Jak pracuje spektrometr

Jednotlivé části

- Magnet
- Sonda
- Vysílač
- Příjímač
- Převodník
- Pulsní programátor
- Počítač

Jak pracuje spektrometr

Magnet

Properties		Nitrogen	Helium
Molecular weight		28	4
Normal boiling point	[°C] [°K]	-196 77	-269 4.2
Approximate expansion ration (volume of gas at 15°C and atmospheric pressure produced by unit volume of liquid at normal boiling point).		680	740
Density of liquid at normal boiling point	[kg m^{-3}]	810	125
Color (liquid)		none	none
Color (gas)		none	none
Odour (gas)		none	none
Toxicity		very low	very low
Explosion hazard with combustible material		no	no
Pressure rupture if liquid or cold gas is trapped		yes	yes
Fire hazard: combustible		no	no
Fire hazard: promotes ignition directly		no	no
Fire hazard: liquefies oxygen and promotes ignition		yes	yes

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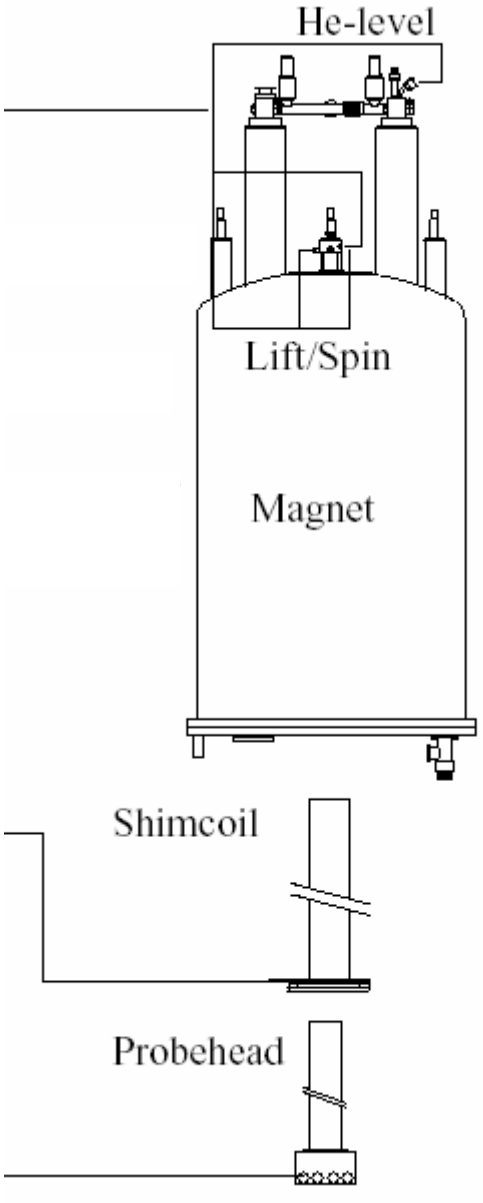
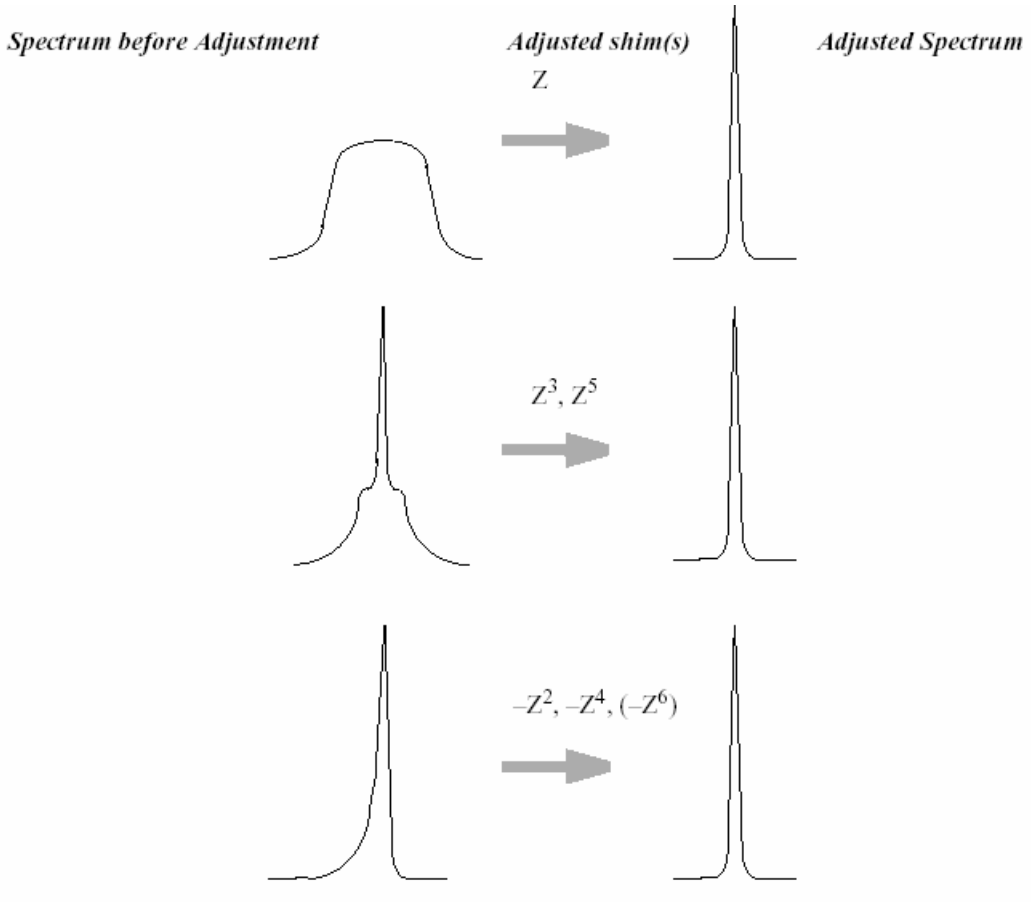
Magnet – korekce (shims)





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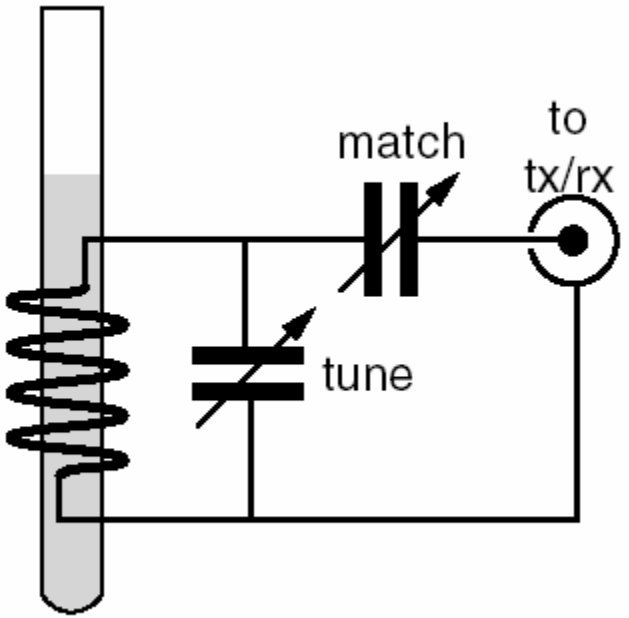
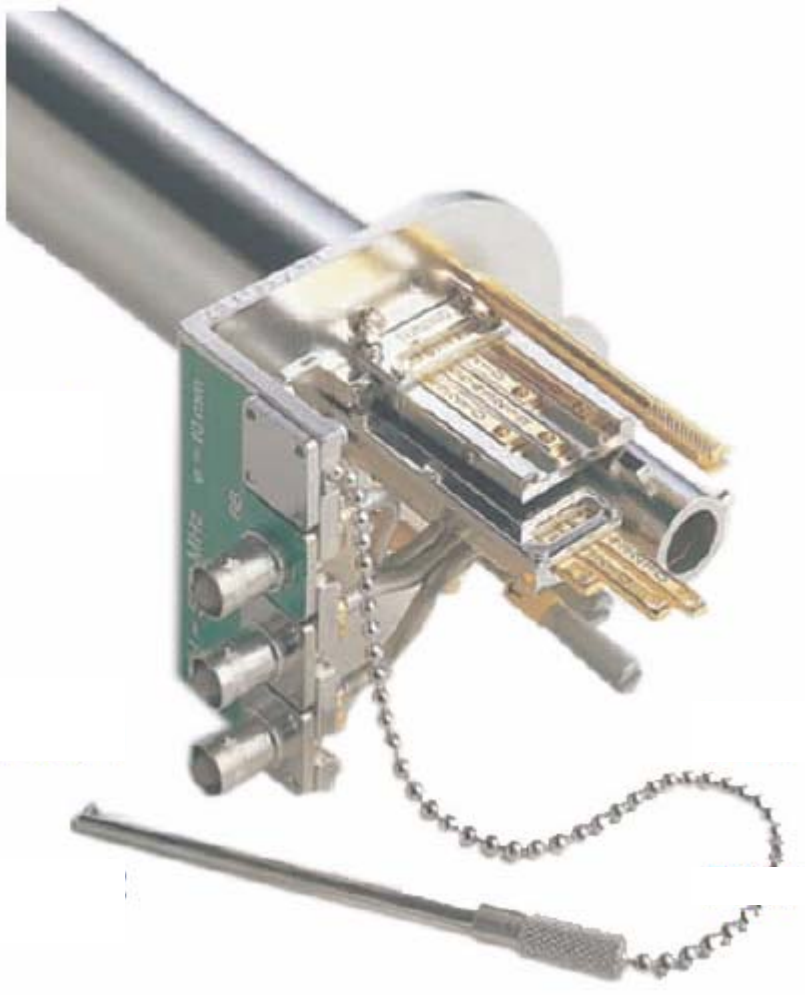
Sonda





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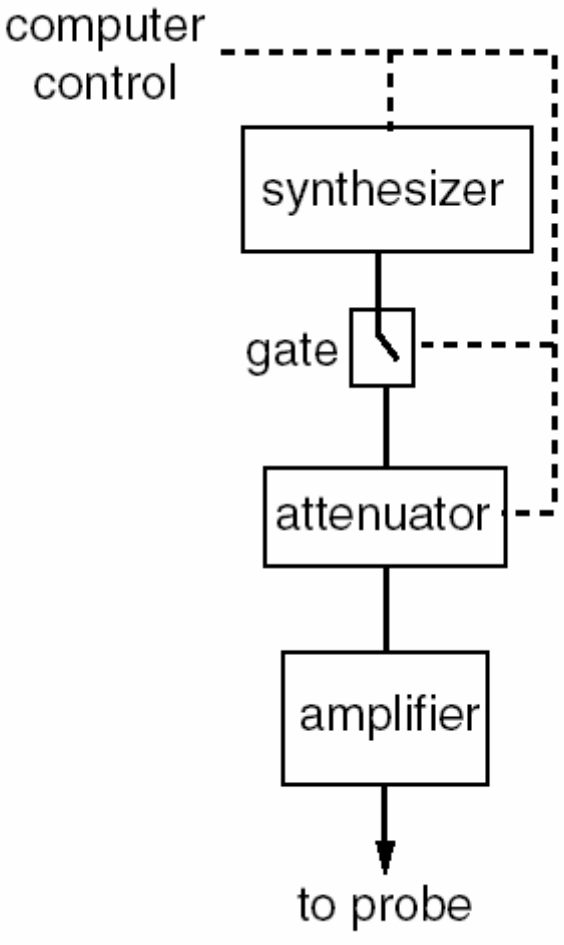
Vysílač – výkon *vers.* indukce rf pole



$$10 \times \log_{10} \frac{P_{\text{out}}}{P_{\text{in}}};$$

$$10 \times \log_{10} \frac{P_{out}}{P_{in}} = 10 \times \log_{10} \frac{1}{2} = -3.0$$

!!!!!!!!$B_1 \sim P^2$!!!!!!!!!!

$$\text{power ratio} = \left(\frac{\omega_1^{\text{new}}/2\pi}{\omega_1^{\text{init}}/2\pi} \right)^2.$$

$$\text{power ratio in dB} = 10 \log_{10} \left(\frac{\omega_1^{\text{new}}/2\pi}{\omega_1^{\text{init}}/2\pi} \right)^2$$

$$= 20 \log_{10} \left(\frac{\omega_1^{\text{new}}/2\pi}{\omega_1^{\text{init}}/2\pi} \right).$$

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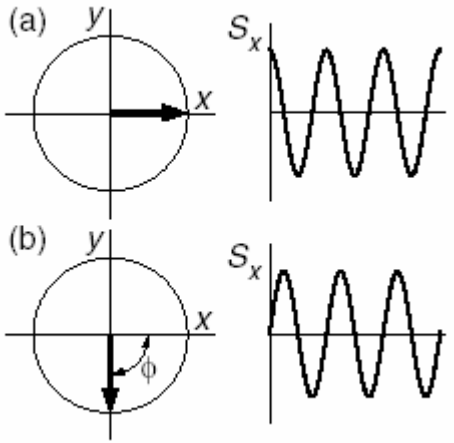
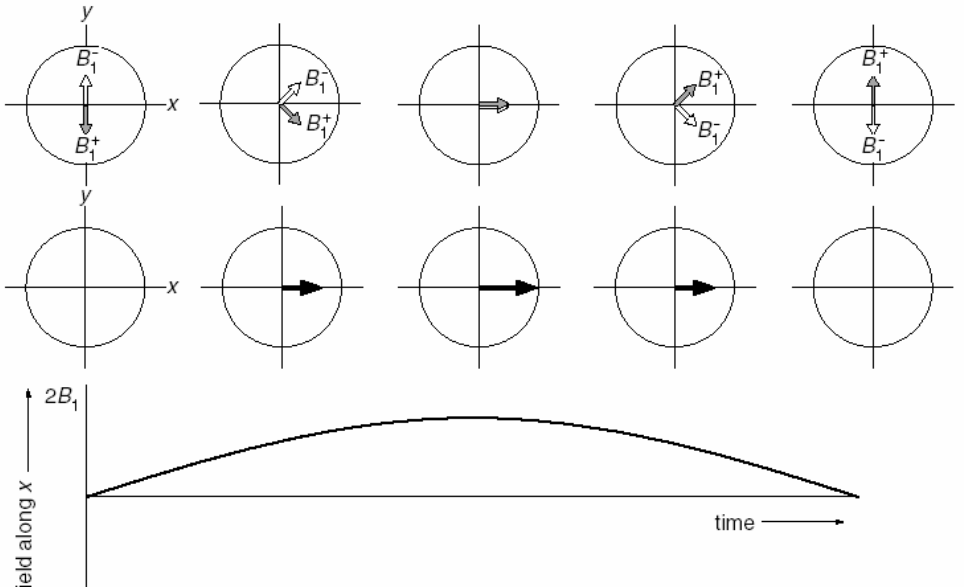
Vysílač – fázově posunuté pulzy



$$2B_1 \cos \omega_{RF} t .$$

$$2B_1 \sin \omega_{RF} t .$$



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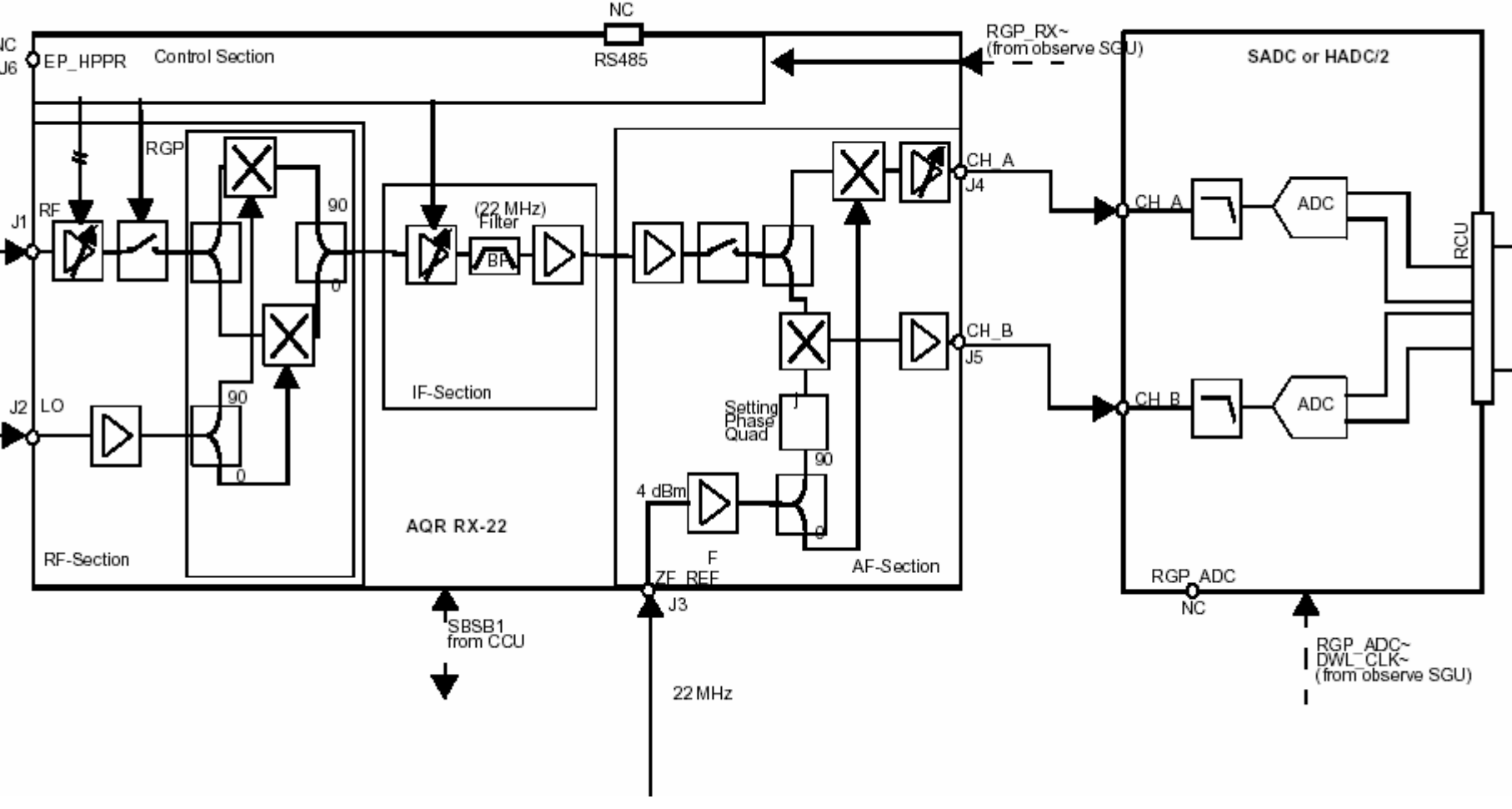
Přijímač



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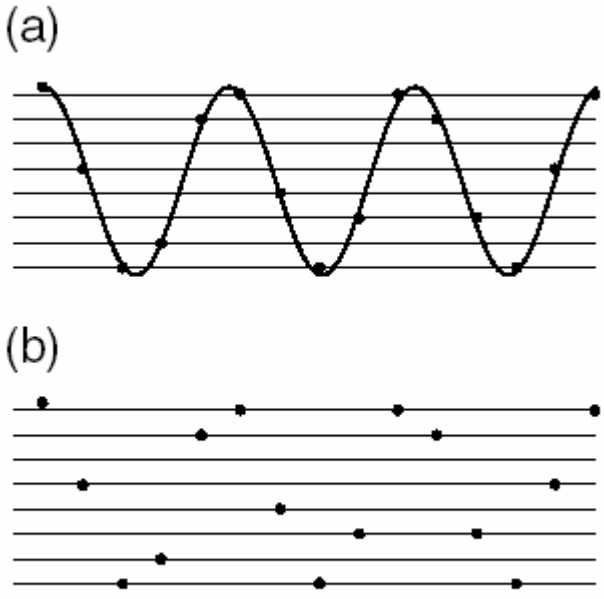
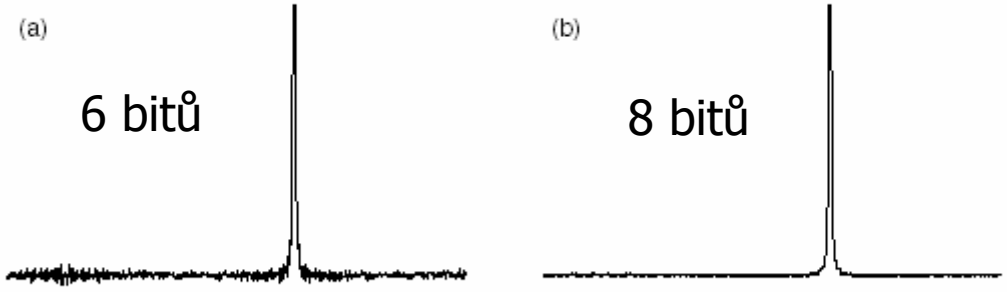
A/D převodník





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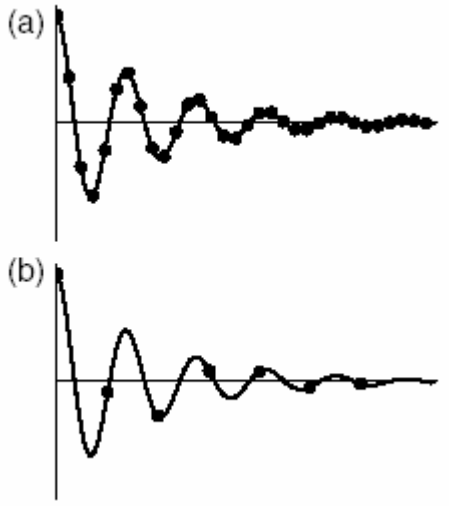
A/D převodník – vzorkovací rychlost



Nyquistova frekvence

$$f_{\max} = \frac{1}{2\Delta};$$

$$\Delta = \frac{1}{2 f_{\max}}.$$

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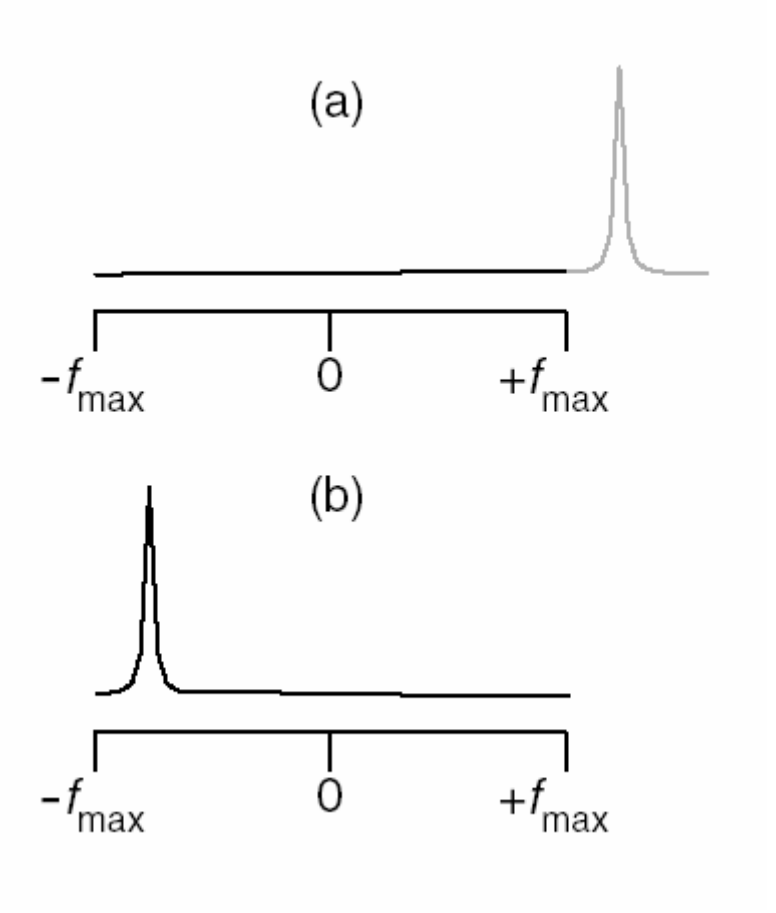
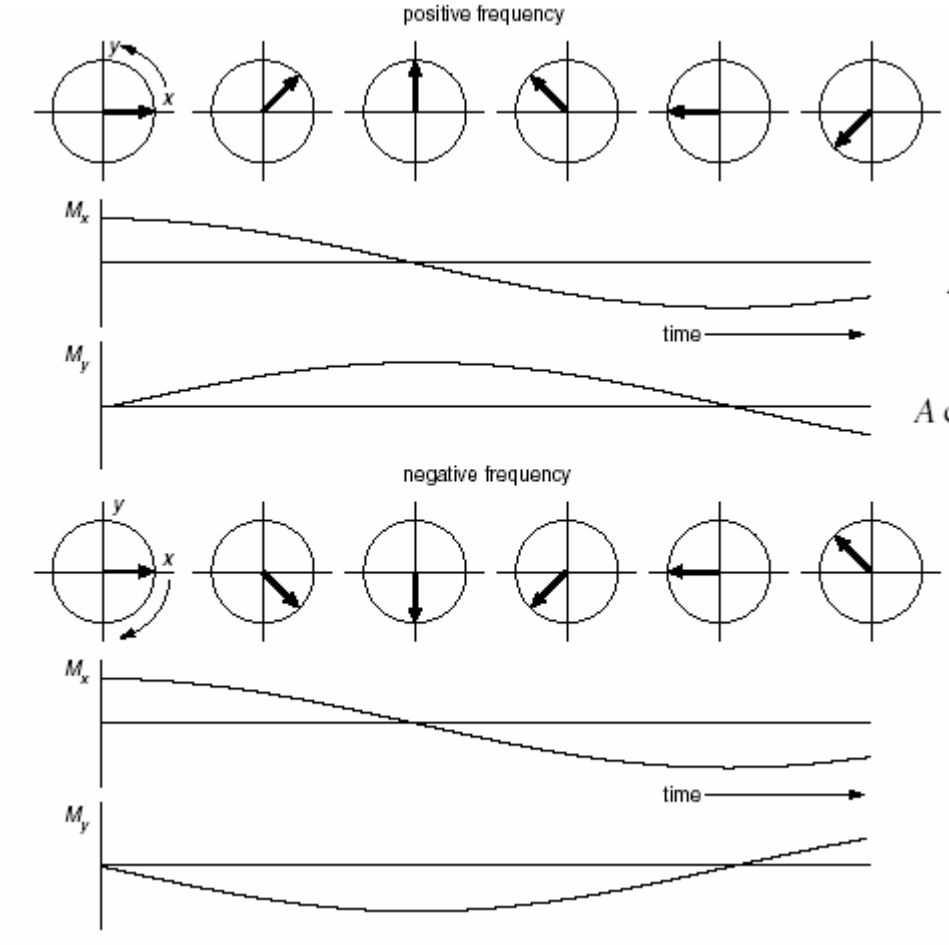
A/D-převodník – překládání signálů

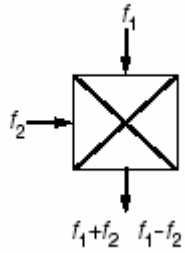


Jak pracuje spektrometr

Kvadraturní detekce



směšovač

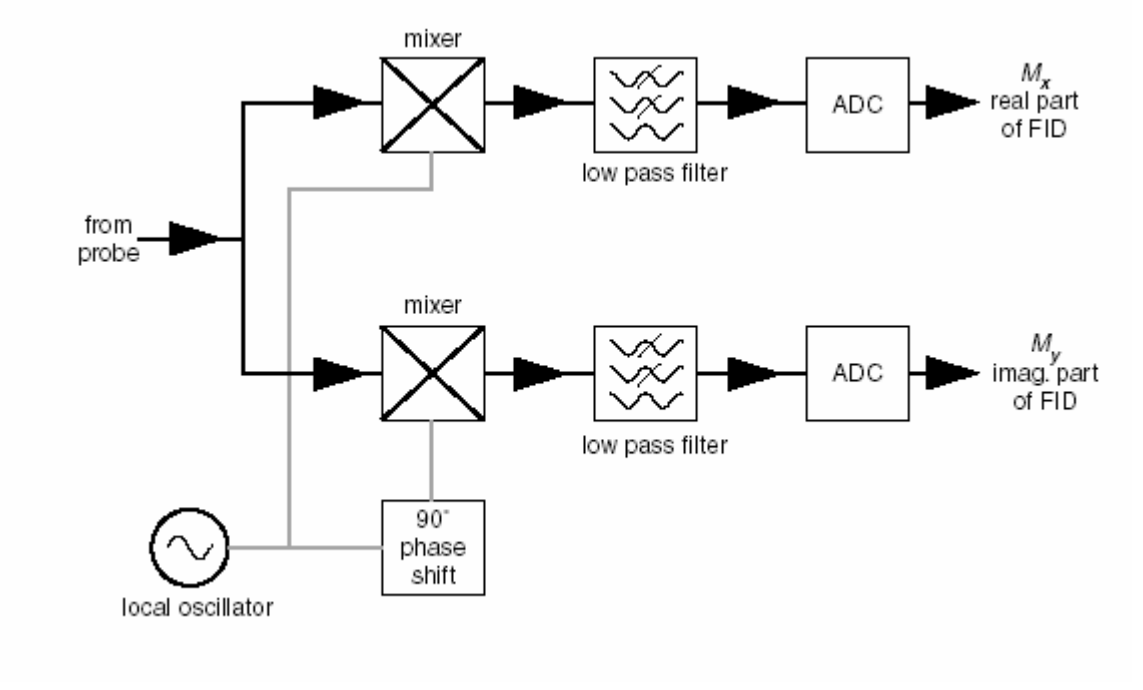


$$A\cos\omega_0 t \times \cos\omega_{rx} t = \tfrac{1}{2}A\,[\cos(\omega_0+\omega_{rx})t + \cos(\omega_0-\omega_{rx})$$

$$A\cos\omega_0 t \times -\sin\omega_{rx} t = \tfrac{1}{2}A\,[-\sin(\omega_0+\omega_{rx})t + \sin(\omega_0-\omega_{rx}$$

Jak pracuje spektrometr

Kvadraturní detekce



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Kvadraturní detekce – čas *vers.* frekvence

Šířka spektra f_{sw} Akviziční čas t_{acq}

N – počet akvizičních bodů

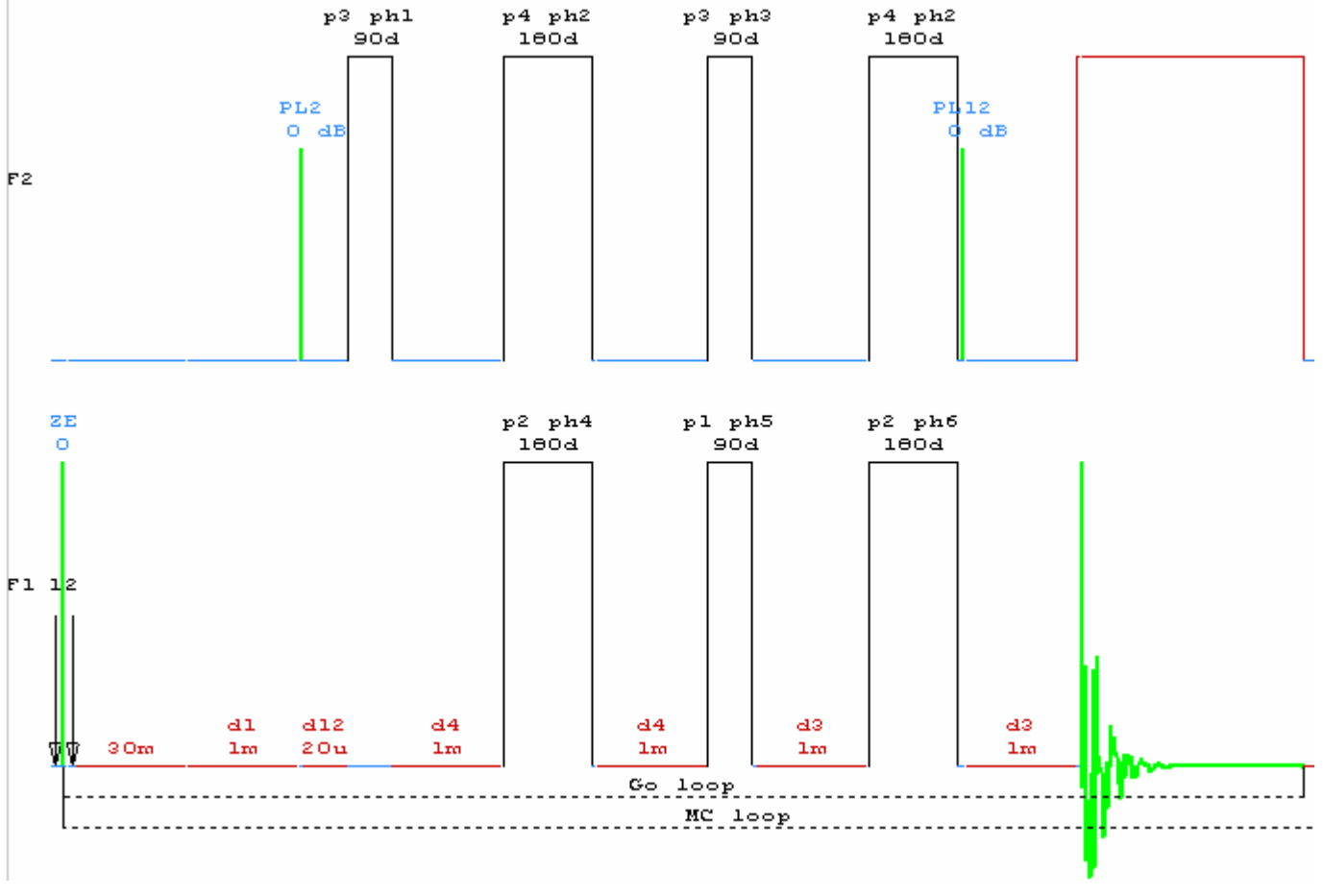
$$\Delta = \frac{1}{f_{SW}} \qquad N = \frac{t_{acq}}{\Delta}.$$

Δ – vzorkovací interval

Jak pracuje spektrometr

Pulzní programátor

INEPT s refokusací



Jak pracuje spektrometr
Pulzní programátor

```
;ineptrd
;avance-version (02/05/31)
;INEPT for non-selective polarization transfer
;with decoupling during acquisition

#include <Avance.incl>

"p2=p1*2"
"p4=p3*2"
"d3=1s/(cnst2*cnst11)"
"d4=1s/(cnst2*4)"
"d12=20u"

1 ze
2 30m do:f2
  d1
  d12 pl2:f2
  (p3 ph1):f2
  d4
  (center (p4 ph2):f2 (p2 ph4) )
  d4
  (p3 ph3):f2 (p1 ph5)
  d3
  (center (p4 ph2):f2 (p2 ph6) )
  d3 pl12:f2
  go=2 ph31 cpd2:f2
  30m do:f2 mc #0 to 2 F0(zd)
exit
```

```
ph1=0 0 0 0 0 0 0 0 2 2 2 2 2 2 2 2
ph2=0 2
ph3=1 1 3 3
ph4=0 2
ph5=0 0 0 0 1 1 1 1 2 2 2 2 3 3 3 3
ph6=0 2 0 2 1 3 1 3
ph31=0 0 2 2 1 1 3 3

;pl1 : f1 channel - power level for pulse (default)
;pl2 : f2 channel - power level for pulse (default)
;pl12: f2 channel - power level for CPD/BB decoupling
;p1 : f1 channel -  90 degree high power pulse
;p2 : f1 channel - 180 degree high power pulse
;p3 : f2 channel -  90 degree high power pulse
;p4 : f2 channel - 180 degree high power pulse
;d1 : relaxation delay; 1-5 * T1
;d3 : 1/(6J(XH))  XH, XH2, XH3 positive
;     1/(4J(XH))  XH only
;     1/(3J(XH))  XH, XH3 positive, XH2 negative
;d4 : 1/(4J(XH))
;d12: delay for power switching                    [20 usec]
;cnst2: = J(XH)
;cnst11: 6  XH, XH2, XH3 positive
;        4  XH only
;        3  XH, XH3 positive, XH2 negative
;NS: 4 * n, total number of scans: NS * TD0
;DS: 16
;cpd2: decoupling according to sequence defined by cpdprg2
;pcpd2: f2 channel - 90 degree pulse for decoupling sequence
```