Fixed-target physics in Run2: LHCb started in 2015 a pioneering program in fixed-target configuration (SMOG)

- Detector geometry covers the forward direction
- Noble gas (He, Ne, Ar in Run2) injected into the LHC beam-pipe in ± 20 m from the nominal IP and p/Pb beam – atoms collisions studied, accessing a rich physics program!

But:
- No precise knowledge of the injected gas pressure → high systematic uncertainties for cross-section measurements
- Gas free to flow in a wide beam vacuum region → gas species and maximum pressure limited to ensure machine safety
- Gas overlapped with the pp luminous region → lower statistics since simultaneous pp and SMOG data-taking not possible

Run3 LHCb:
- Replacement of most of the subdetectors, the electronics and the DAQ system. New tracking system made up of a pixel vertex locator (VELO), upstream chambers (UT) and a forward scintillating-fiber (SciFi) detector
- Removal of the hardware trigger: full-software trigger reconstructing and selecting events at 40 MHz
- Real Time Analysis (RTA) project is responsible for the development of the LHCb data processing from Run3

Fixed-target physics in Run3 - Cell:
- SMOG2: confinement cell for the gas to be installed upstream of the nominal IP (z in [-500, -300] mm)[1,2]
  - Two retractable halves to cope with the Velo opening
  - Gas density increased by up to two orders of magnitude for the same gas flow
  - Equipped with sensors to measure the gas pressure
  - H₂, D₂, He, N₂, O₂, Ne, Ar, Kr, Xe gases (potentially) injectable

Fixed-target physics in Run3 - Data-taking:
- pp and SMOG2 luminous regions separated → simultaneous data-taking possible?
  - Can SMOG2 events, displaced wrt nominal IP and with forward collisions, be efficiently reconstructed?
  - Does the gas presence disturb the pp physics program?
  - Does the SMOG2 events processing fit into the LHCb real-time strict timing constraints?

VELO tracking performance [3]
- VELO clustering and tracking performed with an intrinsically parallel reconstruction algorithm[4]
- Same Velo tracking efficiency for pp and pHe
- No efficiency decrease for pp by overlapping pHe collisions
- Efficiency independent on the injected gas

Upstream and forward performance
- Tracks extrapolated from VELO to UT and then to SciFi requiring a minimum 500 MeV p_T
- Same efficiencies between pp and pHe
- Negligible decrease in efficiency for pp by overlapping pHe collisions

Next steps:
- Finalize reconstruction efficiency studies also including vertexing and timing costs evaluation
- Implement trigger lines for the SMOG2 data acquisition

Conclusions:
- First studies indicate excellent performance and small overhead for the SMOG2 event reconstruction!

References: