LHC beam energy uncertainty:

Proposal for treatment in physics analyses and summary plots

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Relative uncertainty on Ebeam ~ 0.66 %

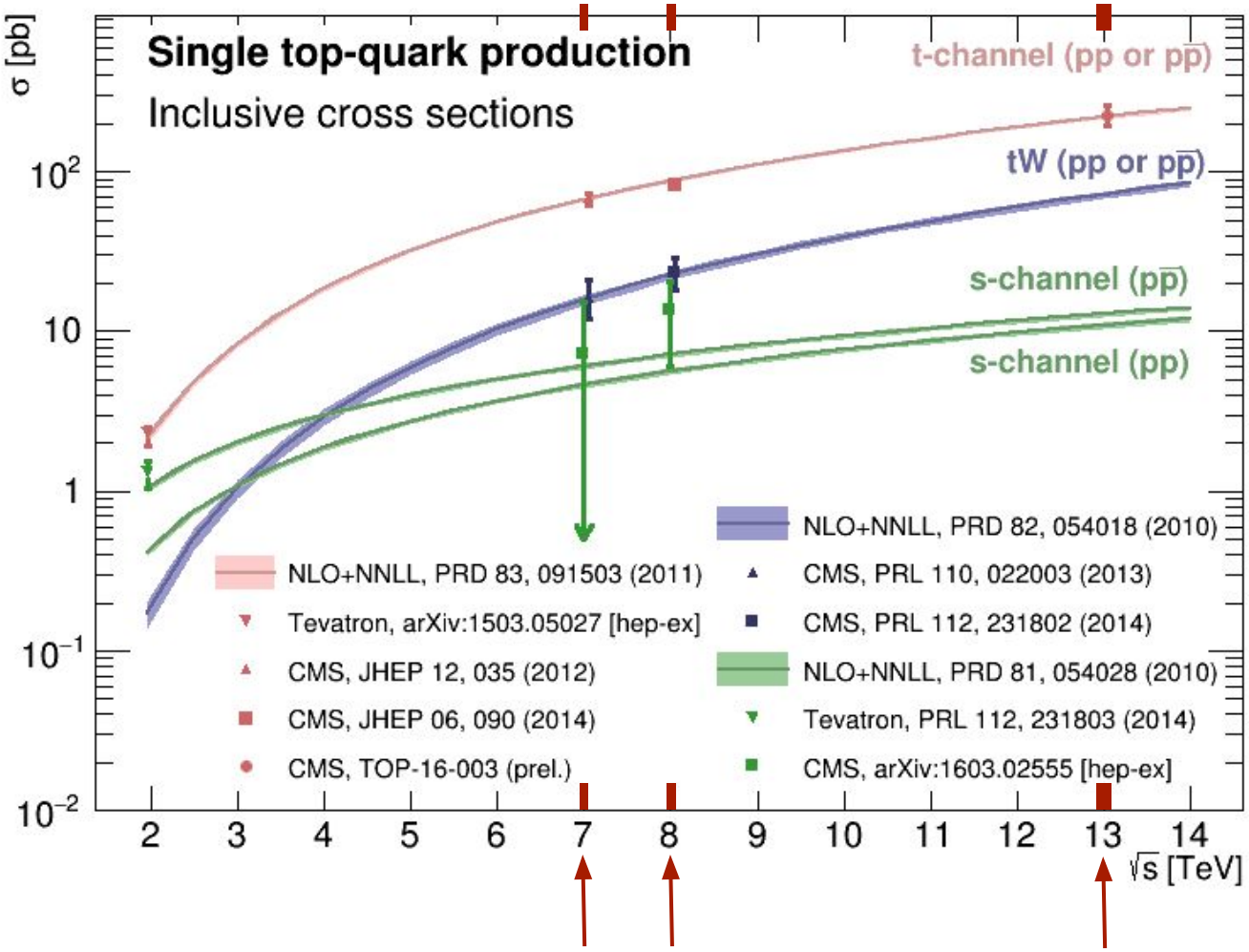
- CERN-ATS-2013-040 : https://cds.cern.ch/record/1546734?ln=en
- Initial uncertainty larger at 13 TeV ?

Effect on measured cross-sections

- Effect on analysis acceptance: negligible (<< 0.1% for e-mu ttbar)
- Effect through background subtraction … probably negligible
- Variation of 'true' cross-section as function of √s → can be sizable… estimated effect for ttbar (using theory prediction):

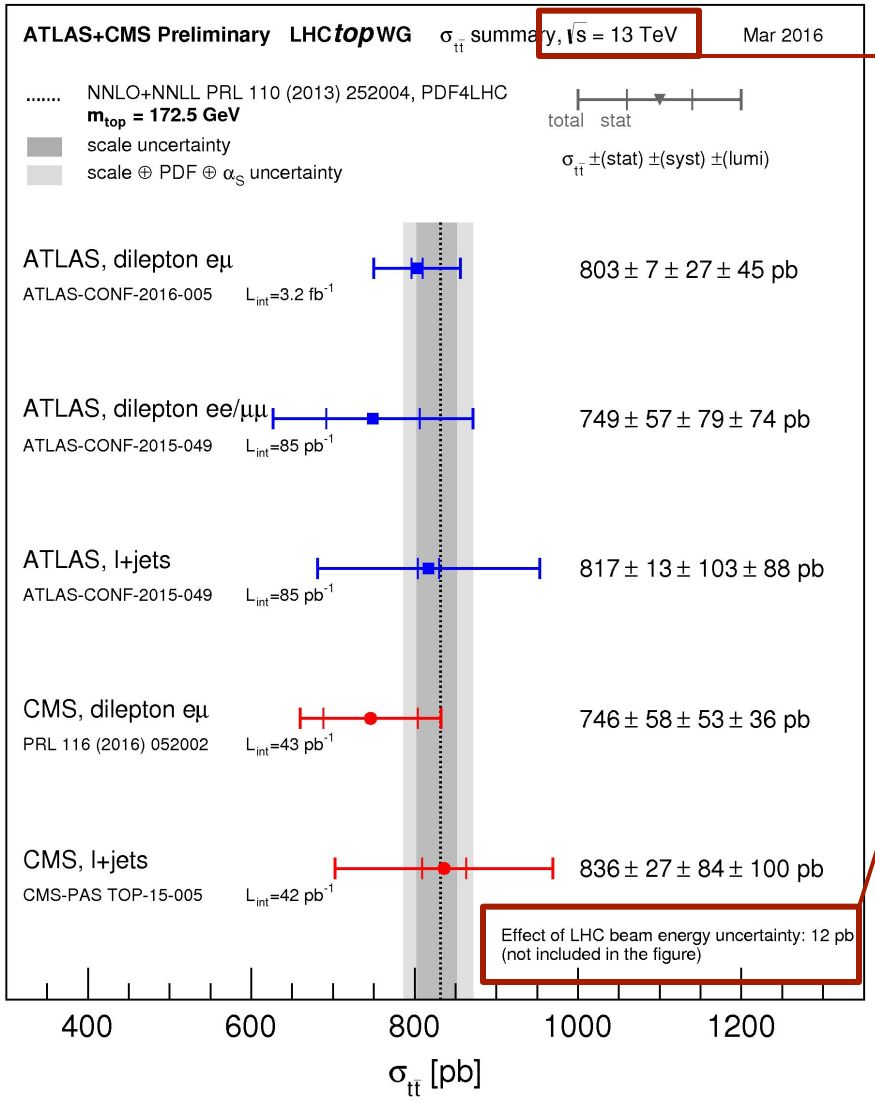
Process	7 TeV	8 TeV	13 TeV	typical precision
Top pair production	1.8%	1.7%	1.5%	3 - 4%

Dependence of cross-section versus √s



Beam energy uncertainty → affects **horizontal position** in this plot (note: effect is bigger than line width !)

Summary plot at fixed energy, eg 13 TeV



Do we really mean 13 TeV ? or:

- approximately 13 TeV
- 13.0 ± 0.1 TeV
- 2015 LHC collision energy

Current disclaimer in plots:

Effect of beam energy uncertainty: XX pb
(not included in the figure)

Proposed in CMS review of Wt note:

Effect of beam energy uncertainty on theory prediction: XX pb
(not included in the figure)

- Pro: more “didactic”
- Con: puts focus too much on theory?

LHCTopWG Proposal

- **(Agreed)** For the measurement of an observable for which the theoretically predicted value depends on the LHC beam energy, **the size of the variation of the theory prediction** for this observable corresponding to the LHC beam energy uncertainty **should be mentioned** in the publication, if it matters

- **(Agreed) Inclusion** of this effect **as a systematic uncertainty**, quoted in the final measurement result, **is optional, unless** the result is an interpretation (eg extraction of Vtb or mt_pole), in which case the uncertainty must be included, if it matters

- **(Agreed)** For our summary plots we stay with the current previously agreed disclaimer, at least for now

For which measurements is this relevant?

- Size of the effect depends on process and on √s
- Can be same order of magnitude as luminosity uncertainty !
- More important for ATLAS+CMS combinations, with partly correlated luminosity(*)
- What about ratios, eg: ttbar / Z ... 13/8 TeV ... W/Z

Process	7 TeV	8 TeV	13 TeV	typical precision
W,Z	**~0.7%**	**~0.7%**	**~0.7%**	**3%**
Single top t-channel		~1% ?		9%
Single top Wt		1.6%		15%
Top pair	**1.8%**	**1.7%**	**1.5%**	**3 - 4% (*)**
ttZ or ttH ?		~2% ?		20-30%

(*) dominated by luminosity uncertainty → 2-2.5 % possible, esp in ATLAS + CMS combination !?