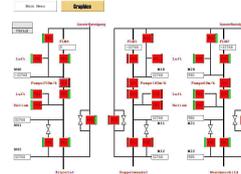
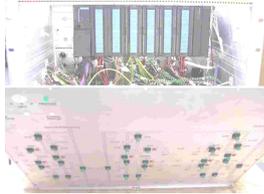




# Microwave and Control system of THE MAINZ FROZEN SPIN TARGET



Motivation

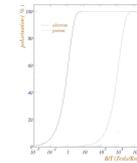
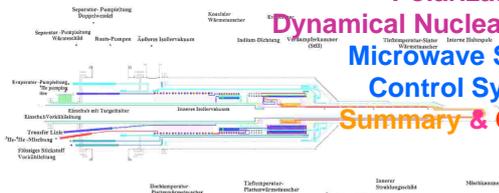
Polarization

Dynamical Nuclear Polarization

Microwave System

Control System

Summary & Outlook



**MAURICIO MARTÍNEZ FABREGATE**

Supporter by S.F.B. and E.U.

Mauricio Martínez Fabregate



## MOTIVATION

- New observables
  - Test models and theories
    - What is a nucleon?
    - Nucleon interaction
    - Resonances studies
    - GDH Sum Rule
- Develop new technology
- Study the polarization process
- Have a lot of fun

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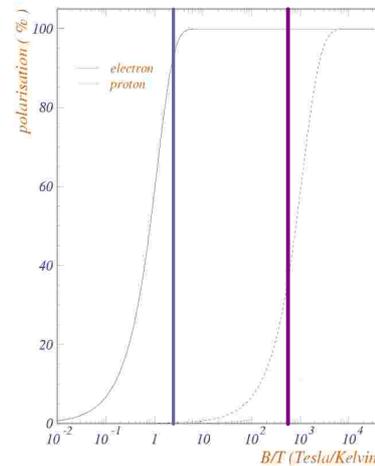
# Polarization of nucleon



- **Polarization of nucleons:** expectation value to find their spin oriented in a certain direction.
- **Zeeman interaction:  $2S+1$  energy levels**
- Increase the polarization: increase the number of particles in a energy level.
- Boltzman law, in thermal equilibrium particles with  $S=1/2$ :

$$P = \frac{N_+ - N_-}{N_+ + N_-} = \tanh\left(\frac{\mu B}{kT}\right)$$

- Magnetic moment  $\mu_e = 660\mu_p$
- $T=1K, B=2,5T \quad P_e=92\%, P_p=0,25\%$
- $T=0,02K, B=10T \quad P_e=100\%, P_p=40\%$



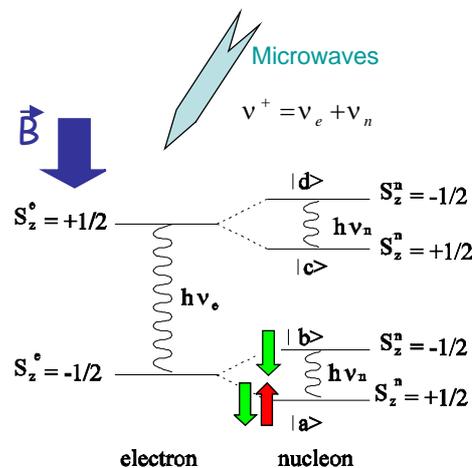
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# Dynamic Nuclear Polarization



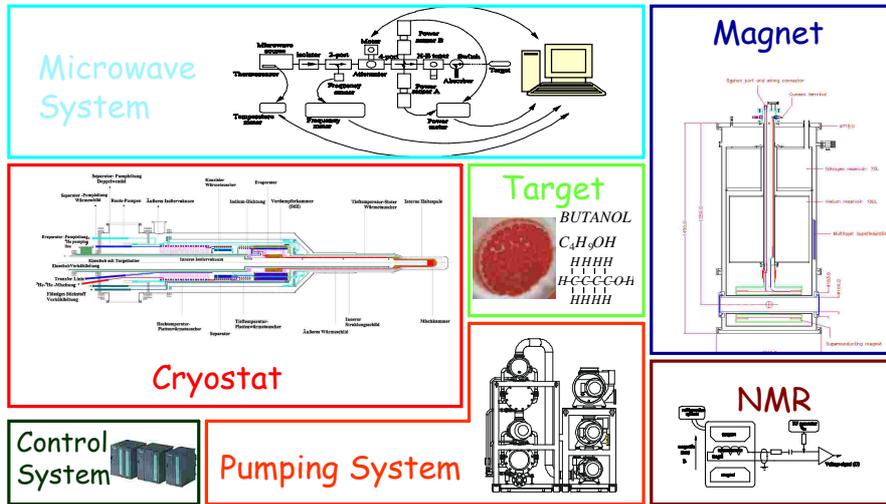
- Let's consider electron-nucleon interaction
- Microwave are applied to induce a simultaneous spin flip.
- The electron flips back, but the proton keeps its orientation, due to differences in relaxation times.
- The electron couple with another nucleon and the process start again



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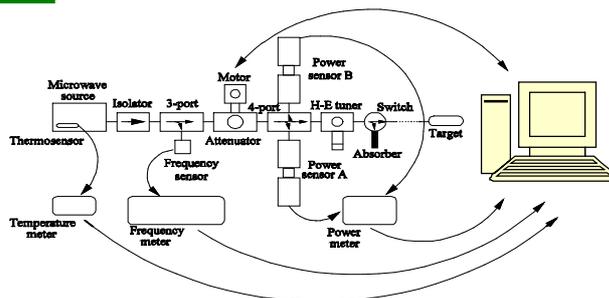
# The Frozen Spin Target



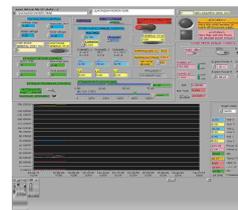
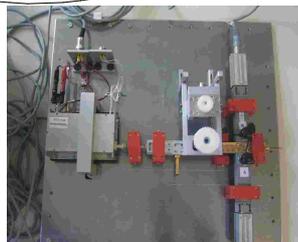
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## Microwave system



- Varactor tuning
- IMPATT diode
- Tunable frequency
- 70GHz +- 200MHz
- Used in the GDH Sum Rule experiment 2003
- LabView control panel



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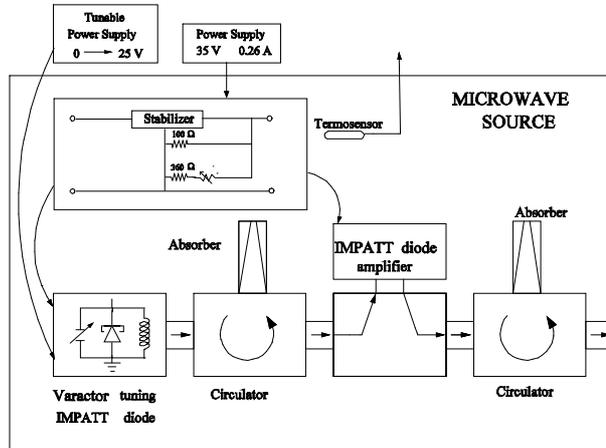


# Microwave source



•Varactor tuning  
IMPATT (IMPact Time  
Transition) diode

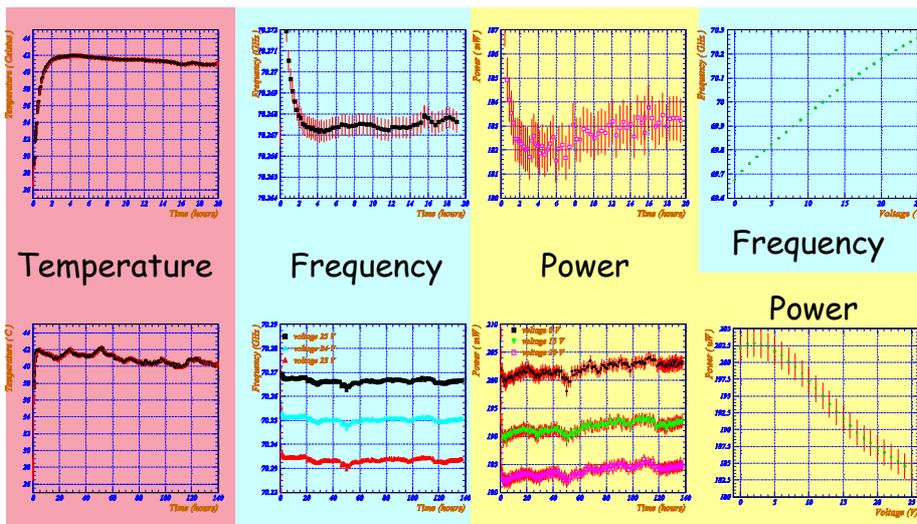
- Frequency from 69.673 up to 70.266 GHz
- Frequency stability of 0.008%
- Power 200 mW
- Power stability of 2%
- Temperature stability of 0.7%



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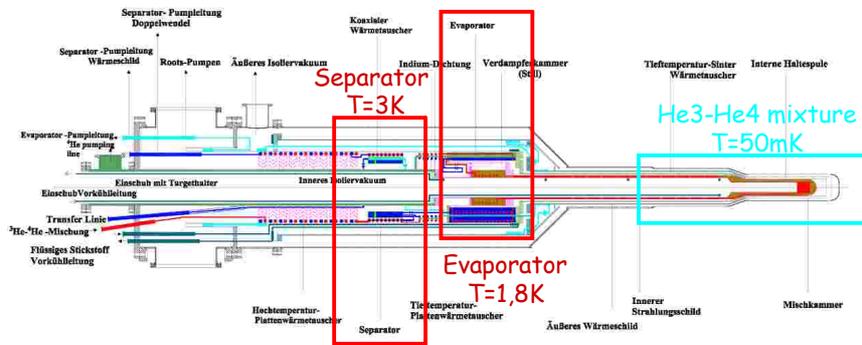
# Microwave results



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# Cryostat



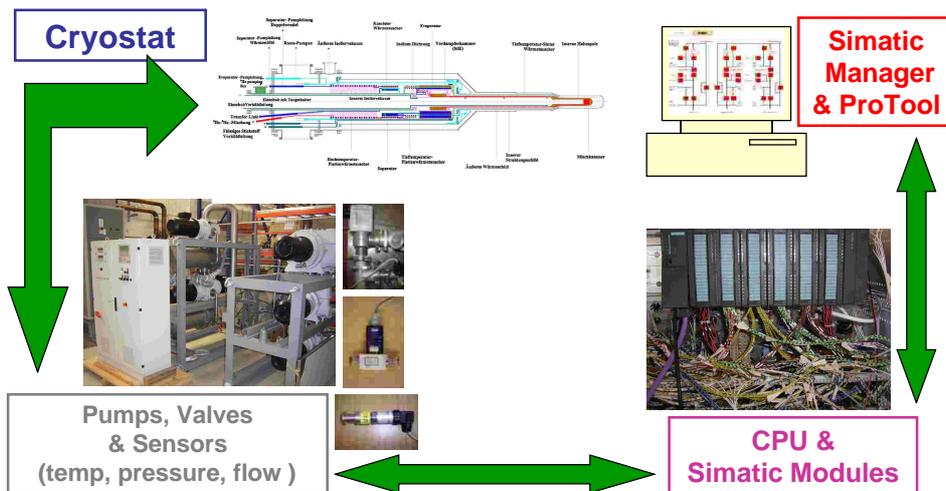
- Horizontal Cryostat
- Temperatures of 50 mK
- Cooling power of 100 mW
- Superconducting holding coil integrated

- Separator and Evaporator precooling stages
- Target insert along the beam axis
- Fits in the geometry of the Crystal Ball detector

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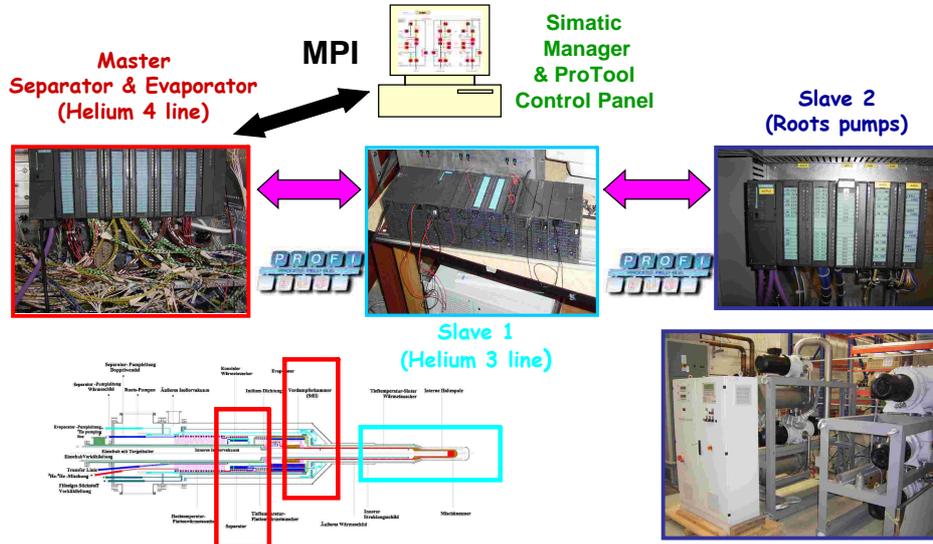
# Cryostat Control System I



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# Cryostat Control System II



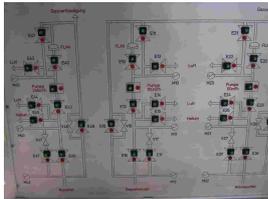
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# Separator and Evaporator Manual Control Panel



## Manual Control Panel



- Separator**
- 2 Rotary pumps
  - 18 Electropneumatic valves
  - 6 pressure sensors
  - 2 Flowmeters
  - Temp = 3 K



- Digital input/output
- Analog input/output
- Serial port



- Evaporator**
- 1 Rotary pumps
  - 9 Electropneumatic valves
  - 3 Pressure sensors
  - 1 Flowmeters
  - Temp 1.8 K

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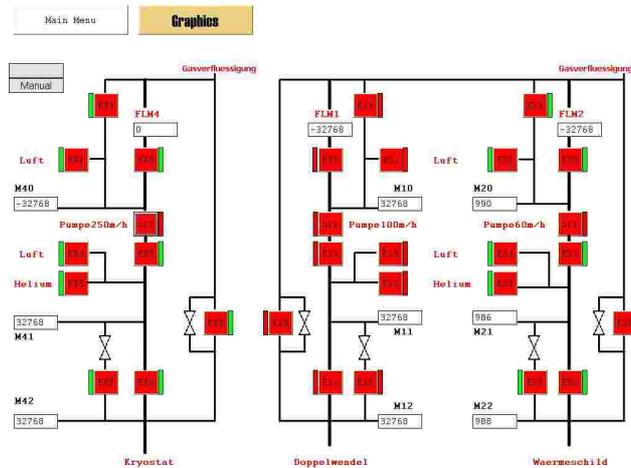
# Separator and Evaporator Automatic Control Panel



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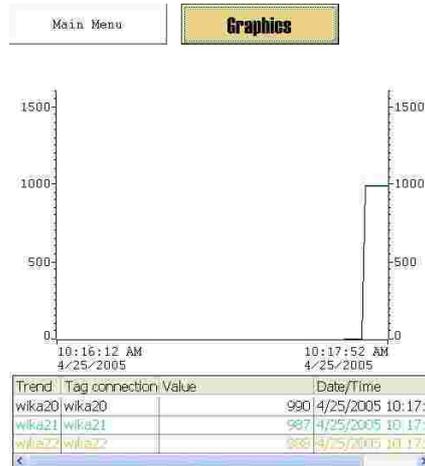
# Separator and Evaporator Automatic Control Panel



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## Separator and Evaporator Automatic Control Panel



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## Summary & Outlook

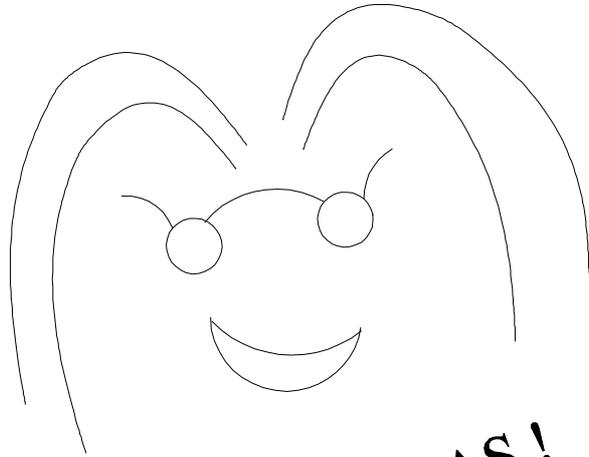


- Different parts of the F.S.T. were presented
- Cryostat is under construction in Dubna since 1 year, and it will arrive in Mainz in 2006
- 5 Tesla superconducting magnet already working in Mainz
- Microwaves system tested and working
- Roots pumps working
- Separator and evaporator tested and working
- Control system for separator and evaporator done

### TO DO

- He3 line and its control system
- Master-slave connections
- Develop ProTool control panel
- Control and monitor of the termosensors
- Step motor's control for the important valves
  
- Put all together and hope that it fits!

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**GRACIAS !**

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