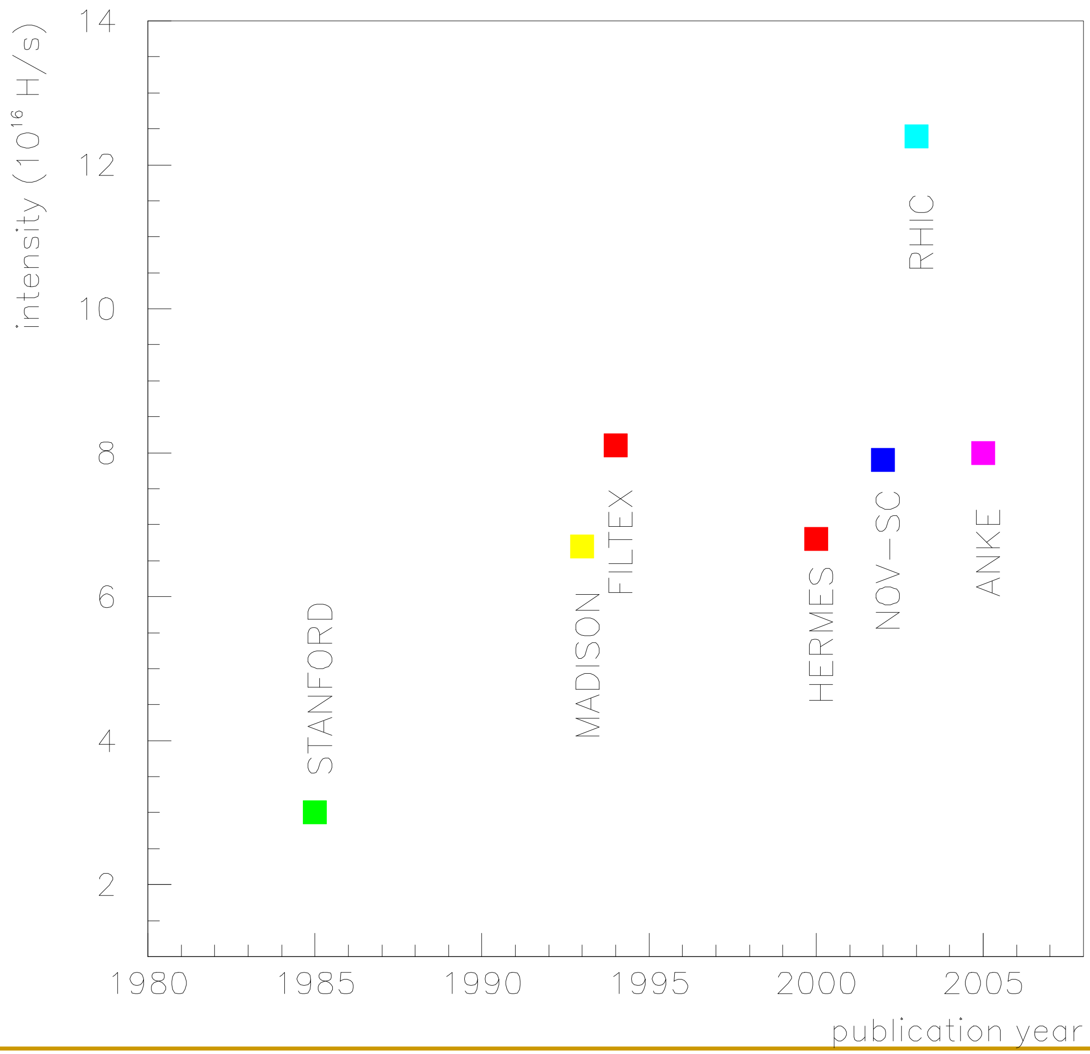
ABS Intensity Studies at SpinLab in Ferrara

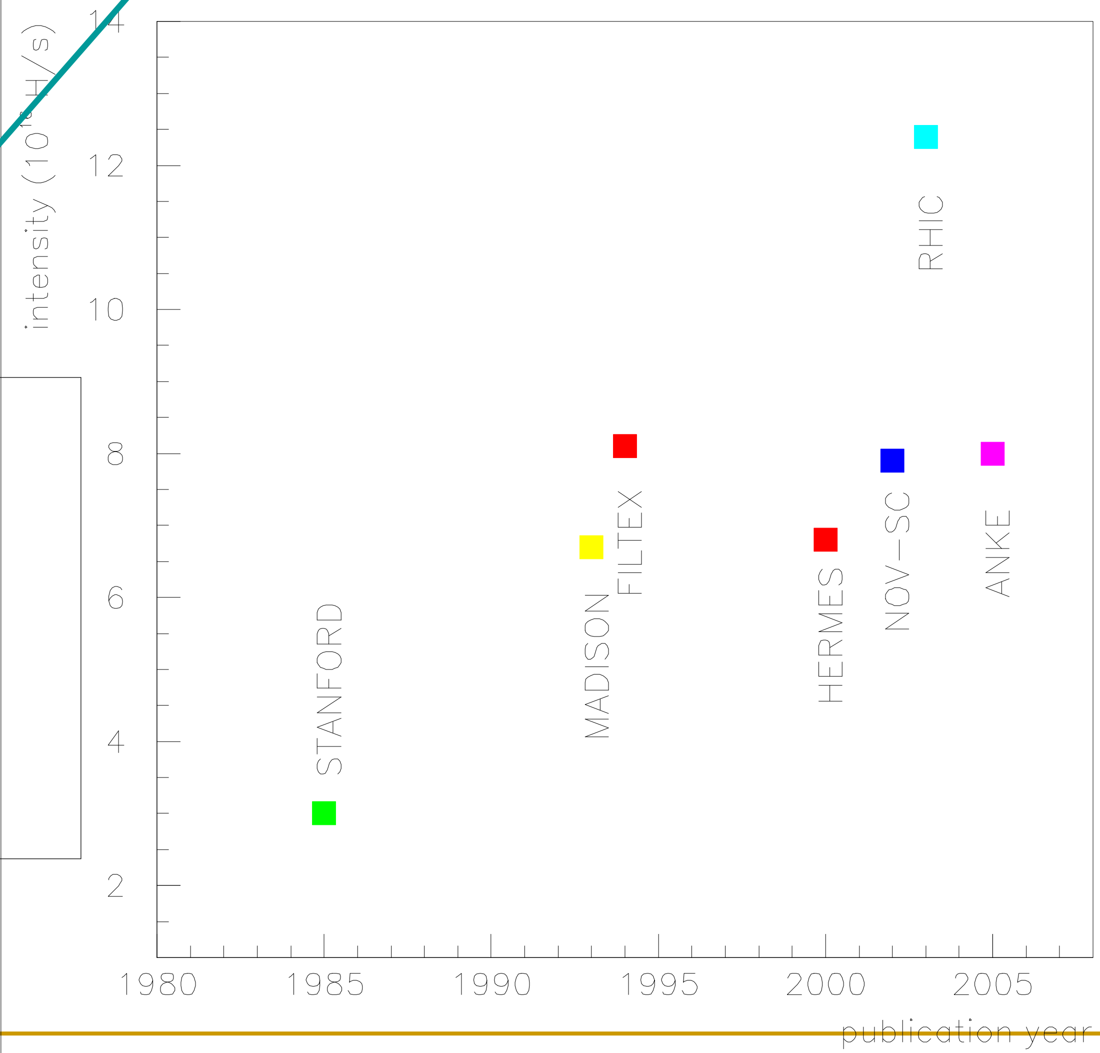
Michelle Stancari
Ferrara University

The last 30 years of Atomic Beams



Increase has no concrete explanation!

The last 30 years of Atomic Beams

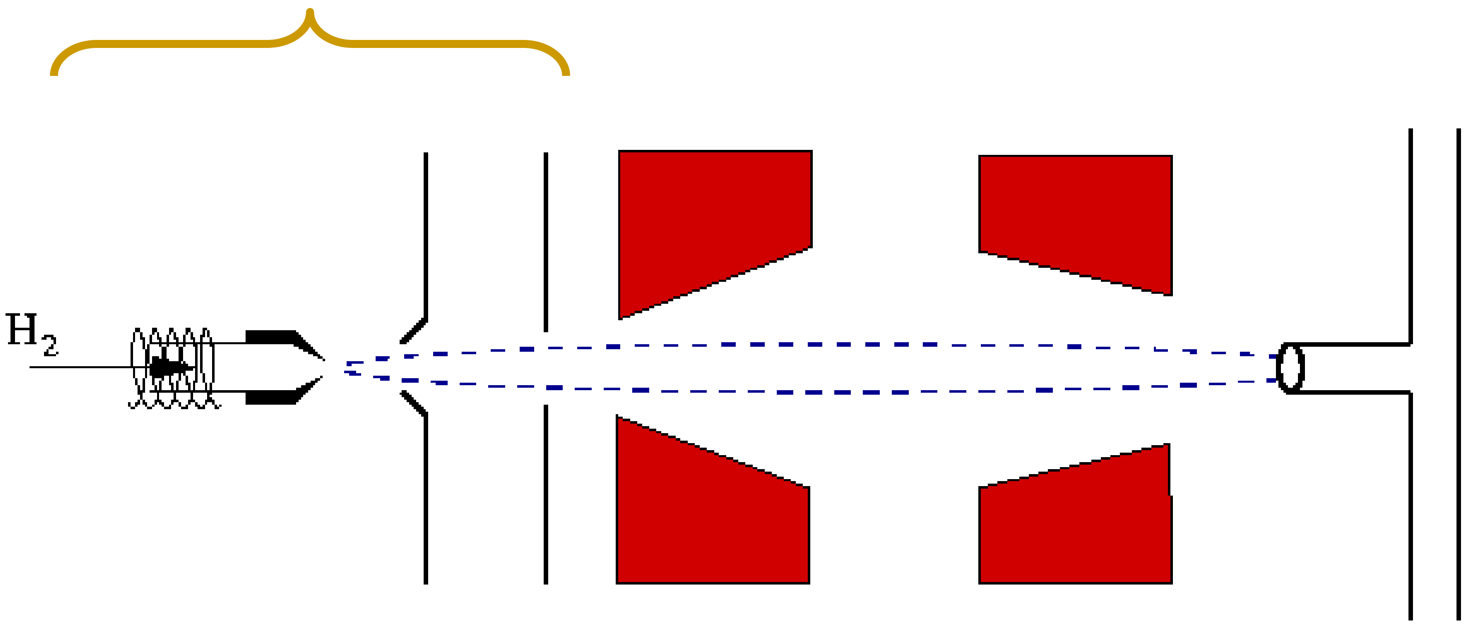


15x10^{16} atoms/s in PAX proposal as minimum intensity.

More intensity
⇒ shorter time for beam polarization
⇒ more data

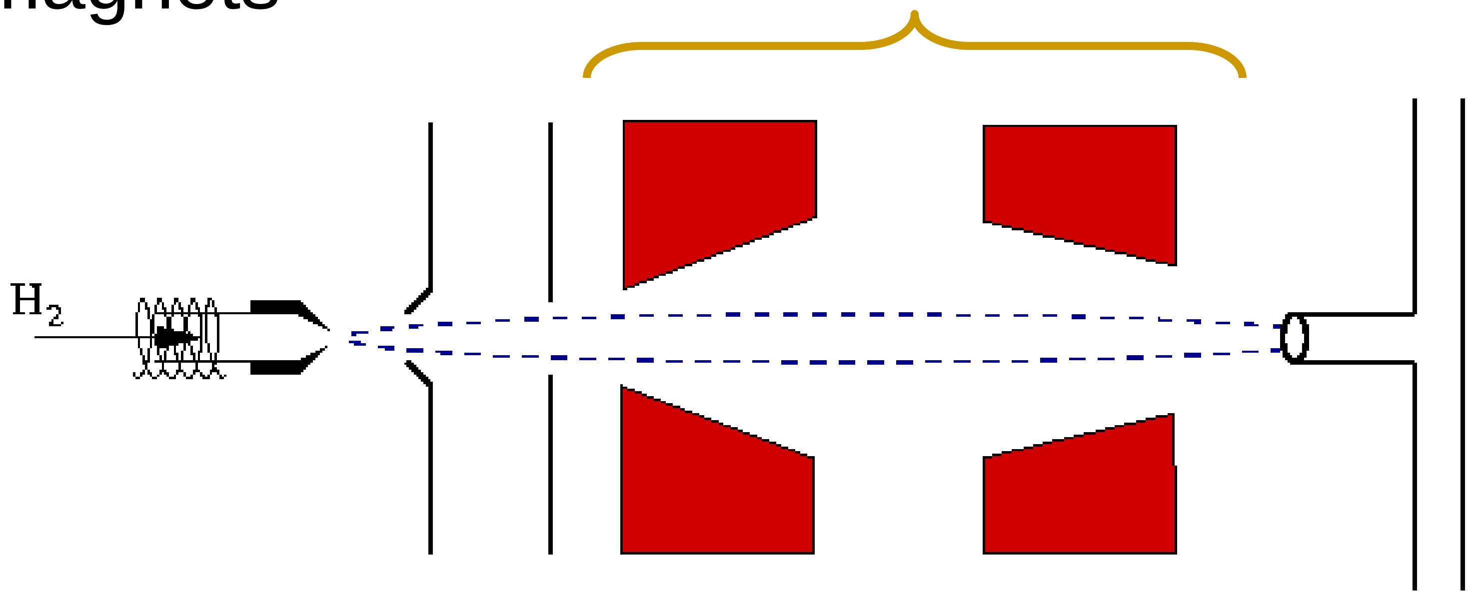
ABS Basics

- Beam formation (dissociator, nozzle and skimmer)



ABS Basics

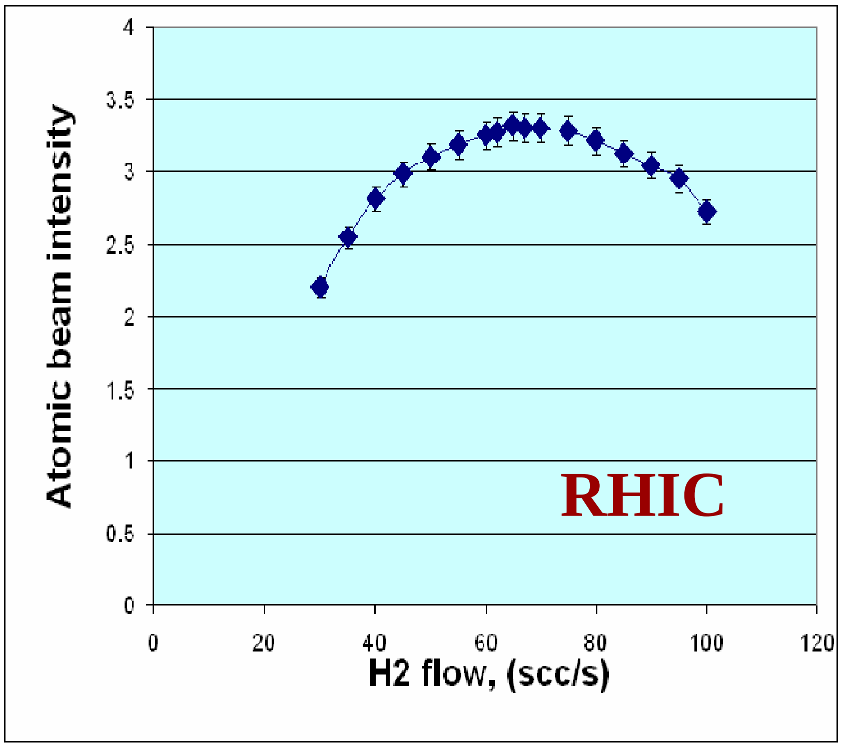
- Beam formation (dissociator, nozzle and skimmer)
- Spin selection and focusing with sextupole magnets



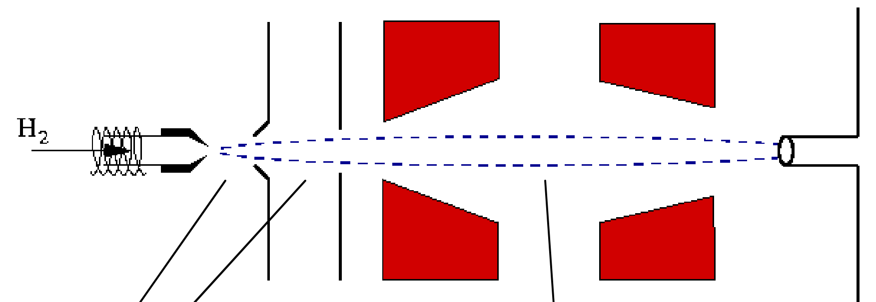
ABS Basics

- Beam formation (dissociator, nozzle and skimmer)
- Spin selection and focusing with sextupole magnets
- Hyperfine state population exchange via RF cavities

More goes in but less comes out???



Where does it go?



Work on adapting dissociator and beam formation to high input flows

Work on reducing attenuation losses

What don't we know?

- How much rest gas is inside the magnets (RGA losses increase with the RG pressure seen by the beam)
- How to estimate quantitatively the losses to intra-beam scattering (IBS losses increase with beam density and with $\Delta v/v$ of the beam)

⇨ Need a combination of simulations and test bench measurements to improve the situation.

SpinLab Program

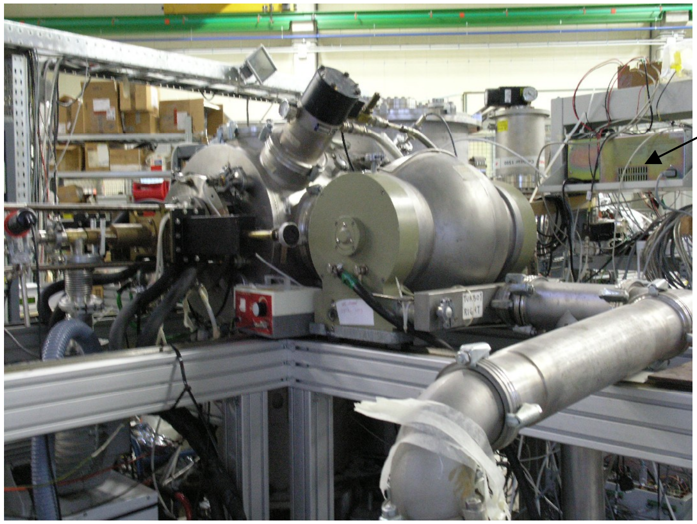
Work in progress

- Study importance of dissociator cooling
- Tune scattering cross section in simulation

Future Plans

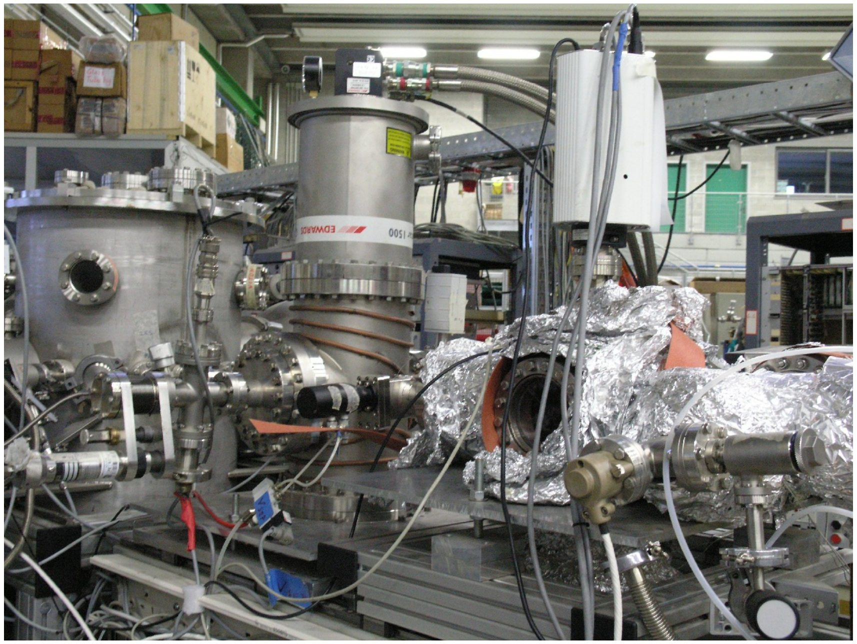
- Simulate and measure beam flux through skimmer
- Simulate and measure intra-beam scattering losses

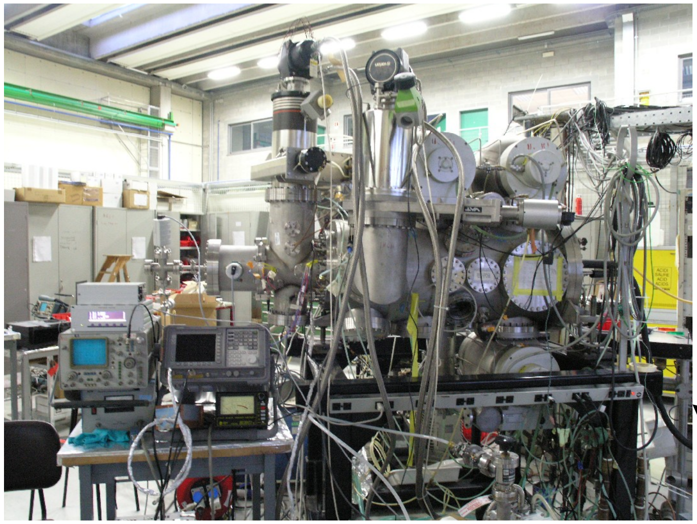
SpinLab



Unpolarized ABS (CERN)

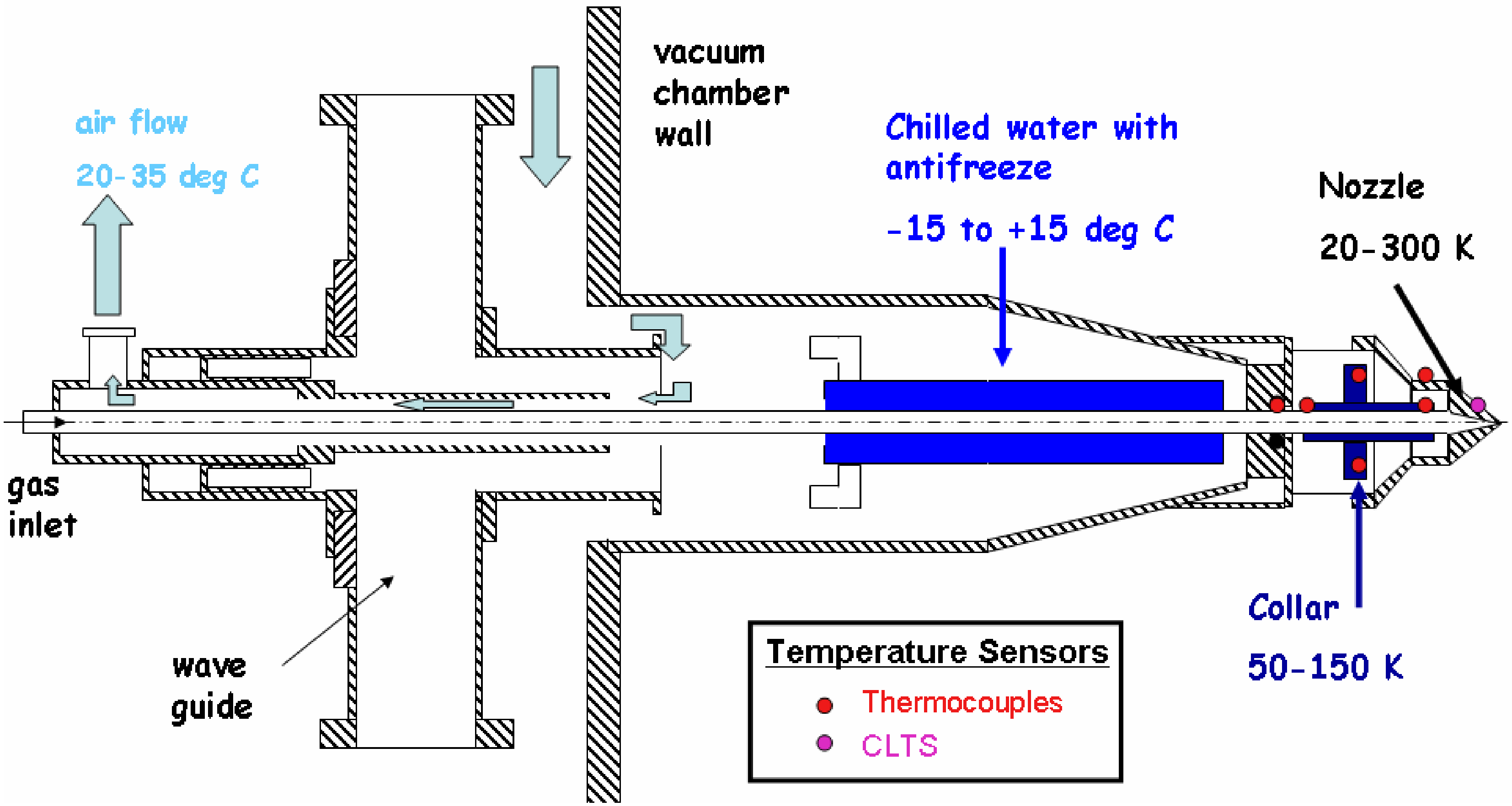
Movable Diagnostic System (Ferrara)





Polarized ABS (Madison)

Microwave Dissociator Cooling

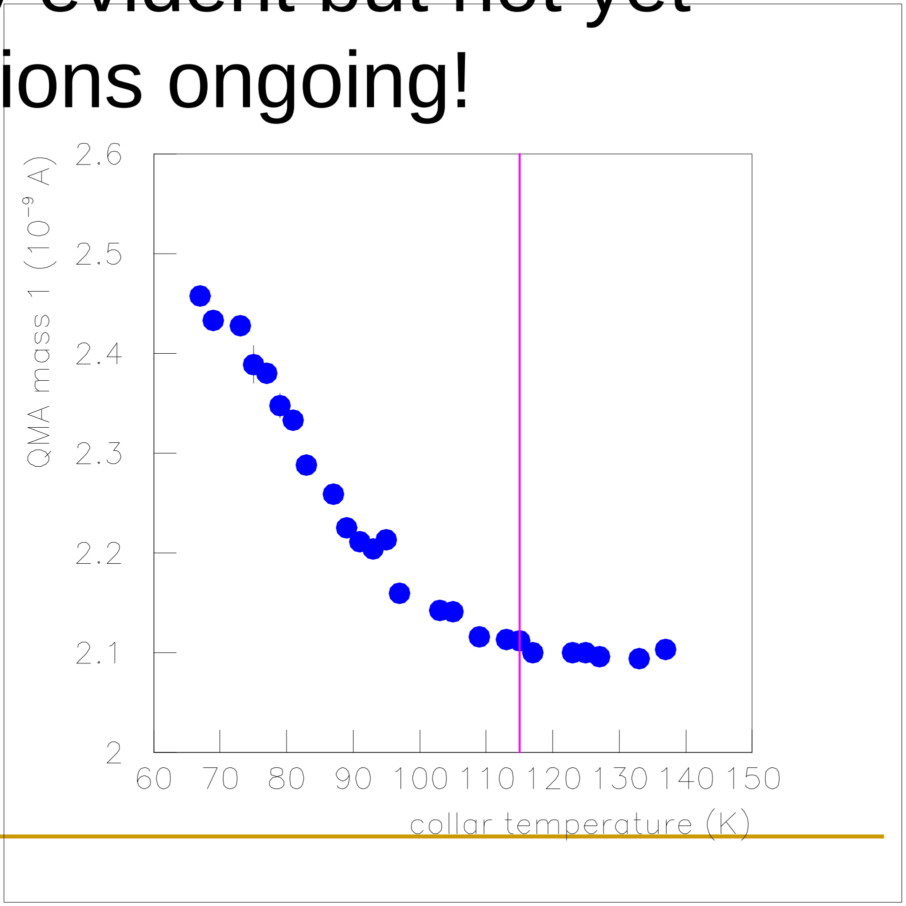


Study of Dissociator Cooling

- WHY? – One difference between RHIC source and others
- What could cooling possibly do?
  - Improve beam thermalization at nozzle $\Rightarrow$ narrow the velocity spread of the beam $\Rightarrow$ reduce losses to IBS.
    - Can we work at higher input flows?
    - Can we work with larger nozzles?
  - Reduce recombination of atomic hydrogen before nozzle exit?
  - Increase forward peaking of beam?

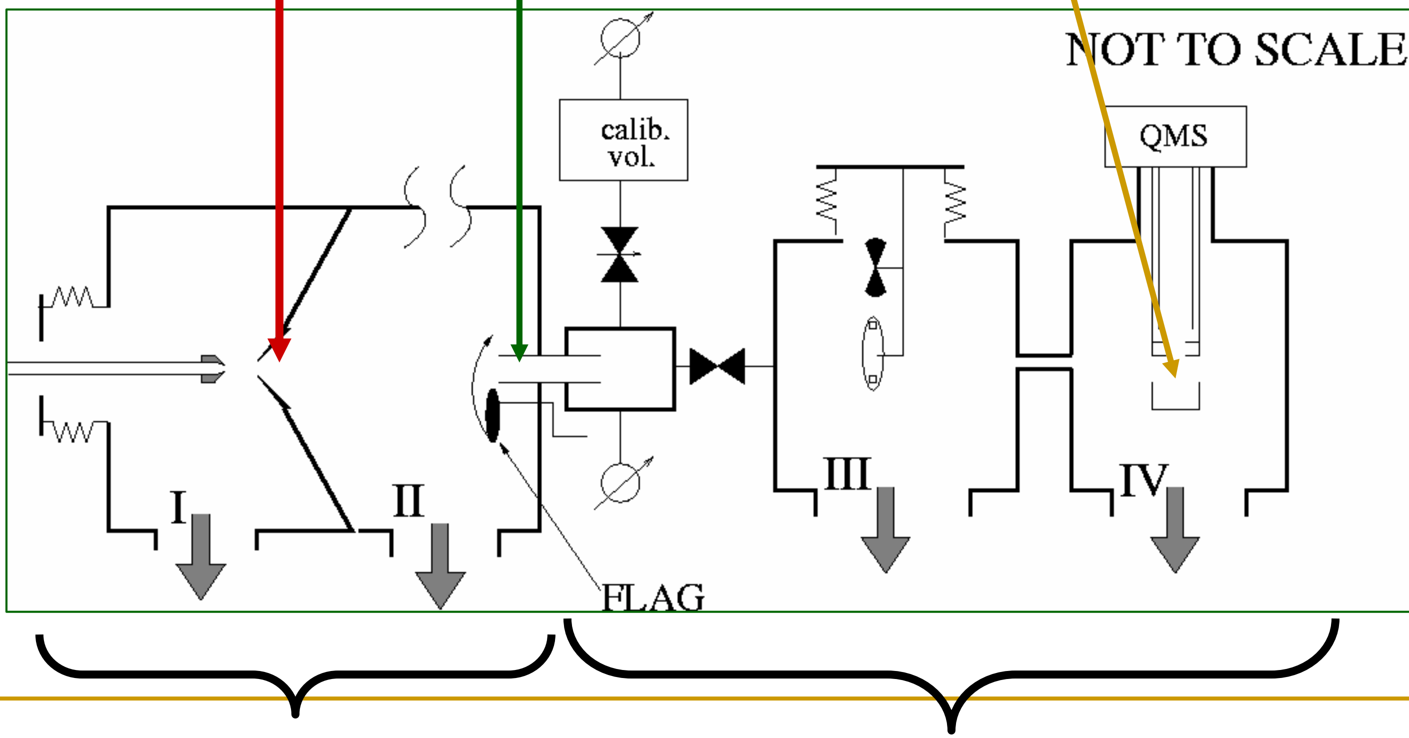
Preliminary Results

- Correlation between collar temperature and beam intensity clearly evident but not yet explained. Investigations ongoing!



Tests of DSMC predictions

- Velocity distribution width (σ at 50-100K?)
- Beam intensity after 0.8m (σ at 200-400 K)
- Beam intensity after skimmer (σ at 10-30 K?)

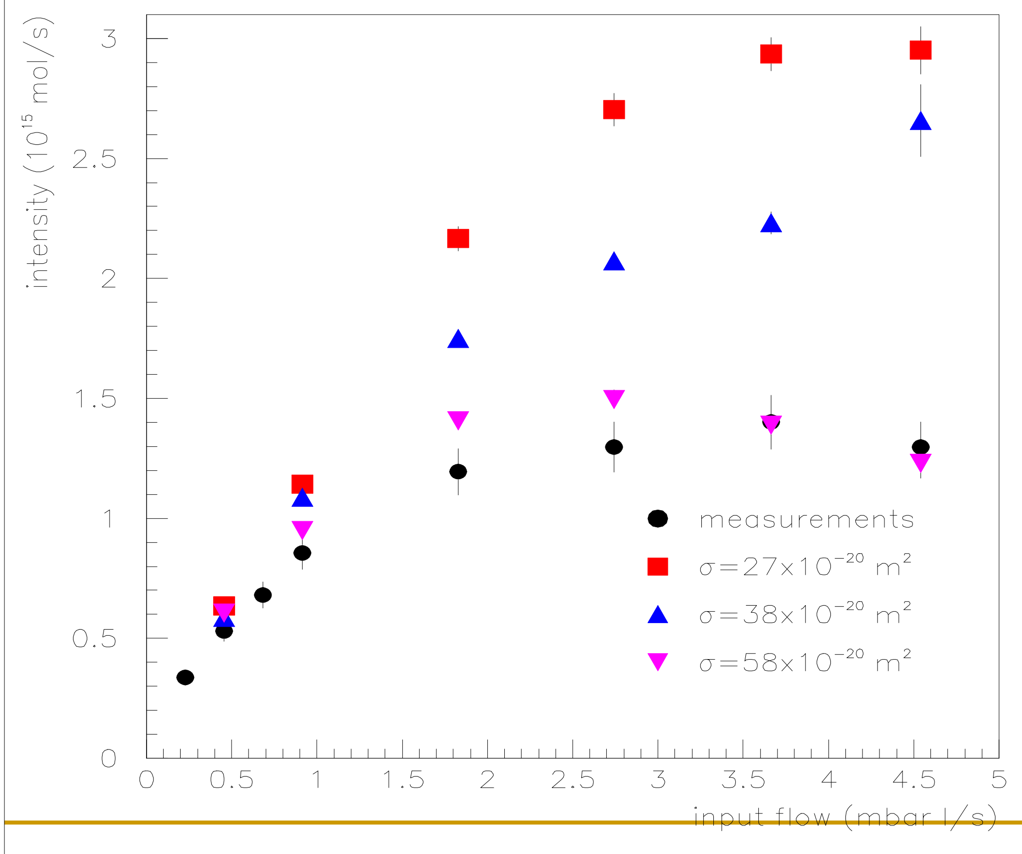


Unpolarized ABS

Diagnostic System

Beam Intensity after Rest Gas Losses

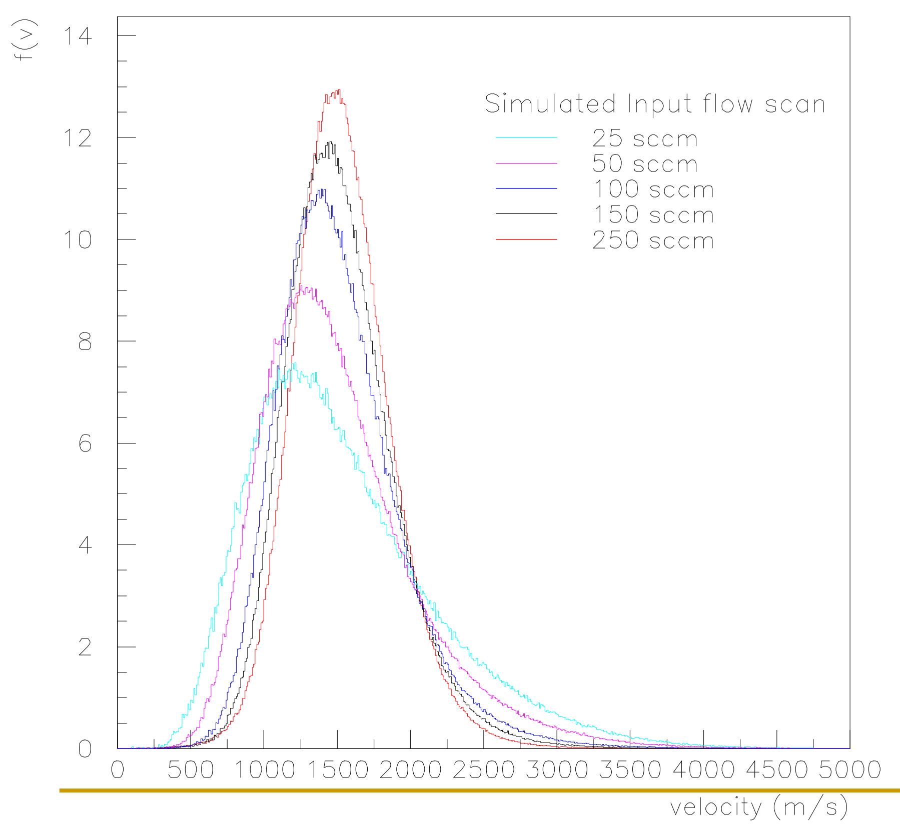
Simulation reproduces the RGA losses in a molecular hydrogen beam for a specific value of the scattering cross section

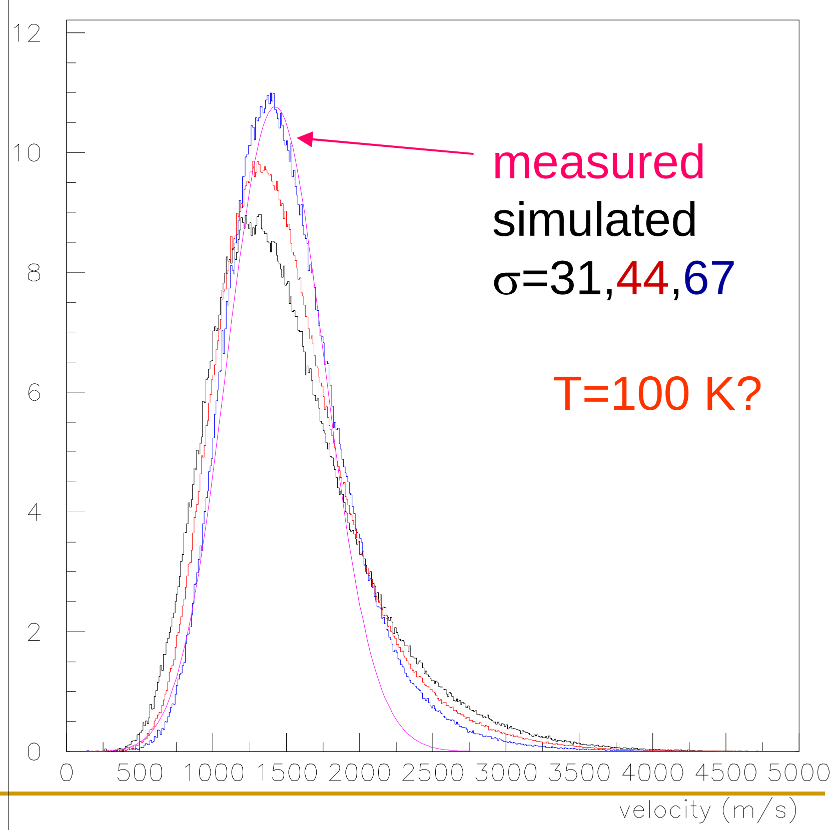


100 K nozzle (T_{eq}~244 K)
Other nozzle temperatures currently being simulated - T_{eq}~200-400K

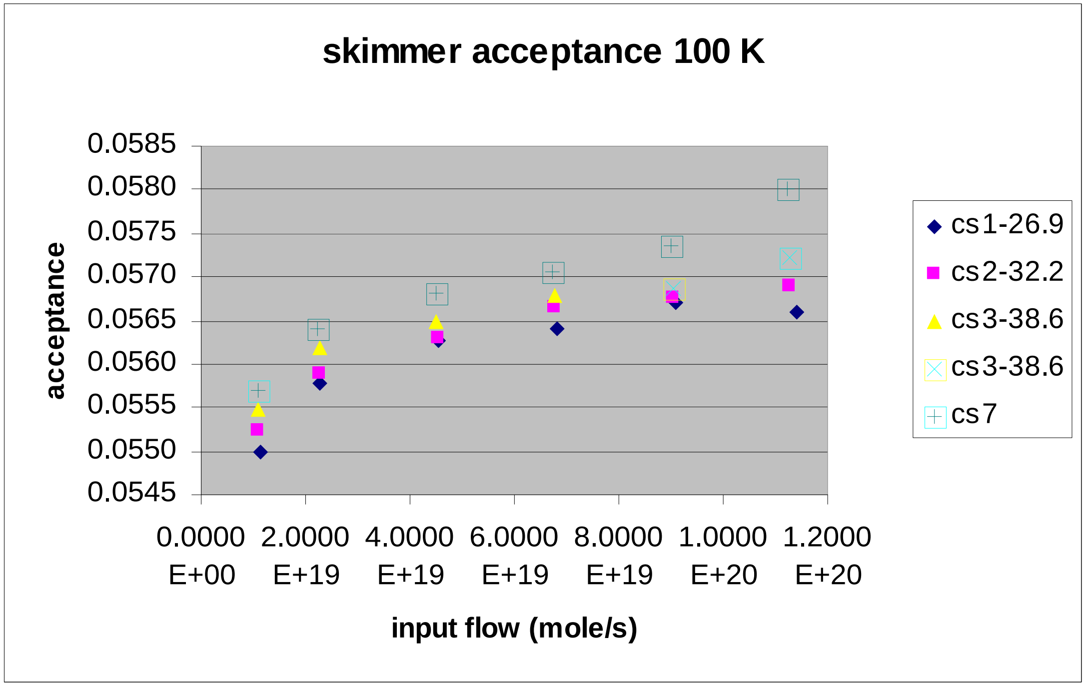
Beam Velocity Distribution

- H_2 molecular beam and 4mm nozzle at 100K
- Final beam temperature depends on number of collisions during expansion – and thus on both input flow and σ





Beam Intensity at Skimmer



<u>For a molecular H2 beam, 4mm, 100K nozzle:</u> Simulation predicts that 5.6% of the input flow passes through the skimmer – 1.5 times more than expected for an effusive beam! Additionally, this fraction is essentially independent of input flow and cross section.

VERY preliminary measurement=4.3+/-1.0 %

SpinLab Program

In progress

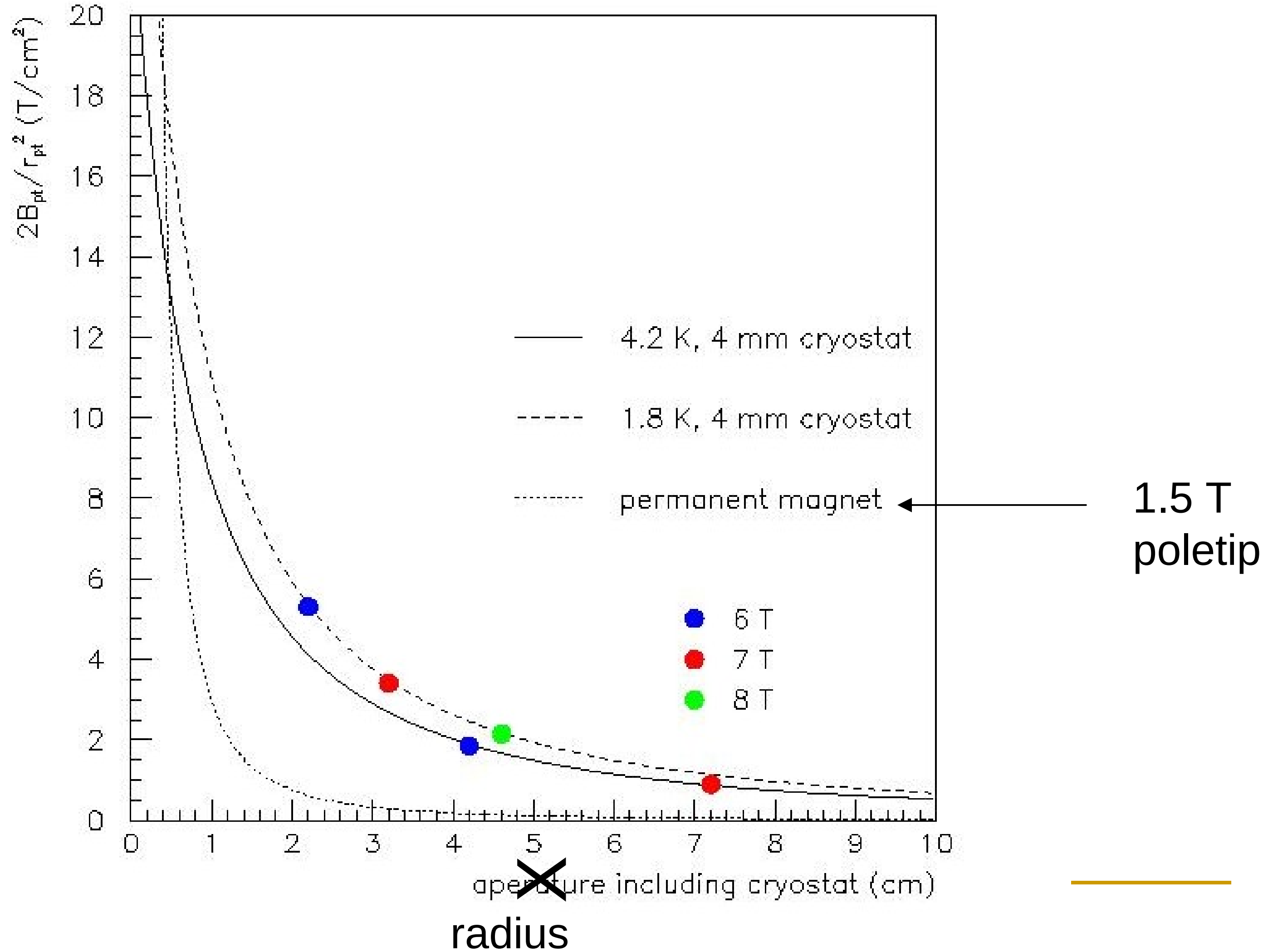
- Study impact of additional dissociator cooling
  - Correlation found with beam intensity, under study
- Tune scattering cross section in simulations
  - RGA losses and velocity distributions match for molecular hydrogen beam
    - Extension to atomic beams still to be done
  - IBS losses may need refined model of cross section and different experimental measurements
- More details in talk at Polarized Sources and Targets 2007!

SpinLab Program

Future Plans

- Measure beam flux through skimmer (movable CT at skimmer exit)
- Measure intra-beam scattering losses (method developed by Z. Ye at Hermes – talk at SPIN2004).
- Investigate the feasibility of large aperture (2-10 cm) super-conducting magnets and their effectiveness at reducing beam attenuation.
- Design the PAX target for antiproton polarization

Permanent vs Superconducting Magnets



Velocity Distribution

Comparison of measured (Jade Hall) and simulated velocity distributions
- molecular H_2 beam
- 100 K nozzle
- 100 sccm input flow

Measured:
- vdrift=1274+/-8 m/s
- Tbeam=19.0+/-1.1 K

Scattering cross section is large for low temperatures!

Simulations underway for SpinLab data