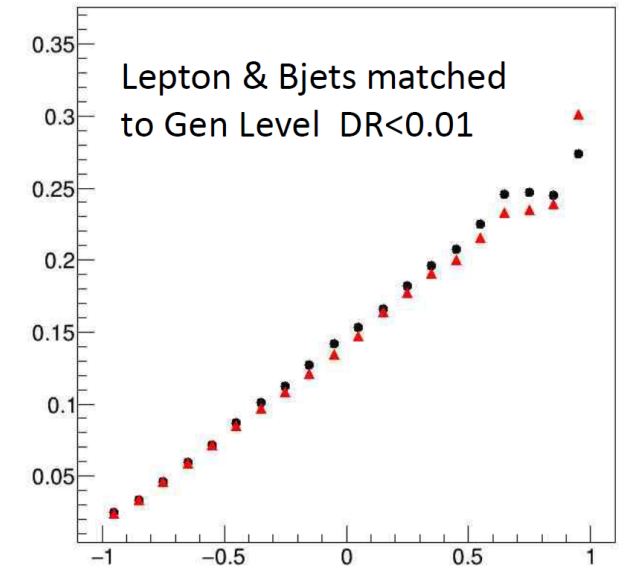


- $\cos(\theta^*)$ needs the reconstruction of the top process ($t\bar{t}$ or single top)
- $t\bar{t}$ kinematic fit introduces a dependency of top mass.

$$\cos\theta^* = 2\left(\frac{M_{lb}^2}{m_t^2 - m_W^2}\right) - 1$$



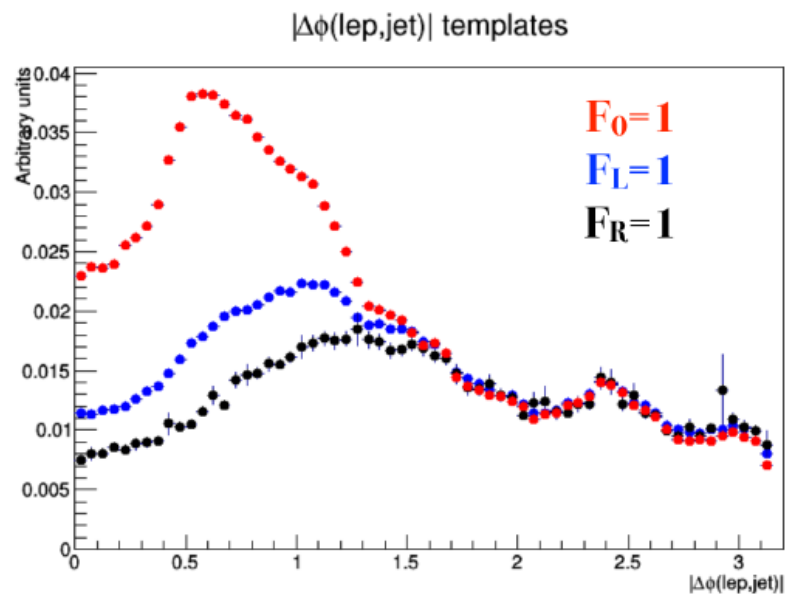
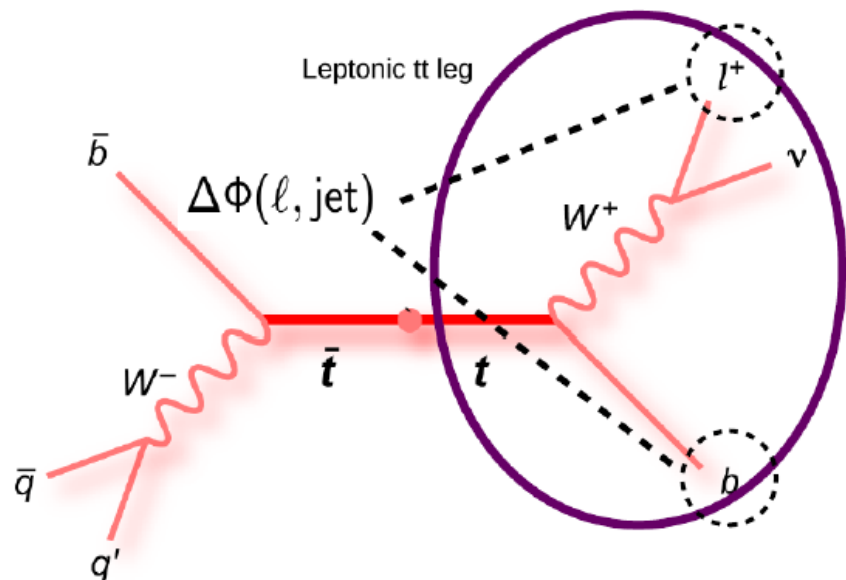
The M_{lb} case



Non uniform resolution versus $\cos(\theta^*)$

- 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 $\Delta\Phi(l, jet)$

- 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
 $\Delta\phi(l, jet)$
case

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

$\cos(\Theta^*)$

$\Delta\phi(l, jet)$

M_{lb}

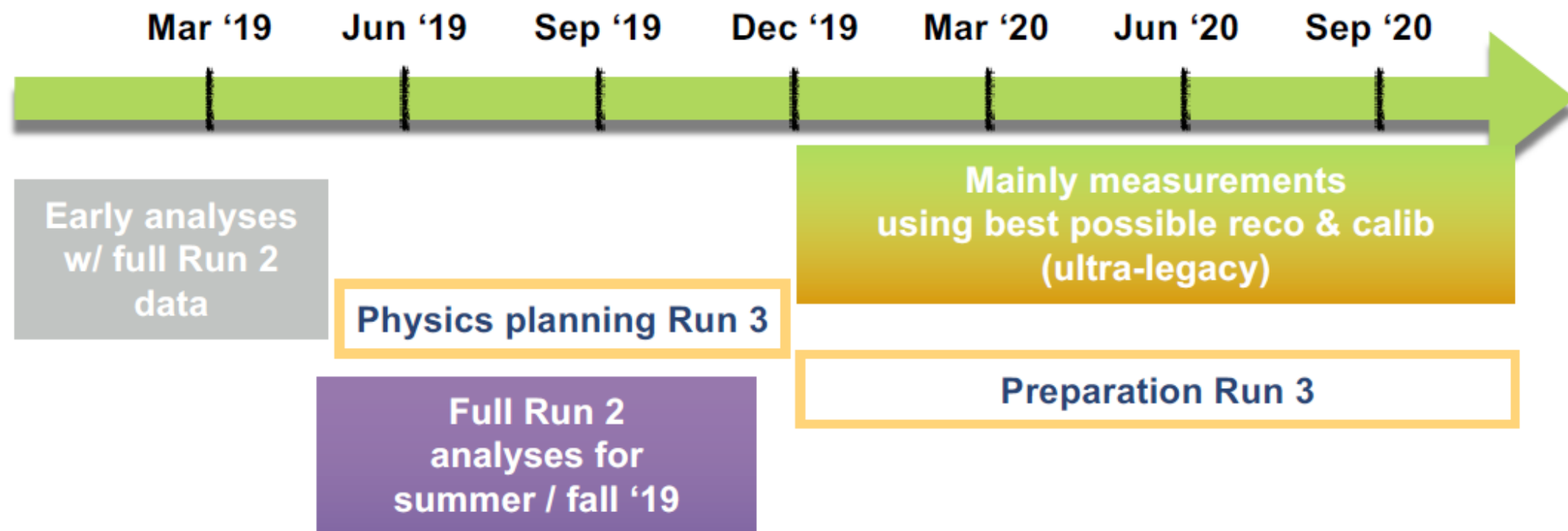
- Estimate basic backgrounds with data driven methods (Wjets & QCD)
- Investigate methods to reconstruct the ttbar system

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**

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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