New High Field Magnet for Neutron Scattering at the Berlin Neutron Scattering Center (BENSC)

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Status of Instrument ExED and Magnet System

Peter Smeibidl

Scientific Perspectives of Neutron Scattering in High Magnetic Fields

Examples:

- **Strongly antiferromagnetic correlated quantum phenomena:**

High-T_c-superconductors:	**30 – 40 T at least**
Heavy fermions:	**22 T (UPt_3), 38T (URu_2Si_2)**
Low dimensional AF:	**20 - 40 T (new quantum-groundstates)**

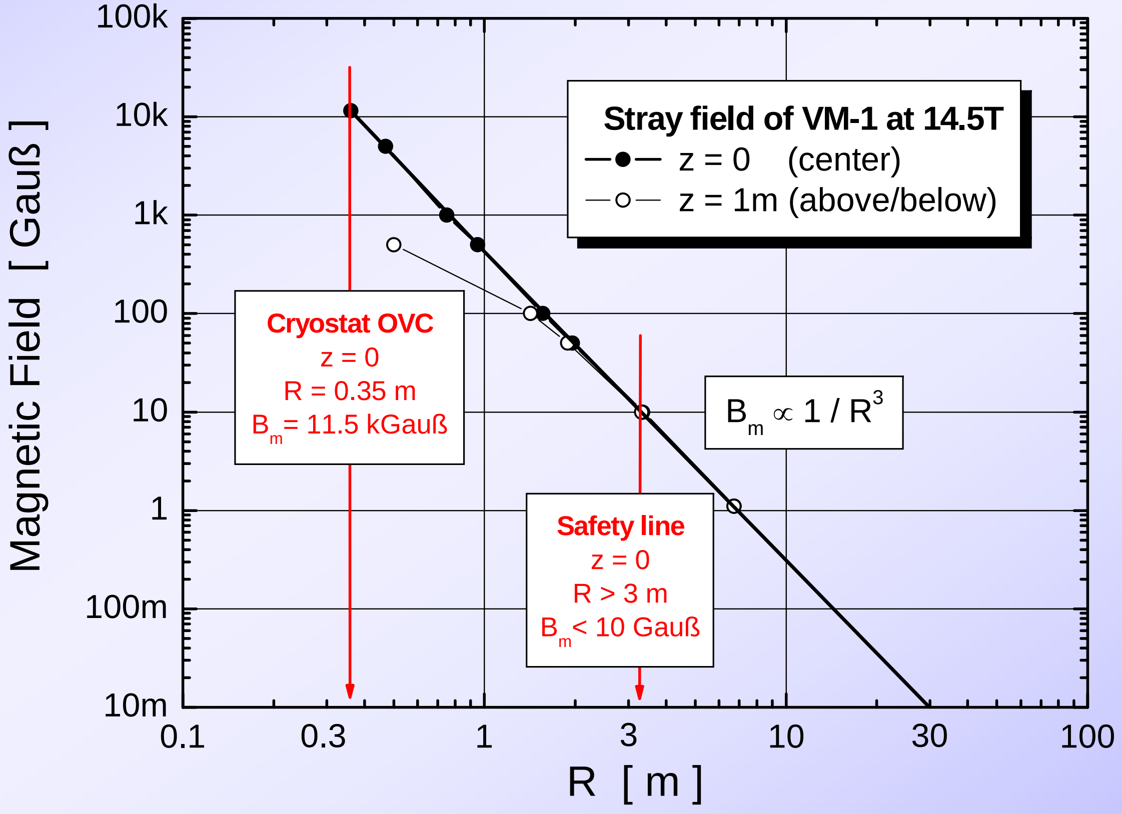
- **Principal understanding:** direct exchange ~ **20 - 30 T**

- **Small gap semiconductors:** closing gap at ~ **30 - 40 T**

Cryomagnets at HMI

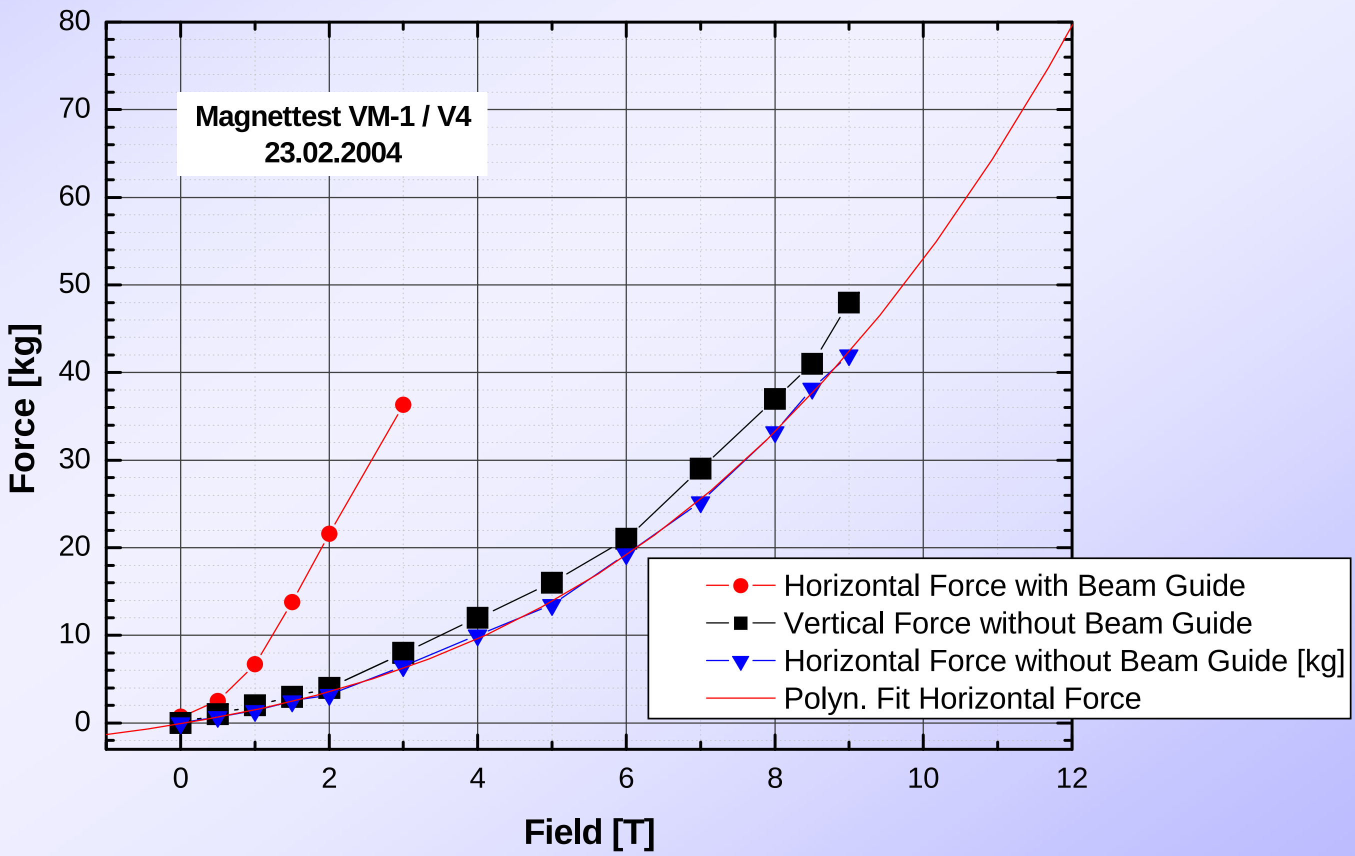
Limitation of Magnets for n-Scattering

Stray Field:



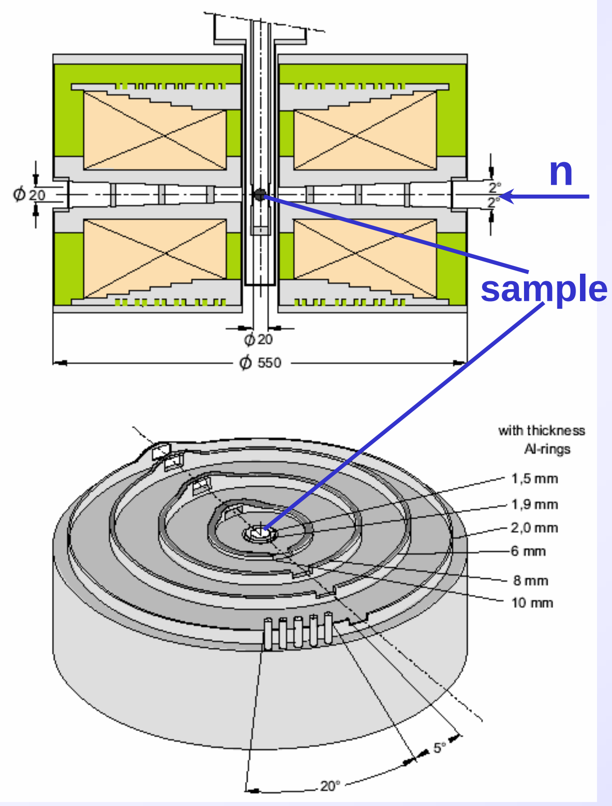
Limitation of Magnets for n-Scattering

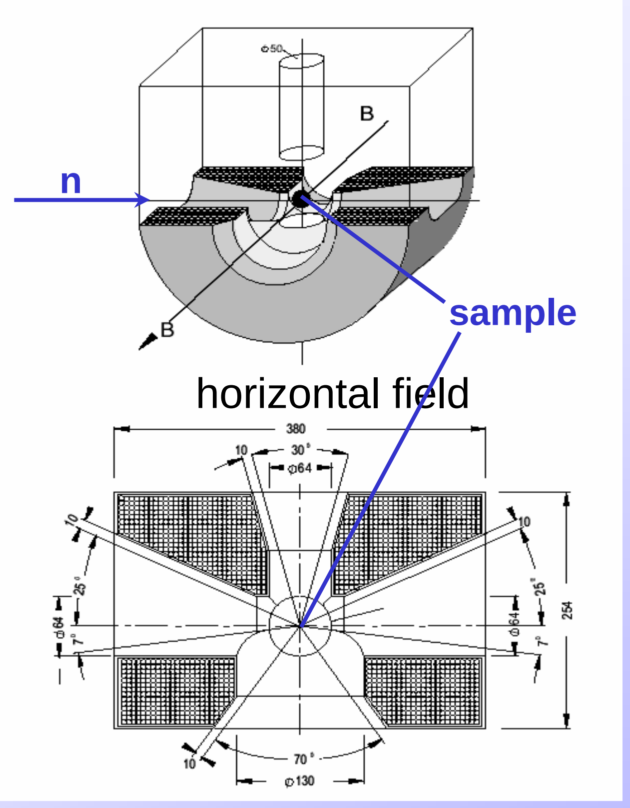
Forces:



Limitation of Magnets for n-Scattering

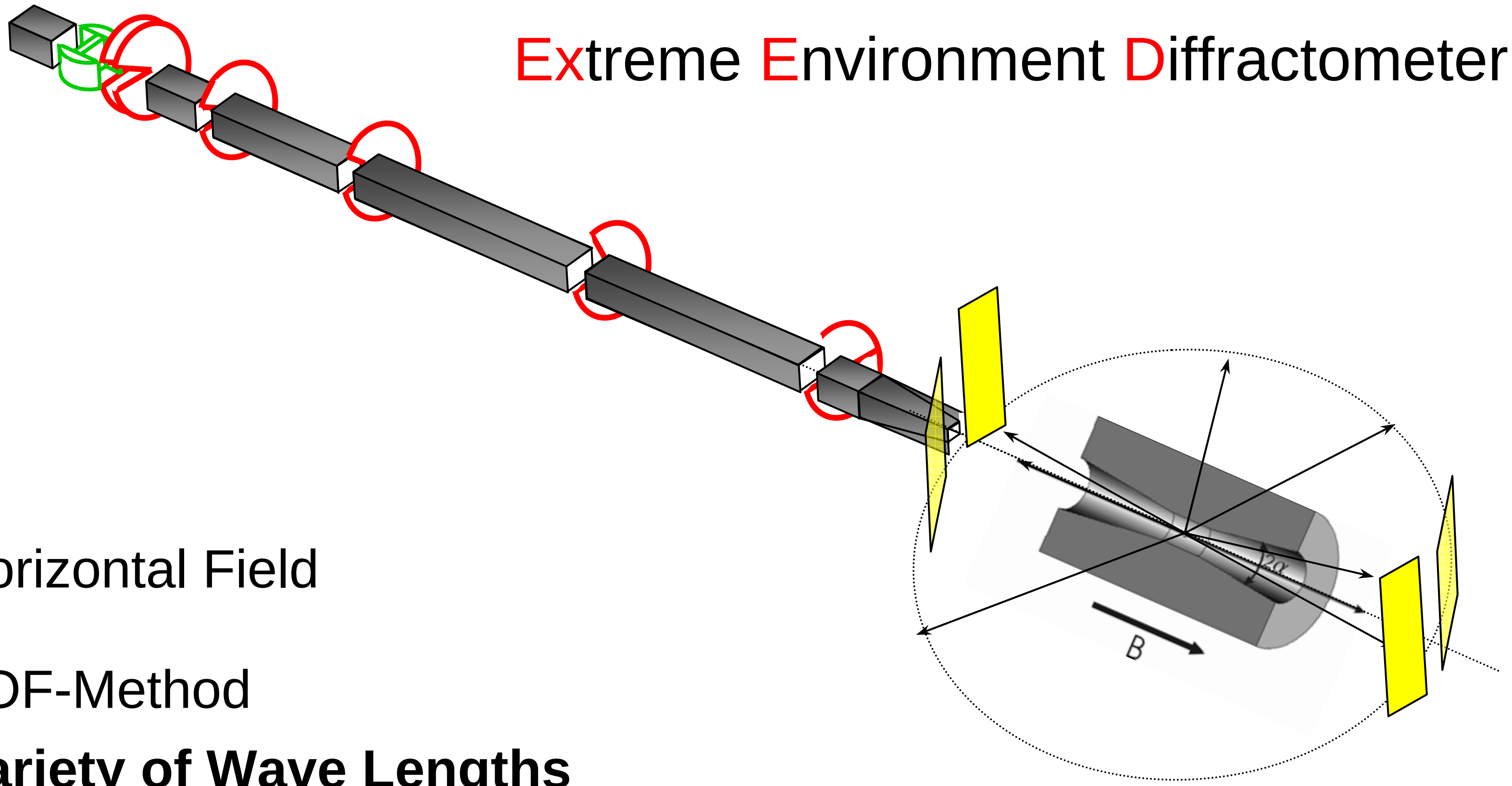
Maximum Field: Geometry of Magnets





Special Neutron Instrumentation for Conical Solenoid

Extreme Environment Diffractometer

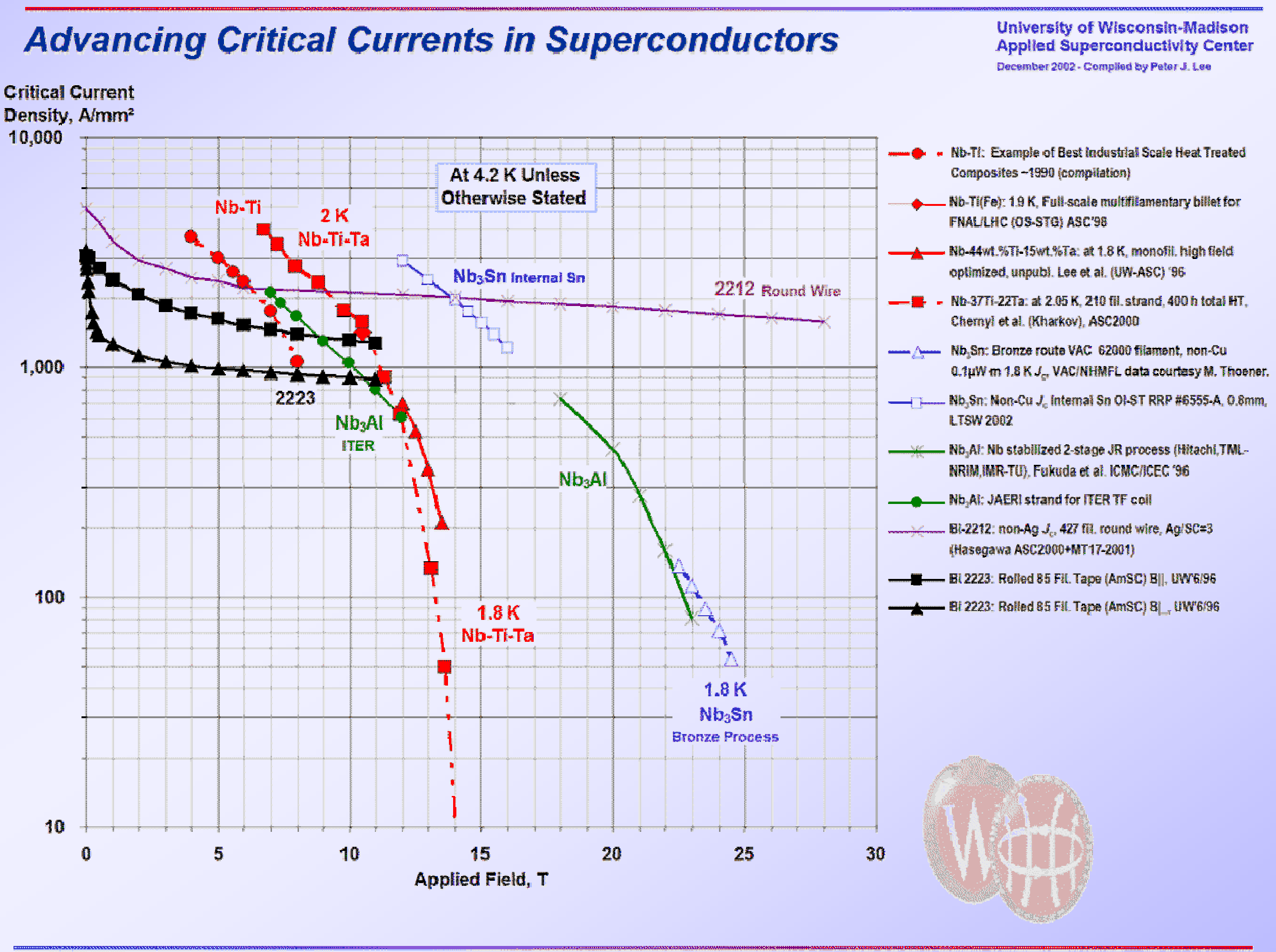


Horizontal Field

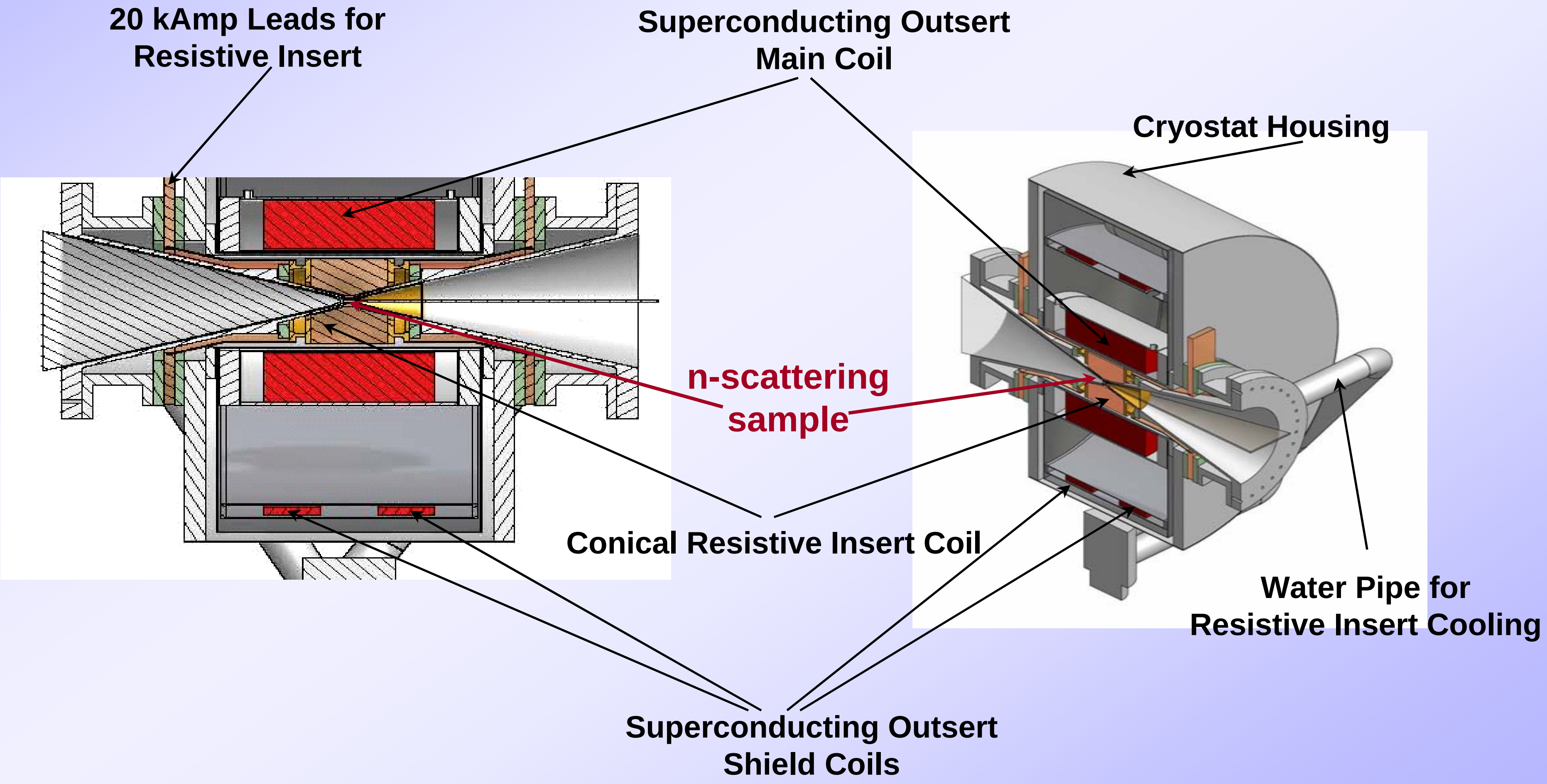
TOF-Method

Variety of Wave Lengths

Superconducting Magnet ?



The Horizontal Series Connected Hybrid



Performance Data of a SCH-System for Neutron Scattering

Feasibility study on magnet system by NHMFL:

- **The basic SCH configuration designed at NHMFL is suited to HMI requirements for neutron scattering in high magnetic fields.**

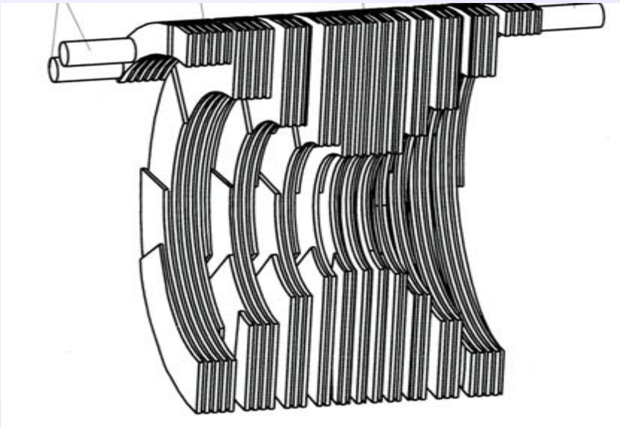
- A system based on the same SC outsert and fitted with a conical resistive insert can produce:
  field > 25 T for power of 4 MW (50 mm bore)
  field > 30 T for power of 8 MW (50 mm bore)
  field ~ 35 T for smaller bore (40 mm).
- Active compensation of stray field.

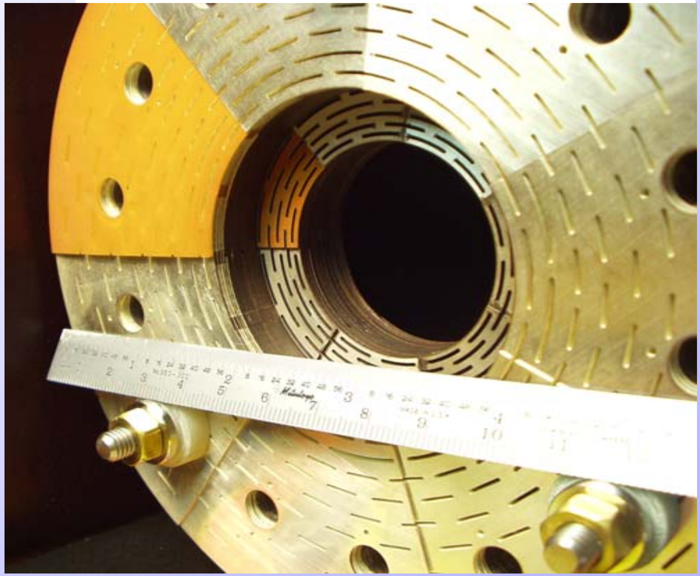
Infra-Structure:

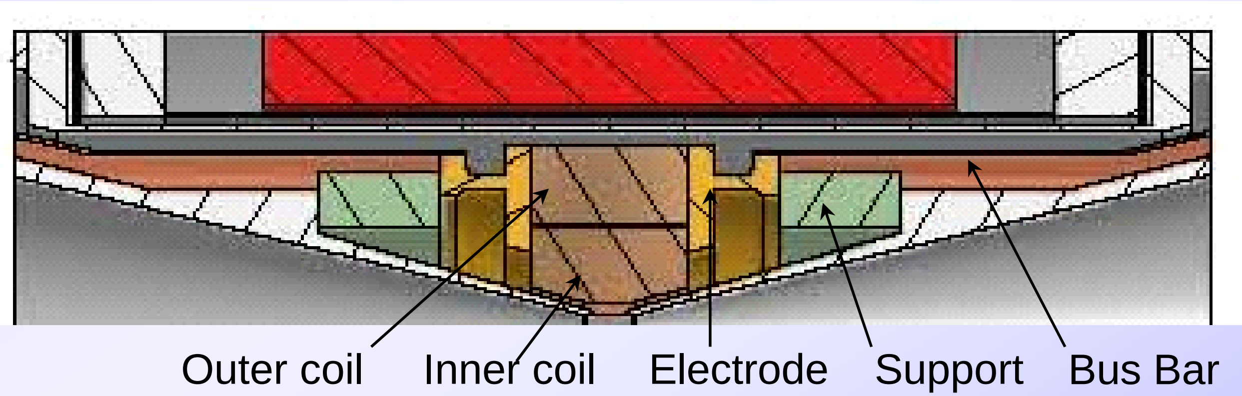
- Available power at HMI
- Design of required infra structure (power supply, water cooling)
- Cost estimate

Resistive Insert: Conical Florida-Bitter

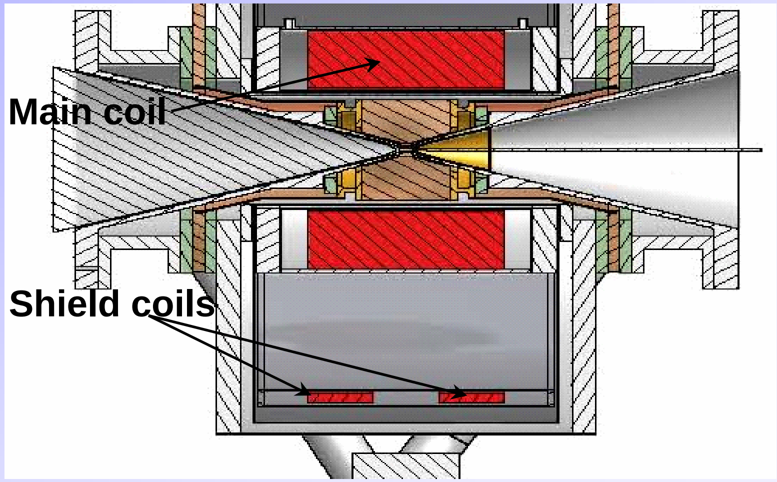
- The NHMFL has invented the Conical Florida-Bitter technology to enable more effective construction of conical, high-field powered magnets.
- All electrical and structural connections are made at the outer diameter of a single large coil.
- Starting from the mid-plane, successive turns have larger inner diameter and greater thickness.

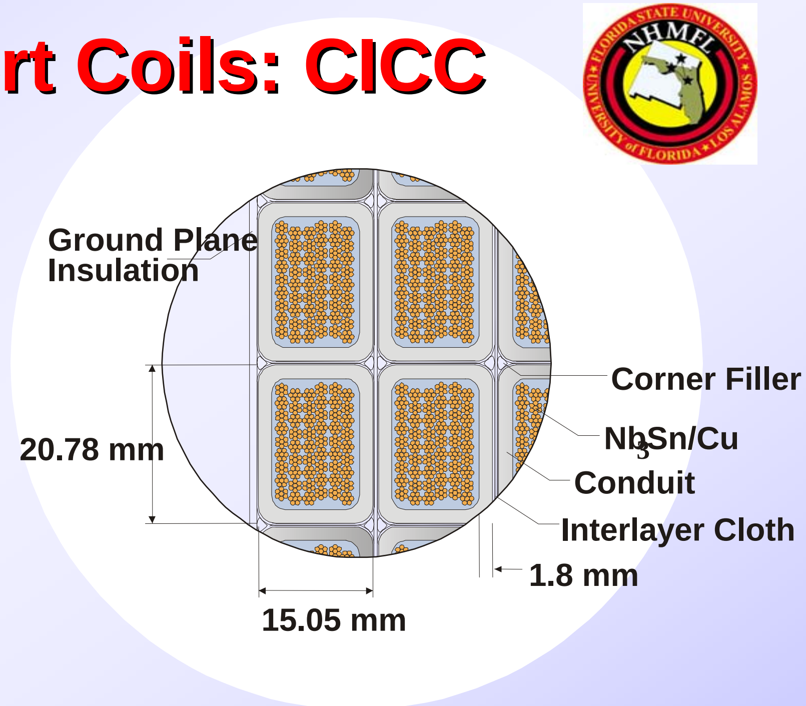




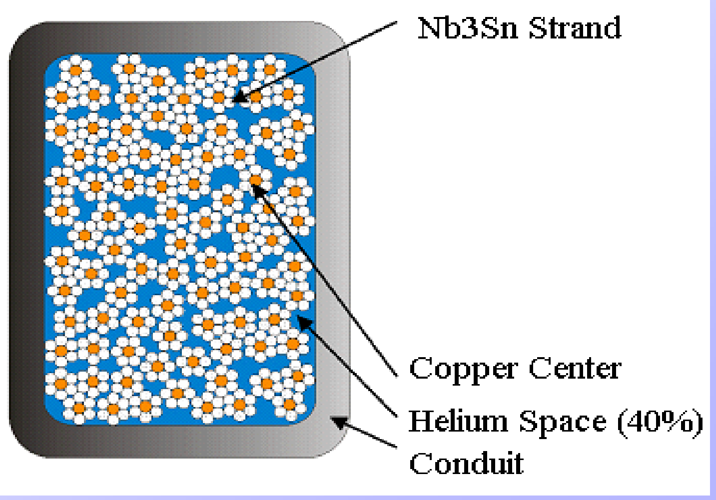


Superconducting Outsert Coils: CICC

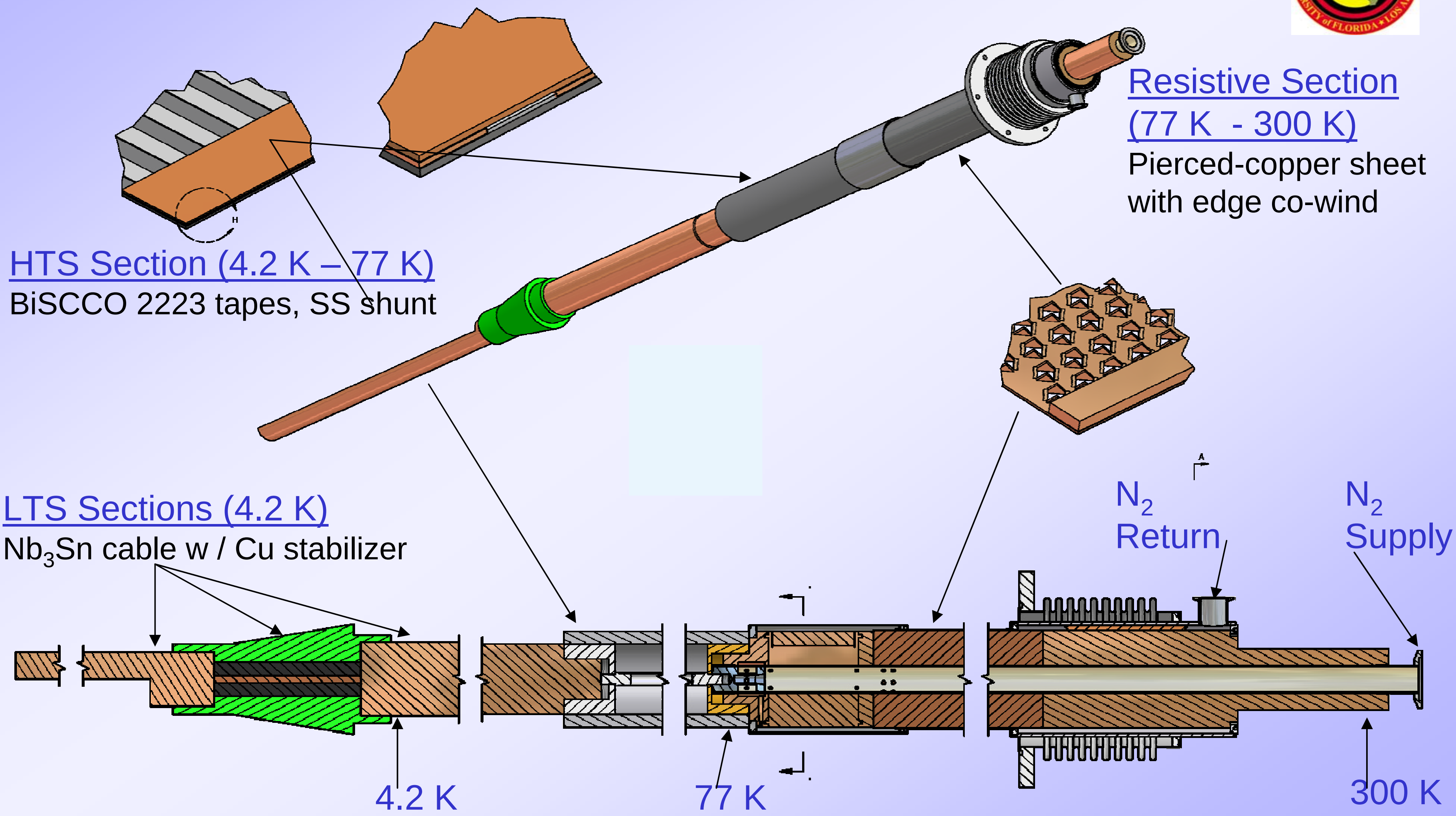




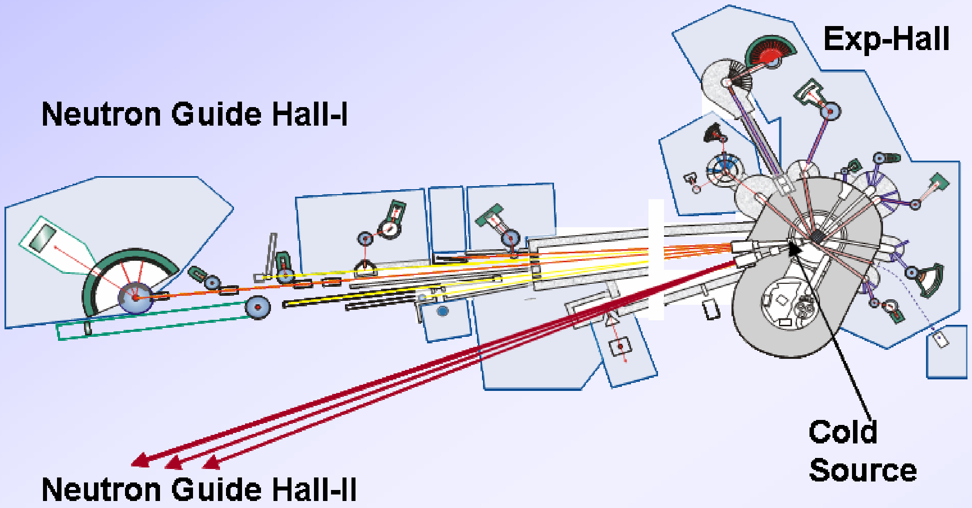
- To build an SCH, cable-in conduit conductor (CICC) is essential.
- The main SC coil will consist of 18 layers, each of which will consist of 39 turns of 20 kA CICC.



HTS Current Leads



Neutron-Guide-Hall-2 with Multi-Spectral Guide



We need more than just magnetic field!!

Sample Environment at HMI / BENSC

Variation of physical parameters:

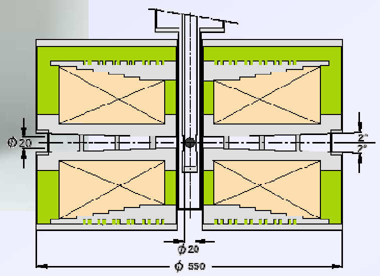
→ **Temperature** T = 30 mK … 1 K … 300K - 600 K … 2000K

→ **Magnetic Field** H = 50 µT … 5 T … 15 T … 17.5 T

→ **Pressure** p = 10^{-6} mbar … 1 bar … 200 bar … 20 kbar

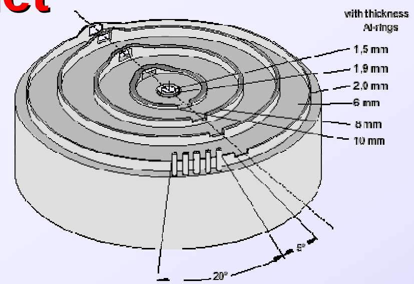
→ combinations of above parameters

Cryomagnets and Inserts



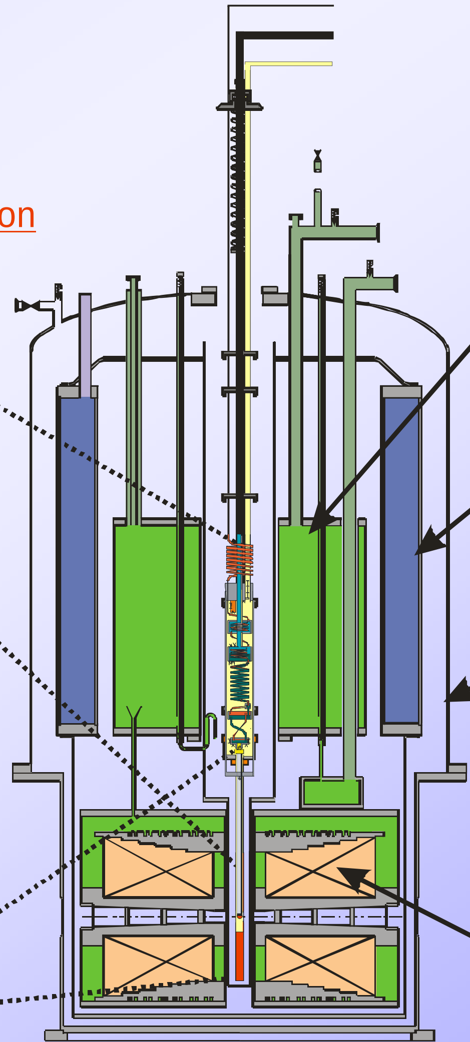
15 T Cryomagnet

Vertical Field

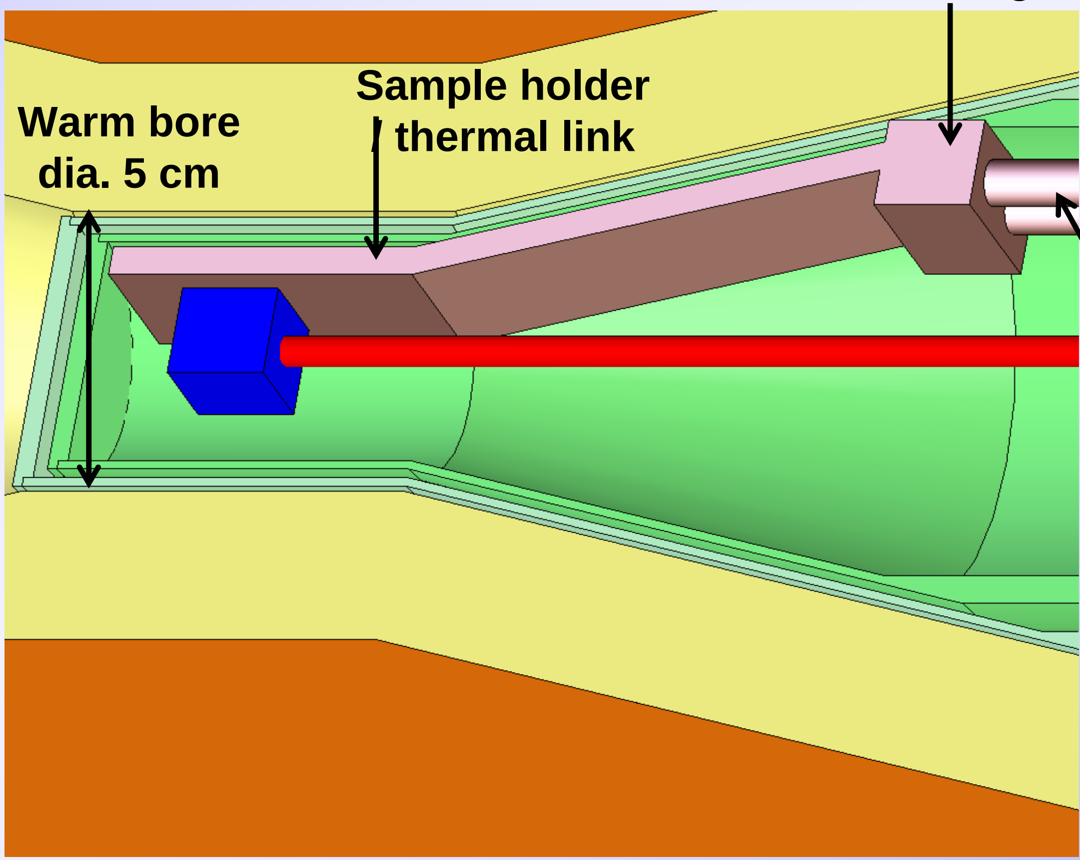


17 Tesla Option
Magnetic Field Dy-Booster

30mK Option
^3He - ^4He Dilution Stick



Insertion Device for Temperatures ~ 0.5 K to 500 K



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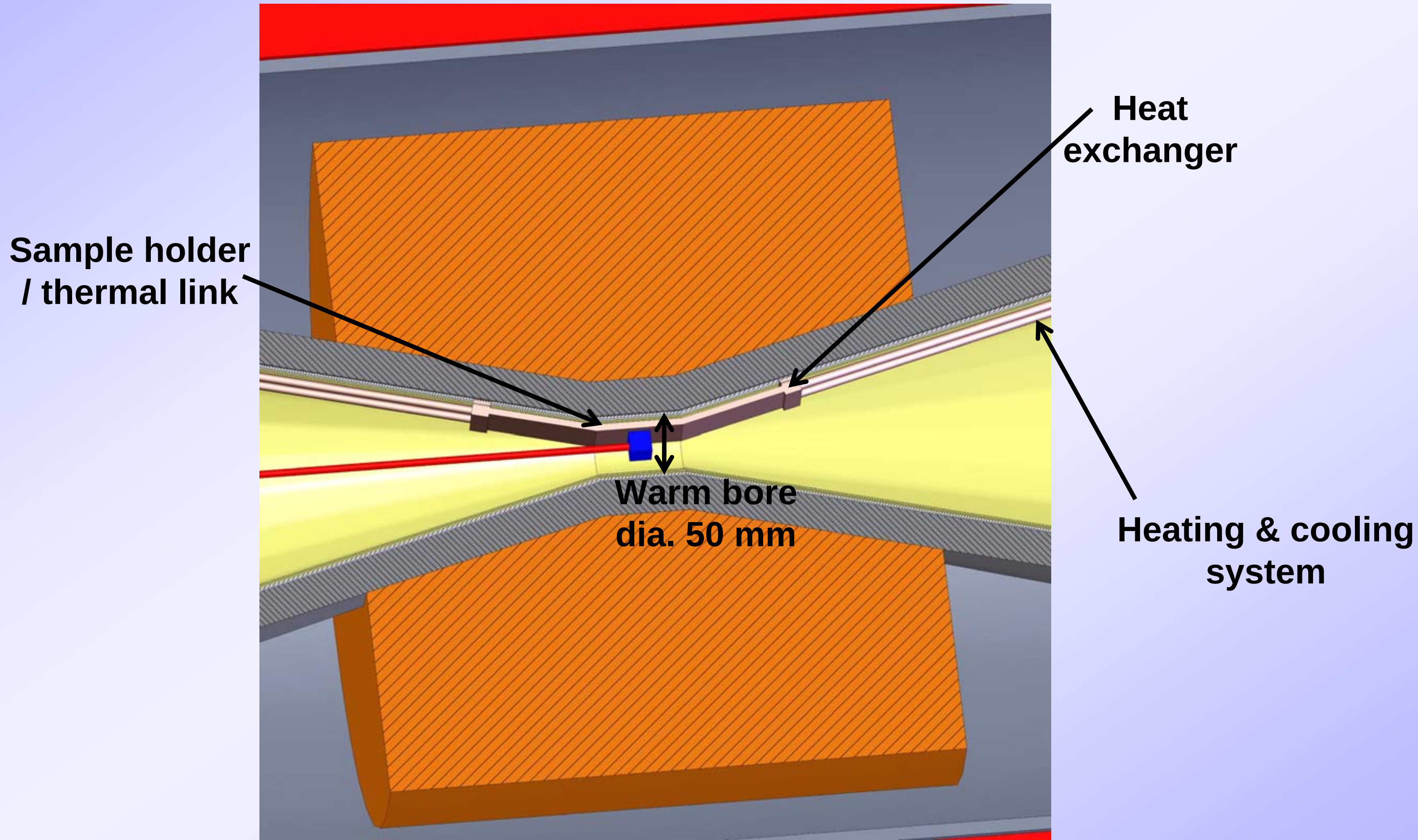


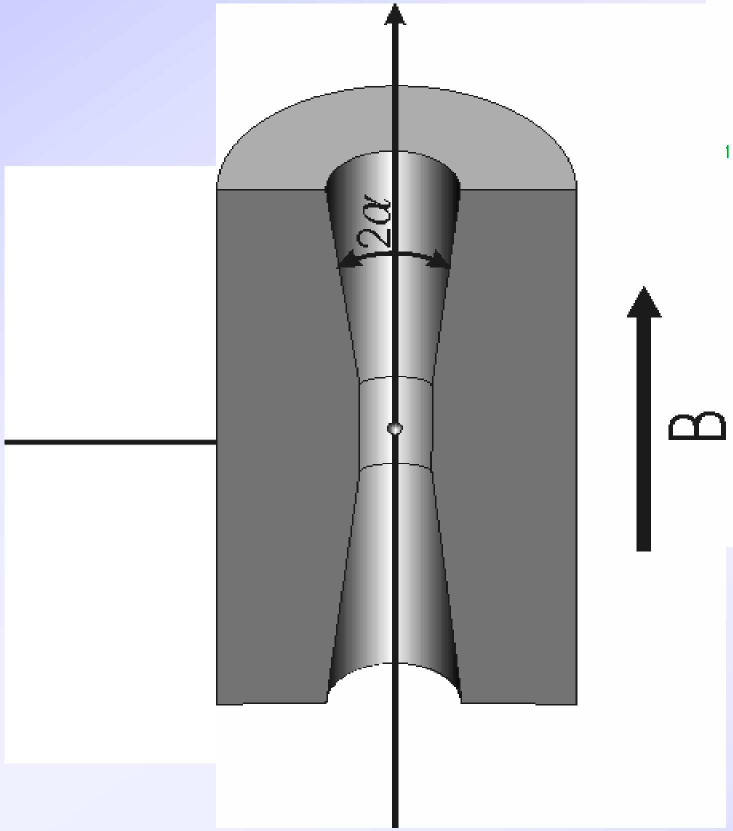
We need horizontal and vertical magnetic field!!

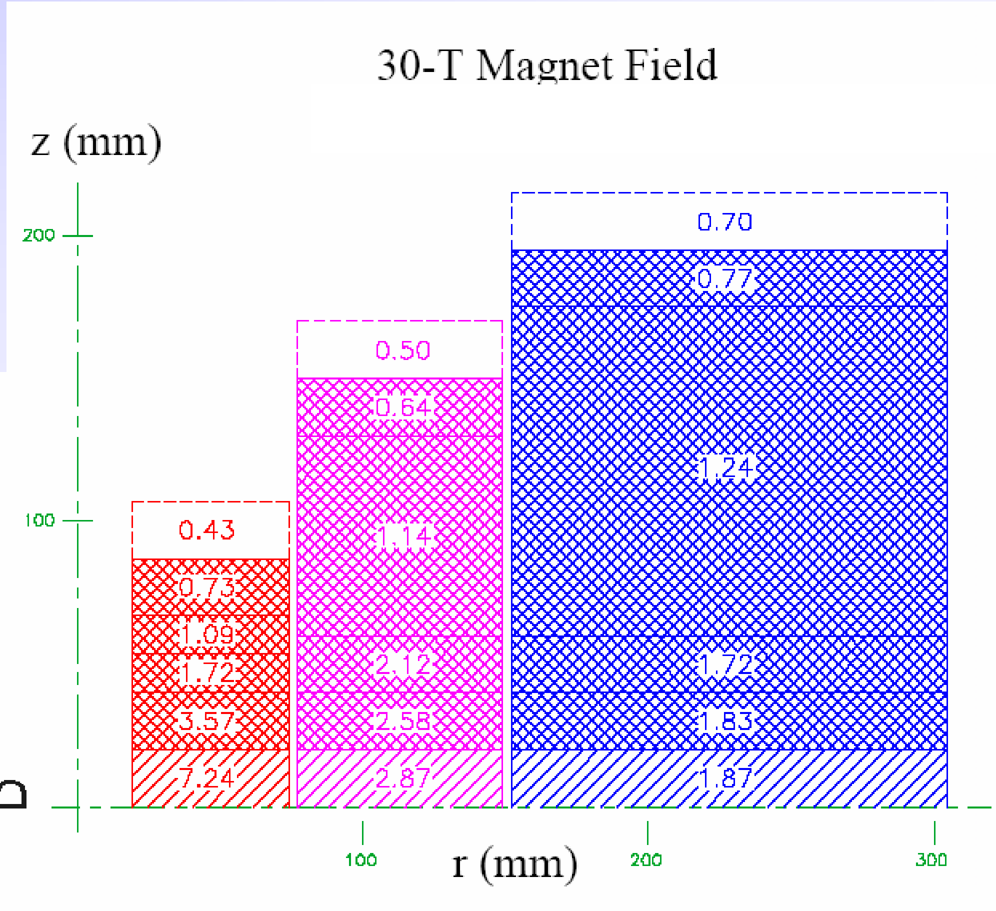
High Field Magnets for Neutron Science

Split-Coil Systems / Tapered Solenoids
Triple-Axis Instrument / TOF-Instrument

Split-Coil	**Tapered Solenoid**
Inelastic Measurements	Powder Diffraction
Magnetic Structures	SANS with B||k_i
Single Crystal Measurements	Inelastic Measurements (flux reduction!)
	Single Crystal Measurements (restrictions!)

Vertical Field





Vertical Field