



# $\pi^0$ analysis status

Alessio

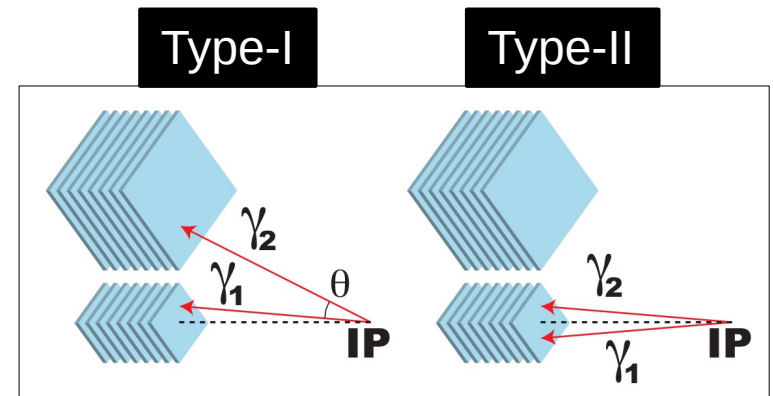
LHCf Collaboration Meeting  
Nagoya, 2023/10/16

## ► Nominal position: Fill 3855

- ★ run 44299-44472 (pile-up = 0.01)
  - ★  $L_{\text{int}} = \mathbf{0.194 \text{ nb}^{-1}}$  (both type I and type II)
- ★ run 44482-45106 (pile-up = 0.03)
  - ★  $L_{\text{int}} = \mathbf{0.620 \text{ nb}^{-1}}$  (type II)
  - ★  $L_{\text{int}} = \mathbf{1.94 \text{ nb}^{-1}}$  (type I, no prescaling)

## ► +5mm position: Fill 3851

- ★ run 43321-43598 (pile-up = 0.03)
  - ★  $L_{\text{int}} = \mathbf{0.290 \text{ nb}^{-1}}$  (type II)
  - ★  $L_{\text{int}} = \mathbf{0.990 \text{ nb}^{-1}}$  (type I, no prescaling)



## ▶ Preselection

- ★ Energy cut ( $E > 200$  GeV)
- ★ Position cut (2 mm fiducial border)
- ★ PID cut ( $L_{90\%} > \text{threshold}$ , with 90%  $\pi$  selection efficiency)
- ★ Multi-hit cut

## ▶ Signal selection and background subtraction

- ★ Sideband method (!)

## ▶ Correction for efficiency and resolution

- ★ correction applied bin-by-bin (no unfolding)

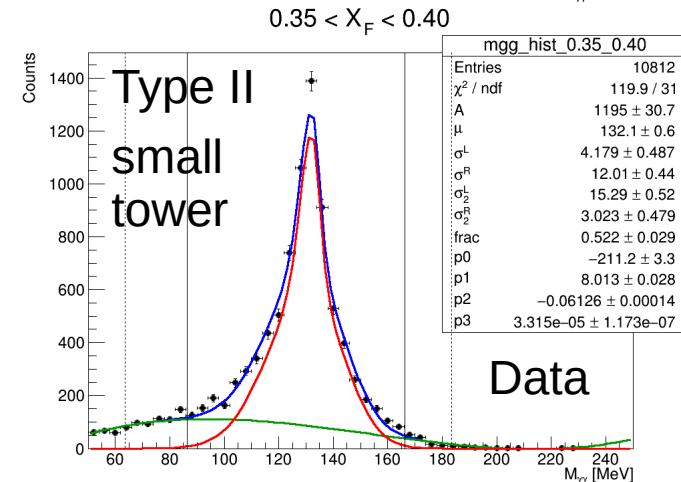
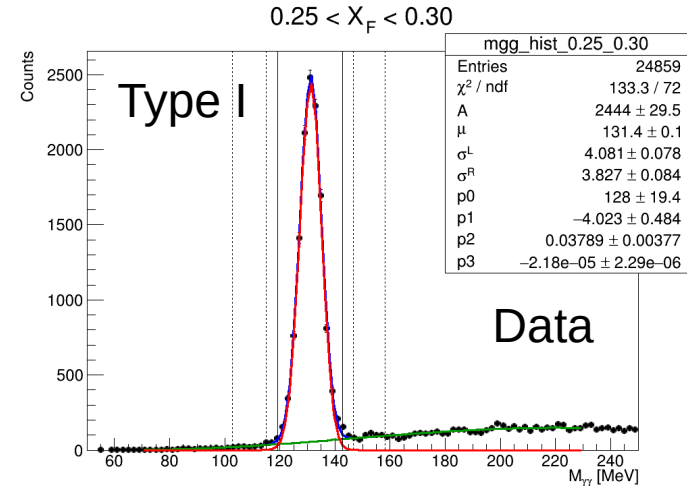
## ▶ Geometrical acceptance correction

- ★ toy MC simulation (!)

## ▶ Assign systematic uncertainties

- ★ beam centre, PID cut, energy scale, sideband method, luminosity

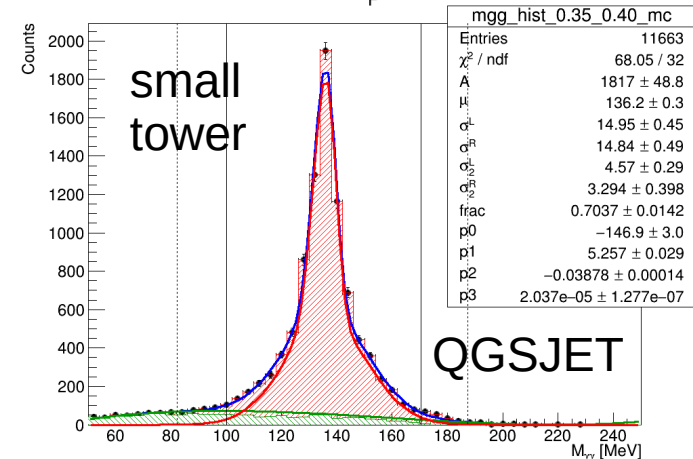
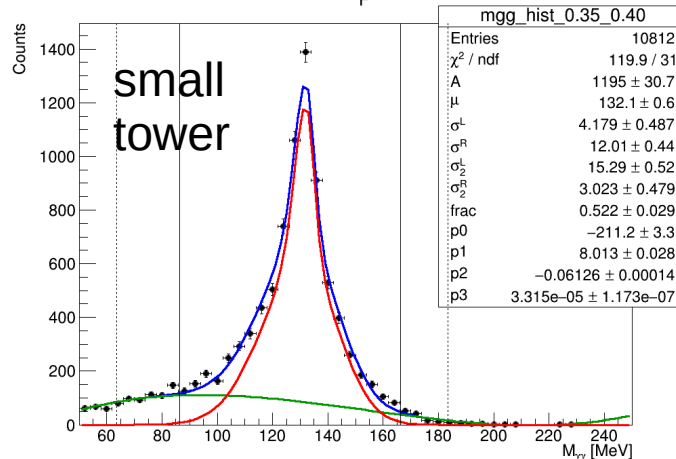
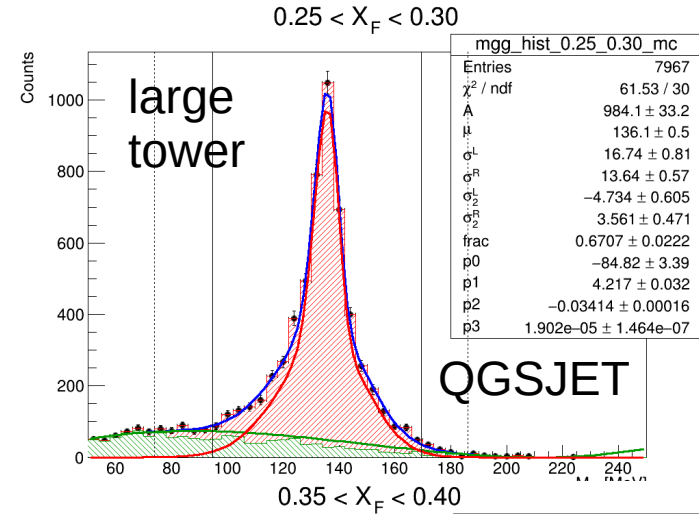
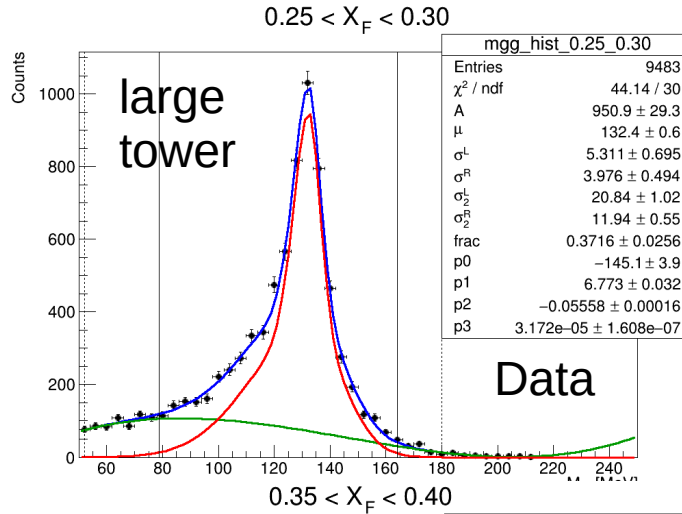
- ▶ Select events in signal window
- ▶ Background subtraction:
  - ★ Estimate background spectrum from background windows
  - ★ Estimate number of background events from the integral of background fit function in signal window
- ▶ In type II events big tails on both side of the peak
- ▶ **Temporary workaround:** fit peak with a two-components Gaussian



# Type II invariant mass issue



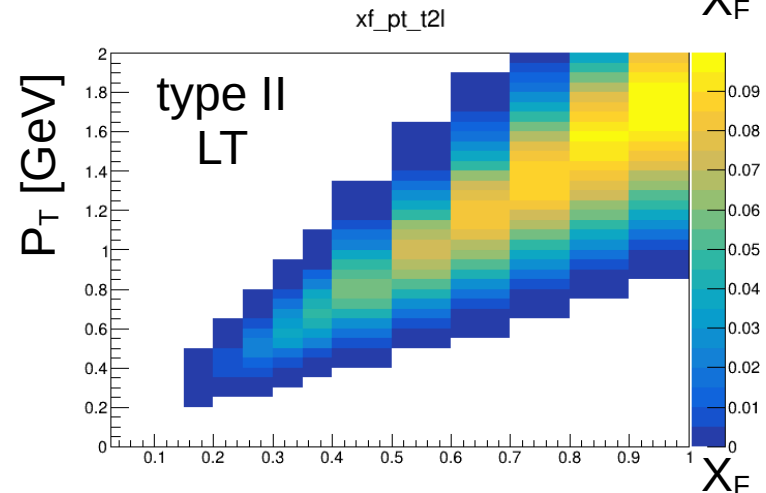
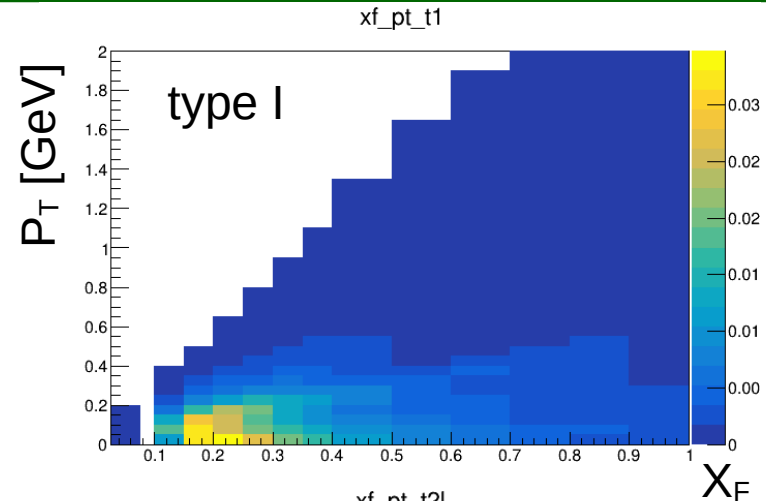
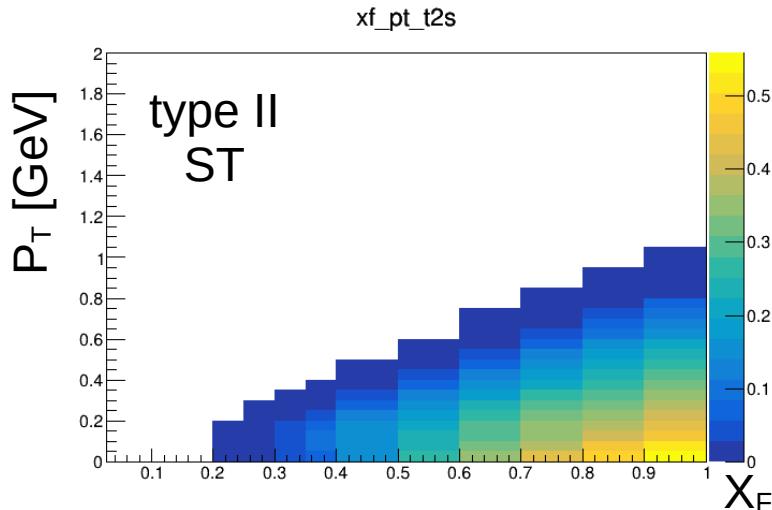
- ▶ That issue is present also in MC
- ▶ Check energy sharing algorithm and position fit function for multi-hit



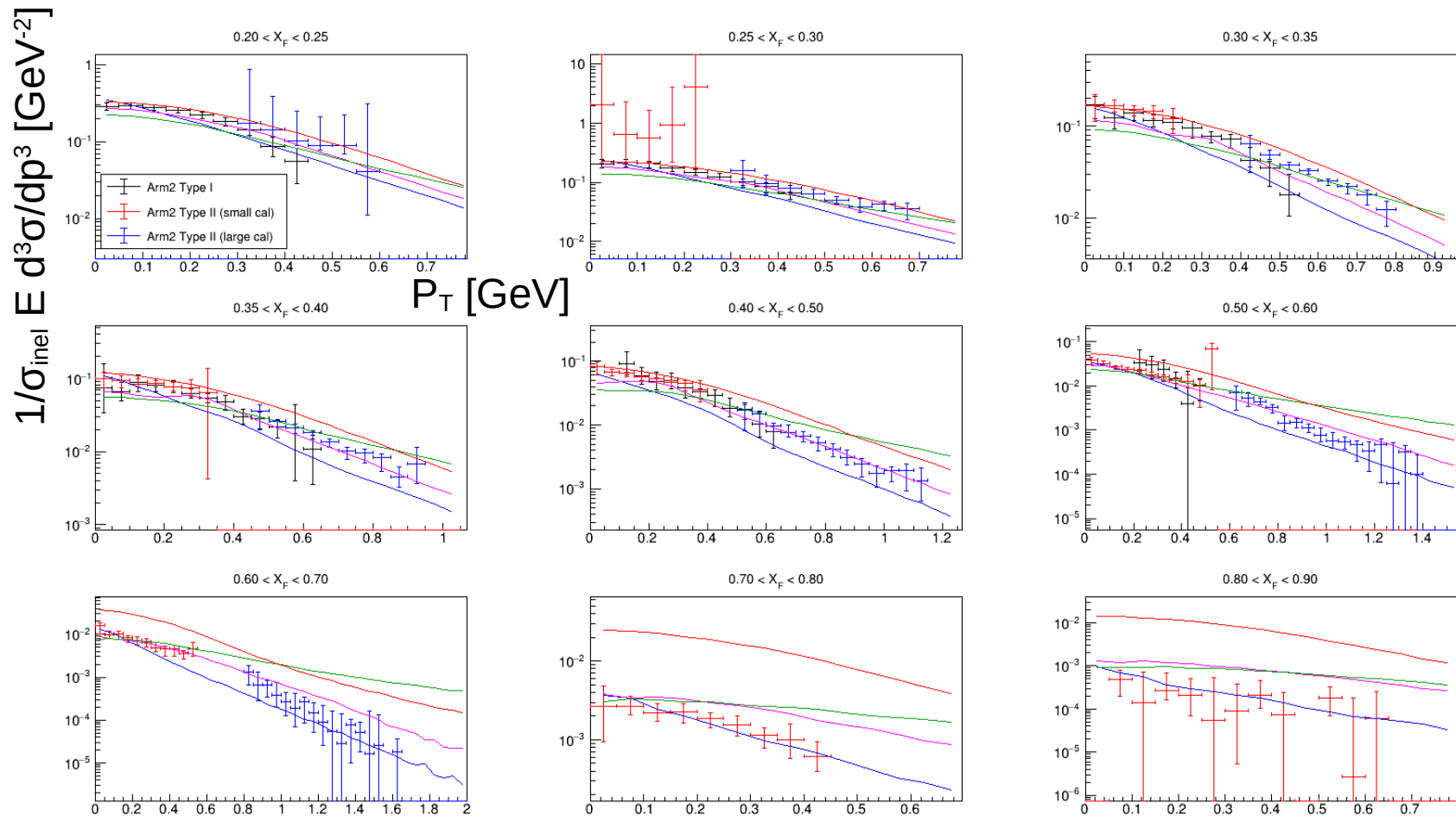
# Acceptance correction



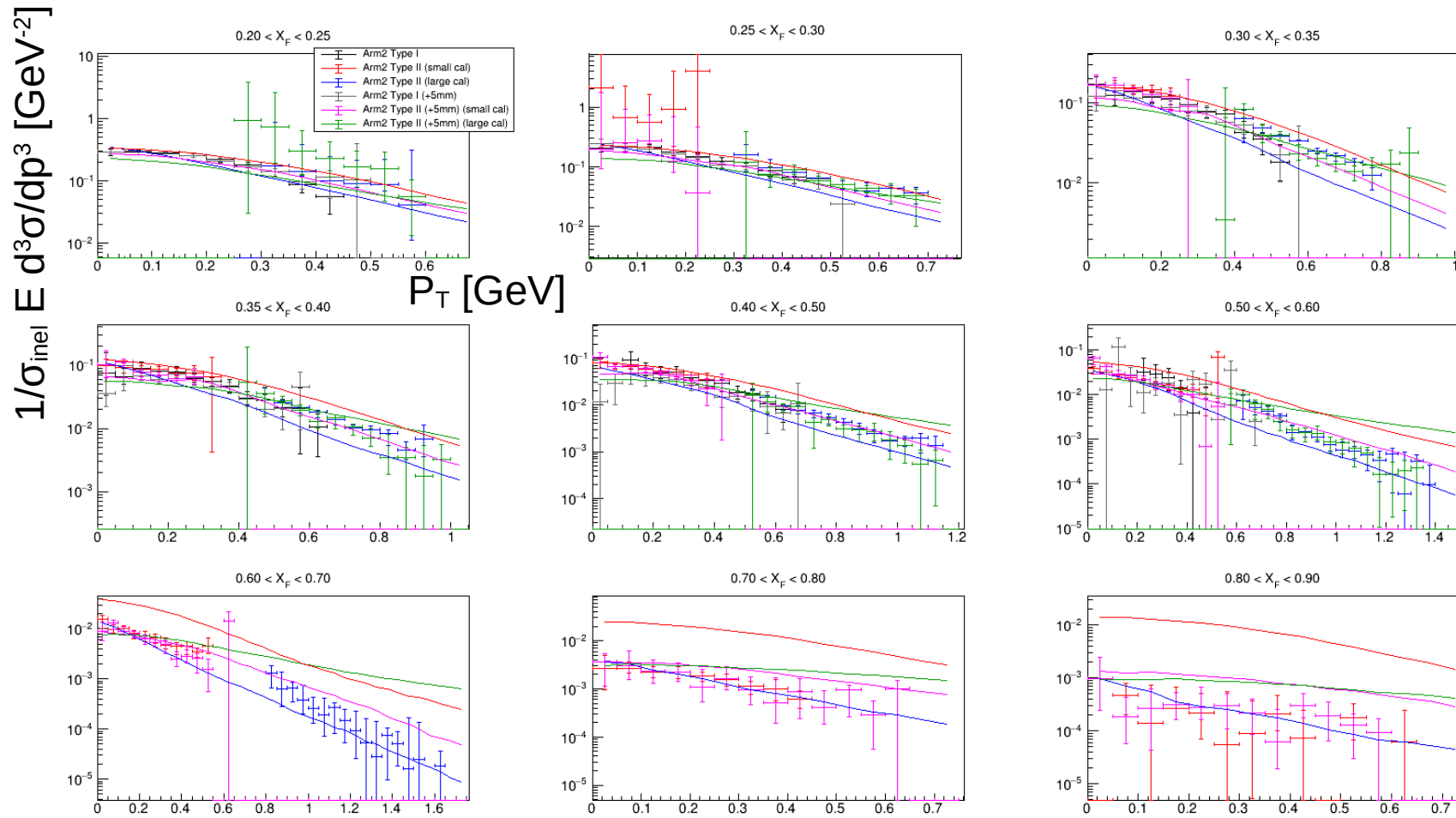
- ▶ Acceptance calculated with a toy MC simulation
- ▶ However, testing it with full MC simulation it does not reproduce the generator spectrum from the one at TAN
- ▶ **Temporary workaround:** calculate it from full MC simulation (drawback: low statistics)



# $\pi^0$ $P_T$ vs $X_F$ spectrum



# $\pi^0$ $P_T$ vs $X_F$ spectrum: +5mm higher position

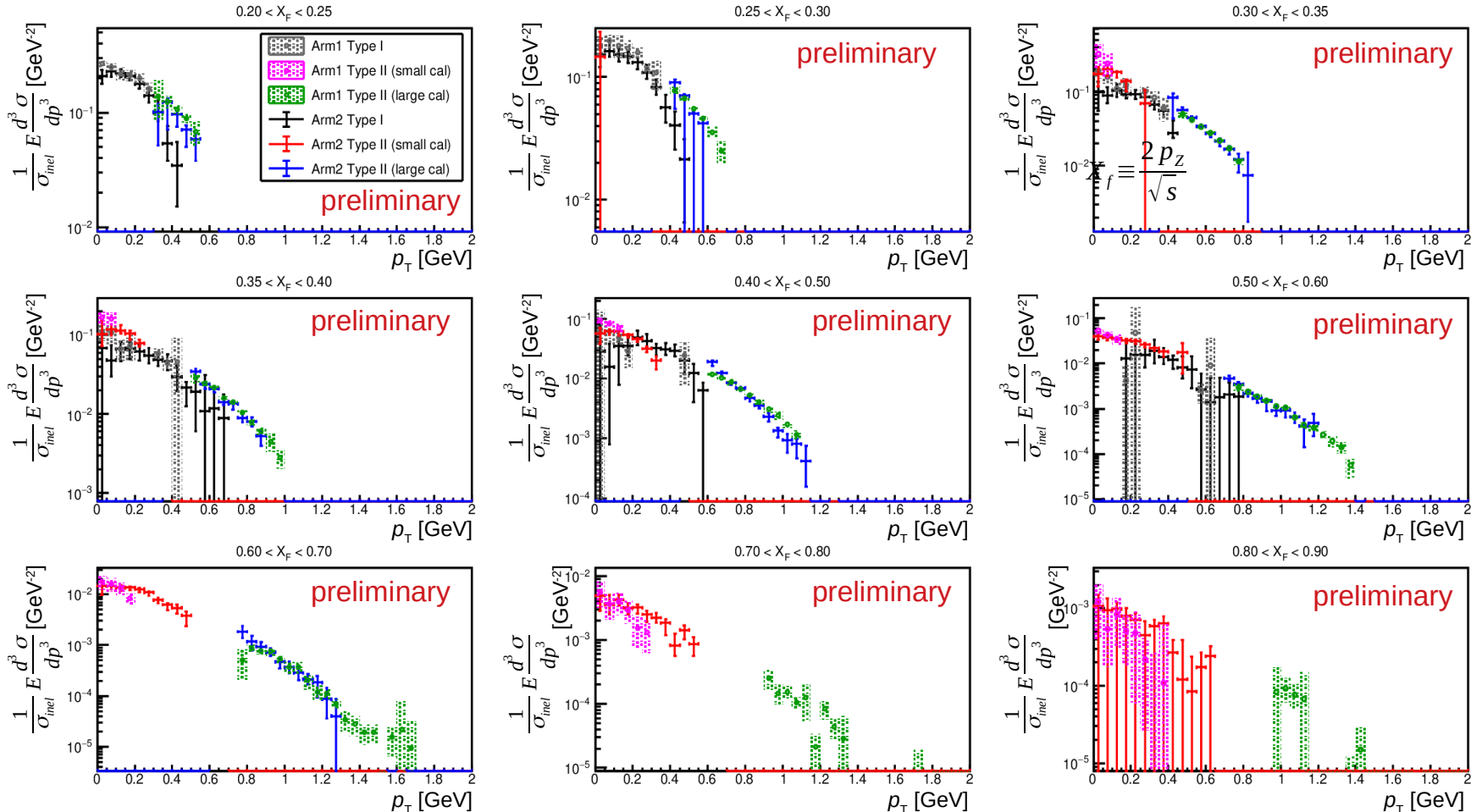




- ▶ Understand and fix Type II mass spectrum tails
- ▶ Fix geometrical acceptance toy MC
- ▶ Check background from beam-gas and beam pipe interactions (expected to be negligible)
- ▶ Check if pile-up is relevant
- ▶ Reduce energy scale systematic as in eta paper (2.7% → 1%)
- ▶ Add systematics for MC model dependant corrections
- ▶ Update inelastic cross section ( ATLAS 73.6 mb → TOTEM 79.5 mb)

backup

# Arm1 vs Arm2



# $\pi^0 P_T$ vs $X_F$ spectrum (same axes range)

