Status of frozen−spin polarized HD targets for spin asymmetry measurement experiments.

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Motivation

Nucleon Spin Sum Rules

- Gerasimov−Drell−Hearn

$$-\frac{\alpha}{2m^2}\kappa^2 = \frac{1}{4\pi^2}\int_{m_\pi}^{\infty}\frac{\sigma_{1/2}-\sigma_{3/2}}{E_\gamma}dE_\gamma$$

  - Nucleon spin strucure at $Q^2=0$
  - LEGS covers ~65%
  - Measurement down to pion threshold is important

- Forward Spin−Polarizability

$$\gamma_0 = \frac{1}{4\pi^2}\int_{m_\pi}^{\infty}\frac{\sigma_{1/2}-\sigma_{3/2}}{E_\gamma^3}dE_\gamma$$

  - Test of chiral perturbation theories
  - LEGS covers ~90%
  - Measurement down to pion threshold is important

Multipole Amplitudes

- Double polarization observables
  - Asymmetries E and G
  - Neutron channels $\pi^o n$ and $\pi^- p$

LEGS-Spin Collaboration

40 Collaborators from 11 Institutes

Brookhaven National Laboratory
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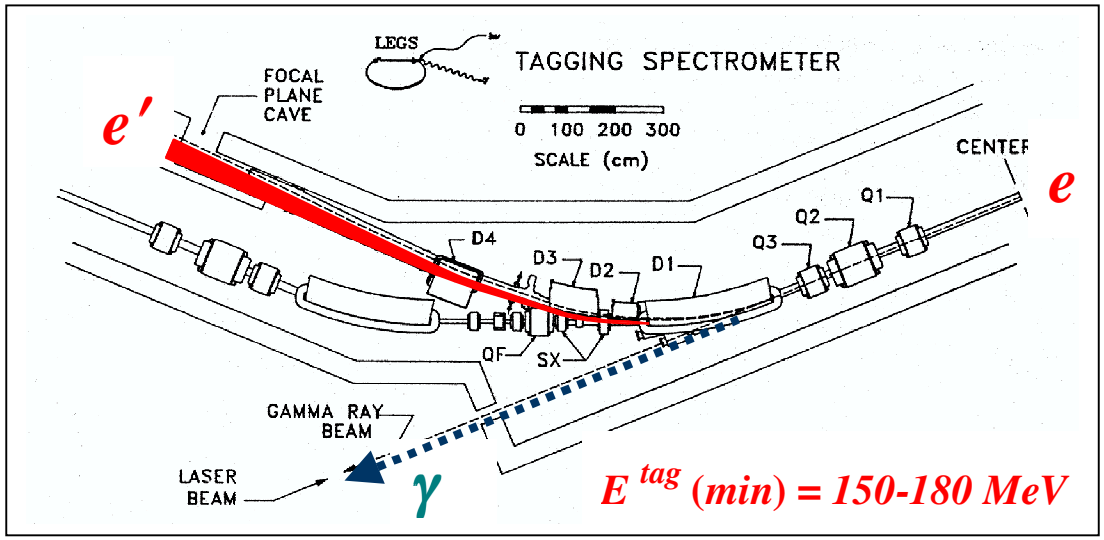
Virginia Polytechnic Institute & State University
M. Blecher, T. Kageya, H. Meyer, T. Saitoh

Laser-Electron-Gamma-Source (LEGS)

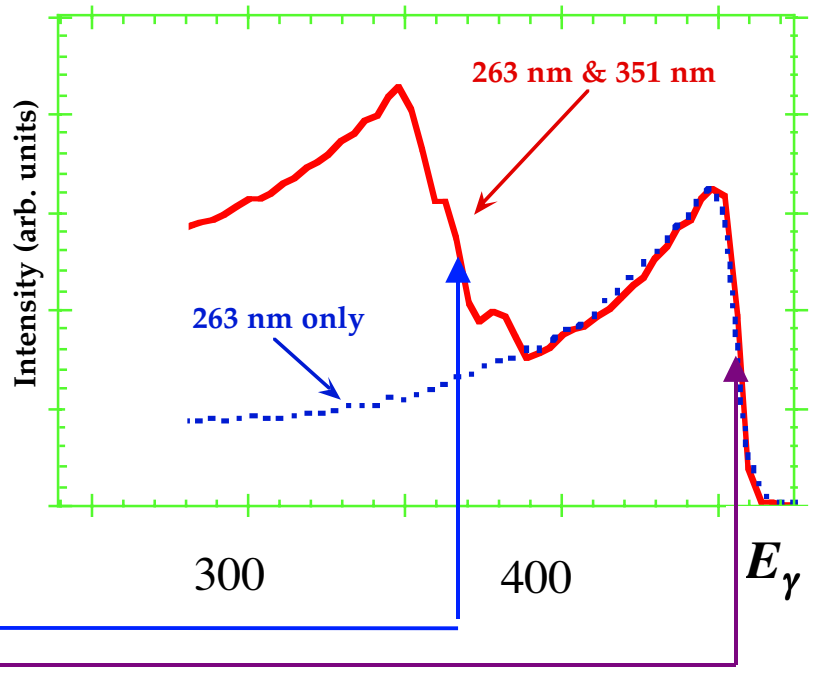


NSLS E_e = 2.8 GeV

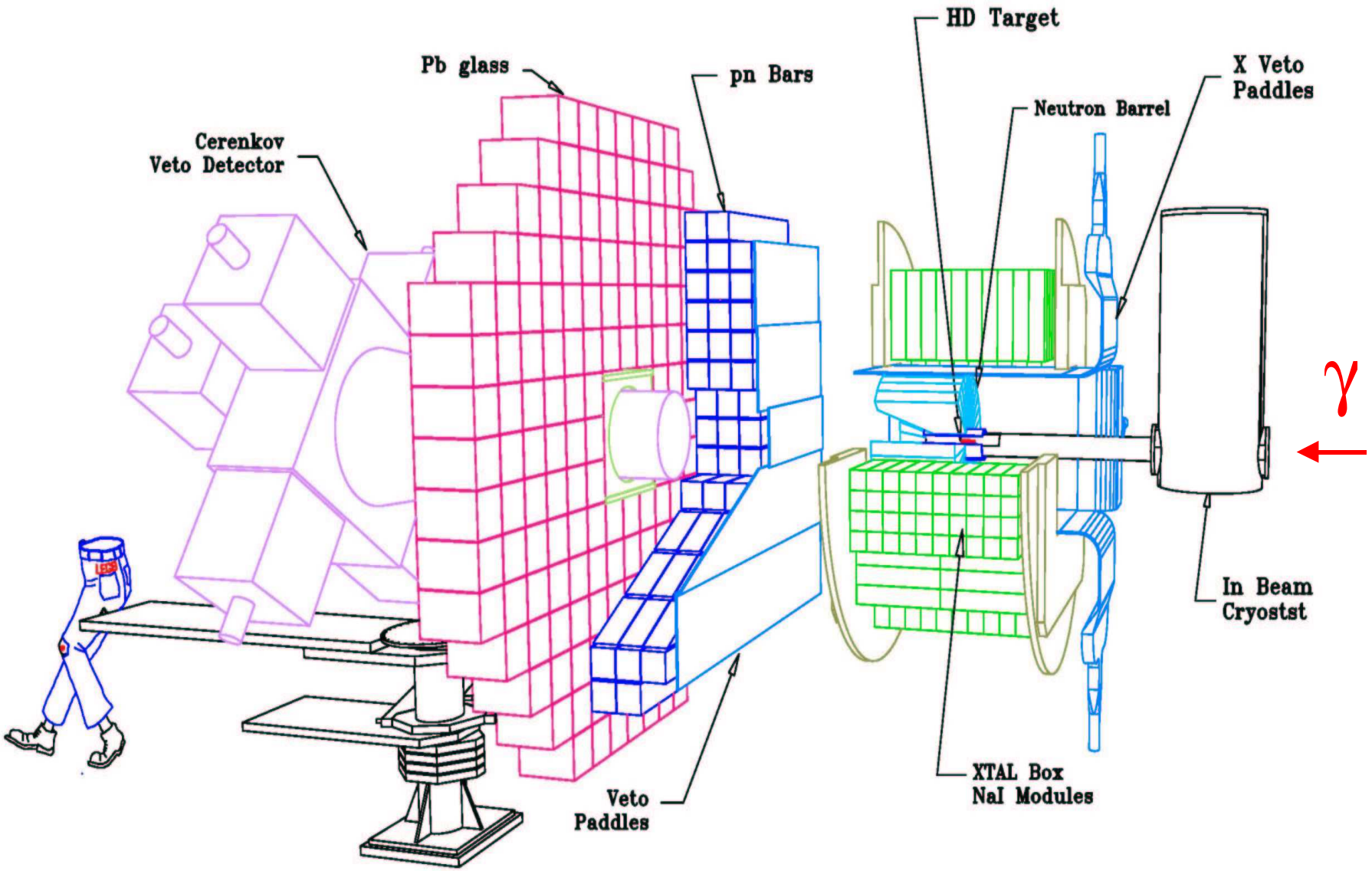
γ beam energy determined by e′ tagging

$E_\gamma = E_e - E_{e'}$, $\Delta E_\gamma = 3$ MeV

	4ω Nd-YLF ring laser	Ar-Ion laser			
λ(nm)	**263**	**300**	**351**	**488**	**515**
E_γ (max)	471 MeV	421 MeV	368 MeV	275 MeV	262 MeV



SASY Current Setup

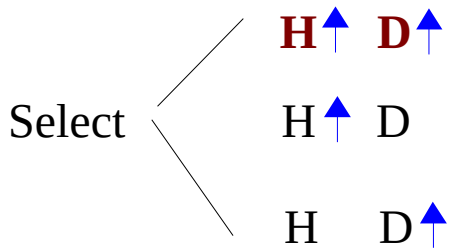


Polarized HD Solid Target

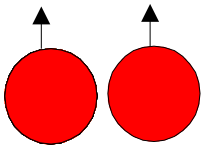
1. Purest Solid Targets

* Dilution Factor : Small
* Background Scattering with Unpolarized Nucleons: Significantly Reduced

2.



H_2 molecule

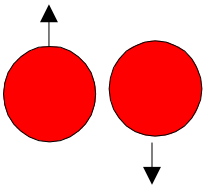


Ortho

I = 1

L = 1

Can be polarized



Para

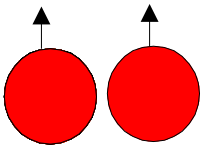
I = 1

L = 0

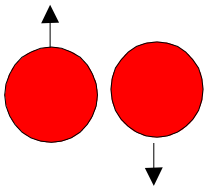
Cannot be polarized

Conversion

at low temp

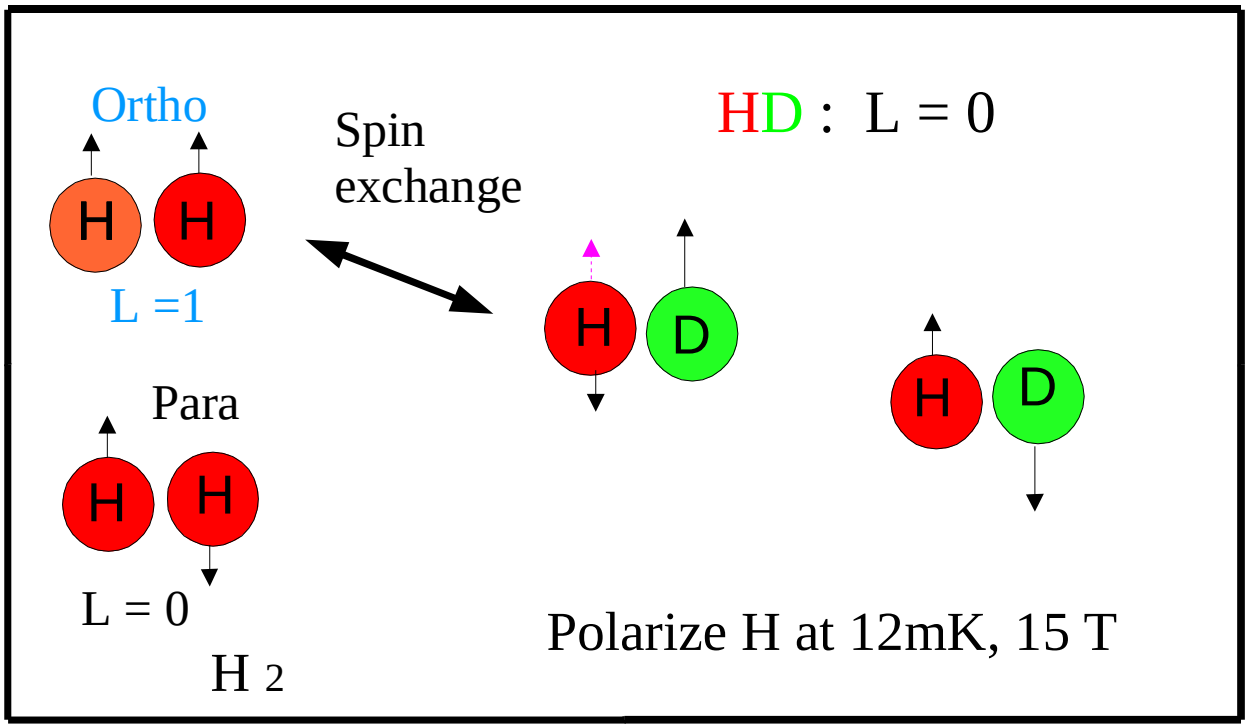


Ortho

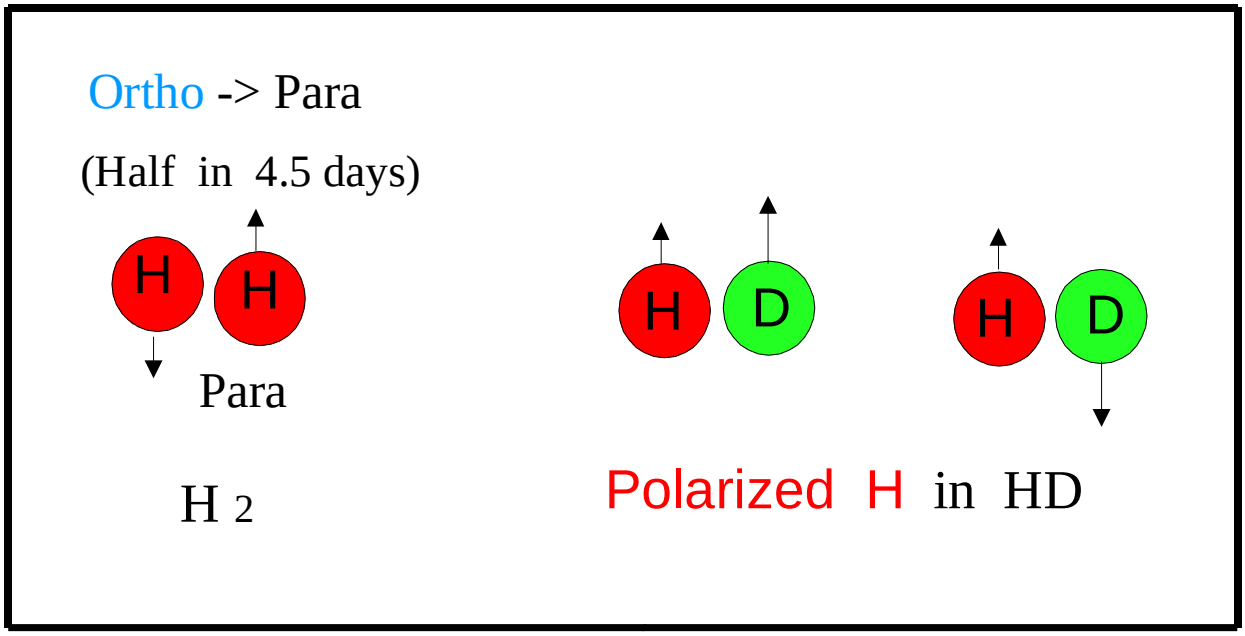


Para

Polarize H in HD using polarized ortho -H_2

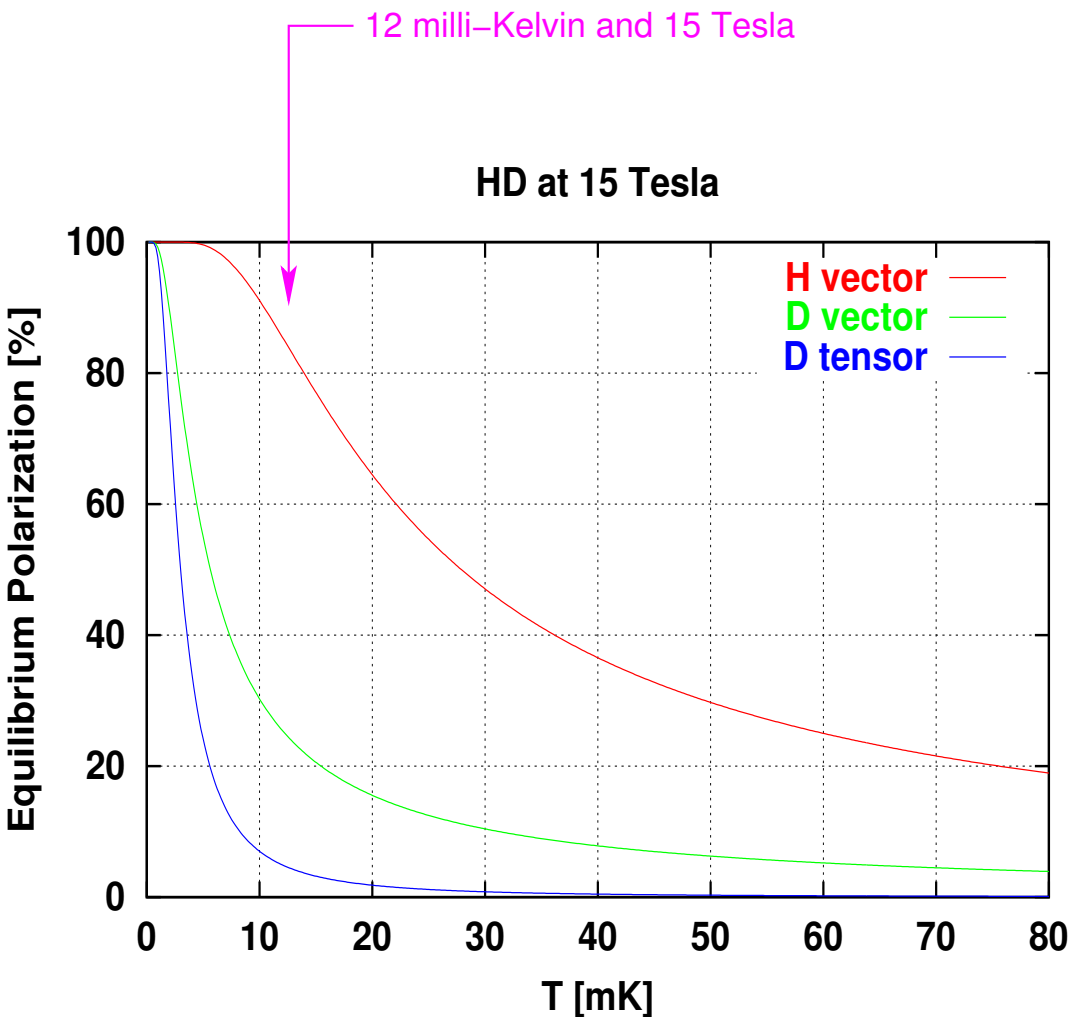


12 mK, 15 T ⬇ Age: 2 - 3 months

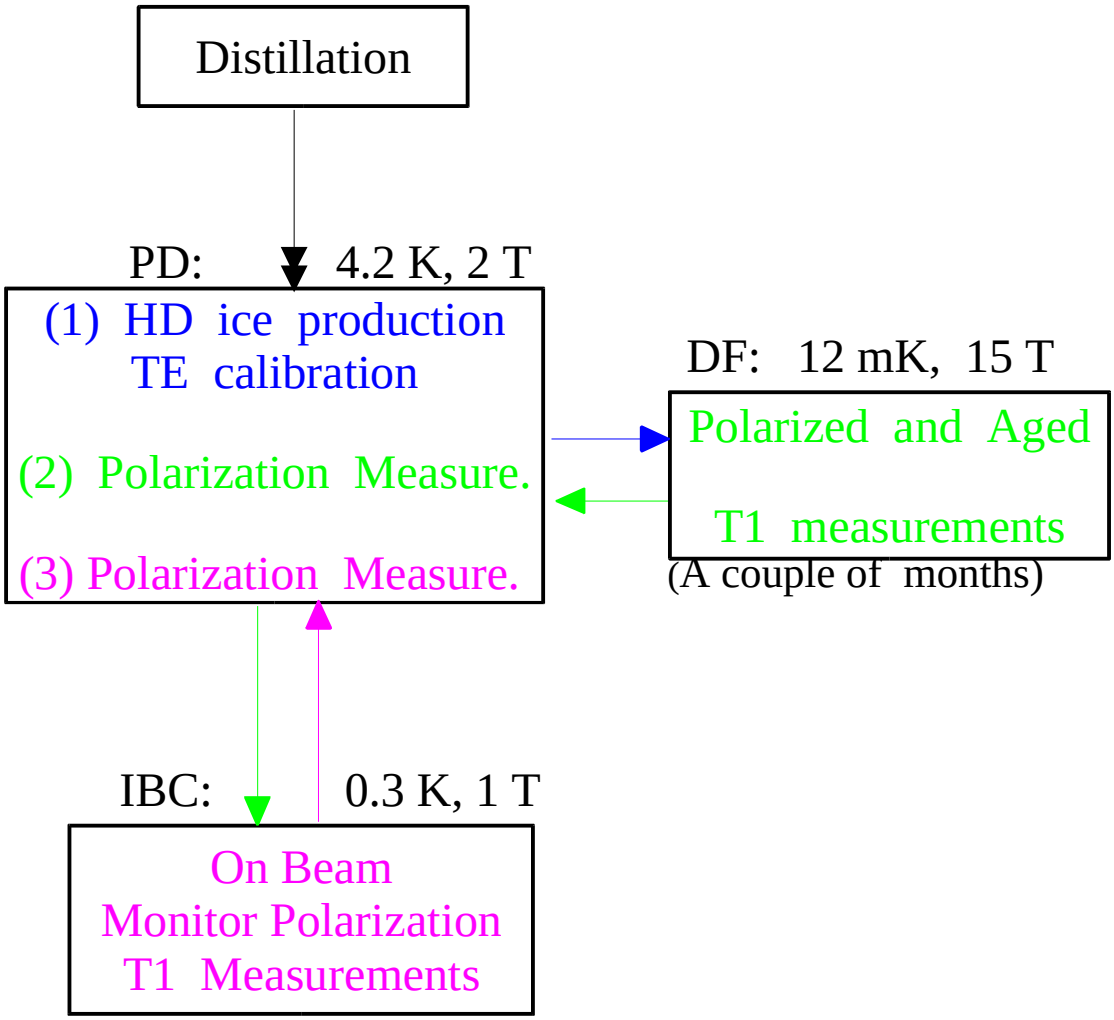


No spin exchange to HD (Frozen Spin)

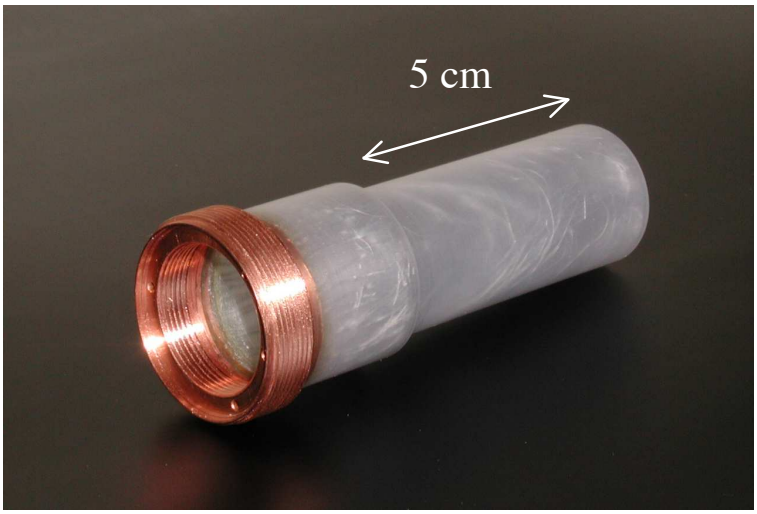
Expected Polarizations



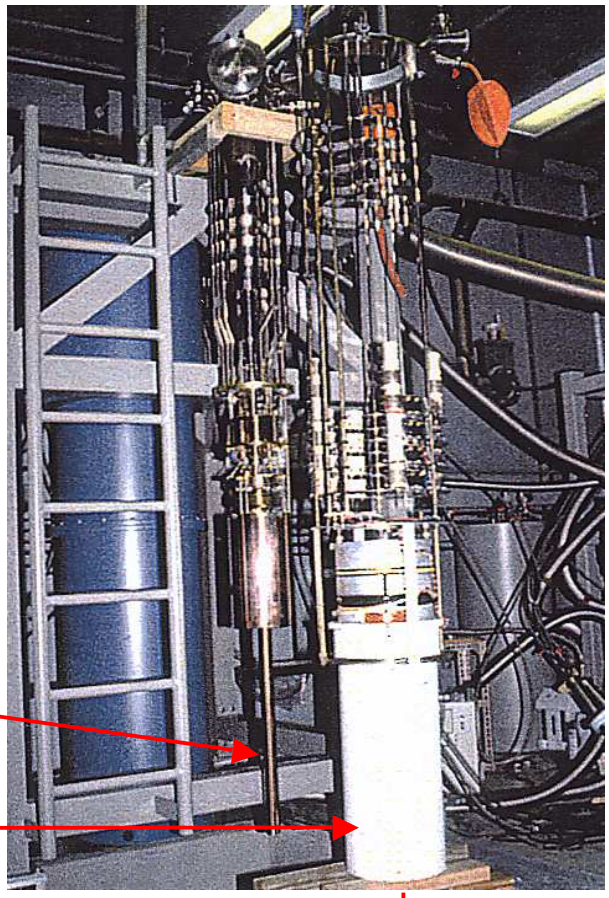
HD target Production, Calibration, Polarized and On the beam



HD target cycle:

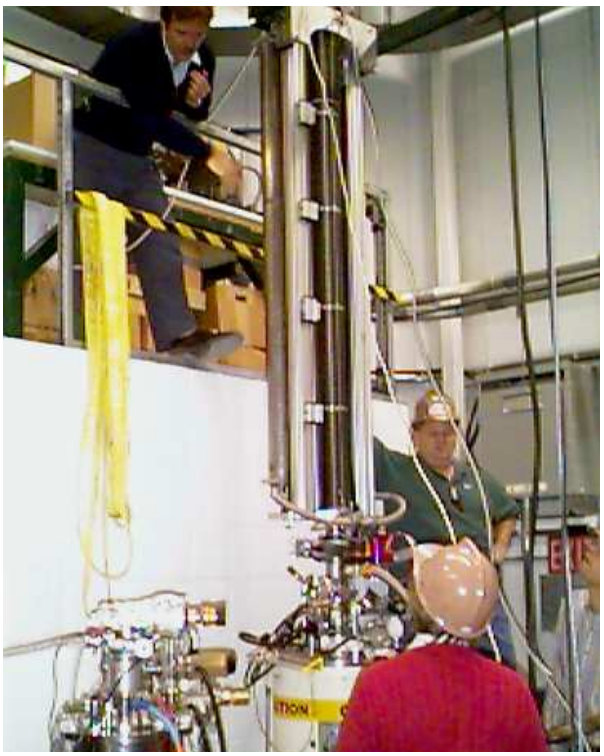


target injection into dilution fridge;
~*min* 45 days at 15 Tesla / 12 mK



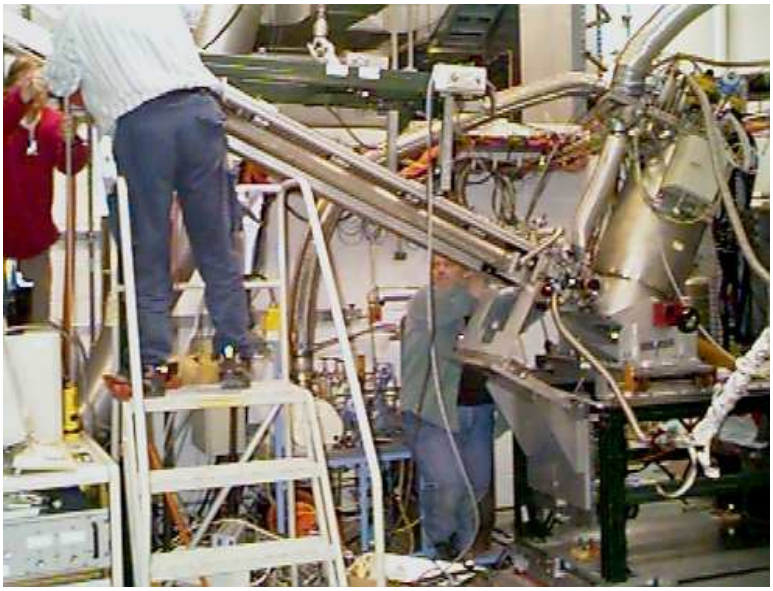
extraction with Transfer-Cryostat

- **2.5 K and 0.120 T**



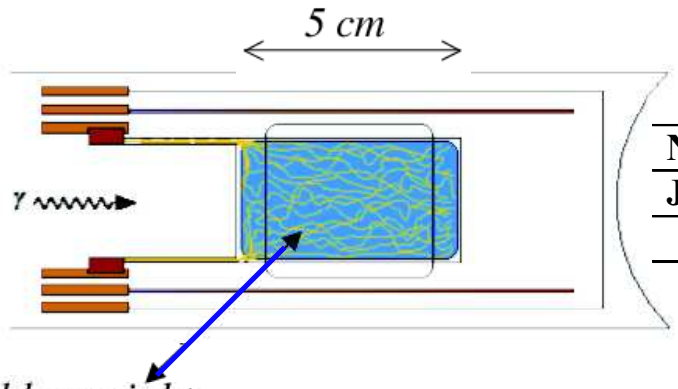
loading In-Beam-Cryostat

- **0.25 K and 1.00 Tesla**



In-beam Relaxation Time

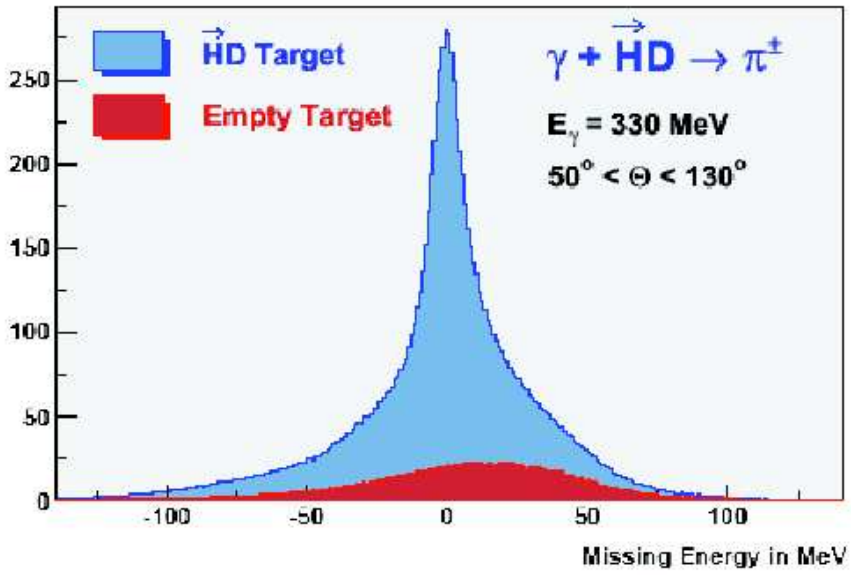
	T_1^H	T_1^H
Nov '01 (T-1.3°K)	13d	36d

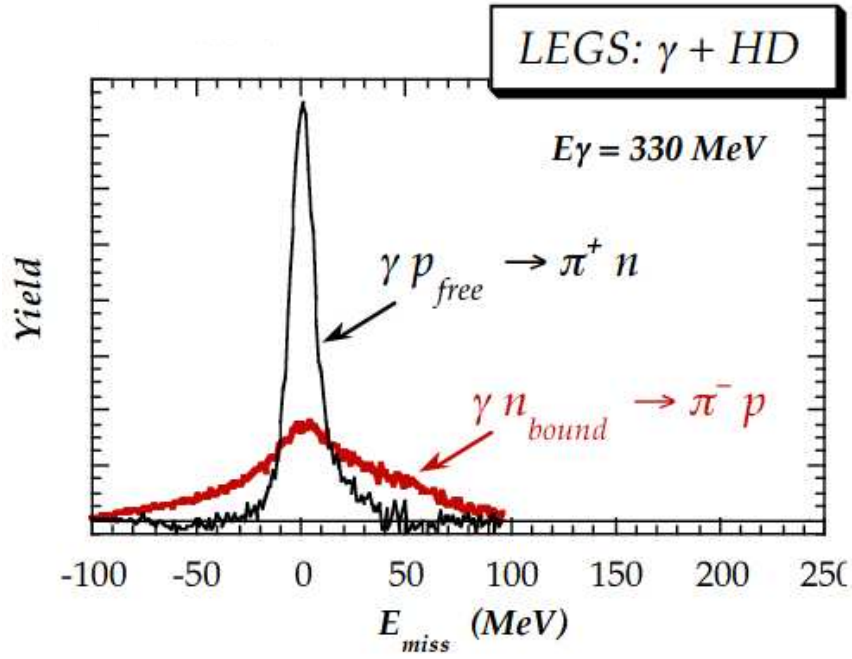


3 gm solid HD + 20% Al by weight
(2050 × 50 μm wires)

Target Polarization

	P_H	P_D
Nov '01	30%	6%
June '04	54%	21%





Recent Progresses

Two new cryostats:
fabricated, working and installed

(1) IBC (Orsay) --> New IBC (Quantum tech.)

1.3 K	0.3 K
0.65 Tesla	1 Tesla

T1 : at least 4 times longer

~ 250 lit./day	~ 125 lit./day

(2) TC (Orsay) --> New TC (BNL/Juelich)

0.016 Tesla	0.12 Tesla

Reduce polarization losses
during target transfers
and aging time

Summary

(1) Two new cryostats (IBC and TC):
constructed, tested, working and installed

- Reduce Aging Time (3 → 2 months)
- Reduce Polarization Loses during Transfers
- Increase T1 on Beam

(2)Polarized HD target has been Aged (2 months) and is ready for Spin Physics experiments

(3) Plan to take data for neutral pion production in 2004 and 2005,
charged pion in 2006 with TPC.

Future Plans for HD target

(1) TE calibrations in IBC

* More accurate Measurements of Polarization at 300 mK

* Calibration at 7K
T1 can be short even after long aging

(2) Forbidden Adiabatic Fast Passage at DF

D polarization -> Goal > 50 %