Electron cloud measurements with the microwave transmission method: Results of MD run in week 19

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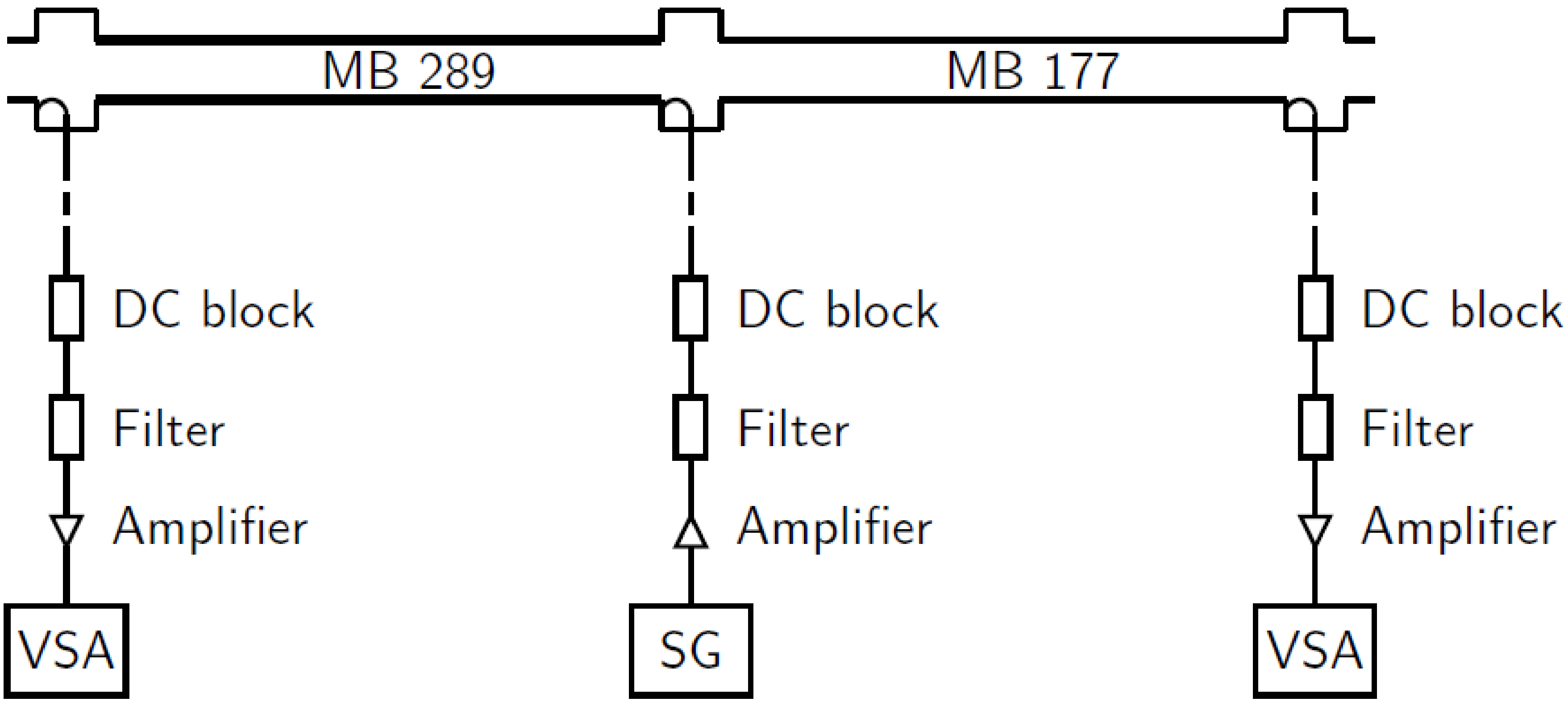
Overview

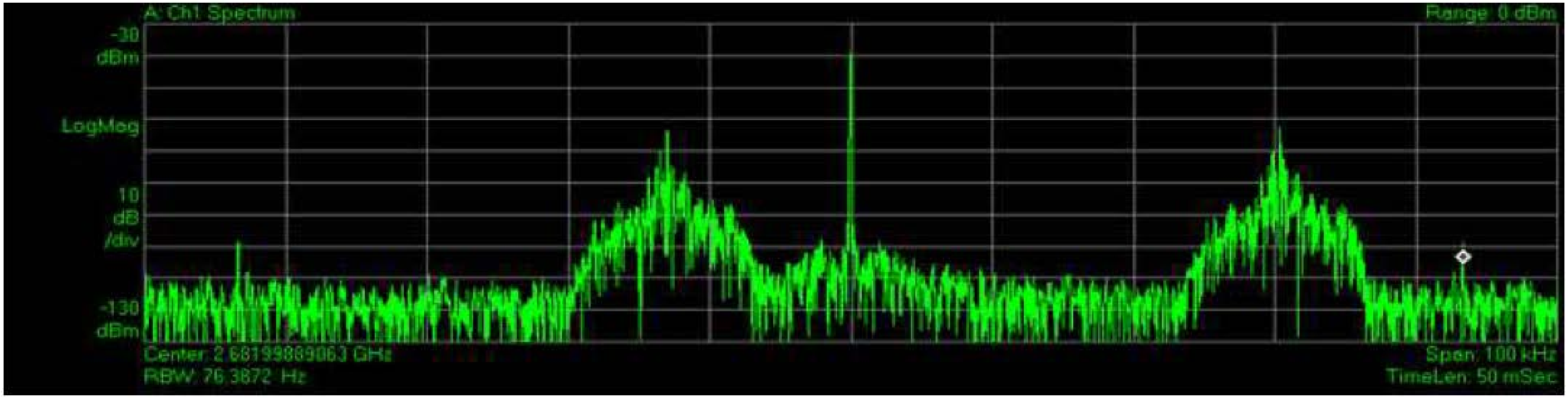
- Experimental setup
- Summary of last years findings
- Results of week 19
- Conclusions

Experimental Setup

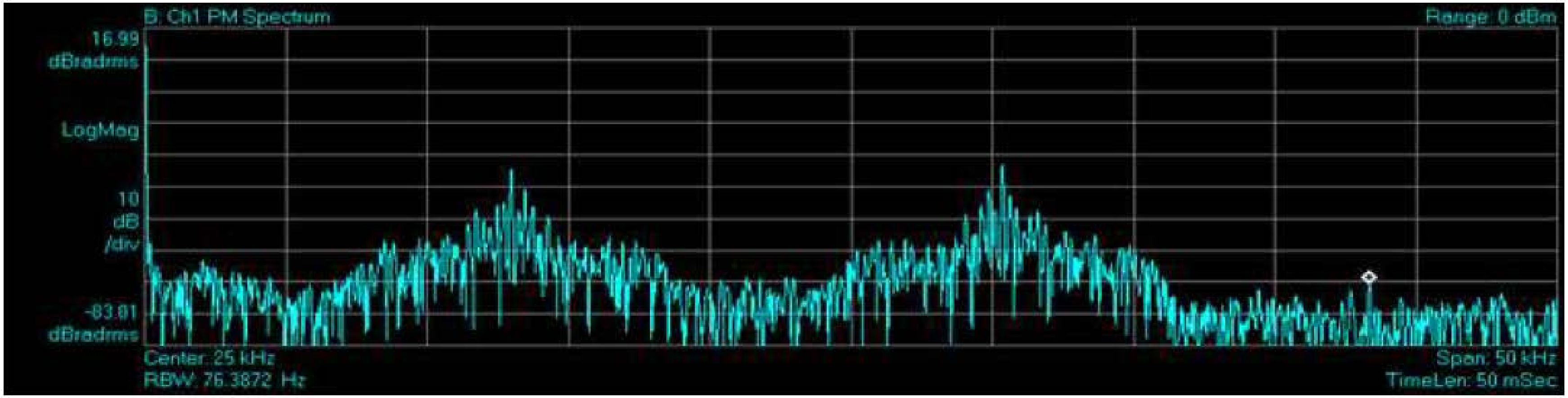


Experimental Setup

- Measurement screen shot



- Demodulation



Last year

- One successful run in September 2010
- Not confirmed in October 2010 with changed carrier frequency
- Instead:
  - Ambiguous data
  - Signal seen in some cases, in other cases not
  - No recognizable pattern in these results
- No satisfactory explanation found last year

Goals for week 19

- Measurement of new hardware transfer function
- Use CW frequency of September and October 2010 -> reproduce results
- Apply different CW frequencies, check with HTF
- Explanation of Octobers data

Results of week 19

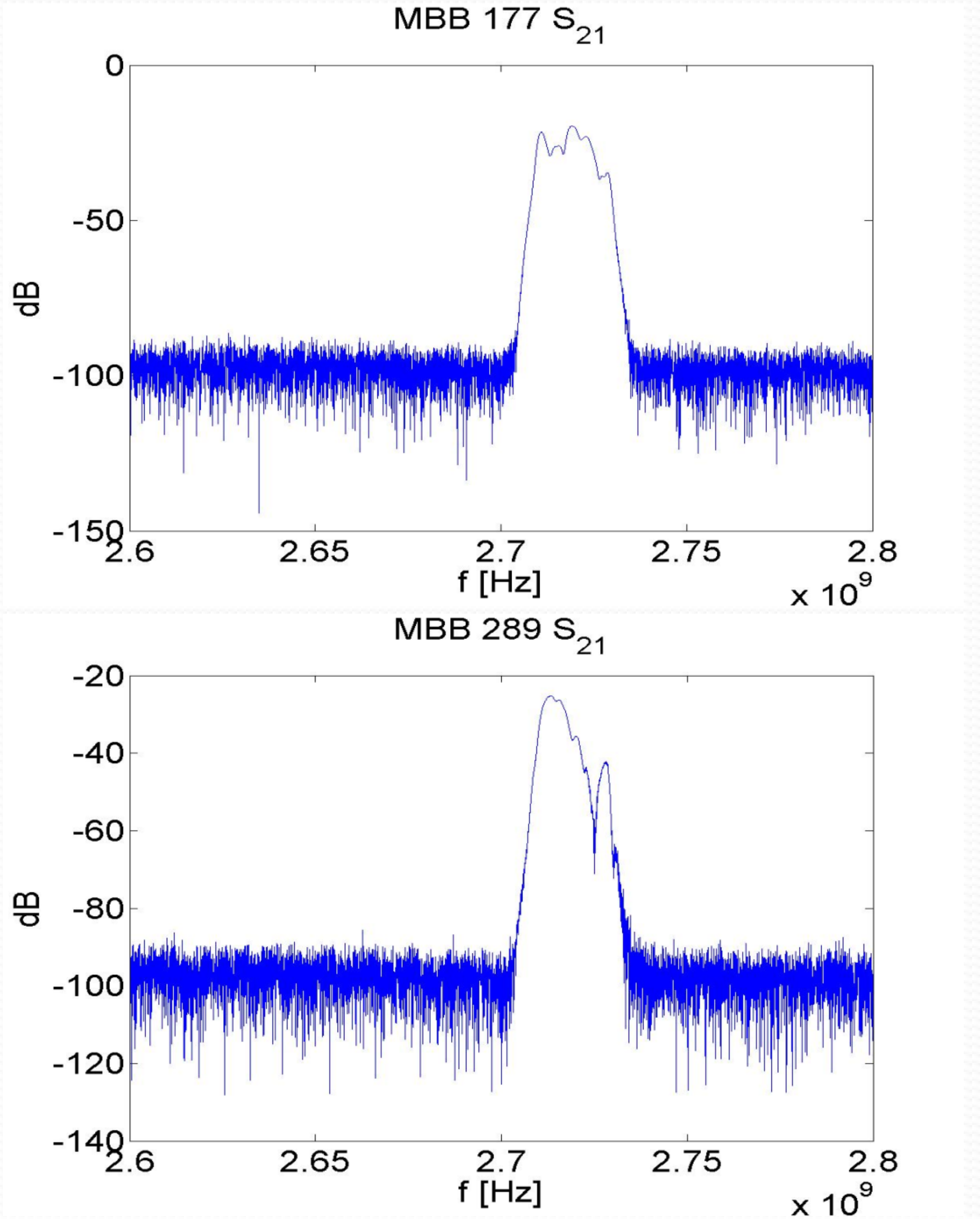
- Carrier frequency varied between
  - 2.71 GHz
  - 2.715 GHz
  - 2.716 GHz

  Frequencies used in week 39 in 2010

  - 2.718 GHz
  - 2.723 GHz

  Frequencies used in week 42 in 2010

  according to HTF

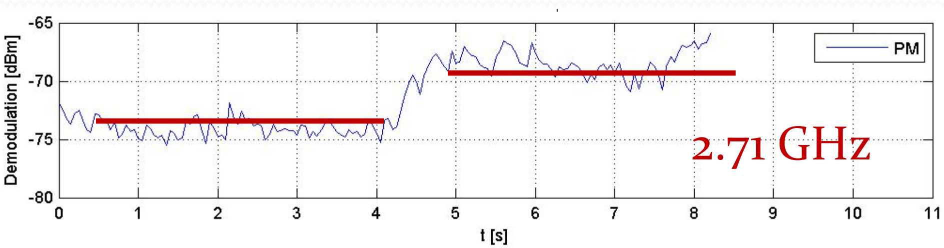


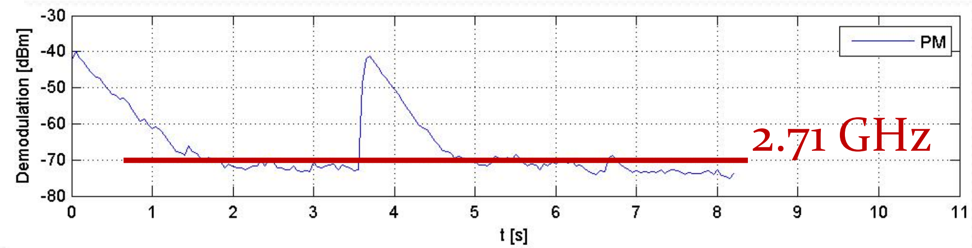
Results of week 19

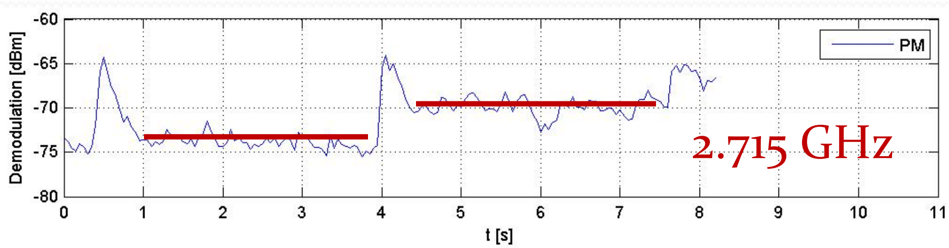
Results for frequencies used in week 39 of 2010 (2.71 GHz, 2.715 GHz and 2.716 GHz)

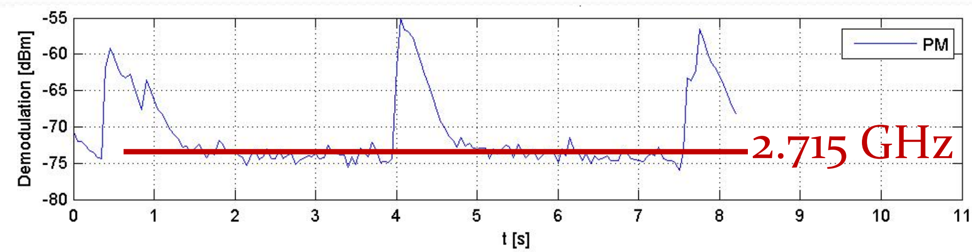
Uncoated magnet MB 177

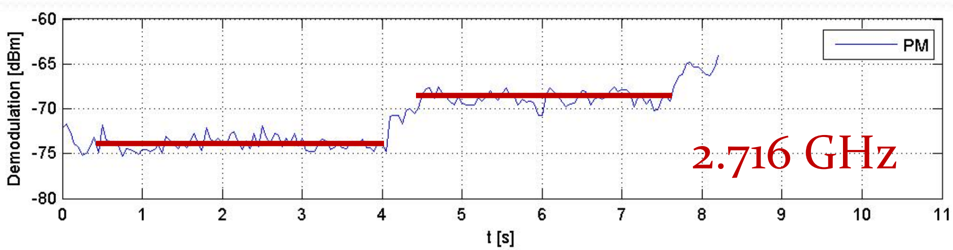
Coated magnet MB 289

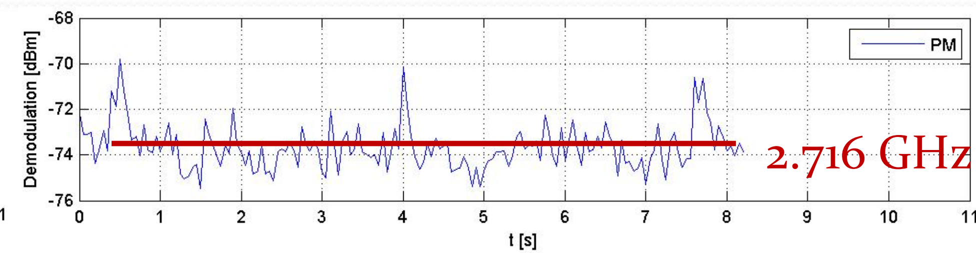












All results obtained with a 25ns beam of 3 batches at flat bottom

Results of week 19

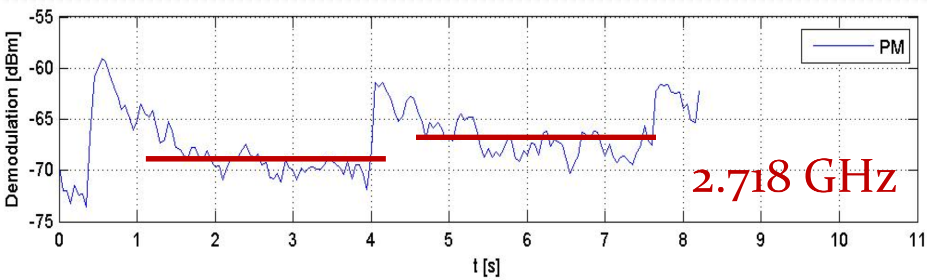
- Results as expected:
  - Uncoated magnet: signal increase of roughly 6dB for each injection
  - Coated magnet: no signal increase visible
- Confirmation of results of week 39 of 2010

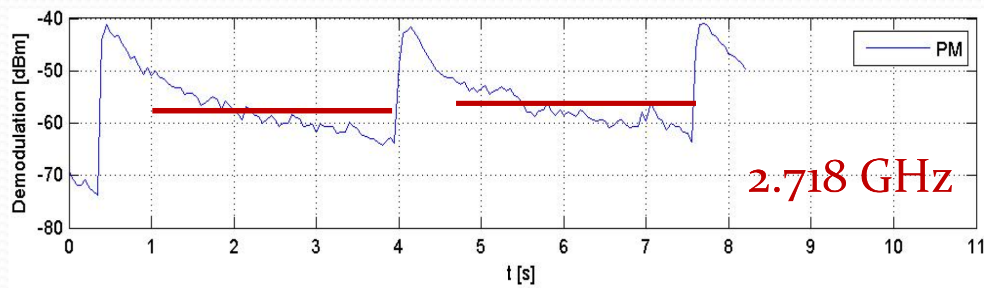
Results of week 19

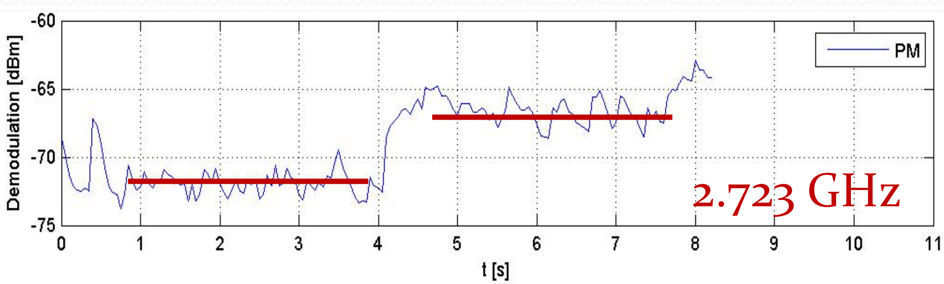
Results for frequencies used in week 42 of 2010 (2.718 GHz and 2.723 GHz)

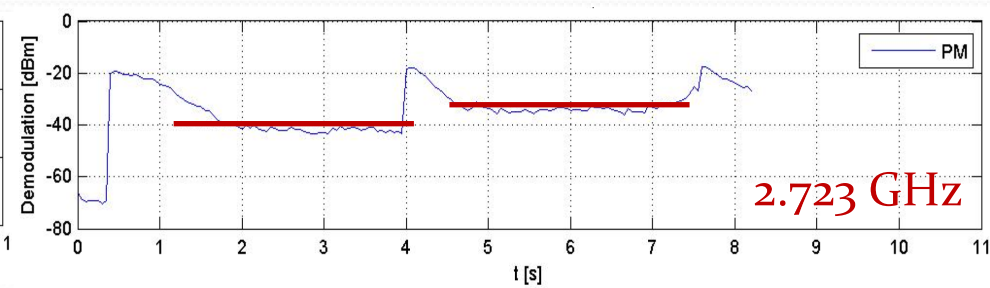
Uncoated magnet MB 177

Coated magnet MB 289









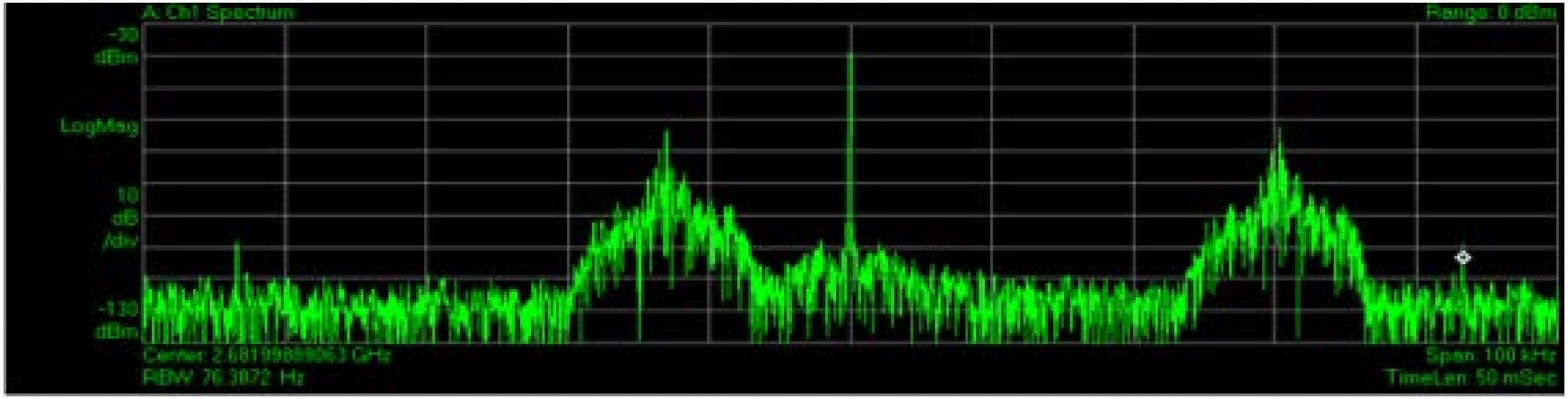
All results obtained with a 25ns beam of 3 batches at flat bottom

Results of week 19

- Results as ambiguous as in week 42 in 2010
- No correlation between other parameters (e.g.: beam intensity, spacing etc.) and this behavior found in 2010
- Simple solution found in week 19: beam induced signals are cause

Results of week 19

- Screenshot of online measurements:



- If the frequency of the carrier wave increases to a certain point, the PM signals are overlaid by the beam induced signals, causing the unexpected behavior

Summary

- New measurement setup works reliably – confirms all measurements obtained before:
  - No signal increase visible in coated magnets
  - Signal in uncoated magnet increases with each injection
- Strange behavior observed for some frequencies due to interference with beam induced signals –> upper limit of frequency range set by these and not by limit of filters (as determined by HTF)

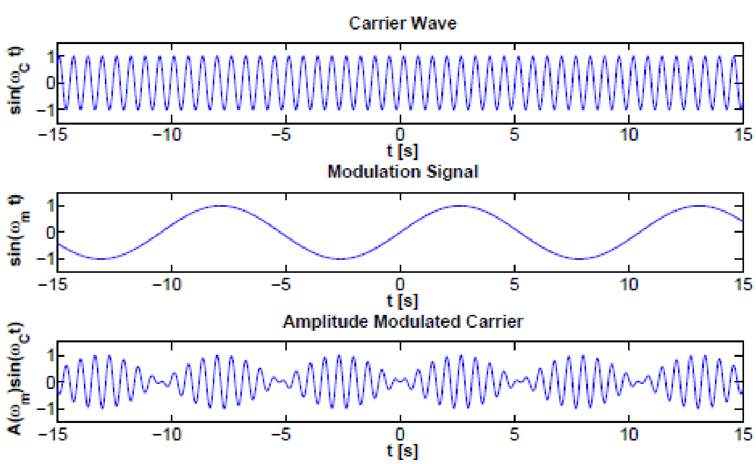
Additional Slides

- Consider carrier wave signal:

$$V(t) = A \cdot \cos(\omega_C t)$$

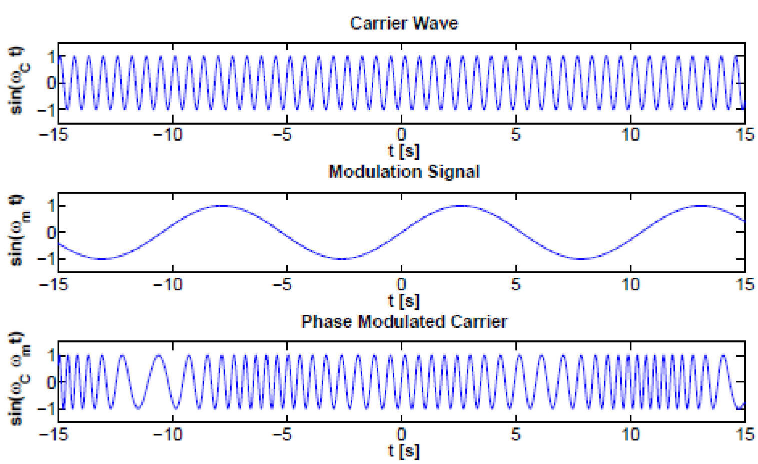
- Amplitude modulation (AM) signal

$$m(t) = A_{\mathrm{m}} \cos(\omega_{\mathrm{m}} t)$$



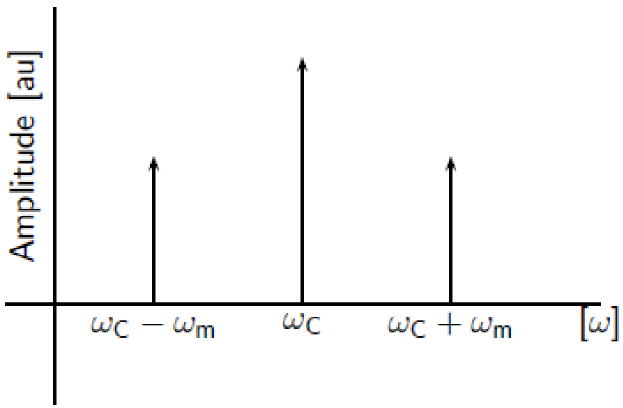
- Phase modulation (PM) signal

$$m(t) = \cos(\omega_{\mathrm{m}} t)$$

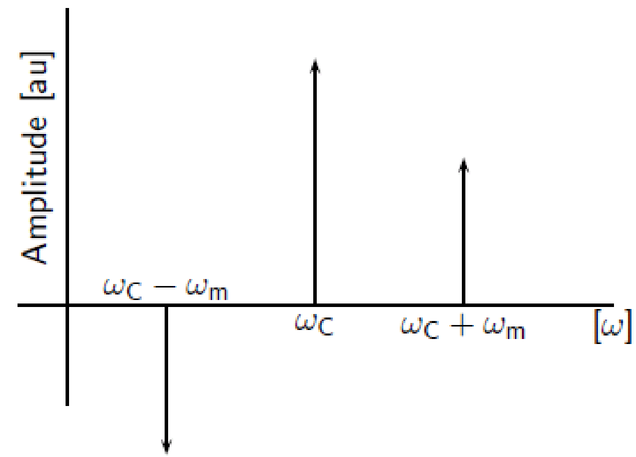


Additional Slides

- Amplitude modulation:



- Phase modulation:



$$V_{AM}(t) = A_C \cos(\omega_C t) + \frac{a\,A_C}{2}\left[\cos((\omega_C + \omega_m)t) + \cos((\omega_C - \omega_m)t)\right]$$

$$V_{PM}(t) = A_C \cos(\omega_C t) + \frac{\beta\,A_C}{2}\left[\cos((\omega_C + \omega_m)t) - \cos((\omega_C - \omega_m)t)\right]$$

Additional Slides

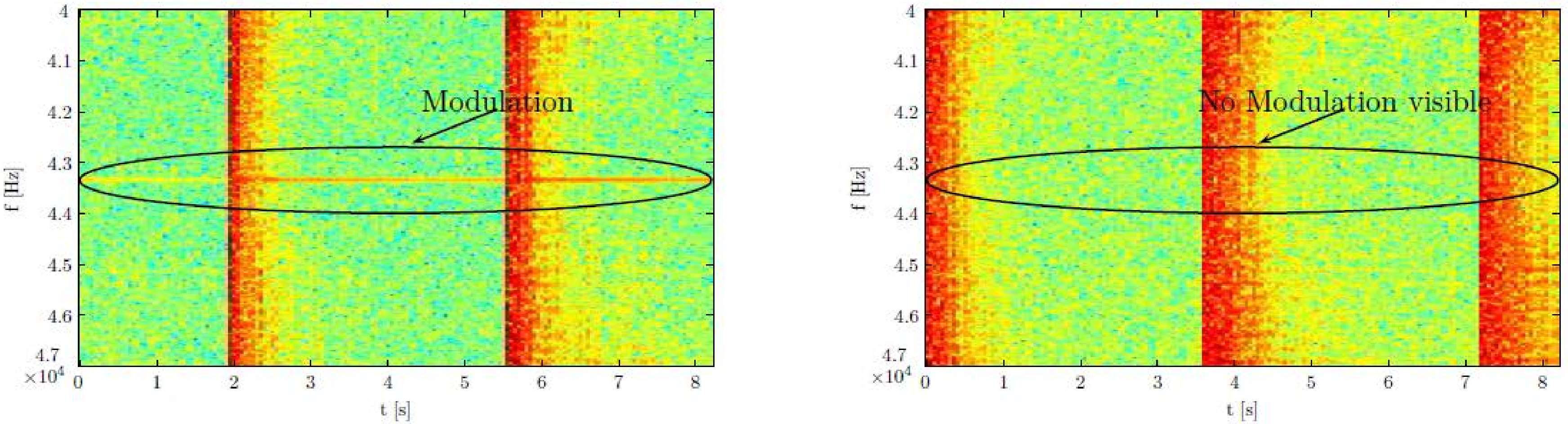
- Principle: Measurement of the induced phase shift of a microwave going through a plasma filled waveguide
- Proportional to electron cloud density:

$$\Delta\varphi = \frac{L\,\omega_p^2}{2c\left(\omega^2-\omega_c^2\right)^{\frac{1}{2}}} = \frac{L\sqrt{\frac{n_e e^2}{\epsilon_0 m_e}}^{2}}{2c\left(\omega^2-\omega_c^2\right)^{\frac{1}{2}}} \cong \frac{L\cdot 3181 n_e}{2c\left(\omega^2-\omega_c^2\right)^{\frac{1}{2}}}$$

where ω is the injected frequency, L the transmission length, ω_c the cutoff frequency of the waveguide, c the speed of light, ω_p the plasma frequency, e the electron charge, ϵ_0 the permitivity in free space and m_e the electron mass

Additional Slides

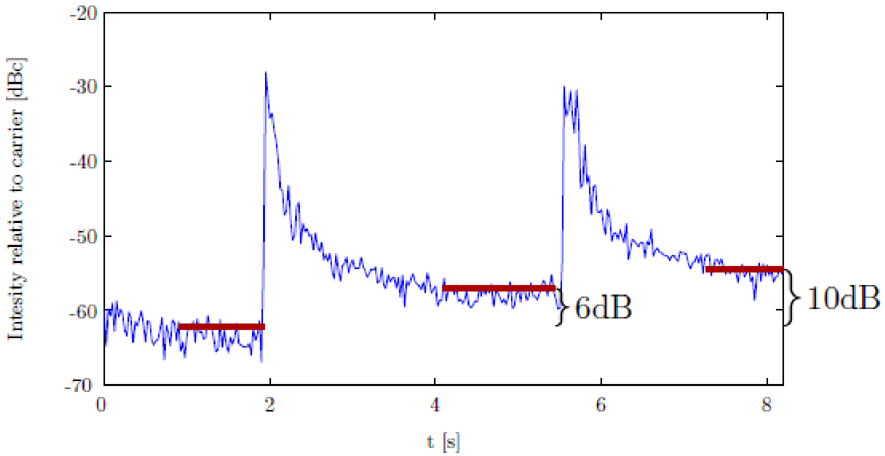
- Spectrum of uncoated and coated magnet

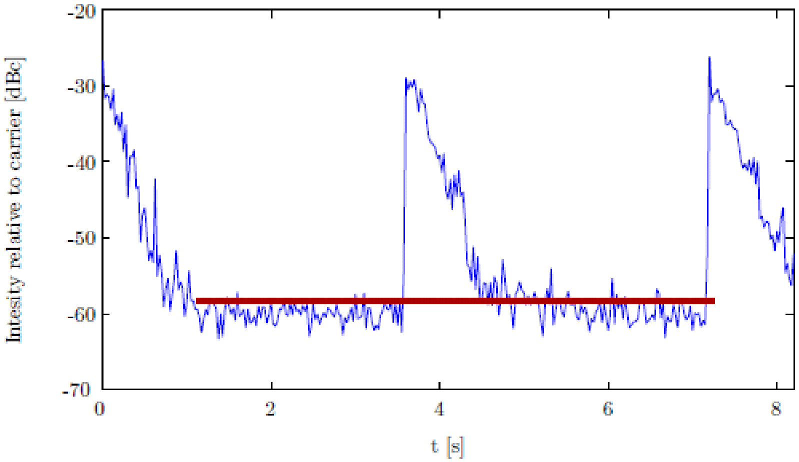


Data taken with 25 ns beam of 4 batches at SPS flat bottom

Additional Slides

- Time trace of uncoated and coated magnet - coated section minimum 6 dB lower signal





Data taken with 25 ns beam of 4 batches at SPS flat bottom