Top quark pole mass with $t\bar{t}$+jet events at 13 TeV

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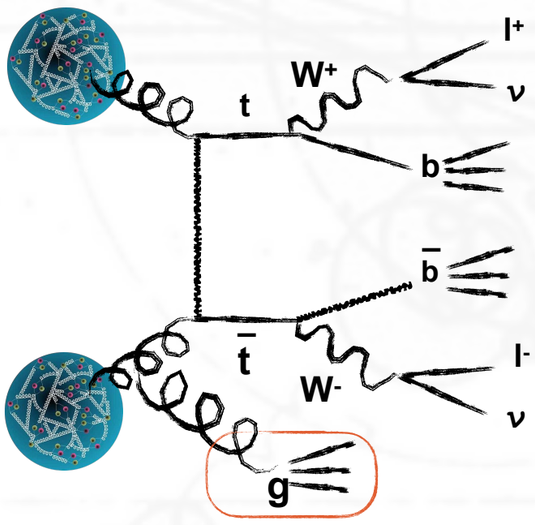
[JHEP 07 (2023) 077]

$t\bar{t}$+jet events in the dilepton final state

jet p_T > 30 GeV & |η|<2.4

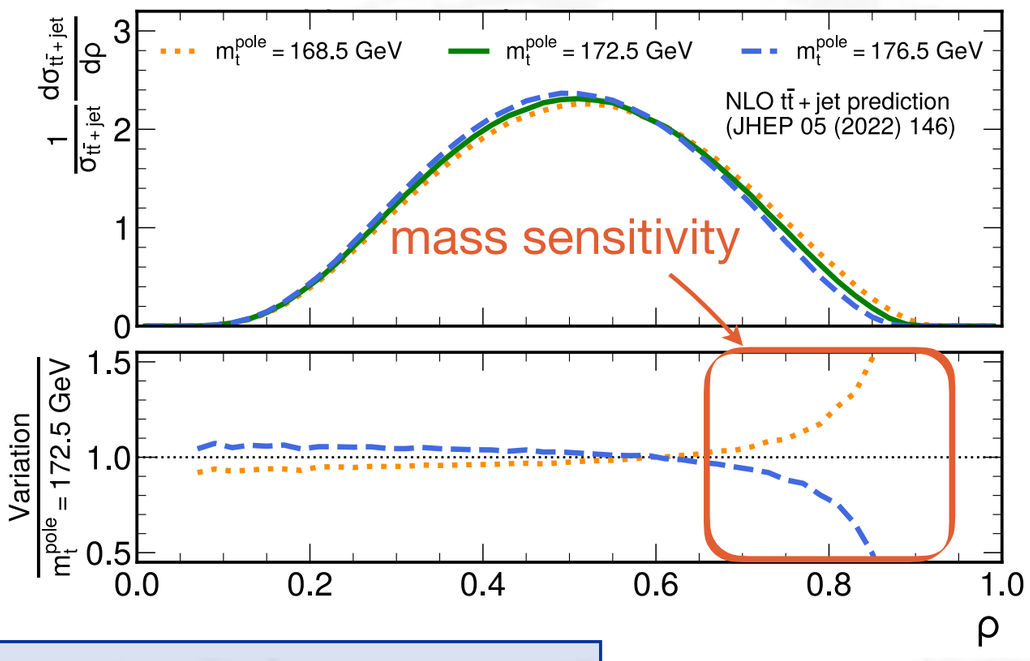


- explore ρ observable:

$$\mathcal{R}(m_t, \rho) = \frac{1}{\sigma_{t\bar{t}+jet}} \frac{d\sigma_{t\bar{t}+jet}}{d\rho}$$

$$\text{with } \rho = \frac{2\, m_0}{m_{t\bar{t}+jet}}, m_0 = 170\,\text{GeV}$$

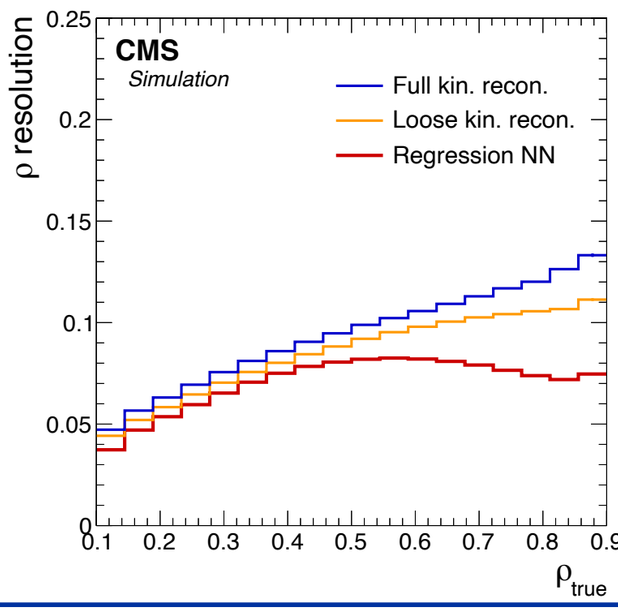
- m_t^{pole} via comparison to NLO calculations

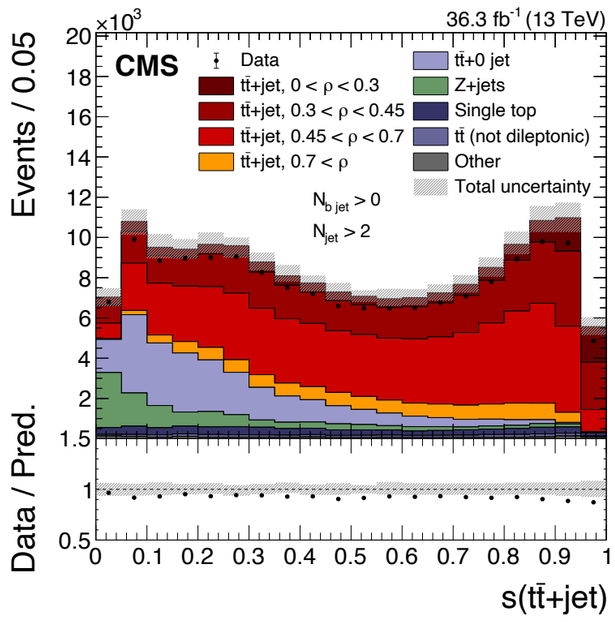


Use advanced analysis techniques to increase precision!

Reconstruction & event classification

- neural-network-based kinematic reconstruction
- resolution improvement by **factor 2** wrt. algebraic solution based on energy-momentum conservation





- multiclass classifier (tt̄+jet / tt̄/ Z+jets)
- **auxiliary variable** in fit

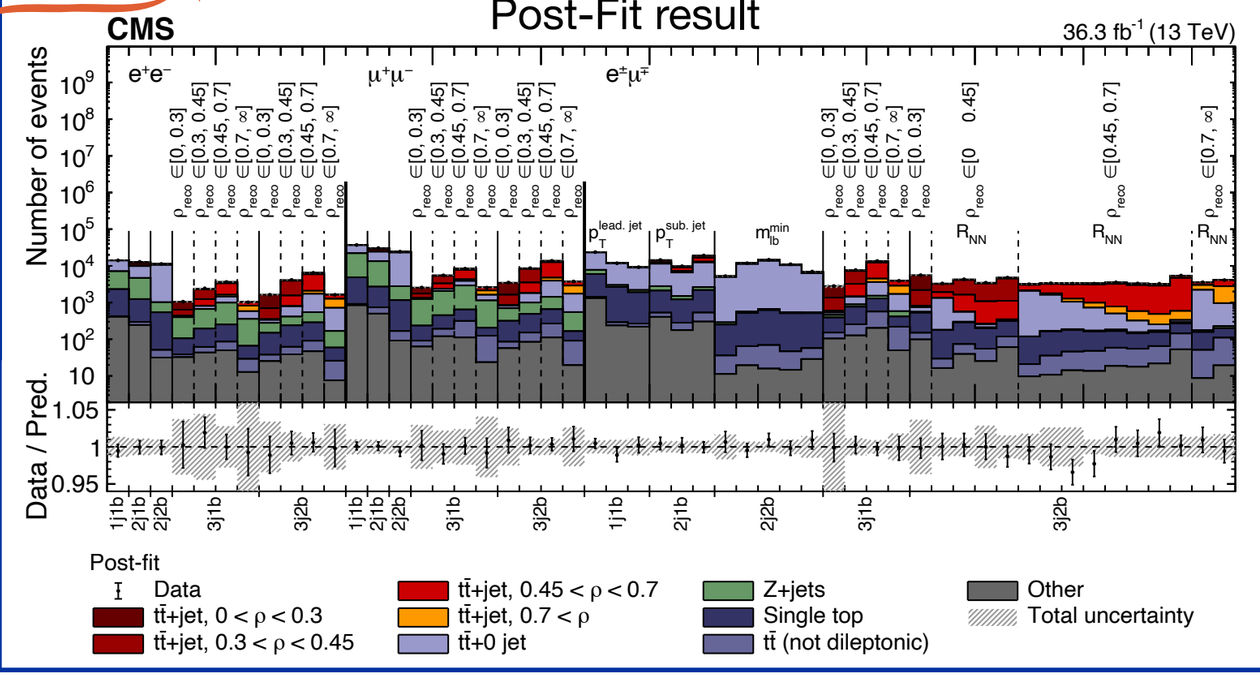
$$R_{NN} = \frac{p(t\bar{t}+\text{jet})}{p(t\bar{t}+\text{jet}) + p(t\bar{t})}$$

Profiled maximum likelihood unfolding

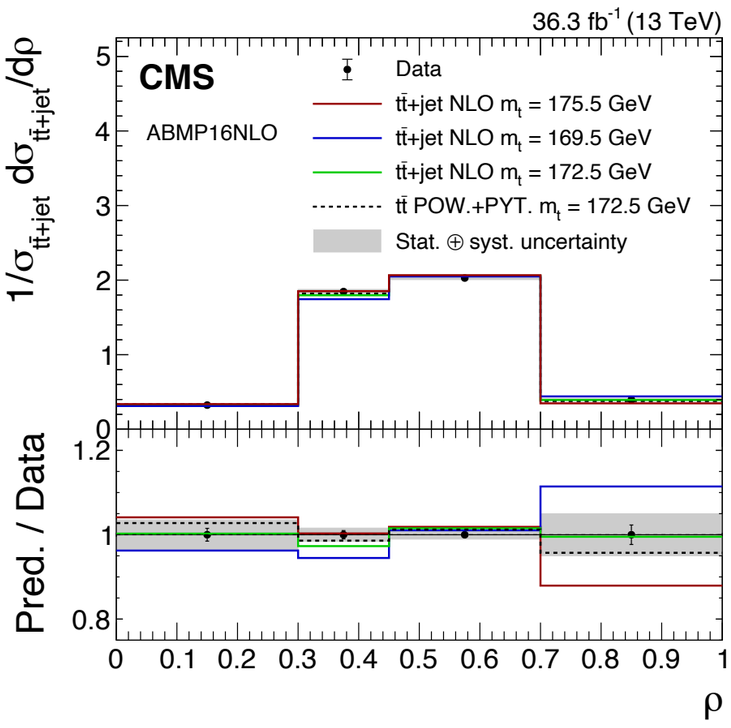
- multidimensional fit to unfold to parton level
- event categories & suitable observables to
  - constrain systematic uncertainties
  - maximize acceptance
- directly accounts for:
  - background subtraction
  - bin-to-bin migrations
- decouples m_t^{MC} from m_t^{pole} extracted from fit

	Reconstructed ρ, $N_{jet} \geq 3$				No reconstructed ρ	
	$\rho < 0.3$	$0.3 < \rho < 0.45$	$0.45 < \rho < 0.7$	$\rho > 0.7$	$N_{jet} = 1$	$N_{jet} = 2$
$N_{b\,jet} = 1$	R_{NN}	R_{NN}	R_{NN}	R_{NN}	$p_T^{leading\ jet}$	$p_T^{subleading\ jet}$
$N_{b\,jet} \geq 2$	R_{NN}	R_{NN}	R_{NN}	R_{NN}	—	$m_{\ell b}^{min}$

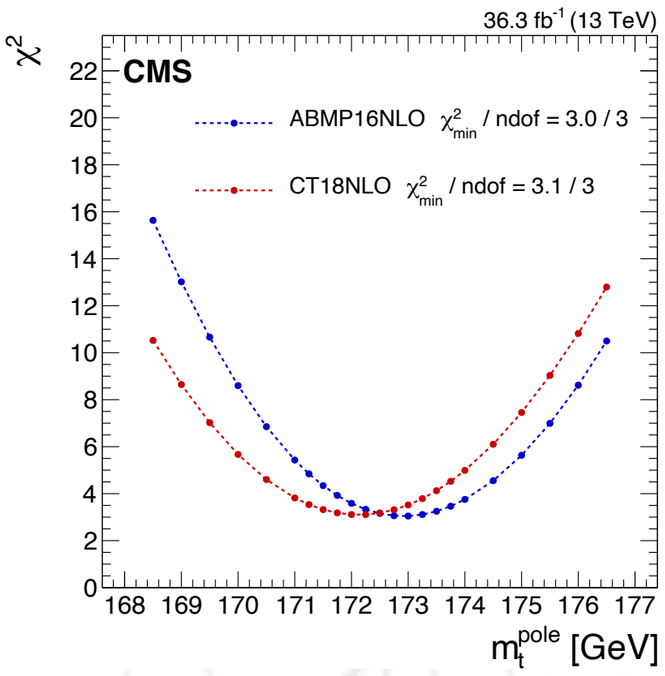
Post-Fit result

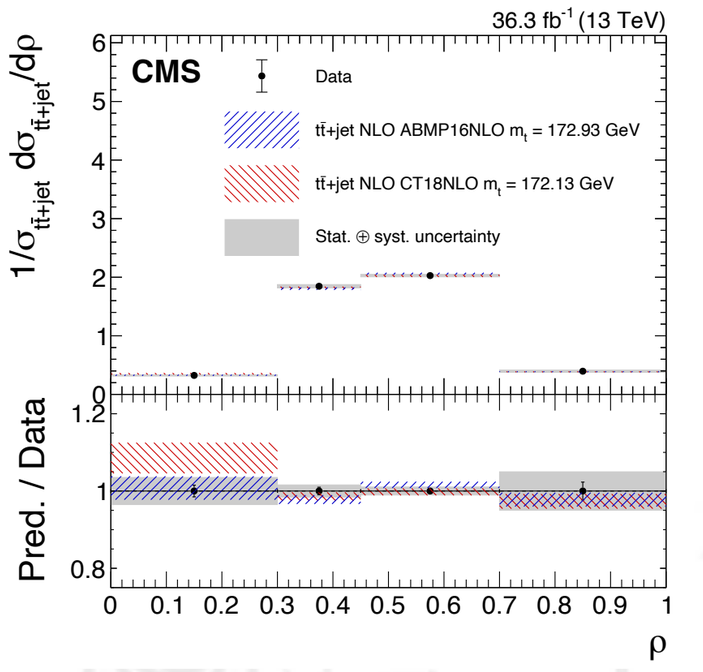


Interpretation & mass extraction



New:
dynamic scale (H_T/2) in NLO tt̄+jet theory prediction [1] reduces uncertainties





- absolute & normalized differential cross section
- compare to NLO tt̄+jet calculations: $\chi^2 = \Delta^T V^{-1} \Delta$
- consider full PDF + extrapolation uncertainties

[1] JHEP 05 (2022) 146

Results:

$m_t^{pole} = 172.13 \pm 1.34\,(\text{fit})\,^{+0.50}_{-0.40}\,(\text{scale})$ GeV (CT18NLO)

$m_t^{pole} = 172.93 \pm 1.26\,(\text{fit})\,^{+0.51}_{-0.43}\,(\text{scale})$ GeV (ABMP16NLO)