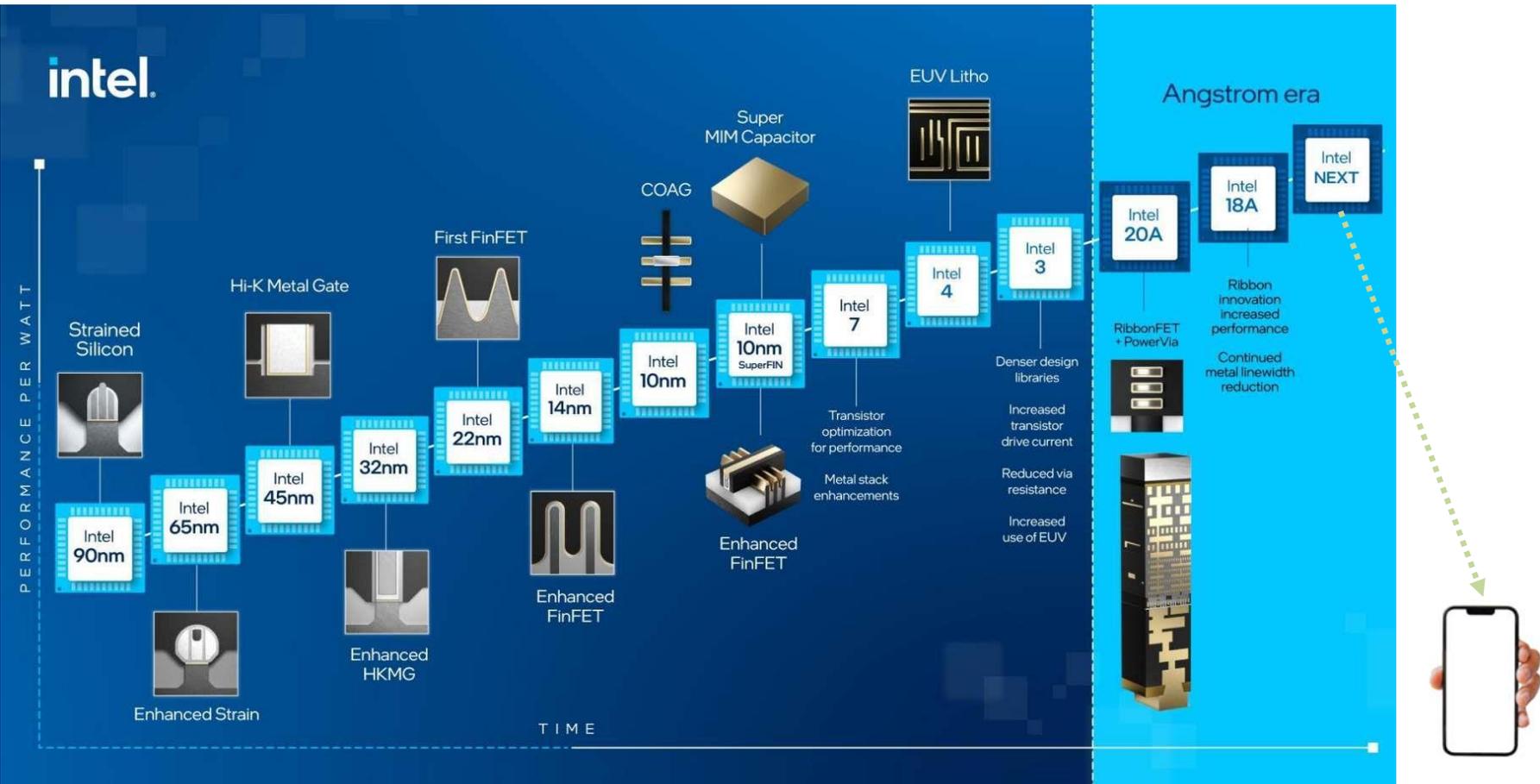


# dDNP at PHIP speed

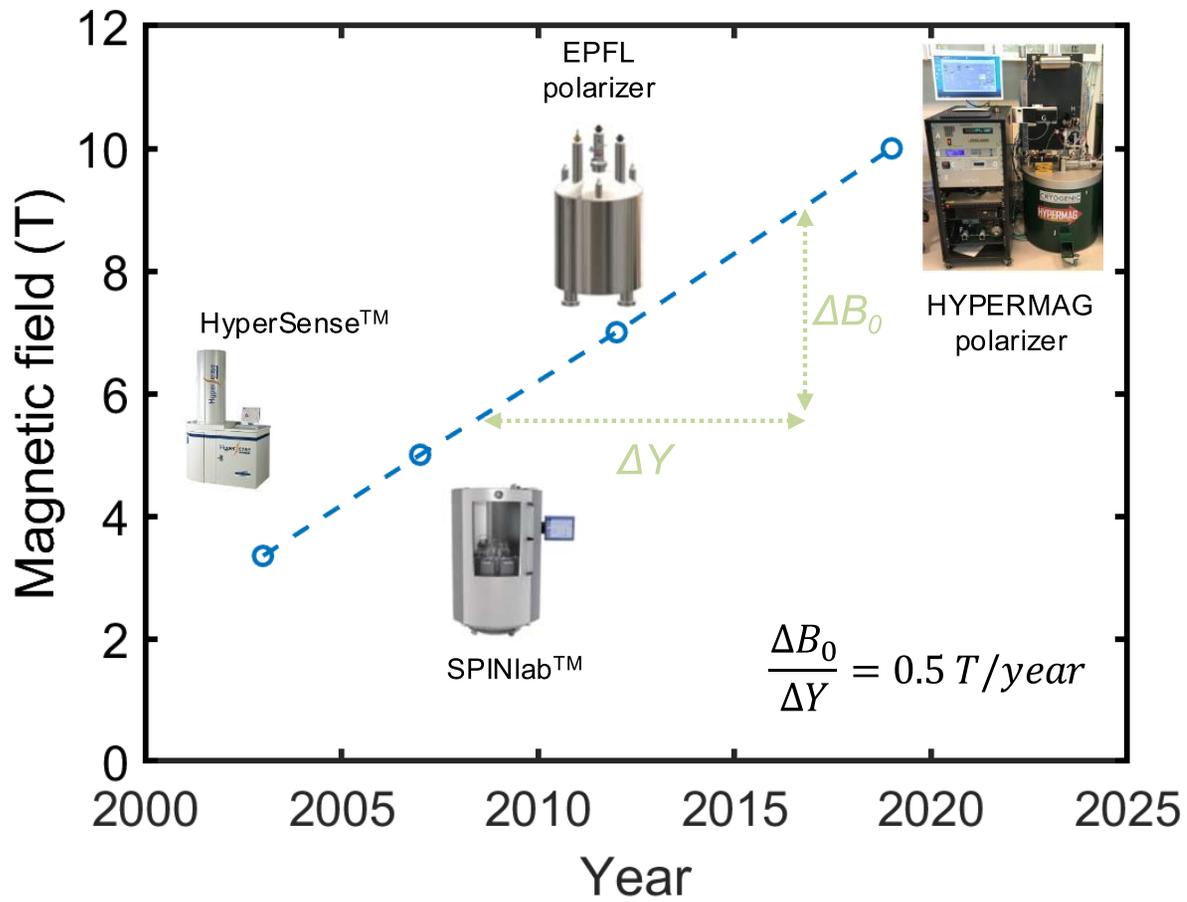
Andrea Capozzi, PhD

Thursday, October 10<sup>th</sup> 2024

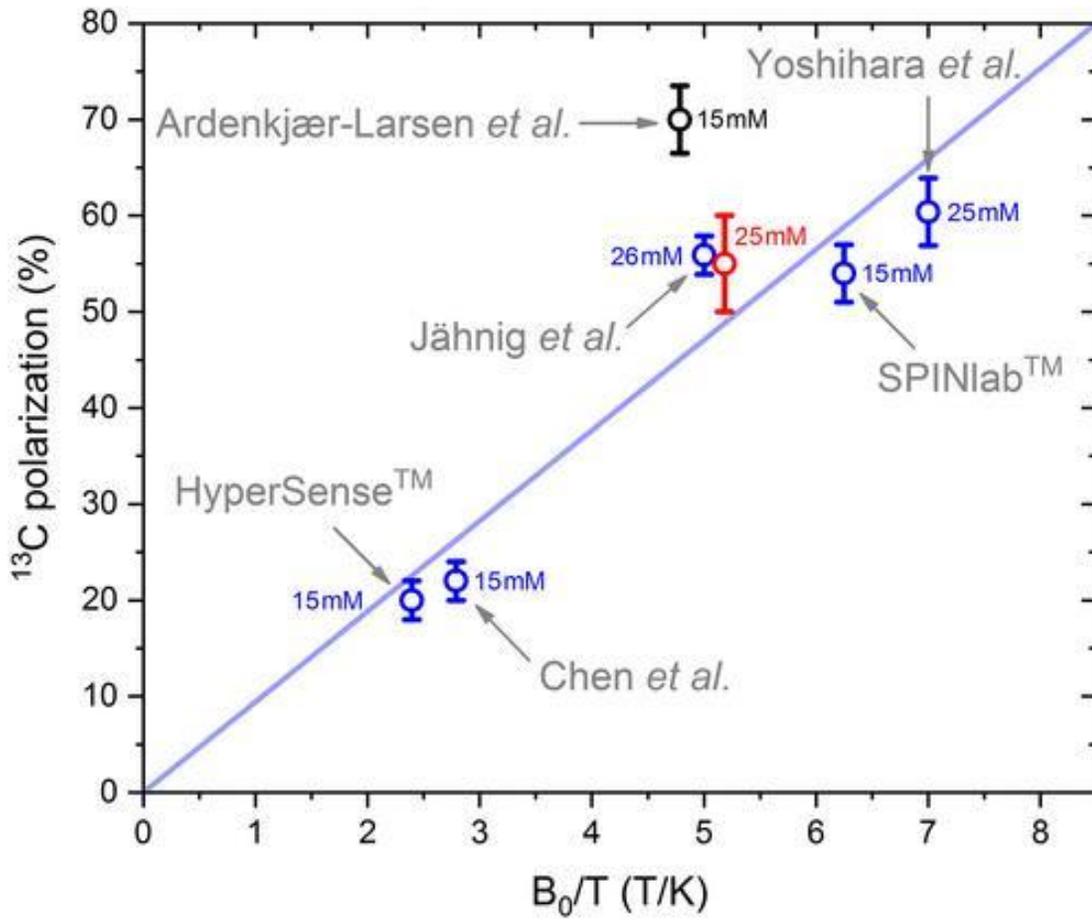
# Moore's law



# “Moore’s law” in DNP

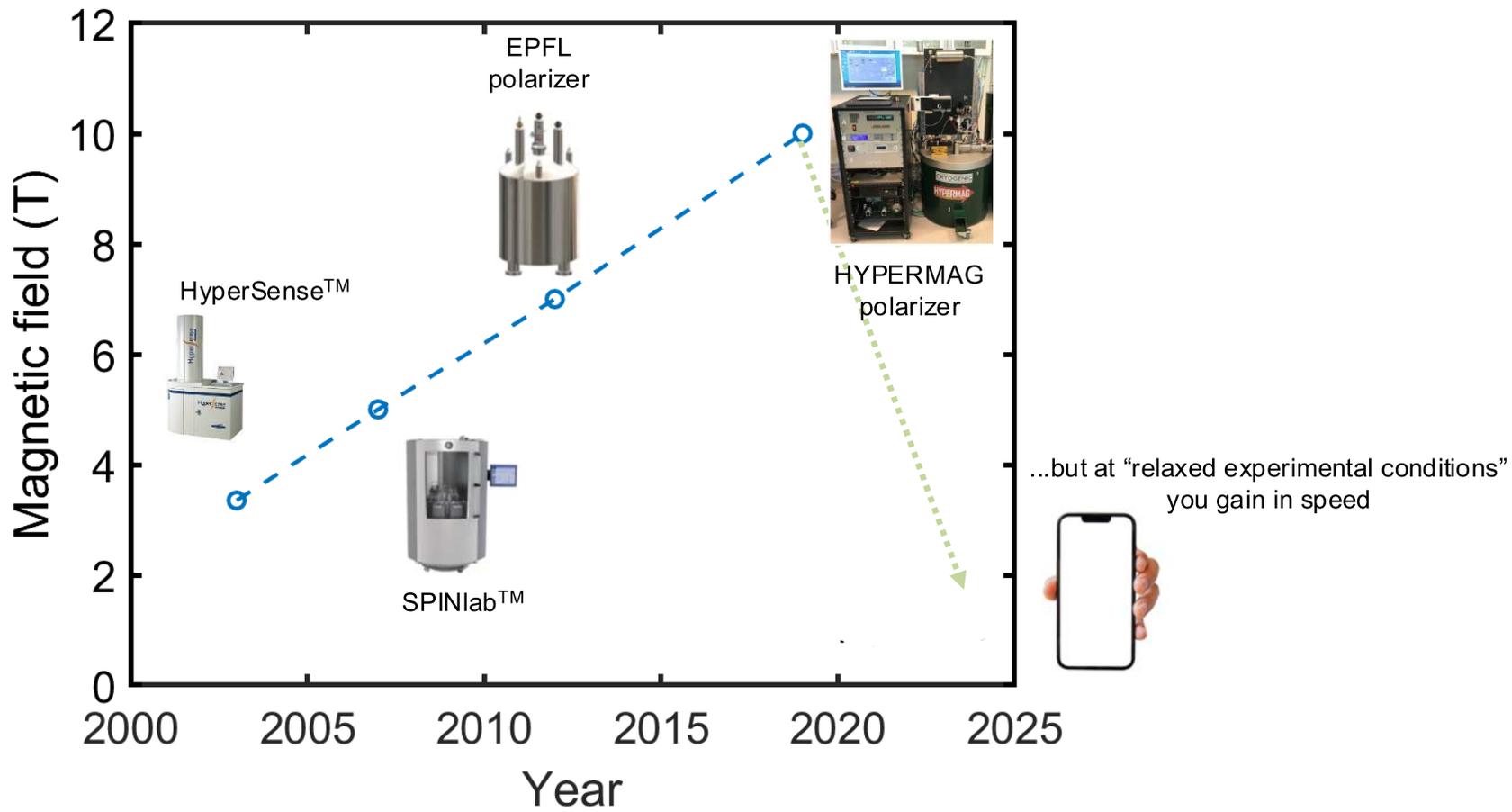


# Polarization, field and temperature

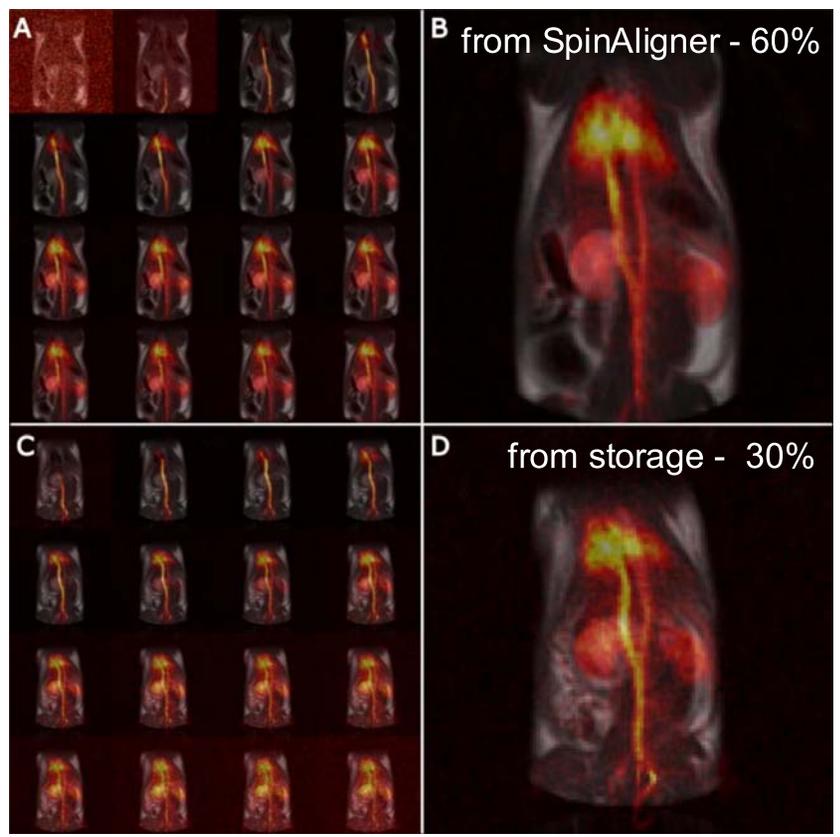


T. Cheng et al, NMR in Biomed. 2020

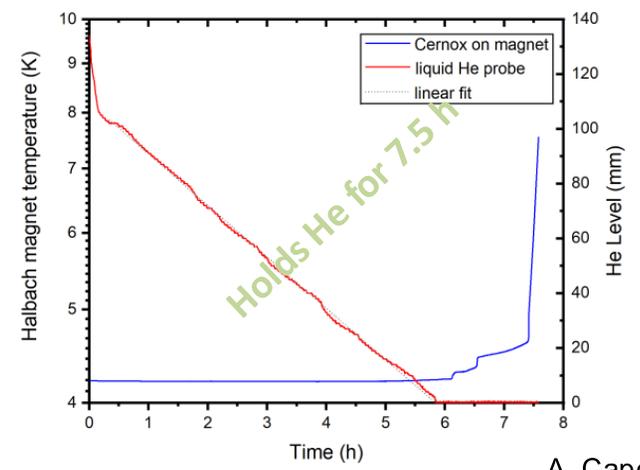
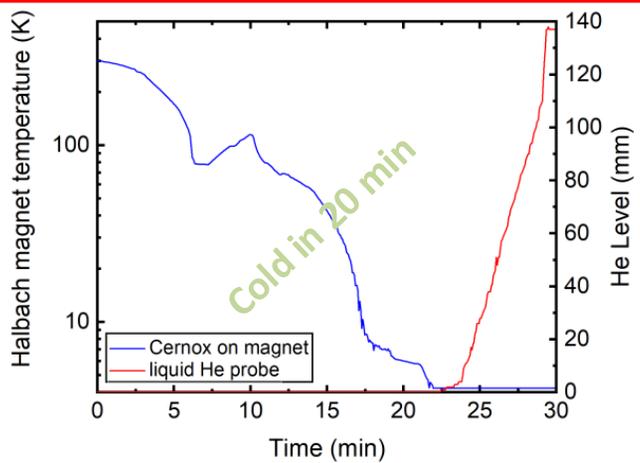
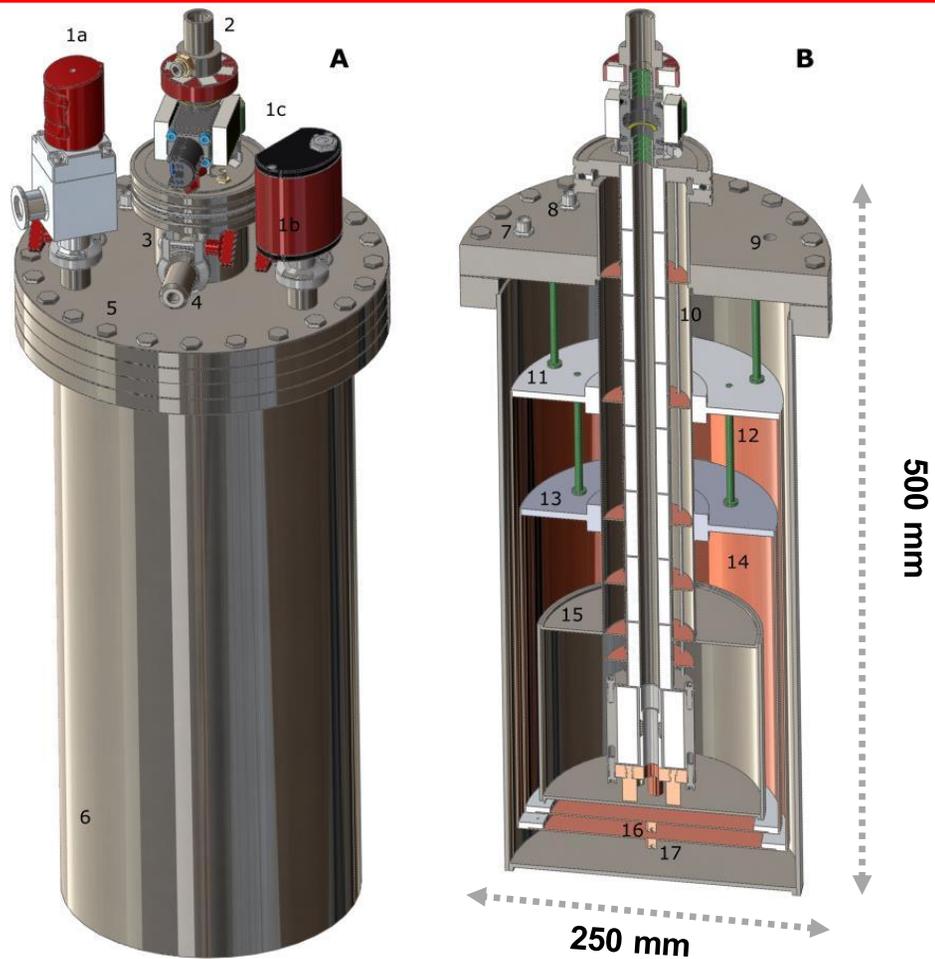
# “Moore’s law” in DNP



# All started by making hyperpolarization transportable

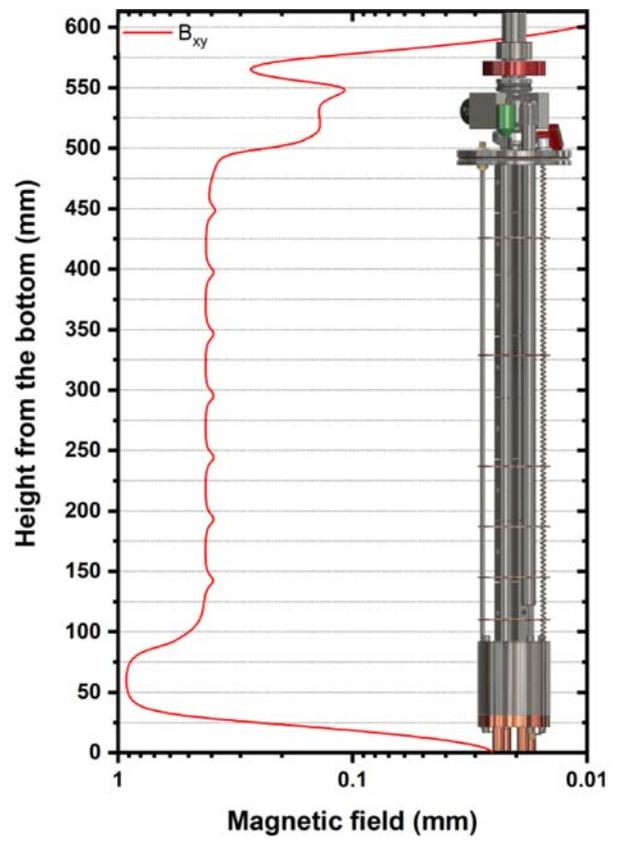
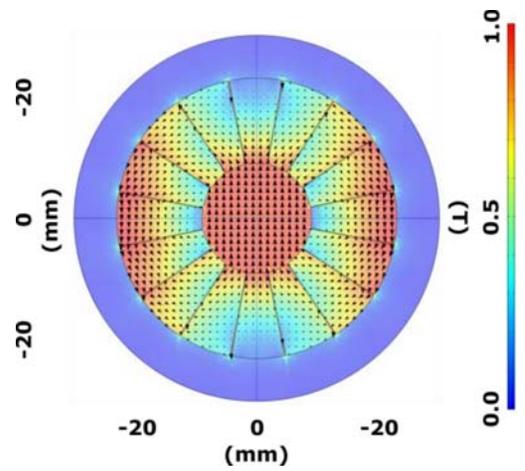
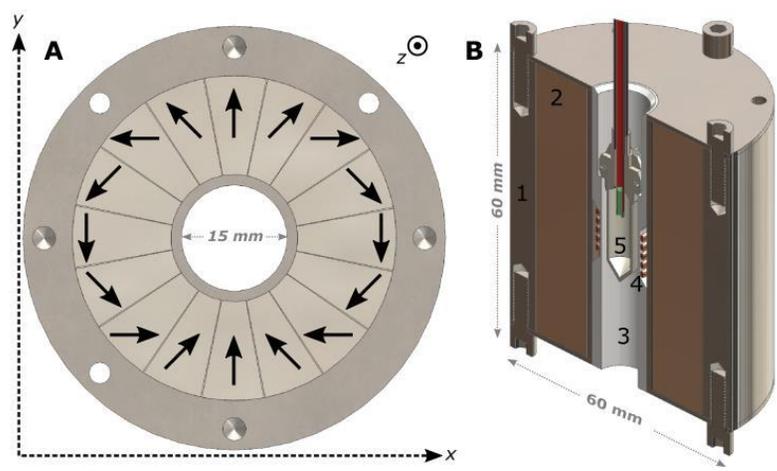


# Evolution of a HP samples transportation device



A. Capozzi, Sci. Rep. 2022

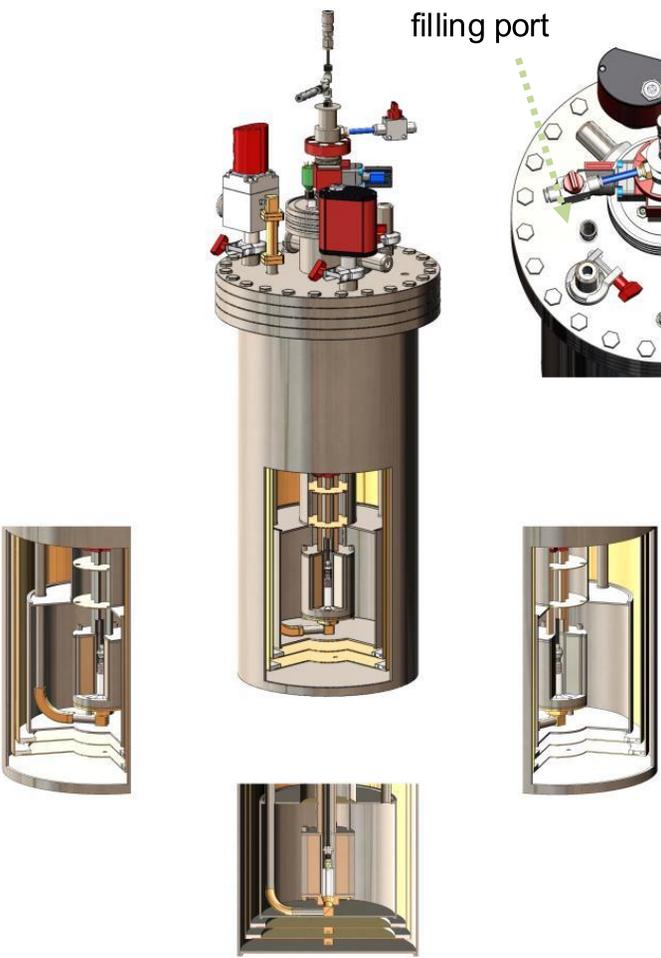
# Evolution of a HP samples transportation device



- Magnetic material SmCo (16 elements)
- OD 60 mm, ID 15 mm
- Field close to 1 T
- Homogeneity 200 ppm (8.5 kHz broad water peak)

A. Capozzi, Sci. Rep. 2022

# Integration of waveguide and microwave source at 25 GHz

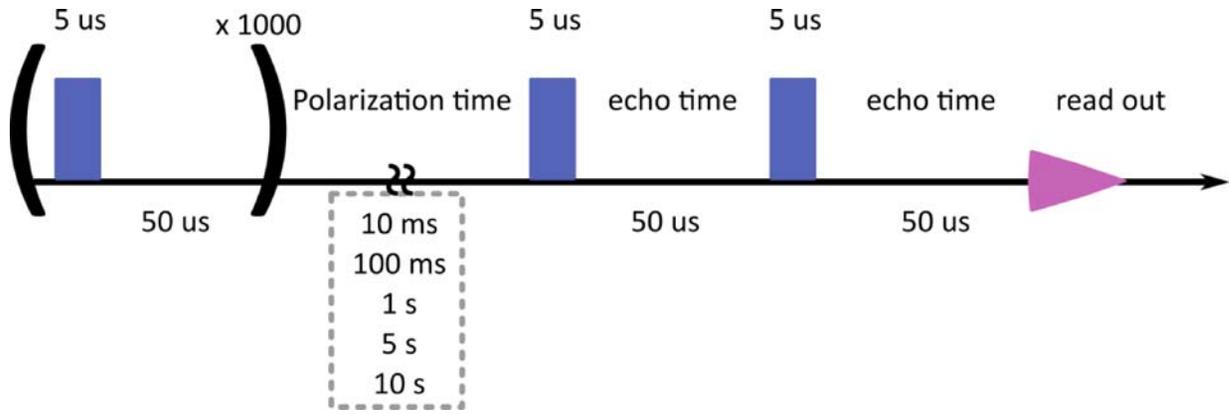


**Setup features:**

- Field: 0.85 T
- Temperature: 77 K, 4.2 K
- Microwaves:  $25 \pm 1$  GHz
- Holding time (4.2 K): 5 h with mw
- Holding time (77 K): 24 h with mw
- Sample volume: up to 300  $\mu$ L
- Integrated dissolution system



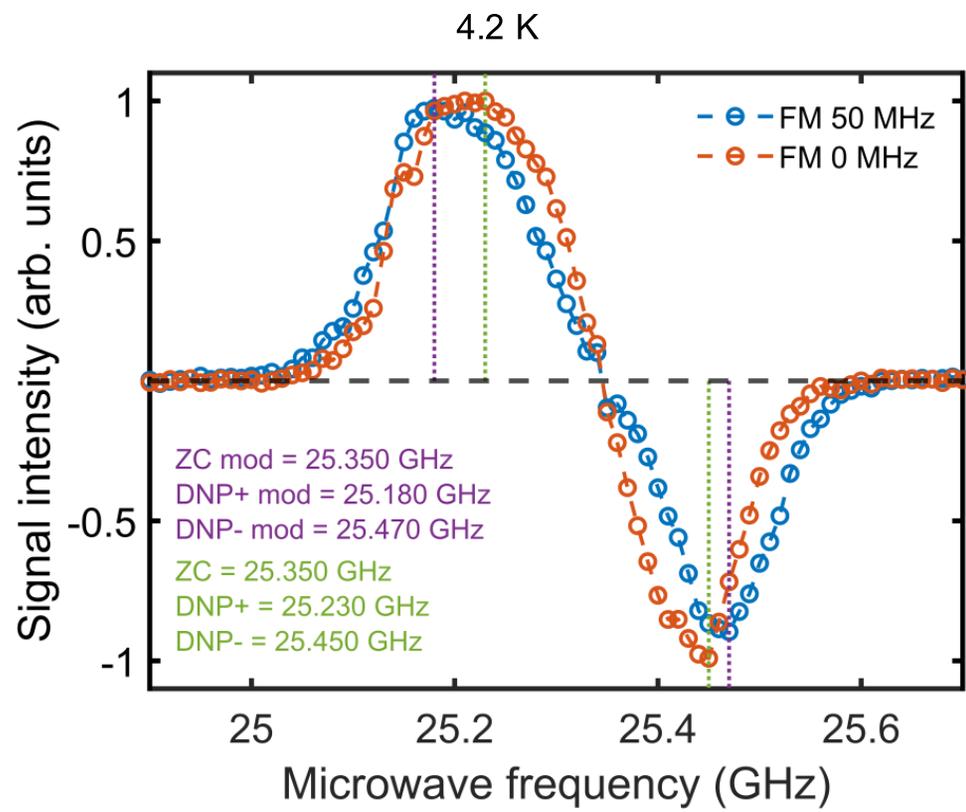
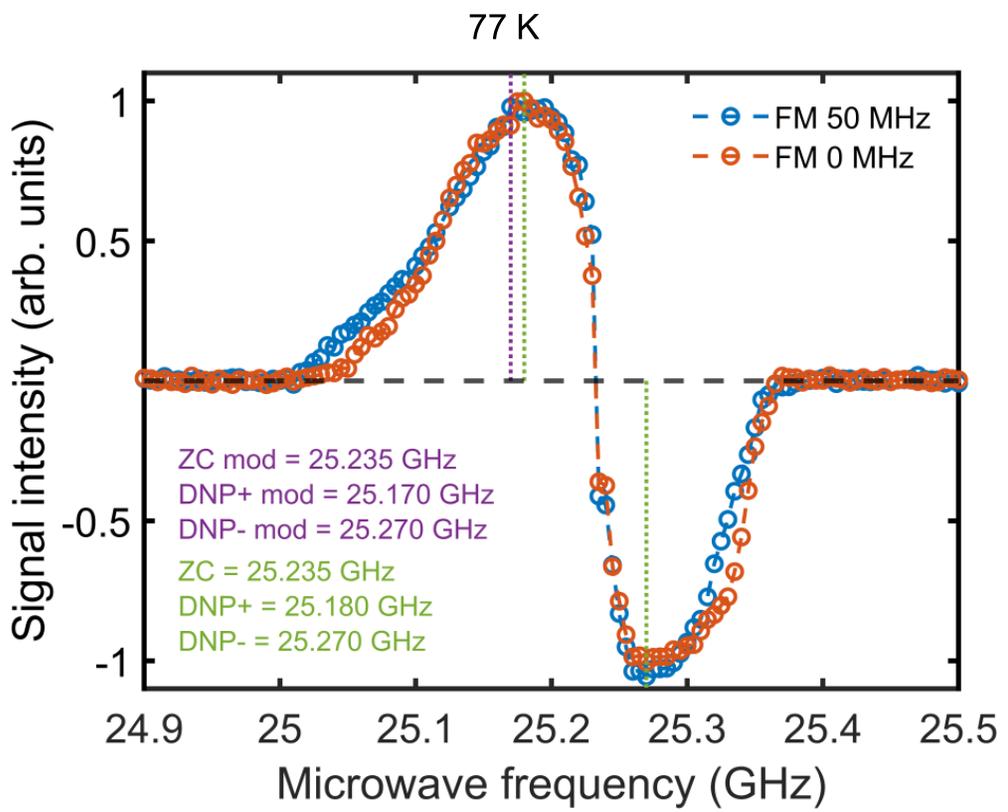
# Materials and methods



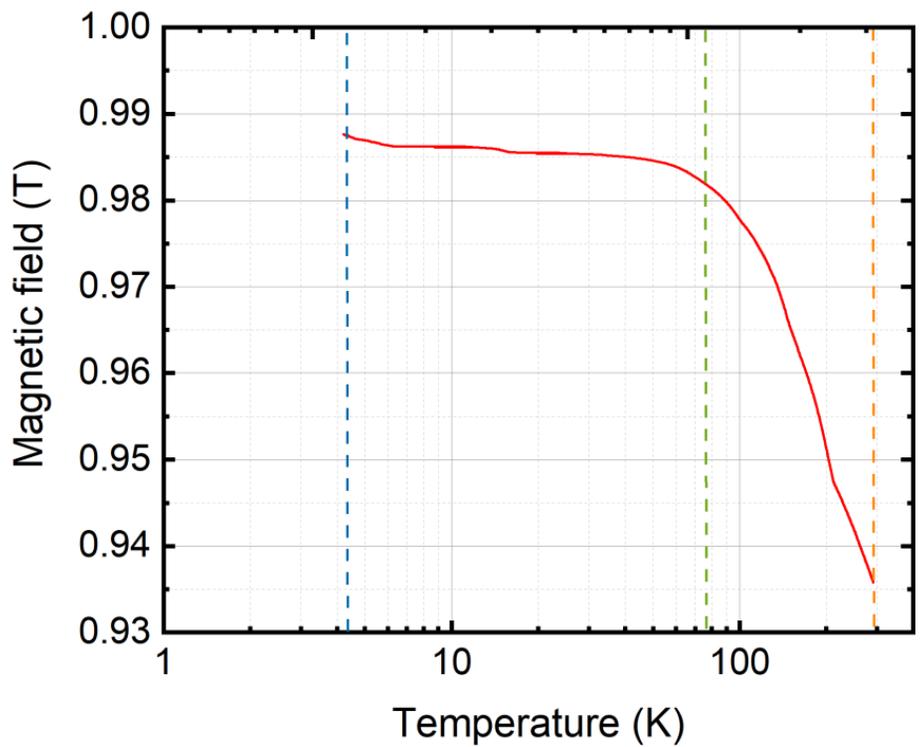
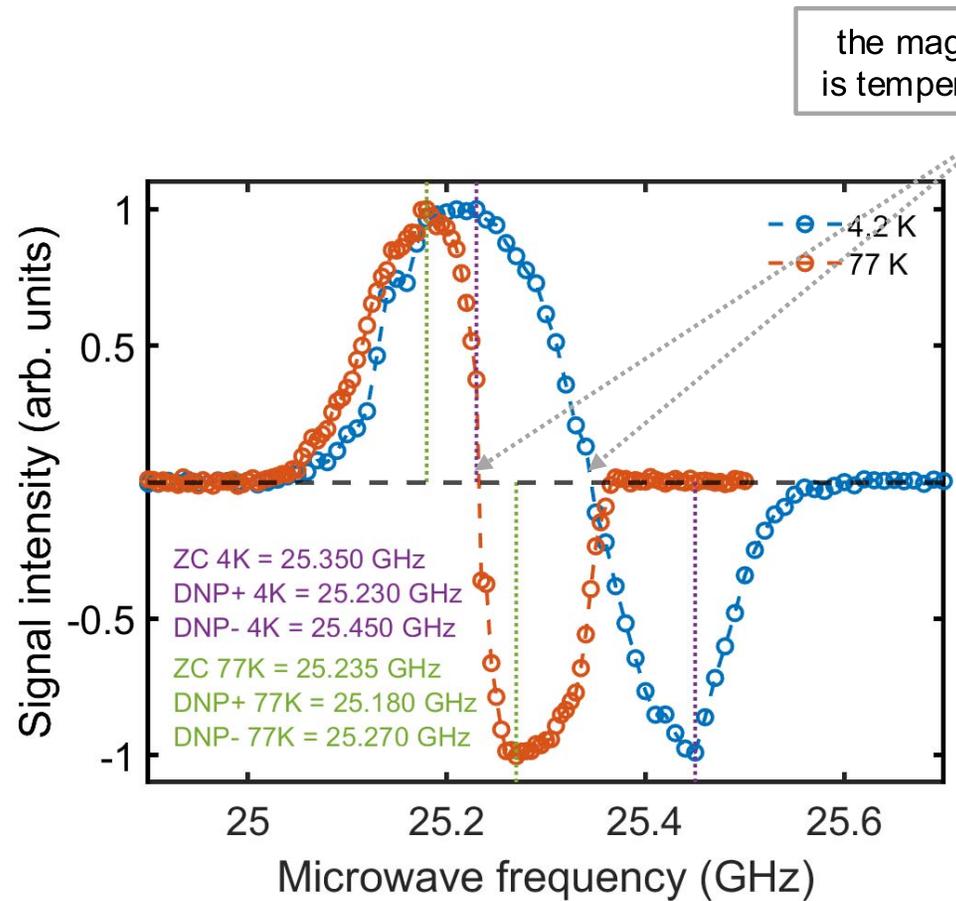
**Max electron polarization**  
15 %

**Sample preparation**  
[d<sub>8</sub>]glycerol:D<sub>2</sub>O:glycerol:H<sub>2</sub>O 45:45:5:5 (v/v/v/v)  
doped with TEMPOL

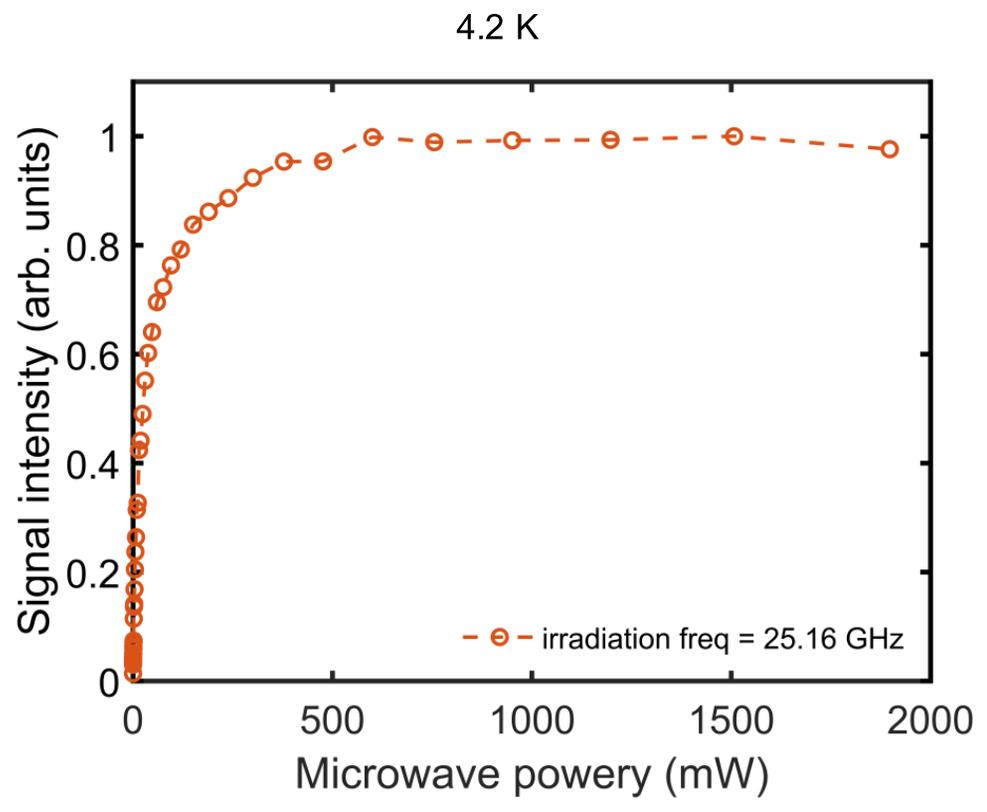
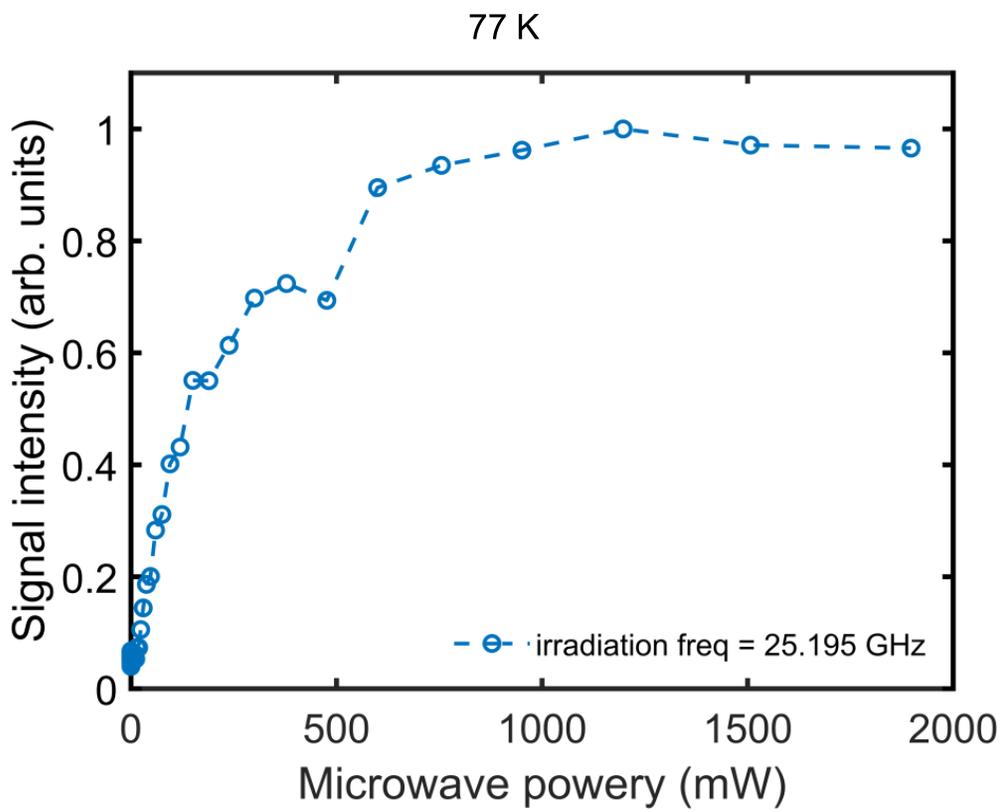
# Microwave frequency sweep



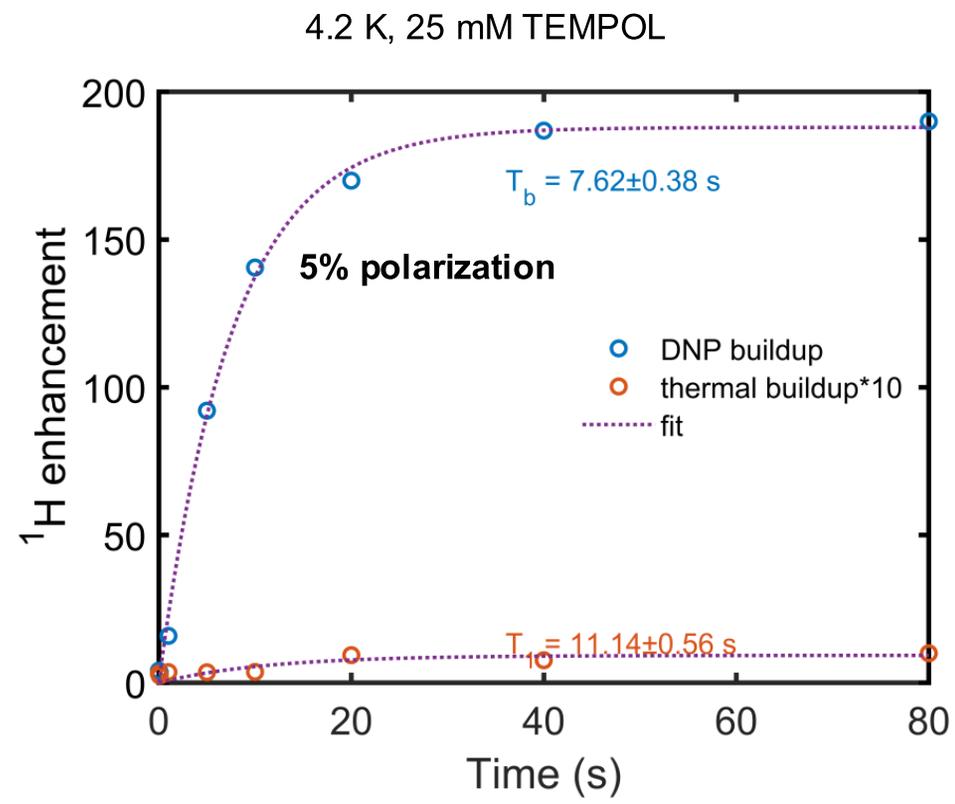
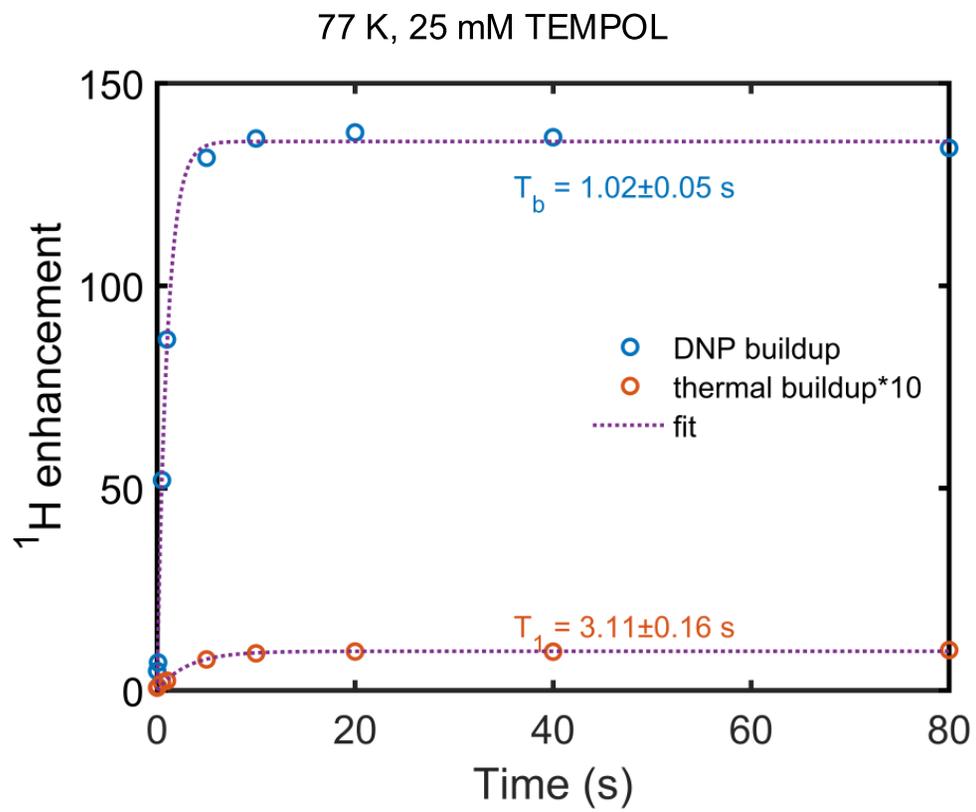
# Microwave frequency sweep



# Microwave power sweep



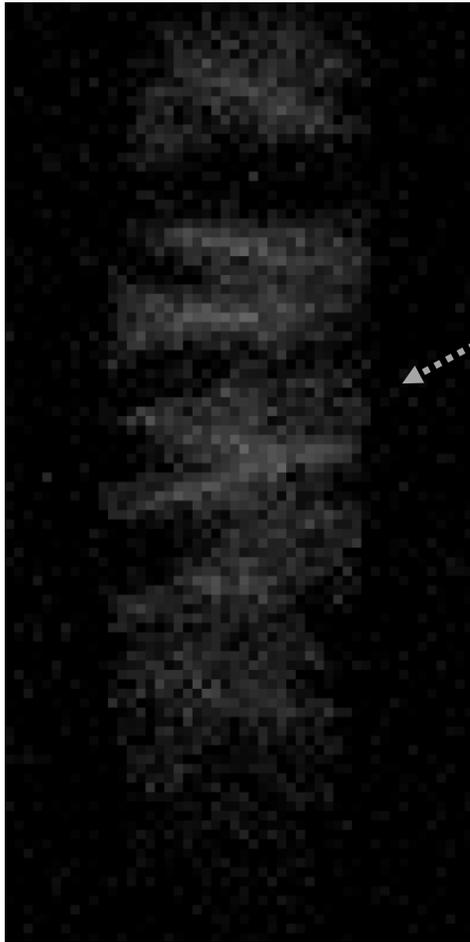
# Polarization buildup



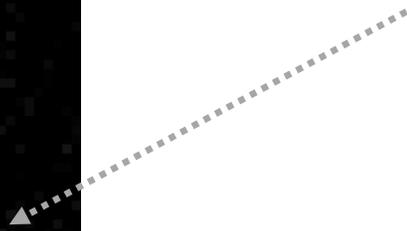
# Is it worth dissolving the sample?



# Is it worth dissolving the sample?



80 mM H<sub>2</sub>O



Gradient-echo sequence, FOV = 25 × 50 mm<sup>2</sup>, resolution = 0.5 × 0.5 mm<sup>2</sup>, FA = 5°, TE/TR = 2.0/6.0 ms, time per frame = 300 ms.

## Take home messages and perspectives

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- If you can live with lower polarization, you can go very fast
- Small dimensions allows to place the polarizer close to the MRI scanner/NMR magnet
- You can train students, nitrogen is safe and costs nothing
- With a membrane pump you can reach 2 K (30% proton polarization)
- Implement cross-polarization
- Make it cryogen free



**EPFL**

Dr Jacques Van der Klink  
Dr Jean-Noël Hyacinthe  
Dr Thanh Lê



Prof Christoffer Lausten  
Dr Esben Søvst Szocska Hansen  
Dr Lotte Bonde Bertelsen

Thanks for your attention



Prof Mathilde Lerche  
Dr Magnus Karlsson  
Prof. Jan Henrik Ardenkjaer-Larsen



Dr Arnaud Comment  
Dr Adam Gaunt

Hyperpolarization training course, Aarhus University

# Radical titration at 77 K

