

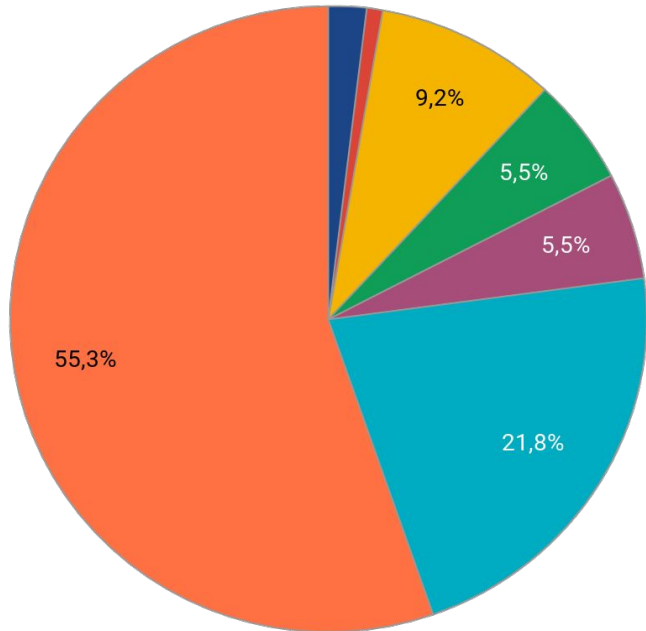
Studies of properties of soft diffractive events based on output from Pythia Monte Carlo generator

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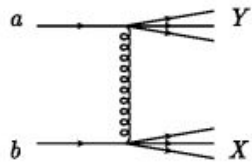
Tutor: dr Maciej Trzebiński, IFJ PAN
IFJ PAN PPSS 2019
02.08.2019



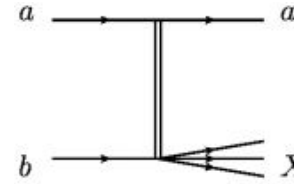
Particle Production Processes at the LHC



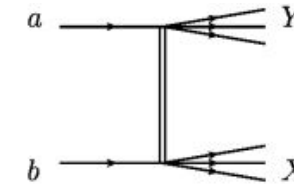
- Hard QCD
- Central diffractive
- Double diffractive
- Single diffractive AB->XB
- Single diffractive AB->AX
- Elastic AB->AB
- non-diffractive



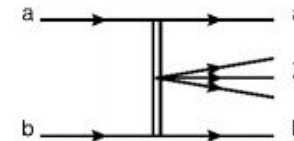
non-diffractive production



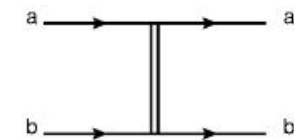
← single diffraction



← double diffraction

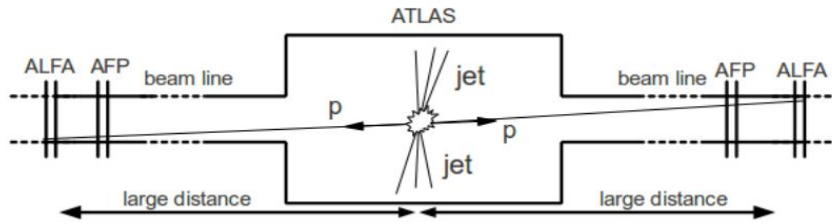


← central diffraction



← elastic scattering

Motivation: ATLAS Data

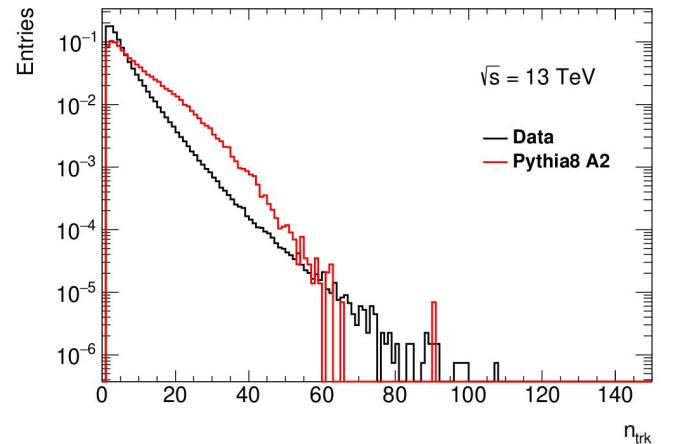
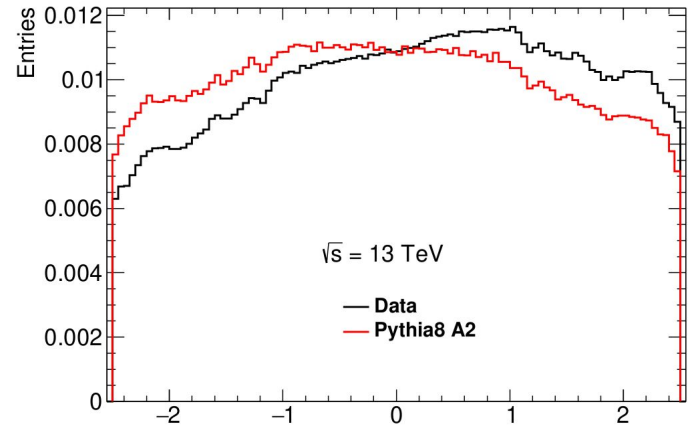


Diffractive events were measured by ATLAS Experiment.

Information about particles produced centrally was enriched by information about scattered proton measured by ATLAS Forward Proton detectors.

Initial results show disagreement between data and MC in basic particle distributions:

- number of charged particles,
- their p_T spectrum and
- pseudorapidity (η) spectrum.



Monte Carlo Generators

- Widely used in high energy physics.
- Allow to take into account e.g. detector effects → data interpretation.
- MC engines based on physics models.
- Models have adjustable parameters.



Our case:

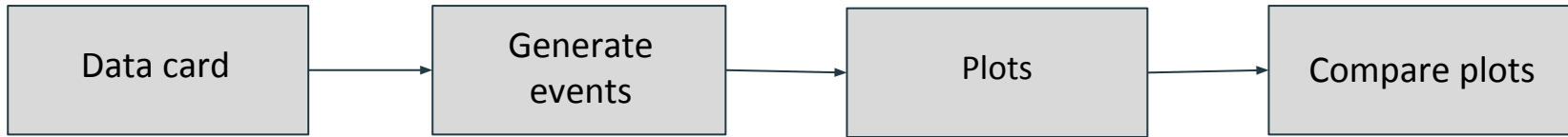
- PYTHIA 8.243.
- MBR model*
- Parameters:
 - MBRepsilon } parameters of Pomeron trajectory.
 - MBRalpha
 - MBRsigma0 - total Pomeron-proton coupling cross section.
 - MBRbeta0 - Pomeron-proton coupling.
 - MBRm2Min - lowest mass-squared of the dissociated system.
 - MBRdyminflux - minimum width of the rapidity gap.
 - MBRdyminSig } cross section suppression for small gap region.
 - MBRdymin

* R. Ciesielski, K. Goulios, *MBR Monte Carlo Simulation in PYTHIA8*, arXiv:1205.1446

Our Project

Reminder: Pythia MC predictions disagree with ATLAS data.

Aim: to check how these parameters modify particle distributions.

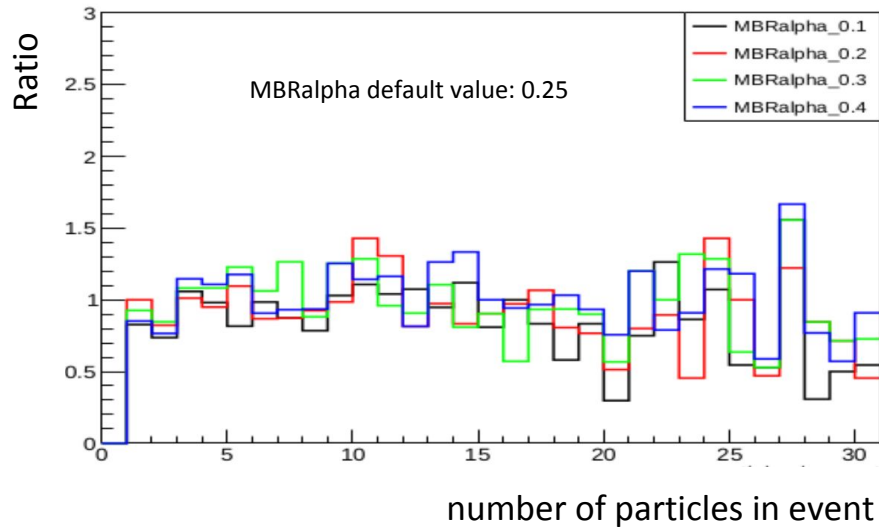


Used cuts:

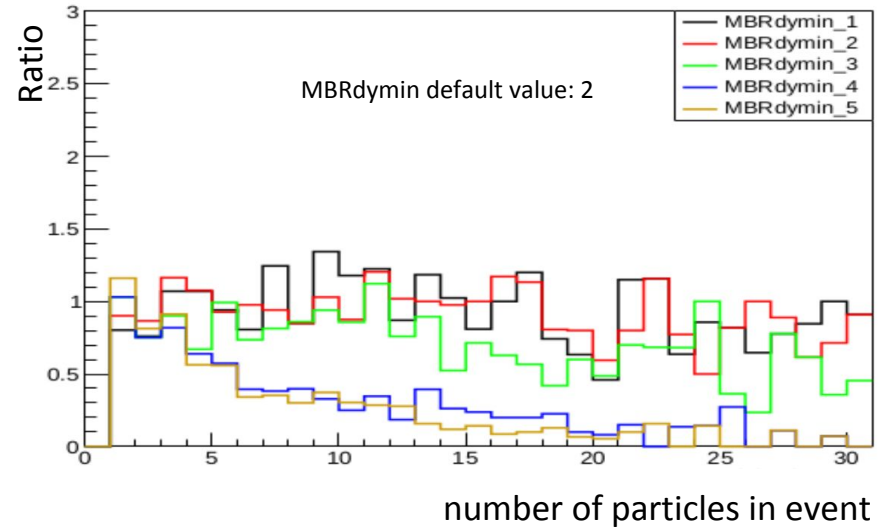
- $0.01 < \xi < 0.2$ - preselection for a proton - at least one of such ξ ,
- $p_z < 0 \rightarrow 0.02 < \xi < 0.1$ - AFP detector acceptance (proton on side C),
- non-zero charge - ATLAS tracker sensitive only to charged particles,
- $|\eta| < 2.5$ - acceptance of ATLAS tracker,
- $p_T > 500$ MeV - standard reconstruction threshold in ATLAS tracker.

Results - Example

Ratio close to 1 \rightarrow no change in shape



Ratio smaller than 1 \rightarrow visible change in shape



Summary

Parameter	Default	Range	n slope	pT slope	η slope	$\sigma \cdot \epsilon / (\sigma_{\text{def}} \cdot \epsilon_{\text{def}})$
MBRalpha	0.25	0.1 - 0.4	no change	no change	no change	(0.95; 1.07)
MBRbeta0	6.566	2 - 10	< def* → smaller avg. multiplicity	slightly smaller pT	no change	(0.90; 1.33)
MBRdymin	2.0	1 - 5	> def* → smaller avg. multiplicity	less particles with high pT	no change	(1.09; 0.57)
MBRdyminflux	2.3	1 - 5	no change	no change	no change	(1.02; 1.10)
MBRdyminSig	0.5	0.001 - 5	no change	no change	no change	(1.00; 0.87)
MBRepsilon	0.104	0.02 - 0.14	< def* → smaller avg. multiplicity	no change	no change	(0.89; 1.03)
MBRm2Min	1.5	1 - 2	no change	no change	no change	(0.95; 0.96)
MBRsigma0	2.82	1 - 5	> def* → smaller avg. multiplicity	no change	no change	(0.46; 1.77)

*default value of parameter

- We checked which parameters have an impact on particle distribution.
- Encouraging initial results - should trigger further studies in this direction!

