Polarized Neutrons JRA

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Tasks of the Polarized Neutron JRA

Wide angle polarization analysis – more and more interest today and becomes one of key issues for the ESS instrumentation.

Further developments of high resolution (E or Q) instruments (NSE techniques) – towards 1 μsec and 30μm

New approaches / instrumentation using polarized neutrons

Tasks of the Polarized Neutron JRA

Wide angle polarization analysis – more and more interest today and becomes one of key issues for the ESS instrumentation.

Further developments of high resolution (E or Q) instruments (NSE techniques) – towards 1 μsec and 30μm

New approaches / instrumentation using polarized neutrons

(Full) polarization analysis for large area detectors; high-performing ^3He analyzers

New correction elements for NSE spectrometers/diffractometers, MIEZE, wide-angle NRSE

Beam tailoring (neutron pulses of nearly arbitrarily short duration); measurements of the three-point correlation function

Here only a few examples of the partners' activities will be given

The Polarized Neutron JRA relies heavily on MC simulations with polarized neutrons.

✓ during last years VITESS capabilities were significantly extended

⇒ MC simulations of spin dynamics in complex (time-dependent) magnetic fields

⇒ simulations of complex spin handling devices.

✓ since 2 years McStas also turned to simulations with polarized neutrons and develops the primary approach with an accent on samples

For simulation of real devices one should measure/calculate actual magnetic field distributions

→

Calculation of magnetic fields using the commercial FEM software (e.g. ANSYS, RADIA, MagNeT, etc.)

↓

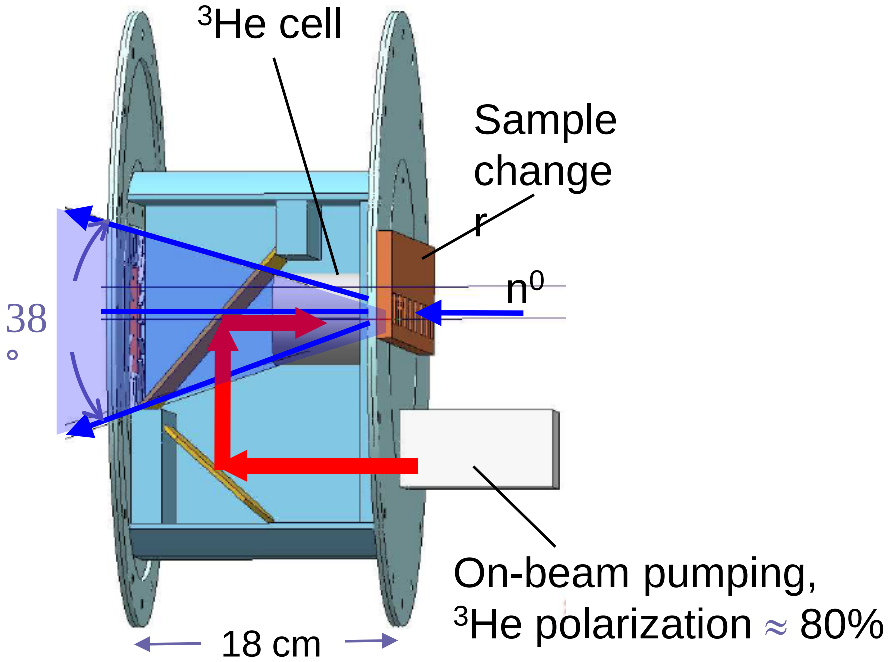
Methods of the import of measured magnetic field maps and FEM calculated data have been developed in VITESS.

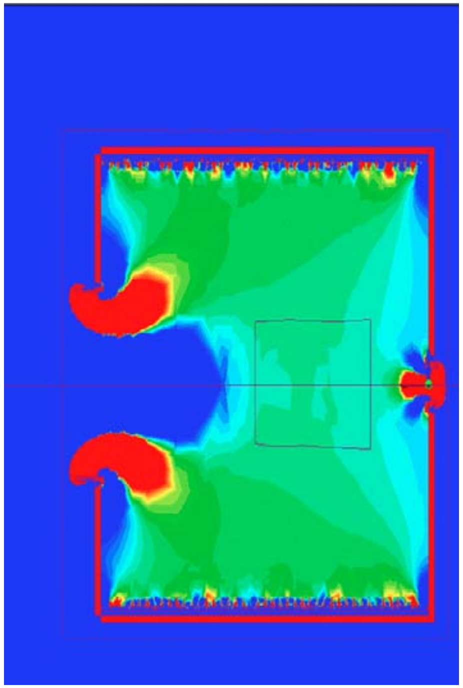
✓ Because of complexity of FEM simulations, most partners will not become expert users and should be supported in these activities.

✓ Such support is provided by dedicated scientists hired in the frame of the JRA; they are also developing new modules for simulations of the polarized neutron instruments

A compact on-beam SEOP analyser for SANS (for non-magnetic samples):

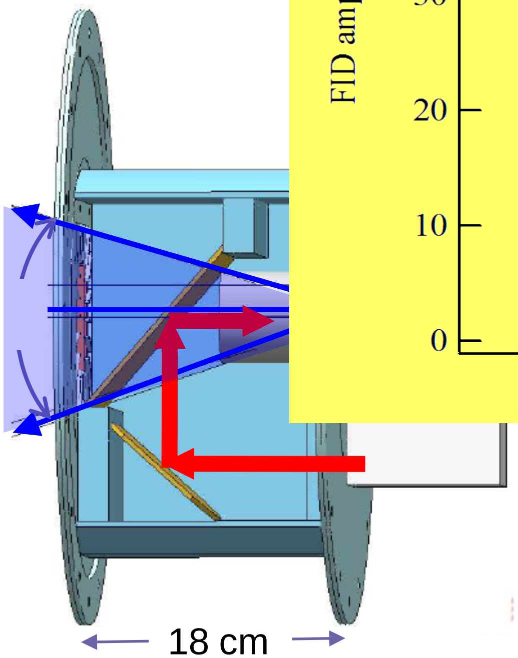
- A few cm between the sample and ^{3}He cell, about 80cm to the PSD
  $\Rightarrow$ a wide-angle $\Rightarrow$ $Q_{max} \approx 1 Å^{-1}$
- Precise calculations of magnetic fields created by a complicate system of coils and magnetic screens by the MagNeT FEM software

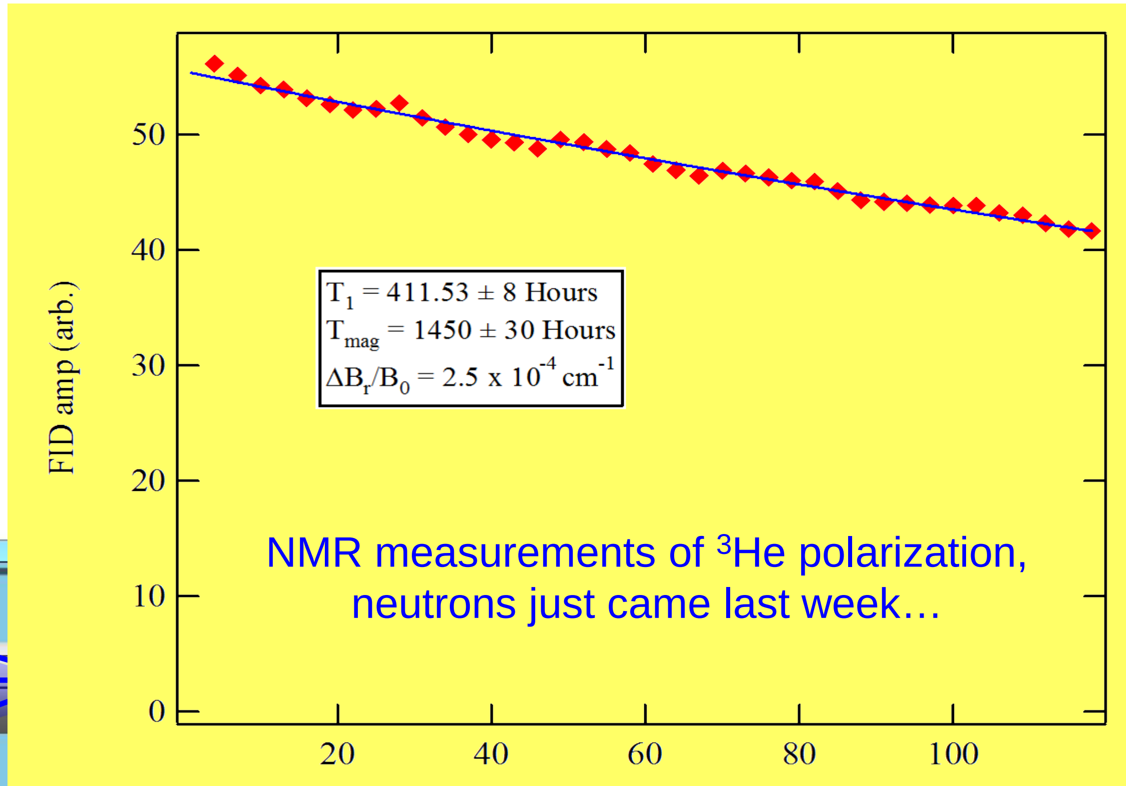


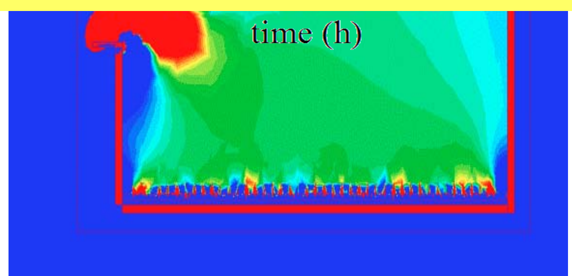


Large solid angle polarization analyzers and spin-handling devices.

A compact on-beam SEOP analyser for SANS:





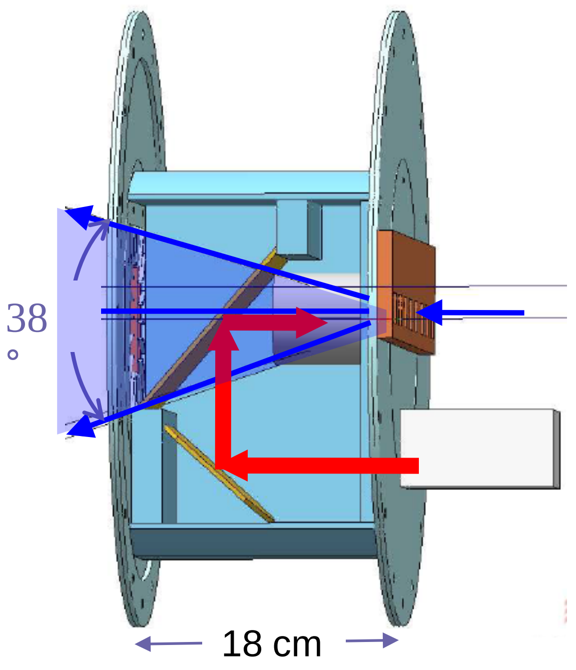


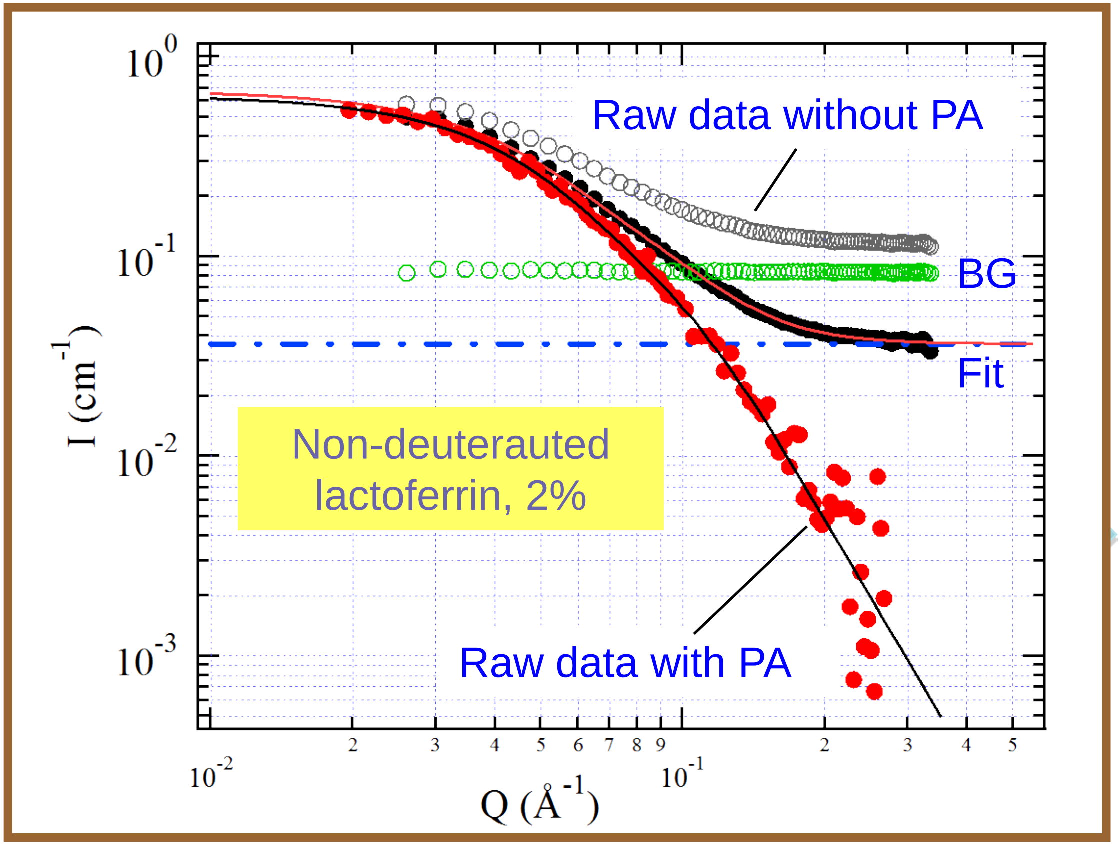
NMR measurements of ^3He polarization, neutrons just came last week…

The prototype device

Separation of coherent/incoherent scattering

At large Q the scattering is dominated by incoherent „background“
1D polarization analysis allows separation of the coherent signal

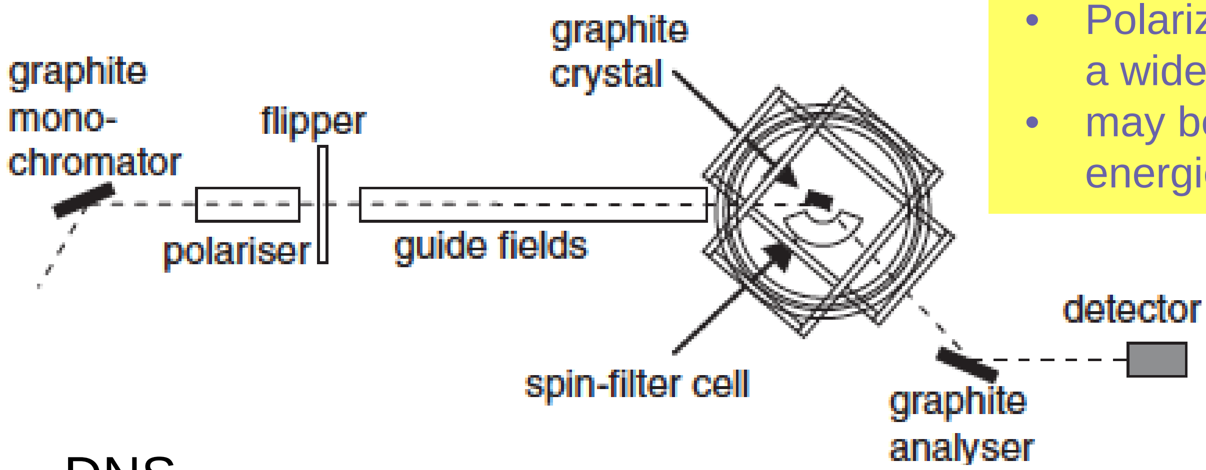




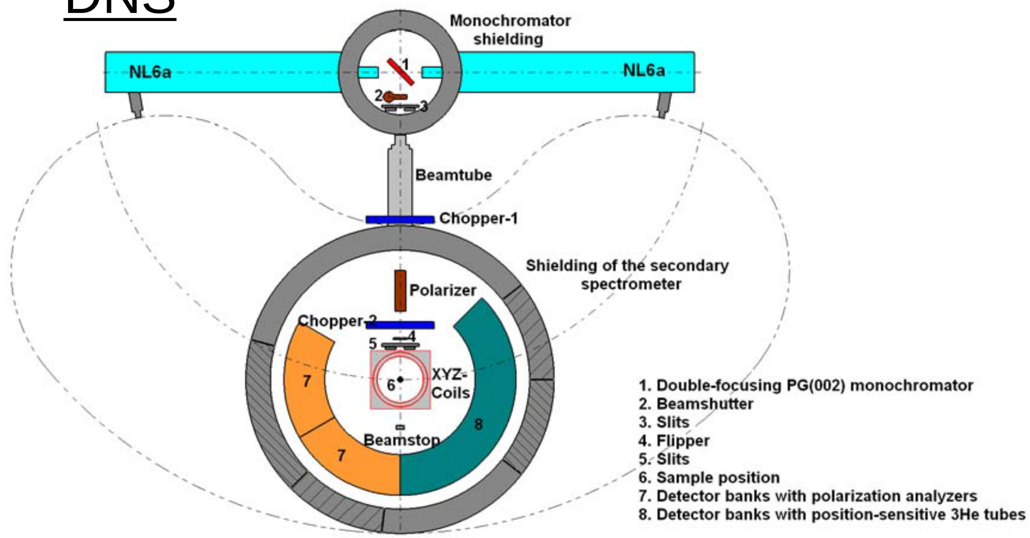
Large solid angle polarization analyzers and spin-handling devices.

PASTIS: J. R. Stewart et. al., Physica B385 (2006) 1142.

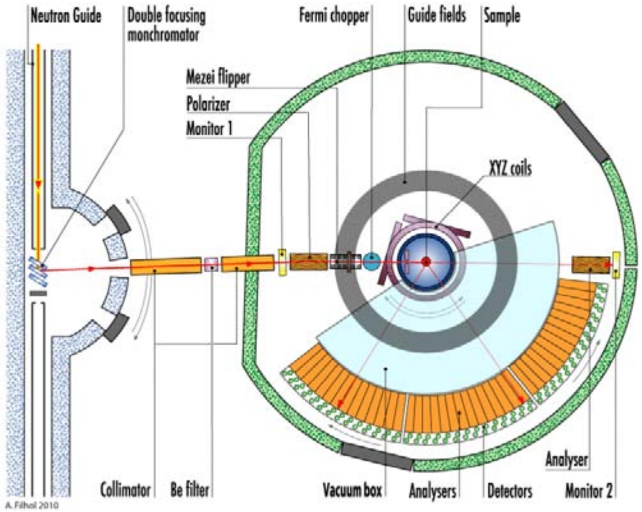
- Polarization analysis via PASTIS* with a wide angle ^3He NSF
- may be only suitable option at thermal energies



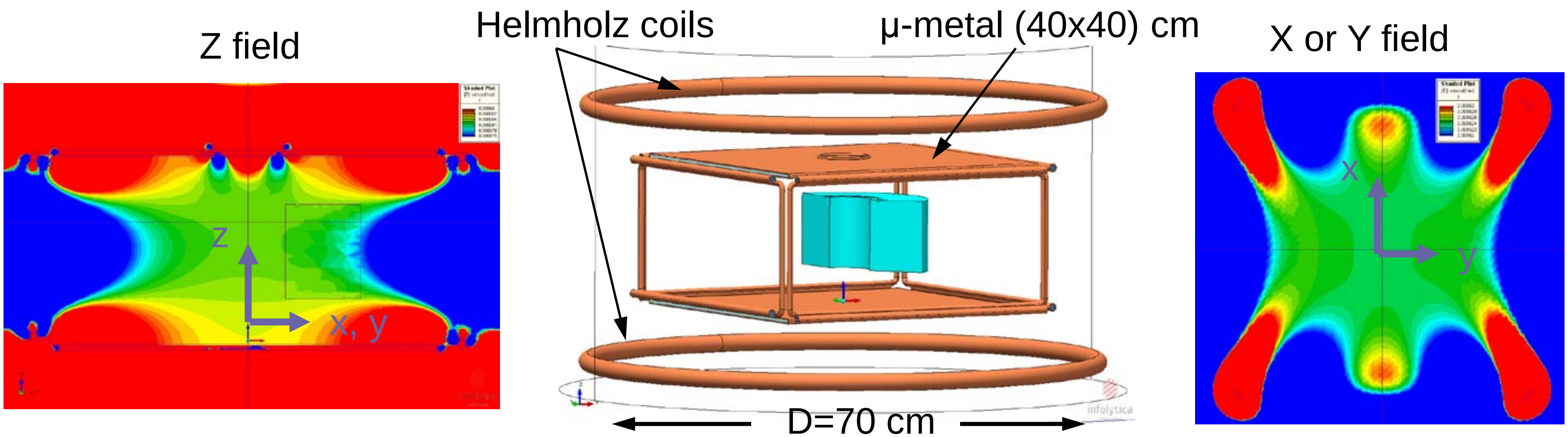
DNS



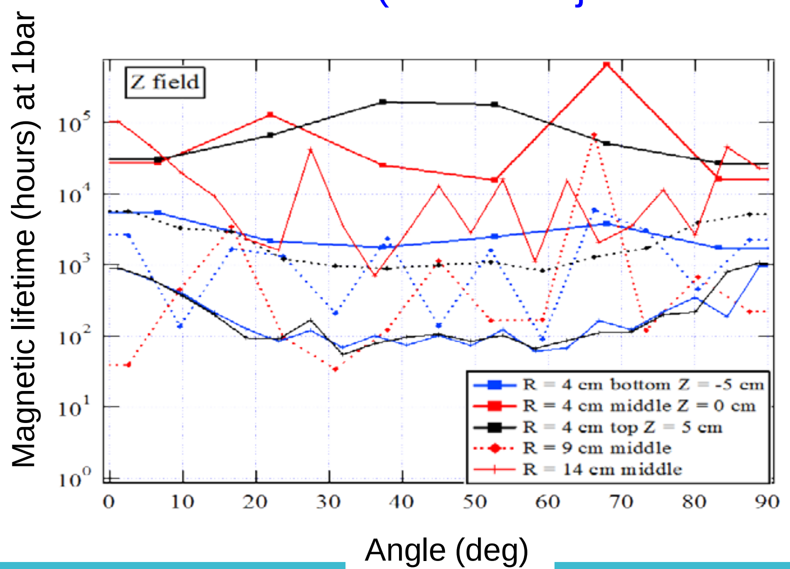
D7

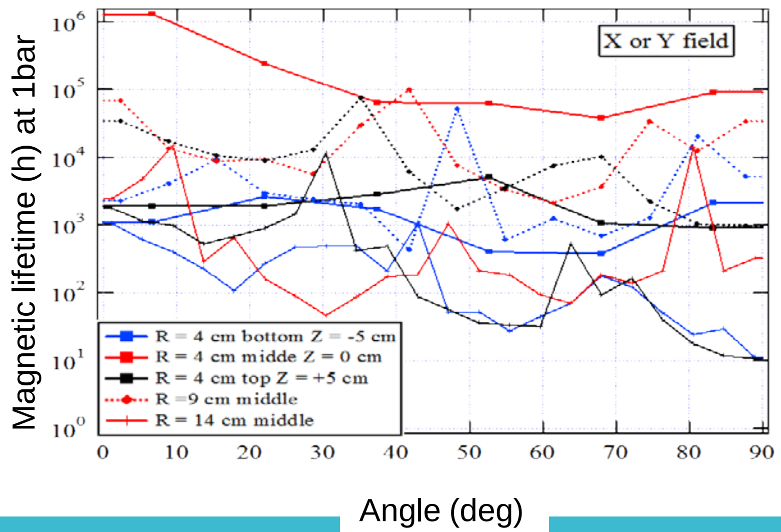


PASTIS: a new approach

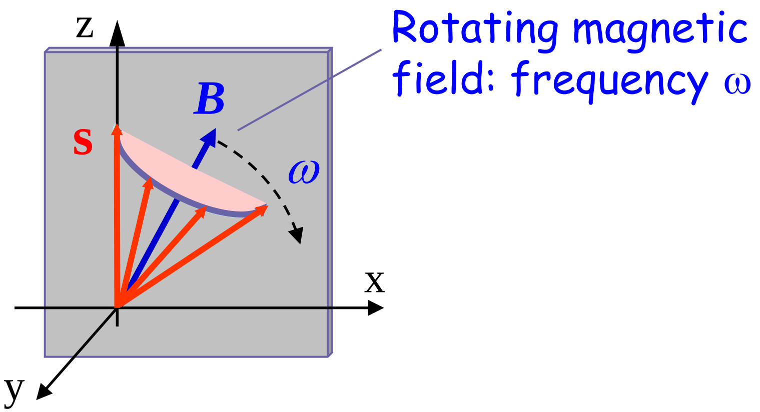


Vertical opening = 45°, horizontal opening 90°, without dead spot
(can be adjusted to instrument (>90°), e.g. rectangular shape)



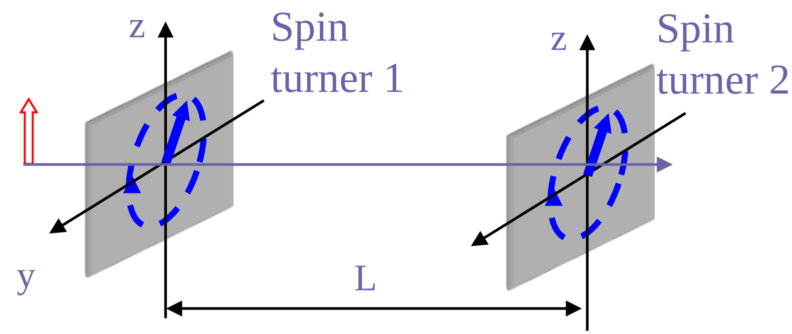


Thin spin turner

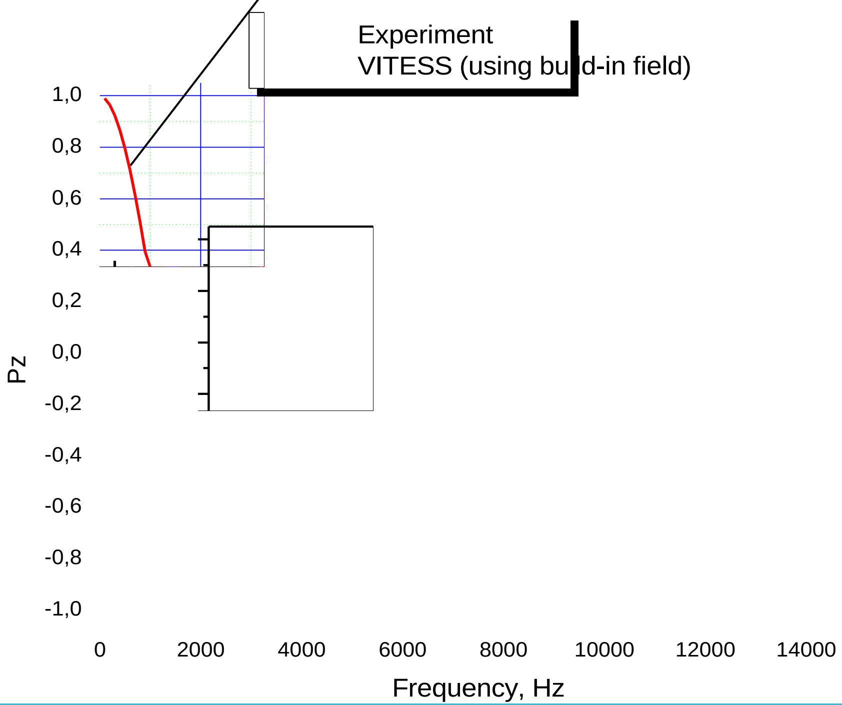


$$\varphi = \omega_L \tau = \gamma B d / v_n = \pi$$

Spin vector returns in the *xz* plane: the neutron clock



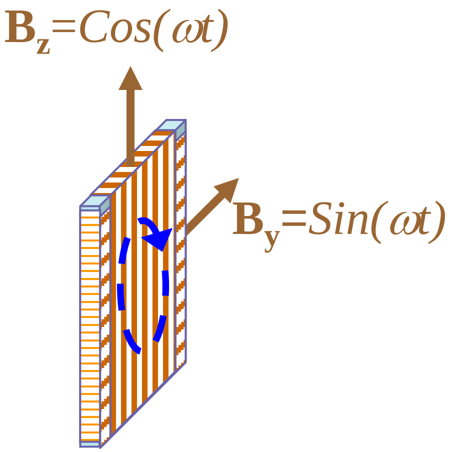
$$P_z(\omega) = \cos(2\omega \frac{m_n}{h} L\lambda)$$

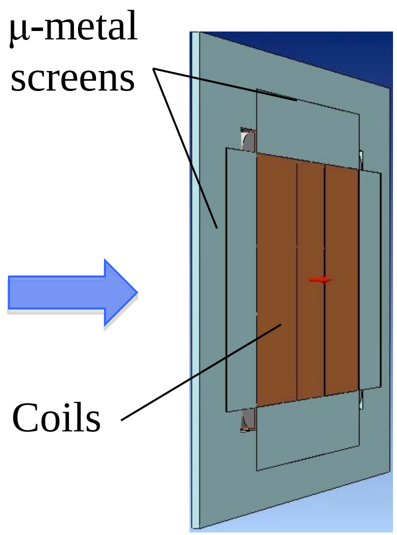


Experiment:
where is the high-frequency limit for such system?

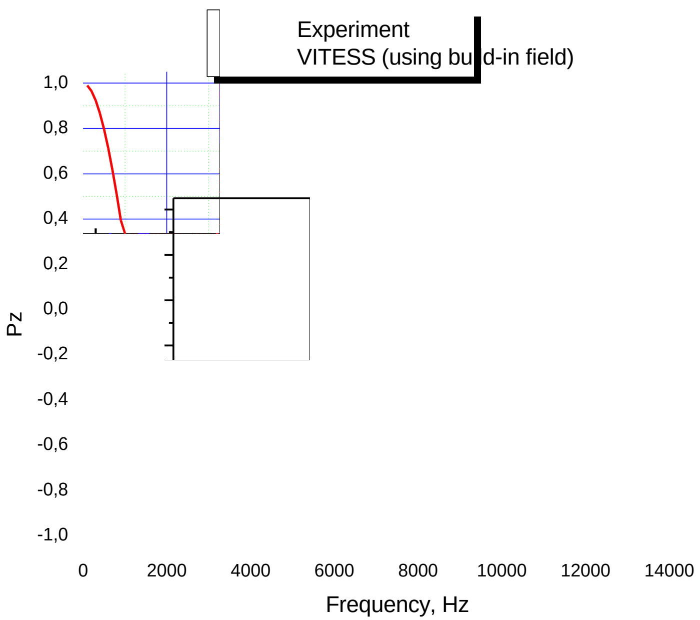
First, we are far way from ideal case:
⇒ to realistic magnetic field distribution

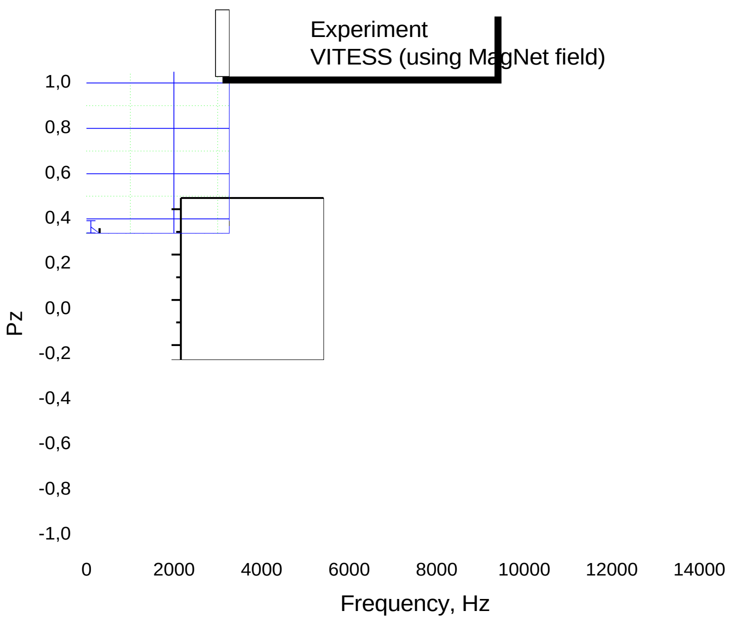
Magnetic field distributions: import



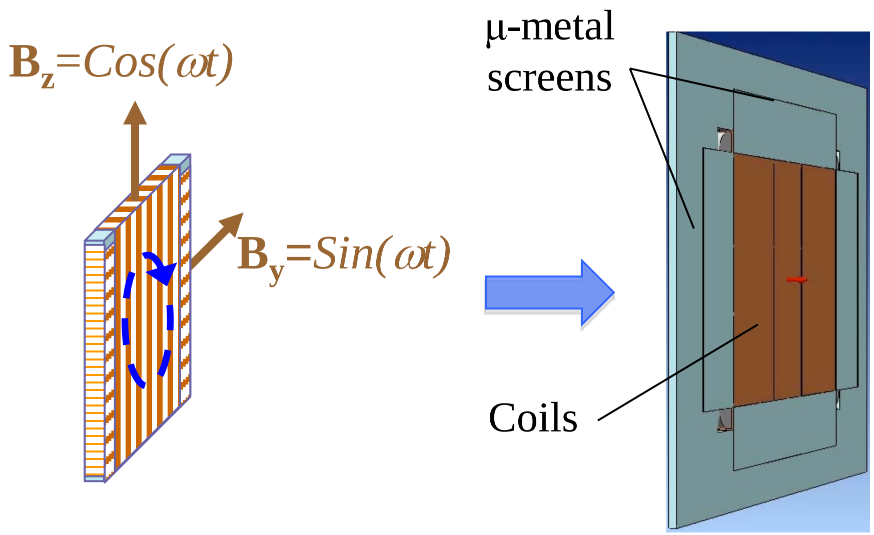


- Calculations of the magnetic field distribution from coils and μ-metal screens by MagNet software (www.infolytica.com)
- Simulations of the neutron spin dynamics by VITESS





Magnetic field distributions: import



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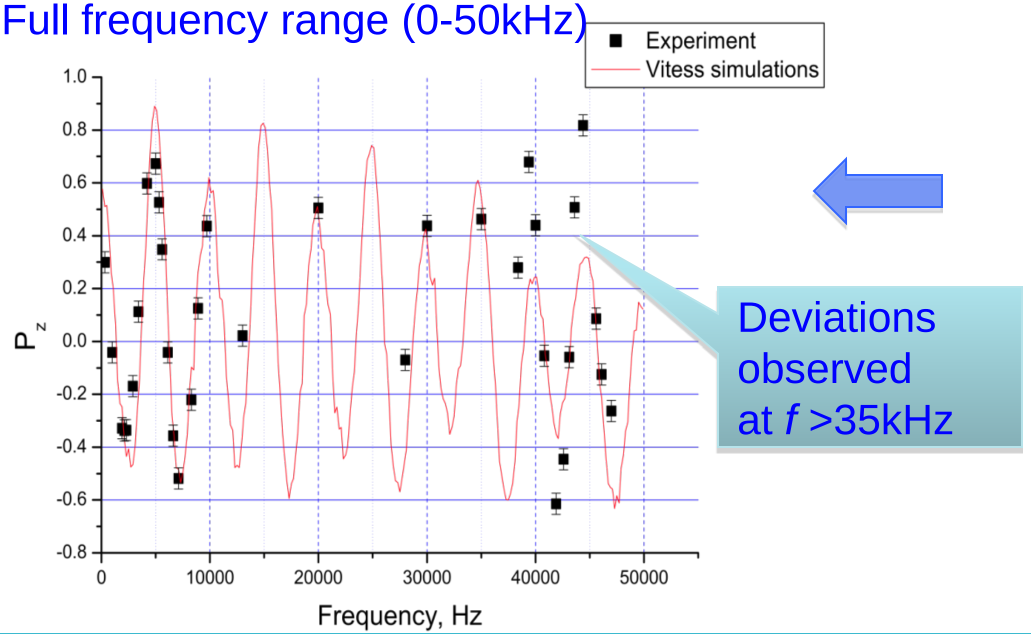
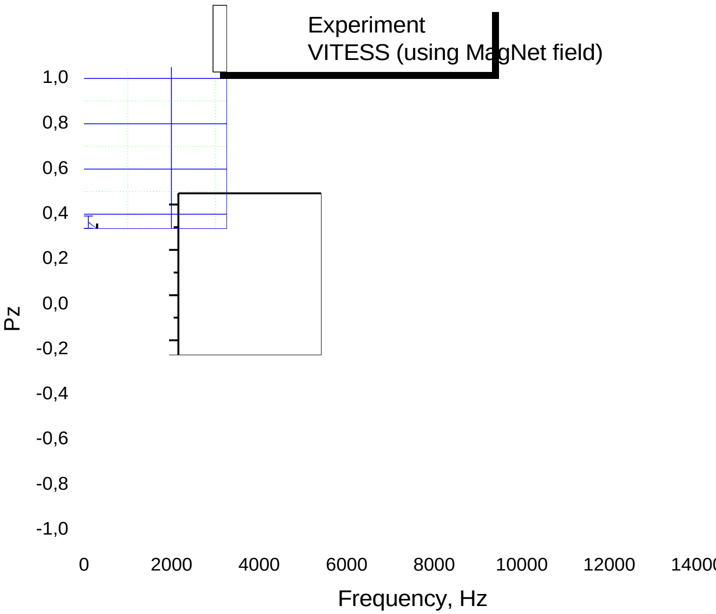
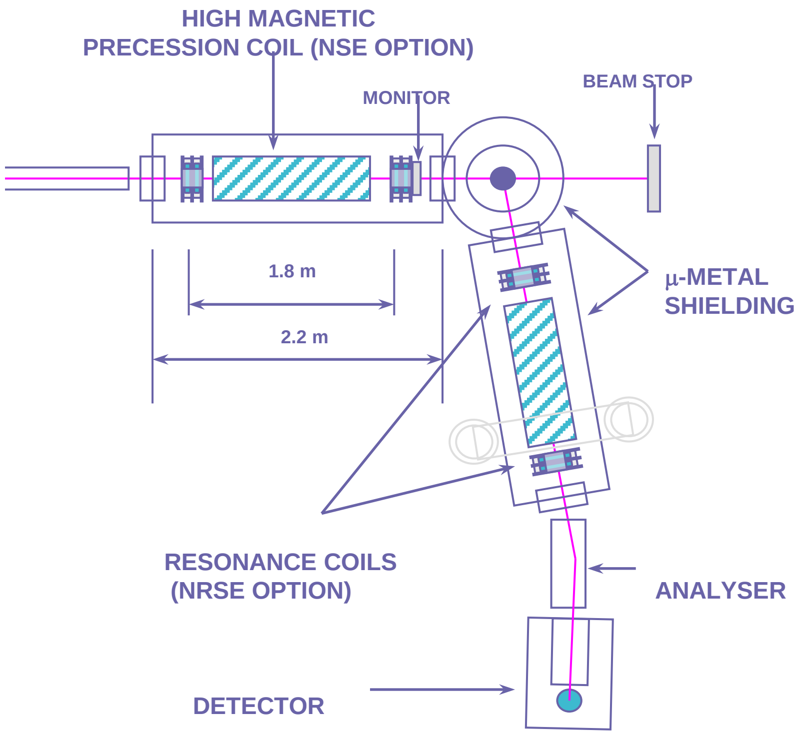
Full frequency range (0-50kHz)



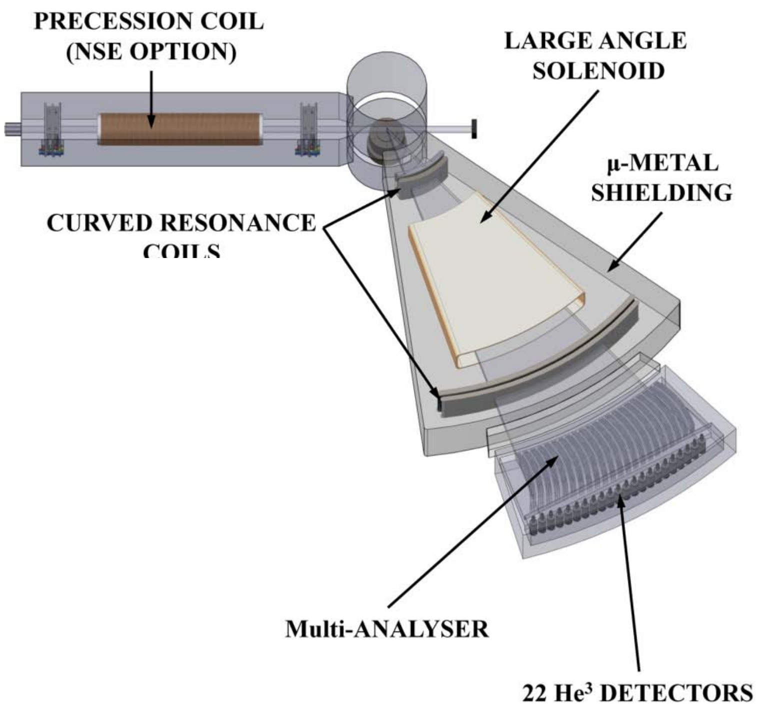


Developments of wide-angle NRSE

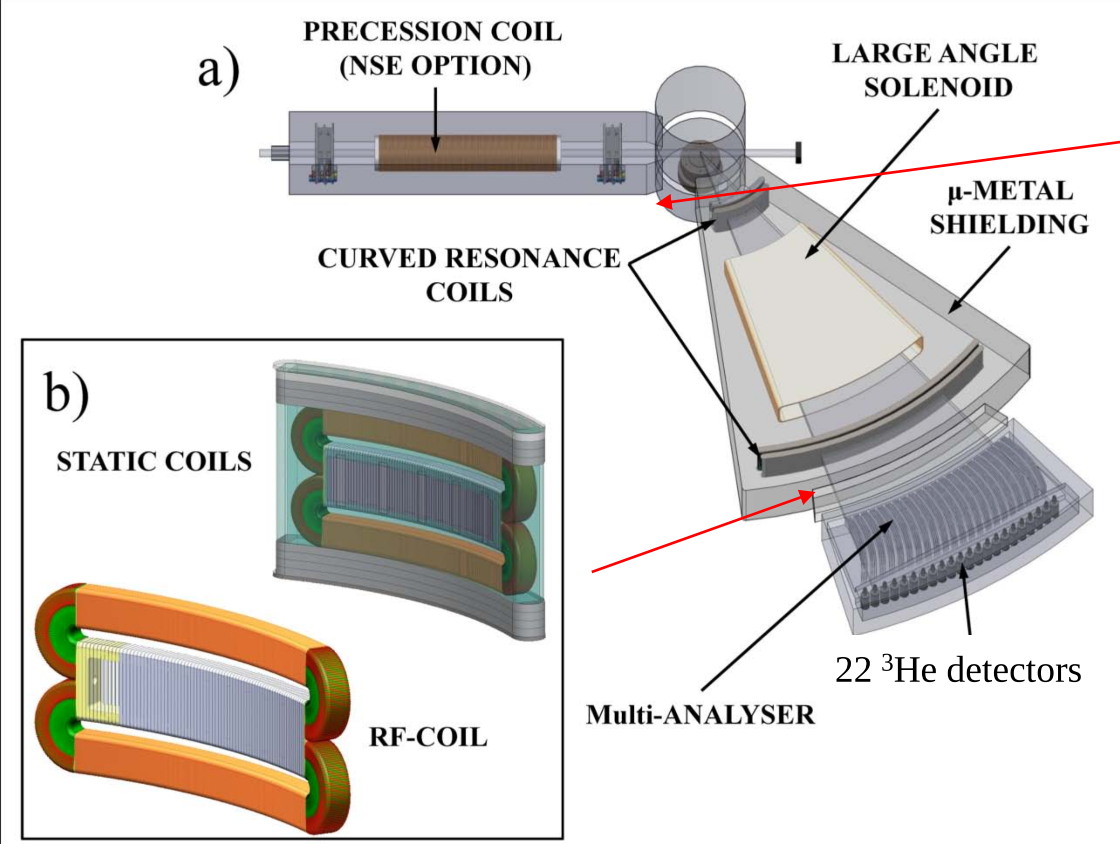


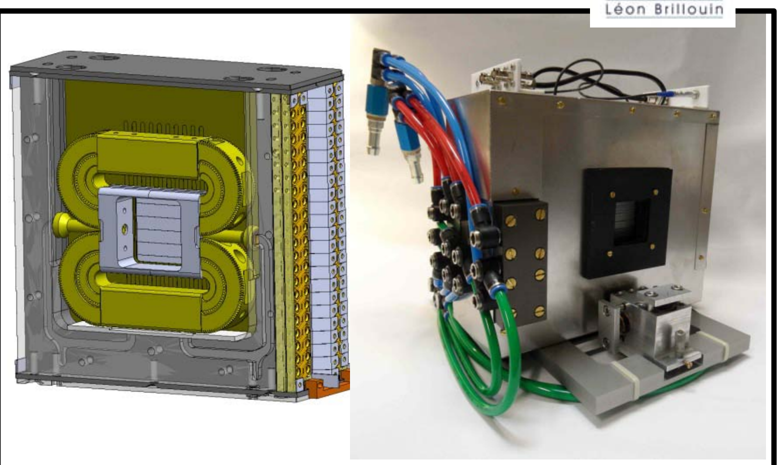
Standard NRSE

Wide-angle NRSE

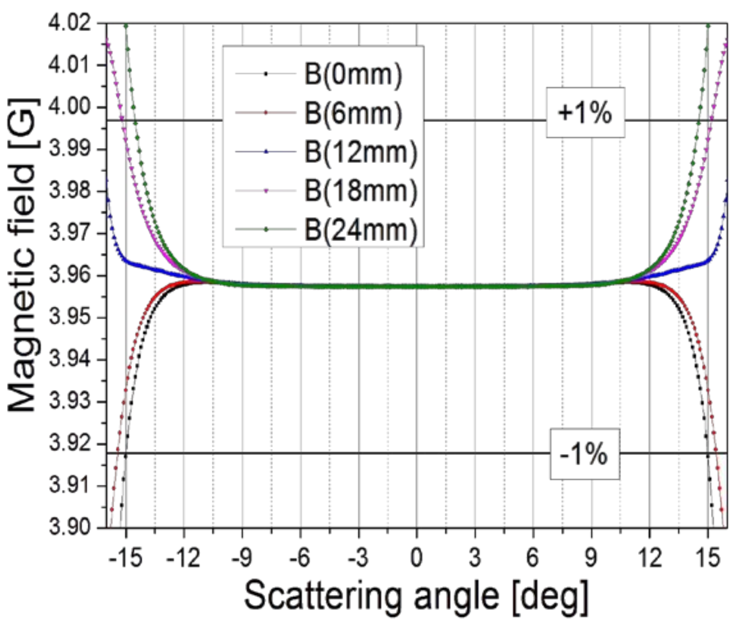


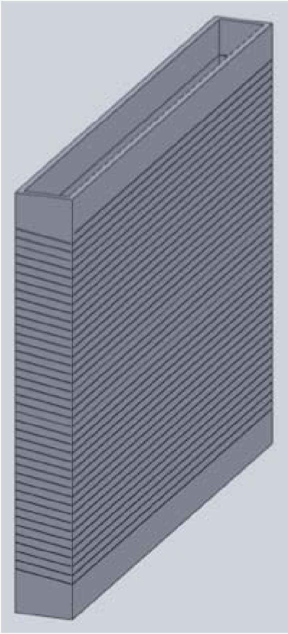
Wide angle RF coils for NRSE



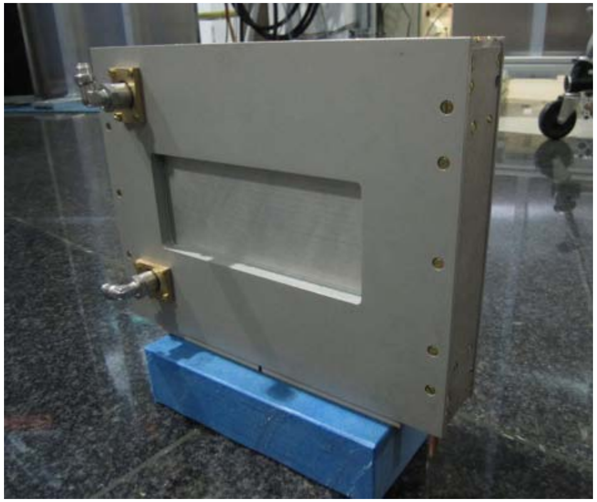


$\omega/2\pi$ =1 MHz, B_o=350 Gauss

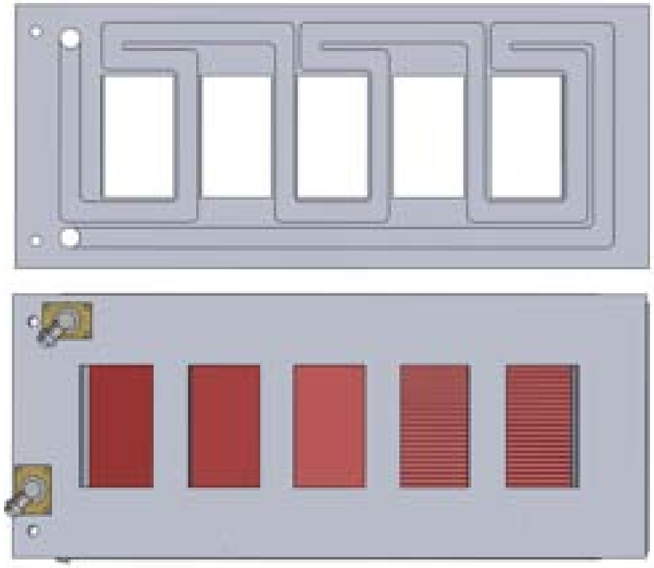




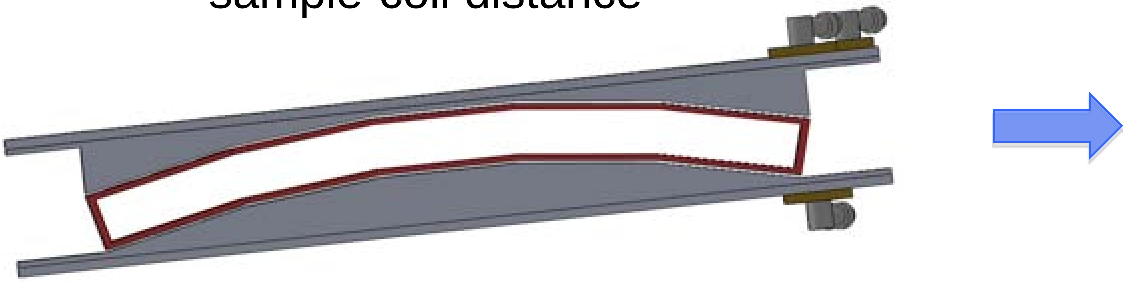
- Coil cut from solid body
- Current step concentrated at one coil side



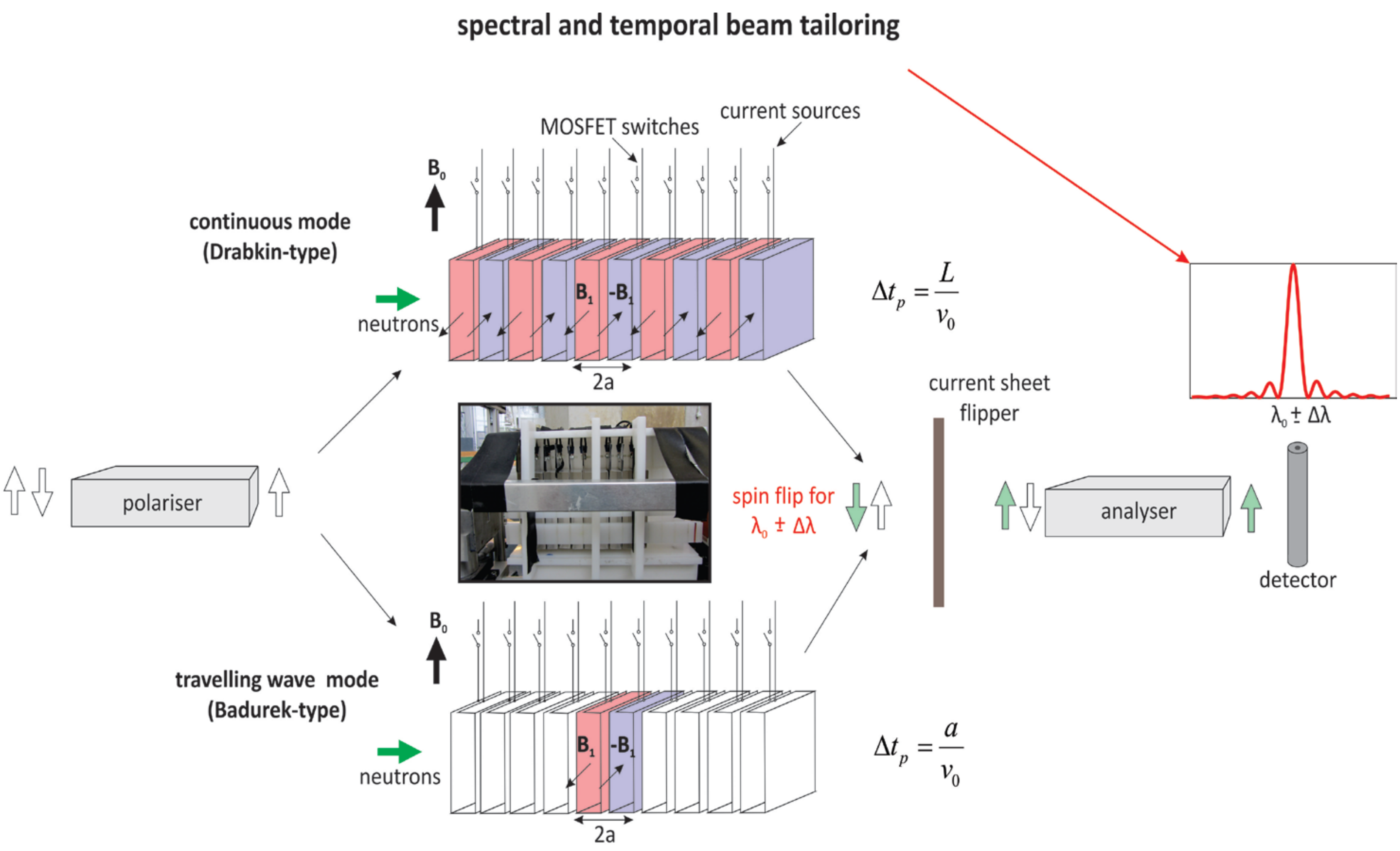
Water Cooling:
– Cooling plates on both sides
– Neutron "windows"



LSA coil with segments for large sample-coil distance



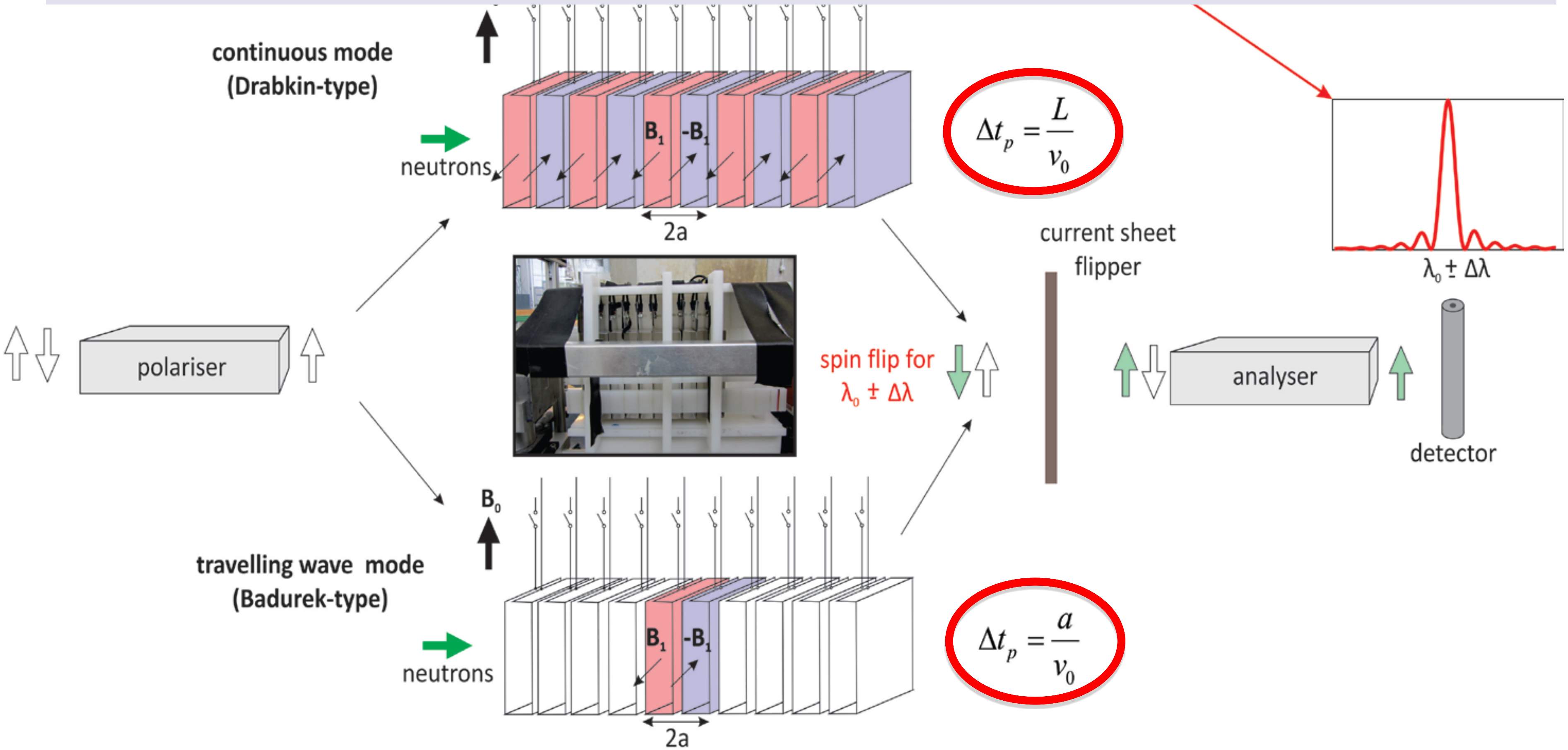
Pulsed neutron spin resonator



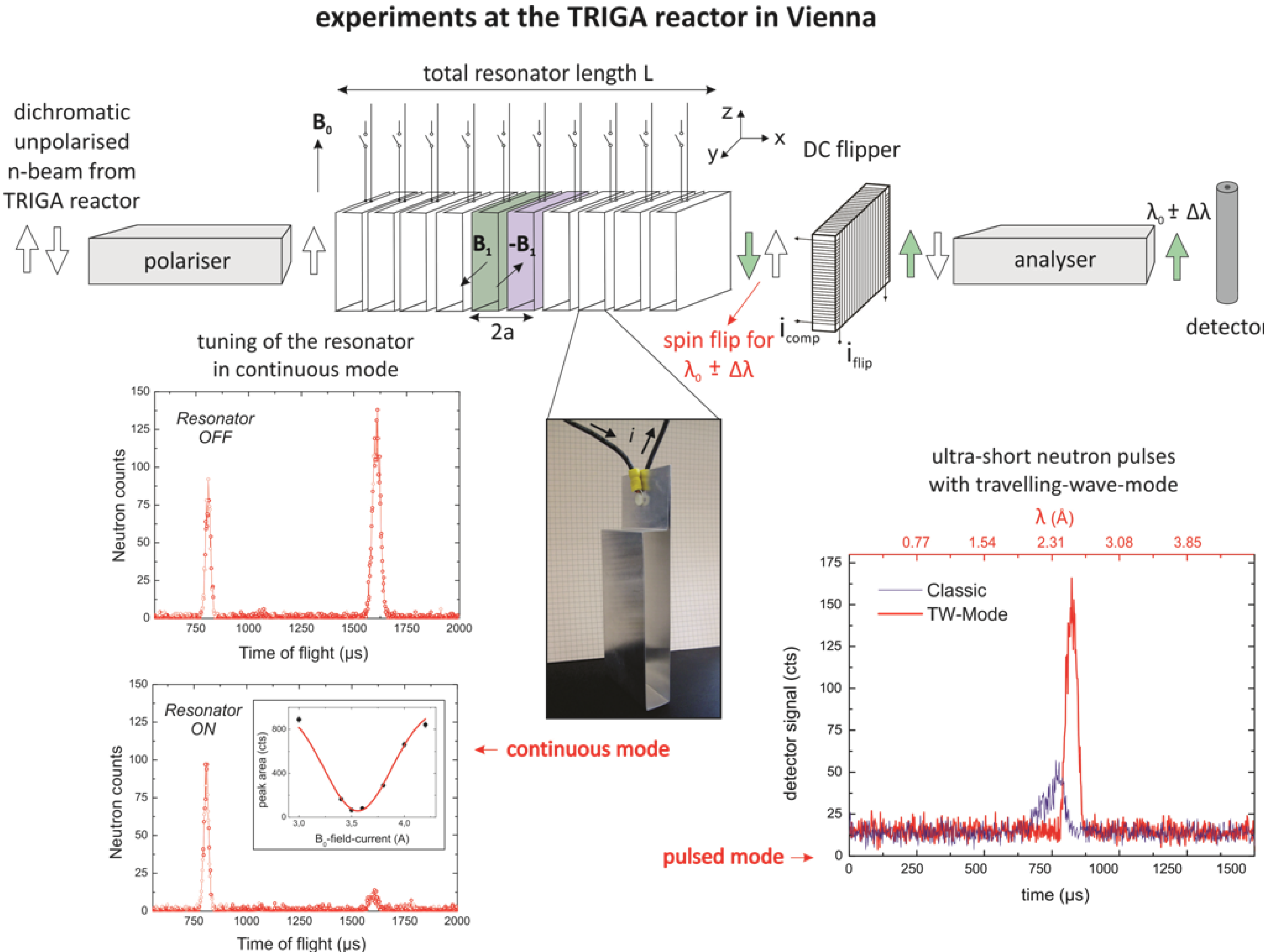
Pulsed neutron spin resonator

spectral and temporal beam tailoring

A `travelling wave' mode: should allow to produce much shorter pulses and to decouple the minimal neutron pulse width from the achievable wavelength resolution, which for given resonator period 2a depends on its total length L.



Pulsed neutron spin resonator



Conclusions

There is a good progress in all planned activities.

A number of remarkable results are achieved and still many to come.

Thank you for your attention!