

Commissioning of the Polarized Internal Gas Target (PIT) of ANKE at COSY

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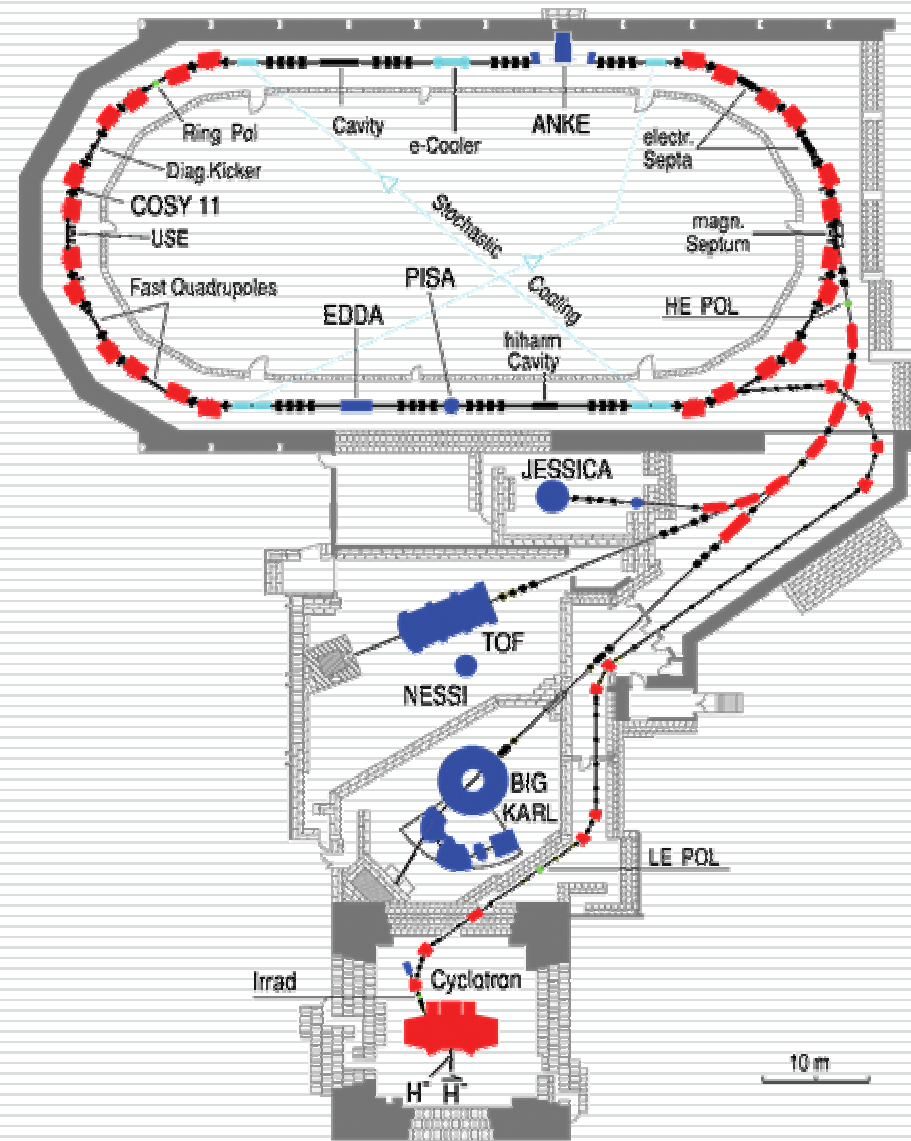
Outline

- Introduction
- PIT installation
 - Setup overview
 - Transfer to COSY hall and installation at ANKE
- PIT commissioning
 - Stray fields at ANKE
 - Cell tests at ANKE
 - Target commissioning
 - Results
- Plans for the future

COSY $\bar{\kappa}$ COoler SYnchrotron

p, \vec{p}, d, \vec{d}
with momenta up to 3.7 GeV/c

- internal experiments –
with the circulating beam
(**ANKE**, COSY-11, EDDA)
- external experiments –
with the extracted beam
(BIG KARL, TOF)



ANKE AND COSY

Magnets

- D2 – spectrometer magnet
- D1, D3 – beam bending magnets

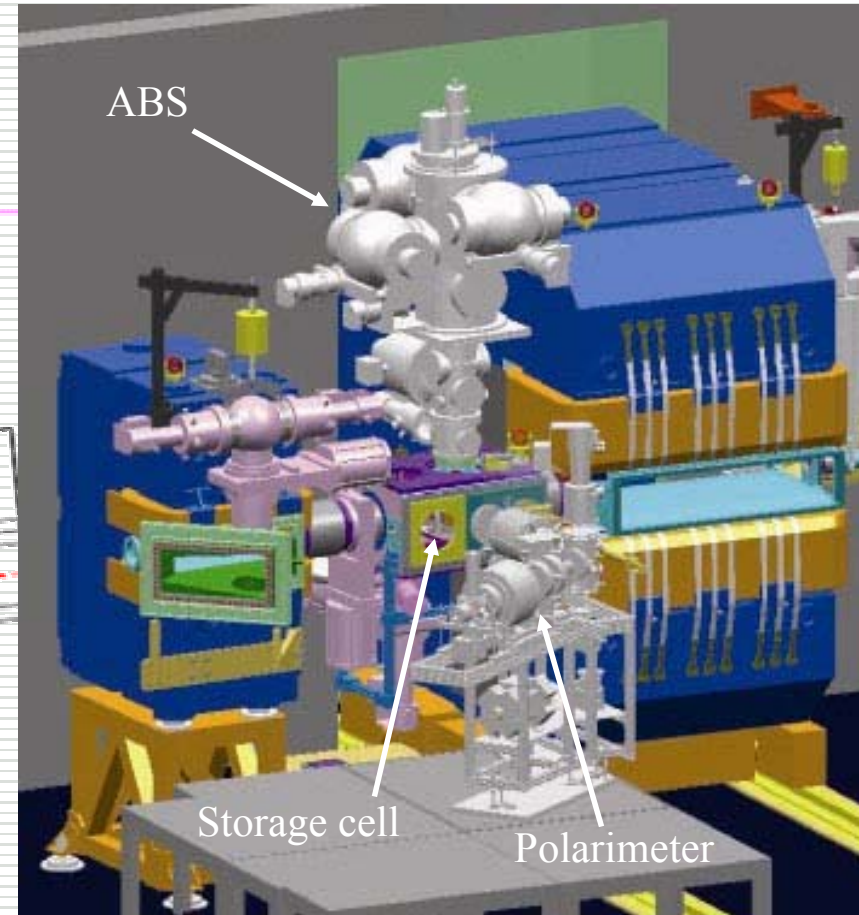
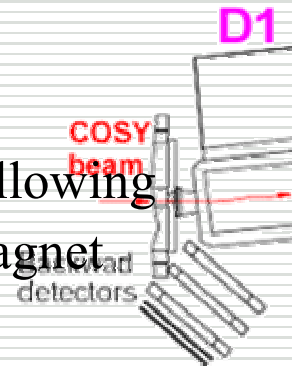
Technical constraints

Detector systems

- **Target exchange** within a maintenance week
- Forward & Backward
- Spectator Detectors
- **New support bridge**, following the movement of D2 magnet

Targets

- Solid strip
- **Magnetic shielding** of components of the Atomic Beam Source (ABS)
- **Polarized gas cell**
(polarized gas jet)

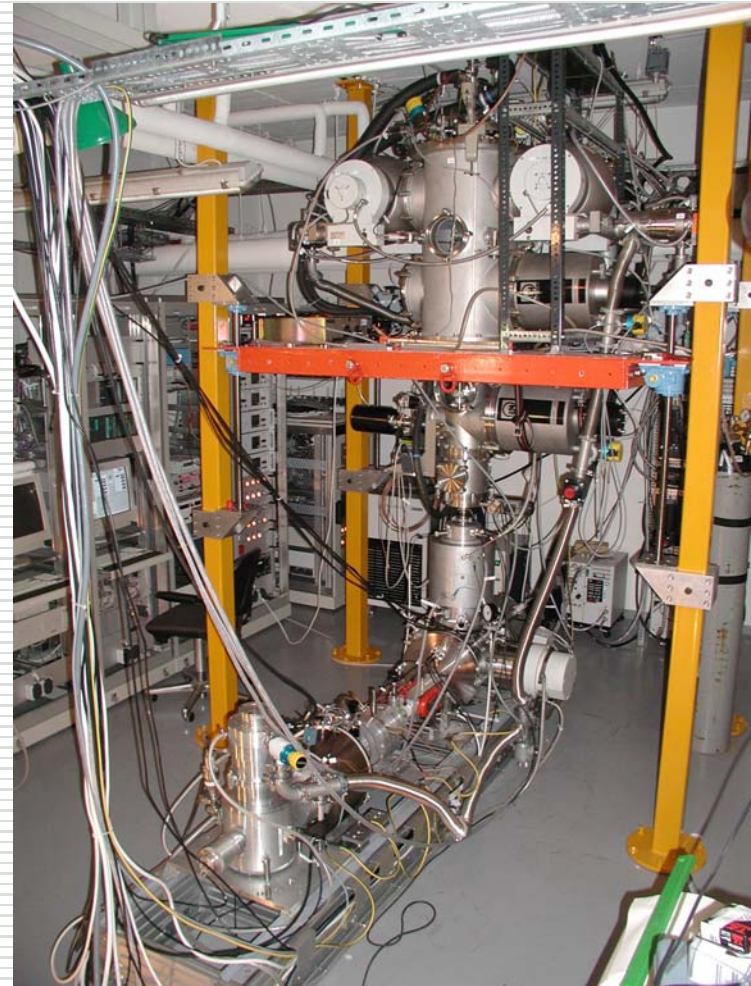


3D CAD drawing of PIT at ANKE Spectrometer

Polarized Internal Gas Target

Main parts of a PIT:

- **Atomic Beam Source**
 - Target gas
hydrogen or **deuterium**
 - H beam intensity (2 hyperfine states)
 $7.6 \cdot 10^{16}$ atoms / s
 - Beam size at the interaction point
 $\sigma = 2.85 \pm 0.42$ mm
 - Polarization for hydrogen atoms
 $P_z = 0.89 \pm 0.01$ (HFS 1)
 $P_z = -0.96 \pm 0.01$ (HFS 3)
- **Lamb-Shift Polarimeter**
- **Storage cell** in a test chamber



ABS and LSP at the laboratory

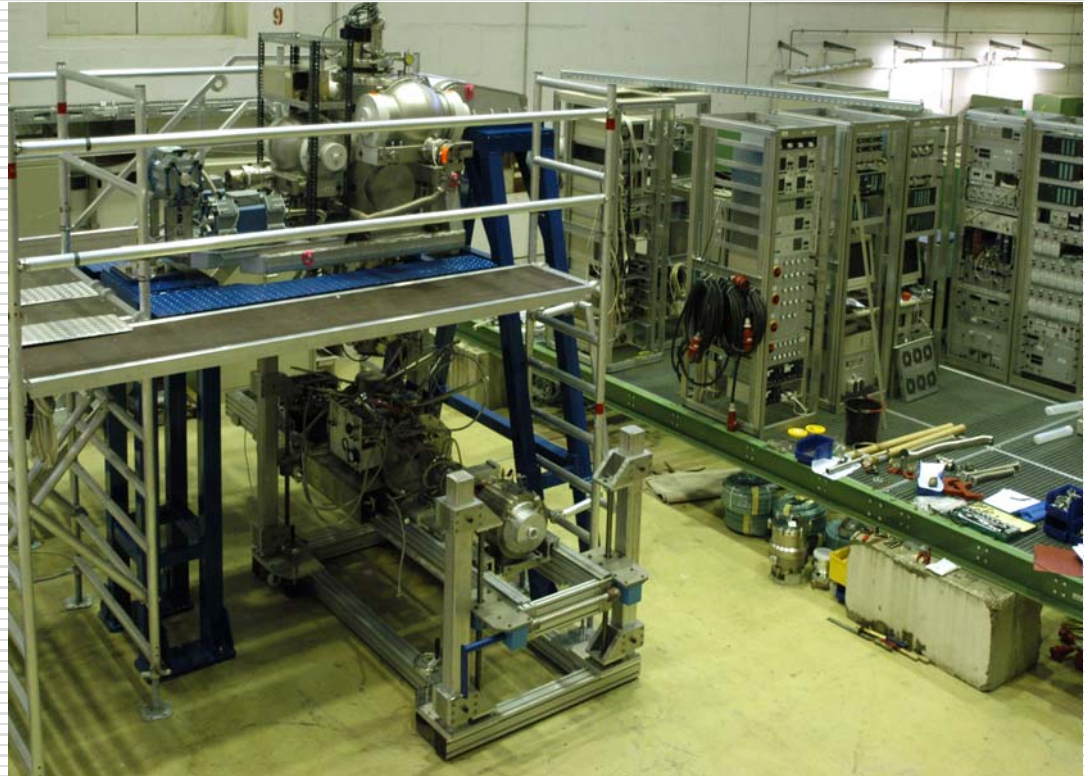
ABS and LSP in the COSY hall

December 2004 – **transfer** to COSY hall (outside of the COSY tunnel)

May 2005 – **tests** after reassembling

- **Platform** for all electronic and supply components
- Heat exchanger with closed **cooling-water circuit**
- New **support bridge**
- **Supports** representing D1 and D2

June 2005 – **setup ready for installation at ANKE**



Setup in the COSY hall

PIT installation at ANKE

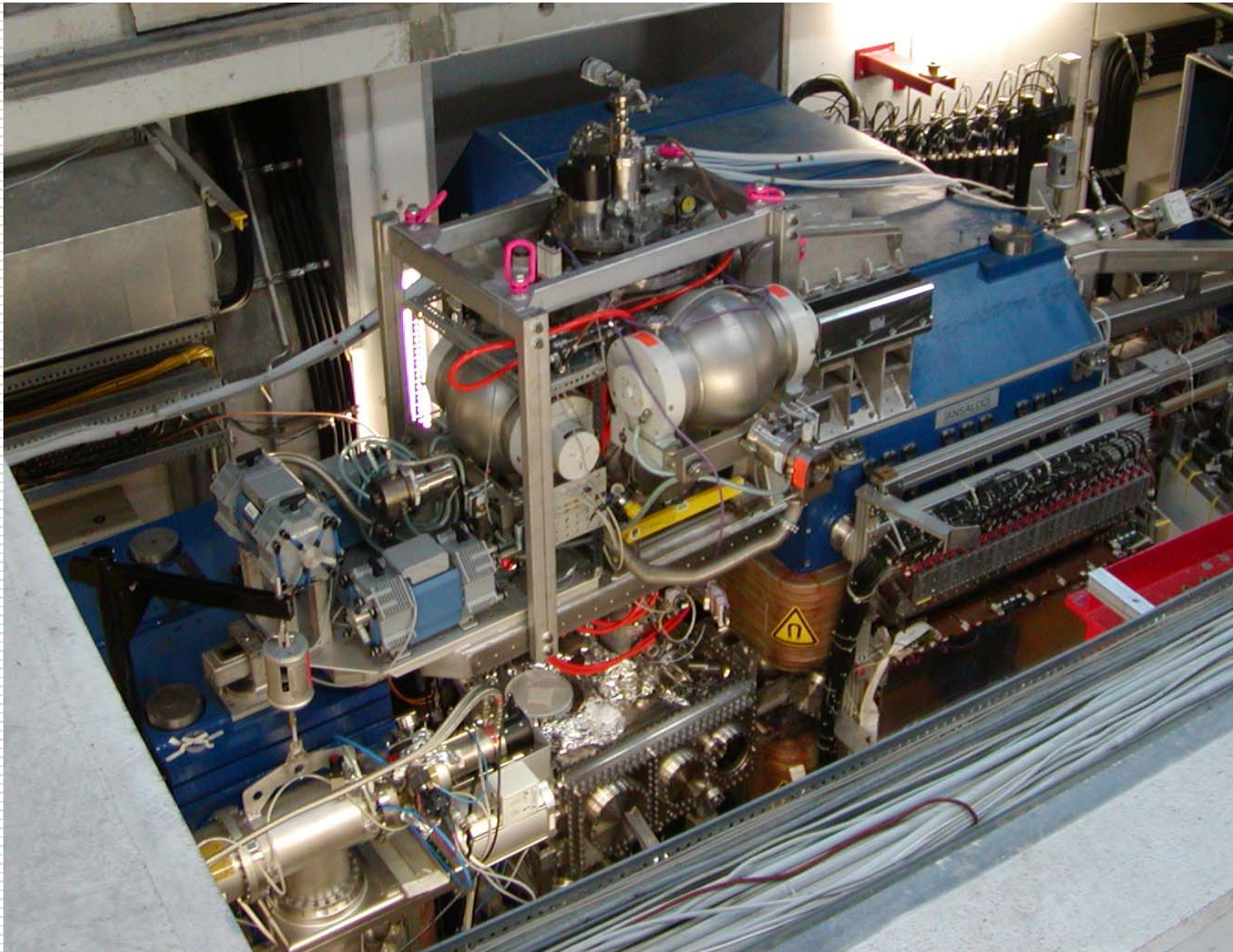


Platform transportation

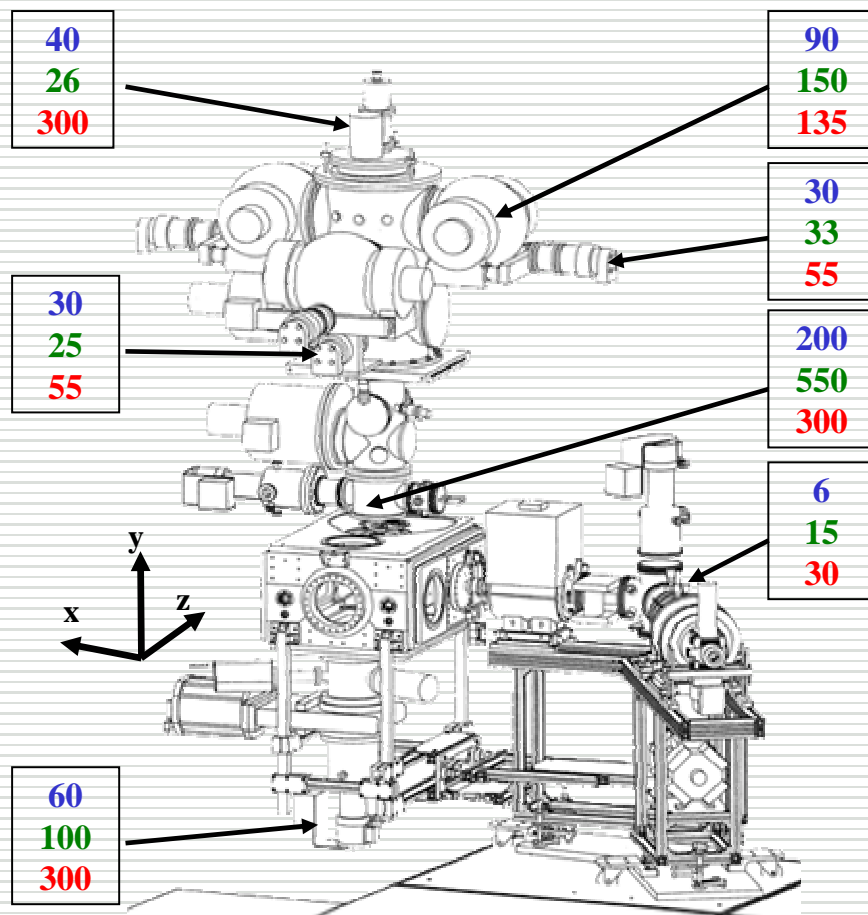


ABS transportation

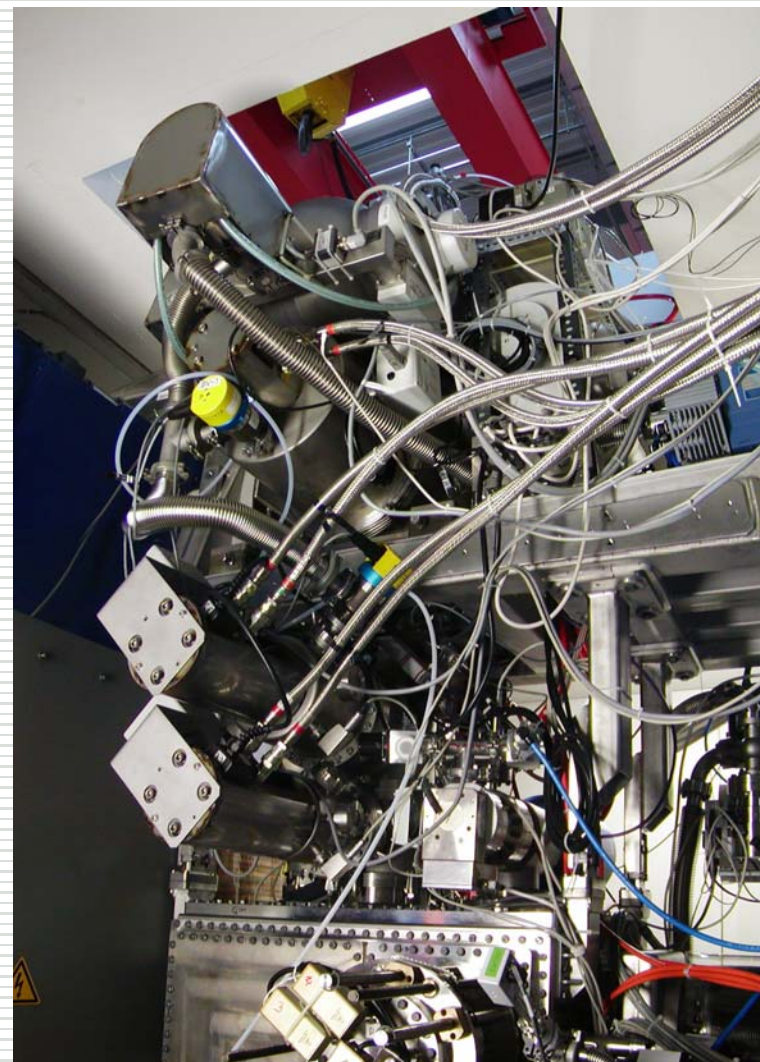
PIT at ANKE



Magnetic stray field of D2

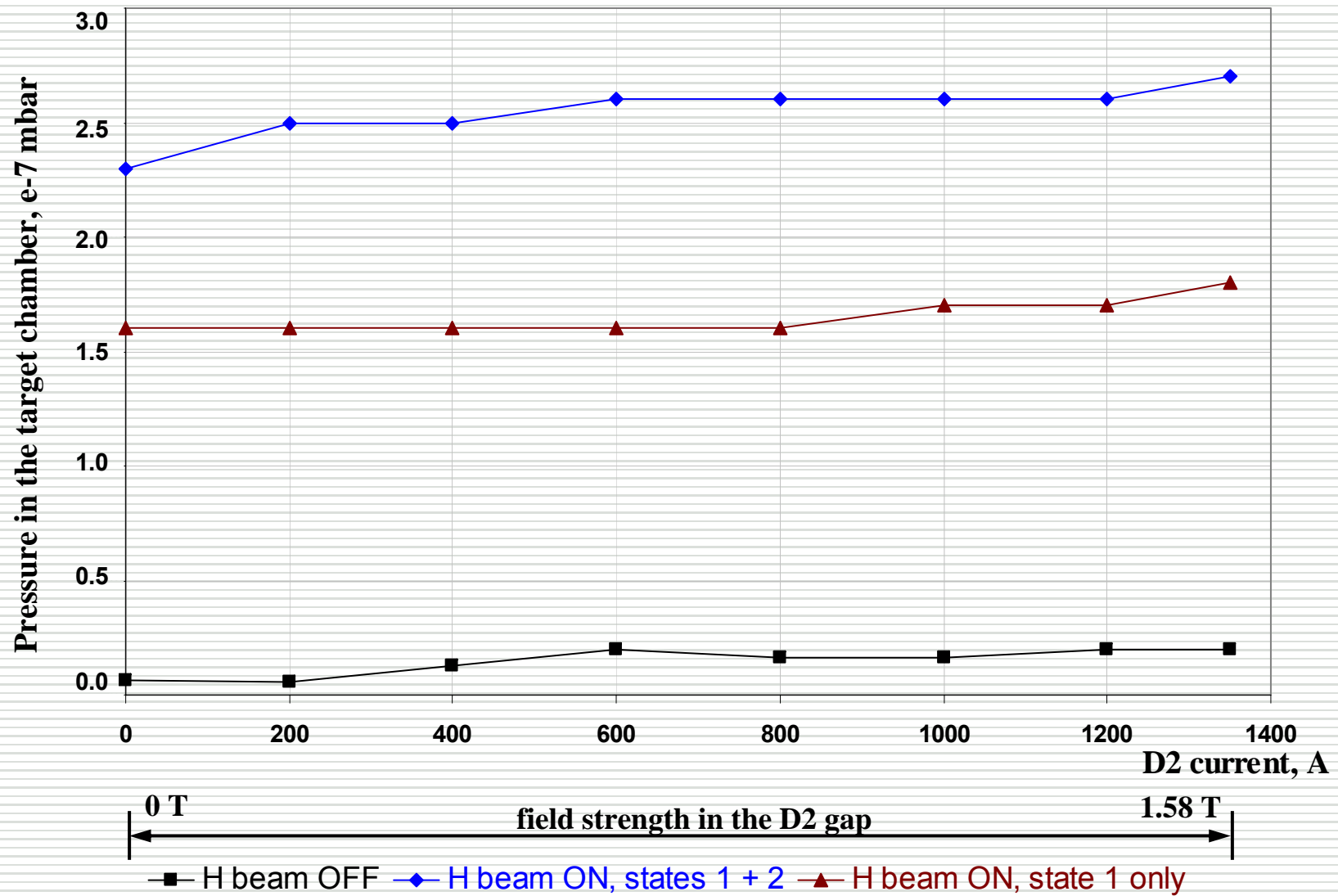


calculated field strength (G)
 measured field strength (G)
 permissible field strength for the device
 given by the producer (G)



PIT setup with shielded components at ANKE

Test of the medium-field rf transition unit



Do we have a zero field crossing ?

Magnetic field scan with ANKE at 5.3° using a 3D Hallprobe (Gatchina):

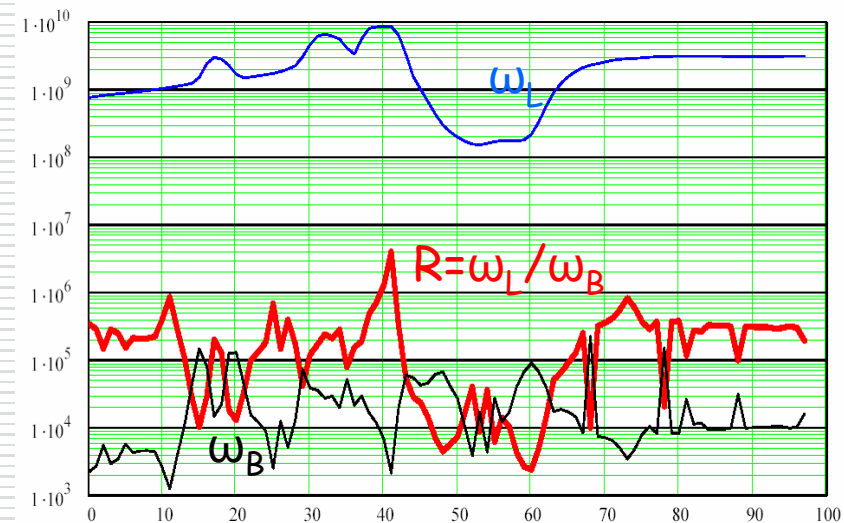
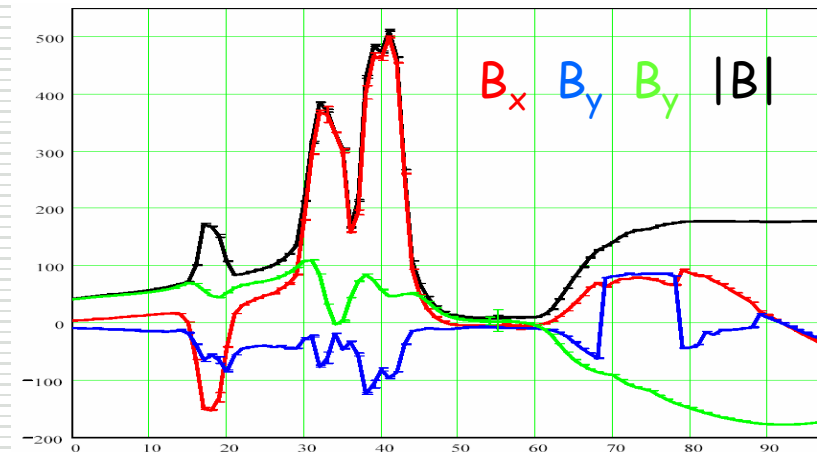
Magnetic field along ABS axis

- $I_{D2}=563$ A
- $I_{D1D3}=1294.84$ A

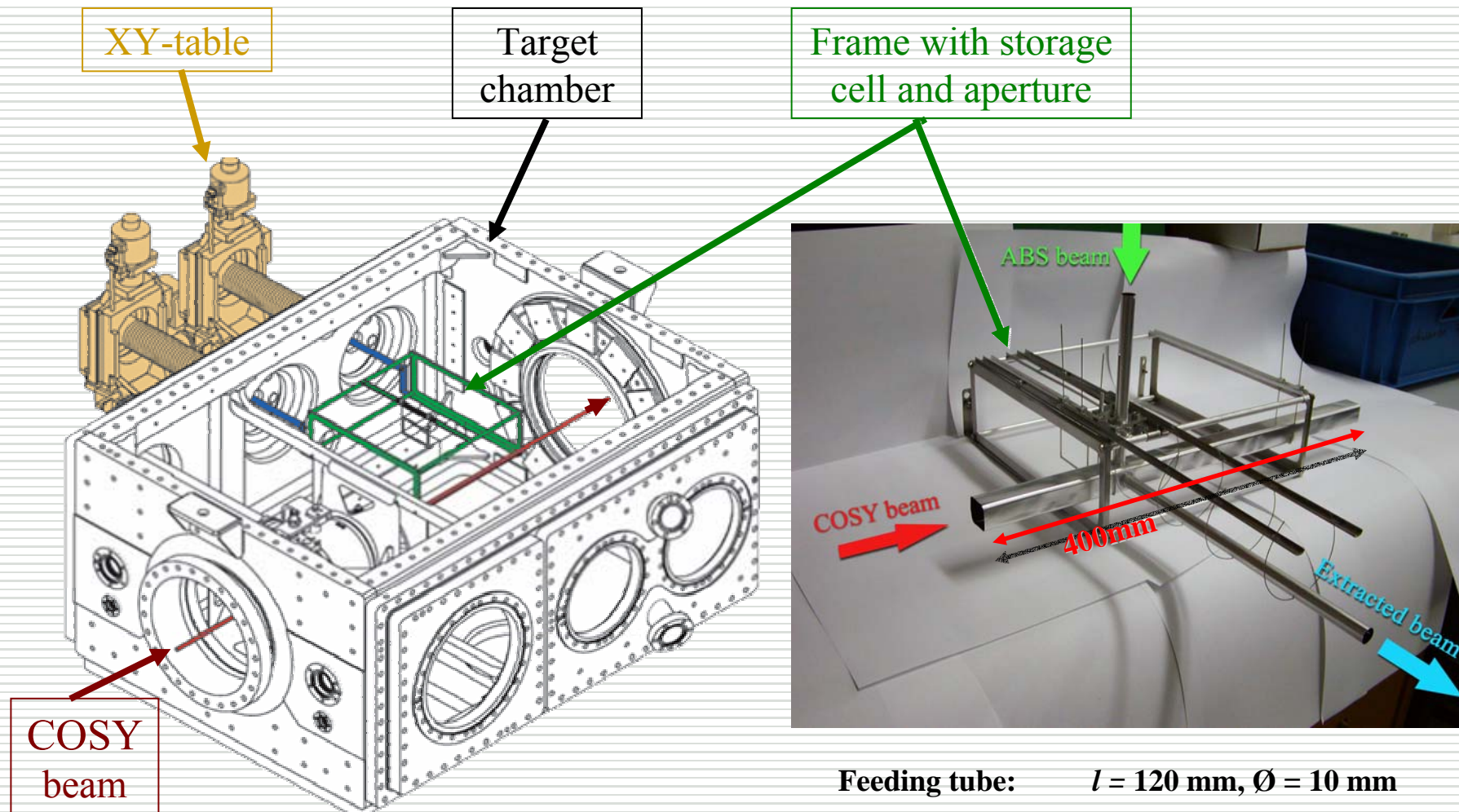
1. Determine the local Larmor precession frequency ω_L
2. The angular velocity of the magnetic field ω_B .

As long as the ratio $R=\omega_L/\omega_B$ is large, the spin of the atom follows the field direction.

→ no depolarization due to zero crossings



Storage cell setup

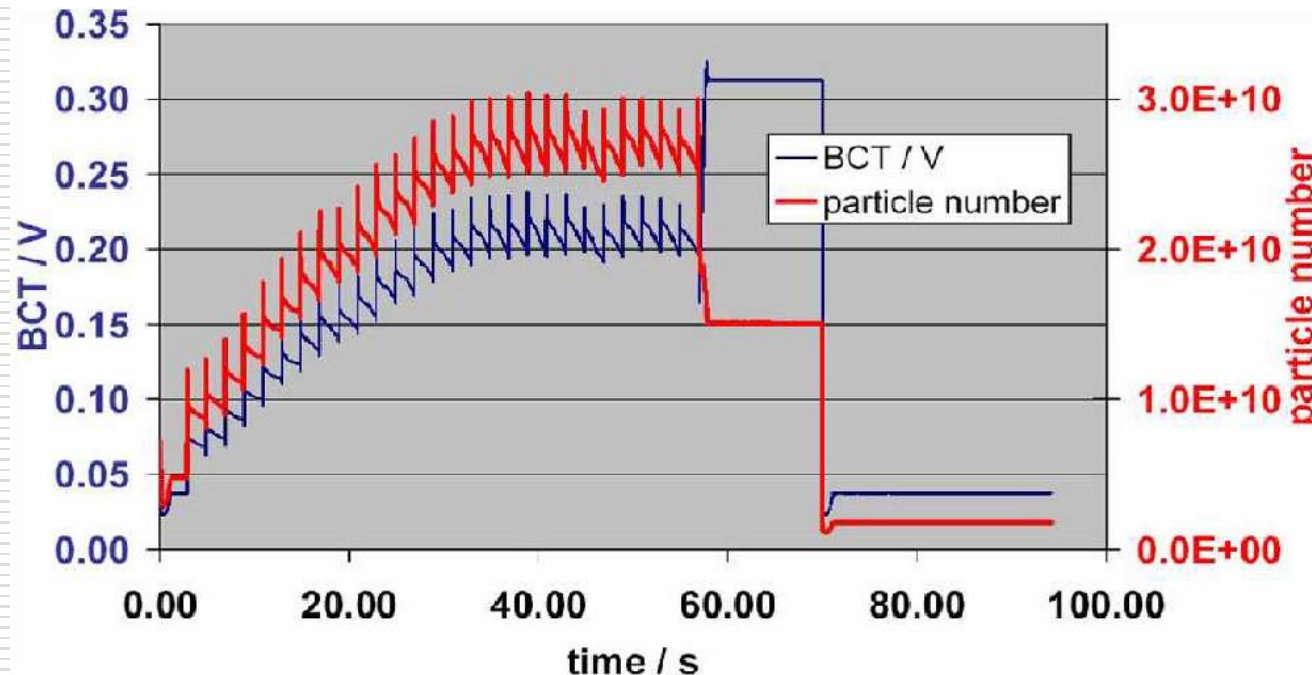


Feeding tube: $l = 120 \text{ mm}$, $\varnothing = 10 \text{ mm}$
Extraction tube: $l = 230 \text{ mm}$, $\varnothing = 10 \text{ mm}$
Beam tube : $l = 400 \text{ mm}$, $20 \times 20 \text{ mm}^2$

Cooler stacking into the storage cell

28 stacks followed by




- 2s electron cooling
- after 58s acceleration to $T_p = 600$ MeV



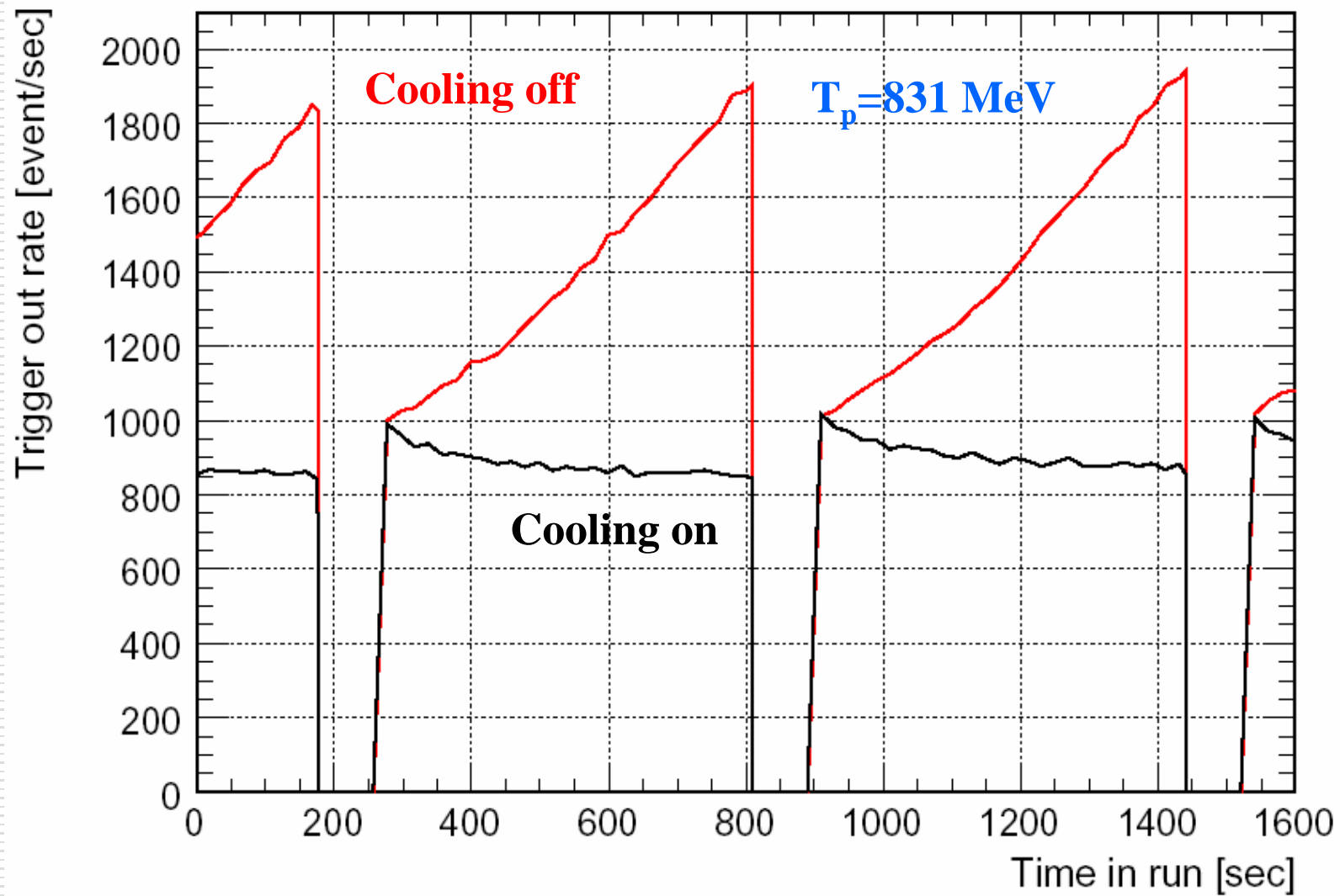
Cooler Stacking at COSY with ANKE is possible.

Without storage cell with micropulsing to simulate the lower polarized source intensity, $2.5 \cdot 10^{10}$ were reached.

Results of the cell tests

Θ_{ANKE}	injection type	target	number of stored protons * 10^9		
			injection	after cooling	flattop (600 MeV)
0°	single injection	no cell	83	21 	14
	single injection	empty cell	7	5 	3
	80 stacking + electron cooling	no cell			26
	30 stacking + electron cooling	empty cell			20
9.2°	30 stacking + electron cooling	cell with H gas from ABS		9 	6

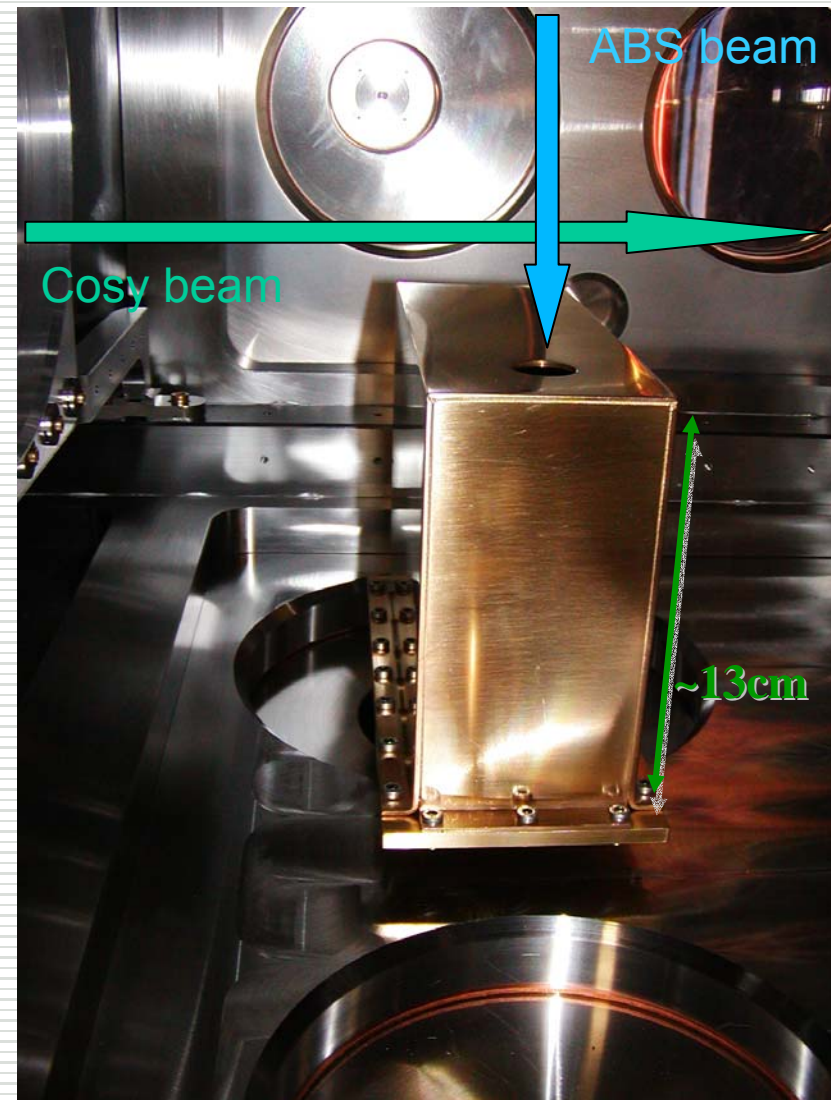
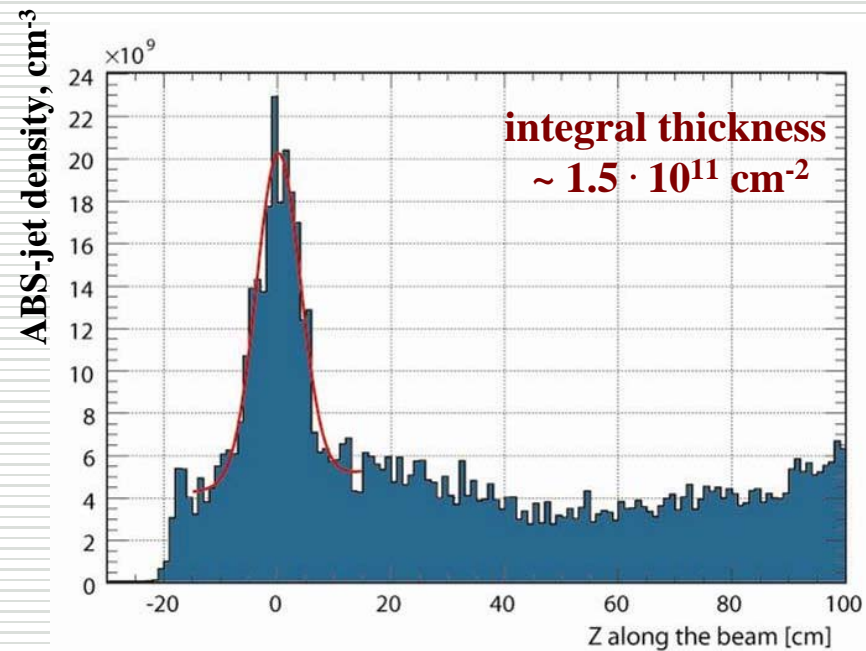
Storage cell and stochastically cooled beam



Use of the ABS jet

Measured pressures in the target chamber, mbar

	Without ABS jet	With ABS jet
Without catcher	$4.0 \cdot 10^{-9}$	$3.0 \cdot 10^{-7}$
With catcher	$4.0 \cdot 10^{-9}$	$3.7 \cdot 10^{-8}$



ABS beam catcher

Summary of commissioning

- PIT transfer to COSY hall - December 2004
- Cell test at ANKE - February 2005
- PIT installation at ANKE - June 2005
- PIT commissioning - Summer'05 – Spring'06

• Tests at ANKE with ABS and storage cell
with stacking injection (Nov. 2005) and stochastic cooling (Mar. 2006)



1. Cell-target thickness for H (HFS 1 only) $\sim 10^{13} \text{ cm}^{-2}$
2. Average luminosity for the storage-cell test $\sim 10^{29} \text{ cm}^{-2}\text{s}^{-1}$
3. ABS jet-target thickness $\sim 1.5 \cdot 10^{11} \text{ cm}^{-2}$

Plans for the nearer future

going on – **new cell production** with Teflon coating

Autumn '06 – studies of nuclear polarization of molecules from recombined polarized H and D atoms
(**use of the ABS** in the ISTC project)

December '06 – **PIT reinstallation** with Lamb-shift polarimeter at ANKE

January '07 – First experiment: $\vec{pd} \rightarrow (pp)n$ with STT

Far future, parallel to ANKE measurements:

Polarized Fusion with ABS and LSP !