Strength of rf induced spin resonances

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- **S.Y. Lee‘s paper ‚On Spin Resonance Strength of a localized rf magnetic field‘ provides an approximate formula to calculate the enhancement of rf induces spin resonances by betatron motion (equation 11).**

$$\varepsilon_k = \frac{(1+\gamma G)\nu_z\sqrt{\beta_z^0}\Theta_1}{4\pi^2(\nu_z^2-\tilde{\nu}_m^2)}\oint K_z(s)\sqrt{\beta_z(s)}\cos\left[\tilde{\nu}_m\phi_z(s)\right]e^{iK\Theta}ds$$

mit $\Theta_1 = \frac{B_x l}{B\rho}$ modulation amplitude of the rf dipole field

β_z^0 vertical betatron amplitude at the rf dipole location

In our paper normalized with $\varepsilon_{\mathrm{Bdl}} = \frac{(1+\gamma G)}{\pi\sqrt{2}}\Theta_1$ in Fig. 6!

Resonance strength calculated with Ernest Courant’s DEPOL program :

$$\varepsilon_R^{DEPOL} = \frac{(1+\gamma G)}{2\pi}\sqrt{\frac{\varepsilon_N}{\pi\gamma}}\oint K_z(s)\sqrt{\beta_z(s)}\cos\left[\tilde{\nu}_m\phi_z(s)\right]e^{iK\Theta}ds$$

Beam and machine parameters

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$$\rightarrow \varepsilon_k = \frac{\varepsilon_{\mathrm{Bdl}} \nu_z \sqrt{\beta_z^0}}{\sqrt{2}(1+\gamma G)(\nu_z^2 - \tilde{\nu}_m^2)} \sqrt{\frac{\pi\gamma}{\varepsilon_N}} \varepsilon_R^{DEPOL} \text{ (betatron part!)}$$

$$\rightarrow \tilde{\varepsilon}_k = \varepsilon_{\mathrm{Bdl}} + \frac{\varepsilon_{\mathrm{Bdl}} \nu_z \sqrt{\beta_z^0}}{\sqrt{2}(1+\gamma G)(\nu_z^2 - \tilde{\nu}_m^2)} \sqrt{\frac{\pi\gamma}{\varepsilon_N}} \varepsilon_R^{DEPOL} \text{ (pure rf dipole and betatron part!)}$$

$\varepsilon_R^{DEPOL}(8-\nu_z) = 1.62 \cdot 10^{-3}$ for $\varepsilon_N = 1\pi mmmrad$

· Values for proton beam time at 2100MeV/c (Nov. 2005)

$\tilde{\nu}_m(8-\nu_z) = 3{,}605021, \beta_z^0 = 6.39m, \gamma G = 4.394979, \gamma = 2{,}451396$

· Values for proton beam time at 1941MeV/c (Sep. 2003)

$\tilde{\nu}_m(8-\nu_z) = 3{,}880545, \beta_z^0 = 6.24m, \gamma G = 4{,}119455, \gamma = 2{,}297717$

· Values for deuteron beam time at 1850MeV/c (Dez. 2004)

$\tilde{\nu}_m(-4+\nu_z) = 3{,}799303, \beta_z^0 = 9.22m, \gamma G = -0{,}200697, \gamma = 1{,}404585$

First results (logarithmic scale)

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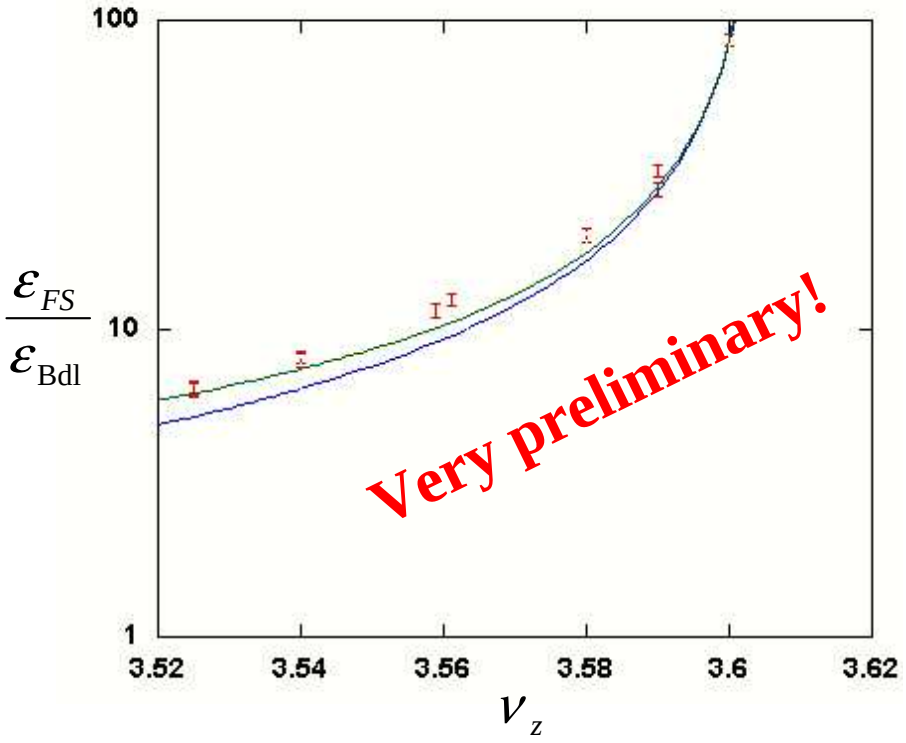
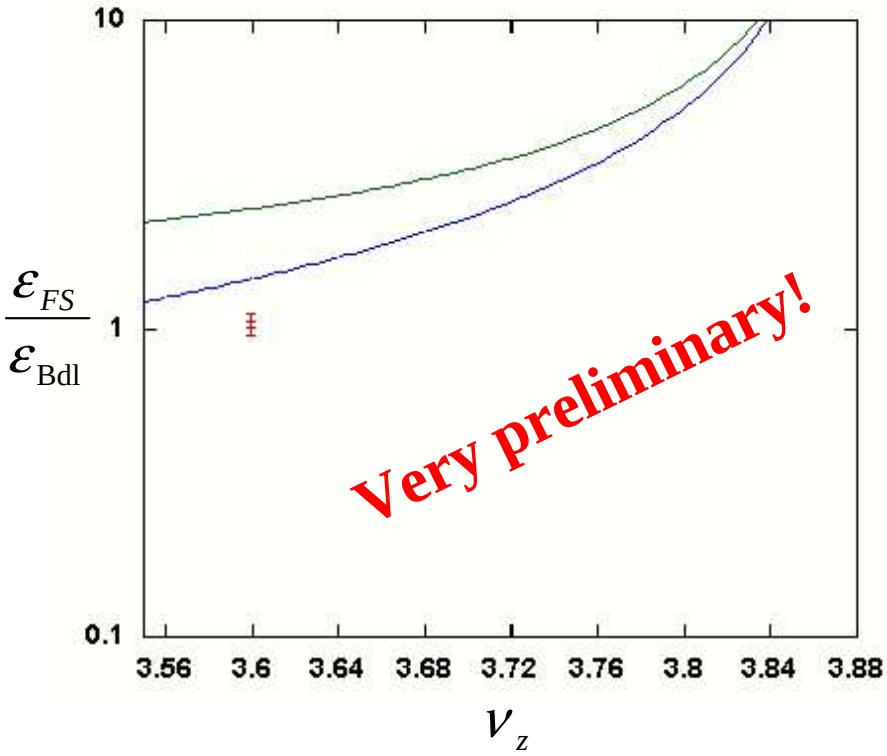
Proton data at 2100 MeV/c



Proton data at 1941 MeV/c



$$\text{blue line}: \frac{\varepsilon_k}{\varepsilon_{\mathrm{Bdl}}}$$

$$\text{green line}: \frac{\tilde{\varepsilon}_k}{\varepsilon_{\mathrm{Bdl}}} = \frac{\varepsilon_k + \varepsilon_{\mathrm{Bdl}}}{\varepsilon_{\mathrm{Bdl}}} = \frac{1}{\varepsilon_{\mathrm{Bdl}}}\left(\varepsilon_k + 1\right)$$

Deuteron data still under investigation!

First results (linear scale)

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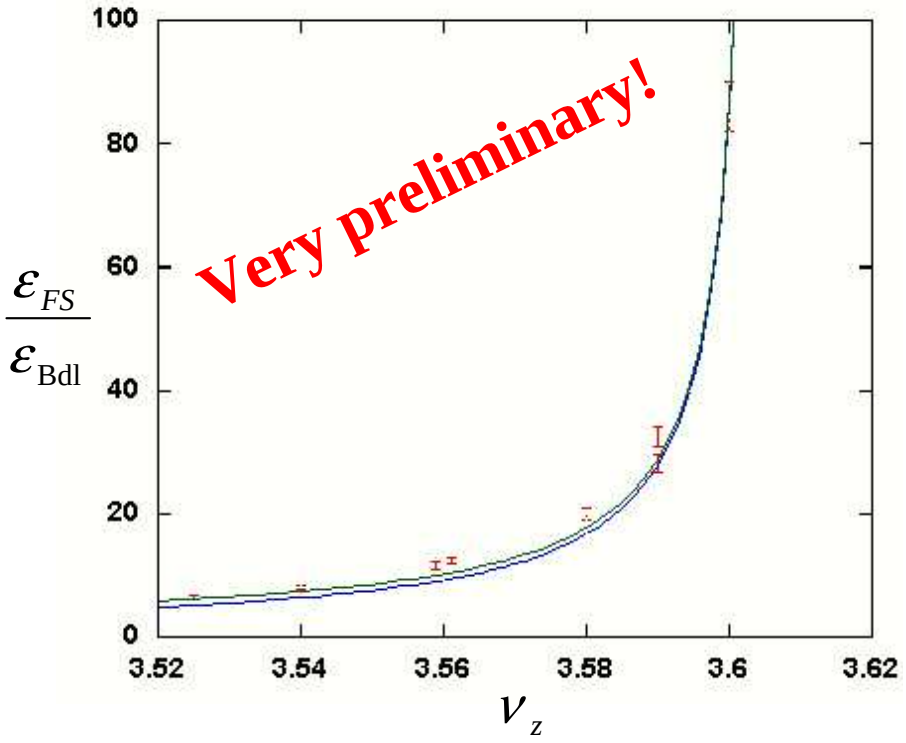
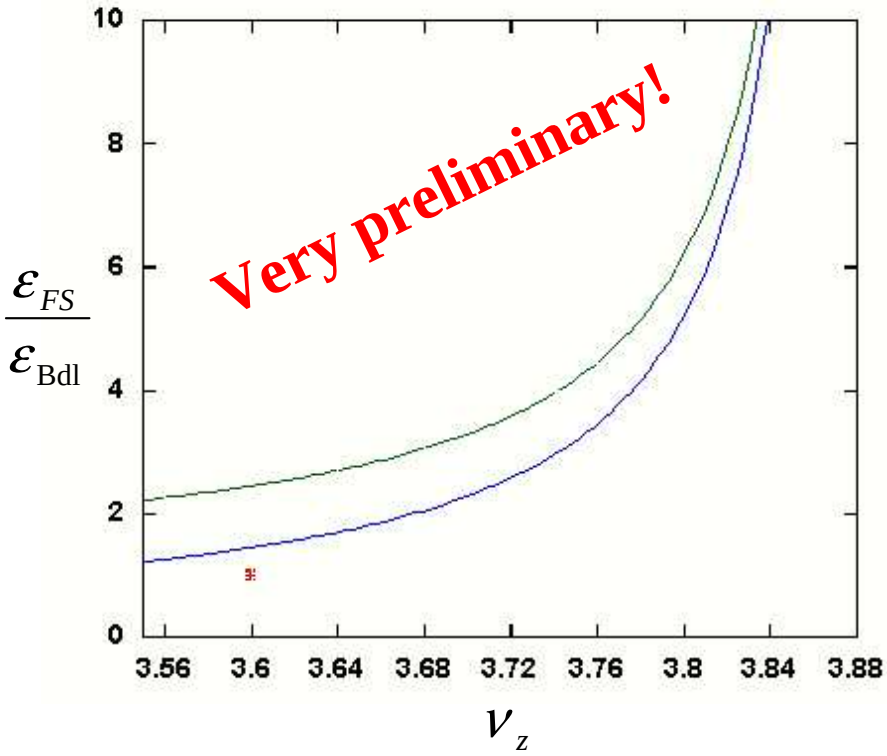
Proton data at 2100 MeV/c



Proton data at 1941 MeV/c



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