Instrumental presentation

NMR Spectrometer -2

Bruker Avance III HD, 600 MHz Cryo

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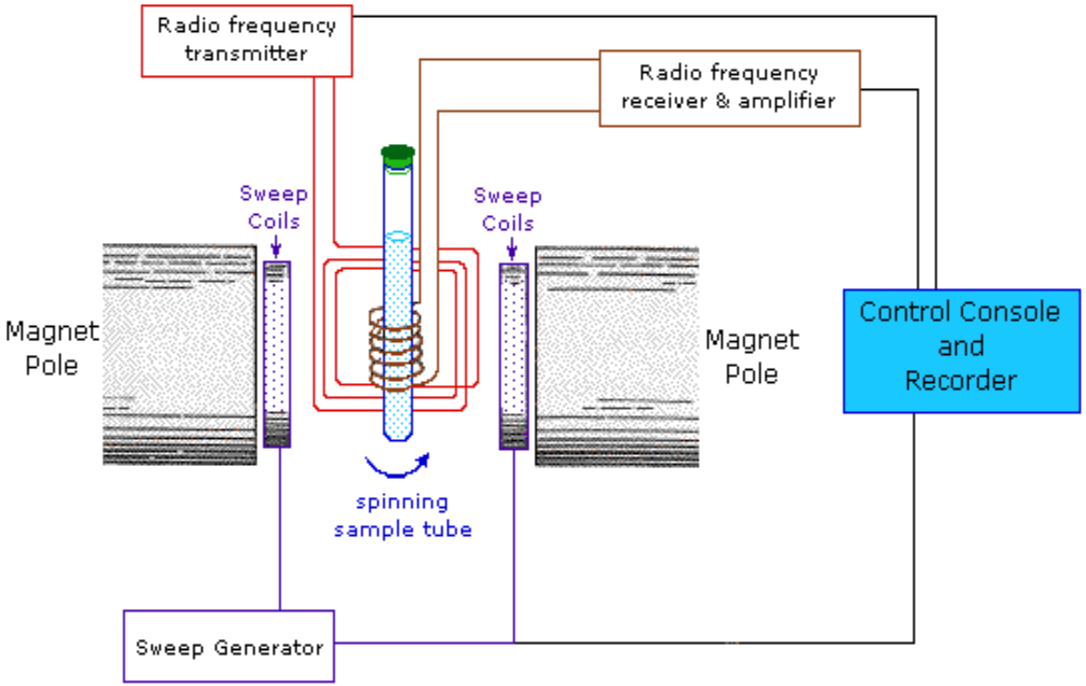
01/06/2019

Components of NMR Spectrometer

1) Sample holder
2) Magnet
3) SHIM Coils
4) NMR probe
5) RF Oscillator
6) RF receiver
7) Detector
8) Amplifier & Recorder



NMR Probe:

- NMR probe is the interface between a sample and spectrometer. It is the probe that excites the nuclear spins and detects NMR signal.
- It usually comprises two radiofrequency coils to enable it to respond to multiple frequencies, and to allow the excitation of multiple nuclei. Modern NMR probes also include an actively-shielded pulsed field gradient (PFG) coil to facilitate the application of field-gradient pulses.

Classification of probes:

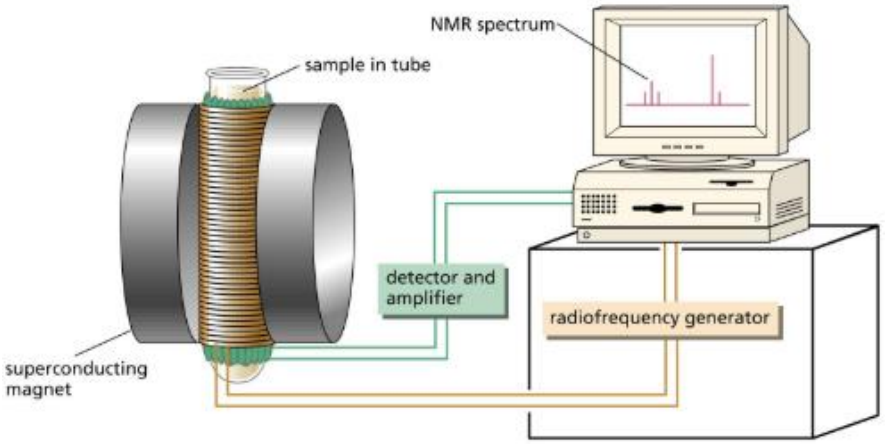
1) Triple resonance cryo probe : Proton optimized triple resonance inverse probe. Three independent channels + lock channel for simultaneous decoupling of multiple nuclei Such as ^{13}C and ^{15}N
2) Room temperature NMR probe:
3) Solid Solid state wide range NMR probe
4) i-probe
5) Flow probes (MAS probe)
6) Cryo probe

The Probe: Positioning, Temperature control and Spinning

- The probe is inserted into the bottom of the superconducting magnet and holds the sample in the centre of the magnet.
- The probe also provides a heater for temperature control of the sample. For temperature regulation, dry air is flown around the sample tube (10 - 20 lpm) after passing an electrical heating element.
- A feedback system regulates the temperature of the air by controlling the power fed to the heater.
- Most probes provide a mechanism to allow spinning of the sample at 15-25 Hz about the *z*-axis. Spinning averages facilitates shimming of the magnet, but is not used for long multidimensional experiments.
- The probes can also have an alternate air flow for cooling of the probe.
- The probe also has knobs at the bottom which are connected to resonant circuits for tuning and matching to corresponding nuclei.

Radiofrequency Transmitter

- The RF transmitter consists of frequency synthesizers, amplifiers and associated electronics for producing pulses of high monochromatic RF electromagnetic radiation with defined phases and amplitudes.



- Many RF channels will contain an optional waveform generator, that allows the production of pulses with arbitrary shapes.

- The pulse is divided into small segments and each segments possesses its own amplitude and phases.

Radiofrequency coils:

- Transmit / receive coil (most common)
- Transmit only coil (can only excite the system)
- Receive only coil (can only receive MR signal)
- Geometry Volume coil (low sensitivity but uniform coverage)
- Surface coil (High sensitivity but limited coverage)
- Phased-array coil (High sensitivity, near-uniform coverage)

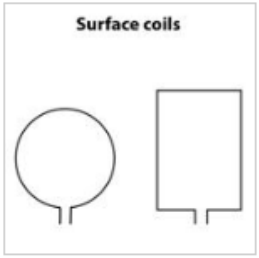


Figure 1: surface coils

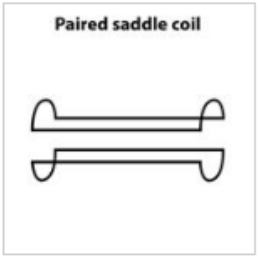


Figure 2: paired saddle coil

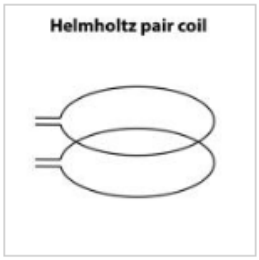
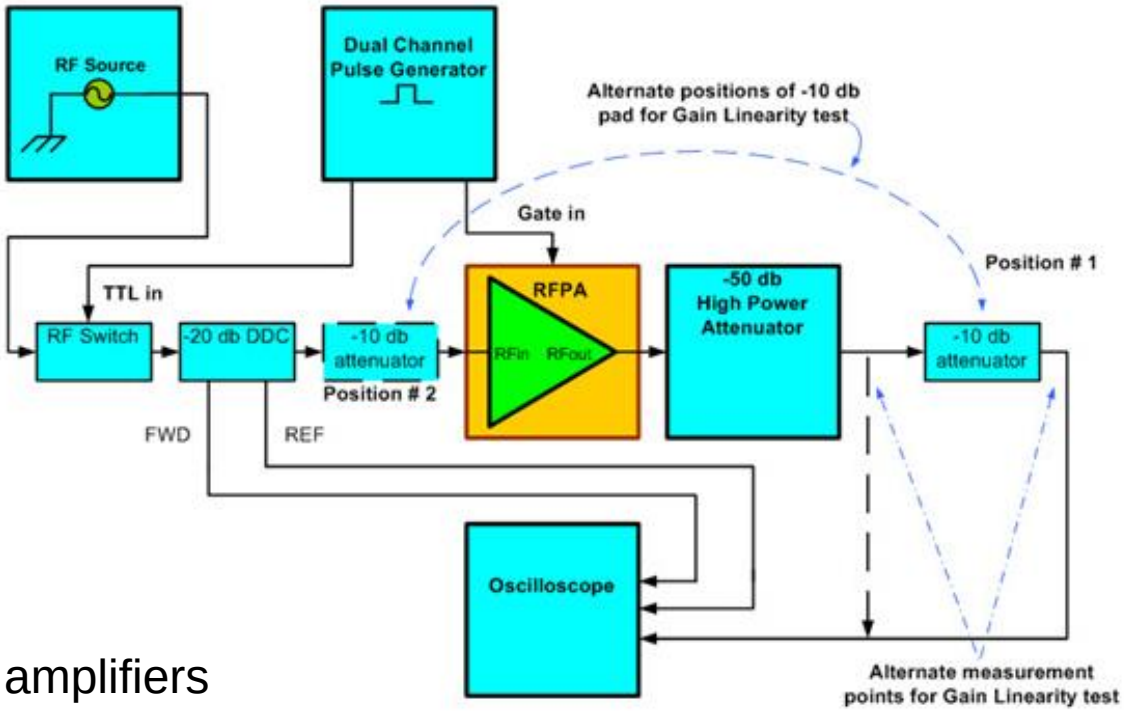


Figure 3: Helmholtz pair coil

Figure 4: birdcage coil

Signal Amplifier and recorder:

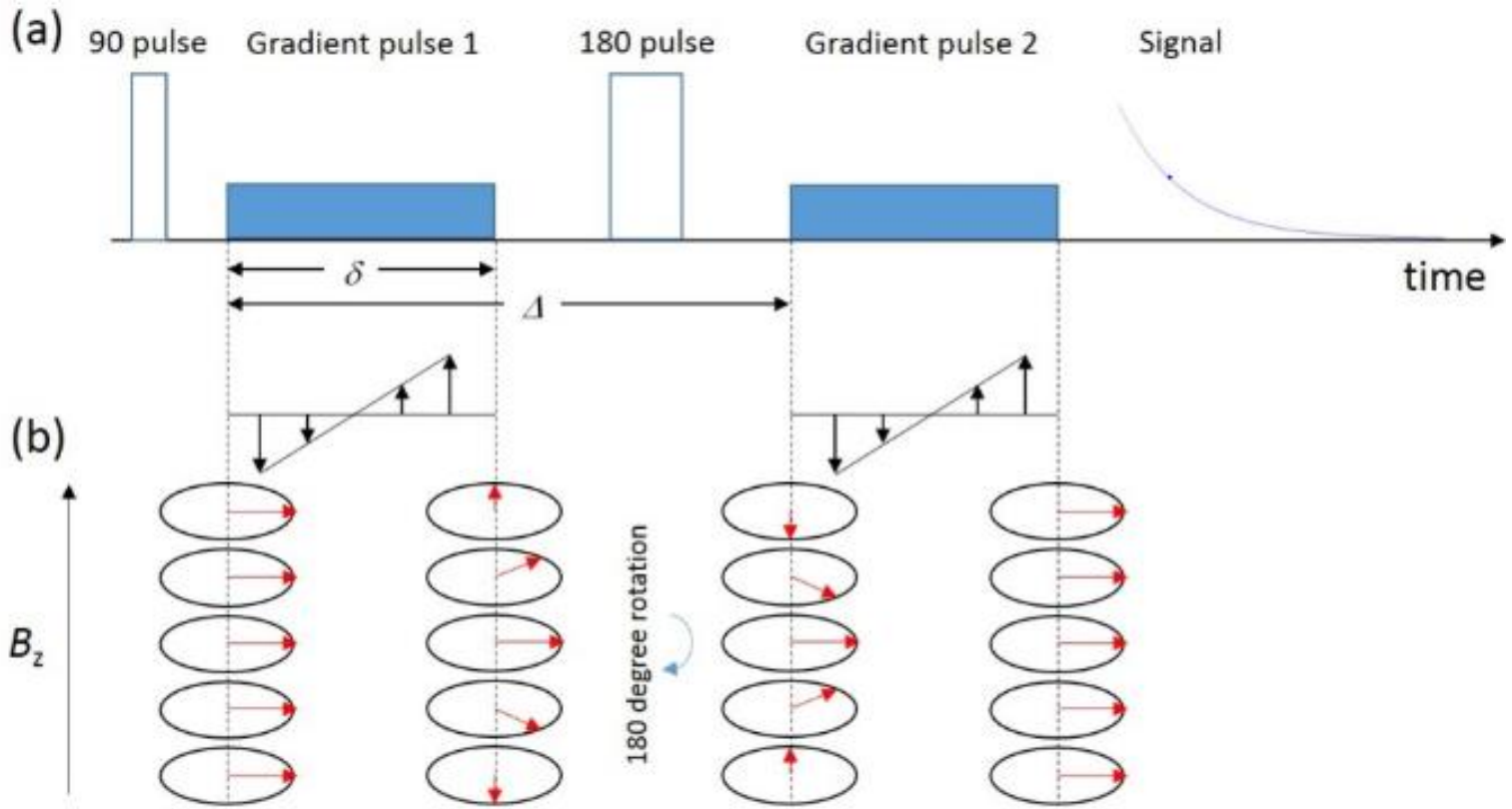
The Radio Frequency Power Amplifier (RFPA) can analogously be thought of as the heart of an NMR Spectrometer. Although executing a conceptually simple and fundamental task; i.e. making a “small” RF signal into a “big” RF signal, how an RFPA operationally deals with a complex RF Pulse sequence design can have direct impact on Signal to Noise Ratio (SNR).



- The main parameters of the amplifiers are gain, output power, bandwidth, power efficiency, linearity (low signal compression at rated power), adaptability to output impedance, and Heat dissipation

Pulse and FT NMR:

Pulse sequences are used to excite signals that are observed in an **NMR** spectrometer. They range from general purpose single-**pulse** experiments to complex highly sophisticated experiments that select specifically interacting nuclei.



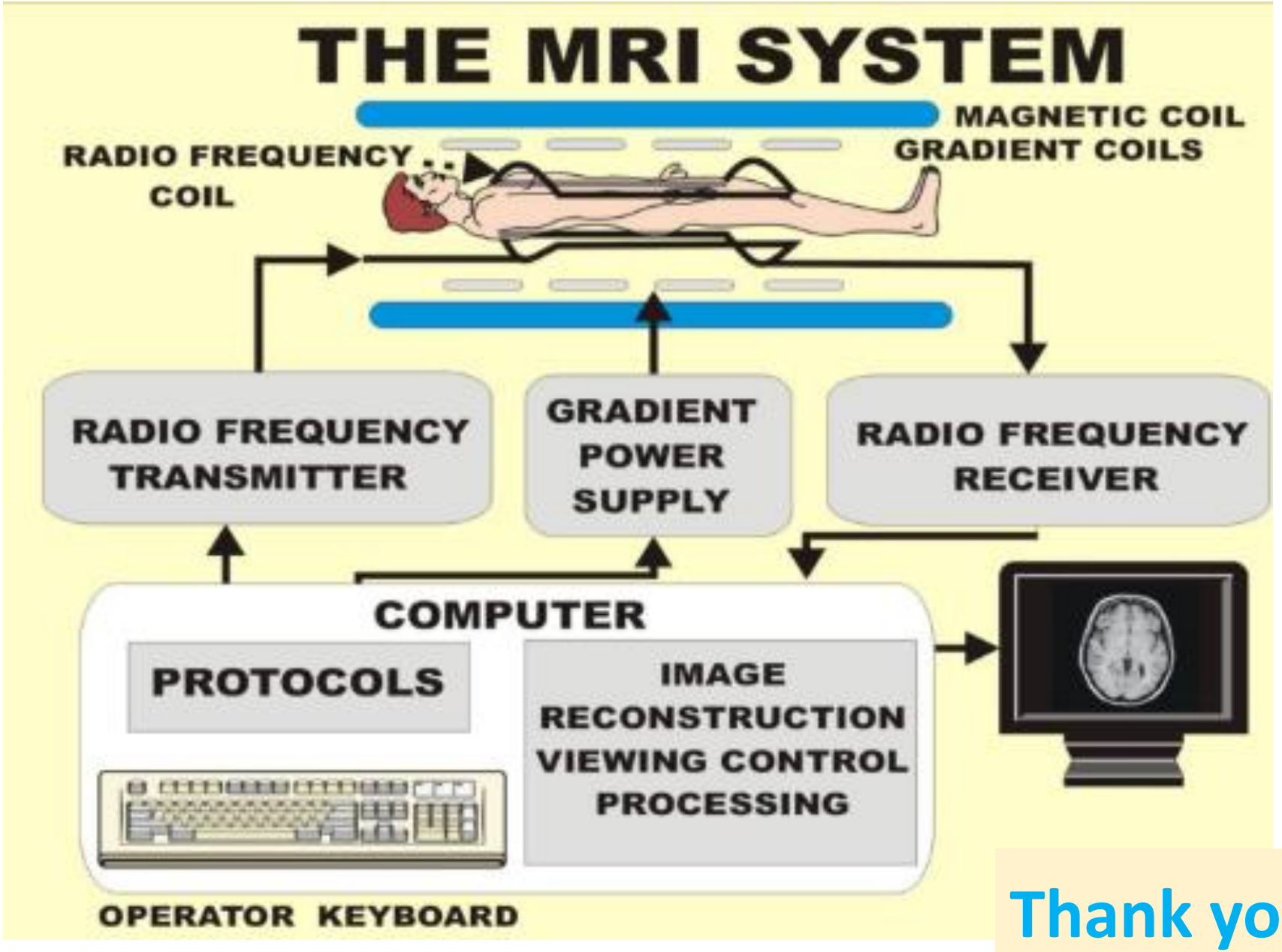
Decoupling

When the signal is split by heteronuclear coupling, for example proton couplings in a carbon spectrum, it is possible to decouple them by continuous irradiation of the coupling nucleus.

Safety of the NMR lab--

- Do not bring any metallic object within 10 feet of any magnet. Assume all metallic objects are ferromagnetic and will be attracted to the magnets, unless verified by NMR staff.
- Do NOT bring compressed gas cylinders into the NMR laboratories without NMR personnel supervision.
- NEVER put any object into the magnet, except the NMR tube and holder.
- For low-temperature NMR experiments, use the non-magnetic nitrogen dewar that is available. Do not use a wrench to disconnect the quick connector on the dewar. Keep the Thermo immersion cooler (which is slightly magnetic) at least 5 feet from the magnet.
- Medical implants people are not allow to go inside the lab.
- Cryogenic safety and hazards.

Great Advancement of NMR……..



Thank you