

# *Fifty Years of Polarized Targets (and Don's Role in them)*

Josh Pierce

Neutron Technologies Division

ORNL is managed by UT-Battelle, LLC for the US Department of Energy

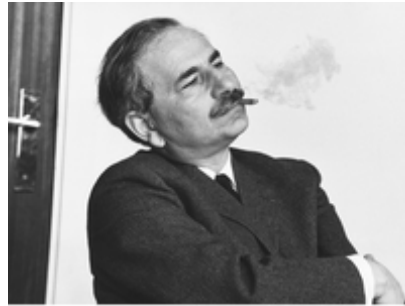


U.S. DEPARTMENT OF  
**ENERGY**

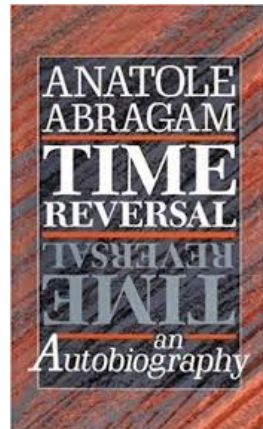
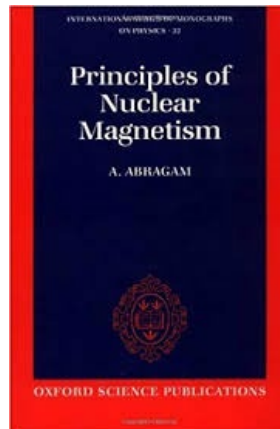
# Beginnings of Polarized Targets

## Anatole Abragam(Saclay)

- Solid Effect
- First targets (1962)
- $\text{La}_2\text{Mg}_3(\text{NO}_3)_{12} \cdot 24\text{H}_2\text{O}$  doped with Neodymium
- 1K 2T 70%
- Author

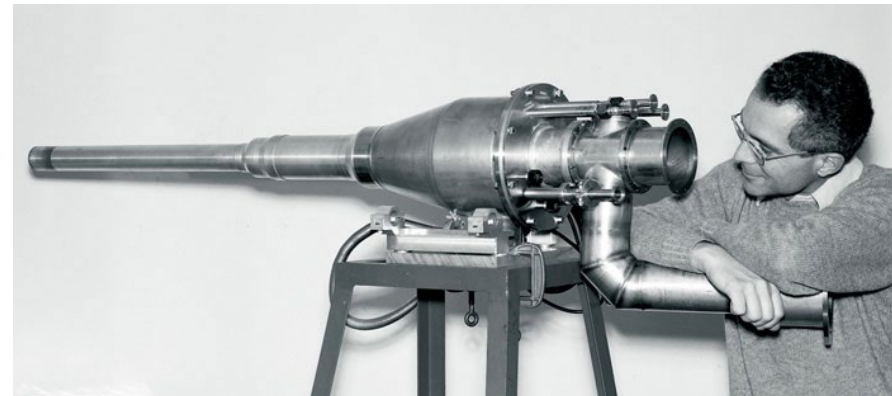


*A. Abragam*



## Michel Borghini(CERN)

- Thermal Mixing
- Alcohol and diol targets, chemically doped
- <0.5K, 2.5T 70-80%
- First \*modern\* targets (~1969)

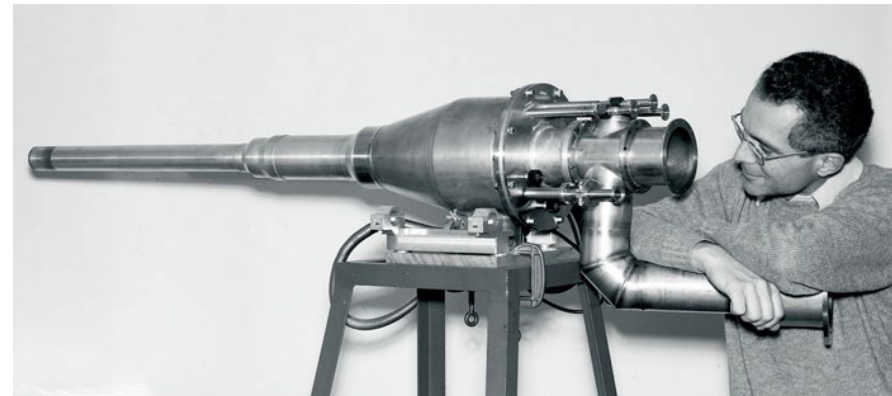


# Beginnings of Polarized Targets

FICHE D'ACHEMINEMENT - ROUTE SLIP		
A : TO : DONALD CRABB		
Veuillez/Please		
<input checked="" type="radio"/> Donner suite/Take action	<input type="radio"/> Noter/Note	
<input type="radio"/> Approuver/Approve	<input type="radio"/> Payer/Pay	
<input type="radio"/> Commenter/Comment	<input type="radio"/> Classer/File	
<input type="radio"/> Signer/Sign	<input type="radio"/> Retourner/Return	
<p><math>P(H)</math> and <math>P(D)</math> are implicitly related by</p> $P_H = \tanh \frac{R f_H}{2kT}$ $P_D = \frac{4 \tanh \frac{R f_D}{2kT}}{3 + \tanh^2 \frac{R f_D}{2kT}}$ <p><math>T</math>: spin temperature is a parameter (varying around a few millidegrees)</p> <p><math>R</math>: Planck's constant  <math>k</math>: Boltzmann "  <math>f_H</math>: proton Larmor frequency (106.5 MHz)  <math>f_D</math>: deuteron " (16.5 " )</p>		
De : M Borghini	No. Tel. 3428	Date 26.1.77
From:		

## Michel Borghini(CERN)

- Thermal Mixing
- Alcohol and diol targets, chemically doped
- <0.5K, 2.5T 70-80%
- First \*modern\* targets (~1969)



# Irradiation Doped

- Initially explored in the 60's
- Allows the use of “any” material
  - For example: single crystal LiH and CaF
  - Neutron digression:
- Modern standard for high intensity charged beams

## Measurement of the Spin-Dependent Part of the Scattering Amplitude of Slow Neutrons on $^{19}\text{F}$ Using a Polarized Beam and a Polarized Target

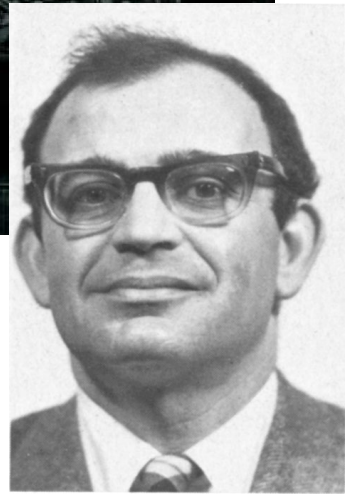
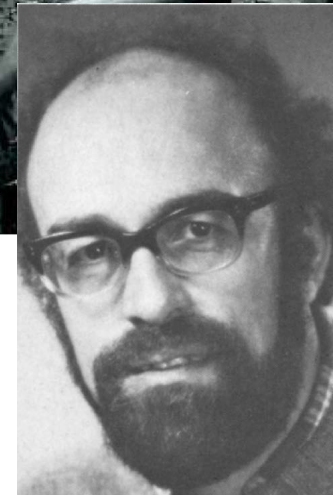
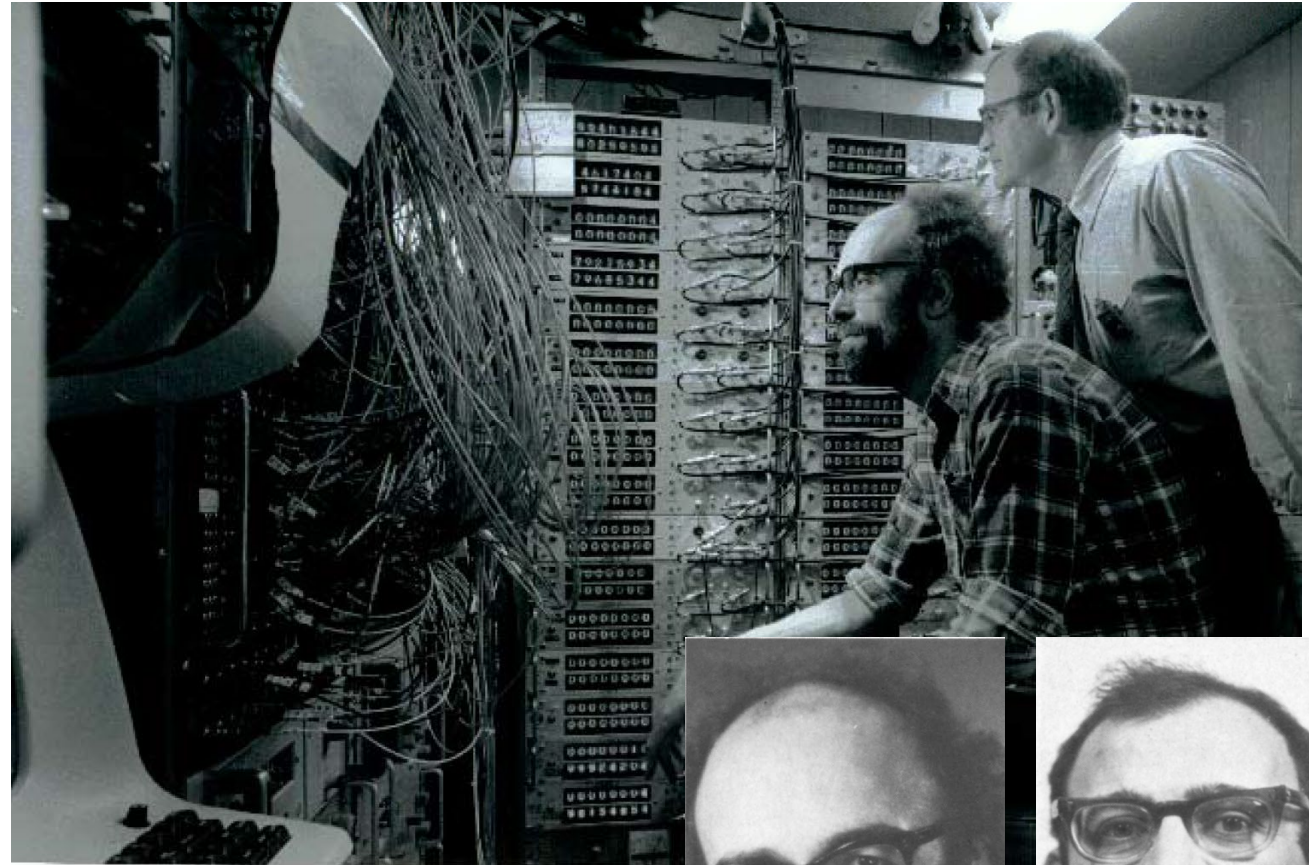
A. Abragam, G. L. Bacchella, C. Long,\* P. Meriel, J. Peisvaux, and M. Pinot  
*Service de Physique du Solide et de Résonance Magnétique, Centre d'Etudes Nucléaires de Saclay,  
91 Gif-sur-Yvette, France*  
(Received 28 December 1971)

Using a polarized target of  $\text{CaF}_2$ , we have measured the spin-dependent part of the scattering amplitude of slow neutrons on  $^{19}\text{F}$ . A value  $\beta = a_+ - a_- = -0.135 \pm 0.002 \text{ F}$  was found, 10 times smaller than a recent theoretical estimate. A control experiment measuring  $\beta = a_+ - a_-$  for the proton by Bragg scattering on a single crystal of LiH yielded the correct value within experimental error.



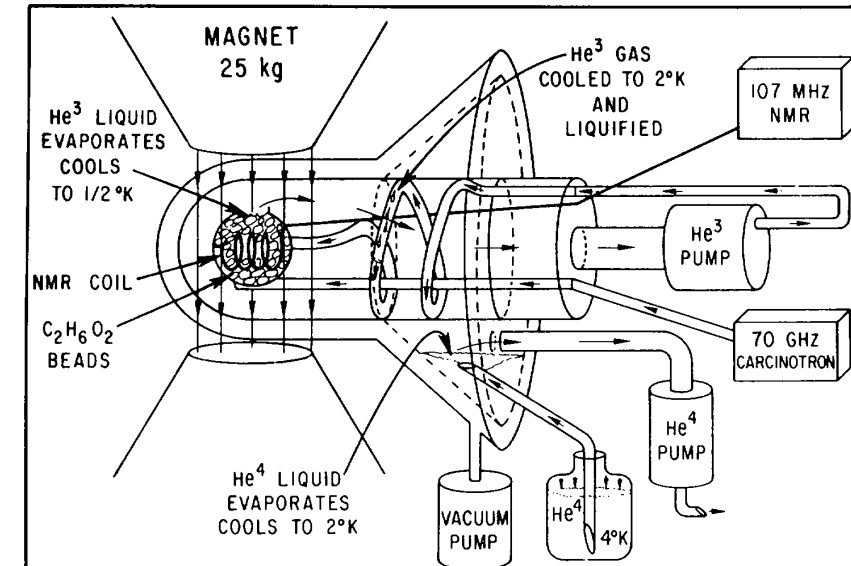
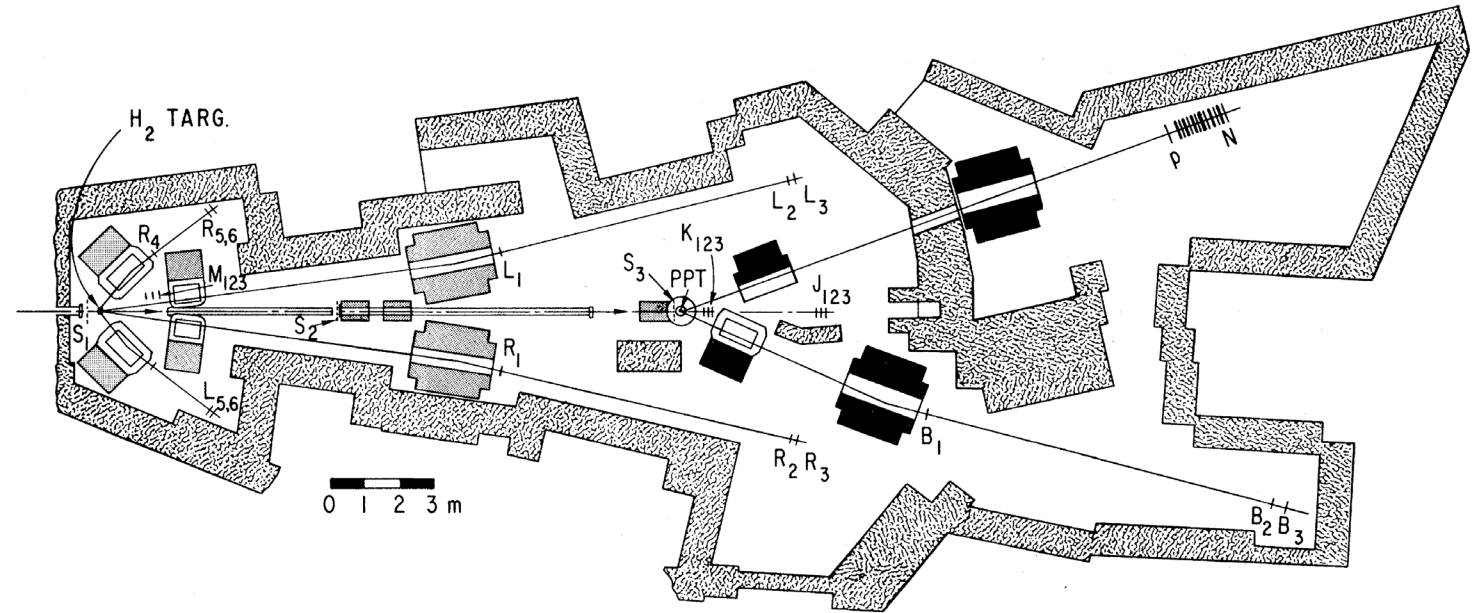
# Don Crabb and Polarized Targets at Michigan

- *Experiments at Argonne and Brookhaven*
- *Solid polarized Targets*
- *Polarized Jet Targets*



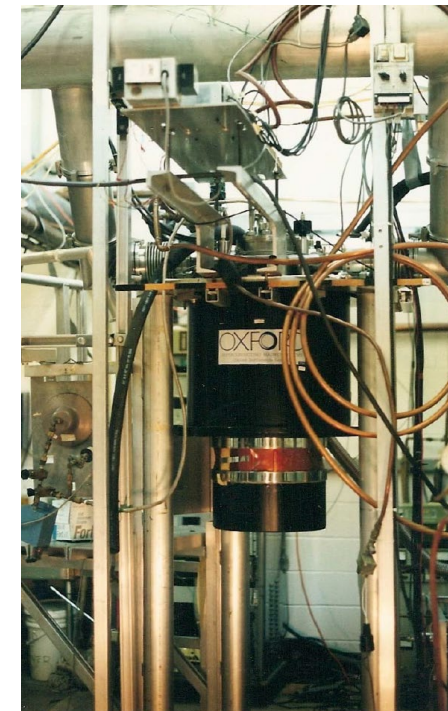
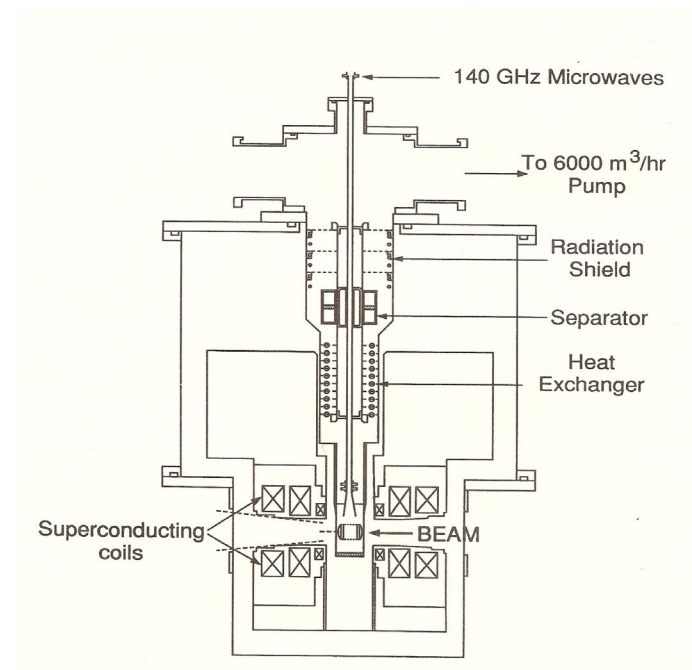
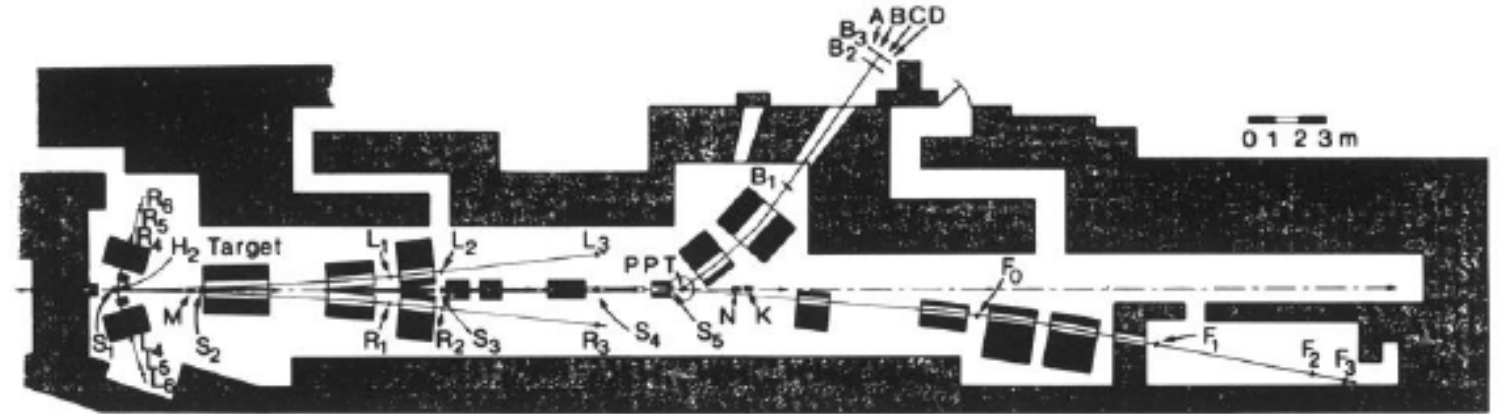
# Polarized Scattering at the Argonne ZGS

- Polarized Deuterium Beam
- Target is CERN style  $^3\text{He}$  evaporation  
– 500mK
- Ethelene Glycol with CrV



# Polarized Scattering at the Brookhaven AGS

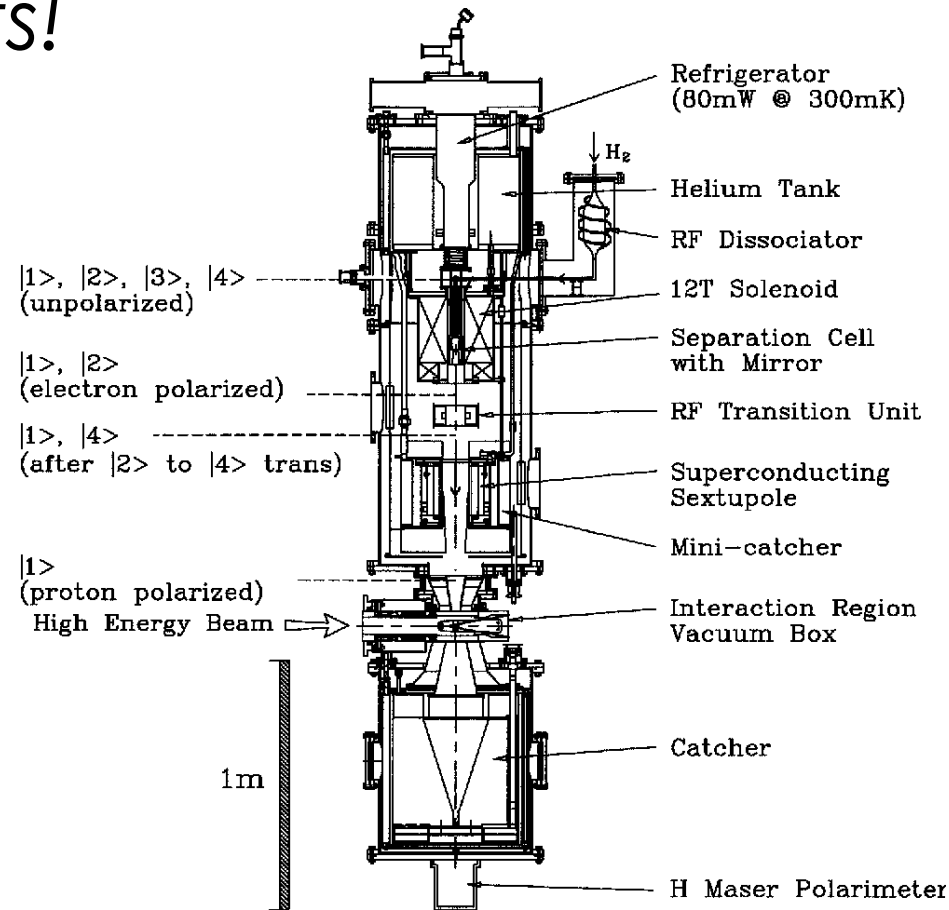
- Polarized Hydrogen
- Target is modern looking NH<sub>3</sub> Target
  - 5T, 1K
  - What I think of as “Crabb” style target





# Don't Forget Jet Targets!

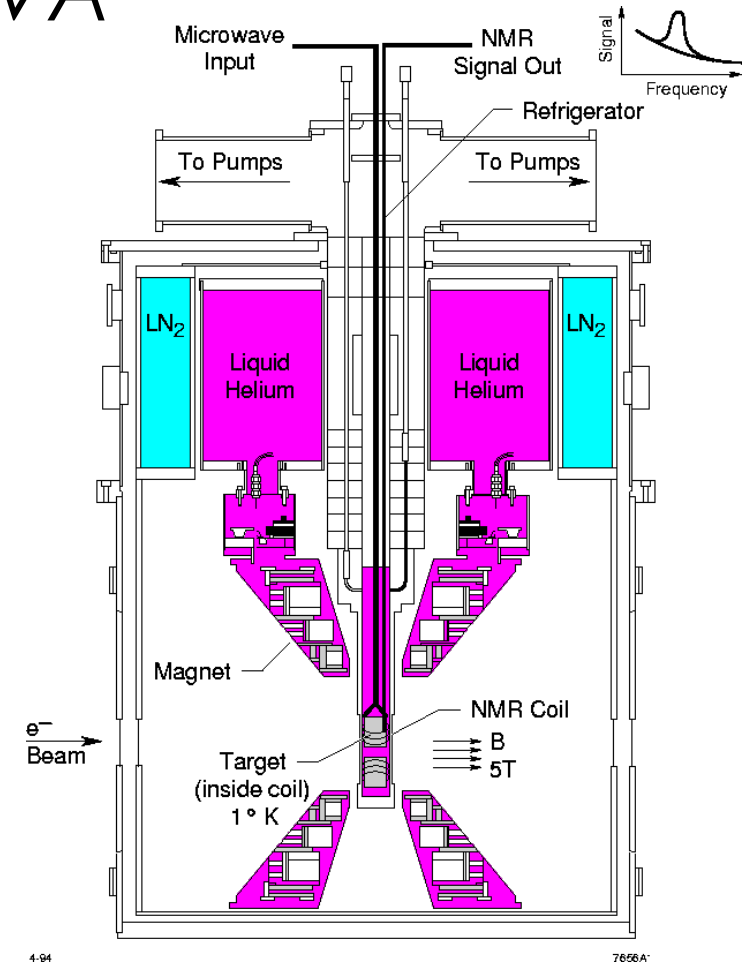
- Similar in concept to polarized ion source at ZGS
- Can create very high polarization, with low target density
  - Ideally suited to experiments in rings
  - See polarimetry talks throughout the week





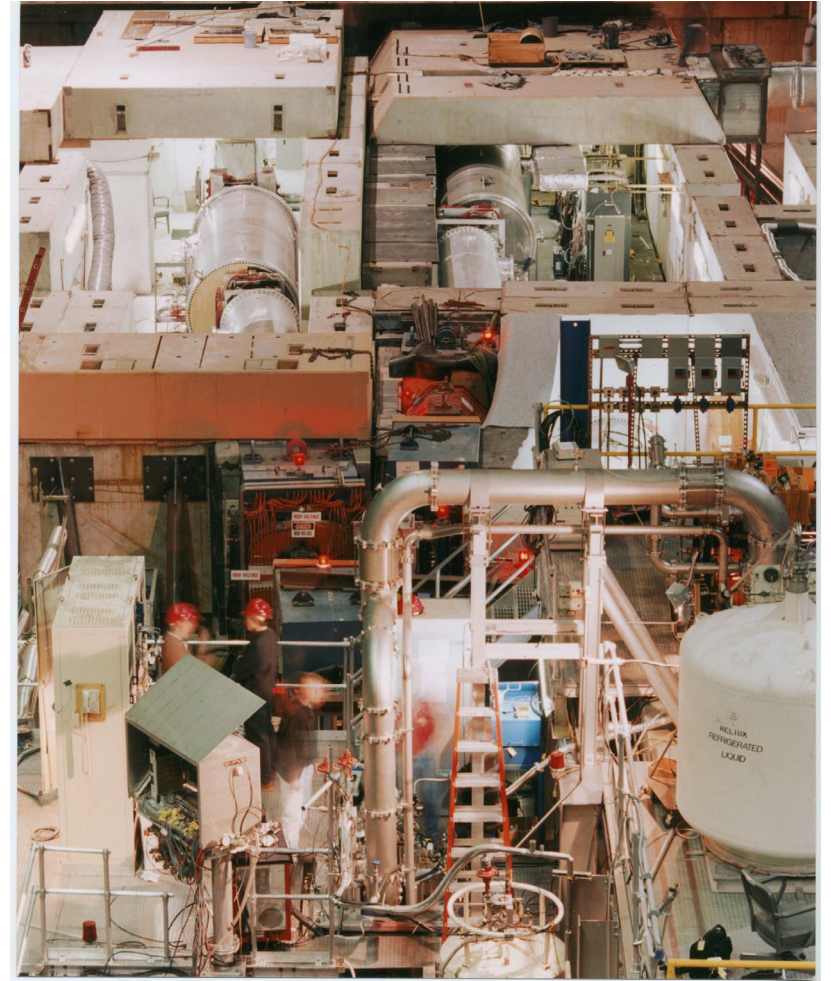
# Don Crabb and Polarized Targets at UVA

- 1990 till now
- UVA polarized Target group
  - along with Jim McCarthy, Donal Day, Oscar Rondon Aramayo (and now Dustin Keller)
- CERN SLAC JLAB FERMILAB
- Others will cover the science of this time better
- Most important to me for obvious reasons



# SLAC and CERN Spin Structure Measurements

- 5T, 1K Target (SLAC/HallC/HallA Target)
- E143, E155, E155x
- Lots of students came out of the target group from these Experiments
  - Tod Averett
  - Paul McKee
  - Dustin McNulty
  - Al Tobias
- SMC experiment
  - Used SMC target (still active as Compass Target)
  - Better discussed by others here (Wednesday)



# JLab Polarized Target Experiments

- Well covered in previous talk by Chris Keith
- Crabb Style Targets used in 3 of 4 experimental Halls
  - 10 polarized target experiments and counting (one scheduled, more proposed)
  - More students on polarized target experiments than can easily be counted (between Don and Donal)

Hungguo Zhu

Renee Fatemi

Yelena Prok

Chris Harris

Nicholas Kvaltine

KangKang Li Kovacs

Jonathan Mulholland

Jonathan Mellor

James Maxwell

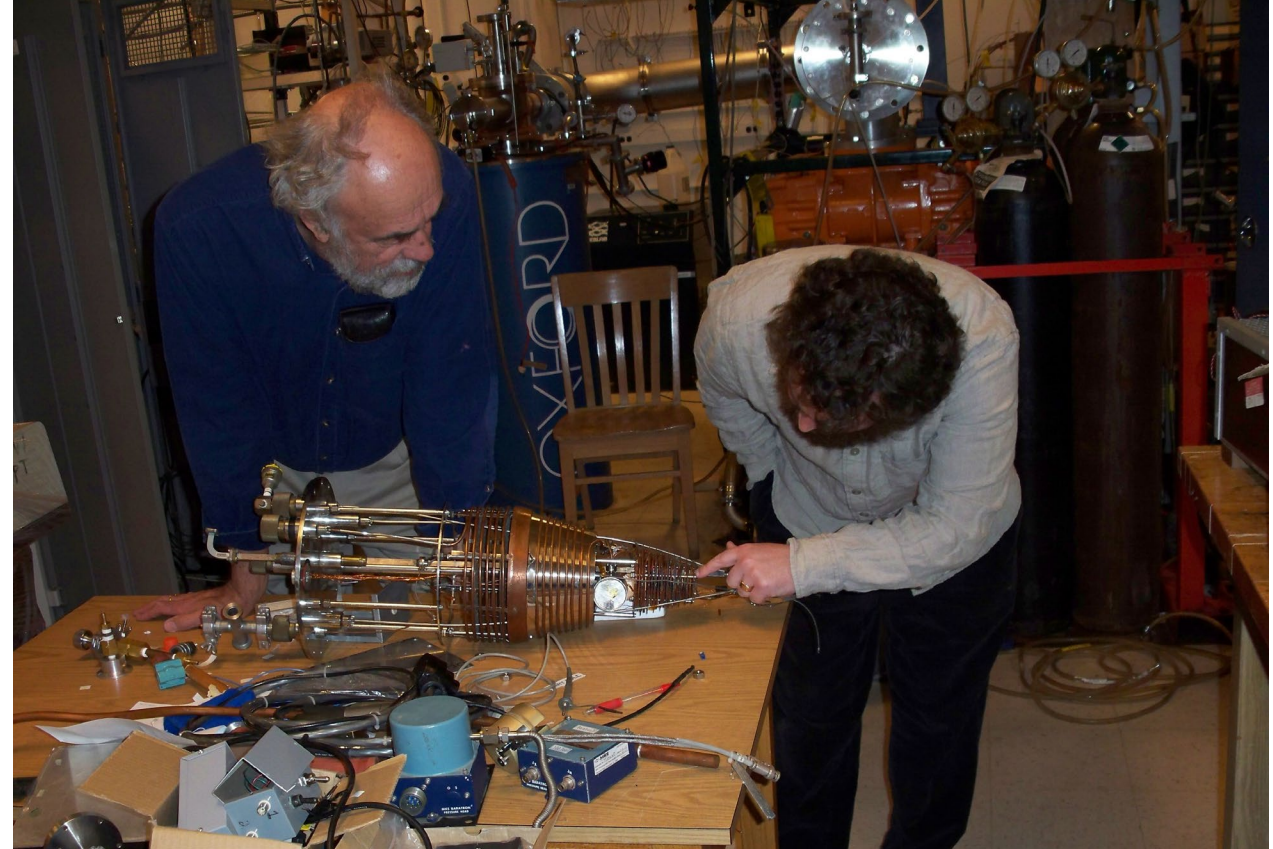
Josh Pierce

....*Those are just the people that overlapped with me!*



# My Personal Perspective

- *I worked for Don from 1999 to 2008*
  - *Undergraduate and Graduate school at UVa*
- *Polarized Target PostDoc at ORNL*
  - *Main job was to bug Don about equipment and ideas*
- *Job in Jlab Target Group*
- *Job in ORNL making polarized targets*
- *Collaborated with Don in every position*
- *Without Don I:*
  - *Would not be here today*
  - *Would not work in physics*
  - *Would not have had to organize this workshop...*



# Current UVA Activities

- Lots of Polarized Target work still going on
  - Don't take my word for it, look at the schedule for tomorrow's talks:

<b>A Polarized Target for E1039 (SPINQUEST) at FERMILAB</b>	<i>Prof. Donald Crabb</i>
<i>Downtown Holiday Inn</i>	13:40 - 14:00
<b>A New Target Polarization Measurement System for the Fermilab Polarized Drell-Yan SpinQuest Experiment</b>	<i>Mikhail Yurov</i>
<i>Downtown Holiday Inn</i>	14:00 - 14:20
<b>Spin-Polarization using Microwave Induced Dynamic Nuclear Polarization</b>	<i>Joshua Hoskins</i>
<i>Downtown Holiday Inn</i>	14:20 - 14:40
<b>Thermal Analysis and Simulation of the Superconducting Magnet in the SpinQuest Experiment at Fermilab</b>	<i>Zulkaida Akbar</i>
<i>Downtown Holiday Inn</i>	14:40 - 15:00

- In addition to SPINQUEST, development work for Jlab continues
  - Tensor Polarization for deuterium