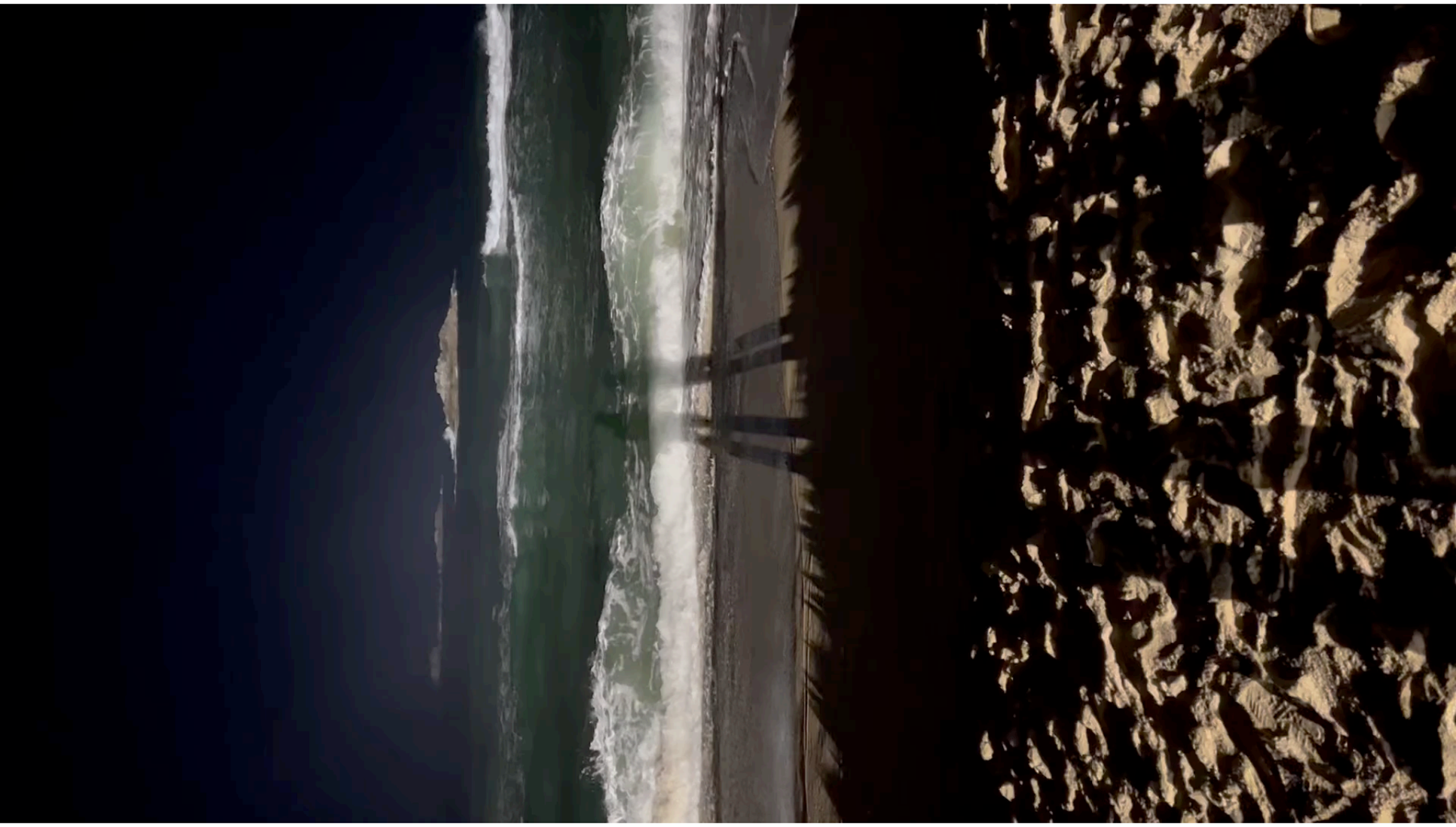
Gangnueng-Wonju Nat'l Univ.

김민석(Kim Min Suk)



1991 vs. 2021

- A year 1991 department of physics at GWNU has last newly appointed assistant professor
- I was a first-year student in department of physics, KNU

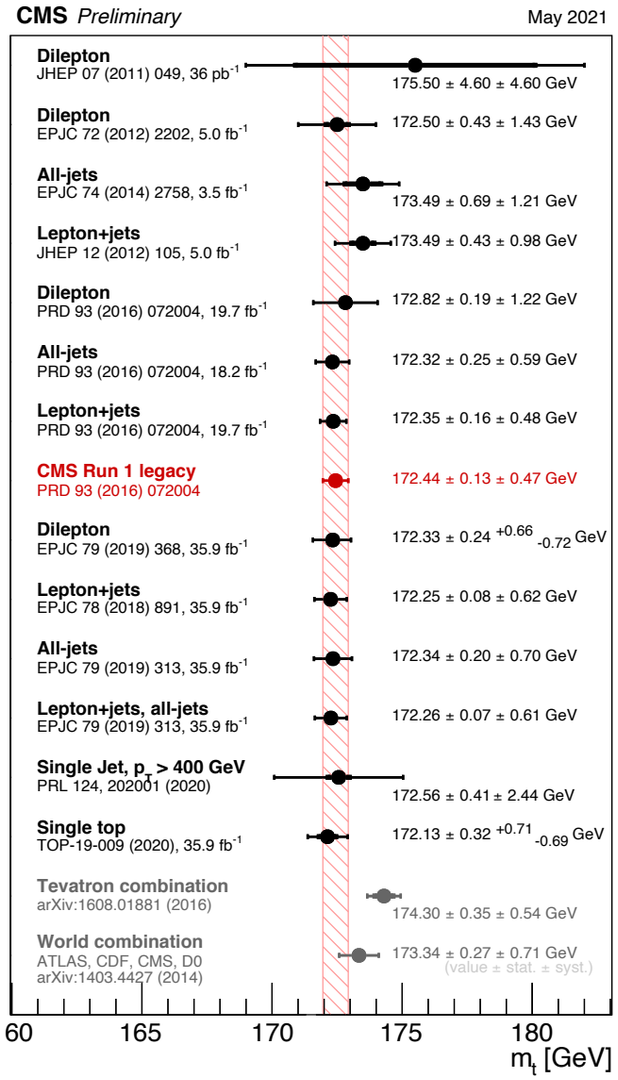
- A year 2021 department of physics has a small chance of survival at GWNU
- I am a first-year professor in department of physics, GWNU

- **JERC working group as a co-convener**
  - Improved jet energy scale corrections ⇨ 13 TeV paper in preparation
  - Will reduce JEC uncertainties ⇨ impact on precision measurements
- **Top quark mass measurement using the full Run 2 data**
  - Co-working with Univ. of Helsinki
- **Search for excited leptons with a photon with more data**
  - Co-working with Kyungpook National Univ. and Yonsei Univ.

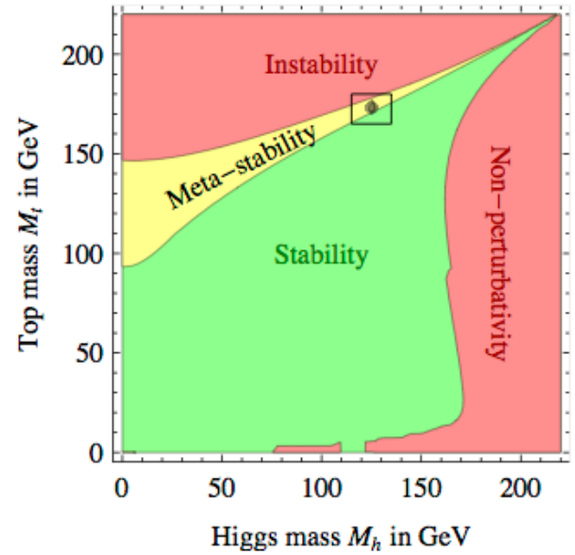
Top Quark Measurements

- **After its discovery ~25 years ago, the top is still one of the hottest topics**
- **LHC: a top quark factory**

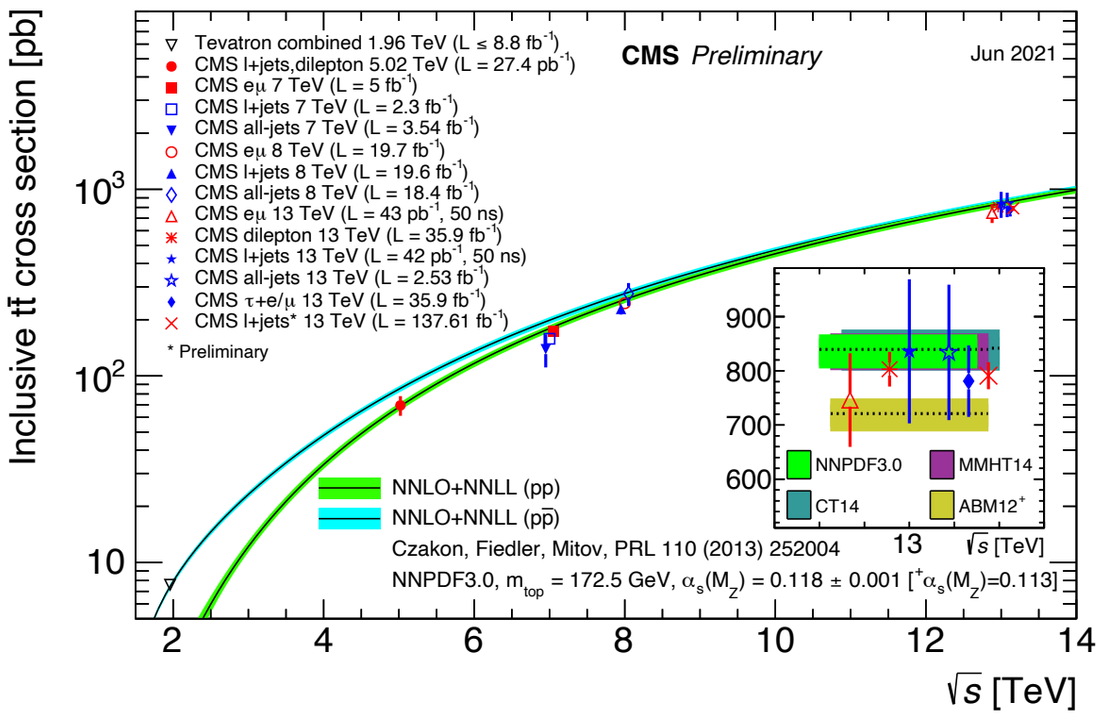
Summary of top quark mass measurements



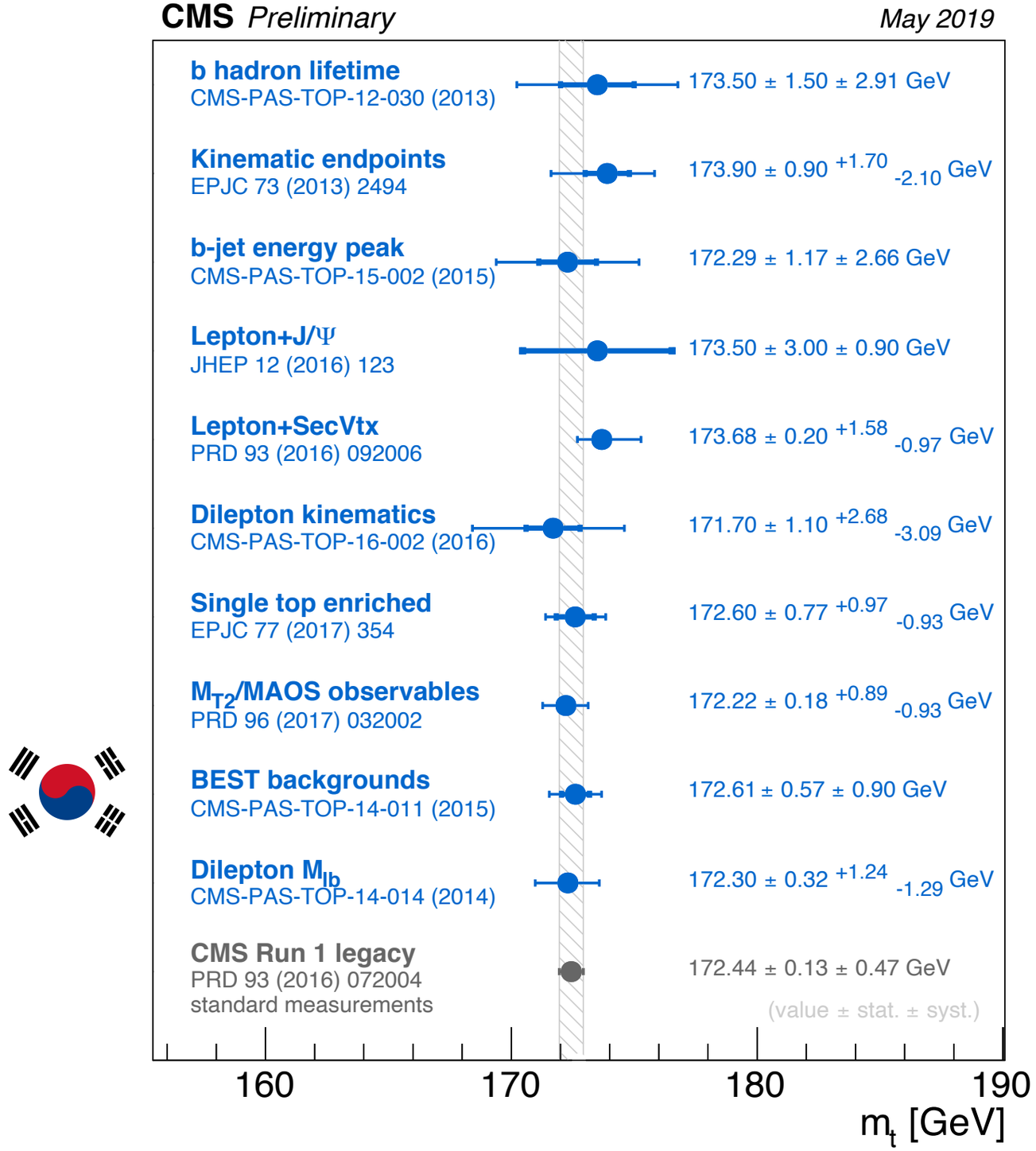
Regions of SM vacuum in M_t-M_h plane



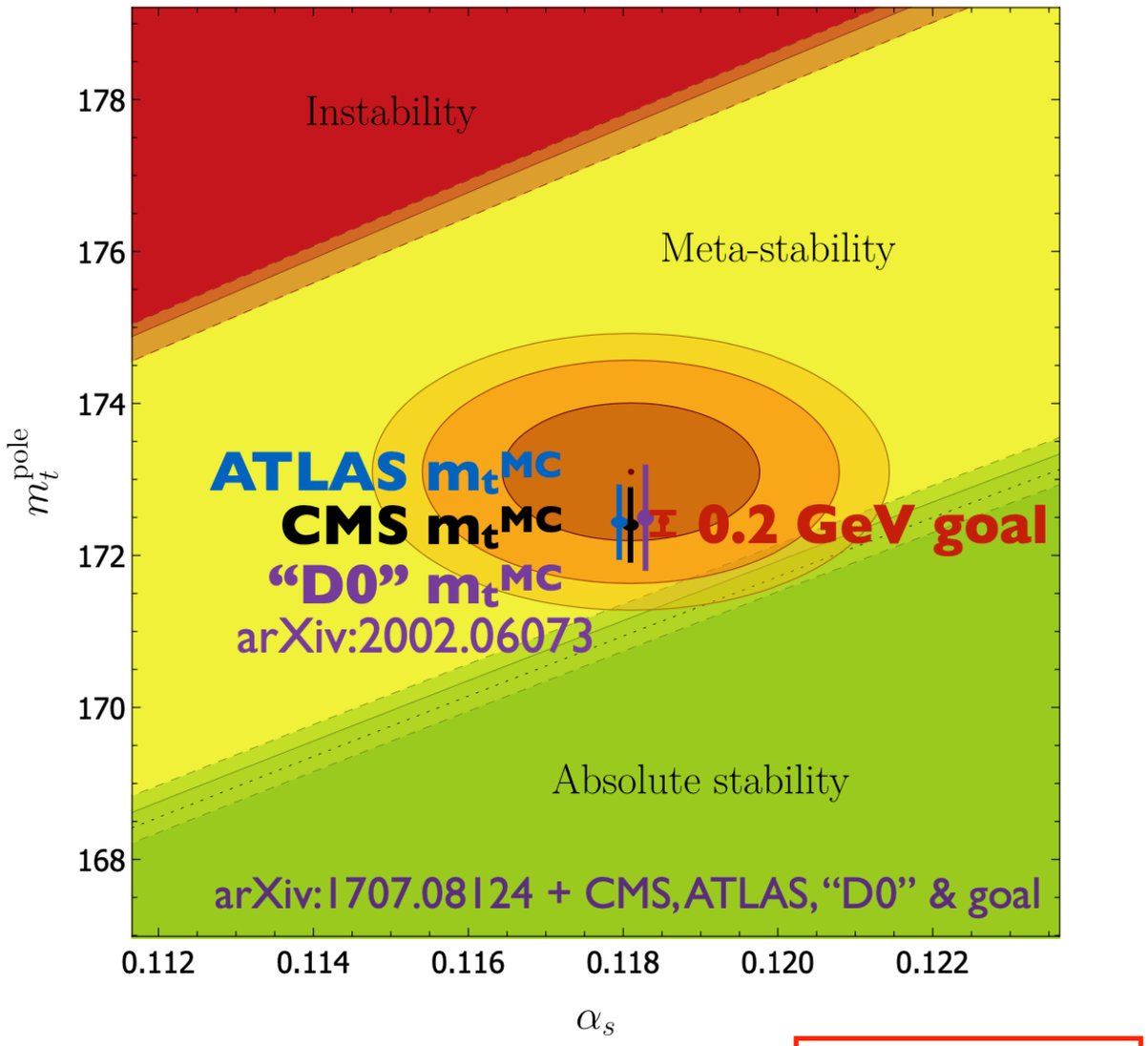
Top quark pair cross section summary with theory



Top Mass



Stability of SM vacuum



Observable	Measured value	Limiting exp.(th.) unc.
m_H (LHC) [12]	$m_H = 125.09 \pm 0.21_{\text{stat}} \pm 0.11_{syst}$	ECAL non-linearity
m_t (CMS) [13]	$m_t = 172.44 \pm 0.13_{stat} \pm 0.47_{syst}$	b-JES ($m_t^{\text{pole}}/m_t^{\text{MC}}$)
m_t (ATLAS) [41]	$m_t = 172.51 \pm 0.27_{stat} \pm 0.42_{syst}$	b-JES ($m_t^{\text{pole}}/m_t^{\text{MC}}$)
α_s from jets [14]	$\alpha_s = 0.1199 \pm 0.0015_{exp} {}^{+0.0031}_{-0.0020\,\text{th}}$	gluon-JES (NLO scale)

lab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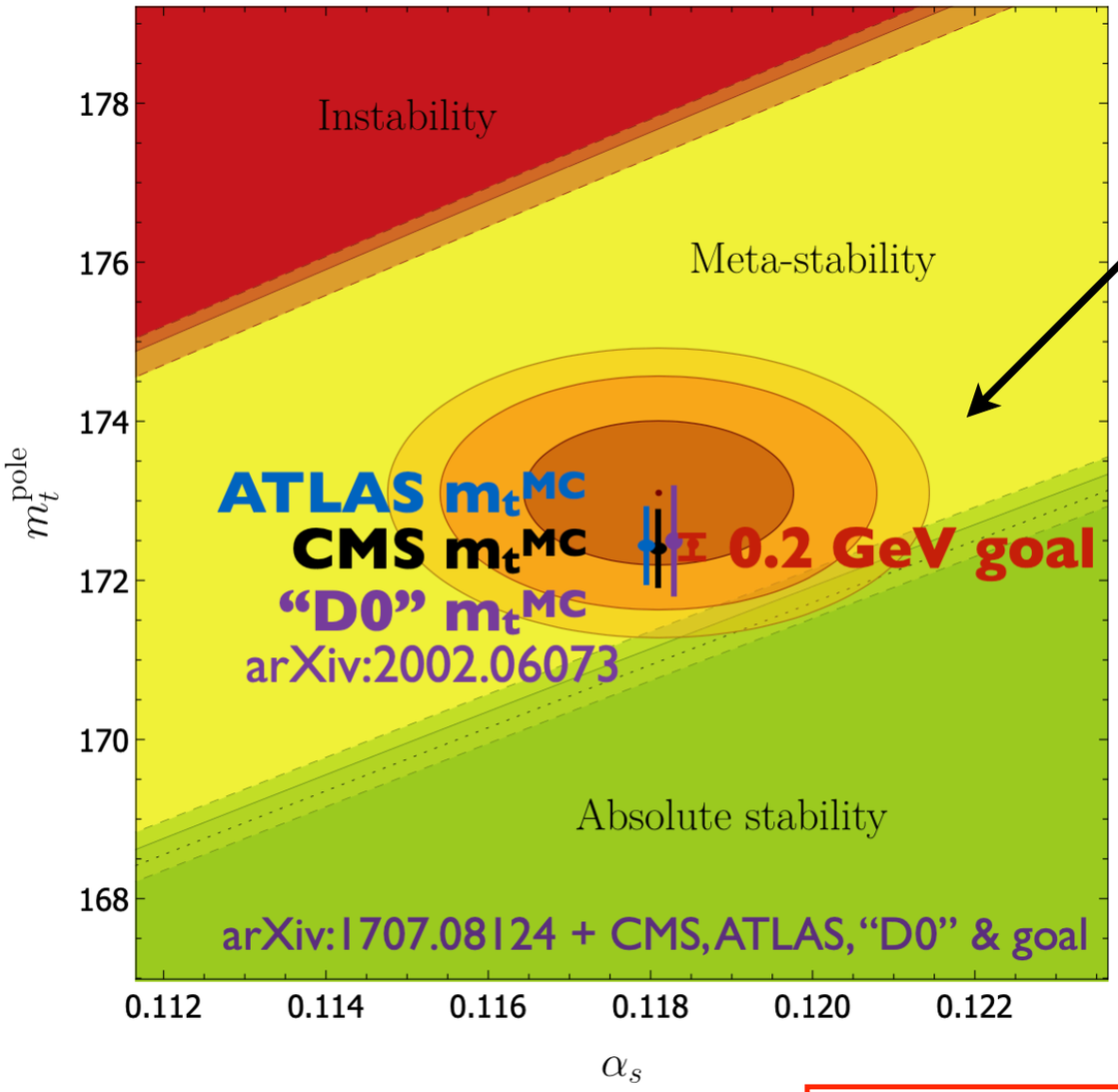
Backup

Importance of Top Mass

Stability of SM vacuum



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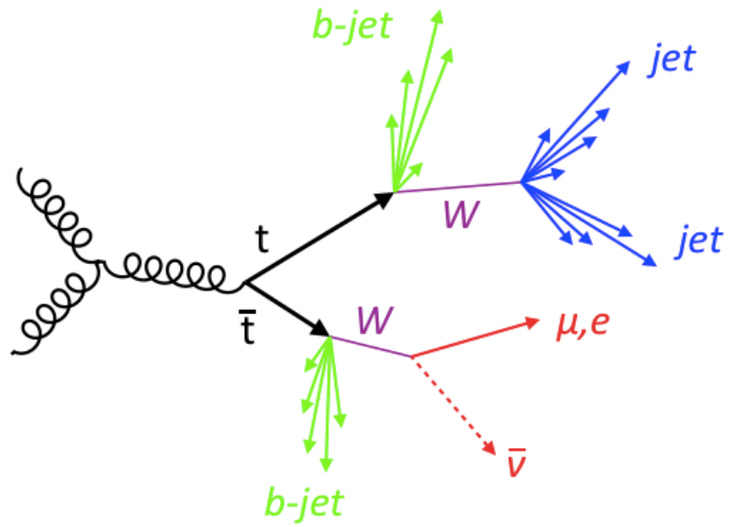
- **Top quark mass**
  - Key parameter in the Standard Model
  - Top quark pair production in lepton+jets

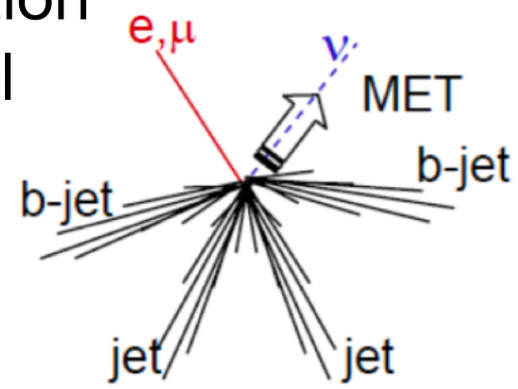


  - **Aiming at ±0.2 GeV in lepton+jet channel, to rule out absolute stability**

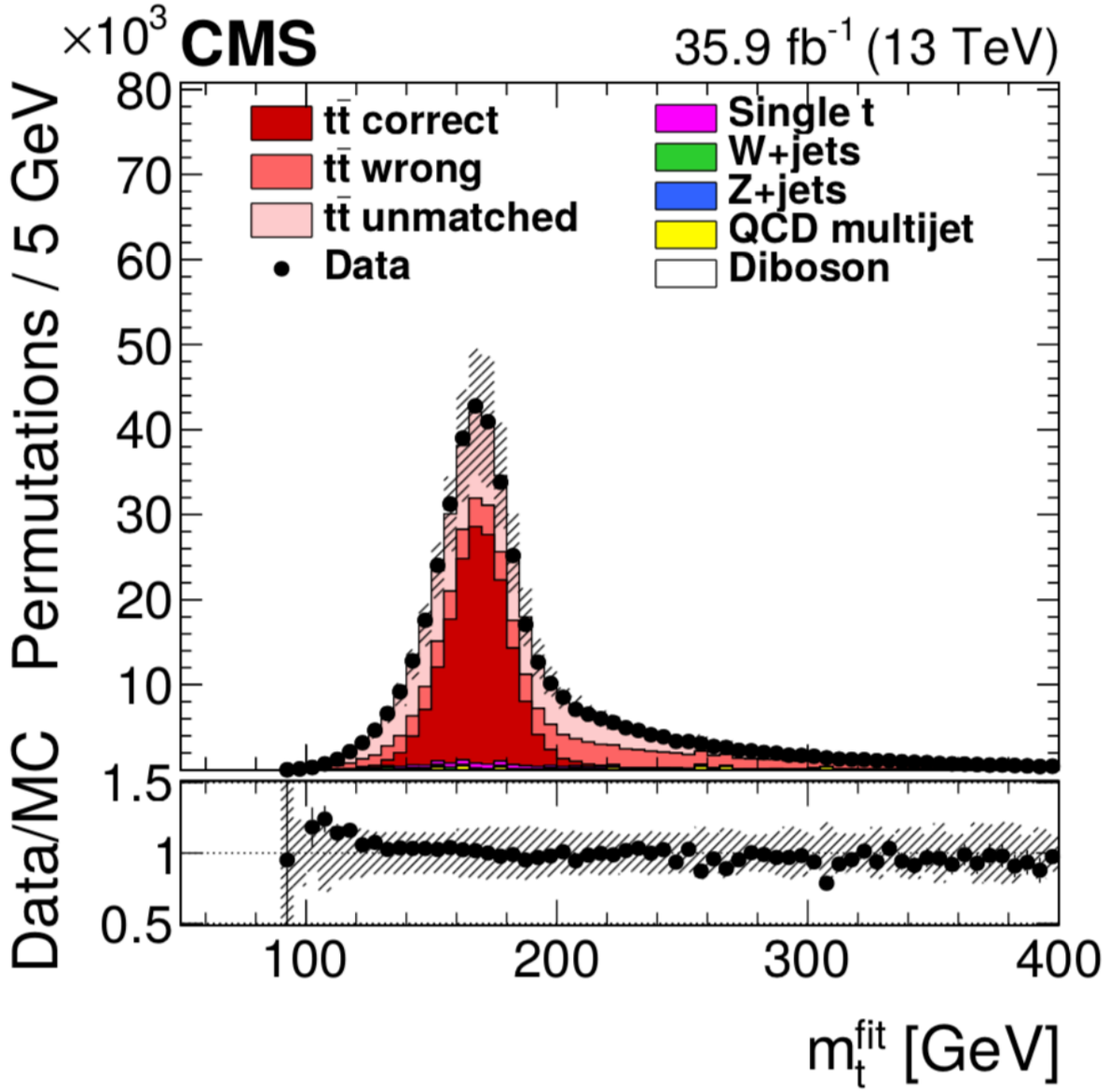
- **LHC jet measurements are key input**
  - Jet Energy Correction (JEC) is their fundamental uncertainty. b-JES, FSR, underlying event are key systematics

Measurement of Top Mass

Top quark pair production in lepton + jets channel



- **Event selection**
  - Split 3 permutation classes: correct, wrong (flipped b-quarks, mistags), unmatched
- **Kinematic fit with constraints:**
  - Two untagged jets, m_{jj} = 80.4 Gev
  - Lepton and neutrino, $m_{l\nu}$ = 80.4 GeV
  - Combine with two b-tagged jets, $m(jj+b_1) = m(l\nu+b_2)$



Constraining $m_{jj}=m_W$ effectively removes light-quark-jet uncertainties, leaving b-jet corrections as the limiting uncertainties

Machine Learning

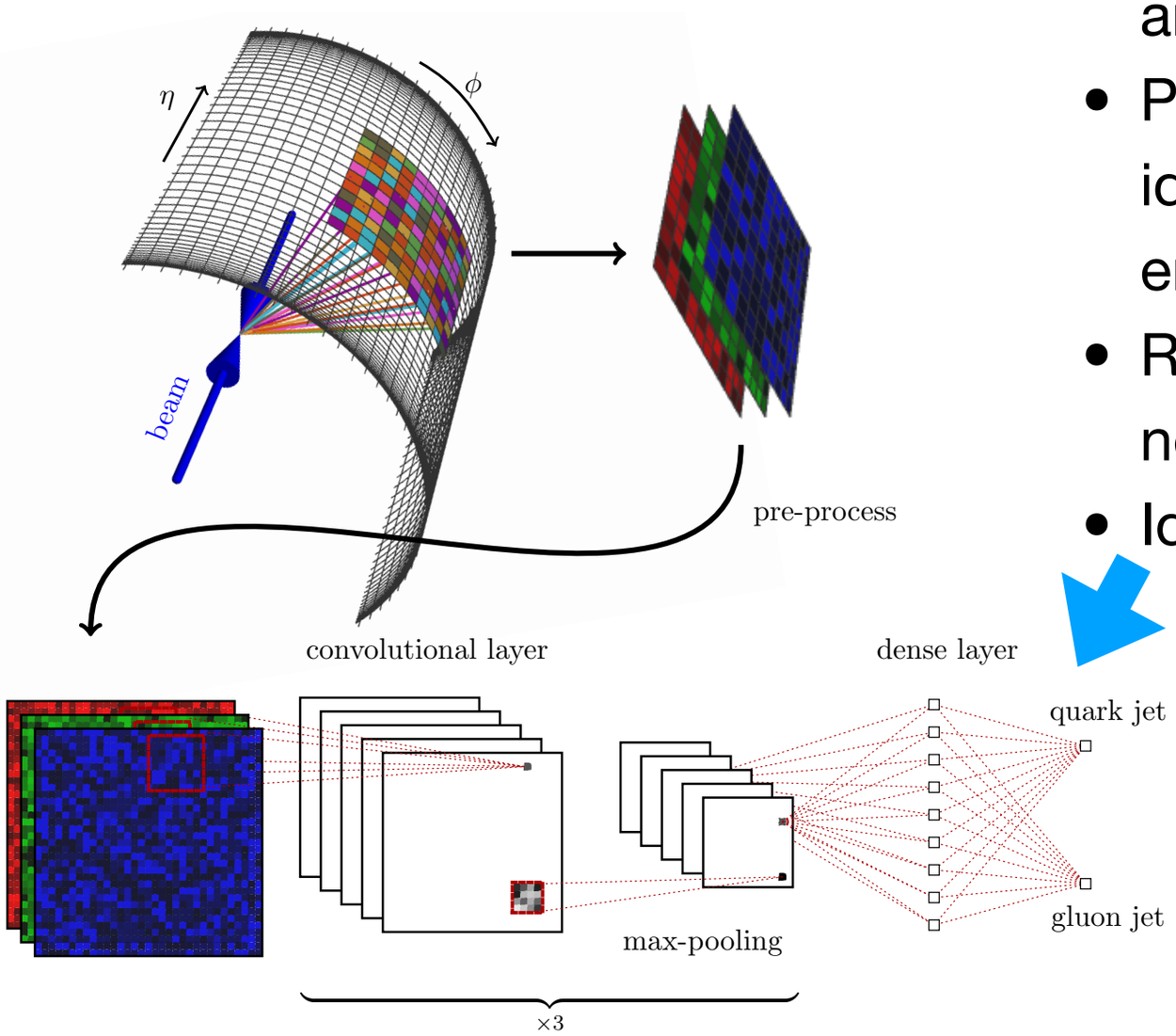
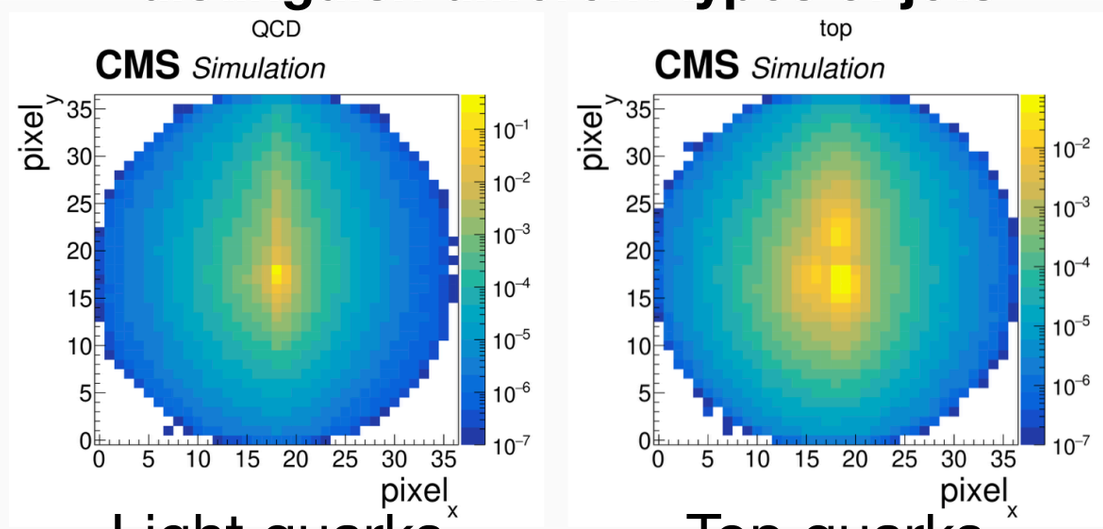


Figure 2: An illustration of the deep convolutional neural network architecture. The first layer is the input jet image, followed by three convolutional layers, a dense layer and an output layer.

https://arxiv.org/pdf/1612.01551.pdf

- A new area of research is the application of artificial intelligence in particle physics
- Physics objects application: jet-tagging, tau identification, MET improvements, b-jet energy regression, **jet energy correction**
- Recent breakthroughs, especially in deep neural networks
- Identification of quark/gluon jets as example

ML techniques for facial recognition distinguish different types of jets



Light quarks Top quarks