The following document reports on the arrangement and setting for the ABS and BRP radiofrequency transitions. The sketch of the system is presented in the following scheme.

![Diagram of the system](image)

**Figure 3.10**: Detailed scheme of the target system from the downstream direction. In the lower corners sketches of the hyperfine splitting of hydrogen and deuterium are drawn to show which states are exchanged in the RFT units (STF, MFT, WFT) of the atomic beam source and Breit-Rabi polarimeter. The numbers below the symbols of the transition units refer to hydrogen, the numbers above the symbols refer to deuterium.

The target consists of the Atomic Beam Source (ABS), the storage cell (SC), the Target Gas Analyzer (TGA) and the Breit-Rabi polarimeter (BRP), in the following there are provided some schemes and operating block diagrams, in order to share information and organized the work to be performed.

More in details we try her to organize the PAX target in order to switch easily from H to D and back, for the use in AD at CERN.

**The ABS radiofrequency transition units**

- **RF modules and their connection**
  In the following we’ll present the modules as they were organized this week by Statera and Ciullo.
We follow the order from upstream (Source) to the BRP-QMS, that means following the scheme of the picture from left to right.

**The MFT and SFT transition unit in between the sextupole.**
The following scheme provides a block scheme of the MFT transition unit

![Diagram of the MFT transition unit](image)

Fig. 4.3:
Structure of a medium field transition. The high frequency field is generated by a coil and oscillates perpendicularly to the static field. The shape of the pole shoes indicates a gradient field that decreases along the direction of the atomic beam. In reality the gradient field is generated by a coil as well and thus can be tuned. The Collins filter allows the adjustment of the impedance of the overall setup to 50 Ω.

For the $H (D)$ the MFT operates at a frequency of **90 MHZ (25 MHz)** $^1$, we have available the following module for the transition:
- RF generator 50-100 MHz useful for $H$,
- RF generator 5-30 MHz useful for $D$.
- RF amplifier for both the $D$ and $H$ running.
- Collins filter for both the $H$ and $D$ running.

The homogeneous magnetic field ($B_{HOM}$) coils and the gradient magnetic field ($B_{GRAD}$) coils.

Previously in HERMES the running with $H$ and $D$ allows enough time to exchange the inner cavity and all the relative module, setting of all the transitions and modules are available in the PAX wiki page, and we report also other references.

In the PAX experiment at AD we have to install the new Dual Cavity for $H$&$D$, a test on this cavity was performed in Ferrara $^2$.

Then in the case of the MFT in between the sextupole we should have the following scheme to change from $H$ to $D$:

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$^2$ M. Capiluppi et al. “Dual H&D cavità for the PAX target polarimeter” internal note.
According to the scheme 4.3 mod., we should use a RF diverter to change from one generator to the other and an RF switch for the operation of the RF transition controlled by the 0-10 VDC output from the DAC.

But in any case we should change the tuning of the Collins Filter.

Otherwise we should investigate the possibility to have two separate Collins Filter tuned properly for H and D like in the following scheme.

Still if it is required we should also have a separate amplifier and then use just before the resonator one diverter and one switch.

For the SFT transition we have a complete separate chain of RF circuit for D and for H. For Hydrogen the amplifier is provided by the trigger-switch on the RF amplifier. For the deuterium we have to by a RF switch.

The frequency are 1430 MHz for H, and 370 MHz for D.

The SFT transition also use Homogeneous field and Gradient field, separate power supplies from the MFT.

**The MFT(WFT) and SFT transition in the appendix.**

The atomic beam just before entering the target experiences another MFT (Called also WFT) and also SFT transition. Some problems, has reported for the transitions in between the sextupole, thereforecwe have to apply the same to this transitions.

There are different frequency for the MFT

For H 14 MHz
For D 7 MHz.
Therefore we could use only one module and change it through the 0-10 VDC frequency remote controller already installed.

The RF generator provide 0 setting 0 V on the Amplitude ext.int.0-10 VDC.  
But by experience (A. Nass) should be better to provide an RF switch.  
Another peculiarity of the appendix transition unit is that for the magnetic field it is used the same Coils for Homogenous and Gradient field for WFT and SFT.

**BRP MFT and SFT transition unit in between the sextupole.**

The configuration of this units is the same like for the ABS transition in between the ABS sextupole Magnets. Therefore we’ll have same problems.  
The difference is in frequency  
MFT  for H 68.2 (79 in the PAX wiki) MHz, for D 17.2 MHz (16 in the PAX wiki).  
This MFT can be the same like that one in between the sextupole at the ABS, then we can use the same configuration.

For SFT we have complete different circuit for D and H, like the one in between the sextupole but we have small difference in frequency.  
SFT for H 1425 MHz (1456 in the PAX wiki) and for D 419 MHZ (390 in the PAX wiki)..

In the following table we report how we organize now the RF module, and if they can be switched off/on Via the 0-10 VDV from DAC.

<table>
<thead>
<tr>
<th>Unit</th>
<th>Atom (frequency MHZ)</th>
<th>Generator</th>
<th>Amplifier</th>
<th>Cavity/resonator</th>
<th>Bfield</th>
</tr>
</thead>
<tbody>
<tr>
<td>SFT</td>
<td>H (1430)</td>
<td>1.45 GHz</td>
<td>1.425± 35 GHz(^4) with switch</td>
<td>Cavity</td>
<td>(B_{\text{HOM}}) (B_{\text{GRAD}})</td>
</tr>
<tr>
<td></td>
<td>D (430 MHz)</td>
<td>0.3-0.6 GHz</td>
<td>0.5-525 MHz(^2) Without Switch</td>
<td>Cavity</td>
<td>(B_{\text{HOM}}) (B_{\text{GRAD}})</td>
</tr>
<tr>
<td>MF</td>
<td>H (90 MHz)</td>
<td>50 100 MHz with switch</td>
<td>0.5-525 MHz(^6) without Switch</td>
<td>Resonator</td>
<td>(B_{\text{HOM}}) (B_{\text{GRAD}})</td>
</tr>
<tr>
<td></td>
<td>D (25 MHz)</td>
<td>5-30 MHz with Switch</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\(^3\) C. Baumgarten Thesis and (PAX wiki page)  
\(^4\) Dressler RFP1450-20C In =1-4mW Out:20 W  
\(^5\) KALMUS R510-FC -CE- 10 W 40dB  
\(^6\) RF powelab R510-FC - 10 W 40dB
In the following table we report the old configuration of power supply and the new one.

**OLD CONFIGURATION**

<table>
<thead>
<tr>
<th></th>
<th>ABS SFT1</th>
<th>ABS MFT</th>
<th>ABS SFT2/WFT</th>
<th>BRP SFT</th>
<th>BRP MFT</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>HOM FIELD</strong></td>
<td>HZ3</td>
<td>HZ3</td>
<td>HZ3</td>
<td>KEPCO 20-10</td>
<td>KEPCO 20-10</td>
</tr>
<tr>
<td><strong>GRAD FIELD</strong></td>
<td>KEPCO 20-5</td>
<td>KEPCO 72-3</td>
<td>KEPCO 20-10</td>
<td>HZ3</td>
<td>KEPCO 50-2</td>
</tr>
</tbody>
</table>

**NEW CONFIGURATION**

<table>
<thead>
<tr>
<th></th>
<th>ABS SFT1</th>
<th>ABS MFT</th>
<th>ABS SFT2/WFT</th>
<th>BRP SFT</th>
<th>BRP MFT</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>HOM FIELD</strong></td>
<td>KEPCO 20-10</td>
<td>HZ3</td>
<td>KEPCO 20-10</td>
<td>KEPCO 20-10</td>
<td>HZ3</td>
</tr>
<tr>
<td><strong>GRAD FIELD</strong></td>
<td>HZ3</td>
<td>KEPCO 72-3</td>
<td>KEPCO 20-5</td>
<td>HZ3</td>
<td>KEPCO 50-2</td>
</tr>
</tbody>
</table>

**Spares module not installed**
In the following we report the module non installed on the rack, with switch we mean that they can be controlled via 0-10 VDC. New module can be controlled instead via RS232.

- RF generator 5-30 MHZ, Heidelberg RF workshop # 1

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7 RFTS RF1 500 10 - 10 W
• RF generator Digimess FG100 0.5Hz 20 MHz Output 10 mV..10V/50 Ω (useful for WFT), controlled via RS232 #2
• RF generator TTi TGR1040 10-1000 MHz, -127 dBm to 7dBm (0.1 μW- 500 mW on 50 Ω) controlled via RS232 # 2
• RF Amplifier RF powerlab model 110 C, 0.1-60 MHz,10 W, 40 dB (useful for WFT), without switch # 1
• RF Amplifier RF1400-10 GV to be checked (useful for H SFT) without switch # 1
• WFT), controlled via RS232 #2
• RF Amplifier RFTSA RF13001500-20 RFPA SAS switch trigger +12 VDC,Input: 1 to 5 mW, Output max:20 W (for H SFT) #1
• RF amplifier RF powerlab R510-FC - 10 W 40dB, .5mW for full output– no switch # 1

Power supplies
• KEPCO BOP 20-5M labeled Cath. Curr. # 1
• Heinzinger LNG32-3 #1