

# Summer conference summary

- LHCP <http://lhcp2019.buap.mx/>
- EPS <http://eps-hep2019.eu/>
- Lepton-photon <http://leptonphoton2019.ca/>
- ICNFP <https://indico.cern.ch/event/754973/overview>

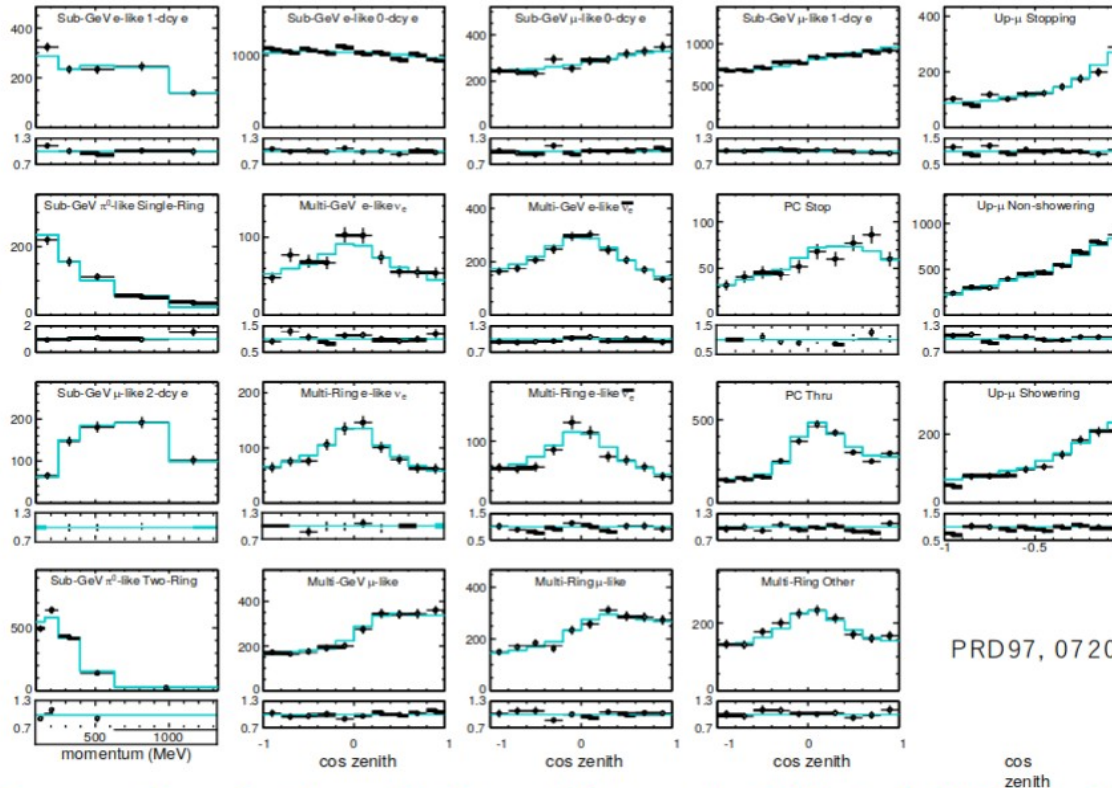
# Topics

- Neutrino properties
- Flavour physics and low-energy probes
- New particle searches
- Electroweak symmetry breaking
  - Higgs physics
  - Electroweak precision observables
  - Vector boson scattering

# Neutrino properties

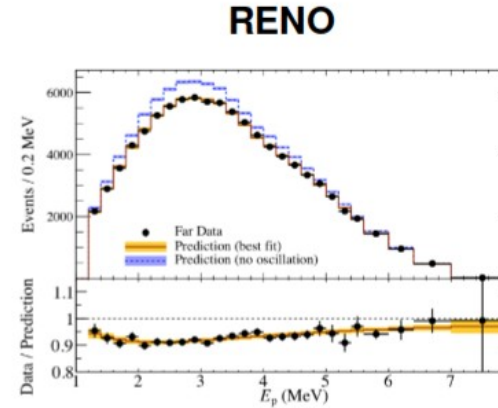
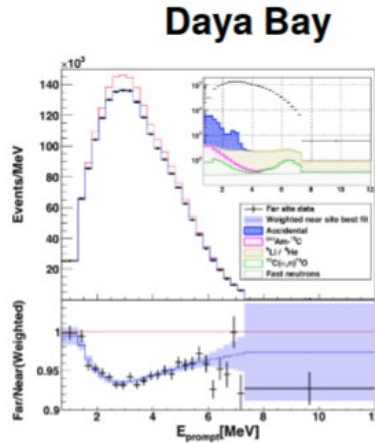
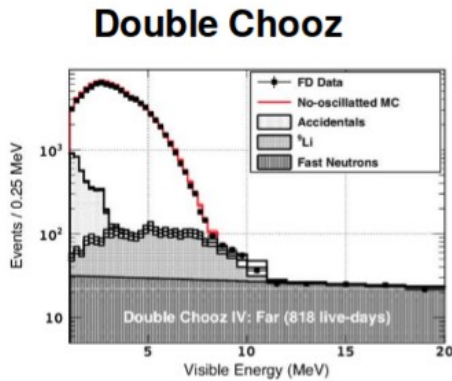
# Atmospheric neutrinos from Super-Kamiokande

High  
precision  
and high  
statistics



Excellent agreement between data and simulation in 19 event categories....  
Simultaneous analysis of  $\Delta m_{23}^2$ ,  $\sin^2\theta_{13}$ ,  $\sin^2\theta_{23}$ ,  $\delta_{CP}$ , including T2K and reactor data

# Reactor neutrinos : $\theta_{13}$



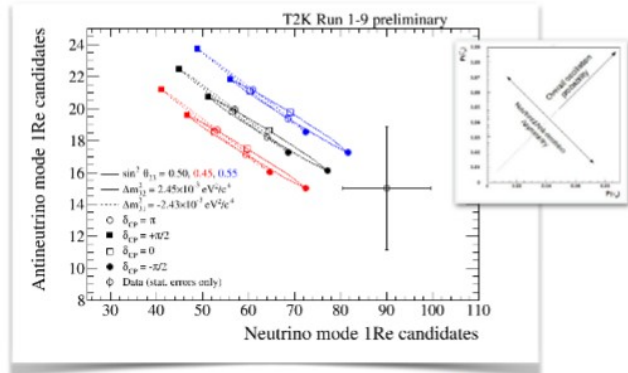
$\sin^2(2\theta_{13})$		
$0.105 \pm 0.014$	$0.0856 \pm 0.0029$ (best precision)	$0.0896 \pm 0.0068$

Mass splitting		
N/A (external constraint)	$\bar{\Delta}m_{32}^2 = (2.471^{+0.068}_{-0.070}) \times 10^{-3} \text{ eV}^2 \text{ (NO)}$ $-(2.575^{+0.068}_{-0.070}) \times 10^{-3} \text{ eV}^2 \text{ (IO)}$	$ \Delta m_{ee}^2  = (2.68 \pm 0.14) \times 10^{-3} \text{ eV}^2$

“Normal” hierarchy strongly favoured : 90-95%CL, depending on analysis

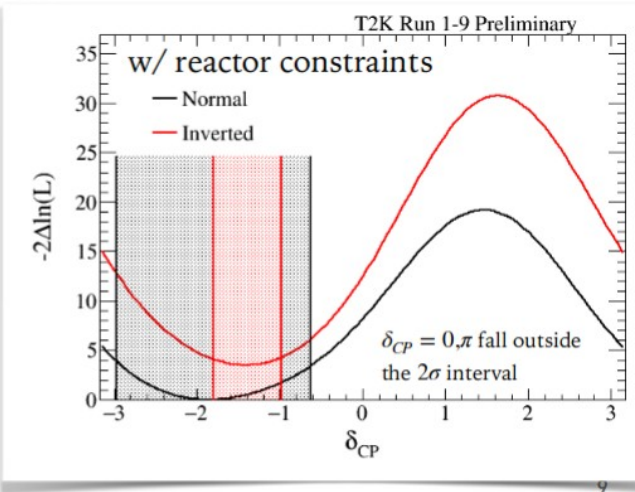
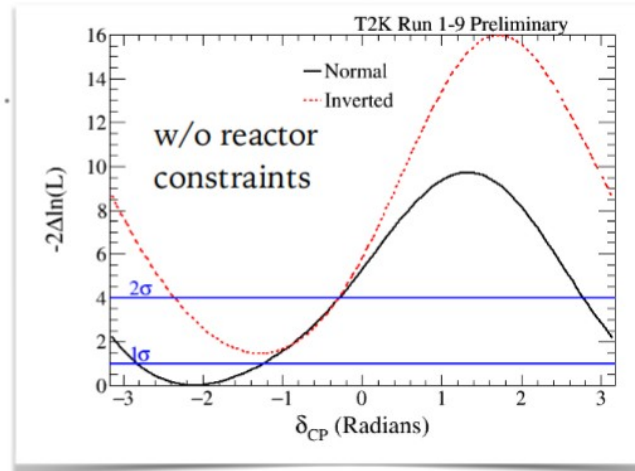
# Neutrinos beams : T2K

## $\delta_{CP}$ MEASUREMENT



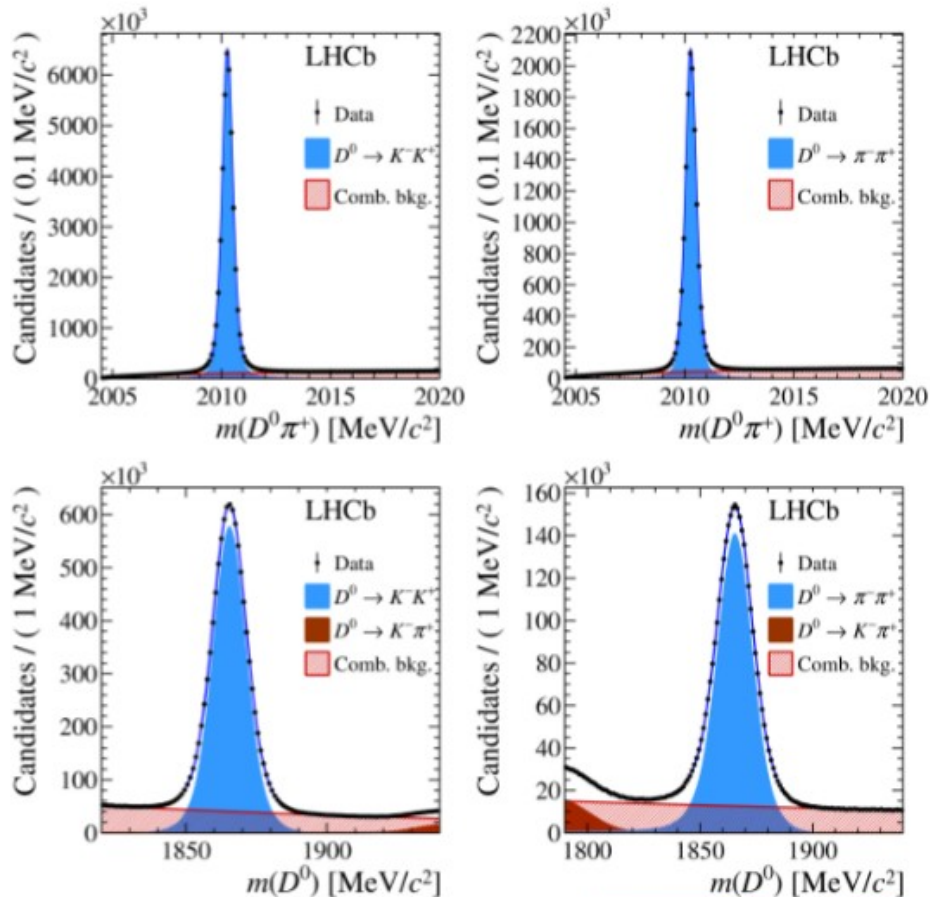
T2K data prefer values of  $\delta_{CP} \sim -\frac{\pi}{2}$ : mostly driven by the large number of events observed in the e-like sample in neutrino mode. CP conservation ( $\delta_{CP} = 0, \pi$ ) disfavoured at  $2\sigma$  for both mass hierarchies.

C.L.	Normal hierarchy	Inverted hierarchy
68%	[-2.51, -1.26]	-
90%	[-2.80, -0.84]	-
$2\sigma$	[-2.97, -0.63]	[-1.78, -0.98]



# Flavour physics

# Direct CP violation in Charm meson decays!



$$A_{\text{raw}} = A_{\text{CP}} + A_{\text{D}} + A_{\text{P}}$$

↓

$$\frac{N(D^0 \rightarrow h^+ h^-) - N(\bar{D}^0 \rightarrow h^+ h^-)}{N(D^0 \rightarrow h^+ h^-) + N(\bar{D}^0 \rightarrow h^+ h^-)}$$

Asymmetry of our interest

Detection asymmetry from  $\pi$  (prompt) or  $\mu$  (semileptonic)

Production asymmetry of  $D^*$  (prompt) or  $B$  (semileptonic)

To eliminate  $A_{\text{D}}$  and  $A_{\text{P}}$ :

$$\Delta A_{\text{CP}} = A_{\text{K}^+ \text{K}^-} - A_{\pi^+ \pi^-} = A_{\text{CP}}(\text{K}^+ \text{K}^-) - A_{\text{CP}}(\pi^+ \pi^-)$$

Phys. Rev. Lett. 122, 211803

► From Run II:

$$\Delta A_{\text{CP}}^{\pi^- \text{tag}} = (-18.2 \pm 3.2 \pm 0.9) \times 10^{-4},$$

$$\Delta A_{\text{CP}}^{\mu^- \text{tag}} = (-9 \pm 8 \pm 5) \times 10^{-4}$$

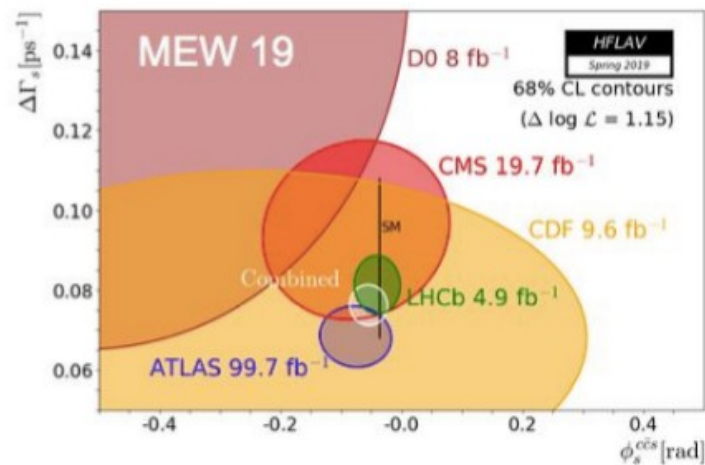
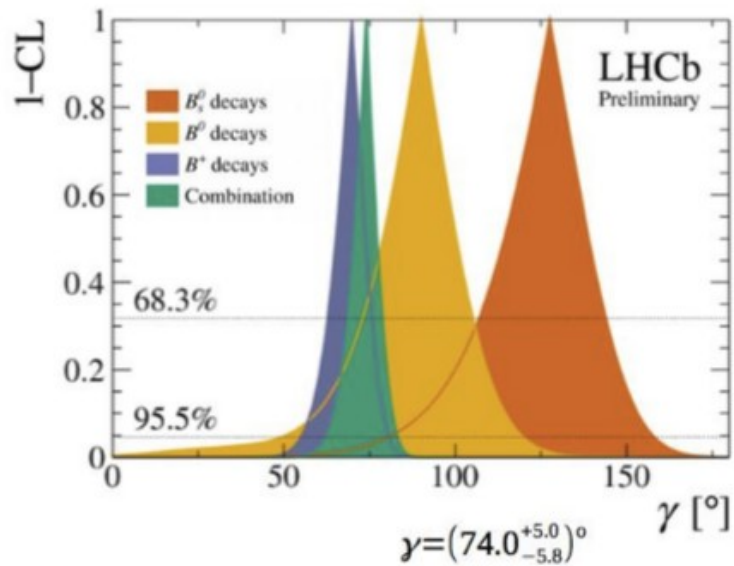
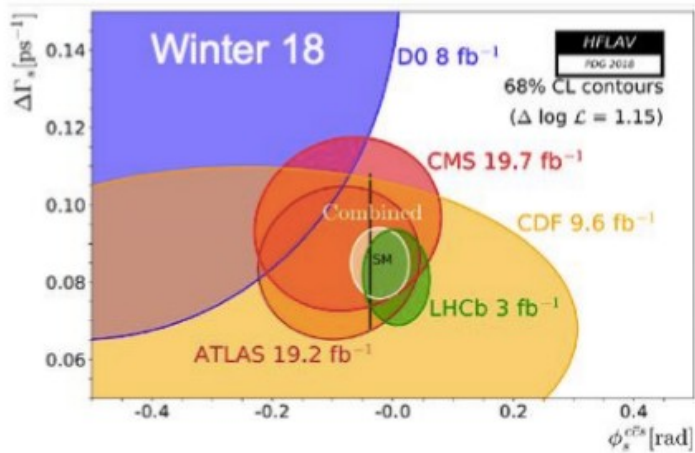
► Combine with LHCb Run I data:

$$\Delta A_{\text{CP}} = (-15.4 \pm 2.9) \times 10^{-4}$$

**Observation of CP violation with  $5.3\sigma$  significance!**



# B physics



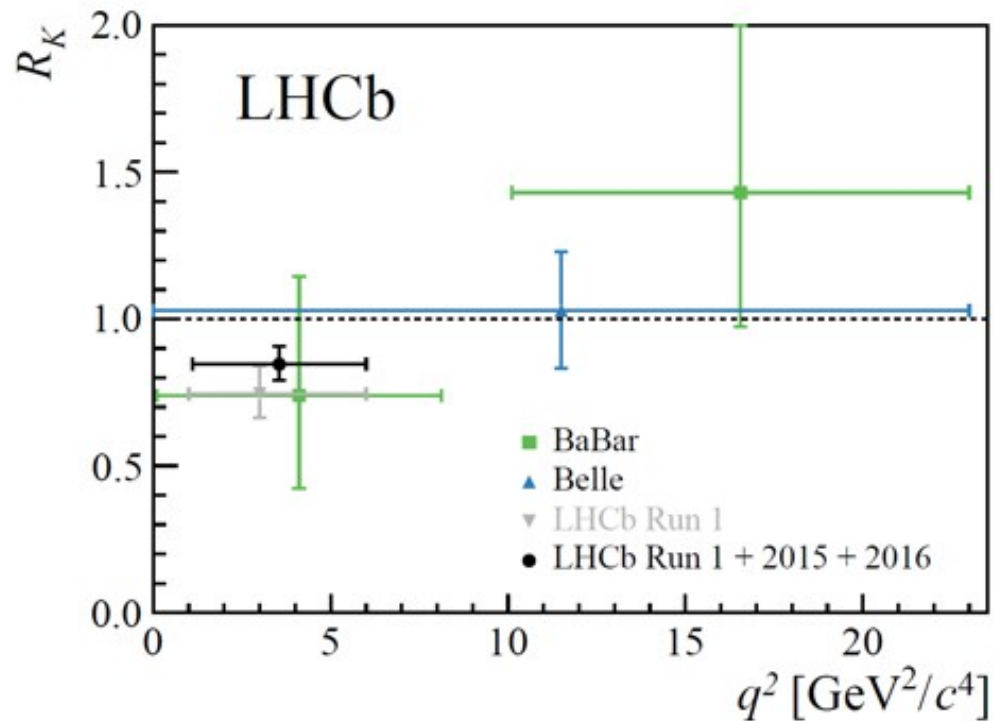
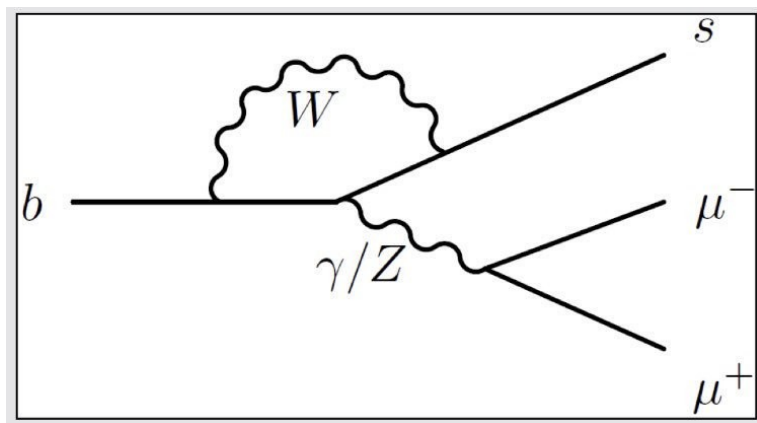
Impressive improvements in  $B_s$  mixing parameters in LHCb

CKM angle  $\gamma$  : tensions ( $\sim 2$  std.dev.)

- between measurement results ( $B_s^0$ ,  $B^+$ )
- between experimental world average and “prediction” from triangle unitarity

# B physics

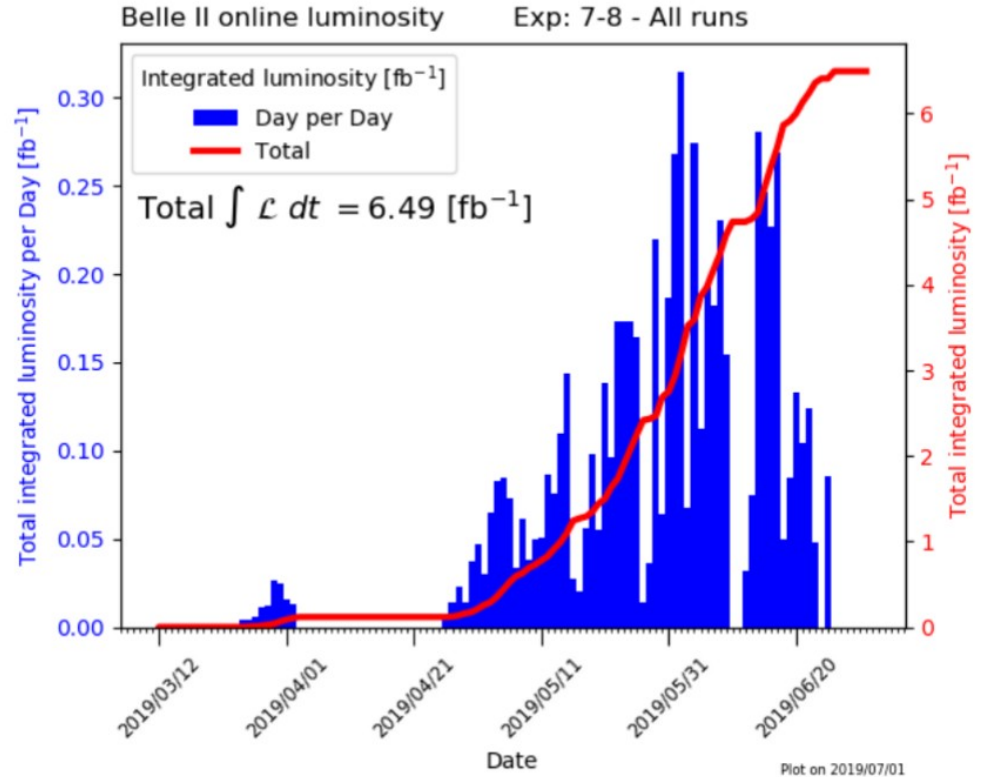
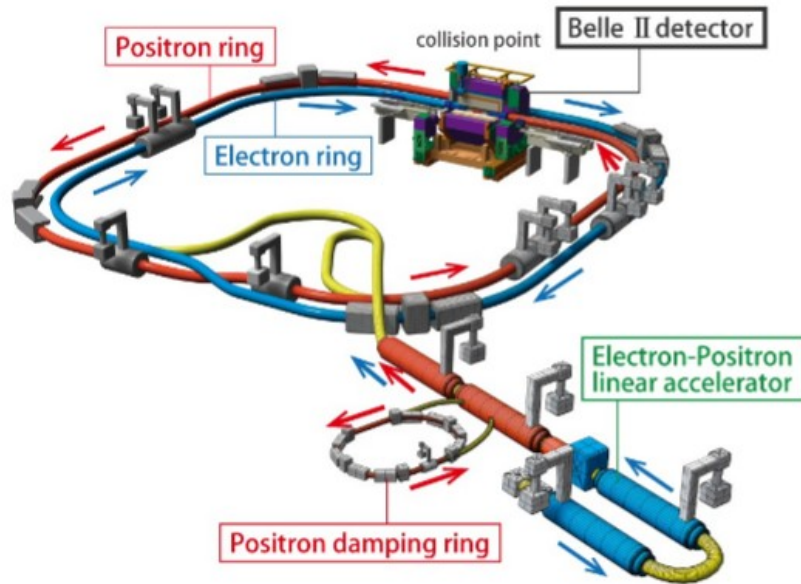
$$R_K = \text{BR}(B^+ \rightarrow K^+ \mu \mu) / \text{BR}(B^+ \rightarrow K^+ e e)$$



$$R_K = 0.846^{+0.060}_{-0.054} {}^{+0.016}_{-0.014}$$

# → Belle 2

Upgrade to achieve **40x peak  $\mathcal{L}$**   
under **20x bkgd**



# → Belle 2

$$\mathcal{L} = \frac{\gamma_{e^\pm}}{2e r_e} \left( 1 + \frac{\sigma_y^*}{\sigma_x^*} \right) \left( \frac{I_{e^\pm} \xi_y^{e^\pm}}{\beta_y^*} \right) \left( \frac{R_{\mathcal{L}}}{R_{\xi_y}} \right)$$

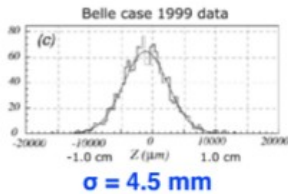
Doubling the beam currents.

Reduction in the beam size by 1/20 at the IP.

Ordinary collision KEKB



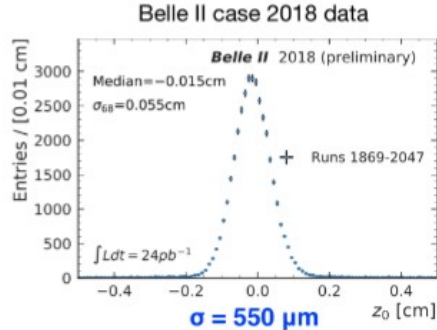
Z vertex distribution



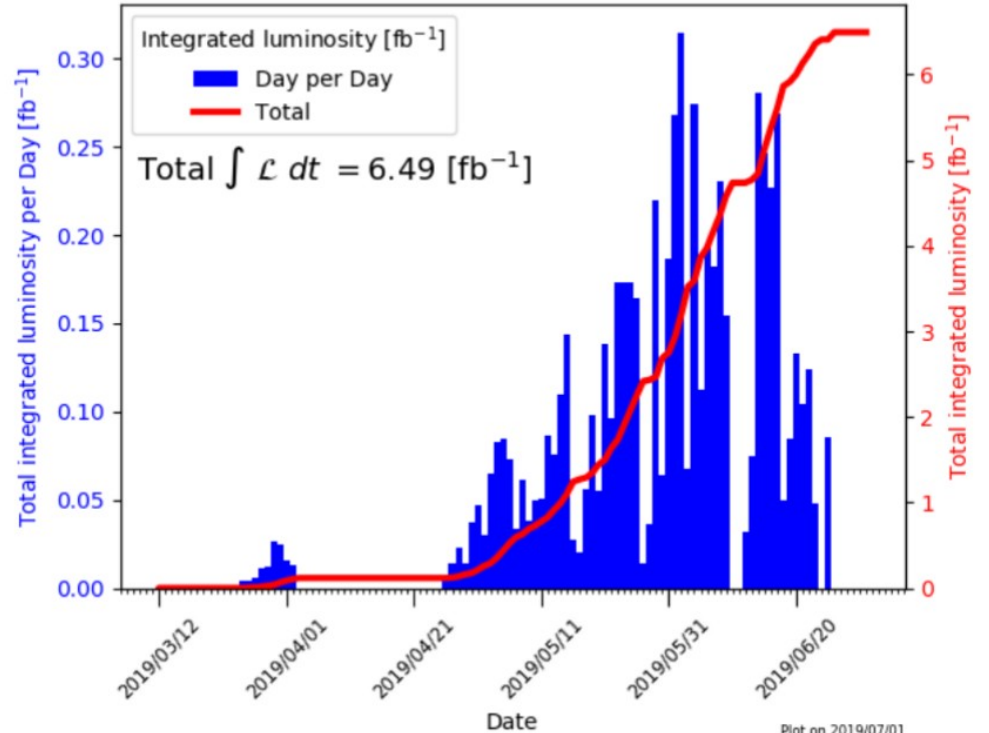
Nano-Beam (SuperKEKB)



Z vertex distribution

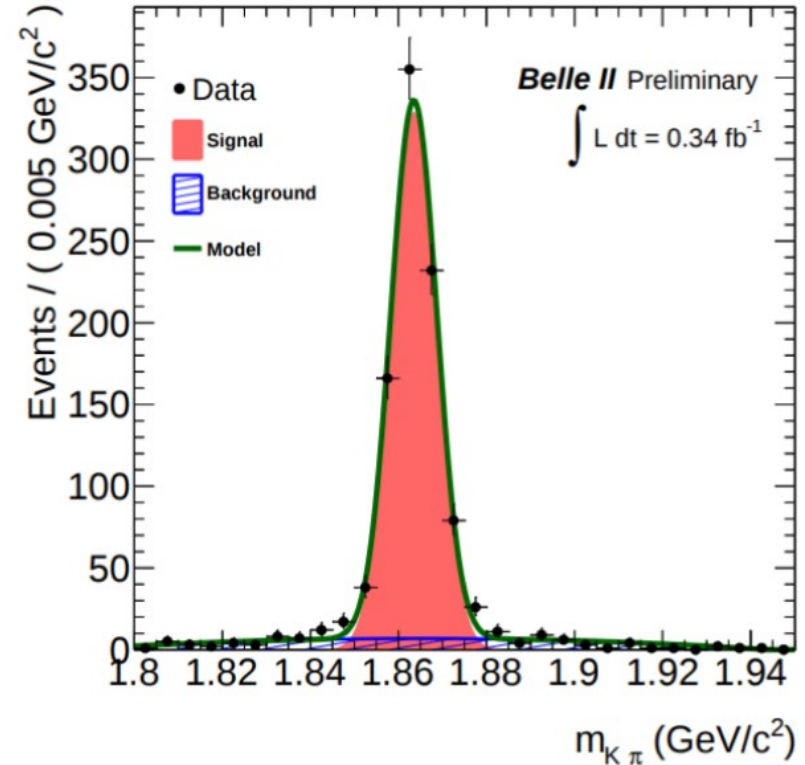
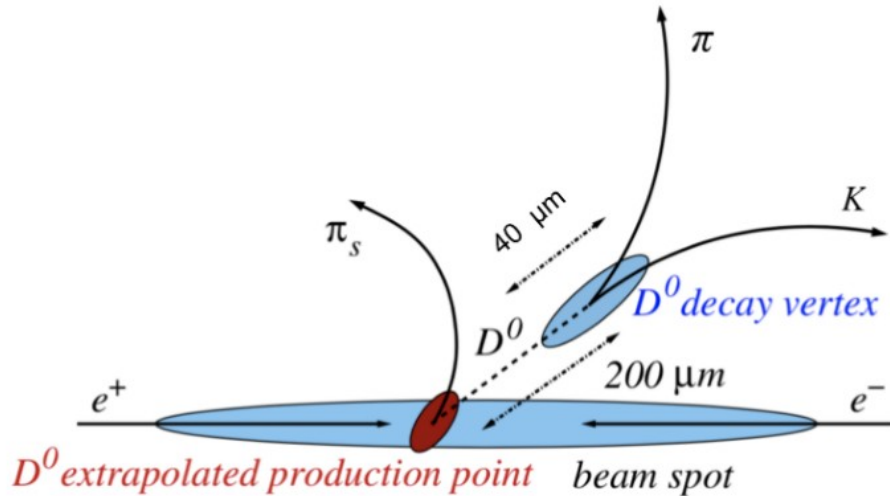


Belle II online luminosity Exp: 7-8 - All runs



→ Belle 2 “physics commissioning” :  $D^0$  lifetime in  $D^*$  decays

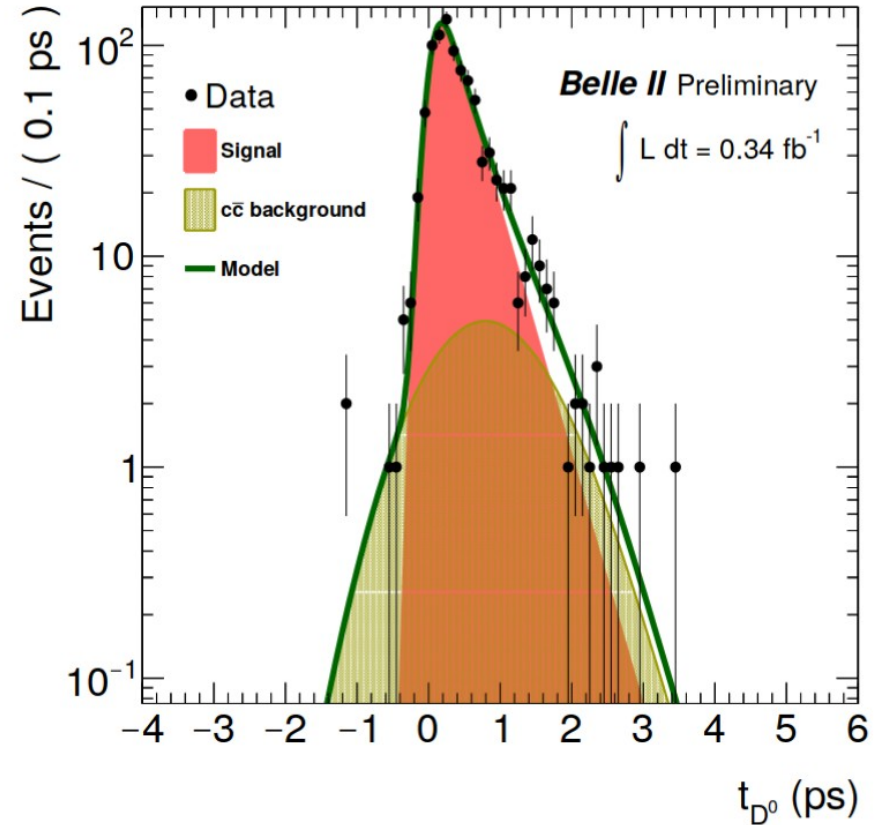
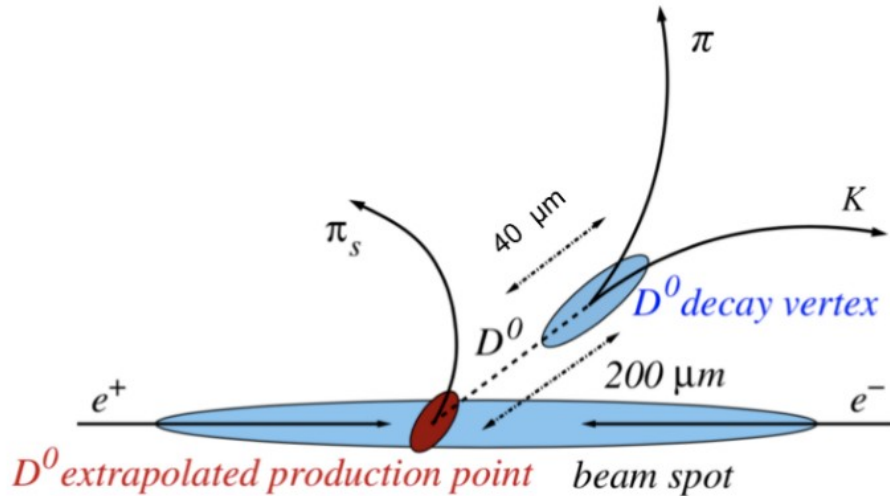
Requires the reconstruction of 2 vertices:



→ Belle 2 “physics commissioning” :  $D^0$  lifetime in  $D^*$  decays

$$\tau_{D^0} = (380 \pm 40) \text{ fs}$$

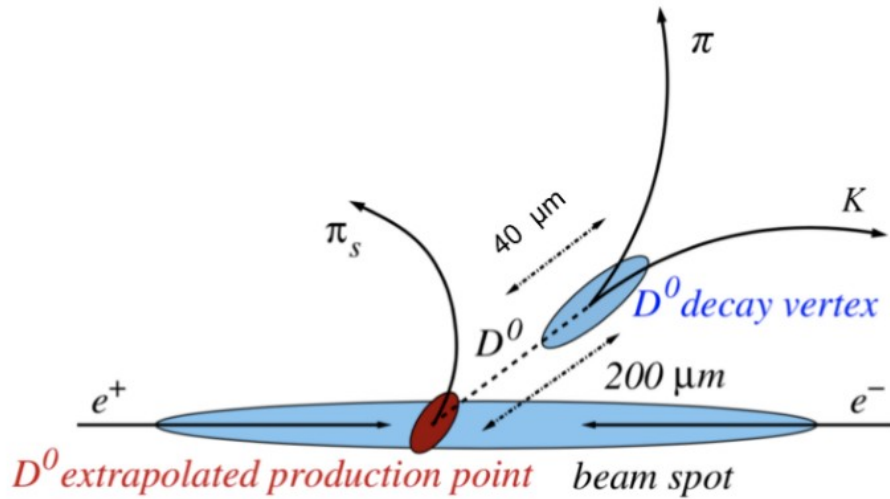
Requires the reconstruction of 2 vertices:



→ Belle 2 “physics commissioning” :  $D^0$  lifetime in  $D^*$  decays

$$\tau_{D^0} = (380 \pm 40) \text{ fs}$$

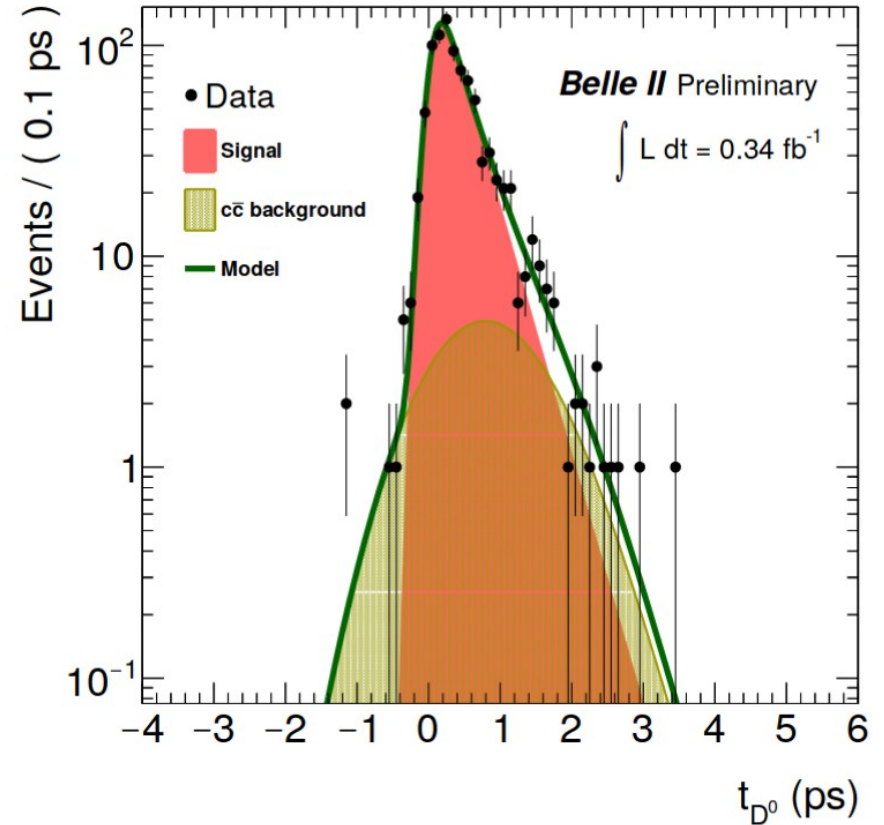
Requires the reconstruction of 2 vertices:



$0.5 \text{ fb}^{-1}$  (now)

→  $\sim 5 \text{ ab}^{-1}$  ( $\sim 2022/3$ )

→  $50 \text{ ab}^{-1}$  (2027)



New particle searches  
(LHC, Dark matter experiments)



# Limit, limits, limits

## ATLAS Exotics Searches\* - 95% CL Upper Exclusion Limits

Status: May 2019

ATLAS Preliminary

$$\int \mathcal{L} dt = (3.2 - 139) \text{ fb}^{-1}$$

$$\sqrt{s} = 8, 13 \text{ TeV}$$

Extra dimensions

W', Z'

Contact int.

Dark matter

Leptoquarks

Heavy quarks

Excited fermions

Model	$\ell, \gamma$	Jets†	$E_T^{\text{miss}}$	$\int \mathcal{L} dt [\text{fb}^{-1}]$	Limit	Reference	
Extra dimensions	ADD $G_{KK} + g/q$	$0 e, \mu$	$1-4 j$	Yes	36.1	$M_0$ 7.7 TeV	$n = 2$ 1711.03301
	ADD non-resonant $\gamma\gamma$	$2 \gamma$	-	-	36.7	$M_s$ 8.6 TeV	$n = 3$ HLZ NLO 1707.04147
	ADD QBH	-	$2 j$	-	37.0	$M_{\text{th}}$ 8.9 TeV	$n = 6$ 1703.09127
	ADD BH high $\sum p_T$	$\geq 1 e, \mu$	$\geq 2 j$	-	3.2	$M_{\text{th}}$ 8.2 TeV	$n = 6, M_0 = 3 \text{ TeV, rot BH}$ 1606.02265
	ADD BH multijet	-	$\geq 3 j$	-	3.6	$M_{\text{th}}$ 9.55 TeV	$n = 6, M_0 = 3 \text{ TeV, rot BH}$ 1512.02586
	RSI $G_{KK} \rightarrow \gamma\gamma$	$2 \gamma$	-	-	36.7	$G_{KK} \text{ mass}$ 4.1 TeV	$k/\overline{M}_{Pl} = 0.1$ 1707.04147
	Bulk RS $G_{KK} \rightarrow WW/ZZ$	multi-channel	-	-	36.1	$G_{KK} \text{ mass}$ 2.3 TeV	$k/\overline{M}_{Pl} = 1.0$ 1608.02380
	Bulk RS $G_{KK} \rightarrow WW \rightarrow qqqq$	$0 e, \mu$	$2 j$	-	139	$G_{KK} \text{ mass}$ 1.6 TeV	$k/\overline{M}_{Pl} = 1.0$ ATLAS-CONF-2019-003
	Bulk RS $G_{KK} \rightarrow tt$	$1 e, \mu$	$\geq 1 b, \geq 1J/2j$	Yes	36.1	$G_{KK} \text{ mass}$ 3.8 TeV	$\Gamma/m = 15\%$ 1804.10823
	2UED / RPP	$1 e, \mu$	$\geq 2 b, \geq 3 j$	Yes	36.1	KK mass 1.8 TeV	Tier (1,1), $\mathcal{B}(A^{(1,1)} \rightarrow tt) = 1$ 1803.09678
Gauge bosons	SSM $Z' \rightarrow \ell\ell$	$2 e, \mu$	-	-	139	$Z' \text{ mass}$ 5.1 TeV	1903.06248
	SSM $Z' \rightarrow \tau\tau$	$2 \tau$	-	-	36.1	$Z' \text{ mass}$ 2.42 TeV	1709.07242
	Leptophobic $Z' \rightarrow bb$	-	$2 b$	-	36.1	$Z' \text{ mass}$ 2.1 TeV	1805.09299
	Leptophobic $Z' \rightarrow tt$	$1 e, \mu$	$\geq 1 b, \geq 1J/2j$	Yes	36.1	$Z' \text{ mass}$ 3.0 TeV	1804.10823
	SSM $W' \rightarrow \ell\nu$	$1 e, \mu$	-	Yes	139	$W' \text{ mass}$ 6.0 TeV	CERN-EP-2019-1100
	SSM $W' \rightarrow \tau\nu$	-	-	Yes	36.1	$W' \text{ mass}$ 3.7 TeV	1801.06992
	HVT $V' \rightarrow WZ \rightarrow qqqq$ model B	$0 e, \mu$	$2 j$	-	139	$V' \text{ mass}$ 3.6 TeV	$g_V = 3$ ATLAS-CONF-2019-003
HVT $V' \rightarrow WH/ZH$ model B	multi-channel	-	-	36.1	$V' \text{ mass}$ 2.93 TeV	$g_V = 3$ 1712.06518	
LRSM $W_R \rightarrow tb$	multi-channel	-	-	36.1	$W_R \text{ mass}$ 3.25 TeV	1807.10473	
LRSM $W_R \rightarrow \mu N_R$	$2 \mu$	$1 j$	-	80	$W_R \text{ mass}$ 5.0 TeV	$m(N_R) = 0.5 \text{ TeV, } g_L = g_R$ 1904.12679	
CI	CI $qqqq$	-	$2 j$	-	37.0	$\Lambda$ 21.8 TeV	$\eta_{LL}$ 1703.09127
	CI $\ell\ell qq$	$2 e, \mu$	-	-	36.1	$\Lambda$ 40.0 TeV	$\eta_{LL}$ 1707.02424
	CI $tttt$	$\geq 1 e, \mu$	$\geq 1 b, \geq 1 j$	Yes	36.1	$\Lambda$ 2.57 TeV	$ C_{G}  = 4\pi$ 1811.02305
DM	Axial-vector mediator (Dirac DM)	$0 e, \mu$	$1-4 j$	Yes	36.1	$m_{\text{med}}$ 1.55 TeV	$g_a = 0.25, g_s = 1.0, m(\chi) = 1 \text{ GeV}$ 1711.03301
	Colored scalar mediator (Dirac DM)	$0 e, \mu$	$1-4 j$	Yes	36.1	$m_{\text{med}}$ 1.67 TeV	$g = 1.0, m(\chi) = 1 \text{ GeV}$ 1711.03301
	$VV\chi\chi$ EFT (Dirac DM)	$0 e, \mu$	$1 j, \leq 1 j$	Yes	3.2	$M_s$ 700 GeV	$m(\chi) < 150 \text{ GeV}$ 1608.02372
	Scalar reson. $\phi \rightarrow \ell\chi$ (Dirac DM)	$0-1 e, \mu$	$1 b, 0-1 j$	Yes	36.1	$m_\phi$ 3.4 TeV	$y = 0.4, \lambda = 0.2, m(\chi) = 10 \text{ GeV}$ 1812.09743
LQ	Scalar LQ 1 <sup>st</sup> gen	$1, 2 e$	$\geq 2 j$	Yes	36.1	LQ mass 1.4 TeV	$\beta = 1$ 1902.00377
	Scalar LQ 2 <sup>nd</sup> gen	$1, 2 \mu$	$\geq 2 j$	Yes	36.1	LQ mass 1.56 TeV	$\beta = 1$ 1902.00377
	Scalar LQ 3 <sup>rd</sup> gen	$2 \tau$	$2 b$	-	36.1	$LQ_3^{\text{mass}}$ 1.03 TeV	$\mathcal{B}(LQ_3^{\text{mass}} \rightarrow b\tau) = 1$ 1902.08103
	Scalar LQ 3 <sup>rd</sup> gen	$0-1 e, \mu$	$2 b$	Yes	36.1	$LQ_3^{\text{mass}}$ 970 GeV	$\mathcal{B}(LQ_3^{\text{mass}} \rightarrow \tau\tau) = 0$ 1902.08103
Heavy quarks	VLQ $TT \rightarrow Ht/Zt/Wb + X$	multi-channel	-	-	36.1	T mass 1.37 TeV	SU(2) doublet 1808.02343
	VLQ $BB \rightarrow Wt/Zb + X$	multi-channel	-	-	36.1	B mass 1.34 TeV	SU(2) doublet 1808.02343
	VLQ $T_{3/3} T_{3/3} \rightarrow Wt + X$	$2(SS) \geq 3 e, \mu \geq 1 b, \geq 1 j$	Yes	36.1	$T_{3/3} \text{ mass}$ 1.64 TeV	$\mathcal{B}(T_{3/3} \rightarrow Wt) = 1, c(T_{3/3} Wt) = 1$ 1807.11883	
	VLQ $Y \rightarrow Wb + X$	$1 e, \mu \geq 1 b, \geq 1 j$	Yes	36.1	Y mass 1.85 TeV	$\mathcal{B}(Y \rightarrow Wb) = 1, c_Y(Wb) = 1$ 1812.07343	
	VLQ $B \rightarrow Hb + X$	$0 e, \mu, 2 \gamma \geq 1 b, \geq 1 j$	Yes	79.8	B mass 1.21 TeV	$\kappa_B = 0.5$ ATLAS-CONF-2018-024	
VLQ $QQ \rightarrow WqWq$	$1 e, \mu \geq 4 j$	Yes	20.3	Q mass 690 GeV	1509.04261		
Excited fermions	Excited quark $q^* \rightarrow qg$	-	$2 j$	-	139	$q^* \text{ mass}$ 6.7 TeV	only $u'$ and $d'$ , $\Lambda = m(q^*)$ ATLAS-CONF-2019-007
	Excited quark $q^* \rightarrow q\gamma$	$1 \gamma$	$1 j$	-	36.7	$q^* \text{ mass}$ 5.3 TeV	only $u'$ and $d'$ , $\Lambda = m(q^*)$ 1709.10440
	Excited quark $b^* \rightarrow bg$	-	$1 b, 1 j$	-	36.1	$b^* \text{ mass}$ 2.6 TeV	1805.09299
	Excited lepton $\ell^*$	$3 e, \mu$	-	-	20.3	$\ell^* \text{ mass}$ 3.0 TeV	$\Lambda = 3.0 \text{ TeV}$ 1411.2921
	Excited lepton $\nu^*$	$3 e, \mu, \tau$	-	-	20.3	$\nu^* \text{ mass}$ 1.6 TeV	$\Lambda = 1.6 \text{ TeV}$ 1411.2921
Other	Type III Seesaw	$1 e, \mu$	$\geq 2 j$	Yes	79.8	$N^0 \text{ mass}$ 560 GeV	ATLAS-CONF-2018-020
	LRSM Majorana $\nu$	$2 \mu$	$2 j$	-	36.1	$N_R \text{ mass}$ 3.2 TeV	$m(W_R) = 4.1 \text{ TeV, } g_L = g_R$ 1809.11105
	Higgs triplet $H^{\pm\pm} \rightarrow \ell\ell$	$2, 3, 4 e, \mu$ (SS)	-	-	36.1	$H^{\pm\pm} \text{ mass}$ 870 GeV	DY production 1710.09748
	Higgs triplet $H^{\pm\pm} \rightarrow \ell\tau$	$3 e, \mu, \tau$	-	-	20.3	$H^{\pm\pm} \text{ mass}$ 400 GeV	DY production, $\mathcal{B}(H^{\pm\pm} \rightarrow \ell\tau) = 1$ 1411.2921
	Multi-charged particles	-	-	-	36.1	multi-charged particle mass 1.22 TeV	DY production, $ q  = 5e$ 1812.03673
	Magnetic monopoles	-	-	-	34.4	monopole mass 2.37 TeV	DY production, $ g  = 1g_D, \text{ spin } 1/2$ 1905.10130

$\sqrt{s} = 8 \text{ TeV}$   $\sqrt{s} = 13 \text{ TeV}$  partial data  $\sqrt{s} = 13 \text{ TeV}$  full data

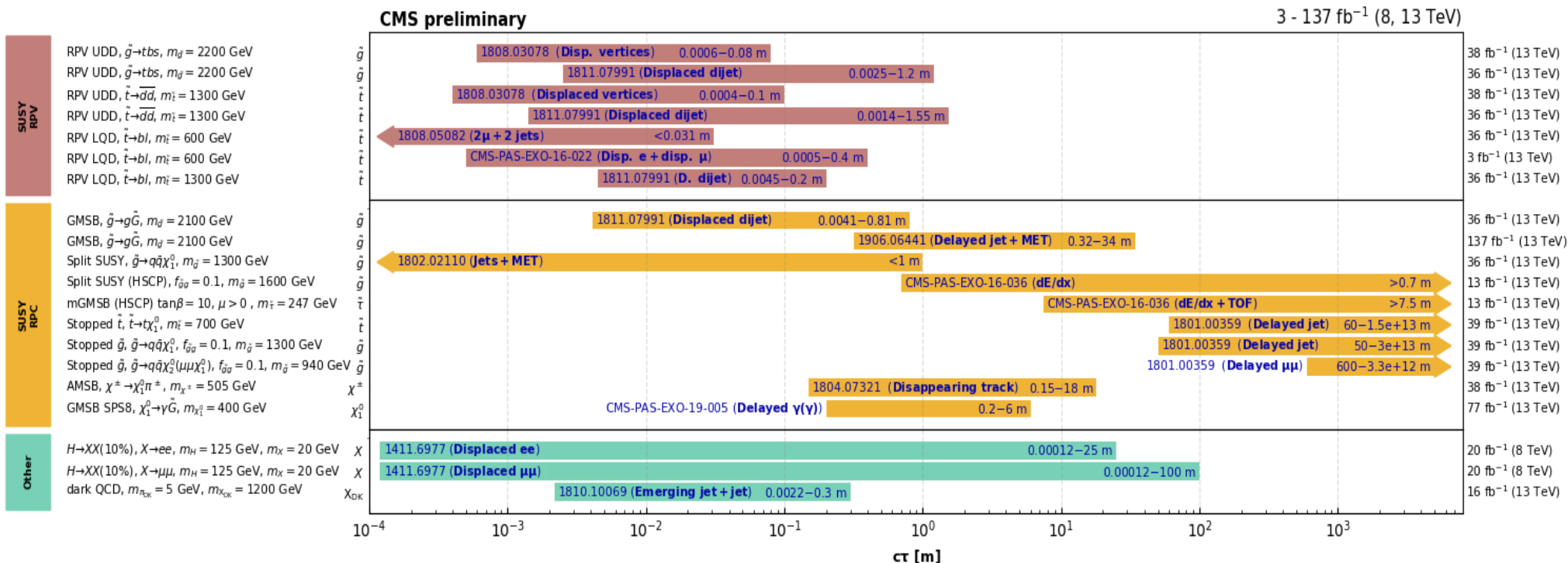
\*Only a selection of the available mass limits on new states or phenomena is shown.

†Small-radius (large-radius) jets are denoted by the letter j (J).

10<sup>-1</sup> 1 10 Mass scale [TeV]

# Limit, limits, limits

## Overview of CMS long-lived particle searches



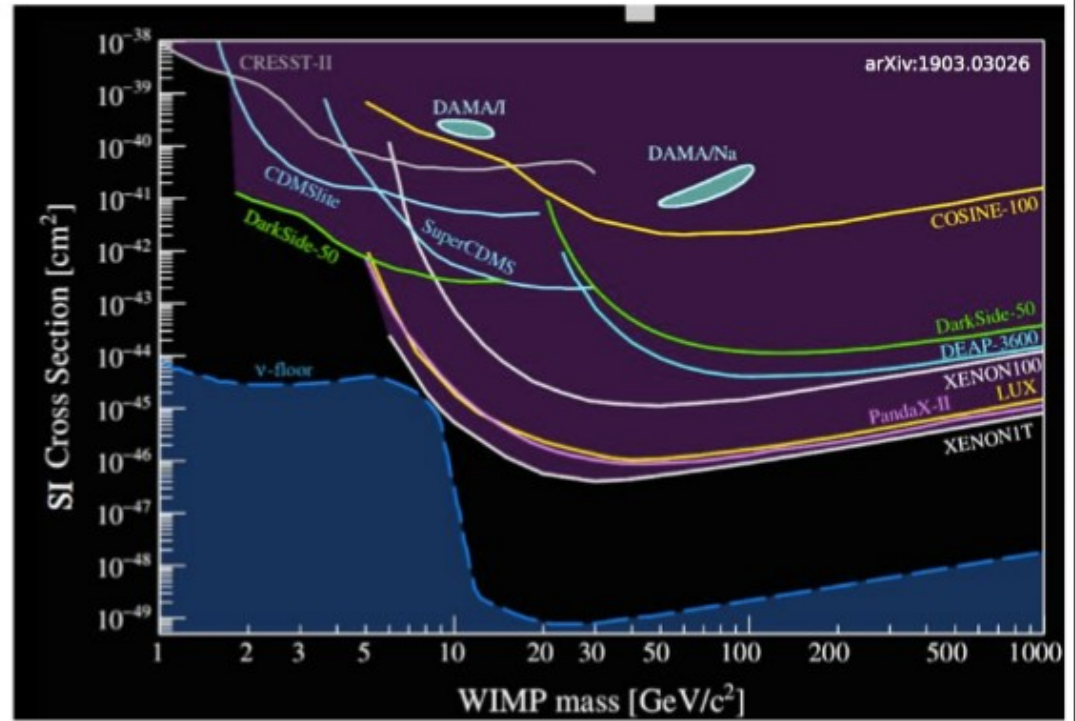
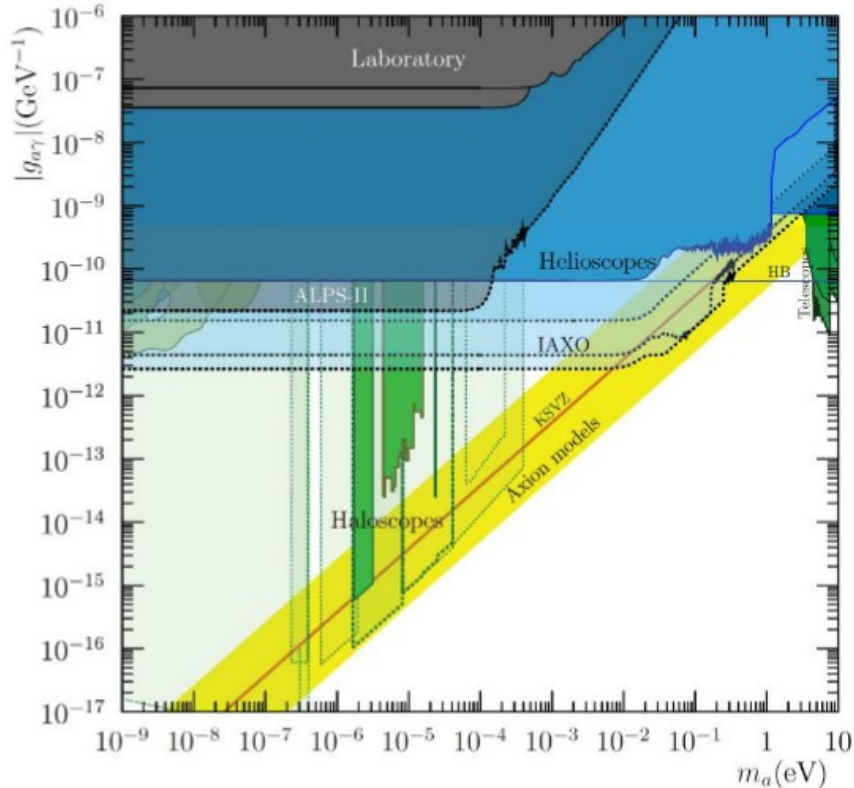
Selection of observed exclusion limits at 95% C.L. (theory uncertainties are not included). The y-axis tick labels indicate the studied long-lived particle.

July 2019

Generally require inventive reconstruction / analysis algorithms, or good control of  $E_T^{\text{miss}}$

# Dark matter (more limits)

- Axions ( $\sim$ eV and lighter), WIMPs (GeV – TeV)



(in Xenon, the recoil energy spectrum of a WIMP with mass 6 GeV and SI cross section  $5 \times 10^{-45} \text{ cm}^2$  matches that of  $^8\text{B}$  Solar neutrinos)

# Electroweak symmetry breaking (LHC)

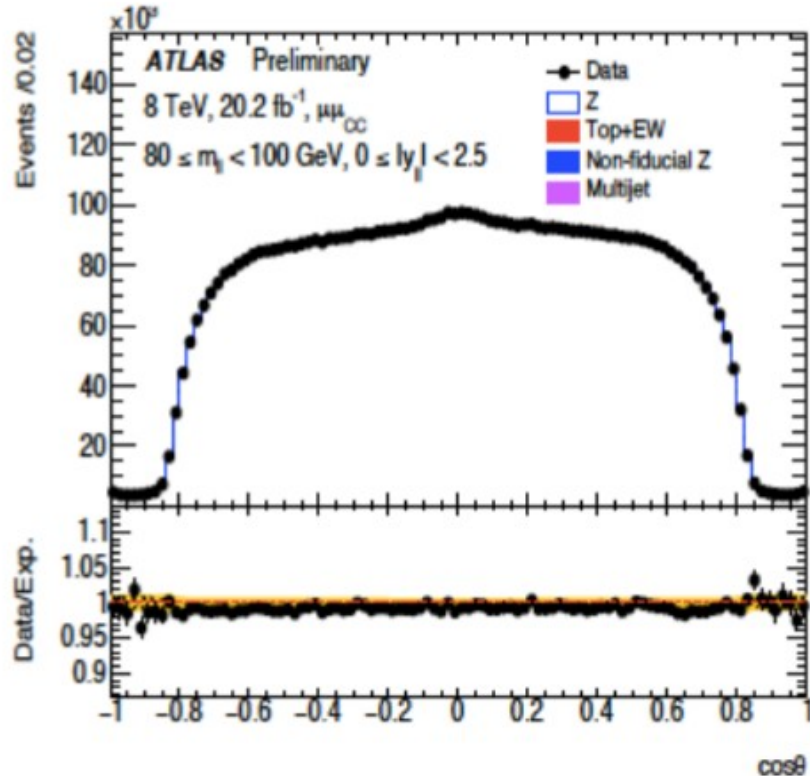
# Precision electroweak observables – $\sin^2\theta_{\text{eff}}$

From forward/backward asymmetry  
In  $Z \rightarrow ee, \mu\mu$  decays

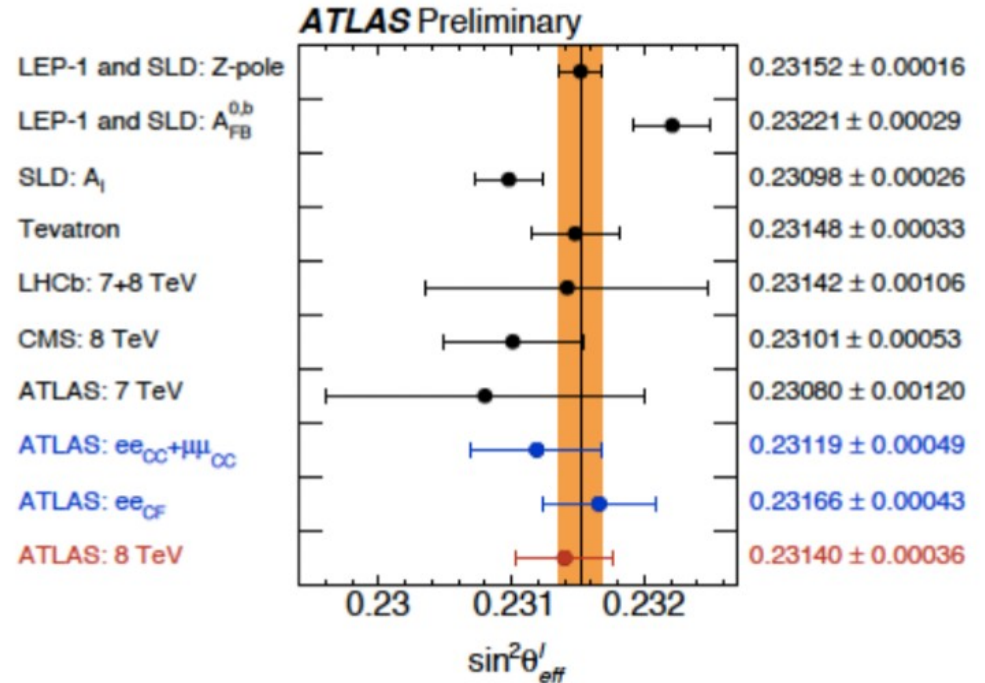
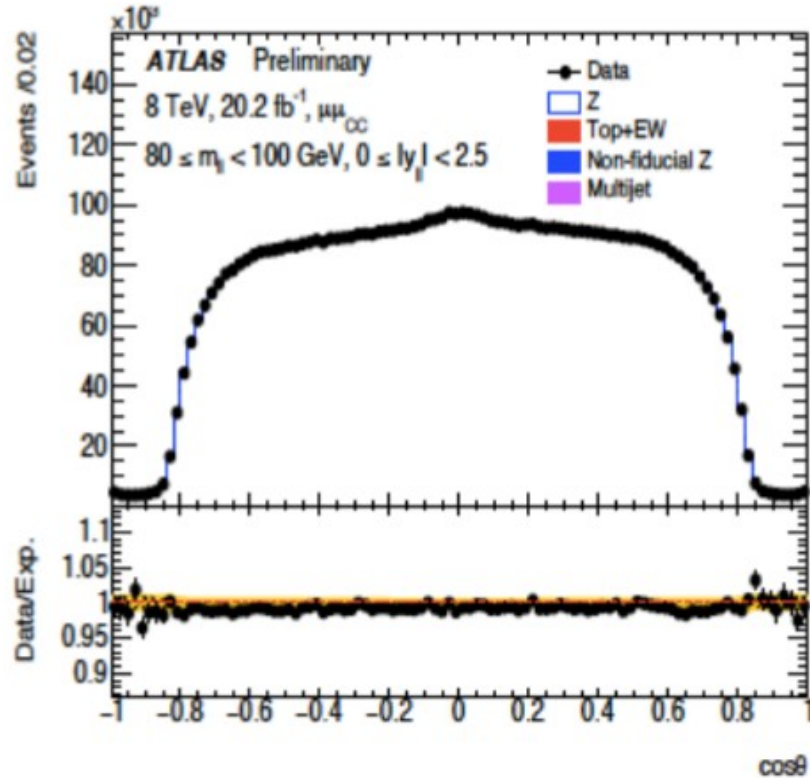
Issues :

direction of initial quark/antiquark?  
→ PDFs

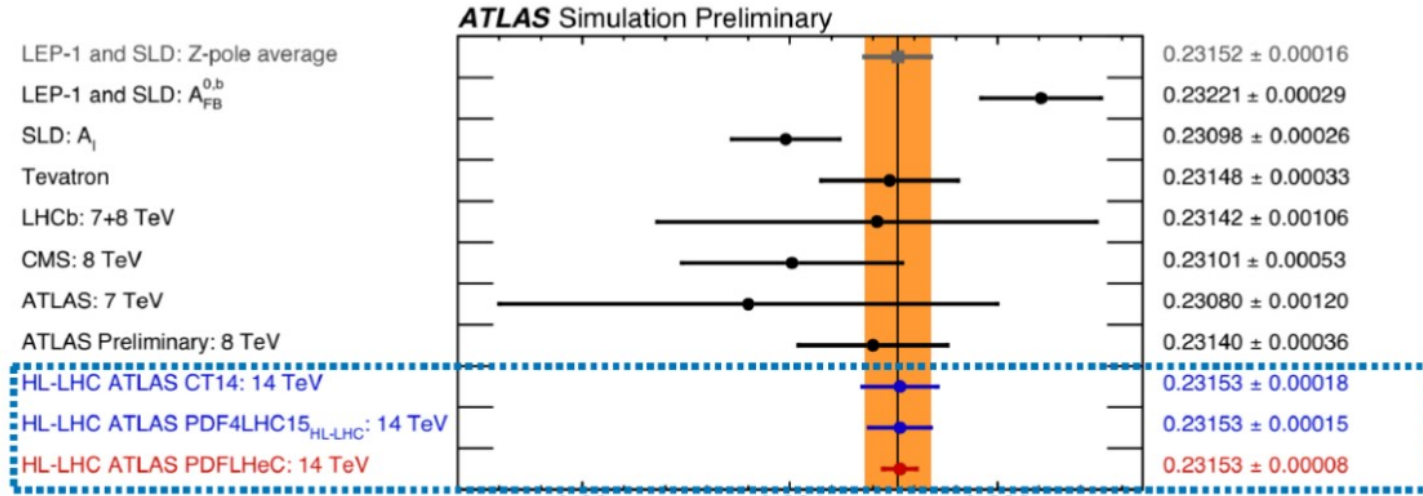
theoretical framework. The LEP paradigm (factorized corrections, form factors  $\Delta\rho, \Delta\kappa\dots$ )  
→ work only on the Z pole; pp experiments “integrate” over a large mass window  
→ full NNLO corrections needed; only NLO available off-peak this far.



# Precision electroweak observables – $\sin^2\theta_{\text{eff}}$

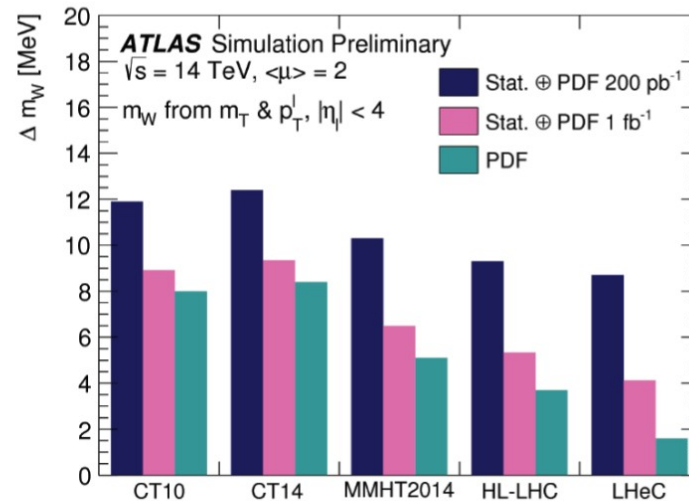


# Precision electroweak observables – prospects for $\sin^2\theta_{\text{eff}}$ , $m_W$

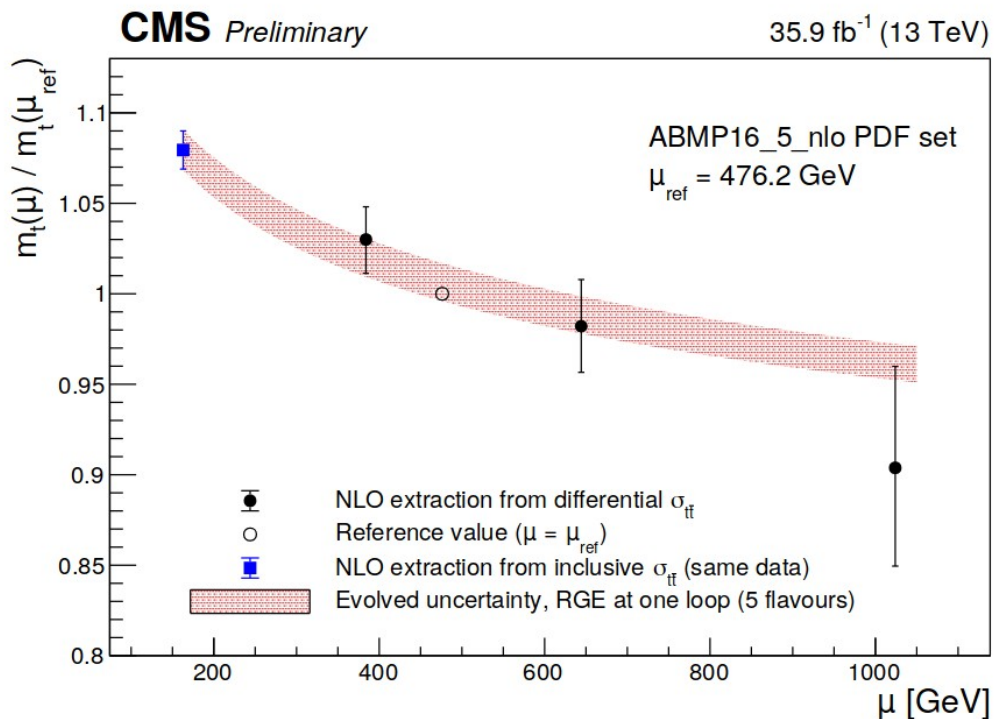
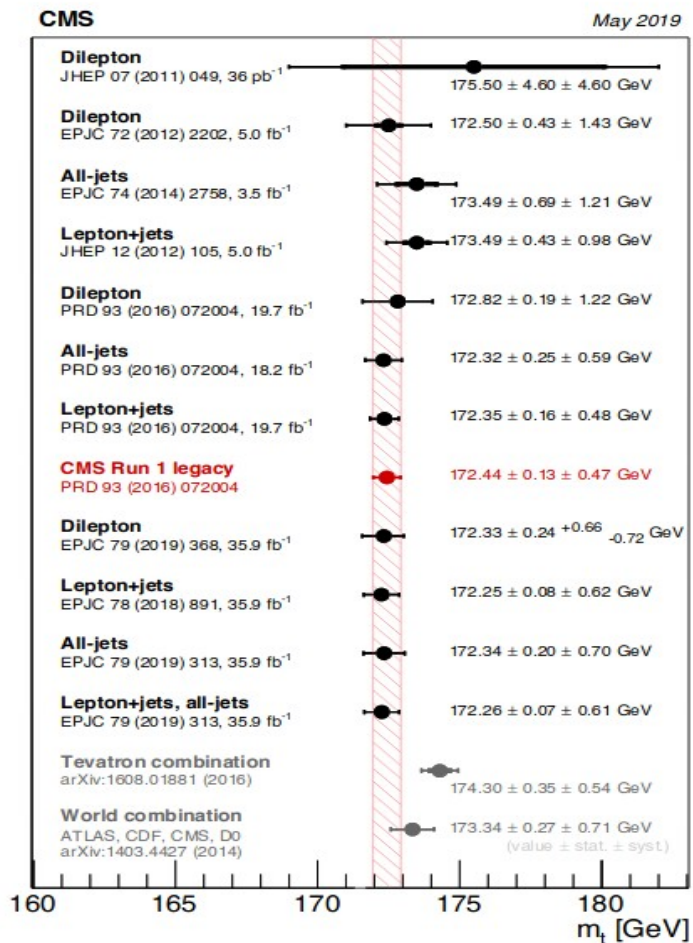


These two very strongly PDF-dominated measurements will greatly benefit from improved constraints on the proton structure.

New DIS data in particular could “remove” this source of uncertainty almost completely.

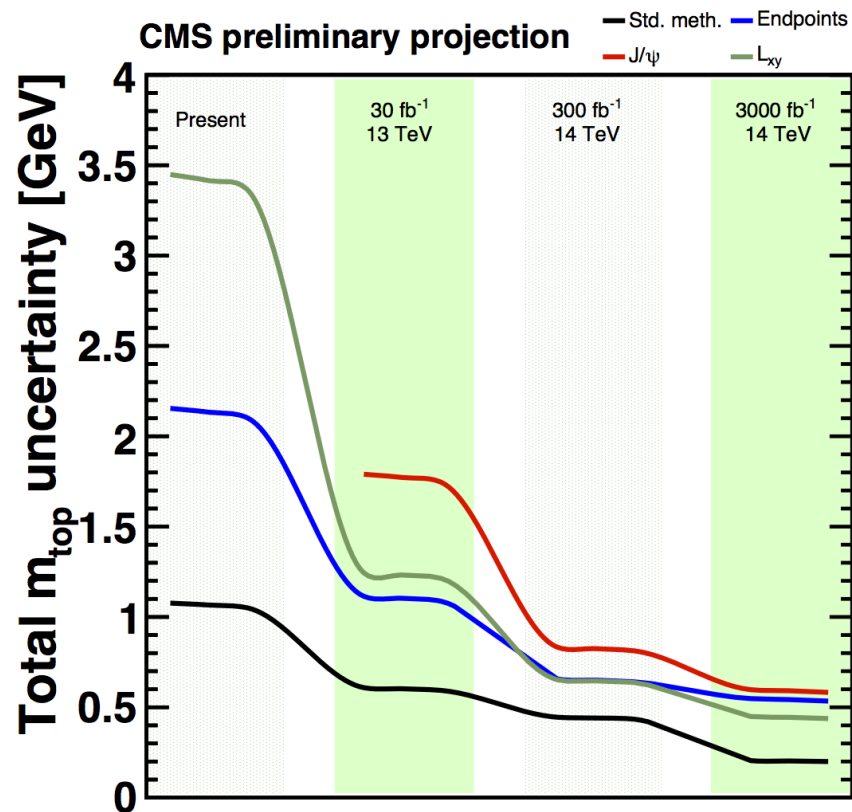
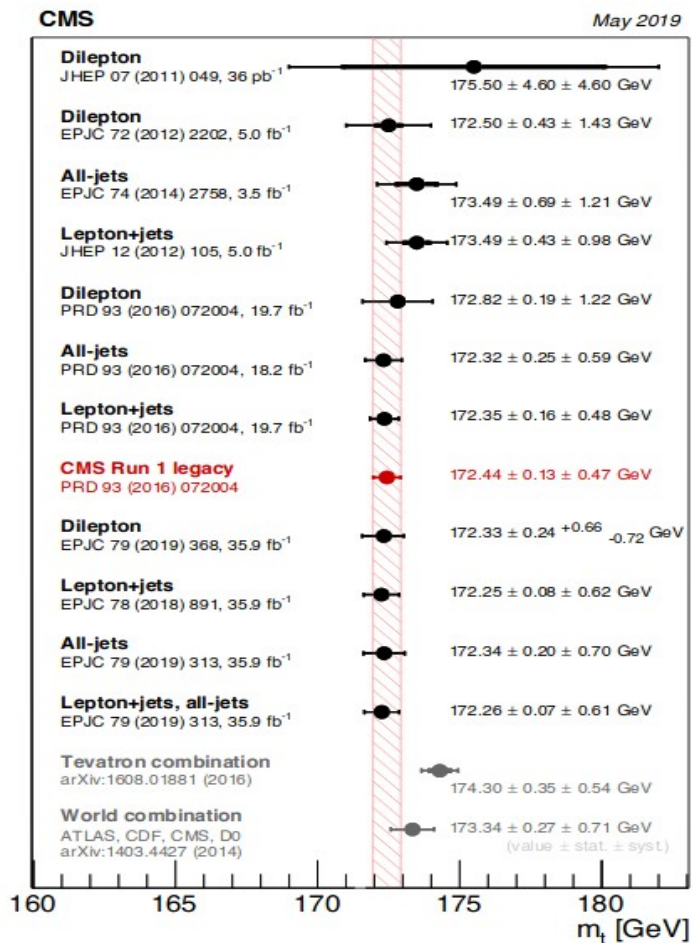


# Top quark mass

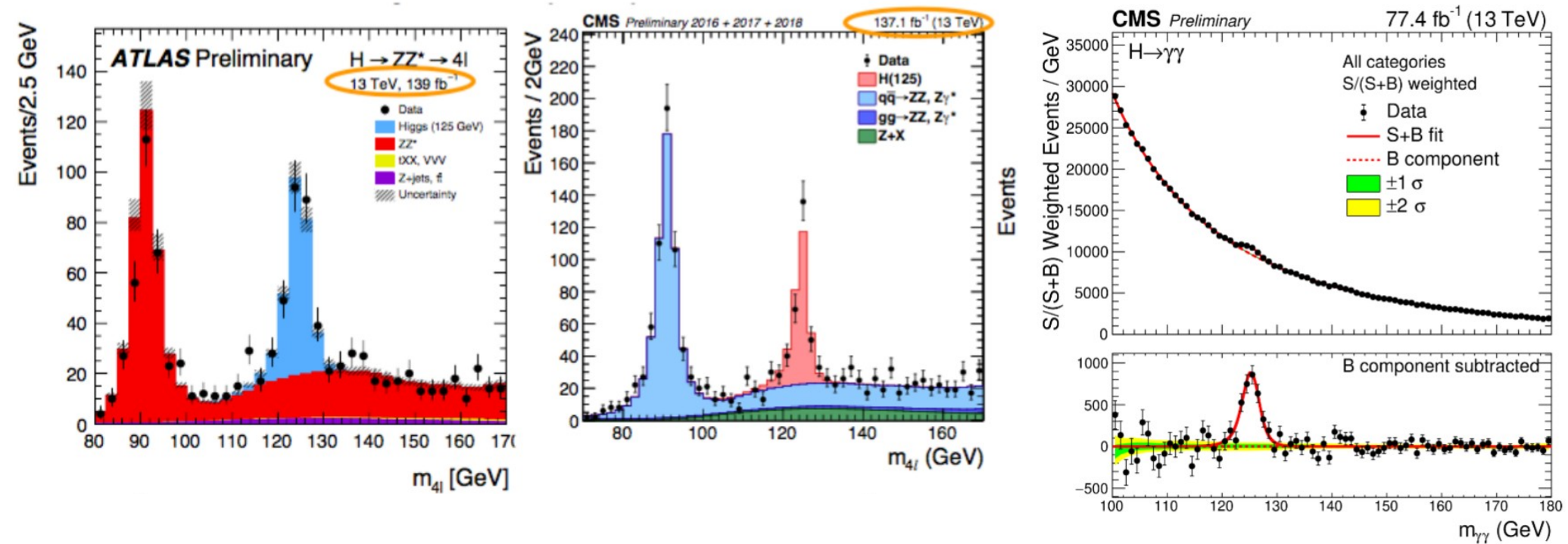




# Top quark mass



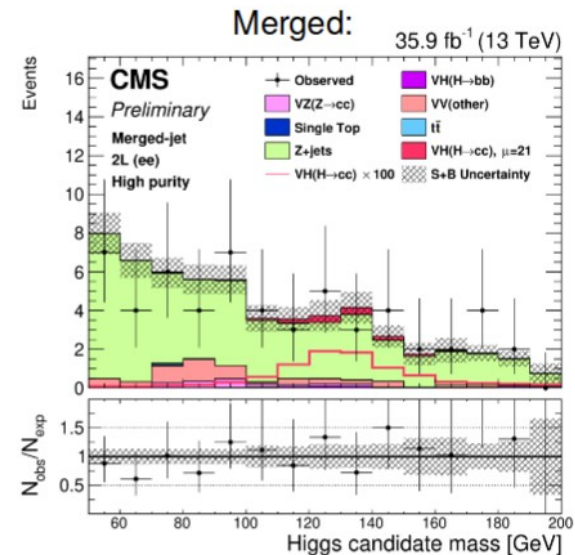
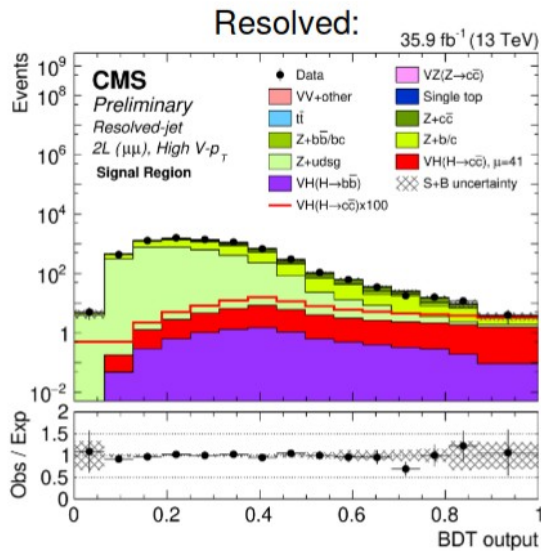
# Higgs boson properties : $m_H$



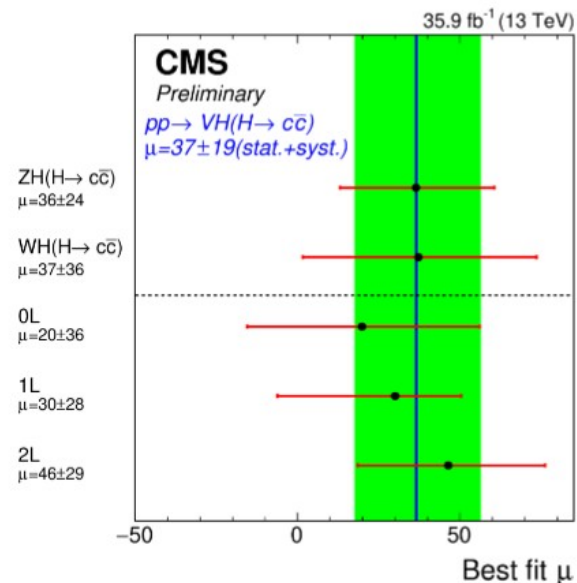
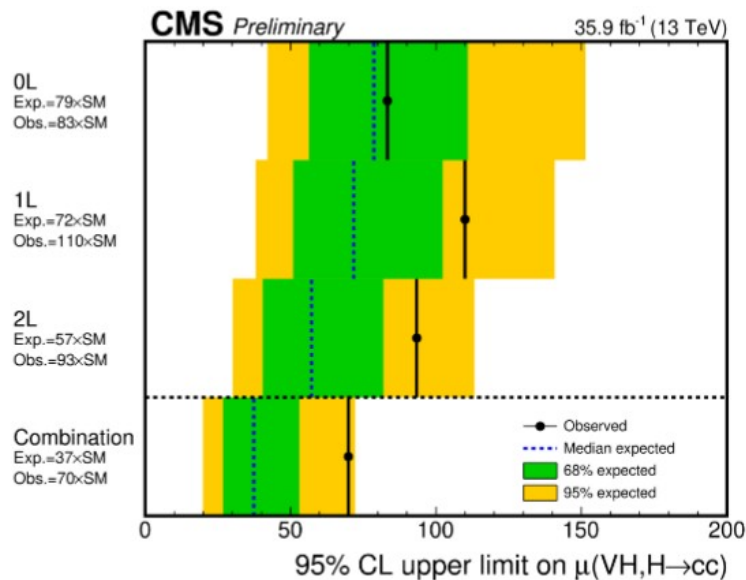
Mass known to  $<0.2\%$  today; will reach  $<0.1\%$  with the complete Run2 dataset

# Higgs boson properties : $H \rightarrow cc$

- Charm tagging based on deep neural networks (DNN)
  - calibration with various control data sets
- Signal extraction by simultaneous fit to signal and control regions
  - analysis variables
    - BDT discriminant (resolved)
    - Higgs candidate mass (merged)
- Validated by measuring  $VZ(\rightarrow c\bar{c})$  process
- For the overall result, combine resolved ( $p_T^V < 300 \text{ GeV}$ ) and merged ( $p_T^V > 300 \text{ GeV}$ )

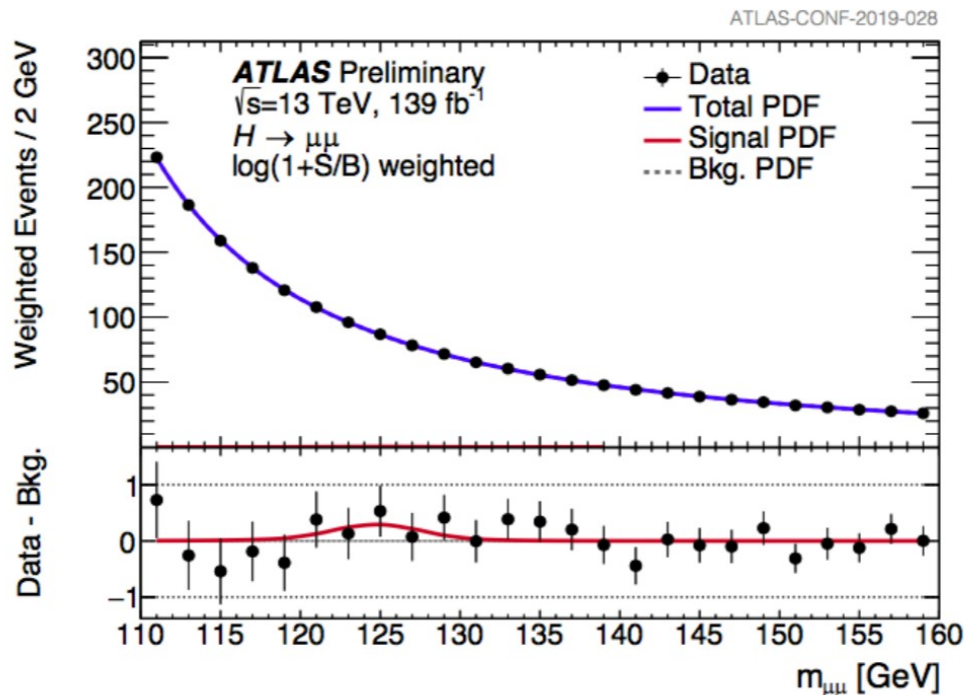


# Higgs boson properties : $H \rightarrow c\bar{c}$



- ➔ Combined upper limit relative to SM expectation:  $\mu < 70$  obs. (37 exp.) at 95% CL
- ➔ Most sensitive direct measurement to date
- A long way ahead to achieve SM sensitivity. Next step: full Run 2 analysis

# Higgs boson properties : $H \rightarrow \mu\mu$



$$\sigma(\text{obs}) / \sigma(\text{SM}) = 0.5 \pm 0.7$$

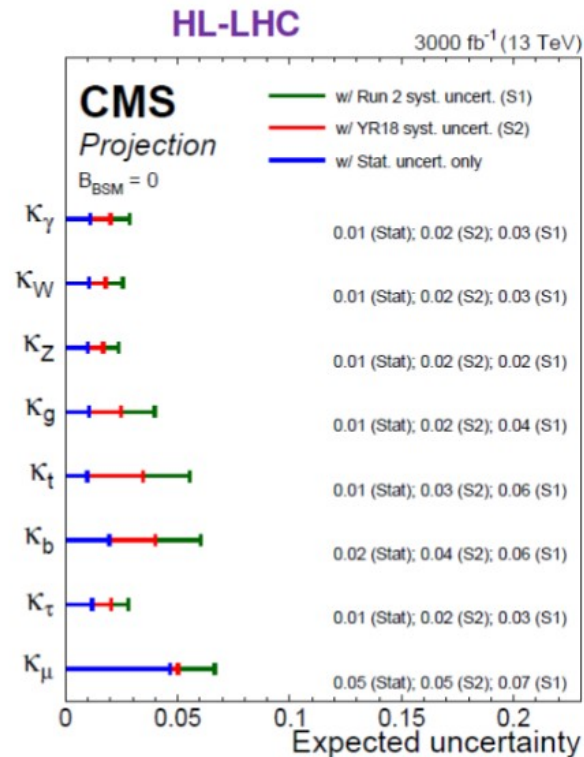
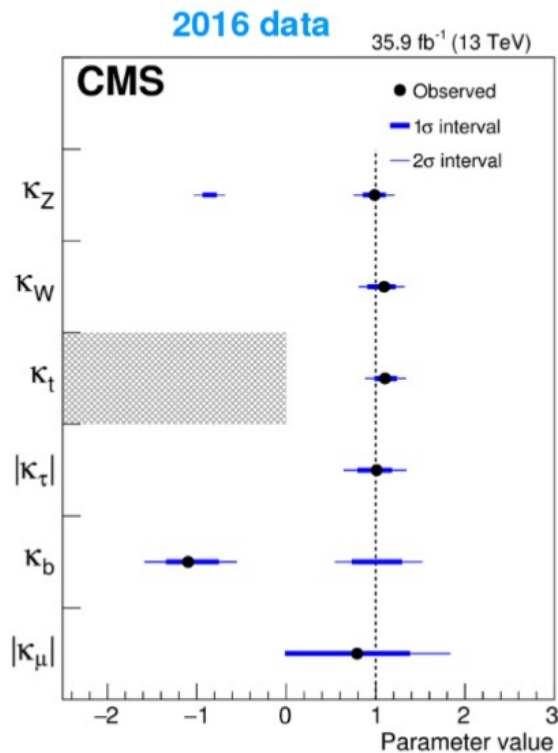
$$< 1.7 \text{ at } 95\% \text{ CL}$$

Sensitivity:  $0.8\sigma$ , for  $1.5\sigma$  expected

Very reminiscent of the  $H \rightarrow \gamma\gamma$  search, with less sensitivity, better theory (for background), and better control of reconstruction resolution (using  $Z \rightarrow \mu\mu$ ). Still mostly a search; combined LHC results after Run3 should be conclusive.

# Higgs boson properties

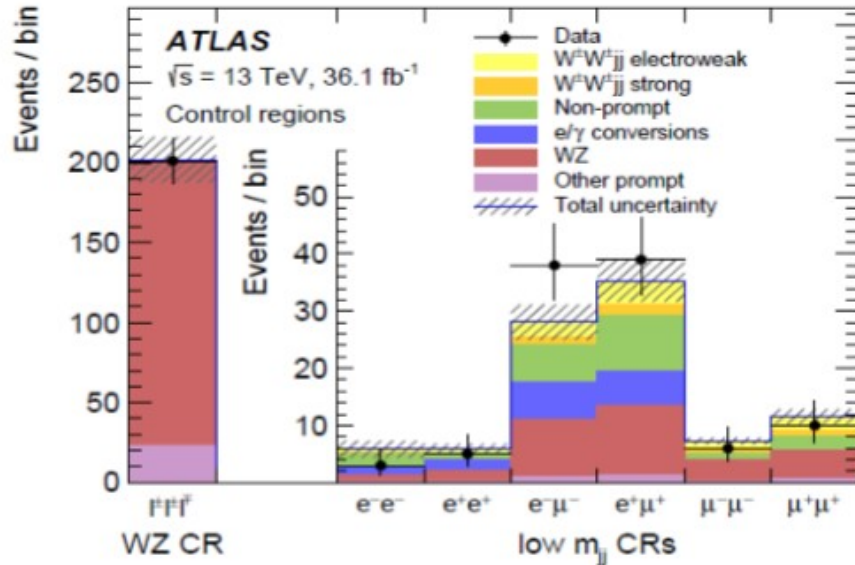
- Coupling modifiers are presented at the level of the 2016 data
  - $ggH$  and  $H \rightarrow \gamma\gamma$  loop processes resolved
  - results are **in line with SM**
  - precision in 10-30% range, apart from  $\kappa_\mu$
  - stay tuned for full Run 2 result
- Projections have been made for full HL-LHC period (3000  $\text{fb}^{-1}$ )
  - precision improves **down to 2-5%** range (apart from  $\kappa_\mu$ )
  - dominated by signal theory in S1 case ( $\kappa_\mu$  dominated by statistics)



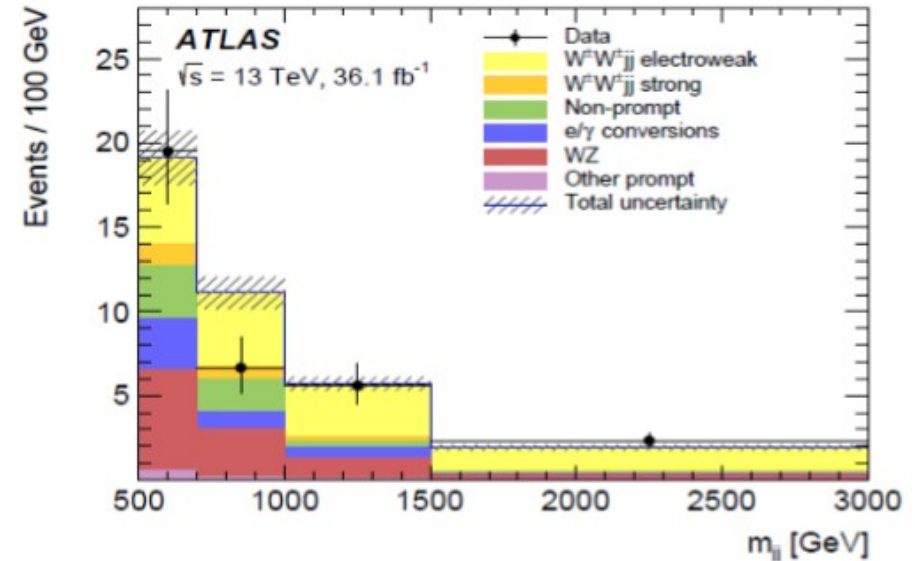
# Vector boson scattering at high energies

Observation of Electroweak  $W^\pm W^\pm jj$  Production

arXiv:1906.03203



Control regions at low  $m_{jj}$   
→ normalize backgrounds



Fairly pure signal (all EW)  
at high values

# Vector boson scattering at high energies

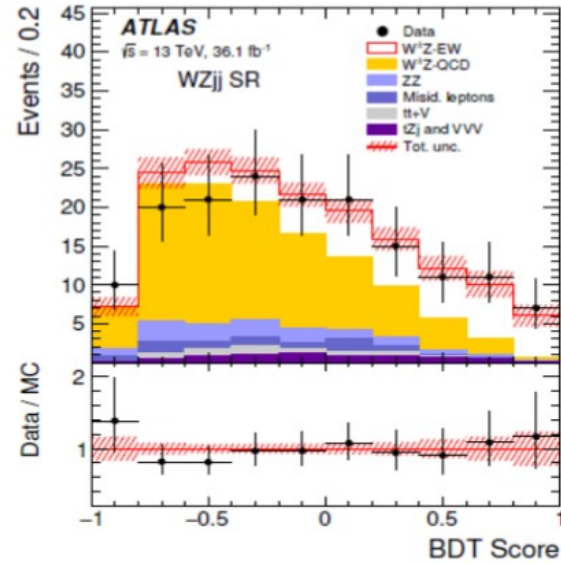
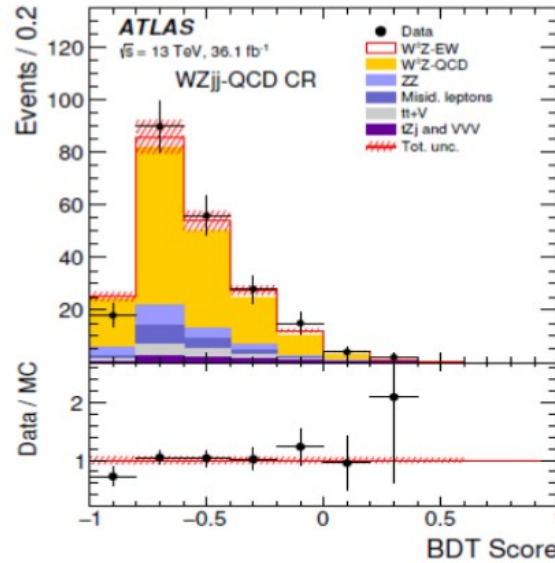
## Observation of Electroweak $WZjj$ Production

Phys. Lett. B 793 (2019) 469

Signal extracted by fitting a BDT discriminant built from 15 variables

- ▶ jet kinematics  
( $m_{jj}$ ,  $p_T^{j1}$ ,  $p_T^{j2}$ ,  $\Delta\eta_{jj}$ ,  $\Delta\phi_{jj}$ ,  $y^{j1}$ ,  $n_{\text{jets}}$ )
- ▶ diboson kinematics  
( $p_T^W$ ,  $p_T^Z$ ,  $\eta^W$ ,  $|y_Z - y_{\ell,W}|$ ,  $m_T^W$ )
- ▶ combined jet-diboson  
( $\Delta R(j_1, Z)$ ,  $R_{p_T}^{\text{hard}}$ ,  $\zeta_{\text{lep}}$ )

Background constrained in three control regions



Experimentally clean final state. Challenge : extract EW component (QCD dominates!)



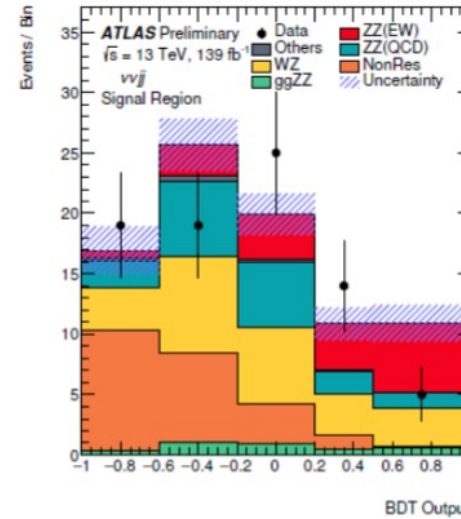
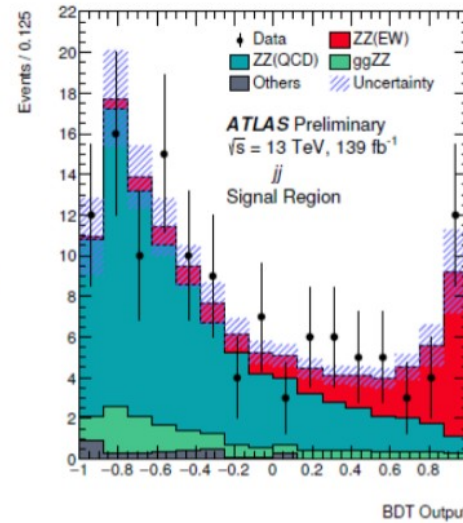
# Vector boson scattering at high energies

## Observation of $EW\ ZZjj$ Production

ATLAS-CONF-2019-033

The electroweak signal is extracted using a BDT with 12 ( $4\ell$ ) or 13 ( $2\ell 2\nu$ ) variables

A fit of the BDT discriminant is performed simultaneously in  $4\ell jj$  and  $2\ell 2\nu jj$  (with a  $4\ell$  QCD CR defined by events failing  $\Delta y_{jj}$  or  $m_{jj}$ )

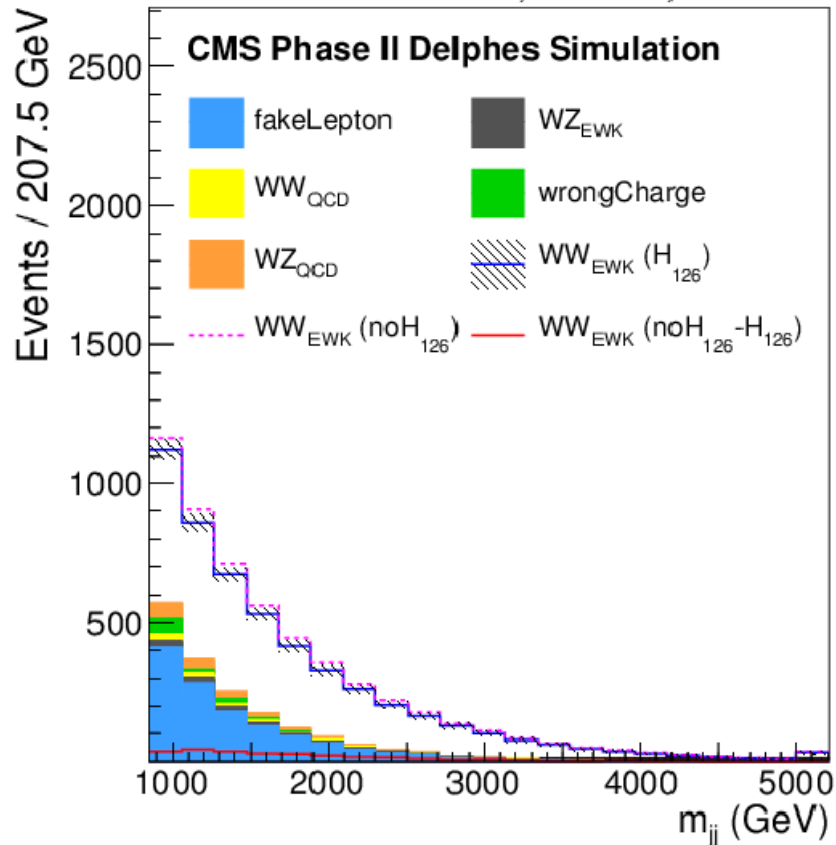


Electroweak  $ZZjj$  production is observed **for the first time** with the background-only hypothesis rejected with  $5.5\sigma$  (expected  $4.3\sigma$  from MG5\_aMC@NLO)

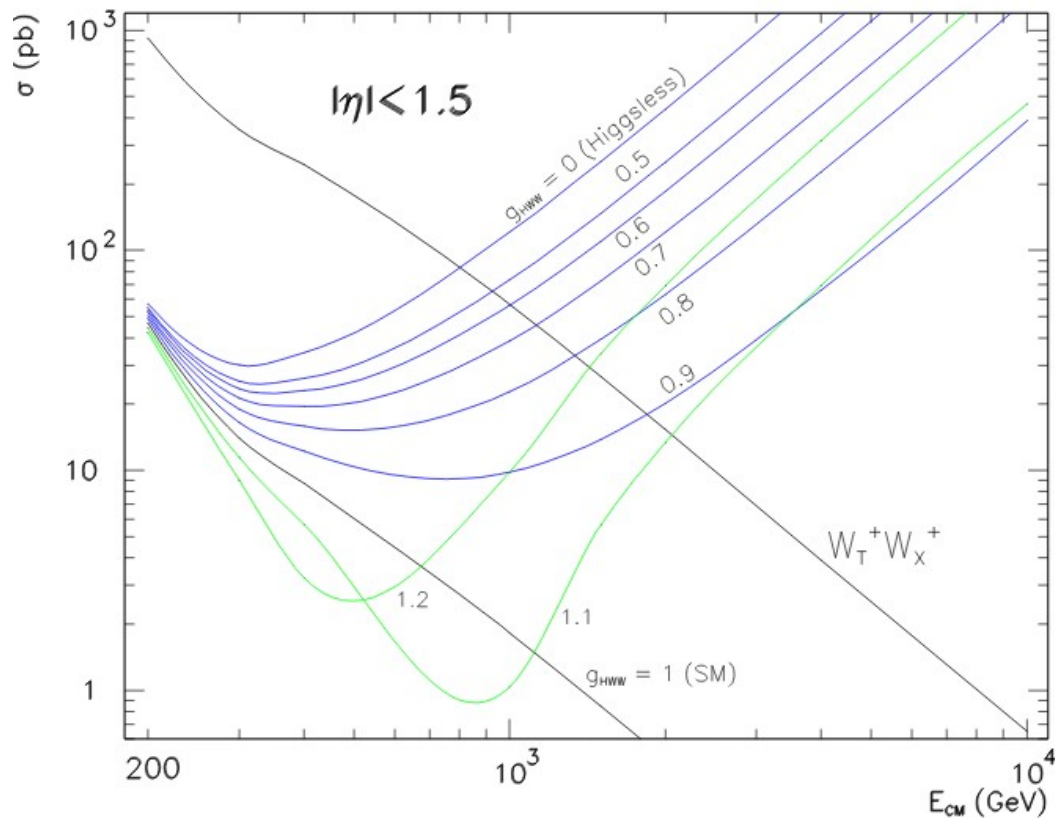
Experimentally clean final state. Challenge : extract EW component (QCD dominates!)

# Vector boson scattering : prospects and link with Higgs

14 TeV, 3000 fb<sup>-1</sup>, PU = 140



$W_L^+W_L^+ \rightarrow W_L^+W_L^+$  with modified Higgs couplings



<https://arxiv.org/abs/1412.8367>

# Summary

- Neutrino physics entered the precision era (or I just realized...)
- Belle II will boost B physics by an order or magnitude, in both precision measurements and searches for rare decays
- The pace of LHC results slows down a little... significant increase in the data sample will now not happen before a long time.
  - Still, precision measurements (W, Z, top, Higgs) have beautiful perspectives on the mid term, and detector/machine preparations for the HL-LHC are in full swing
  - Finally, we close in on the last element of the electroweak “triangle”, namely explicit studies of vector boson scattering at the highest energies and their interplay with the Higgs boson properties, and with EWPO’s in W, Z production.