Johannes Gutenberg-Universität Mainz
Institut für Kernphysik

Status of the Mainz Frozen Spin Target

3rd Meeting ‚Polarized Nucleon Targets for Europe'
in the 6th European Framework Program

Status of the Mainz Frozen Spin Target

- Polarization of a nucleon
- The Frozen Spin Target
- Microwave System
- Magnet
- N.M.R.
- Cryostat
  - Separator-Evaporator
  - Temperature measurement
  - Needle valve
  - Control System
- Conclusions and Outlook

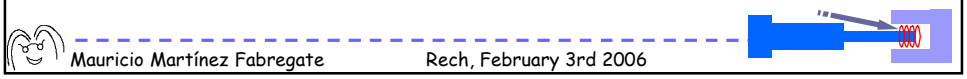
Mauricio Martínez Fabregate Rech, February 3rd 2006

Polarization of nucleon

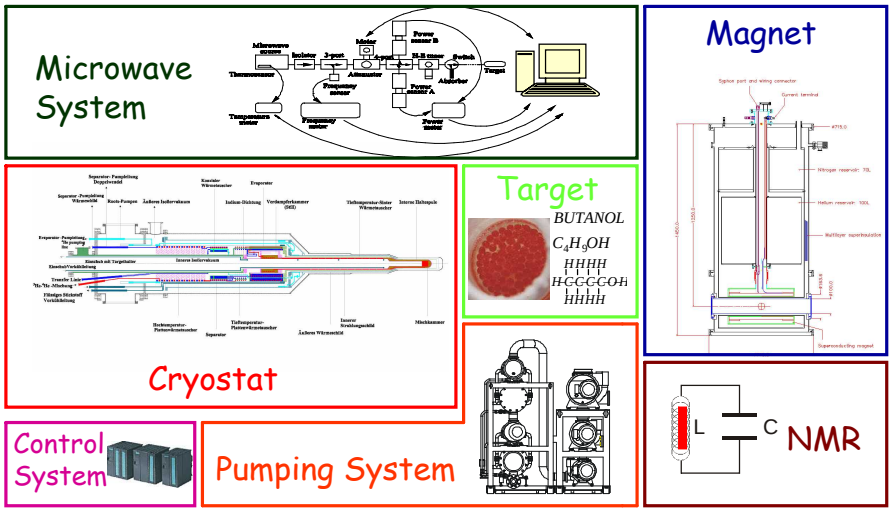
- Particles with S=1/2 in a external magnetic field, follow Boltzman law in thermal equilibrium:

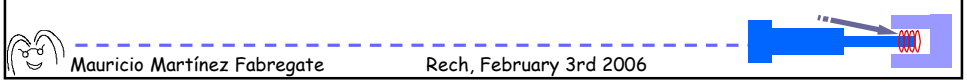
$$P = \frac{N_+ - N_-}{N_+ + N_-} = \tanh\left(\frac{\mu B}{\kappa T}\right)$$

- Magnetic moment $\mu_e = 660\mu_p$
- T= 1K, B=2,5T Pe=92%, Pp=0,25%
- T=0,02K, B=10T Pe=100%, Pp= 40%
- **Dynamical Nuclear Polarization**: Microwave are apply to induce a simultaneous spin flip, and transfer polarization from electron to nucleon.

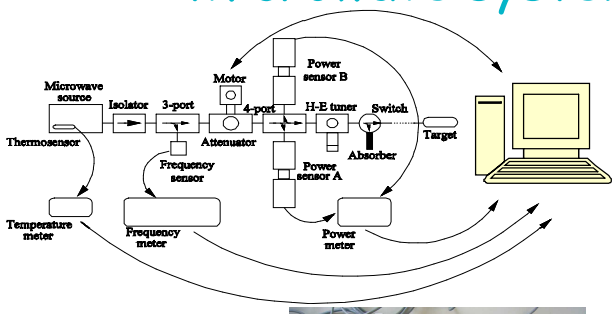


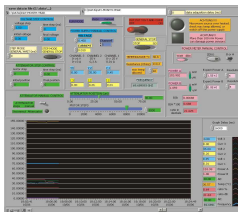
The Frozen Spin Target

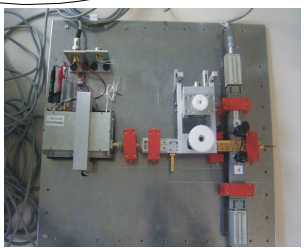


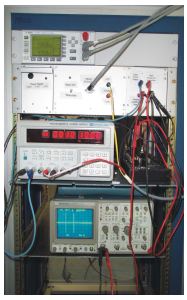


Microwave system









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

Magnet

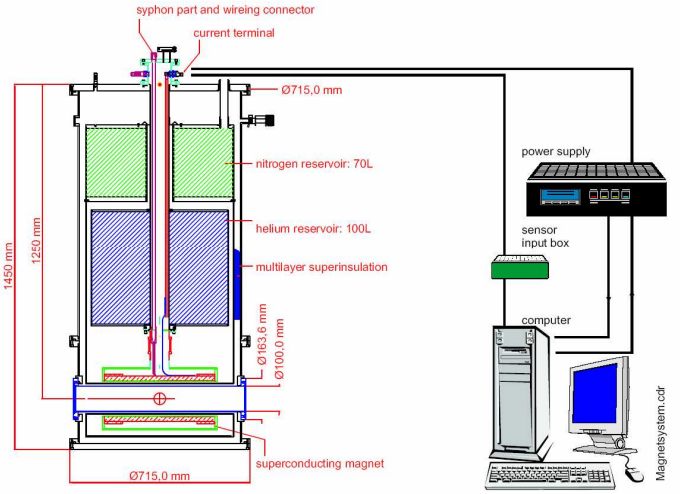
- Maximum field: 5 Tesla
- High Uniformity:

$$\frac{\Delta B}{B} < 10^{-4}$$

- Liquid He bath at 4 K
- Radiation shield cooled by nitrogen

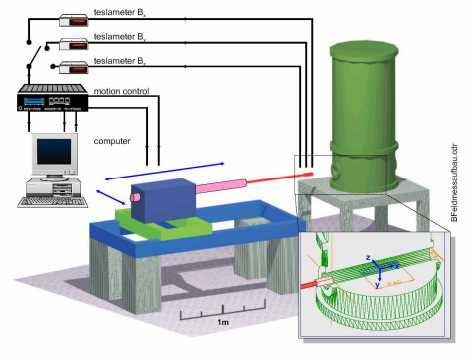
- Refilling time:
  12 days He
  5 days N

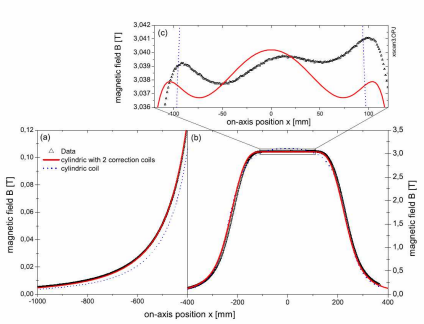
- LabView program



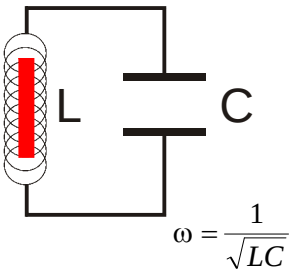
Magnet, uniformity test

(Heiko Rochholz Diplomarbeit in X1 group)

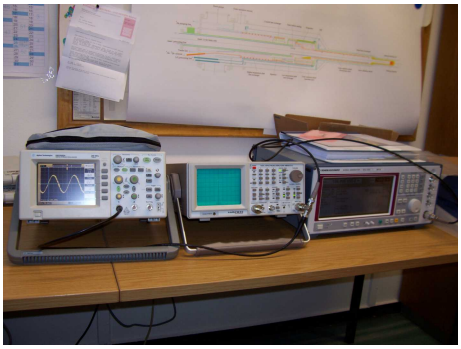




NMR System

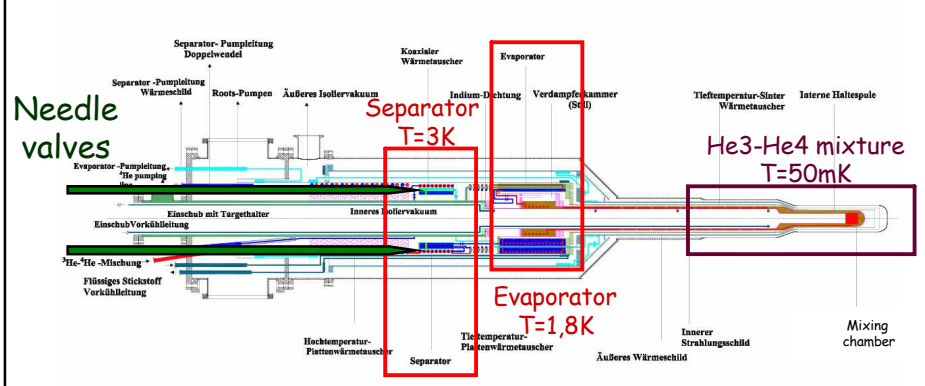


$$\omega = \frac{1}{\sqrt{LC}}$$



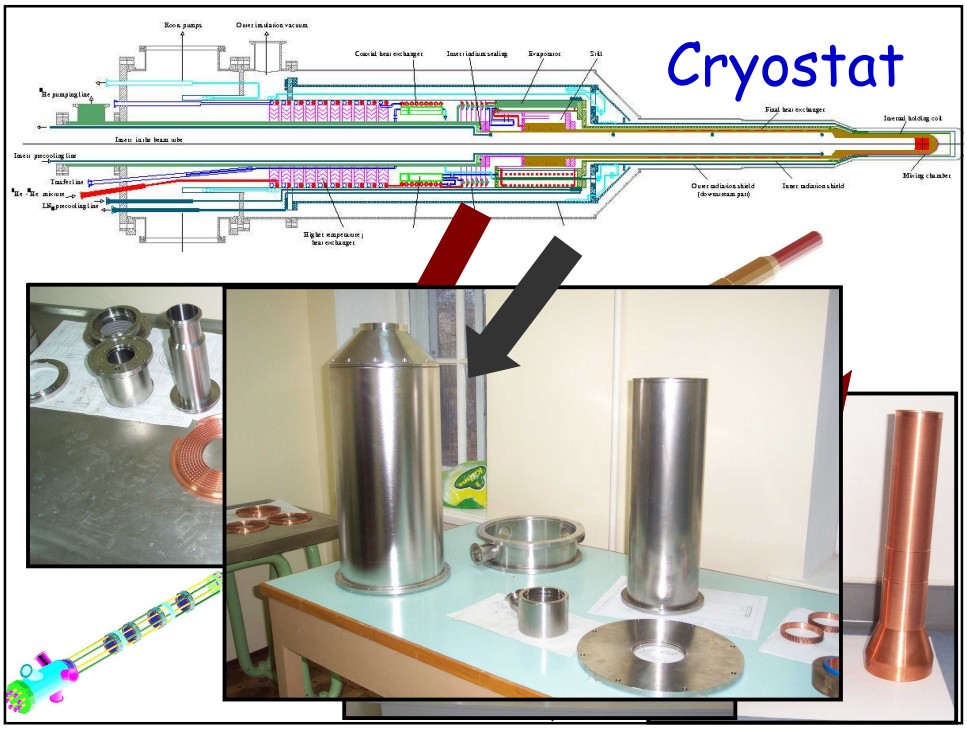
- Serial resonance circuit LC with a coil around the target material
- Change in polarization induce change in susceptibility of the coil
- Signal obtained by frequency scan over the resonance Larmor frequency
- Andrea Knezevic and Milorad Korolija from Ruddjer Boscovic Institut Zagreb and important collaboration from Bochum University.

Cryostat



- Temperatures of 50 mK. He3-He4 mixture. **He3 line**
- Cooling power of 100 mW
- Superconducting holding coil integrated

- Separator and Evaporator precooling stages. **He4 line**.
- Target insert along the beam axis
- Fits in the geometry of the Crystal Ball detector



He4 line

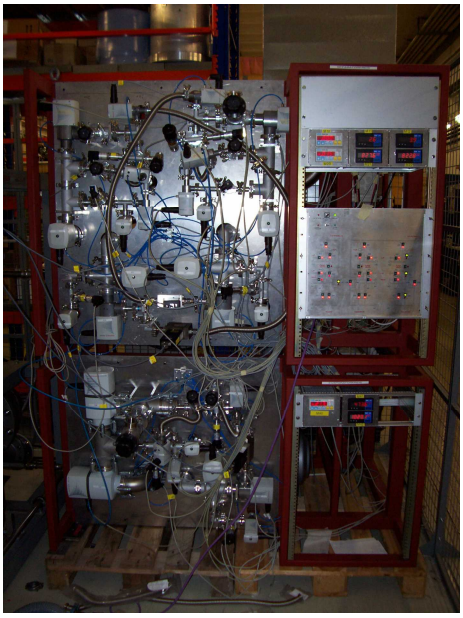
(Mohamed Mouahid Diplomarbeit)

Separator

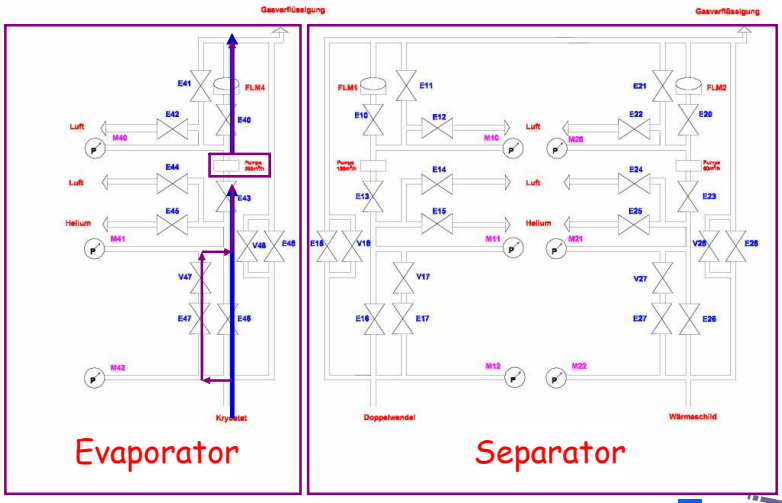
- 2 Rotary pumps
- 18 Electro pneumatic valves
- 6 pressure sensors
- 2 Flow meters
- Temp = 3 K

Evaporator

- 1 Rotary pumps
- 9 Electro pneumatic valves
- 3 Pressure sensors
- 1 Flow meters
- Temp 1.8 K

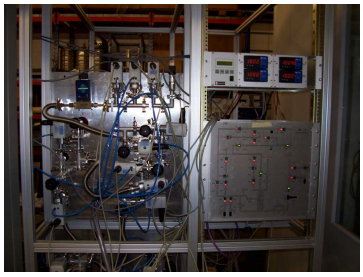


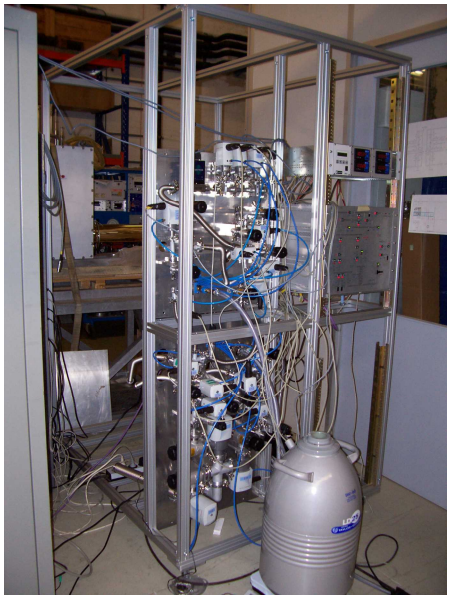
Separator and Evaporator



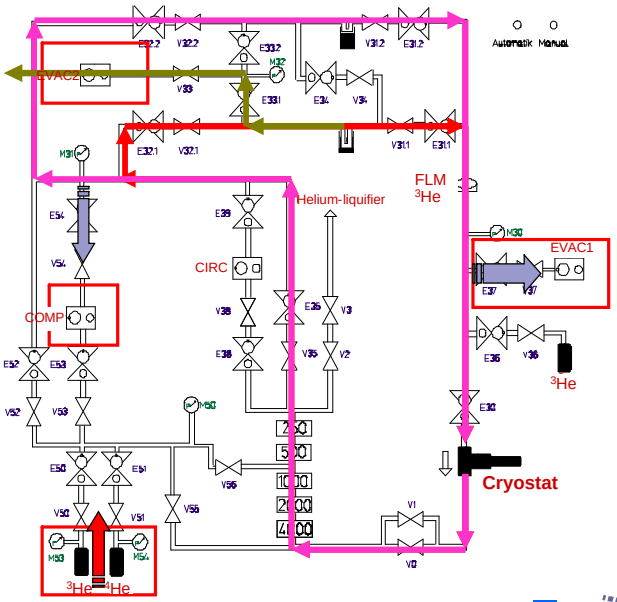
He3 line

- 39 Valves
- 1 Flow meter
- 4 Pressure sensors
- 4 Rotary Pumps
- 2 Cooling Traps
- 5 Roots Pumps

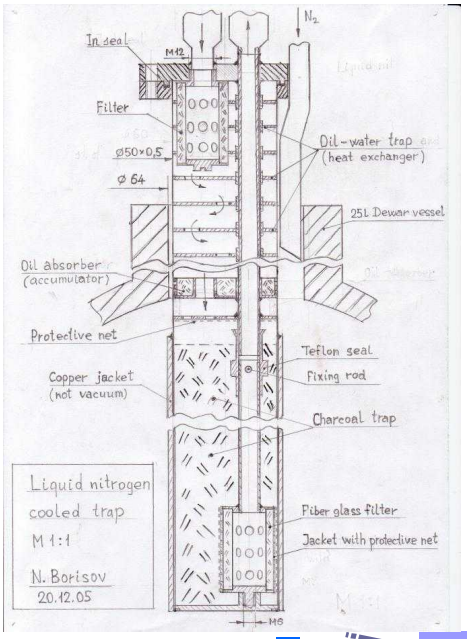




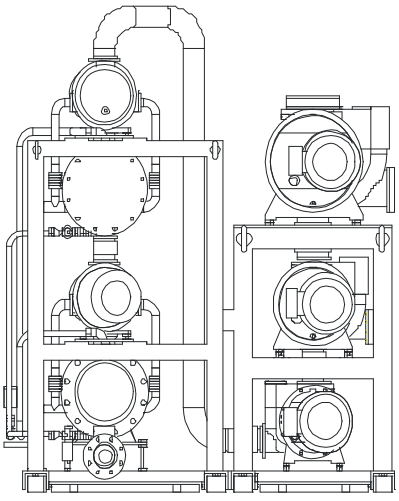
He3 line



Cooling trap



Roots Pumps



-Series of 5 Roots pumps:
4000 m^3/h, 2000 m^3/h, 1000 m^3/h,
500 m^3/h and 250 m^3/h
-Very low leak rate
- Pressure and temperature sensors
-Simatic program to control it

Temperature measurements

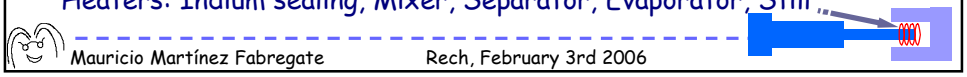
Type of sensors:
PT100, Allen Bradley, Speer and TVO (4 and 2 poles measurement)

Number of Sensors:

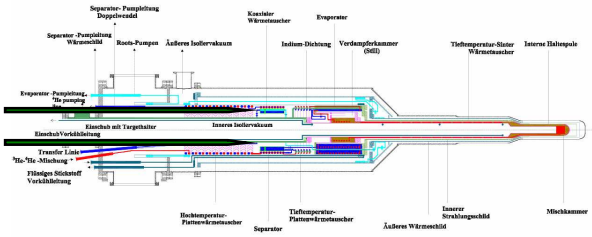
Insert	8 sensors	1AVS
Shields	8 sensors	1AVS
Precooling	8+20 sensors	1AVS + 1Keithley Digital Voltmeter

AVS Resistor Bridge
- 8 Channels
- GPIB connection to PC
- Optical coupling
- Read/Write parameters with LabView

Heaters: Indium sealing, Mixer, Separator, Evaporator, Still

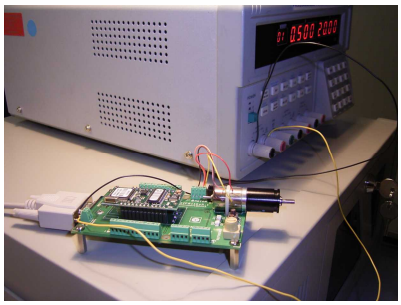


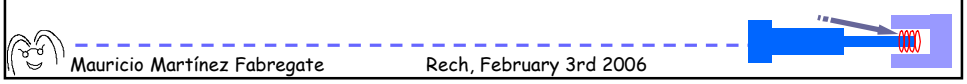
Motor for needle valves

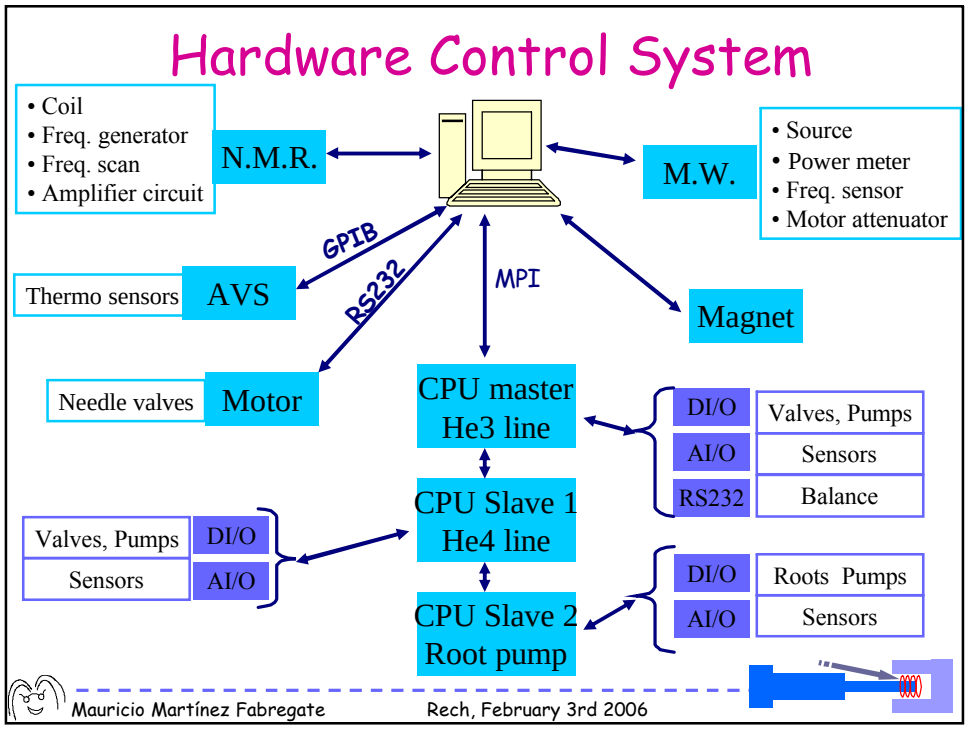


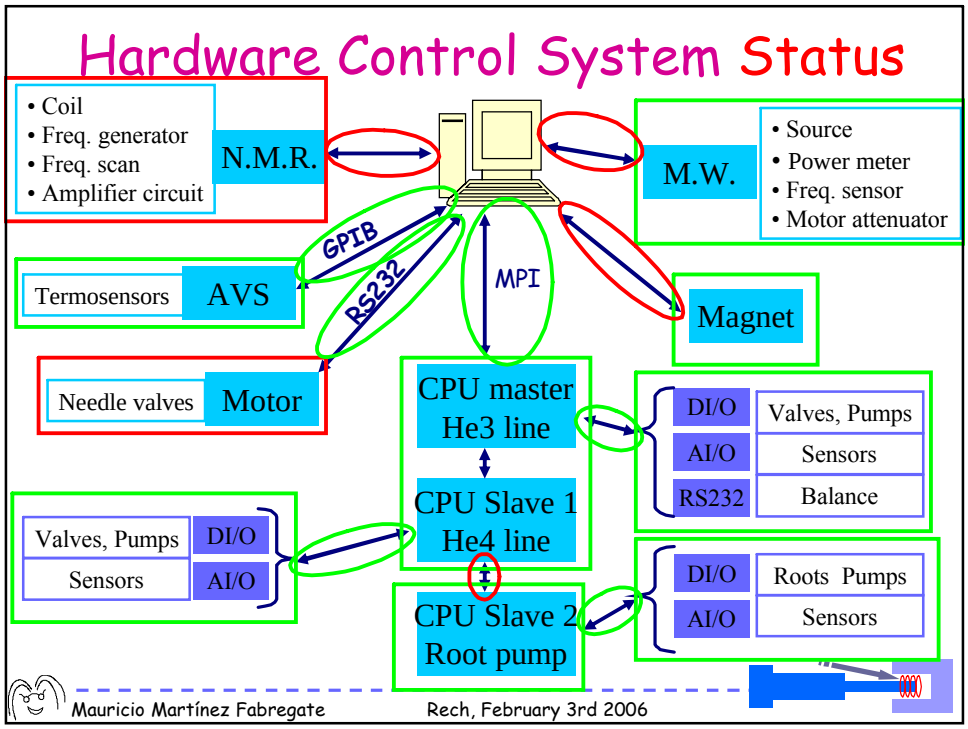
- 6 Step motors
- Guide system
- Technosoft software
- LabView connection

(Joachim Scholz)






Hardware Control System
• Coil
• Freq. generator
• Freq. scan
• Amplifier circuit
N.M.R.
M.W.
• Source
• Power meter
• Freq. sensor
• Motor attenuator
GPIB
RS232
MPI
Thermo sensors
AVS
Magnet
Needle valves
Motor
CPU master
He3 line
DI/O
AI/O
RS232
Valves, Pumps
Sensors
Balance
CPU Slave 1
He4 line
Valves, Pumps
Sensors
DI/O
AI/O
CPU Slave 2
Root pump
DI/O
AI/O
Roots Pumps
Sensors
Mauricio Martínez Fabregate
Rech, February 3rd 2006


Hardware Control System Status
• Coil
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GPIB
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Magnet
Needle valves
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CPU master
He3 line
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AI/O
RS232
Valves, Pumps
Sensors
Balance
CPU Slave 1
He4 line
Valves, Pumps
Sensors
DI/O
AI/O
CPU Slave 2
Root pump
DI/O
AI/O
Roots Pumps
Sensors
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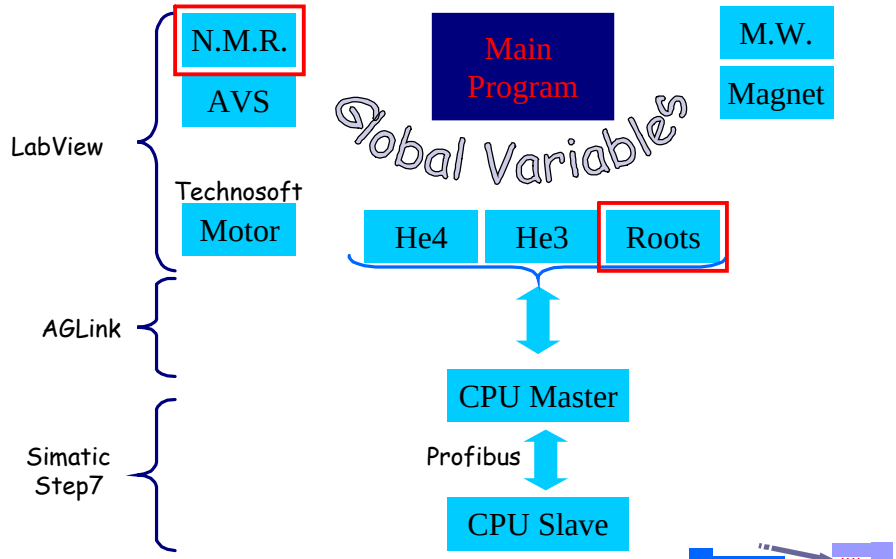
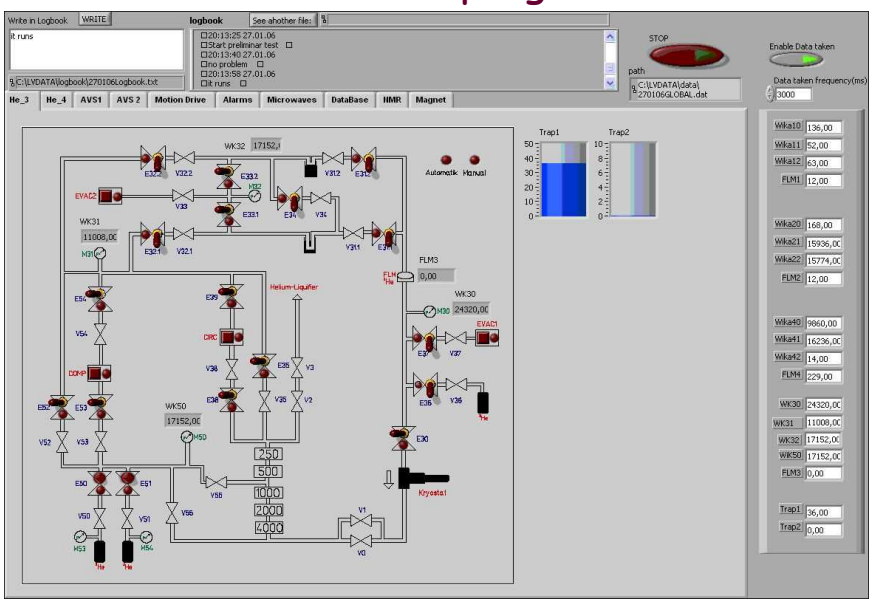
Software Control System



LabView Main program



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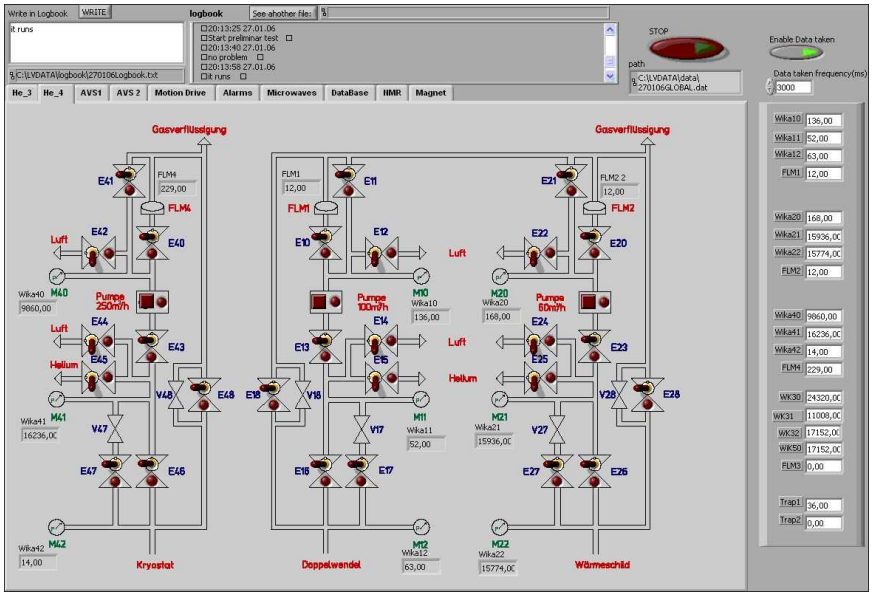

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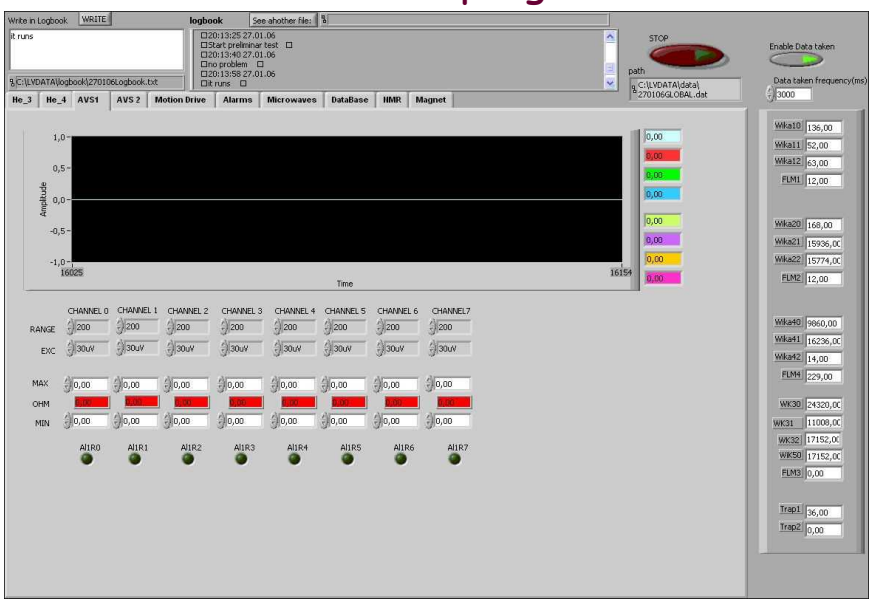

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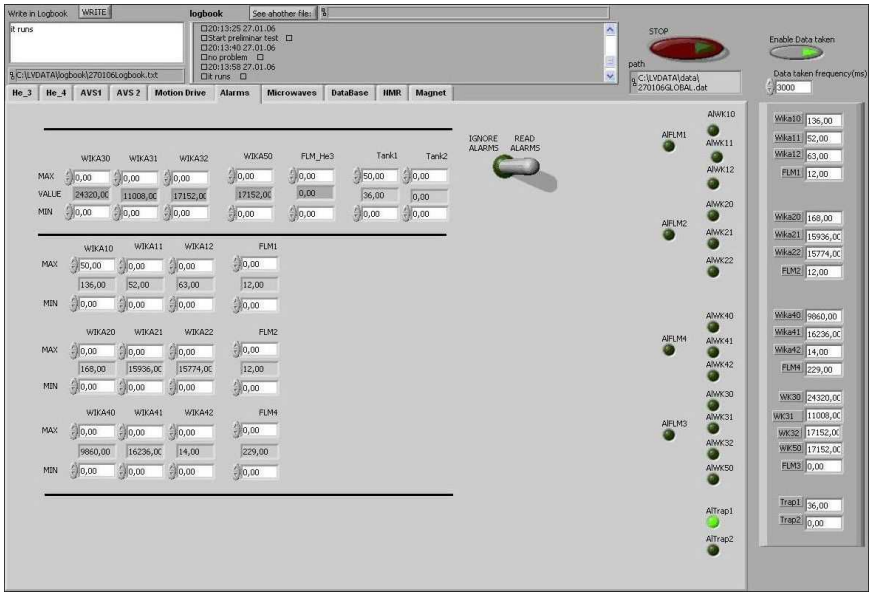

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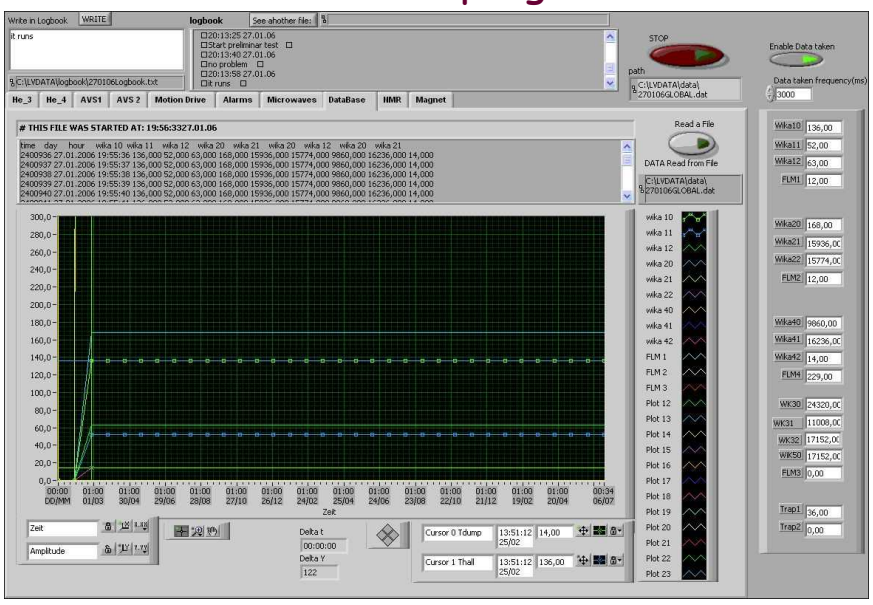
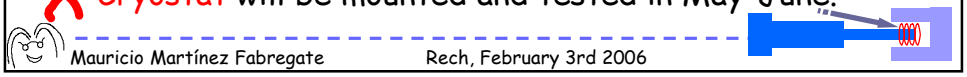


Summary & Outlook

- ✓ Microwave system used in 2003.
- ✓ Magnet working and tested by X1 group.
- ✗ NMR under construction.
- ✓ Roots Pumps working and tested.
- ✓ He3 and He4 line (66 valves, 7 pumps, 13 pressure sensors, 4 flow meters) working, leak test missing.
- ✗ AVS Thermo sensors software system done.
- ✓ Cooling trap refilling system working, trap is being produced in Dubna.
- ✗ Motor-needle valve connection missing, software done.
- ✓ LabView-Simatic control system done, but more parts have to be implemented.
- ✗ Cryostat will be mounted and tested in May-June.



Target Group:

Andreas Thomas
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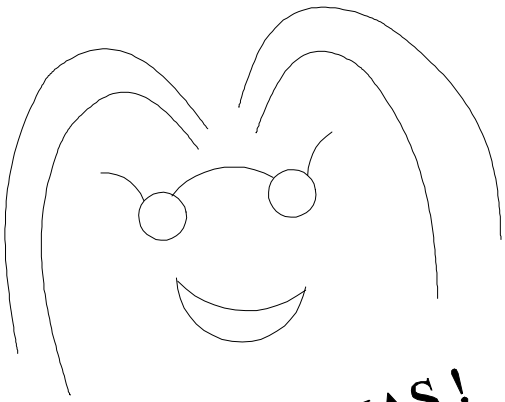
Mauricio Martínez Fabregate
Garik Palagashvilik
Oleksandr Kostivov
Milorad Korolija
Andrea Knezevic

Patricia Aguar Bartolomé

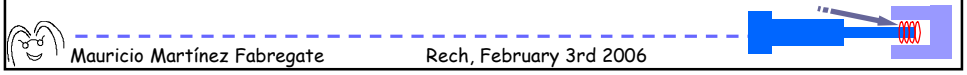
Francis Pheron

Joachim, Mohamed,
Vicenta, Noelia, Dave,
Steven, Chris…



GRACIAS !

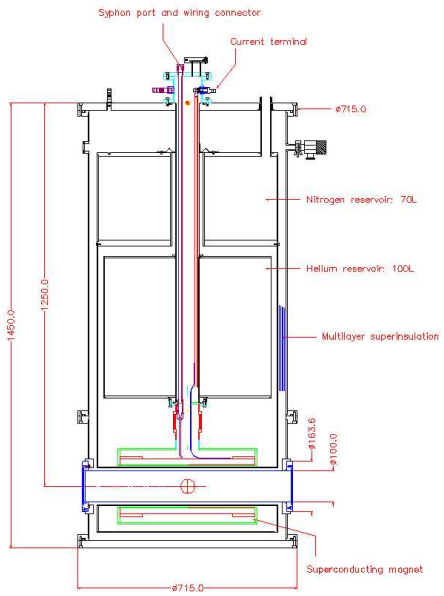
+ Bonn + Bochum + COMPASS

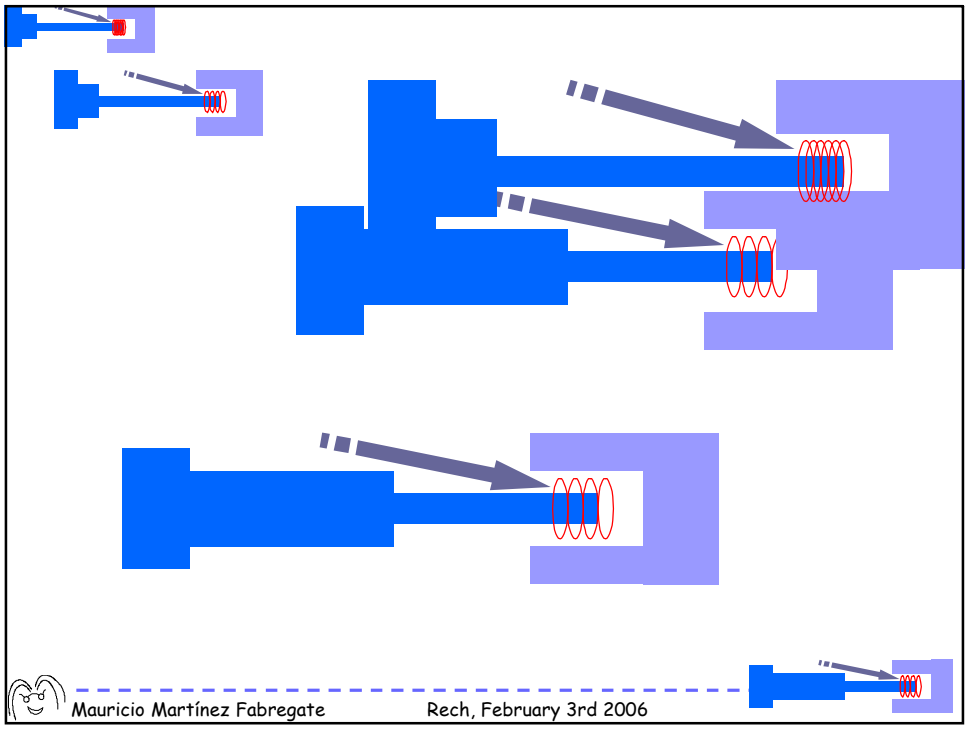


Magnet

- Liquid He bath at 4 K
- Radiation shield cooled by nitrogen
- Maximum field: 5 Tesla
- High Uniformity:

$$\frac{\Delta B}{B} < 10^{-4}$$





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Summary & Outlook

- ✓ Microwave working and tested since 2003
- ✓ Magnet
- ✓ AVS
- ✓ LabView-Simatic control System
- ✗ Needle valve motor
- ✗ N.M.R.

- ✓ Roots Pumps
- ✓ 66 valves, 7 pumps, 13 pressure sensors, 4 flowmeters
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- Cooling trap
- ✗ Leak test
- Mount and test Cryostat

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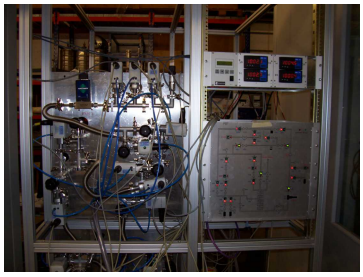
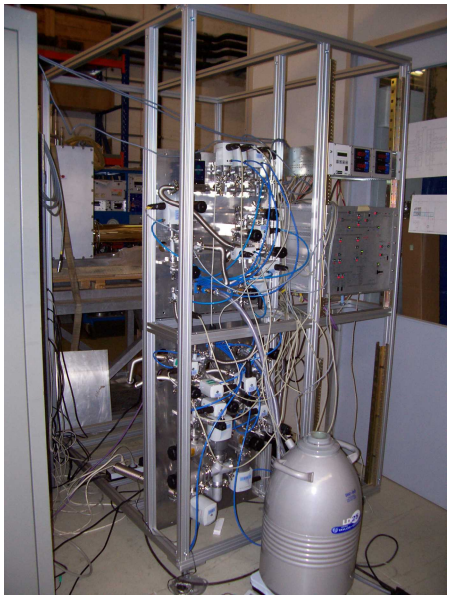
He3 line

- 1 tank of ^{3}He gas
- 1 tank of ^{4}He gas
- 39 Valves
- 1 Flow meter
- 4 Pressure sensors
- 4 Rotary Pumps
- 2 Cooling Traps
- 5 Roots Pumps





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