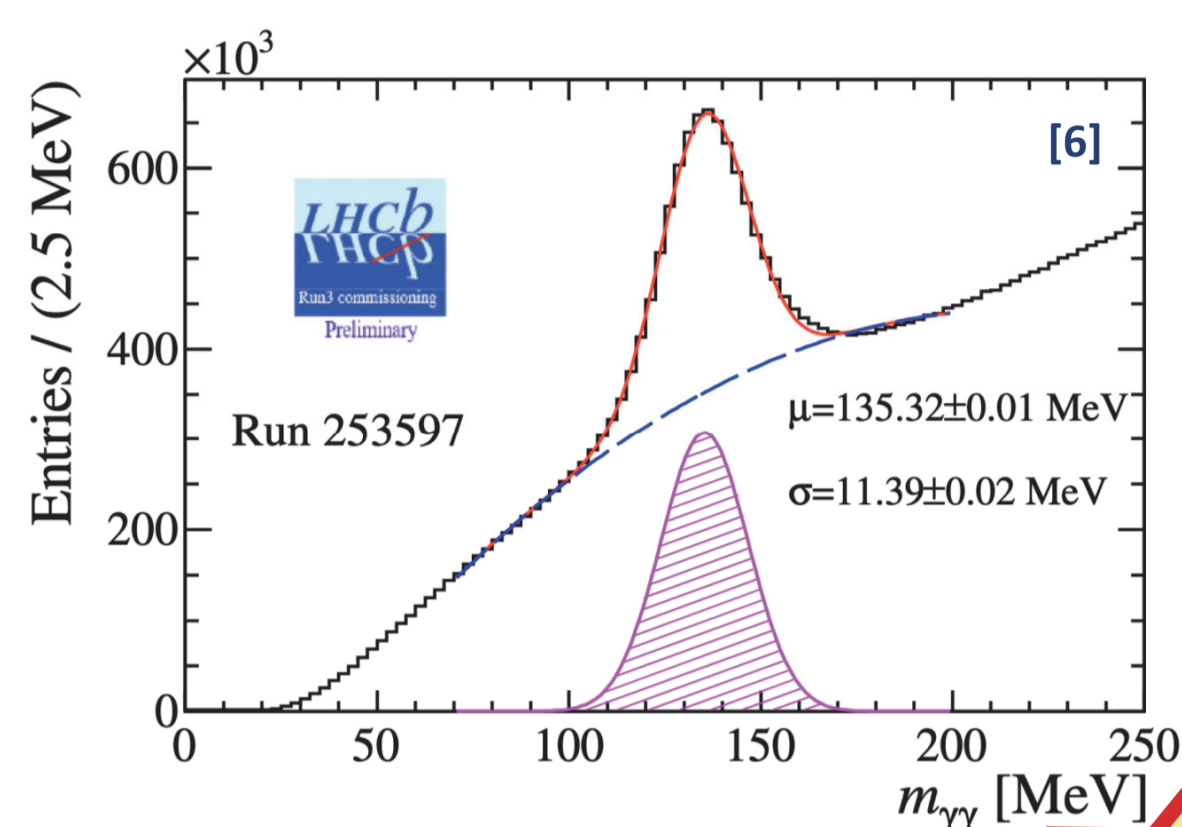


## LHCb is a general purpose detector in the forward region: $2 < \eta < 5$

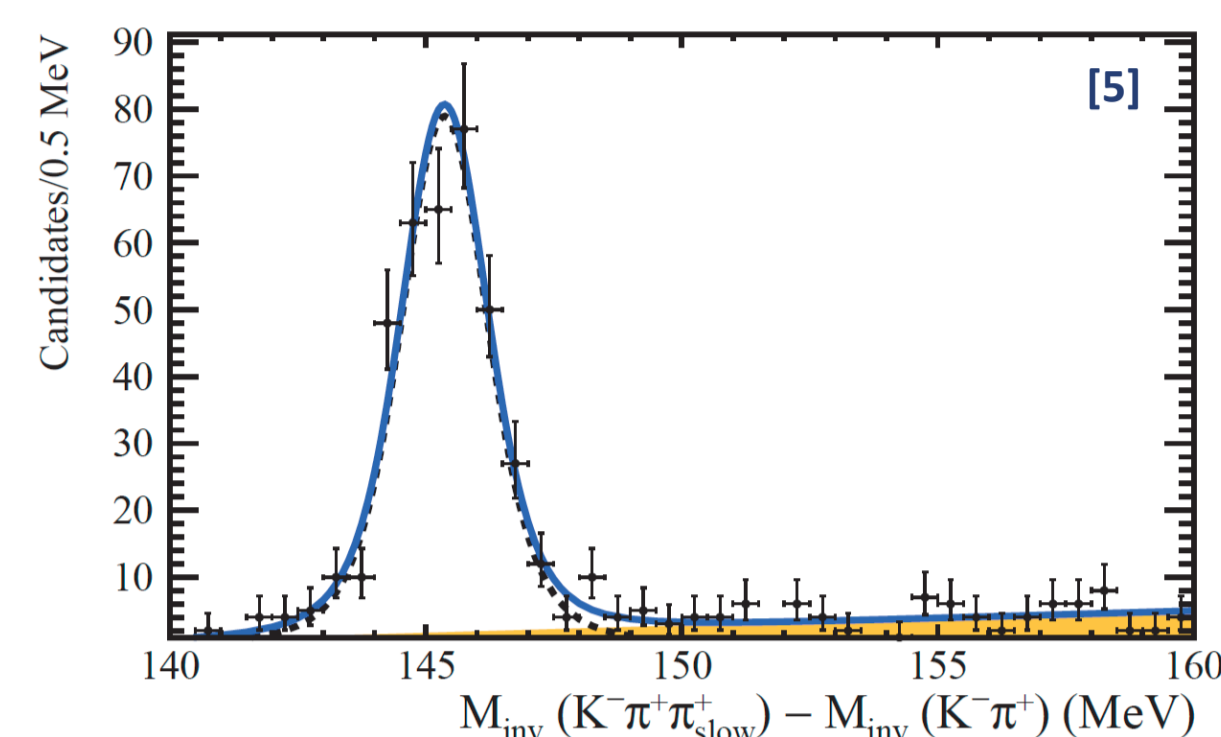
For Run3, upgrade of >90% of experiment:  
**Brand new detector!**

To extend the reach to a new range of physics signatures

To increase the precision on key observables statistically limited



**First Run 3 reconstruction of  $\pi_0$**



**First mass peaks with HLT1 filtering and HLT2 reconstruction and PID!**

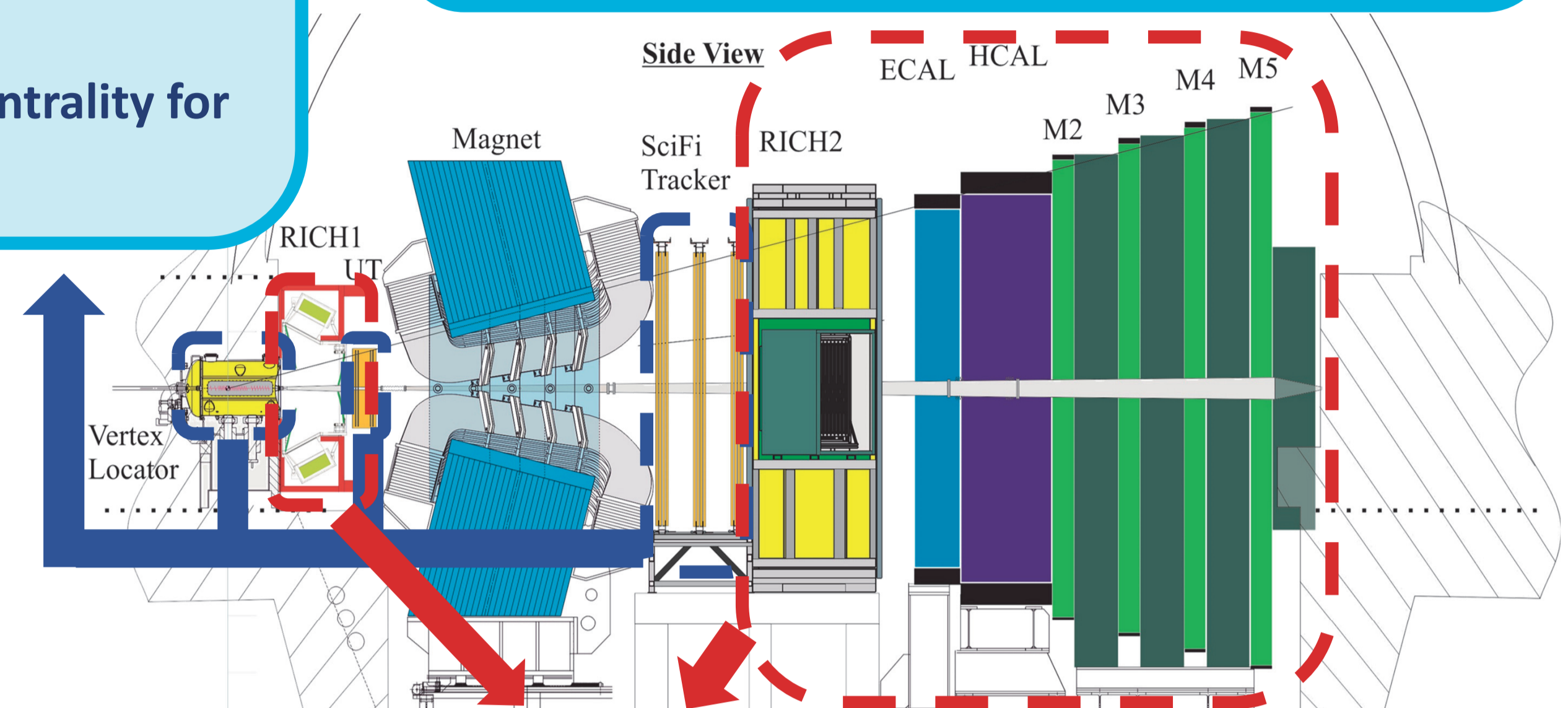
### New tracking system

- Hybrid pixel Vertex LOcator detector<sup>[2]</sup>
- Silicon strips Upstream Tracker<sup>[3]</sup>
- SCIntillating Fibers tracker<sup>[3]</sup>

**No saturation up to 30% centrality for PbPb collision!**

### Full DAQ chain only software<sup>[1]</sup>

- First trigger level completely on GPUs, 30 MHz
- Real-time alignment & calibration and event reconstruction & selection

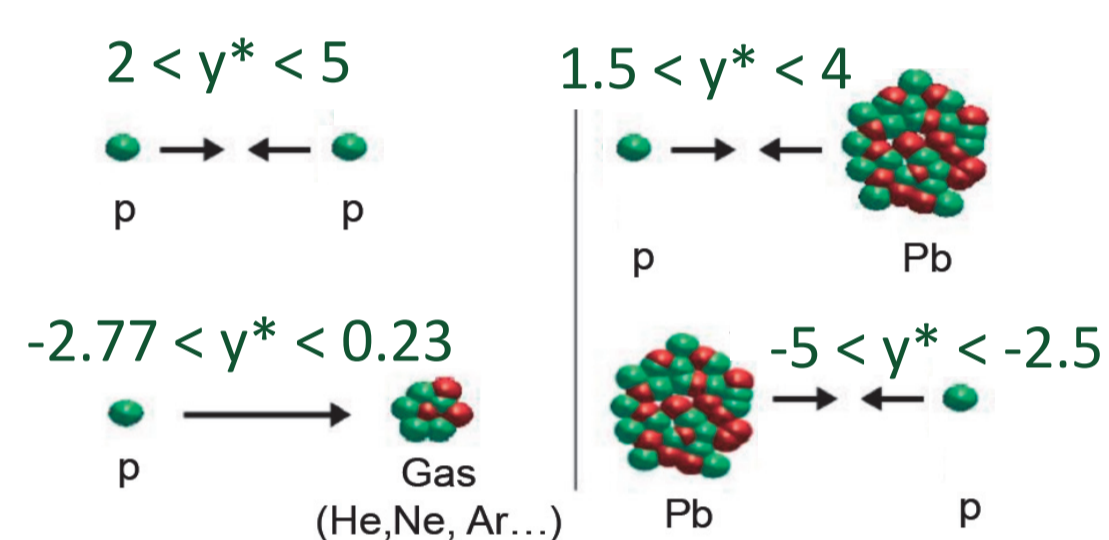


### Upgraded PID detector<sup>[4]</sup>

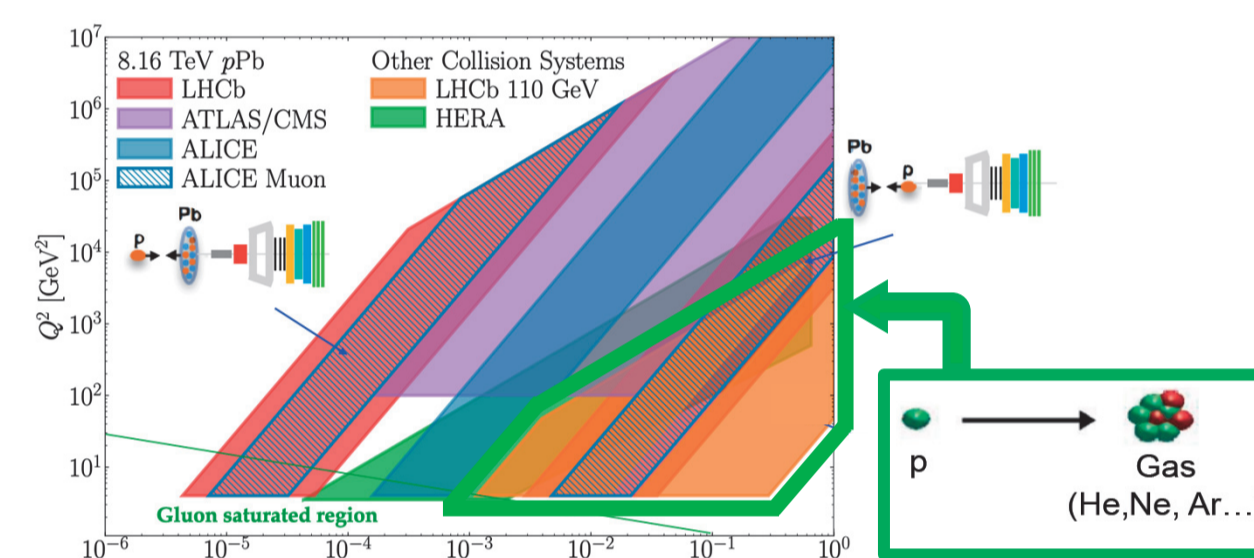
- New optics, photodetectors and readout for RICH1 and RICH2
- New readout for Calorimeters and Muon stations

## LHCb is the highest energy fixed-target experiment ever with a unique $Q^2$ -x coverage

Various interacting systems cover different rapidity regions



Unique possibility to inject gases in the LHC beam pipe: SMOG



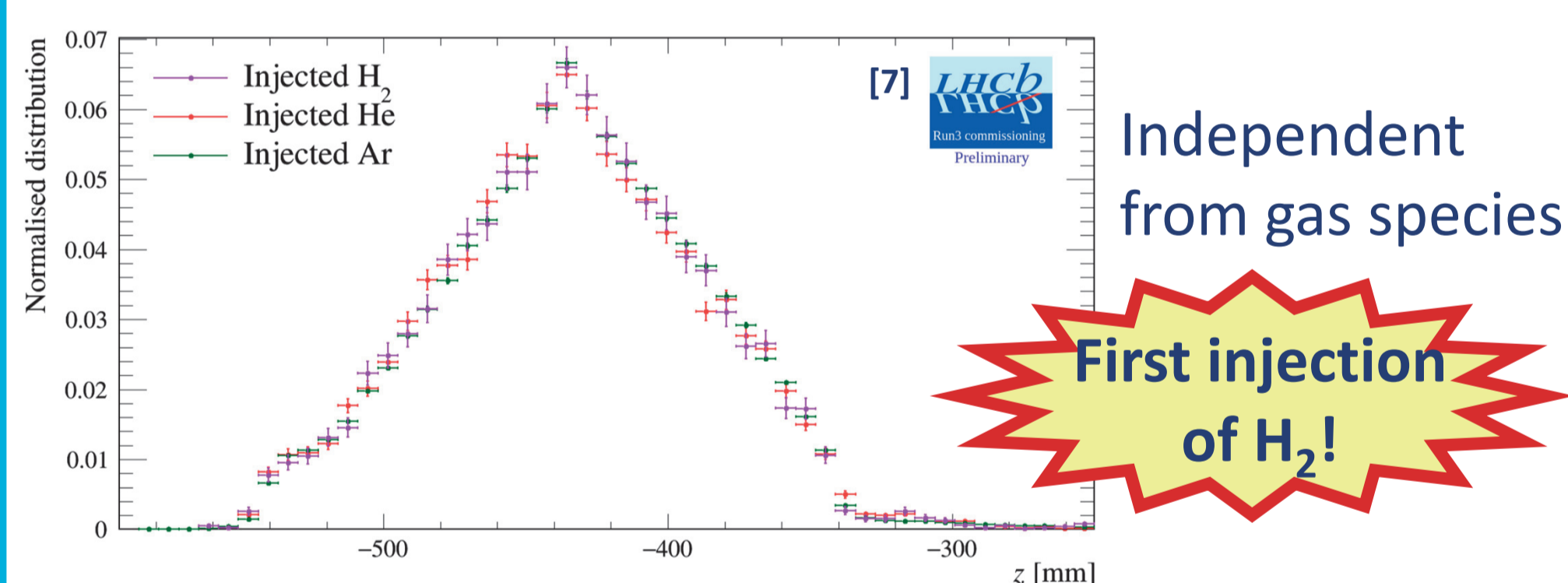
During Run 2:

- Gas flows in a wide vacuum region:  $\pm 20$  m around IP  $\rightarrow$  **Limited pressure and gas species**
- No direct pressure measurement  $\rightarrow$  **Large systematic uncertainty on luminosity**
- Overlapped with  $pp$  luminous region  $\rightarrow$  **Limited data taking time and lower statistic**

## For Run3, major upgrade of SMOG apparatus to improve systematics and expand the physics reach: SMOG2

### GAS DENSITY PROFILE:

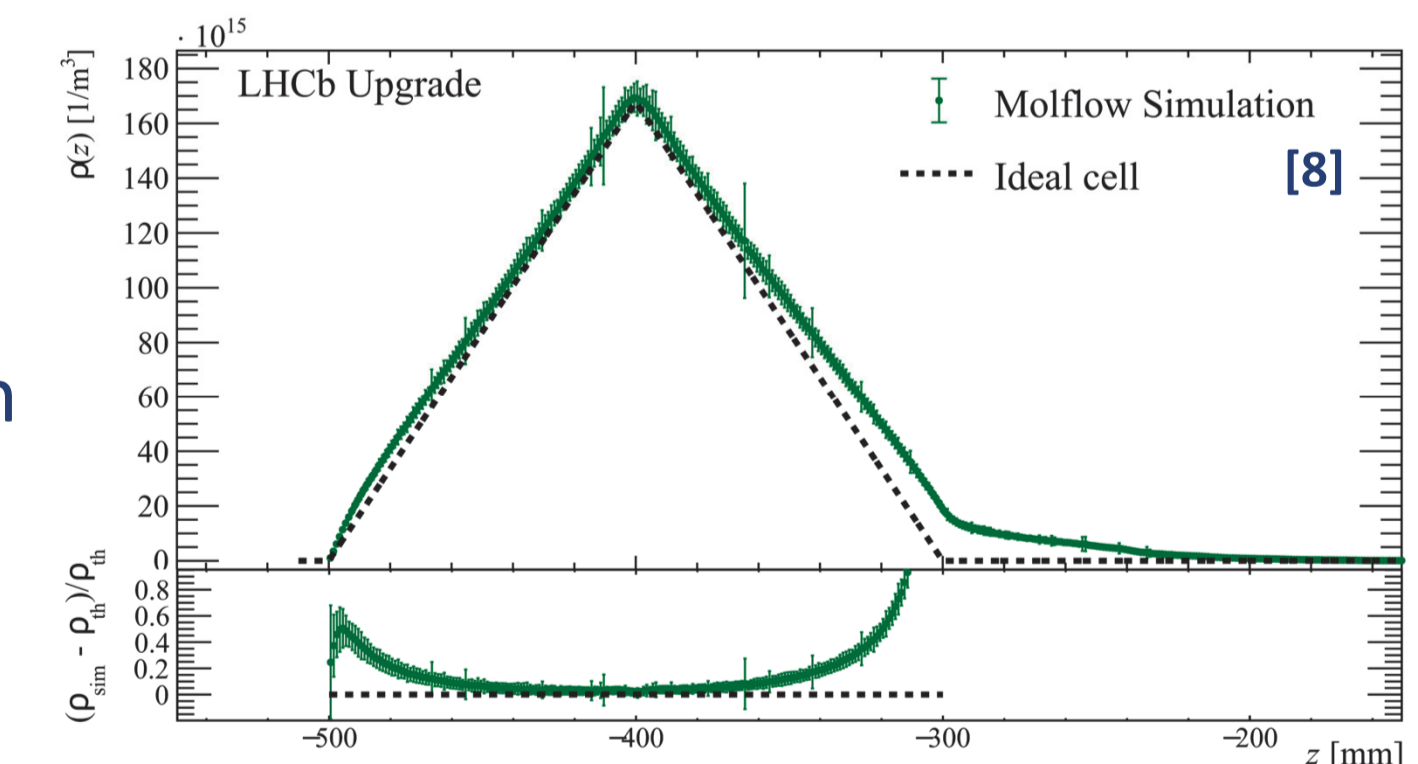
Beam-gas vertices follow a triangular profile, as expected from cell geometry:



**First injection of  $H_2$ !**

Independent from gas species

Qualitative agreement with simulation

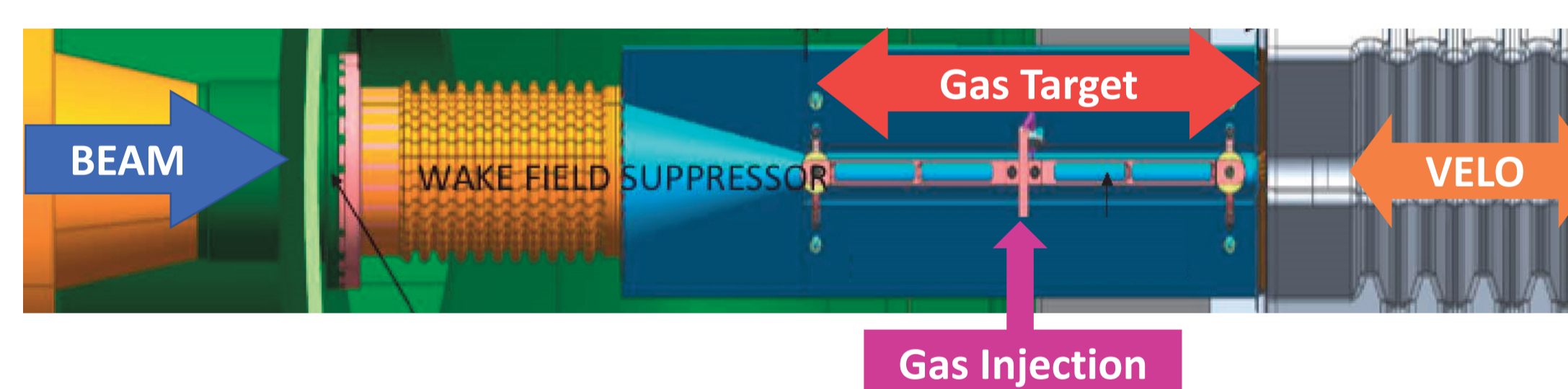


Full validation of simulated profiles ongoing

### New storage cell upstream of the VELO:

- Up to **100x** gas density with same gas flow
- Precise and **direct pressure measurement**
- More injectable gases:  $H_2$ ,  $D_2$ , He,  $N_2$ ,  $O_2$ , Ne, Ar, Kr, Xe
- **Simultaneous  $pp$  + fixed target data taking**

### STORAGE CELL:



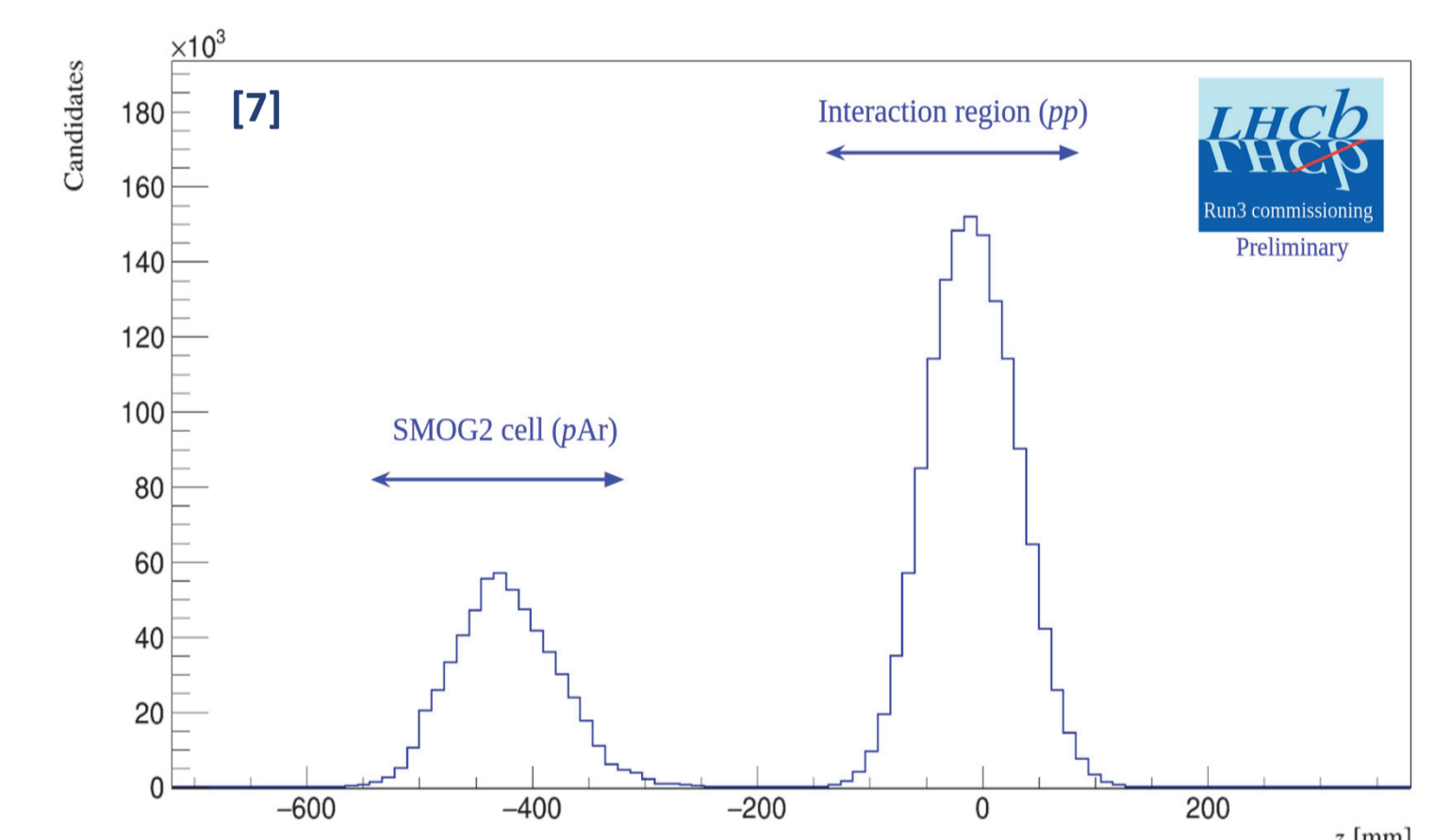
### LHC AND LHCb OPERATION:

- Completely transparent for LHC beam: beam life-time reduction <2%
- Small contribution to total data flow wrt  $pp$  data-taking

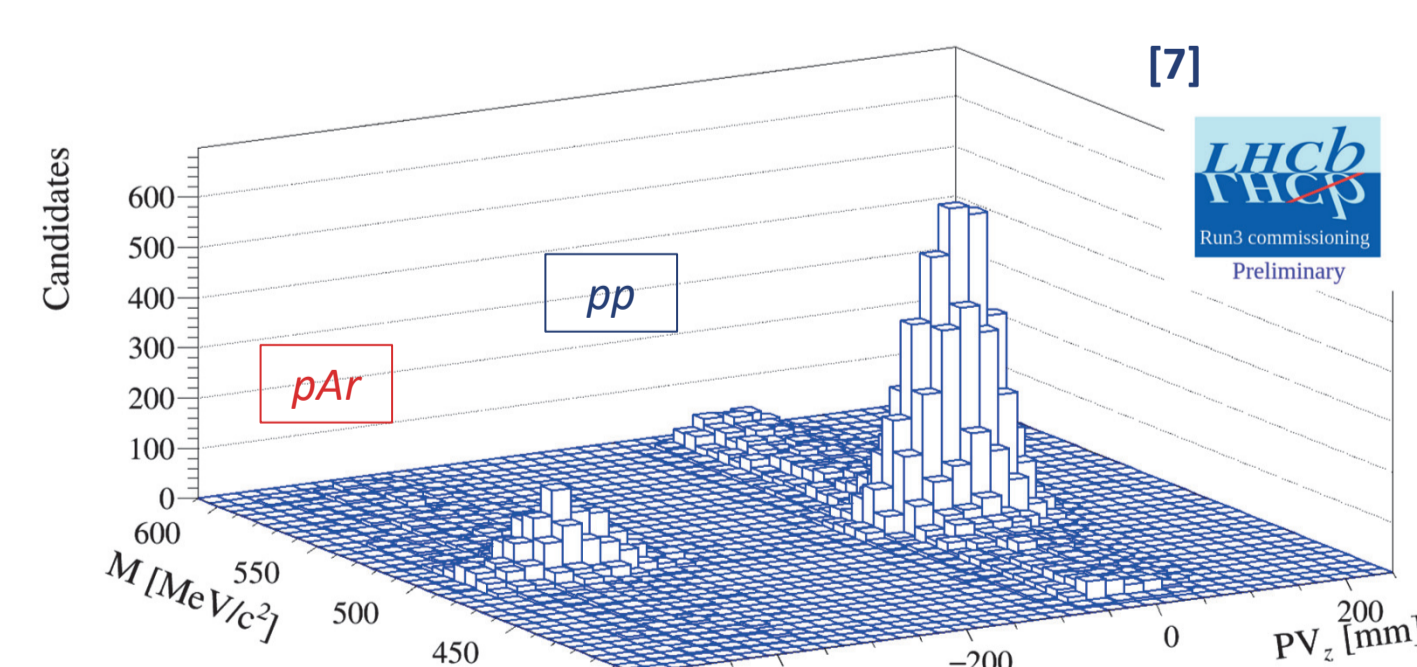
**Negligible impact on standard LHC and LHCb operation**

### SIMULTANEOUS DATA TAKING:

Highly efficient separation between  $pp$  and  $pAr$ : vertices well separated in  $z$  and distributed around  $z = -441$  and  $z = 0$  mm

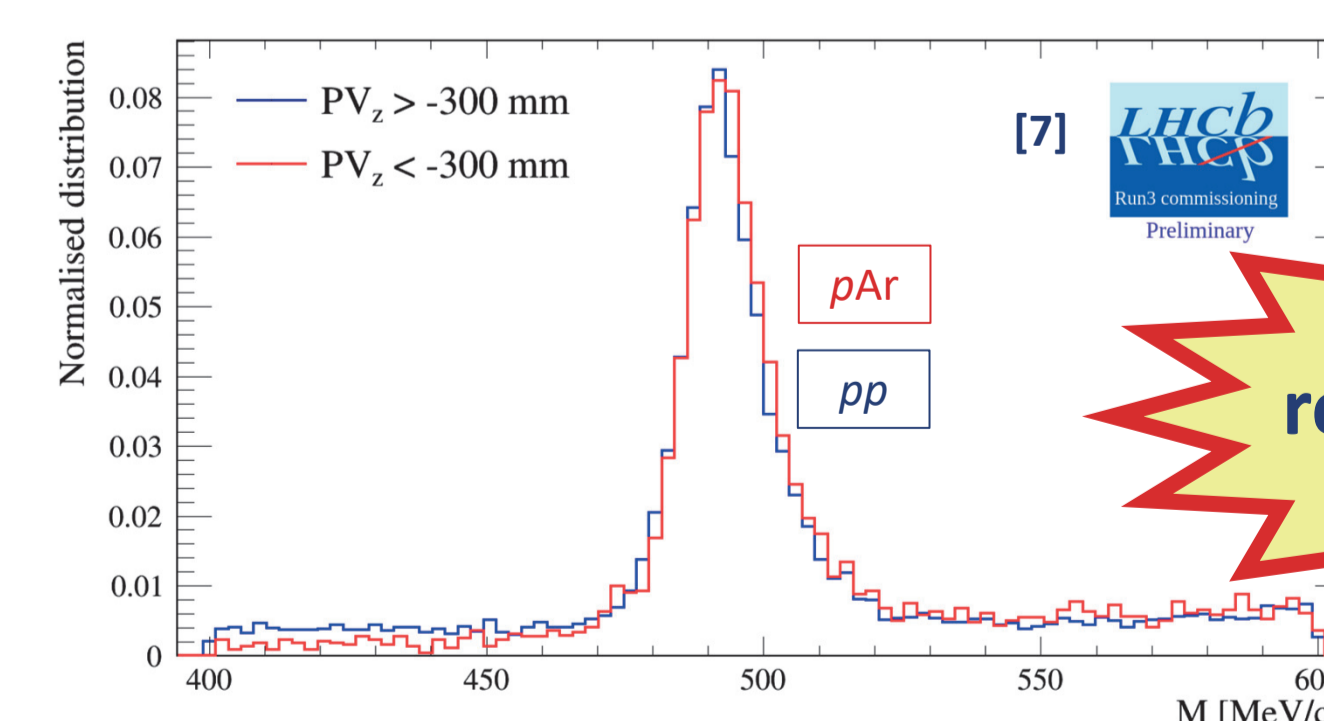


**Only experiment operating simultaneously in collider and fixed target mode with two interaction points!**



### RECONSTRUCTION AND MASS PEAKS:

Composite particles produced in beam-gas collisions can be reconstructed

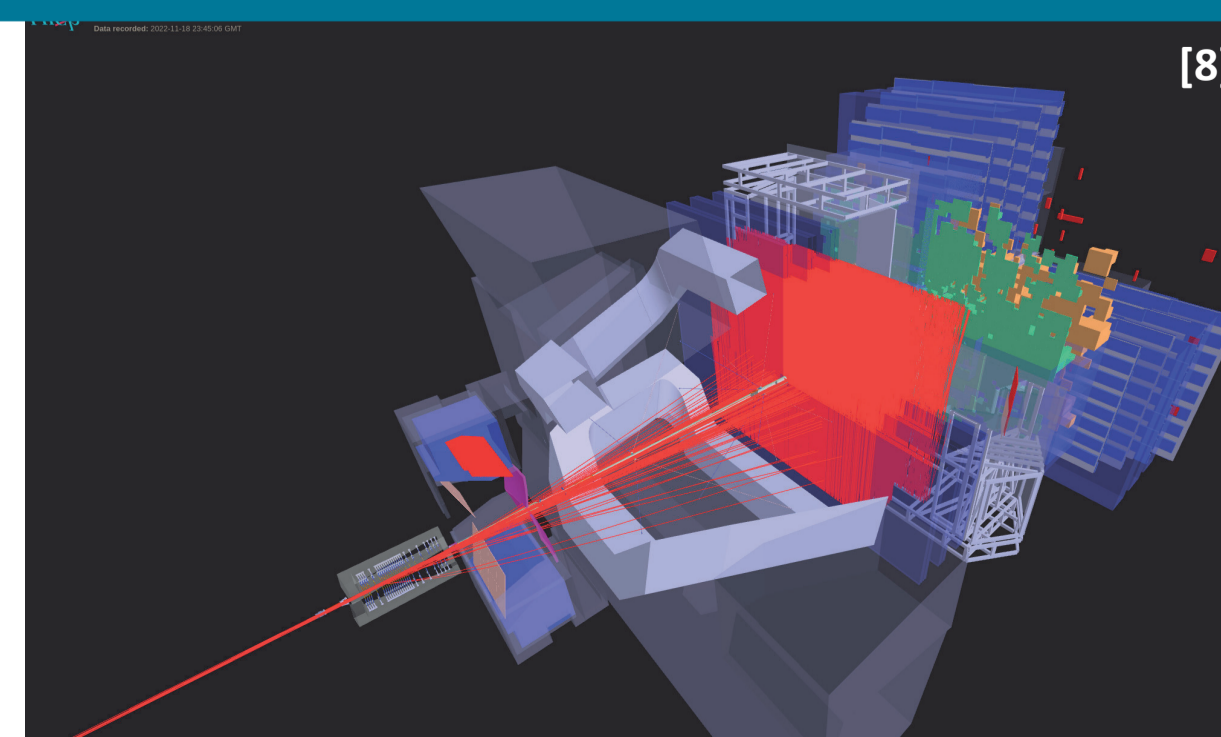


**Same mass resolution for Ks in  $pp$  and  $pAr$ !**

## Intense and successful commissioning year of the new upgraded LHCb detector:

- Validation of the upgraded full detector chain
- Commissioning and calibration of new SMOG2 apparatus:
  - Comparable performances as for  $pp$  events!
  - Operating simultaneously with two interaction points for  $pp$  and fixed target!
  - Running both in p-Gas and Pb-Gas!

**Many new exciting opportunities for LHCb Heavy Ion program ahead!**



### References

- |                        |                          |
|------------------------|--------------------------|
| [1] CERN-LHCC-2014-016 | [5] LHCb-FIGURE-2023-002 |
| [2] CERN-LHCC-2013-021 | [6] LHCb-FIGURE-2022-019 |
| [3] CERN-LHCC-2014-001 | [7] LHCb-FIGURE-2023-001 |
| [4] CERN-LHCC-2013-022 | [8] LHCb-FIGURE-2022-002 |