

# Target polarimetry

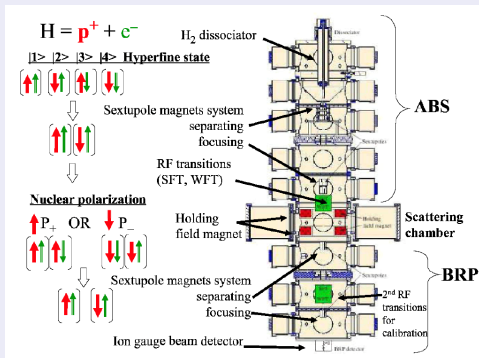
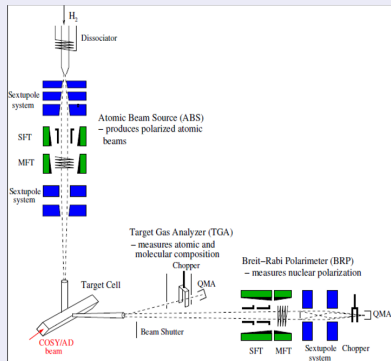
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# Atomic beam source with Breit-Rabi polarimeter (BRP)

## Storage cell vs free jet configurations



## Breit-Rabi polarimeter

- Stern-Gerlach effect + RF-transition to determine HFS occupation number
- Only sensitive to atomic polarization (no information on molecules)
- Viable solution for free-jet target ( $\rightarrow$  A. Nass' talk)
  - ▶ Measured polarization at RHIC:  $P_{target} = 92.4\% \pm 1.8\%$

# Polarization measurement with BRP - Sampling Polarimeter

## Polarization in a Storage Cell

$$P_T = \alpha_0 \alpha_r P_a + \alpha_0 (1 - \alpha_r) P_m$$

- $P_T$   $\equiv$  total target polarization
- $\alpha_0$   $\equiv$  atomic fraction in absence of recombination
- $\alpha_r$   $\equiv$  atomic fraction surviving recombination
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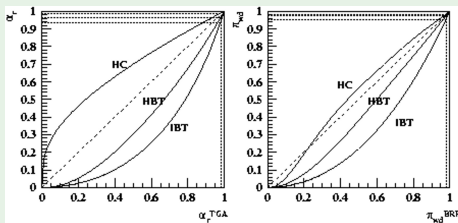
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- $\alpha_r = C_\alpha \alpha_r^{TGA}$
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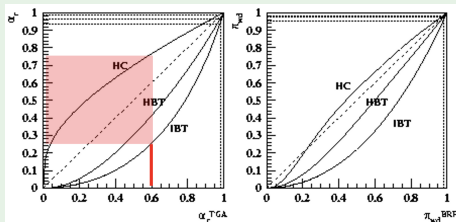
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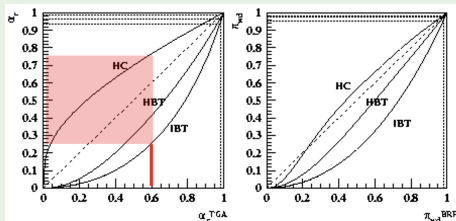
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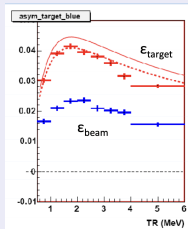
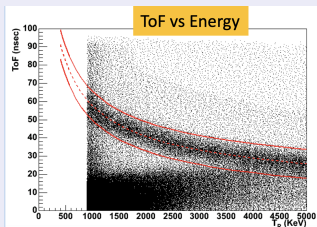
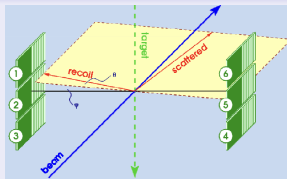
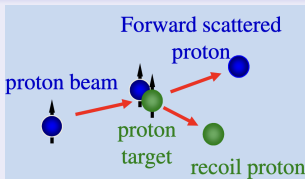


## Limits of sampling polarimetry with BRP

- Systematic error increases with recombination and depolarization
- Not able to measure molecular polarization ( $\rightarrow$  R. Engels' talk)

# Absolute Polarimetry with Carbon Nuclear Interference (CNI)

## Recoil spectrometer at RHIC

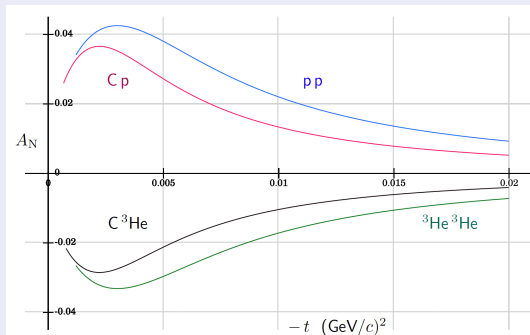


- Array of Si detectors measures  $T_R$  & ToF of recoil proton.
- Channel no corresponds to recoil angle  $\theta_R$ .
- Correlations ( $T_R$  & ToF) and ( $T_R$  &  $\theta_R$ )  $\rightarrow$  elastic process
- $A_N \rightarrow$  beam/target polarization

# Recoil polarimetry at LHCspin

Estimations from prof. N. Buttimore (Trinity College), Ferrara - 16.07.19)

- Analyzing power:



- Cross section at 7 TeV:  $\sigma_{tot} = 47$  mb (255 GeV:  $\sigma_{tot} = 39.2$  mb).
- Recoil energies at 7 TeV:  $1.7 \text{ MeV} < T_R < 4.6 \text{ MeV}$
- Recoil angles at  $90^\circ$ :  $30 \text{ mrad} < \theta < 50 \text{ mrad}$



# A staged approach to target polarimetry for LHCspin

## Stage 1: jet target + BRP + Si-detectors (recoil polarimeter)

- Use of BRP + left/right Si-detectors ( $\geq 500 \mu\text{m}$  to stop 5 MeV protons)
  - ▶ **Validation** of theoretical predictions of analysing power at 7 TeV
  - ▶ Evaluation of detection efficiency and background
- Note: recoil polarimeter measures weighted atomic + **molecular** polarization

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## Stage 2: ABS and storage cell + BRP + recoil polarimeter

- Use of Storage cell with "**windows**" + left/right Si-detectors
  - ▶ BRP with opened cell for tuning of RF transitions of ABS
  - ▶ **Recoil detector viable polarimeter for a molecular polarized target**
  - ▶ Unpolarized gas for absolute calibration of target density