Poster P02-20

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Tunable13C/1H Dual Channel Matching Circuit for Dynamic Nuclear Polarization System with Cross-Polarization

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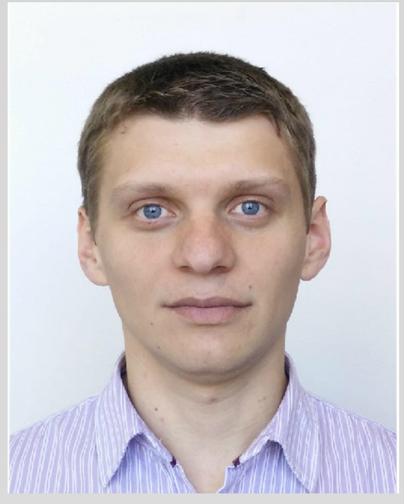


INTRODUCTION

Dynamic Nuclear Polarization (DNP) is rapidly developing and unique technique especially applying to magnetic resonance (MR) imaging. In DNP the sample under investigation is irradiated with microwaves facilitating the transfer of spin polarization from electrons to nuclei thereby dramatically improving the sensitivity of MR experiments.

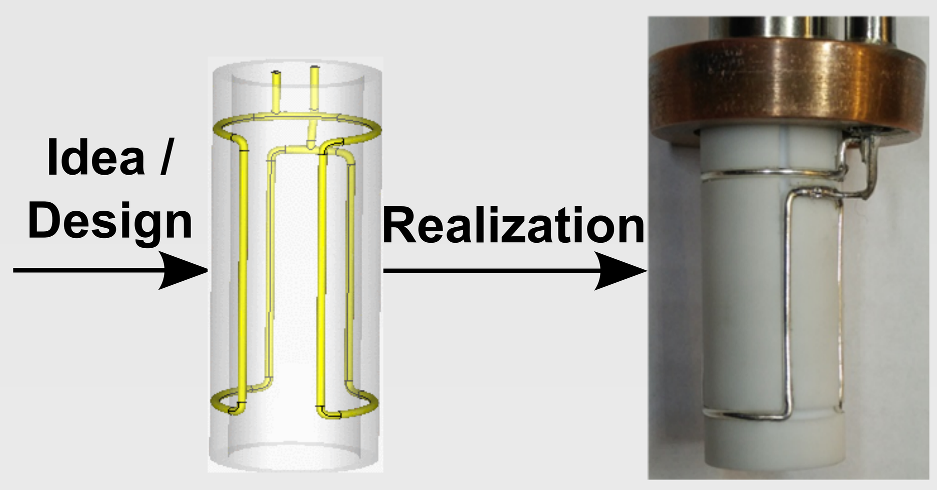
A great deal of effort is expended optimizing the polarization process from microwave and radiofrequency point of view. However, the transfer of microwave power, RF coil construction and sample position have a large effect on the end results. Because of this, it is necessary to consider the overall efficiency as a function of each of these parameters.

To increase the sensitivity by several orders of magnitude existing systems require an implementation of sensitive receiving radio frequency coil elements, tuning and matching circuit or significantly higher signal to noise ratio of the signal from the nuclear under investigation.

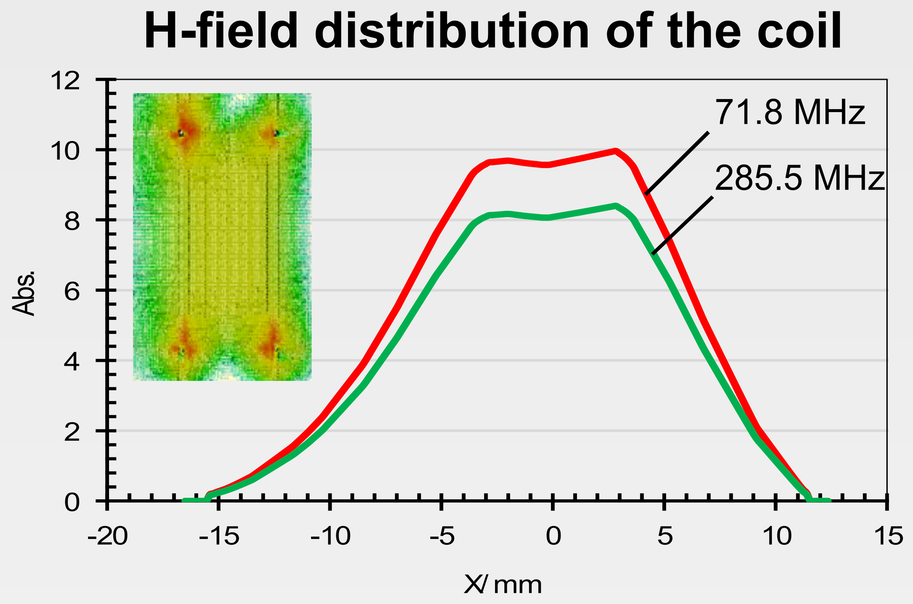
While it is important to optimize the arrangement of radiofrequency components. We will describe results on the radiofrequency perspectives that make the polarization process more efficient. The improvements would further increase the sensitivity enhancement provided by DNP.

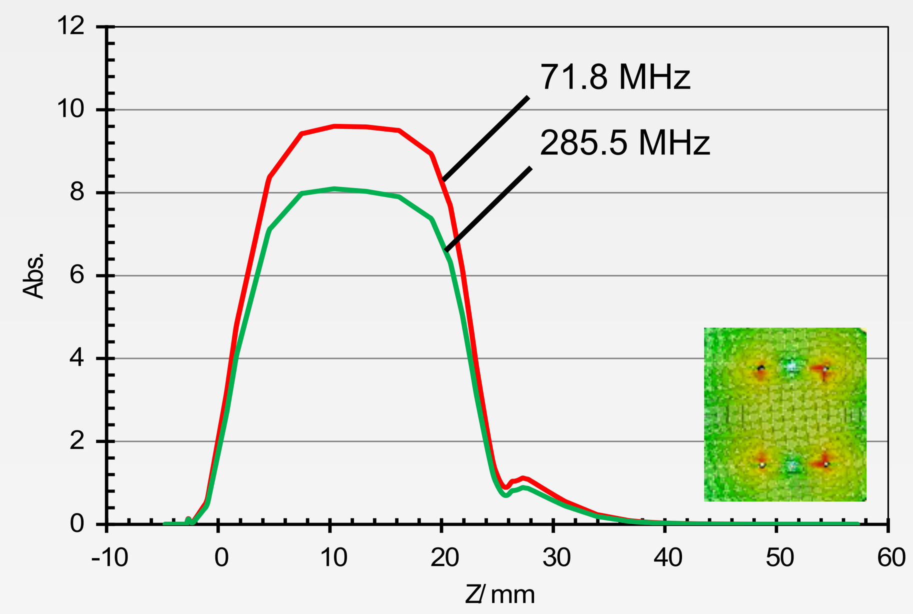
RADIOFREQUENCY COIL

We present the RF design of double channel DNP probe for operation at 6.7 T: 13C frequency is 71.8 MHz, 1H frequency is 285.5 MHz, electron resonance frequency is 188 GHz.



H-field distribution of the coil

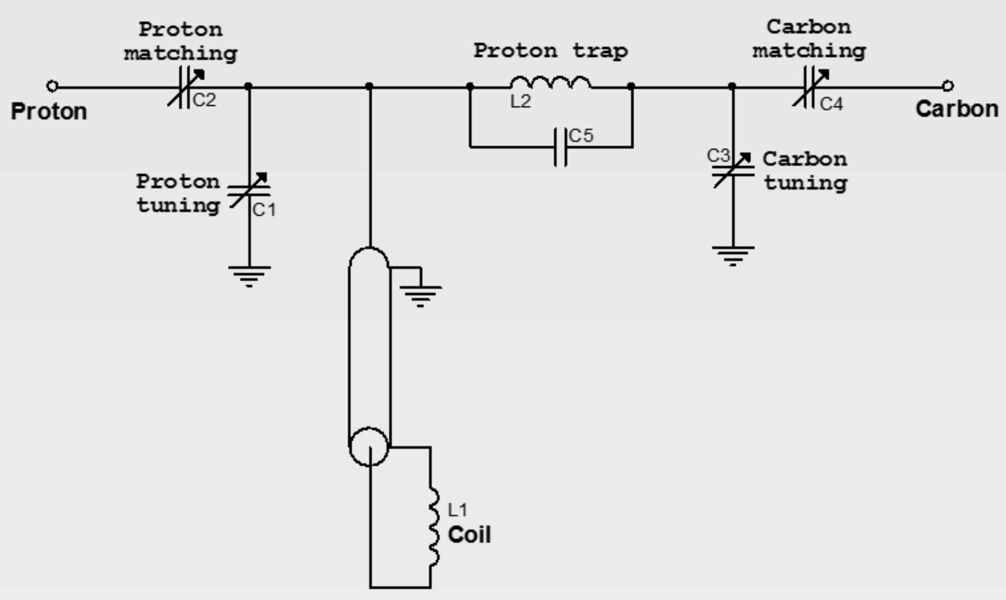




The coil is made from a silver plated copper wire with diameter equal to 0.7 mm. Coil dimensions are: diameter 13 mm; height 22.0 mm.

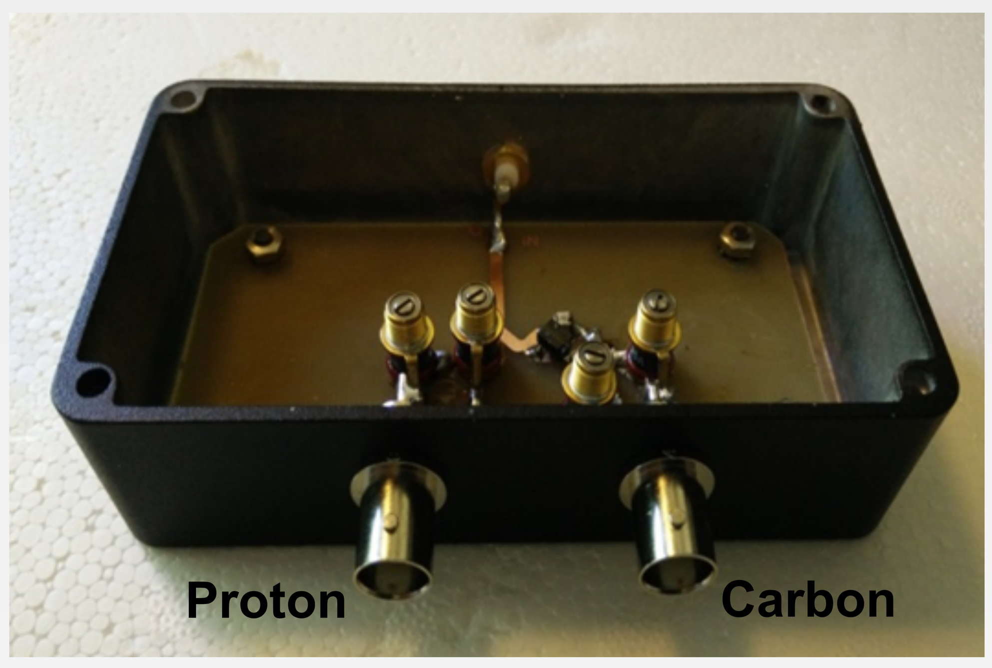
MATCHING CIRCUIT

The design, optimization and evaluation of the tuning and matching circuit for DNP system has been investigated numerically and experimentally. The investigation has been carried out to determine the possibility of using the one double channel circuit to observe the enhancement of DNP and to control a cross polarization of the sample.



The cut-off frequency of the LC trap can be deremened using the Thomson's formula:

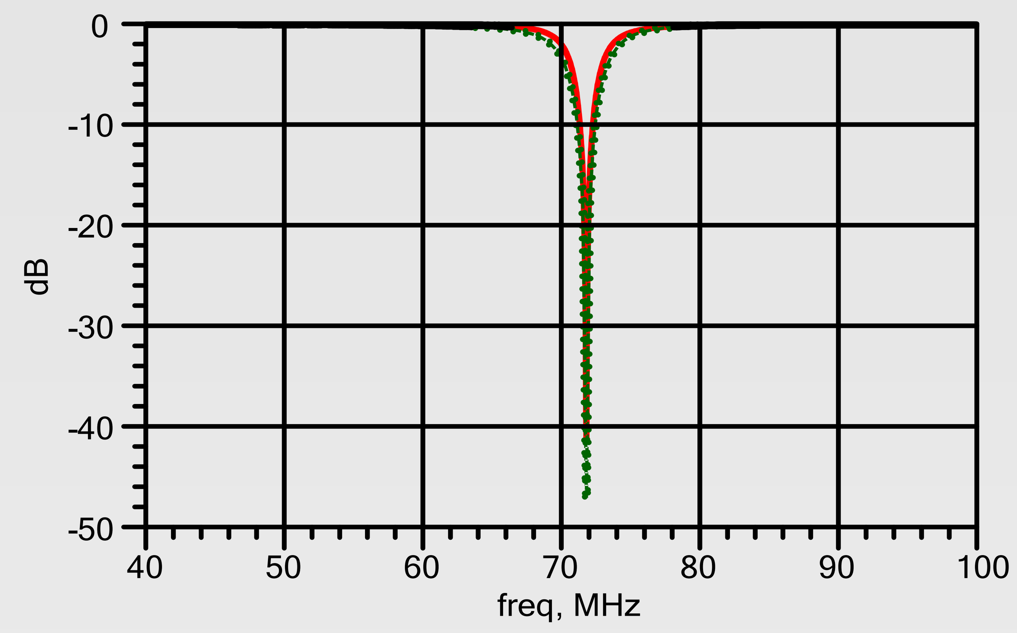
$$f=1/(2\pi\sqrt{LC})$$

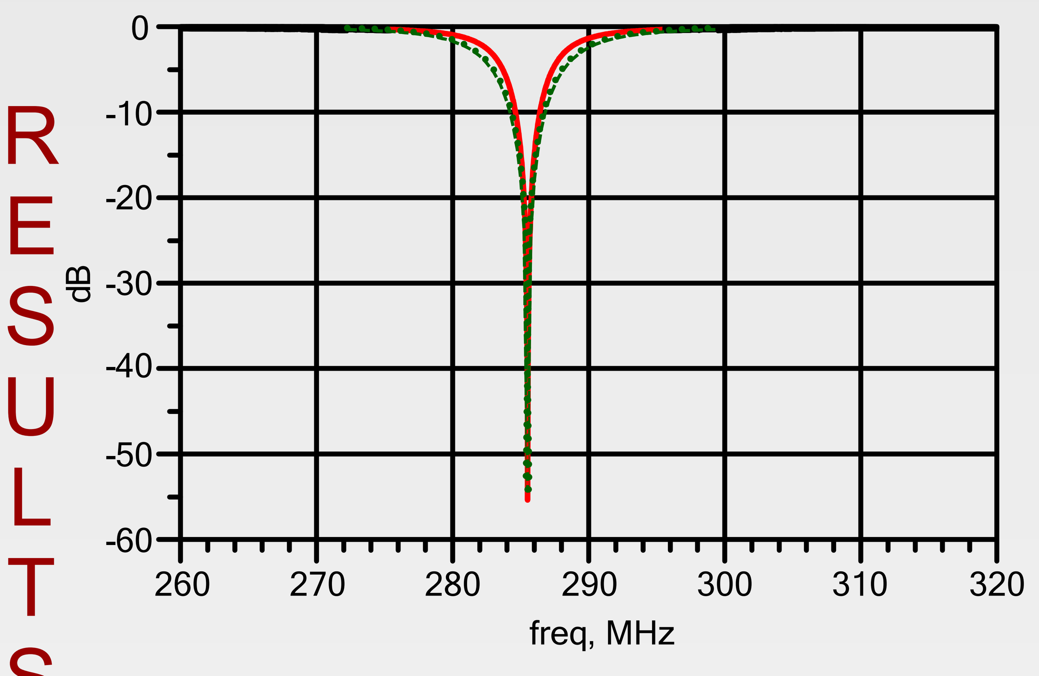


The tuning range for both channels is ±3 MHz. Simulated and measured S11 is approximately - 45 dB and -55 dB for at carbon and proton frequency, respectively. Measured/simulated Q factor of the whole system at 285.5 MHz is 76/104 and 71.8 MHz is 38/50.

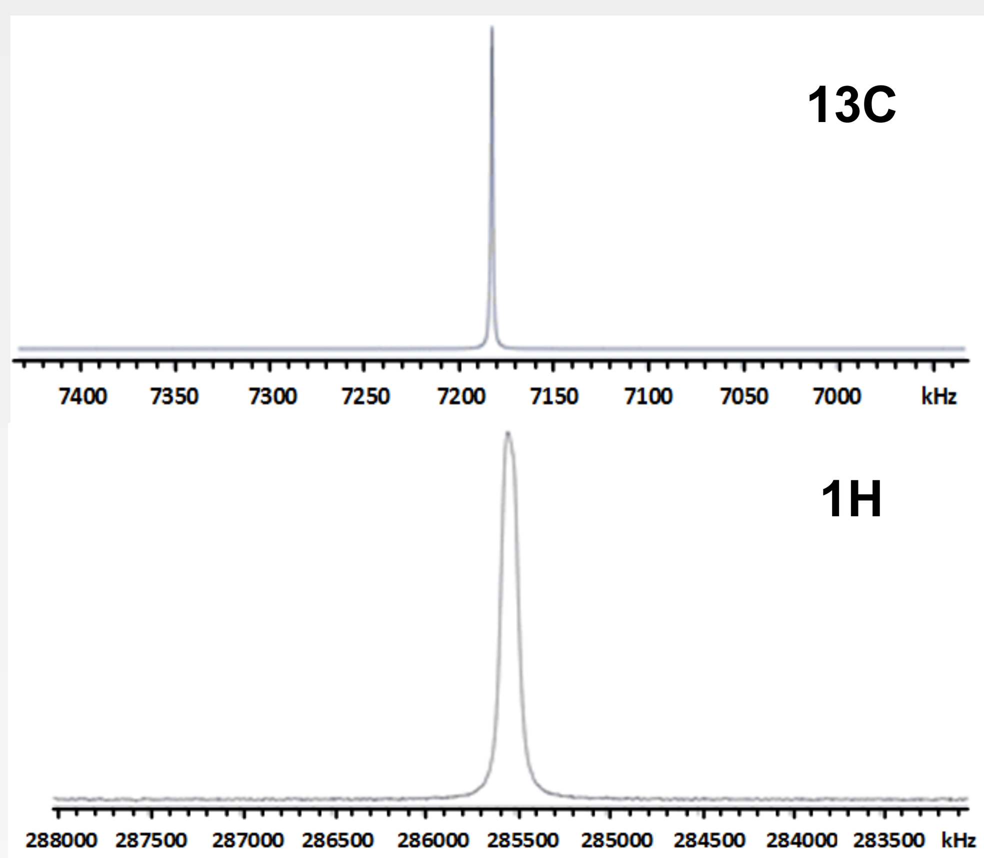
RESULTS

S parameters





Obtained 13C and 1H spectra



CONCLUSIONS

The feasibility of the probe design for DNP applications at 6.7 T from the RF point of view have been demonstrated. The performance simulations of the coil have demonstrated that the magnetic field is effectively concentrated at the sample location and it has good strengths along x, y, z, directions.

A tuning and matching box containing an RF circuit for capacitive tuning and matching of the coil for 1H and 13C frequency have been developed. The probe operates for 1H and 13C, respectively. Both channels are tuned to an attenuation of - 45 dB.

Using suggested RF setup at 6.7 T the spectra of proton and carbon have been obtained and analysed.

The described structure of the probe might be useful for low field DNP application too. Especially the RF coil design might be very attractive to achieve a homogeneous field distribution around the sample volume at lower frequencies.

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HYPERMAG

DTU Technical University of Denmark