LHCb ideas for AA

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Introduction

- As shown by Michael, LHCb obtained very interesting results from the 2013 pA run.
- What are ideas in LHCb to extend what has been done last year:
  - pA in run 2
  - AA collisions
  - Fixed targets with Pb LHC beam
- Focus here about *quarkonium* and *heavy flavour production*

pA in run 2

- LHCb advantages are the precision of the vertexing and tracking down to very low p_T, allowing for precise production measurements and separation of prompt/non-prompt components
- Important measurements could be done with our pA data but lack statistics: for example, measurement of J/ψ and Y nuclear modification factors as a function of the track multiplicity which can bring information on cold nuclear matter effect models.
- In run 1, statistics were limited, as it was considered a test run for LHCb for pA. Now that it is proven it works, we can expect to record 10 times more data in the next pA run (2017)

AA in LHCb

- Multiplicities of the most central AA collisions give too large occupancies in the tracking detectors in particular and cannot be reconstructed by LHCb.
- However, low multiplicity events in AA collisions could be recorded:
  - Central exclusive production (J/ψ, χ_c, …): new forward and backward counters have been installed to increase the rapidity coverage of LHCb
  - J/ψ production in ultra-peripheral collisions is also a hot subject
  - Peripheral AA collisions could be reconstructed, as can be inferred from the pA run
- We must first be completely sure that running in AA collisions is safe for the detector (which seems to be the case)
- Event with large multiplicities (central collisions) can be easily rejected at trigger level (with the SPD multiplicity counter for example)
- Simulation studies will be done to know the limits of the reconstruction.

AB with fixed targets in LHCb

- As shown by Michael, the ***SMOG system*** allows injecting a noble gas at the LHCb interaction point.
- The LHC beams (*p* or Pb) collide on this gas as fixed target.
- Data were already taken in 2013 with Ne gas (30 minutes of PbNe data): it works !
- Physics can be done with these pNe or PbNe collisions.

AB with fixed targets in LHCb

- Center of mass energy (per nucleon), unique at the LHC:
  - 7 TeV p: E_{cms} = 114.6 GeV
  - 2.75 TeV Pb: E_{cms} = 71.8 GeV
- A strong physics case is the measurement of charmonium, charm and beauty production: QGP is formed at these energy densities (NA50 was PbPb collisions at 17.2 GeV)
- Advantages:
  - Much lower multiplicities in the most central events compared to PbPb
  - LHCb coverage includes the central region in the CM frame:
    - $-2.3 < y_{LHCb}^* < -0.3$ (p)
    - $-1.8 < y_{LHCb}^* < 0.2$ (Pb)

AB with fixed targets in LHCb

- Luminosity for 1 month of running would be ~0.7 nb^{-1} (depending on the gas pressure)
- Corresponding numbers of $J/\psi \rightarrow \mu^+\mu^-$ produced in the LHCb acceptance, for different targets:

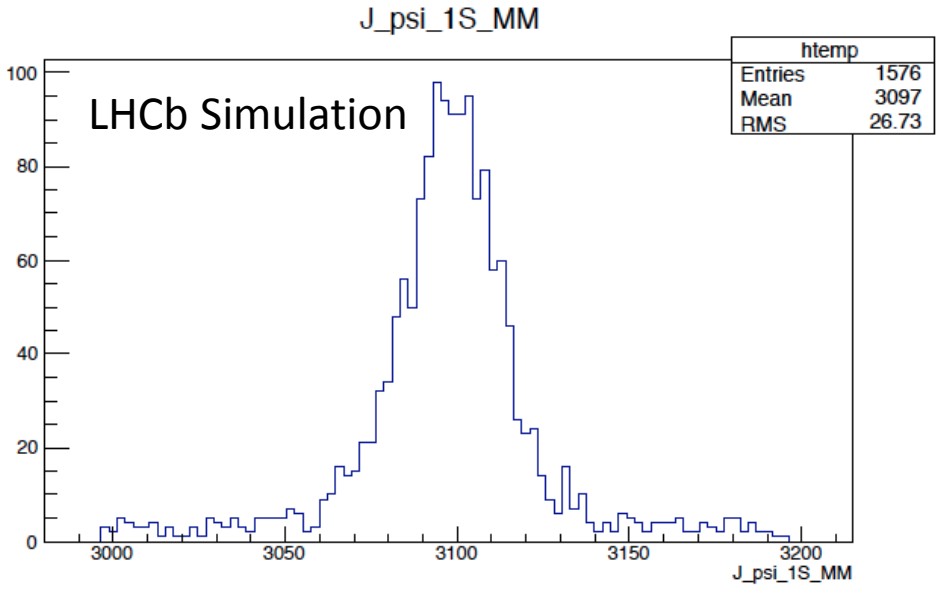
	A	$A \times 5.6\ pb^{-1} \times 24\ nb$	$A \times 208 \times 0.7\ nb^{-1} \times 24\ nb$
Ne	20	$2.7\ 10^6$	$0.7\ 10^5$
Ar	40	$5.4\ 10^6$	$1.4\ 10^5$
Kr	84	$11.3\ 10^6$	$2.9\ 10^5$
Xe	131	$17.6\ 10^6$	$4.6\ 10^5$
		p	Pb

AB with fixed targets in LHCb

First full LHCb simulations done with the EPOS generator + LHCb Geant4 simulation + LHCb official reconstruction (shown here for Ar target).
J/ψ invariant mass for J/ψ signal samples (including the underlying minimum bias event)

M(J/ψ)

Total efficiency ~ 20%



J/ψ can be reconstructed, even in the most central collisions

Conclusions

- pA program will be extended in run 2 with more statistics collected
- Consider seriously to take PbPb data to analyse low multiplicity events
- Nice option to do fixed target AB measurements that would be unique to LHCb