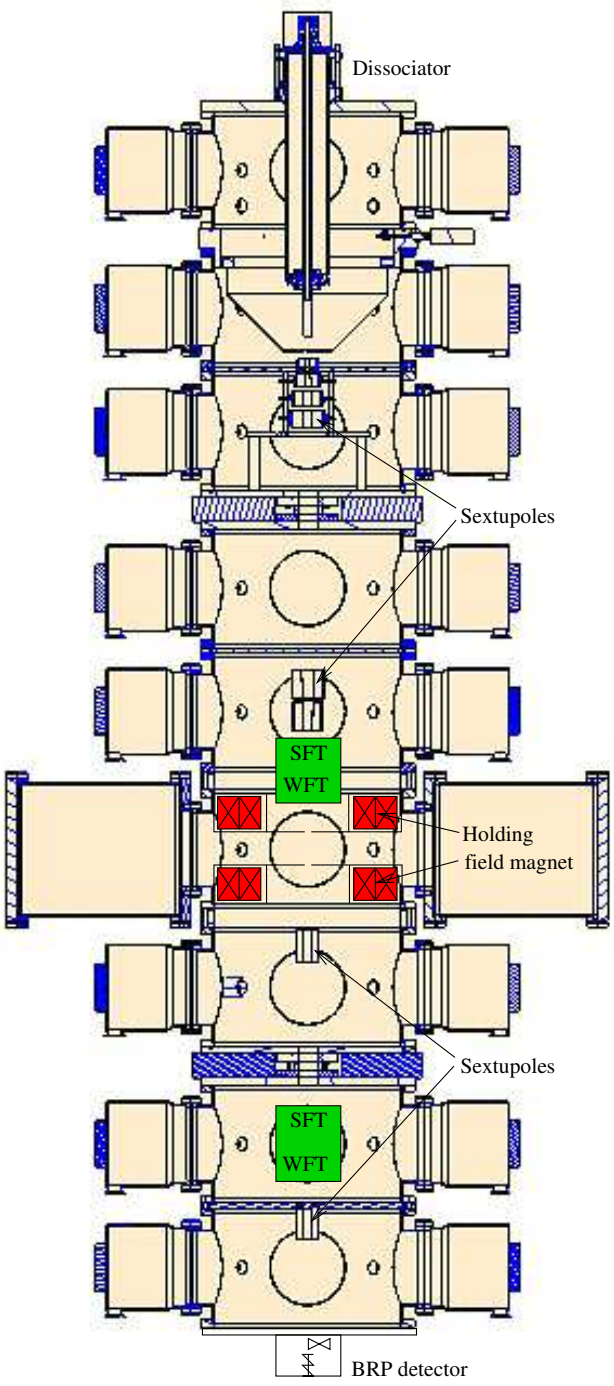
Update on the H-Jet

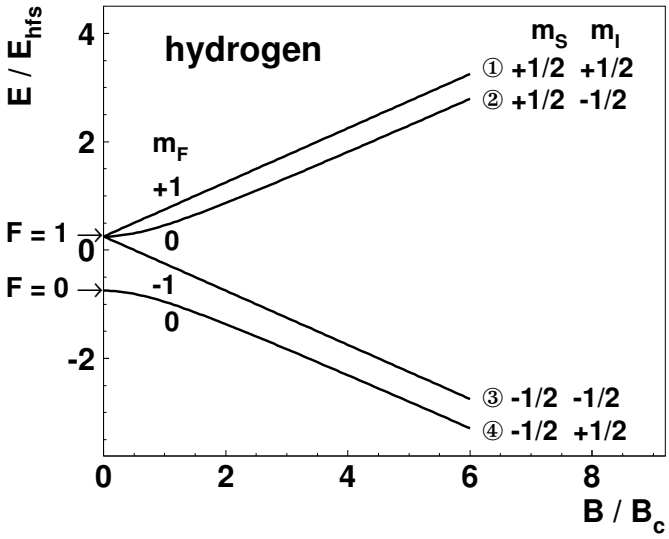
1. High frequency transitions installed and tested.
2. Holding field magnet powered up.
3. Running under PLC control.
4. Modifications to the IR completed.
5. Moved the jet to the IR.
6. Water cooling system completed.
7. Jet systems running in the IR.
8. Started to monitor the jet through the VME crate.
9. Results of the Safety Review.
10. Next steps.

The Jet


Dissociator
Sextupoles
SFT
WFT
Holding
field magnet
Sextupoles
SFT
WFT
BRP detector

Achieving polarized atoms in the Jet

Hyperfine structure of hydrogen in an external magnetic field.



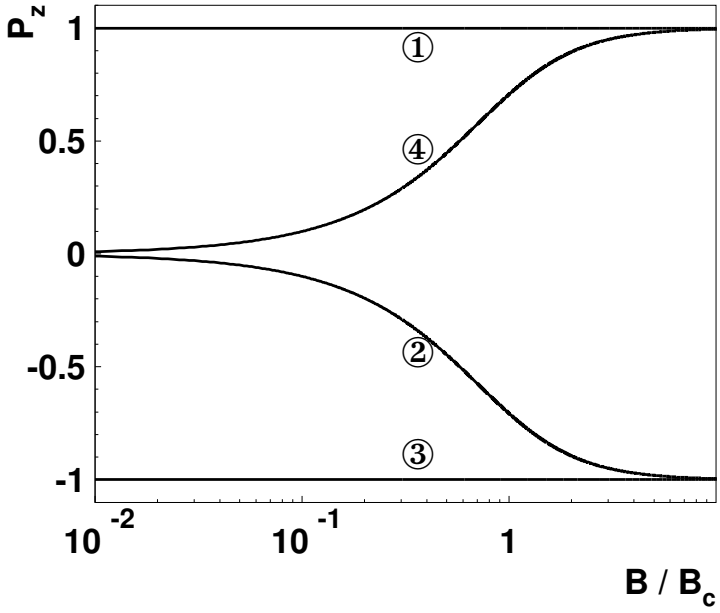
$$
\begin{aligned}
|1\rangle &= |+\frac{1}{2},+\frac{1}{2}\rangle \\
|2\rangle &= \cos\theta|+\frac{1}{2},-\frac{1}{2}\rangle \\
&+ \sin\theta|-\frac{1}{2},+\frac{1}{2}\rangle \\
|3\rangle &= |-\frac{1}{2},-\frac{1}{2}\rangle \\
|4\rangle &= \cos\theta|-\frac{1}{2},+\frac{1}{2}\rangle \\
&- \sin\theta|+\frac{1}{2},-\frac{1}{2}\rangle
\end{aligned}
$$

with $\theta = \frac{1}{2}\arctan\frac{B_c}{B}$

$B_c = 0.507$ kGauss

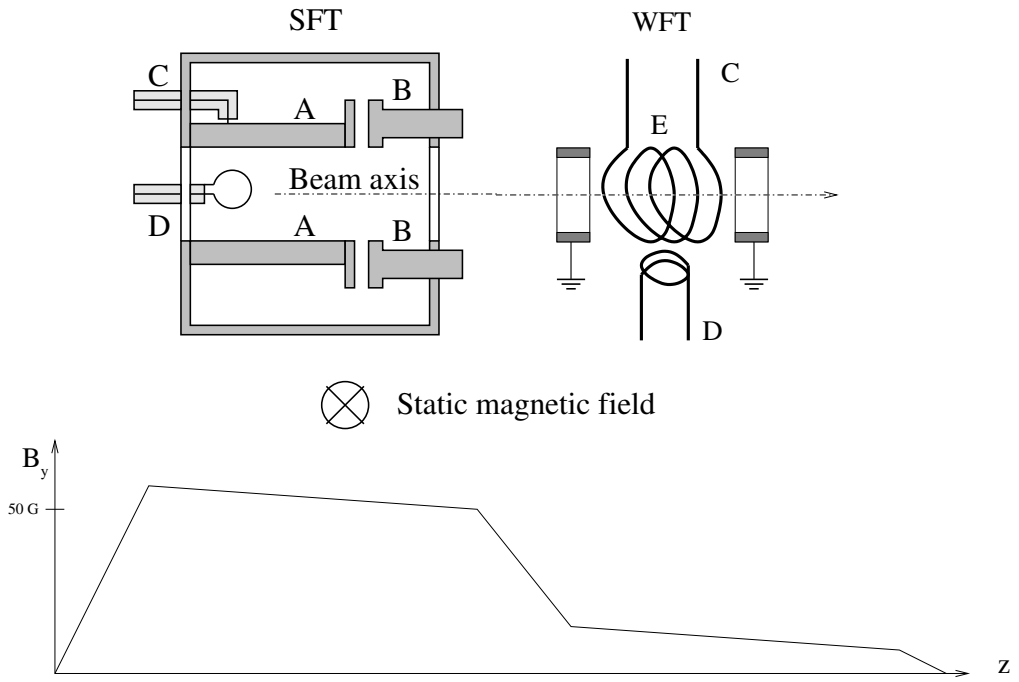
Achieving polarized atoms in the Jet

Calculation of the nuclear polarization:
$P_z = n_1 - n_3 + (n_4 - n_2)\cos 2\theta$



- Focussing atoms with electron spin $+\frac{1}{2}$ into the target region while defocussing atoms with electron spin $-\frac{1}{2}$ by 2 sets of sextupole magnets using the Stern-Gerlach effect
- Exchange of occupation numbers of states $|1\rangle$ and $|3\rangle$ ($|2\rangle$ and $|4\rangle$) with the WFT (SFT) to obtain a negative (positive) nuclear polarization.
- $\Rightarrow$ 95% (96%) maximal polarization at 1kGauss (1.2 kGauss) holding field.

High frequency transitions and holding field magnet



- High frequency transitions installed in a shielding box to reduce z-field in the transition region.
- Installed water cooling to remove the heat from the coils.
- Measured efficiencies of all transitions to be $> 99.5\%$.
- Installed 2 beam blockers to remove states $|3\rangle$ and $|4\rangle$ and molecules completely from the BRP beam.
- Main holding field magnet powered up without problems. No polarization losses due to non adiabatic conditions of the field.
- $\Rightarrow > 94.5$ % (95.5 %) polarization at 1kGauss (1.2 kGauss) field.

PLC control

- Setup of a PLC system to completely interlock the Jet.
- Hardware now protected in case of failures (power, water, comp. air ...).
- PLC can be monitored and controlled by a PC.
- Additional interlocks for power supplies of holding field magnet, HFT coils and HFT RF (temperature, cooling water, vacuum).
- Readout of vacuum gauges, water flow meters, valve and forpump status via ADC of PLC.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Modifications and moving to the IR

- Crane installed and tested in the IR.
- Rails mounted on the floor.
- Cable trays installed from the service building to the IR.
- Cables pulled and terminated for the whole system.

- Moving started October 9th by splitting the jet in 3 parts:
  1. ABS stage (3 upper chambers)
  2. RHIC and BRP stage (6 chambers)
  3. Racks
- Riggers moved all 3 parts out of Bldg. 930 to Bldg. 1012.
- Items 1 and 2 $\Rightarrow$ IR, 3 $\Rightarrow$ service building.
- Moved part 1 ontop of the rails with the crane.
- Moved part 2 ontop of 1 using a forklift (only this time, modifications on the crane in progress).
- Beamline not in place.
- Connected cables between Jet and racks.

- $\Rightarrow$ whole moving will need 1 day of RHIC down.
  + an additional day for leak checking.

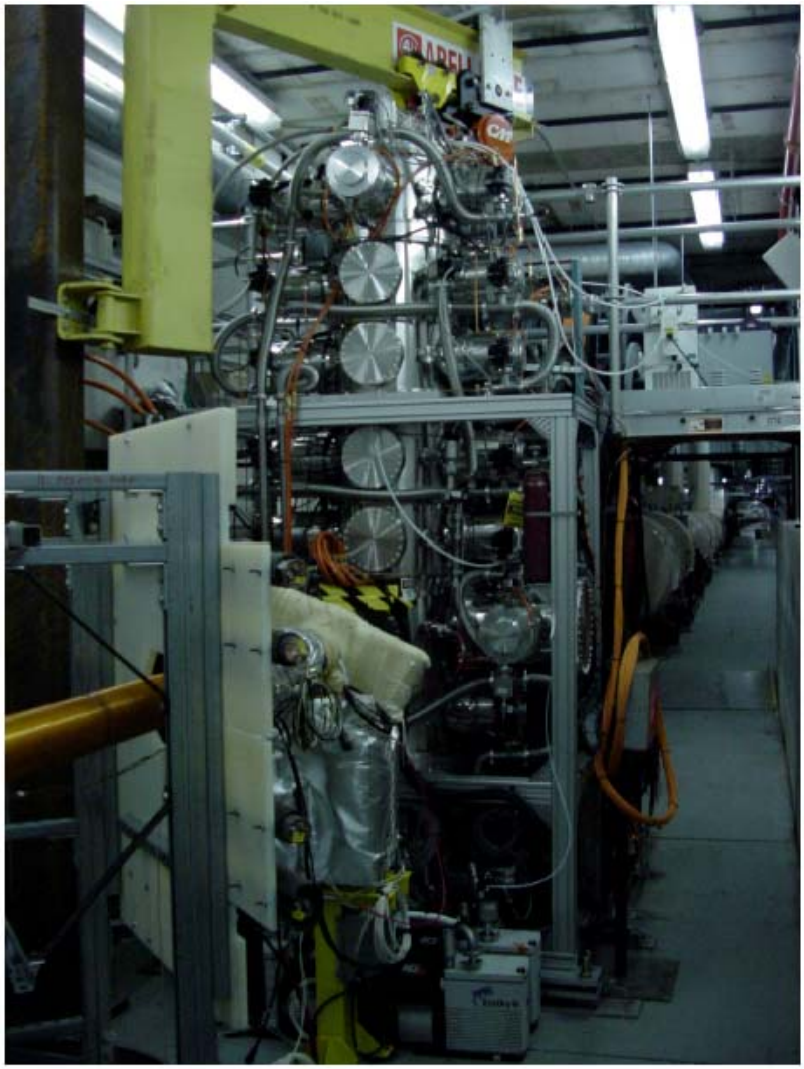
Water cooling system

- Heat exchange system located in the service building.
- Water lines running to the IR as well as to the racks.
- Cooling needed for the holding field magnet, the turbo pumps, the RF-coils, the nozzle cold head compressor and the RF-amplifier for the dissociator.
- Additional chiller in the IR for the dissociator tube cooling.
- Closed cycle system using tap water for heat exchange at the moment.
- Filters installed to clean up the system to prevent blocking of the small conductance holding field magnet lines.
- Decision to use cooling tower or chiller for heat exchange will follow.

Jet running in the IR

- After fixing some leaks start of all pumps. Pressures achieved $\approx 10^{-8}$ Torr without hydrogen beam (chamber in RHIC vacuum $7 \cdot 10^{-9}$ Torr without RHIC pumps running).
- Dissociator was running but intensity droped after some hours running.
- Exchange of the glass tube (2 mm thickness $\Rightarrow$ 1mm thickness) $\Rightarrow$ stable operation at a high intensity level.
- Running the high frequency transitions without any big problems. Stable operation and high polarization.
- Holding field magnet powered up and running without problems (up to 1.2 kGauss).
- No problems found when running all devices with the 50 m cables instead of the short cables before.
- Replaced (50 m) BRP gauge cable with shielded one and improved power supply to increase the signal to noise ratio.

- Now testing for long term stability.
- Started to monitor the jet via VME crate.
- Using 'pet' pages and archiving to monitor the different parameters.
- Cabling on the way to fully monitor and digitally control the jet.



Next Steps

- When vacuum established in the beam lines adjoining the jet, $\Rightarrow$ open the vacuum valves and measure the true jet beam gas load.
- Control the power supplies through the VME crate and PET control.
- Some minor things to fix after Safety Review Committee review and initial walkthrough.
- Move out of the IR on November 20th with beamline in place.
- Move back to Bldg. 930 and continue long term stability tests as well as controll and measurement of the polarization via VME.
- Focus on preparations to install the silicon detectors on the jet (flanges, collimators, etc.).
- Developing and constructing the H_2 (H_1, H_2O) monitor
- Check alignment of the whole system.