

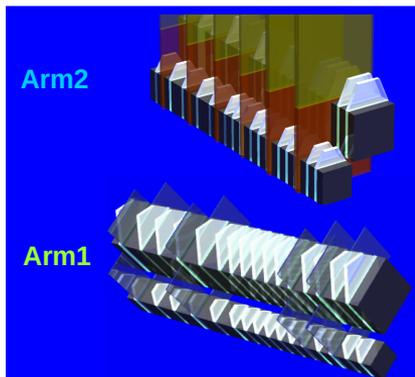


# Very-forward $\pi^0$ production cross section in proton-proton collisions at $\sqrt{s} = 13$ TeV measured with the LHCf experiment

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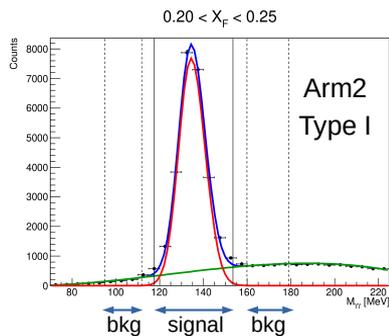
## The LHCf experiment

- Two independent detectors, placed  $\sim 140$  m from the Interaction Point 1 (IP1) along the beam line on opposite sides: **Arm1** and **Arm2** [1]
- Each detector is made of **two** sampling and position sensitive **calorimeters** with thickness  $\sim 44 X_0$  ( $\sim 1.6 \lambda$ ) and different transverse dimensions
- Transverse position measurement:
  - Arm1: GSO bars [2]
  - Arm2: silicon microstrip detectors
- Measurement of **very forward** neutral particles (photons [3,4], neutrons [5-7],  $\pi^0$  [8-10])
- Experimental data in the very forward region are fundamental for the tuning of **hadronic interaction models** used to simulate the interaction of cosmic rays with the atmosphere



## $\pi^0$ reconstruction

- Two typologies of  $\pi^0$  events detected:
  - one photon in each calorimeter ("**Type I**")
  - two photons in the same calorimeter ("**Type II**")
- Invariant mass measured from the reconstructed transverse hit position for the two photons and their energy
- Signal fitted with an asymmetric Gaussian, background with a 3<sup>rd</sup> order polynomial
- Signal window within  $3\sigma$  from the peak
- Background  $p_T$ -dependence estimated within 4-7  $\sigma$  from the peak on both sides ("**sideband method**")
- Unfolding procedure to correct selection efficiency and energy/position resolution effects



## References

- [1] O. Adriani et al., JINST **3** (2008) S08006.
- [2] Y. Makino, A. Tiberio et al., JINST **12** (2017) P03023.
- [3] O. Adriani et al., PLB **703** (2011) 128.
- [4] O. Adriani et al., PLB **780** (2018) 233.
- [5] O. Adriani et al., PLB **750** (2015) 360.
- [6] O. Adriani et al., JHEP **2018** (2018) 1.
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- [8] O. Adriani et al., PRD **86** (2012) 092001.
- [9] O. Adriani et al., PRC **89** (2014) 065209.
- [10] O. Adriani et al., PRD **94** (2016) 032007.

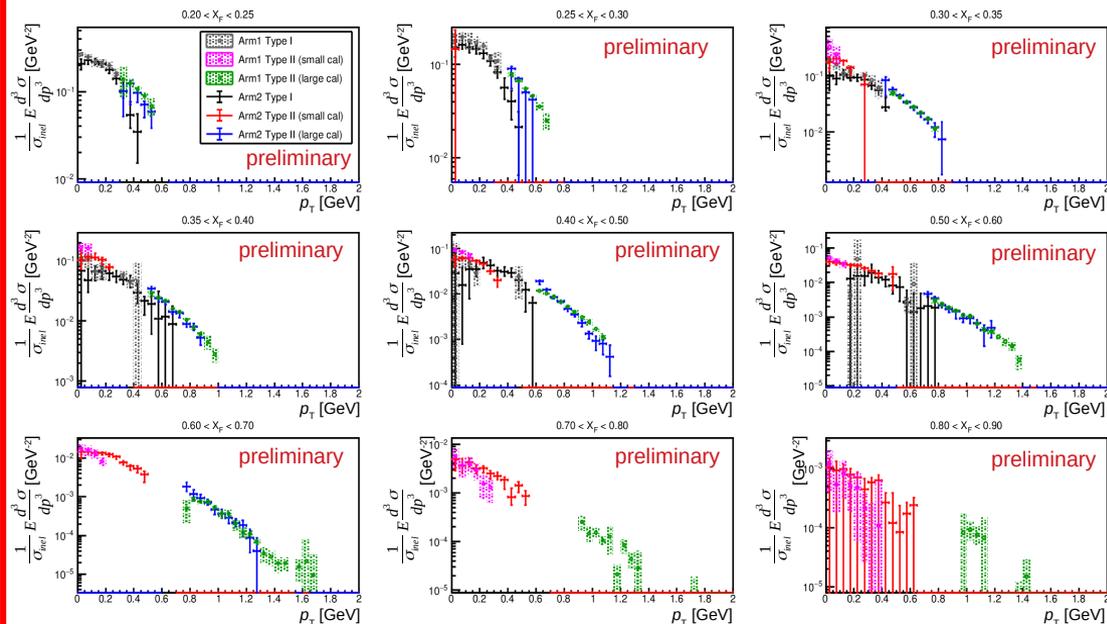
## Data set

- LHC fill #3855 (p-p at  $\sqrt{13}$  TeV)
- $\sim 14$  hours of data taking with luminosity:  $0.3\text{-}1.6 \times 10^{29} \text{ cm}^{-2} \text{ s}^{-1}$

## Integrated luminosity

- Type I  $\pi^0$ : **2.1 nb<sup>-1</sup>** (dedicated trigger without prescaling)
- Type II  $\pi^0$ : **0.8 nb<sup>-1</sup>**

## Results



- Good agreement** between Arm1 and Arm2 data and between "Type I" and "Type II" events
- Arm2 acceptance covers the gaps in Arm1 data for  $X_F < 0.6$  and extends the low- $p_T$  coverage for  $X_F > 0.6$ , while Arm1 extends the acceptance to higher  $p_T$