Experimental Setup for Spin-Filtering Studies at COSY and AD

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Requirements for Spin Filtering

- Highly polarized internal gaseous target with areal densities up to $10^{14}$ atoms/cm$^2$ → **Storage cell**
- Passing of the stored p/$\bar{p}$ beam through this cell and high acceptance → **Low beta section**
- Ability to produce and measure nuclear polarization of H and D target gas with xyz-target holding fields → **Atomic Beam Source and polarimeter**
- Longitudinal spin filtering → **Siberian snake**
- Detection of recoil particles → **Silicon detectors**
Experimental Overview @ COSY

COSY-Quadupoles

ABS

Target chamber w storage cell and detectors

Low-β-Quadrupoles
Setup of the Polarized Target

- Production of a polarized atomic beam by an atomic beam source (ABS)
- Increase of the target density by means of a storage cell
- Analysis of target polarization by a so-called Breit-Rabi polarimeter (BRP) and a target gas analyzer (TGA)
- Calibration of the BRP by means of pp-scattering data
Polarized Target Overview

ABS
BRP
Gas cabinet
Electric power
Cooling Water
Test chamber w storage cell
Polarized Target Control

Target chamber

vacuum

BRP

HFT’s

QMA’s

bakeout

ABS
The Polarized Atomic Beam Source

- Former HERMES ABS rebuilt with modified vacuum system
- New cabling for fast installation and removal and new interlock system
- Construction of an analysis chamber with QMS and compression tube
- First intensity measurements done (intensities up to $6 \times 10^{16}$ atoms/s)
- Tests with a new alcohol cooled microwave dissociator on the way
- Setup of a beam shutter to prevent gas entering into the target cell during p/p beam injection
The Polarized Atomic Beam Source

Design of the new beam shutter in 1st 6-pole chamber:

Rotary vacuum feed through and stepper motor
The Polarized Atomic Beam Source

The liquid cooled microwave dissociator

Plasma ignited by small rf coil
**The Polarized Atomic Beam Source**

Intensity vs $T_{\text{alcohol}}$

- $H_2$ flux = 82 sccm
- $O_2$ flux = 0.2 sccm
- MW power = 1200 W

Intensity linearly increasing with MW power
Storage Cell and Holding field

- Filtering requires $10^{14}$ atoms/cm$^2$ → storage cell
- Walls of Teflon foil to let recoils pass and suppress depolarization and recombination
- Openable cell to allow injected uncooled AD beam to pass
- First cell prototype built and to be tested soon
- Weak holding field coils at the outside of the target chamber to provide quantization axis for the spins of the target atoms

Cell cross section 10 x 10 mm
Storage Cell
The Breit-Rabi Polarimeter

- Former HERMES BRP rebuilt with modifications due to new configuration
- Tracking calculations → modified sextupole magnet configuration for 300 K effusive H / D beam
- New strong field transition cavity for hydrogen and deuterium
- New cabling and interlock system, QMA‘s and HFT‘s working
- More information see C.Barschels talk
The Target @ AD

Removable ventilation pipe

BRP

ABS

Target chamber

Walkway and logistics
The Breit-Rabi Polarimeter @ AD

Plans for installation at AD:

→ Rebuilding of the stand and lower vacuum part
The low-\(\beta\)-section

- Increase of luminosity and acceptance to reach reasonable polarization build-up times and polarization

- Calculations show that 4 (6) additional quadrupoles are necessary for COSY (AD)
Vacuum in the Target chamber

- Flow limiters to reduce gas flow into the beam tubes
- Pump with large cryogenic pump (~20000 l/s)
Vacuum in the Target chamber

- Shield 75 K
- Active baffles 8 K
- Cryo chamber
- Gate valves
- Cold head
- TPH 1600
- Gate valves
- Cryo chamber
Silicon Detectors

- Measurements of beam polarization using $pp$ ($\bar{p}p$)-elastic scattering at COSY (AD)
- Good azimuthal resolution (up/down asymmetries)
- Low energy recoils (<8 MeV) detected by silicon telescopes
Transverse & Longitudinal Filtering

- Use of the WASA and electron cooler solenoid to form a Siberian snake at COSY for long. filtering

- Implementation of a Siberian snake into AD target
Planned activities

- 2009: Installation of the low-\(\beta\) magnets into COSY (done).
- 2009/10: Beam development to understand and run the system.
- 2010: Installation of the full target into COSY
- 2010/11: Filtering measurements at COSY with nuclear polarized hydrogen target in a weak magnetic holding field using a proton beam to produce polarized protons and commission the experiment for AD.
- 2010: Installation of the low-\(\beta\) magnets into AD.
- 2010/12: Beam development to understand and run the system.
- 2012/13: Filtering measurements at AD with nuclear polarized hydrogen and deuterium target in a weak magnetic holding field and an antiproton beam to show the ability of the method to produce polarized antiprotons.