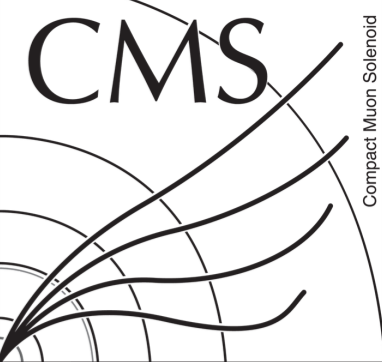
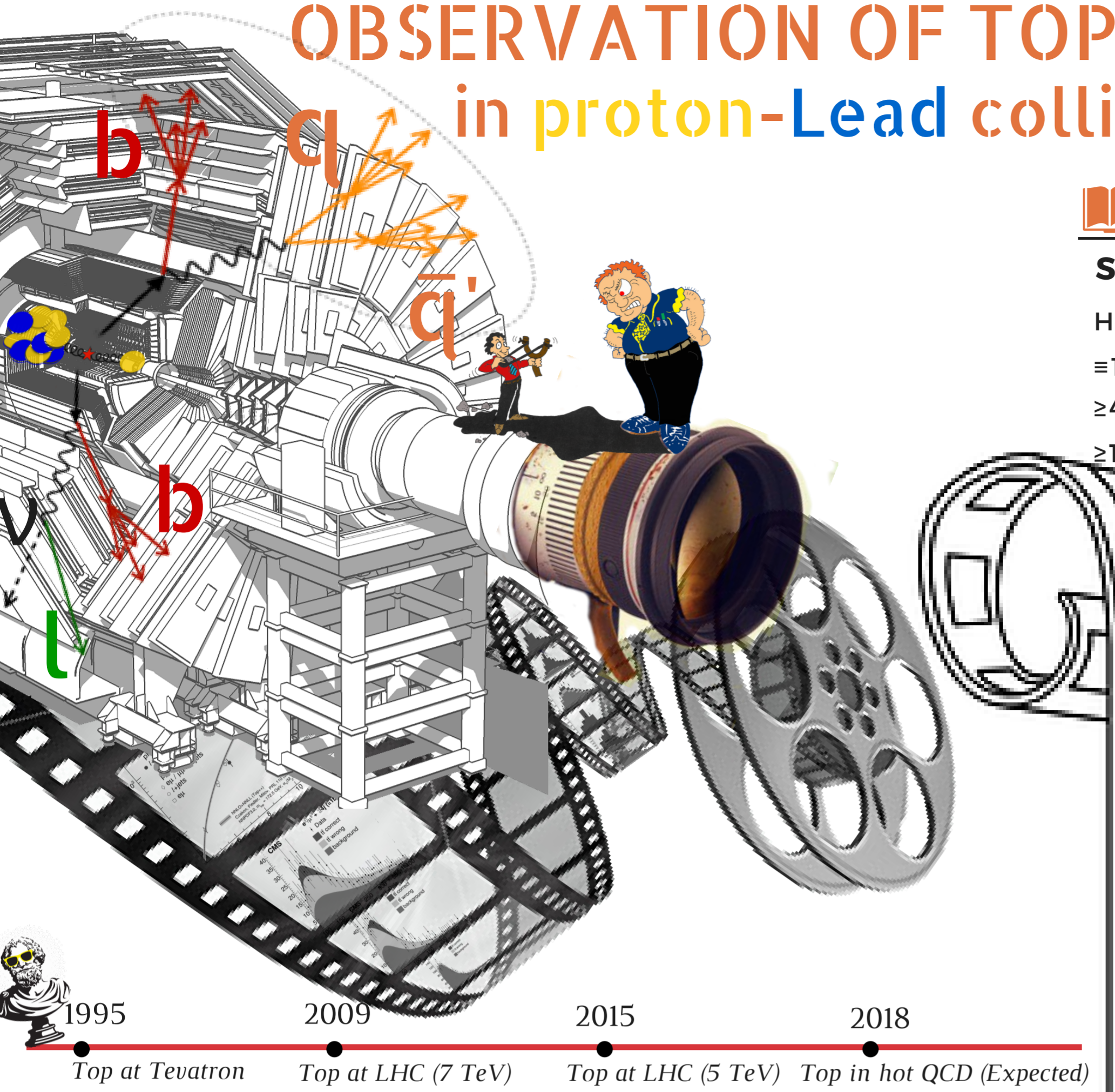


# OBSERVATION OF TOP QUARK in proton-Lead collisions

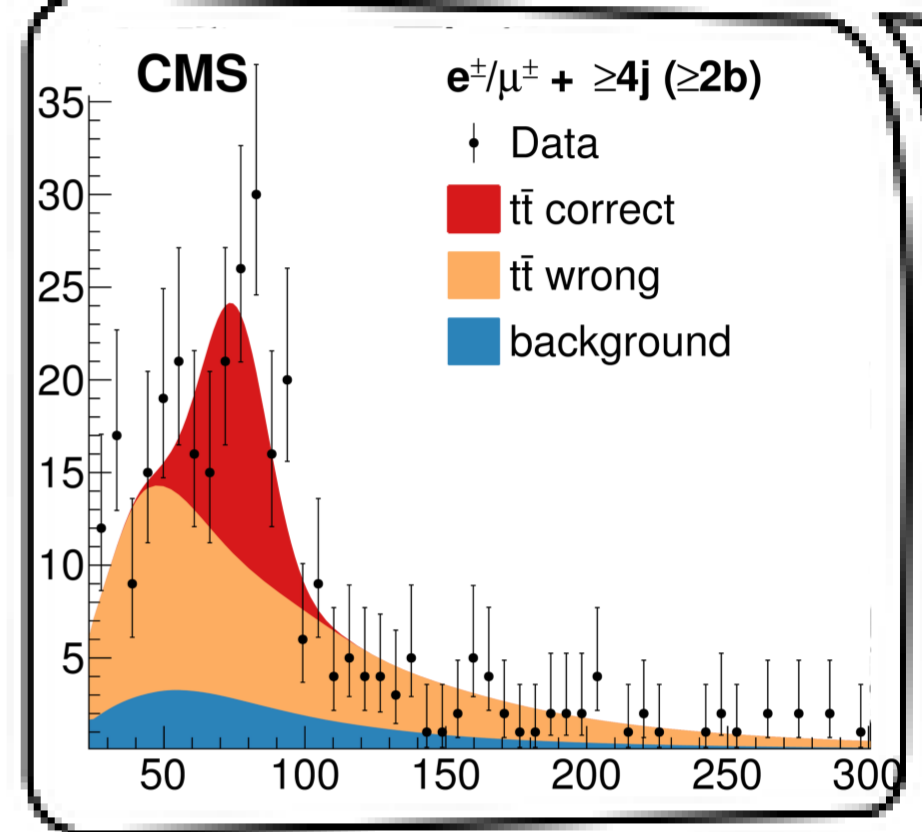


CMS Collaboration. PRL 119, 242001 (2017)  
Observation of Top Quark Production in Proton-Nucleus Collisions

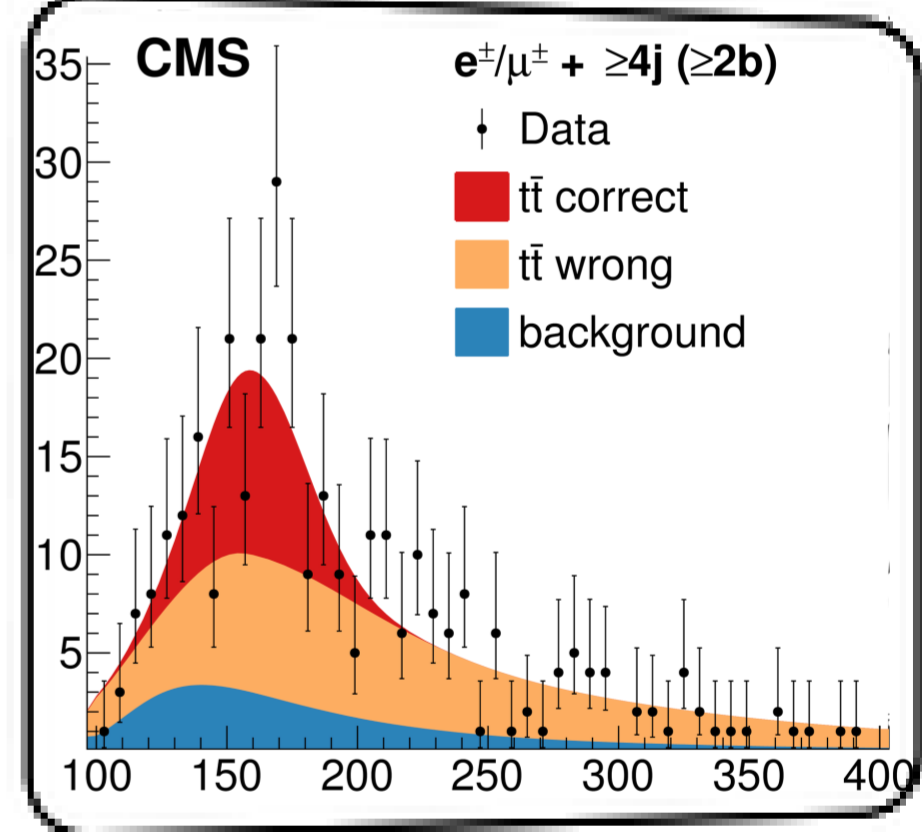


SELECTION	SIGNAL
High Level Trigger	● ● ● ● ●
$\geq 1$ high $p_T$ lepton ( $\mu$ or $e$ )	● ● ● ● ●
$\geq 4$ anti-kt clustered jets	● ● ● ● ●
$\geq 1$ b tagged jet	● ● ● ● ●

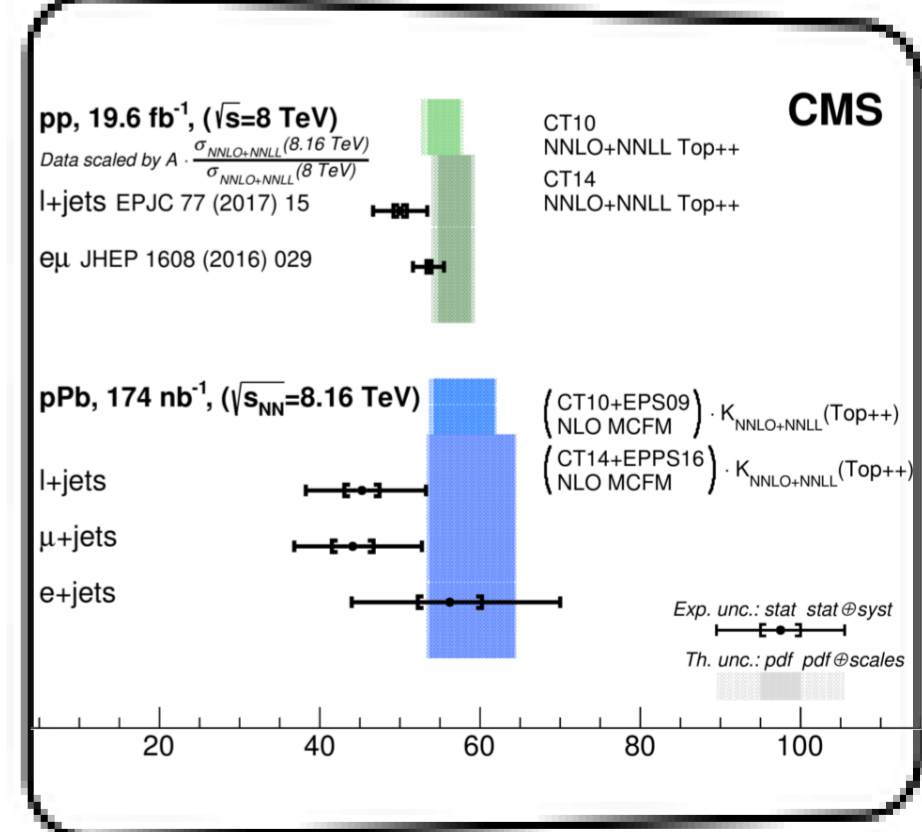
## W BOSON INV. MASS [GEV]



## TOP QUARK INV. MASS [GEV]

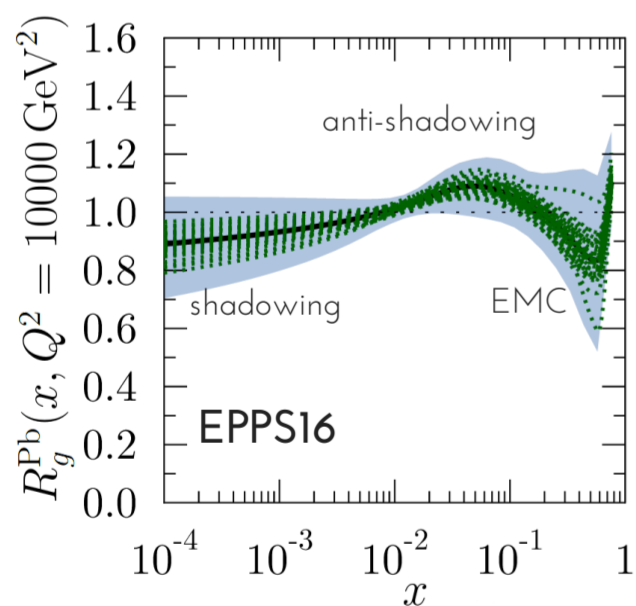


## CROSS SECTION IN PP, PPB [NB]



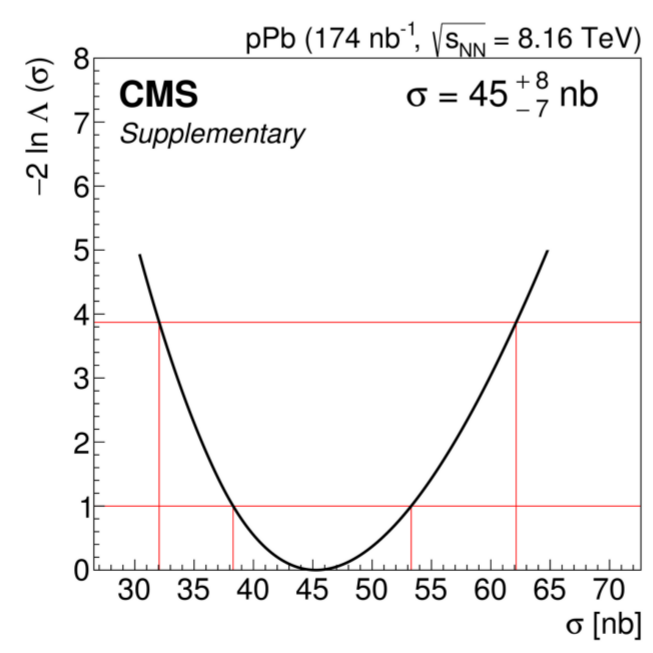
### In pPb collisions? Not a typo?

In November 2016, the LHC delivered **proton-Lead** (pPb) collisions at  $\sqrt{s} = 8.16$  TeV. This is a unique opportunity to verify the **pQCD** prediction of the top pair-production ( $t\bar{t}$ ), providing complementary constraints on the **large-x gluon PDF**. Such a measurement further serves as a reference for measuring top quark in PbPb collisions.



### Is the signal significant?

The total number of observed events is  $710 \pm 130$ , and the background-only hypothesis is excluded at  $> 5\sigma$  level **including all** systematic uncertainties as nuisance parameters with Gaussian priors. To further examine the hypothesis that the selected data are consistent with  $t\bar{t}$  production, **a proxy** of the top quark mass is defined by pairing the highest scored b jet with the W boson candidate.



### How you extracted the signal?

The background contribution is parameterized from **dedicated** event samples, while the scale is determined from **a combined fit** including signal-enriched regions in the l+jets channel. The  $t\bar{t}$  signal is separately considered for **fully** and **partially** reconstructed W boson candidates and is taken from a NLO MC simulation interfaced to state-of-the-art nuclear PDFs.

### And, with what precision?

Experimental uncertainties include **b tagging**, trigger and **lepton** efficiencies, plus **jet energy scale** and **resolution**. Theoretical ones involve **QCD scales**, and free- and bound-proton **PDFs**.

Experimental	• 13/4/4 %
Luminosity	• 5 %
Background	• 7 %
Theoretical	• 4 %
Total systematic	• 18(23)% in $\mu(e)+jets$
Statistical Precision	• 7 %
Total	• 17 %



### Result

$\sigma_{t\bar{t}} = 45 \pm 8$  nb  
in-line with theory

L=174NB-1