

QCD with Forward Jets at the CMS experiment

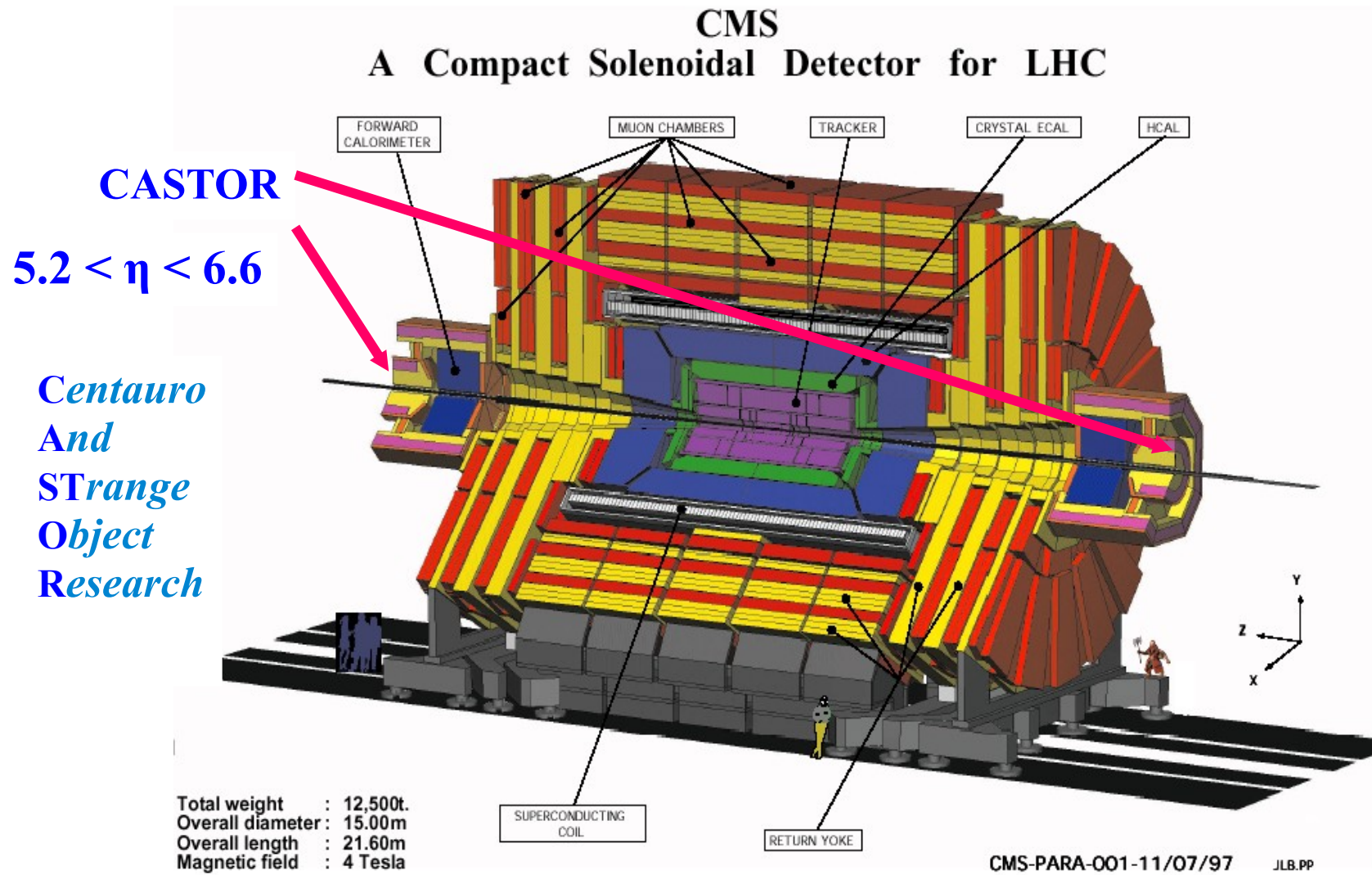
Niladri Sen, DESY

DESY-Lund MC meeting '09

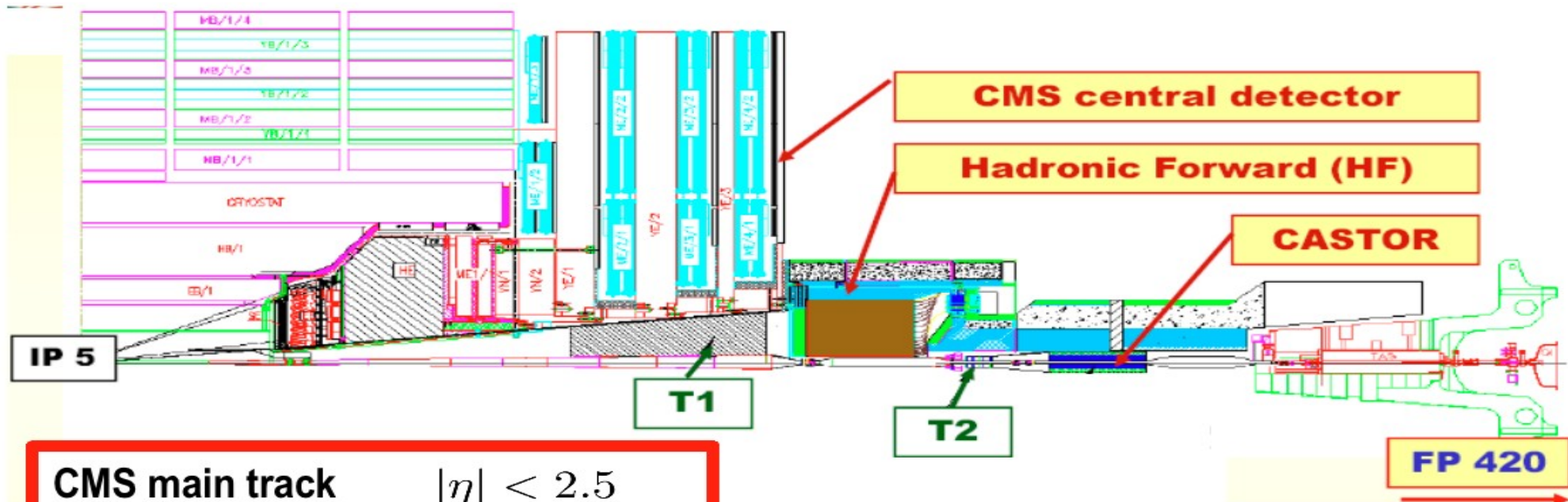
Outline

- **CASTOR & CMS**
- **Multiple Interactions**

CASTOR in CMS



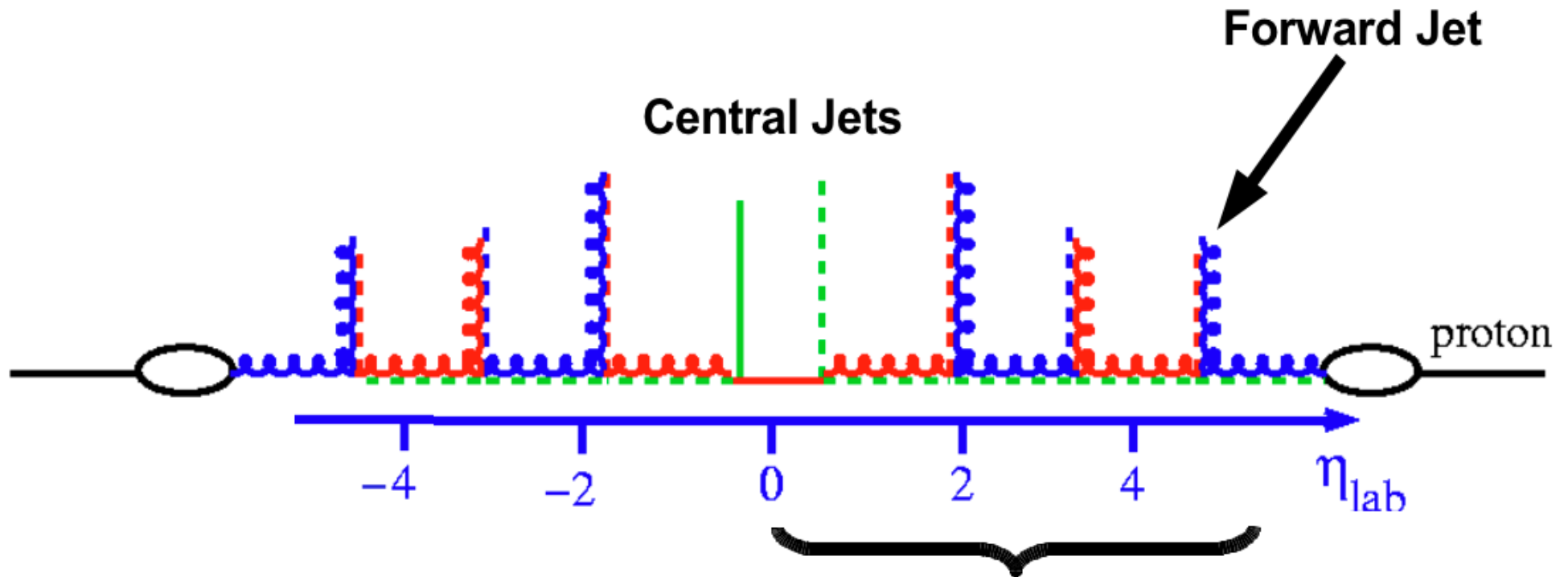
Forward Detectors around IP5



CMS main track	$ \eta < 2.5$
CMS main calo	$ \eta < 3.0$
TOTEM 1	$3.1 < \eta < 4.7$
HF cal	$3.0 < \eta < 5.0$
TOTEM 2	$5.2 < \eta < 6.5$
CASTOR	$5.2 < \eta < 6.6$
Zero Deg Calo	$\eta > 8.0$
FP420	420m
TOTEM-RP	147/220m

Few gaps, good coverage!

Forward Physics at LHC



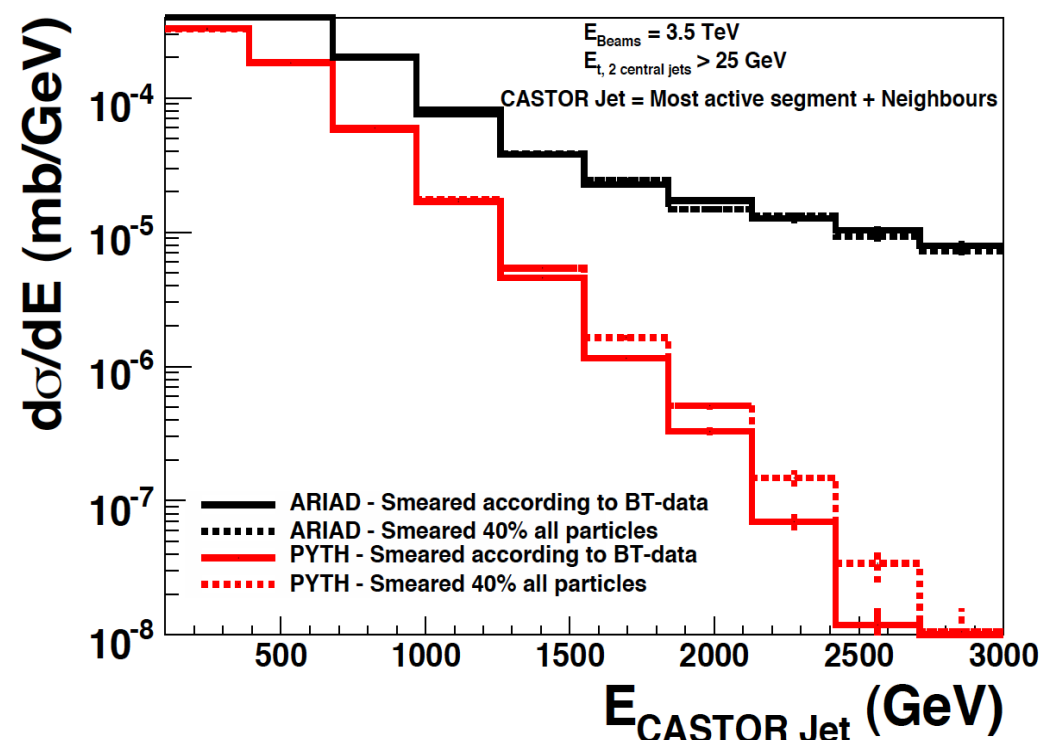
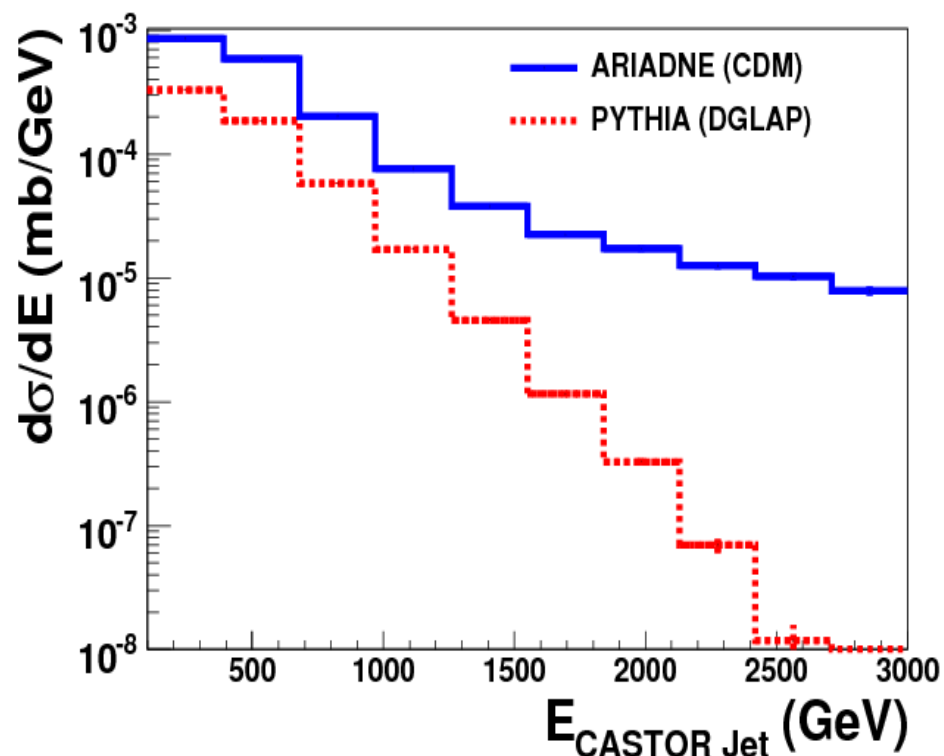
- Opens up phase space for emissions, higher order reactions
- Possible to apply constraints on parton ladder
- Gain information on the full parton evolution

→ Tool to study higher order QCD reactions

Forward Jets in CASTOR (with 3.5 TeV beams)

Selection: 2 central jets with $E_T > 25 \text{ GeV}$, 1 jet in CASTOR region ($5.2 < \eta < 6.6$)

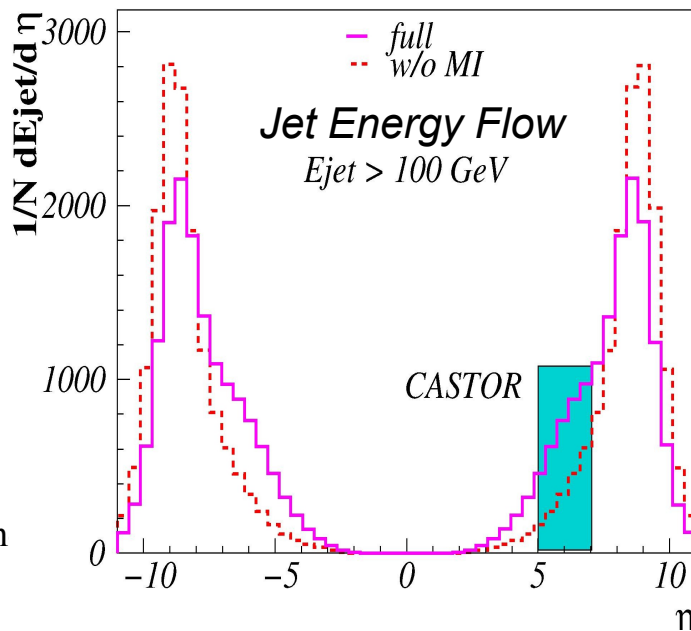
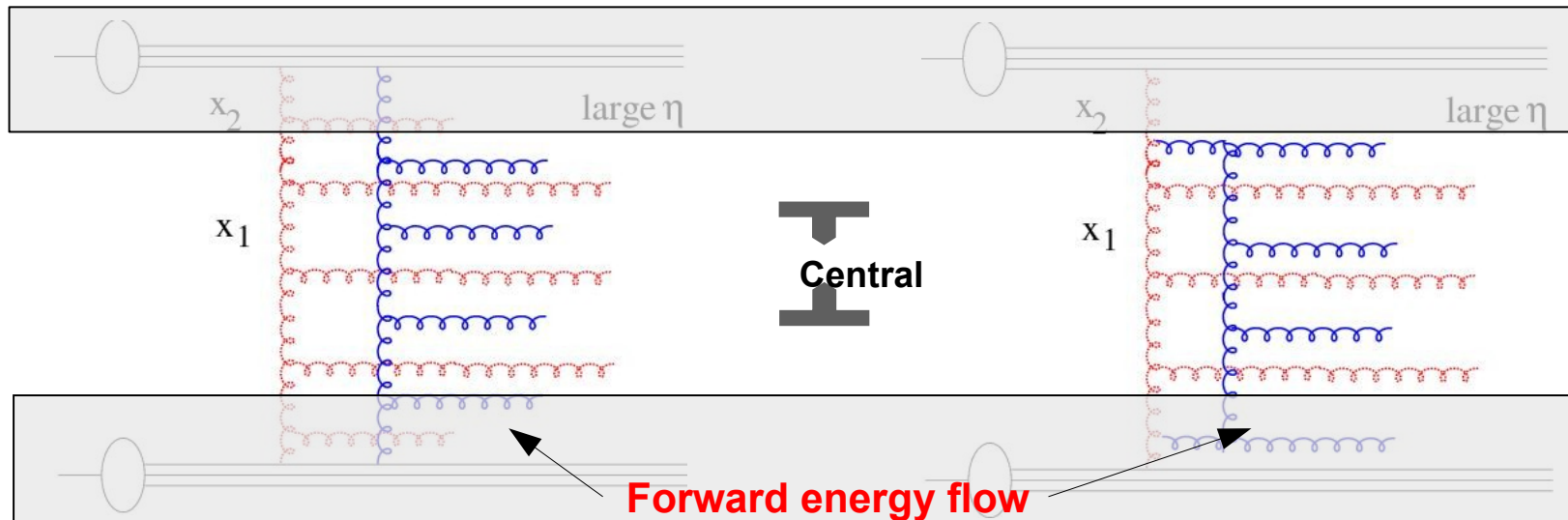
Study made for $< 1 \text{ pb}^{-1}$



➔ One of the first topics to be analyzed using CASTOR

Multi-parton Interactions

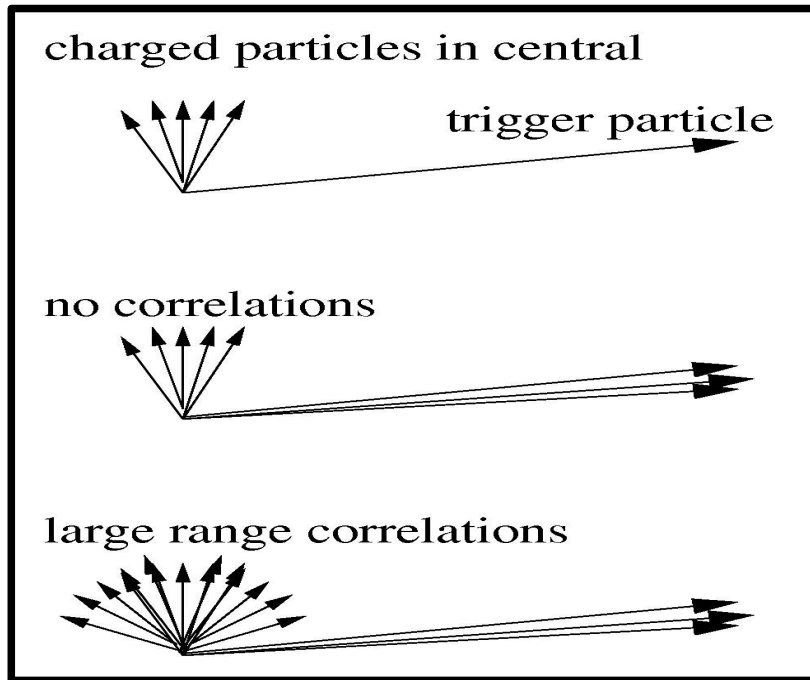
Can expect sensitivity to different MI scenarios close to the proton remnant (forward region).



MPIs affect the energy transferred from the beam remnant.

Sensitivity in the **CASTOR** region.

Long range correlations and MI

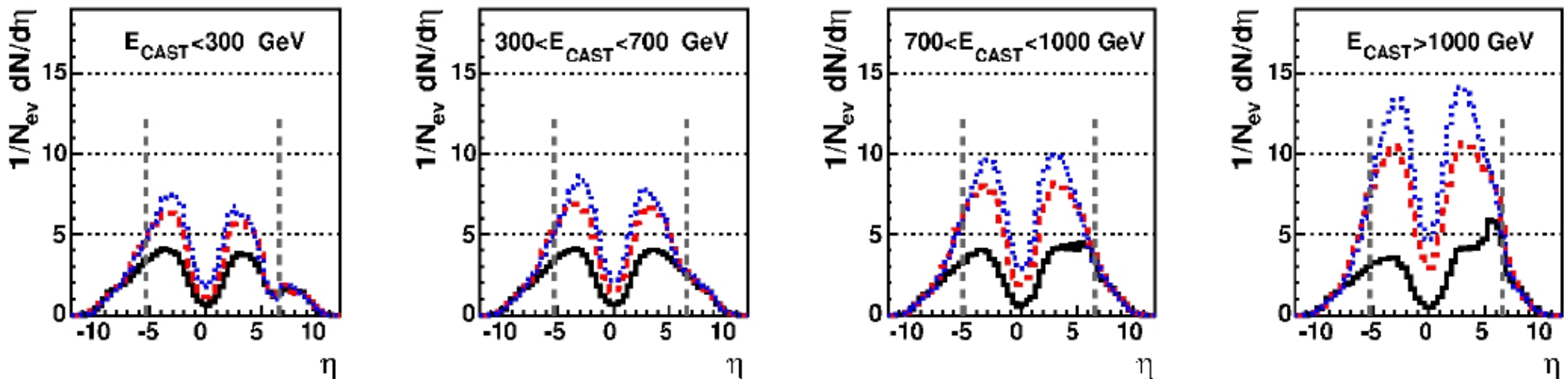


QCD events

- **With MPI:**
Large energy of trigger in CASTOR,
Higher particle multiplicity in central region
- **Without MPI:**
No, or very small, correlation

PYTHIA:

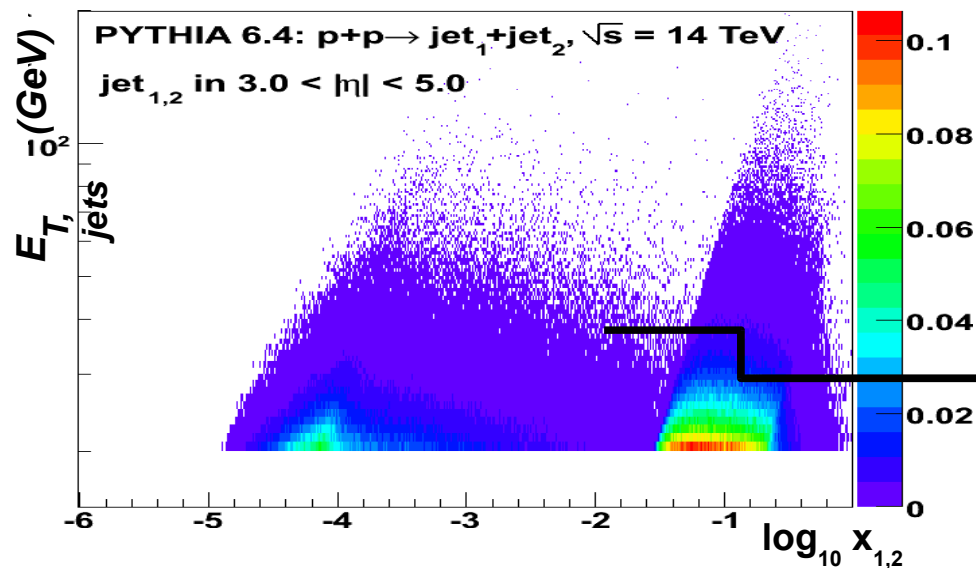
- Rick-Field's CDF tune A (tune A)
- Sandhoff-Skands tune 0 (tune S0)
- MI switched off



(CASTOR particles smeared according to beam test data + 1 GeV noise cut applied.)

Backup Slides

Forward means Low x



Jets in CMS Hadronic Forward Calorimeter
 $(3 < \eta < 5)$

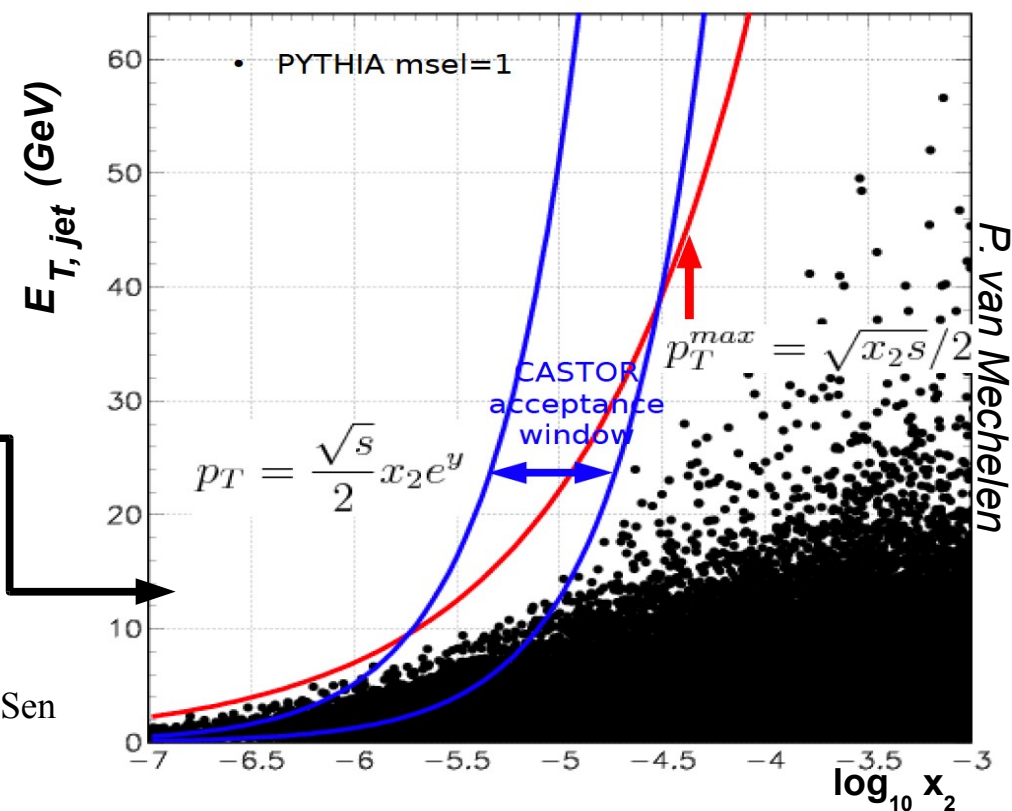
$$x \sim 10^{-5}$$

Dijets, at least one jet in HF
 CMS note PAS-FWD-08-001

2 units in rapidity

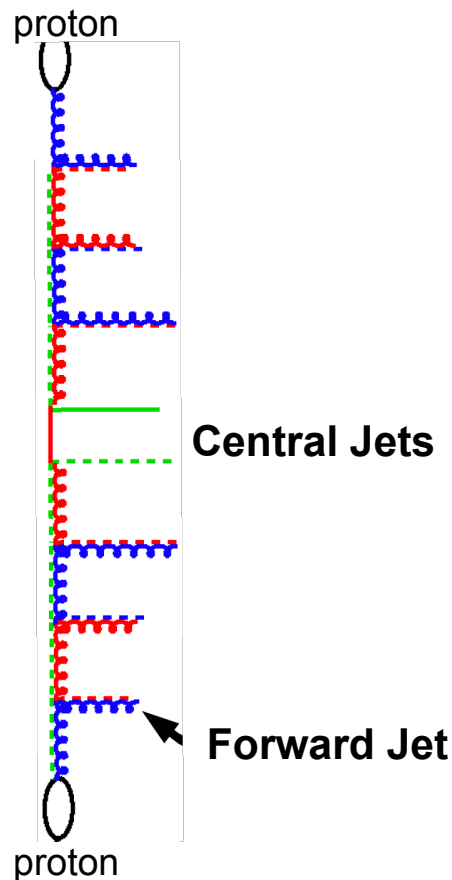
 Roughly 1 magnitude in x

Dijets with at least one jet in CASTOR
 $(5.2 < \eta < 6.6)$
 $x \sim 10^{-6}$

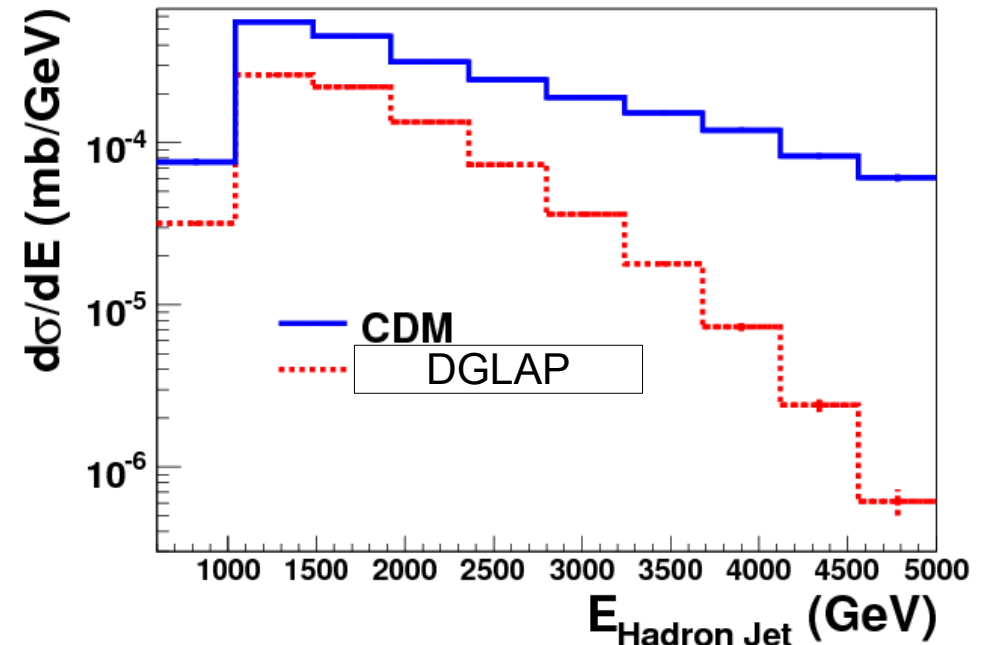


Forward Jets in CASTOR (with 7 TeV beams)

Selection: 2 central jets, 1 jet in CASTOR region ($5.2 < \eta < 6.6$) with $E_T > 10$ GeV



Hadron level – Generator studies



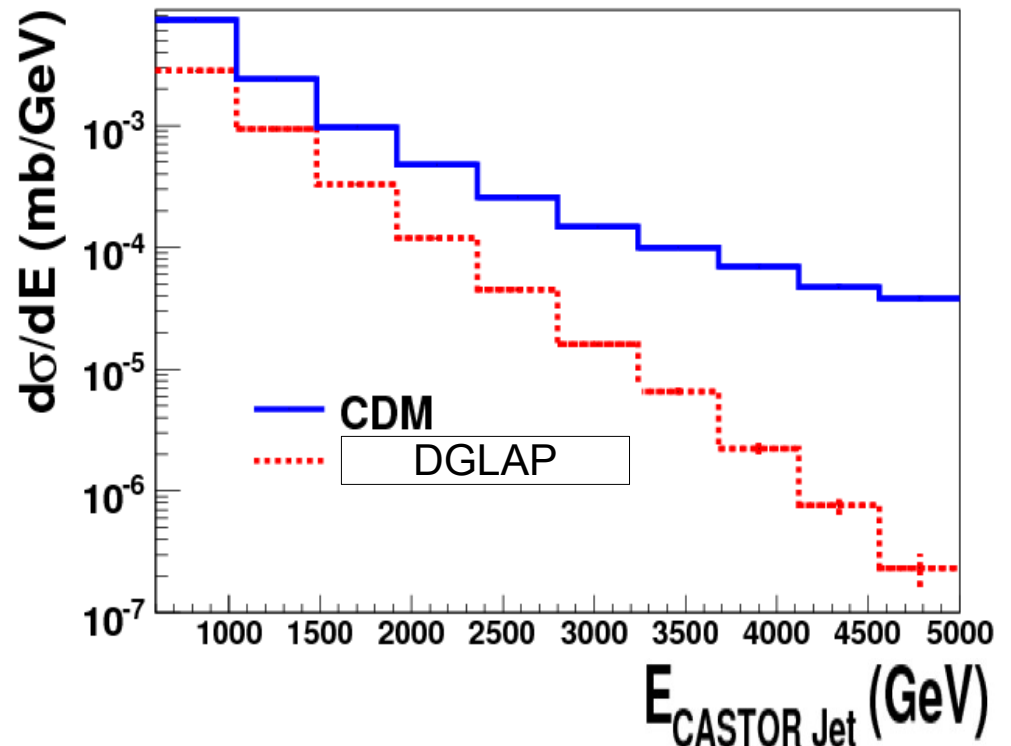
➡ CDM (BFKL like final state) predicts more hard jets in the CASTOR region

CASTOR Jets

- Selection: 2 central jets with $E_T > 10$ GeV , 1 jet in CASTOR region ($5.2 < \eta < 6.6$)
- Instead of conventional jet algorithm: “**CASTOR Jets**” (most active segment + neighbours)

Particle energy smeared according to test beam data

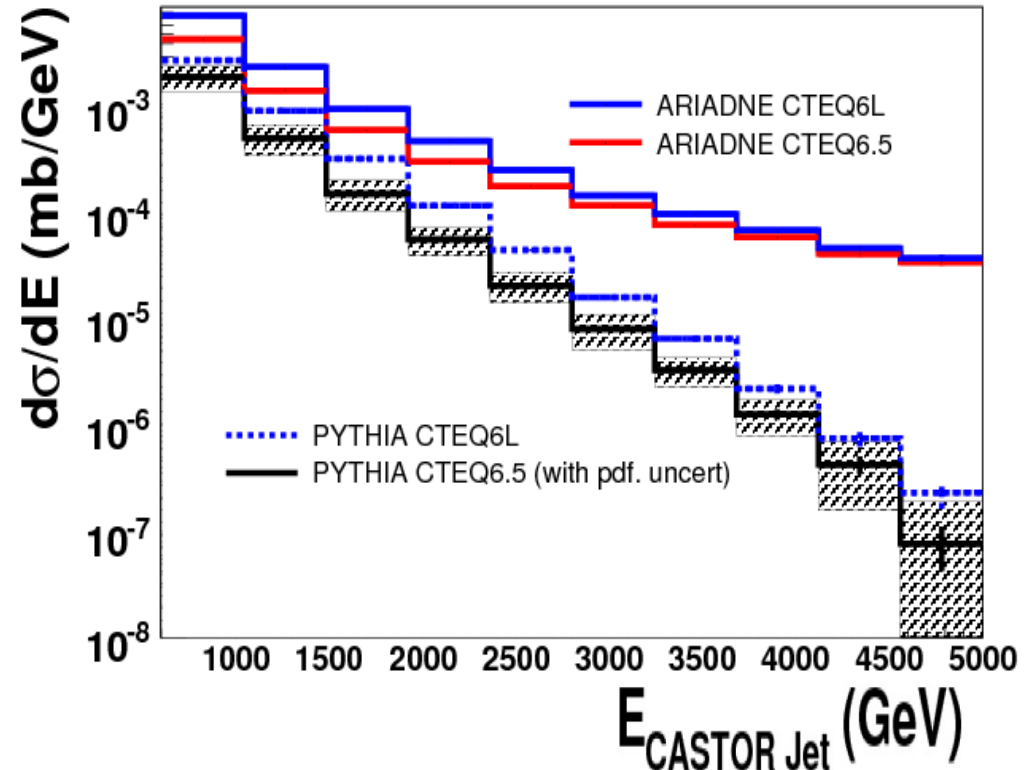
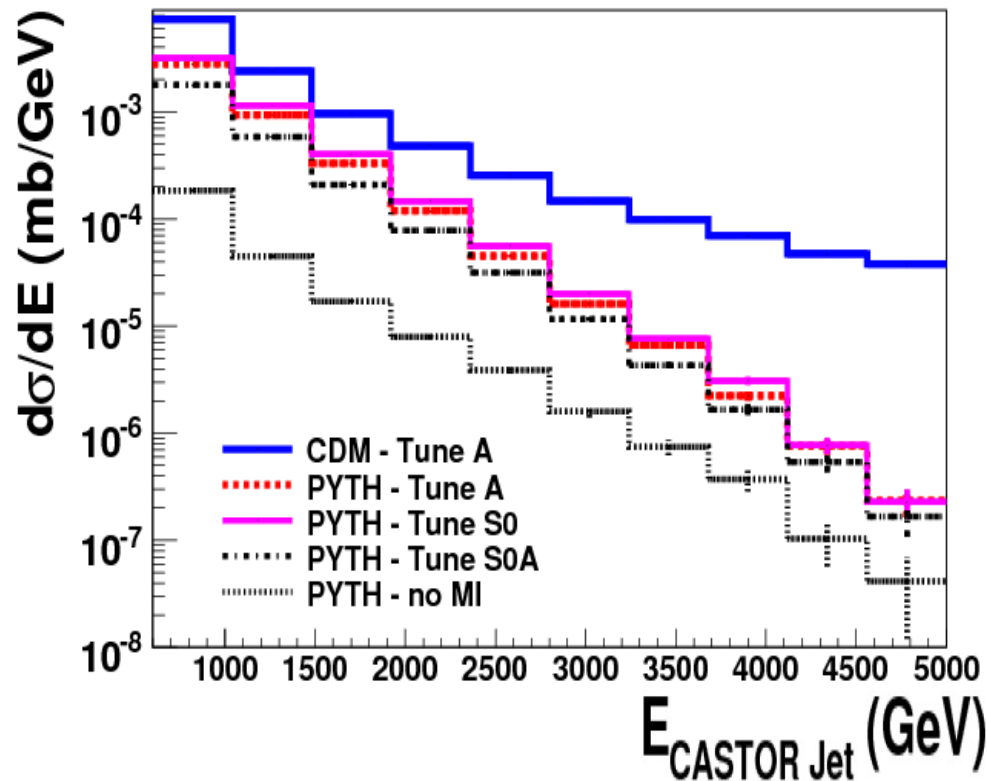
Noise cut of particles ($E_{\text{particles}} > 1$ GeV)



➡ **Measurements distinguish between different QCD models (DGLAP/non-DGLAP)**

Uncertainty from PDFs & MI

Selection: 2 central jets with $E_T > 10$ GeV, 1 jet in CASTOR region ($5.2 < \eta < 6.6$)

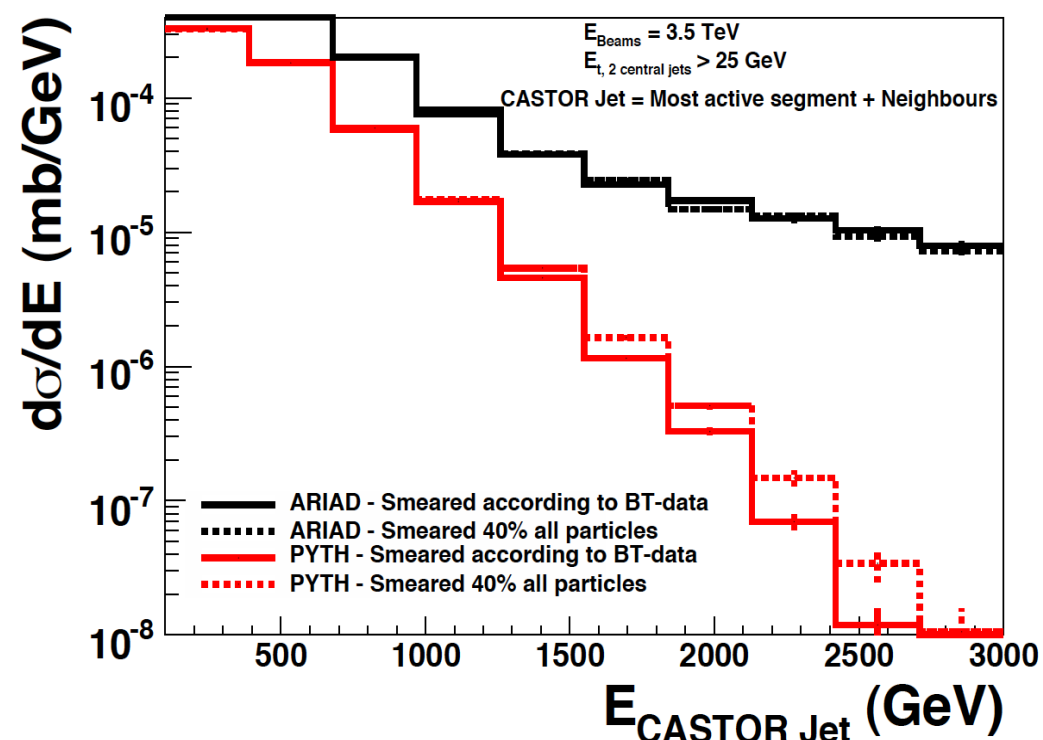
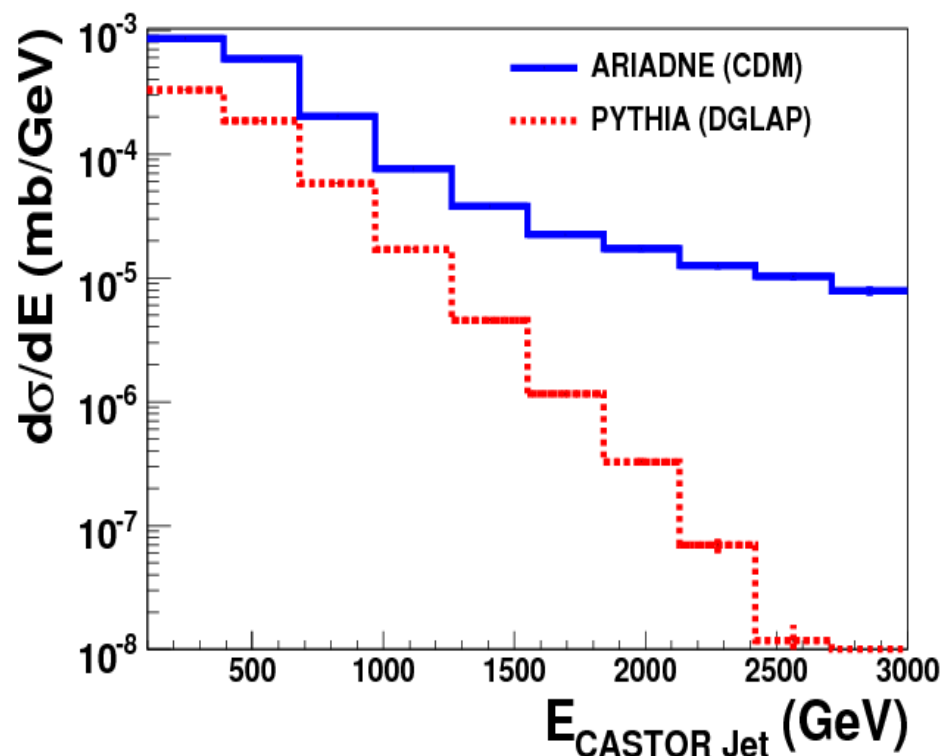


- Large effect from switching MI off in MC.
- Difference between CDM and PYTHIA still large at high energies
- DGLAP/non-DGLAP separation $\gg$ PDF uncertainty/sensitivity at high energies

Forward Jets in CASTOR (with 3.5 TeV beams)

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