Qualification Task

The Study of Potential Common Joint-Data Taking Between ATLAS, AFP, ZDC and LHCf Detectors

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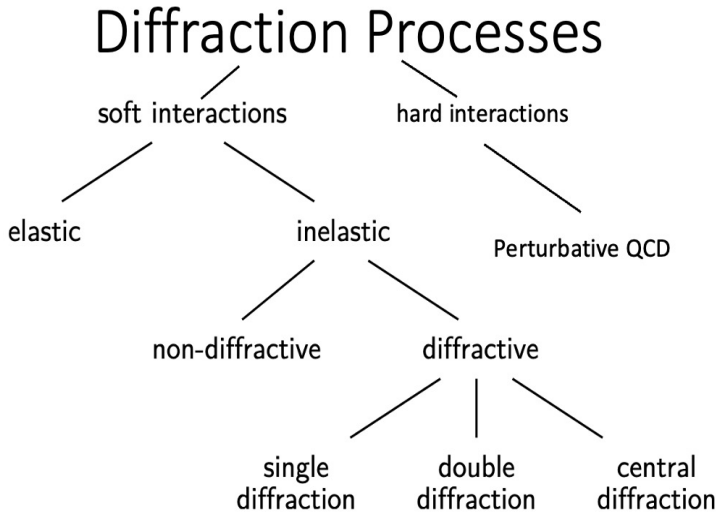
HELMHOLTZ RESEARCH FOR GRAND CHALLENGES

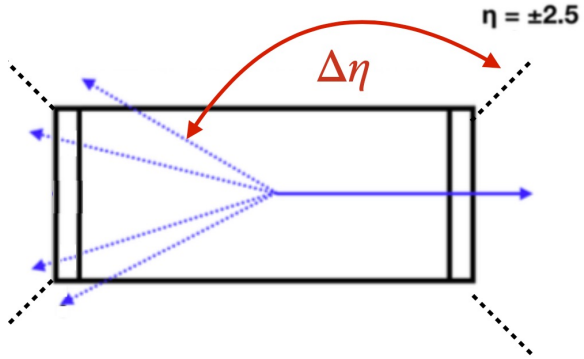
DESY.

Motivation

- Forward studies at LHC focus on diffraction processes
- Diffraction processes are poorly understood yet constitute of ~10% of total LHC cross-section
- The forward studies aim to improve MC generators for cosmic ray air showers and pile-up modelling



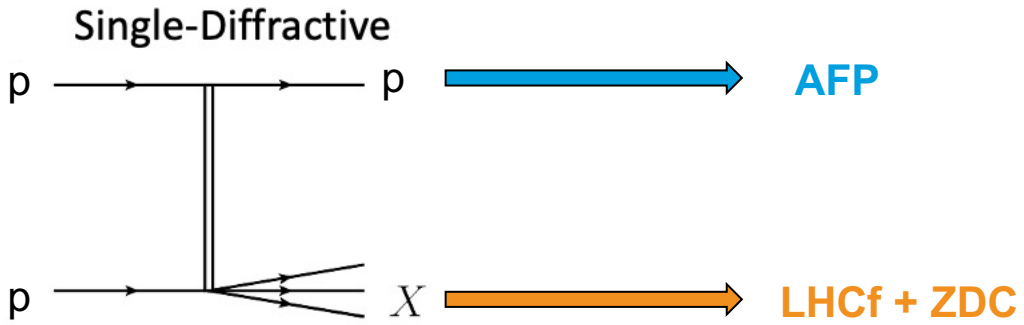
- Diffractive processes, in general, are identified by the large rapidity gaps at the final state
- Single diffractive (SD) processes has one intact proton and one disassociated proton after color singlet “Pomeron” exchange

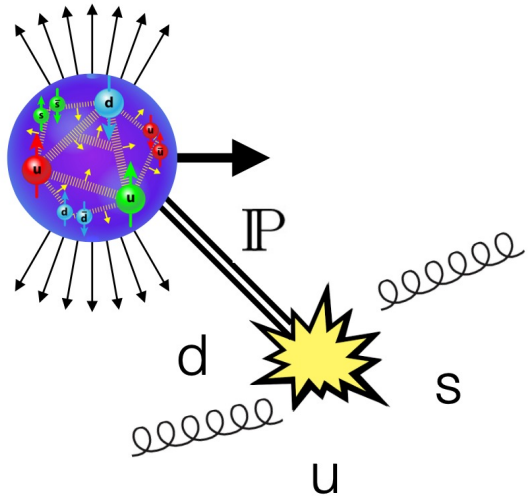


Large rapidity gap

Motivation

Single Diffractive Processes

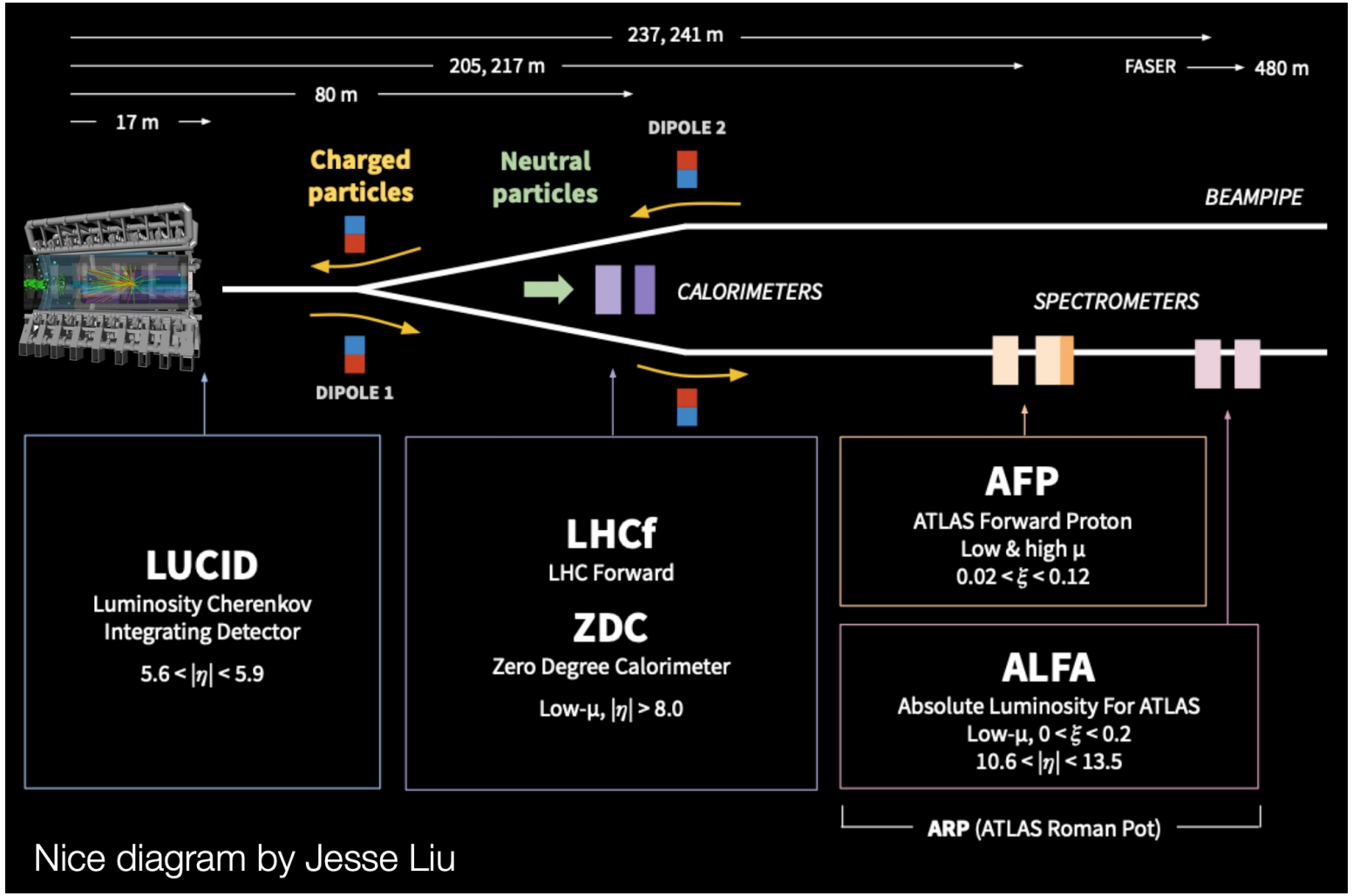




Pomeron exchange between two protons

- Single diffractive processes are studied before with only neutral coming data from LHCf or ZDC.
- Proton tagging with AFP has a potential of improving single diffractive process selection rate, thus improved uncertainty level for the research.
- The combination of LHCf and ZDC detectors also promises an improvement in the energy resolution of neutral particle detection.

Motivation



- **AFP**
  - is a proton detecting system that sits next to a beampipe
  - which can be used for the tagging of intact proton in SD processes
- **ZDC and LHCf**
  - measure neutral particles even at “0 degree” angle
  - which can be used for the reconstruction of the secondary particles coming from disassociated proton

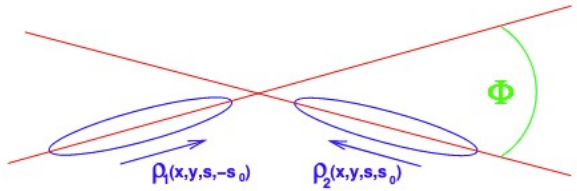
Goals and Methodology

- Determine common acceptance for AFP + LHCf + ZDC (+ ATLAS) using uniform distribution
    - The common acceptance of combinations of detectors will be studied using the simulated events, assuming nominal beam optics for Run 3 low pile-up running.
- Apply to single diffractive MC events to determine rates
    - Produce or re-weight (to higher collision energy) existing MC simulated samples of single-diffractive signal events.
    - Determine potential rates and kinematics accordingly.
- Optimise common acceptance
    - The beam optics and settings will then be modified to within reasonable limits in order to optimise the common acceptance.

Goals and Methodology

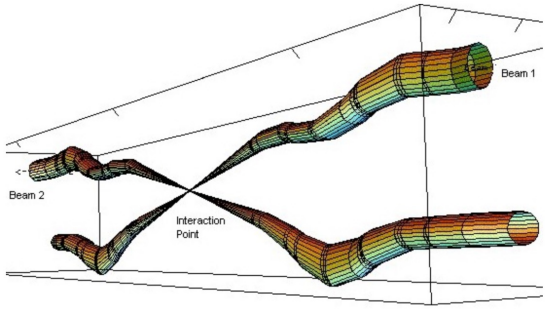
The interested beam optics for this study, so far, are “Crossing-Angle” and “Beta*” values.

Crossing Angle

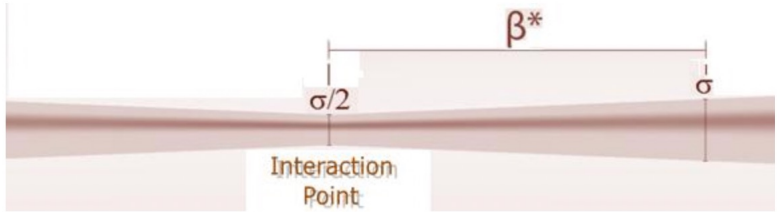


- The angle between two crossing bunches.
- Lower the angle higher the luminosity (collisions).
- For our study crossing-angle is chosen to be 290 µrad.

Beta Function



- The amplitude function, *β ,* is determined by the accelerator magnet configuration and powering.
- If β is low, the beam is narrower, "squeezed". If β is high, the beam is wide and straight.
- Amplitude function at the interaction point is called *β*.*
- For our study β* is chosen to be 19 m.



Sometimes β is referred as the distance from the focus point that the beam width is twice as wide as the focus point.

Timeline and Progress

- We are at the stage of determination of AFP acceptance values using standalone code provided by the AFP group. The code takes simulated beam optic conditions and produces particle kinematics in truth level (without any detector effects).
  - I have already managed to run the code and created kinematics data.
  - Plotting the acceptance values will be next.

- The QT plan includes extensions like (depending on the progress speed):
  - Study for a common trigger between detectors
  - Re-do of the study for planned proton-Oxygen run in Run3
    - p-O run is planned for 2024

- Dedicated LHCf + ZDC pp run is planned for right after the first Run 3 technical stop - June/July 2022
  - The plan is having a convincing results by this time for the inclusion of AFP into this data taking.

Thank you!