Wire Measurements on the LHC wire scanner

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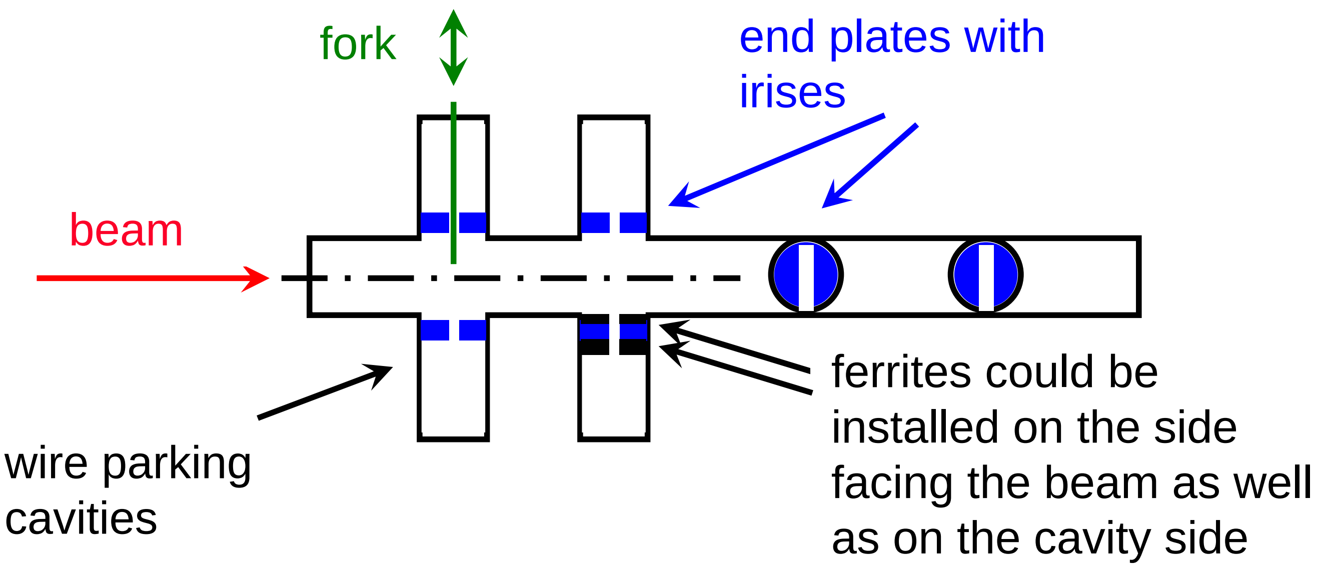
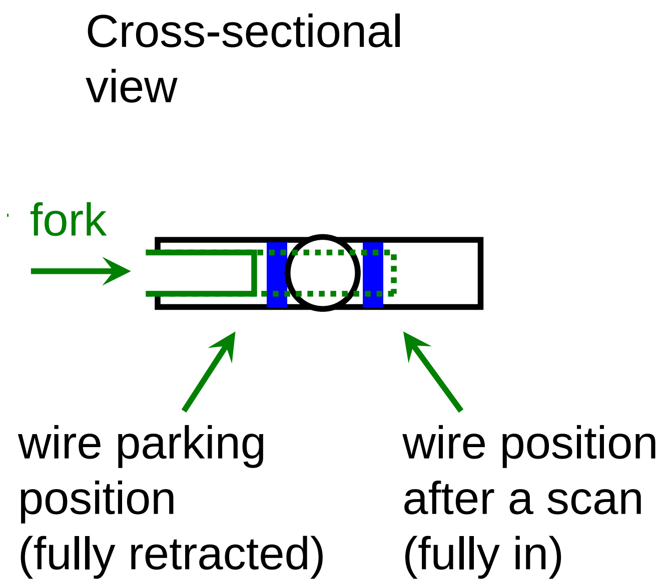
Longitudinal Measurements

- Object: 1 m long 80 mm diameter beam pipe with branches for wire scanner
  - Two horizontal and two vertical wire scanner ports
  - Each port consisting of two arms
  - Towards beam irises, dimensions: 73 mm long, 9 mm wide and 6 mm
  - Fork with mounted carbon wire (fragile!!!)
  - Carbon wire DC resistance: $\approx$1.5 kΩ; replaced be 2.2 kΩ resistor for ease of handling





Longitudinal Measurements

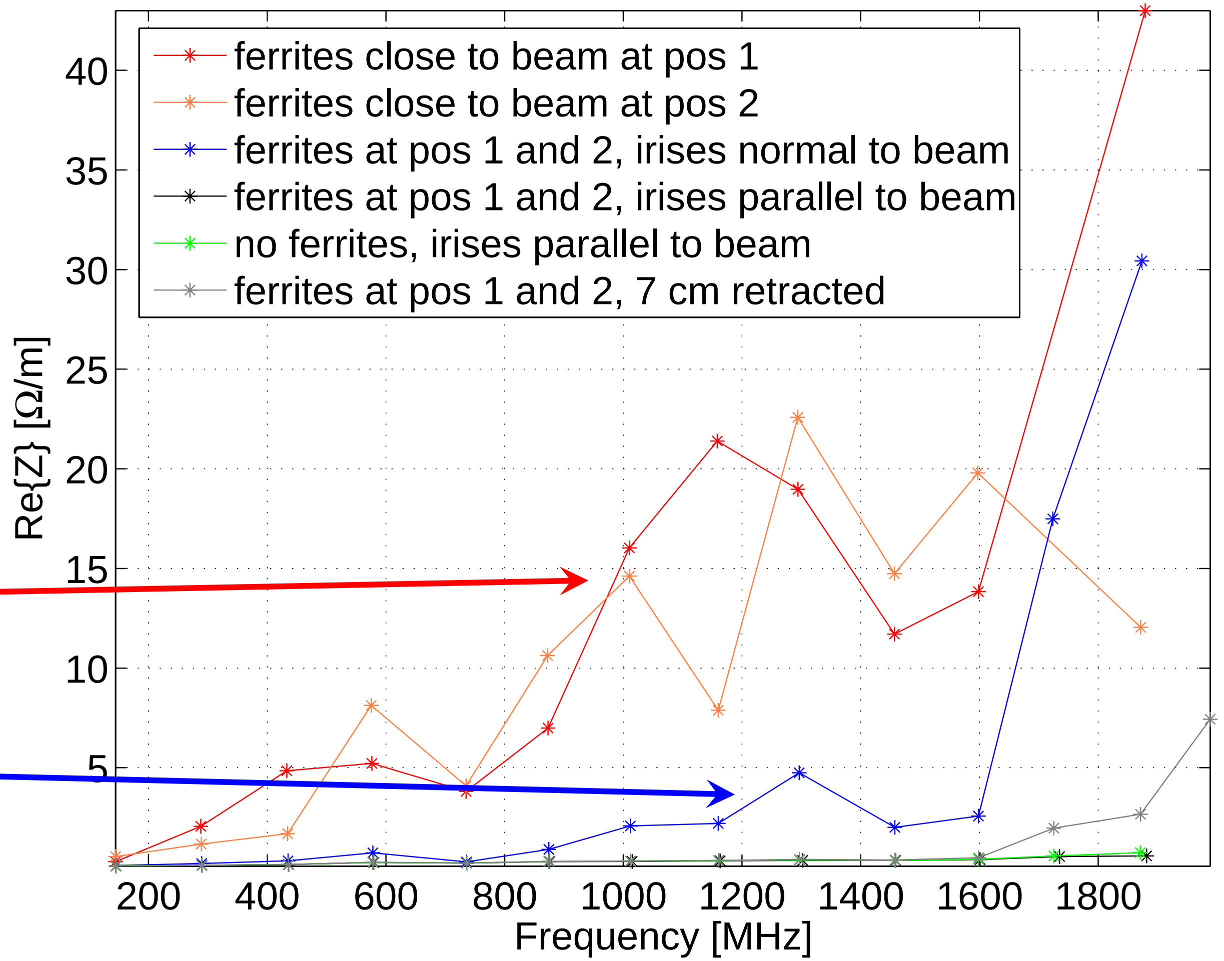
- Potential problems
  - In parking position, the wire is sitting in a cavity; excited modes may burn it $\Rightarrow$ ferrites inside cavities necessary?
  - The irises with the cavities behind present a significant beam-coupling impedance, resonances might occur; need to be damped?
  - When the fork is in parking position at the other side, inductive as well as capacitive coupling to the beam possible

- At which places can/must ferrites be put to mitigate these problems?
  - In present design ferrites can put on the flange of the wire scanner ports close on both sides of the iris
  - Ferrites can be put on the side facing the beam as well as on the side looking away from the beam

Resonator Measurements

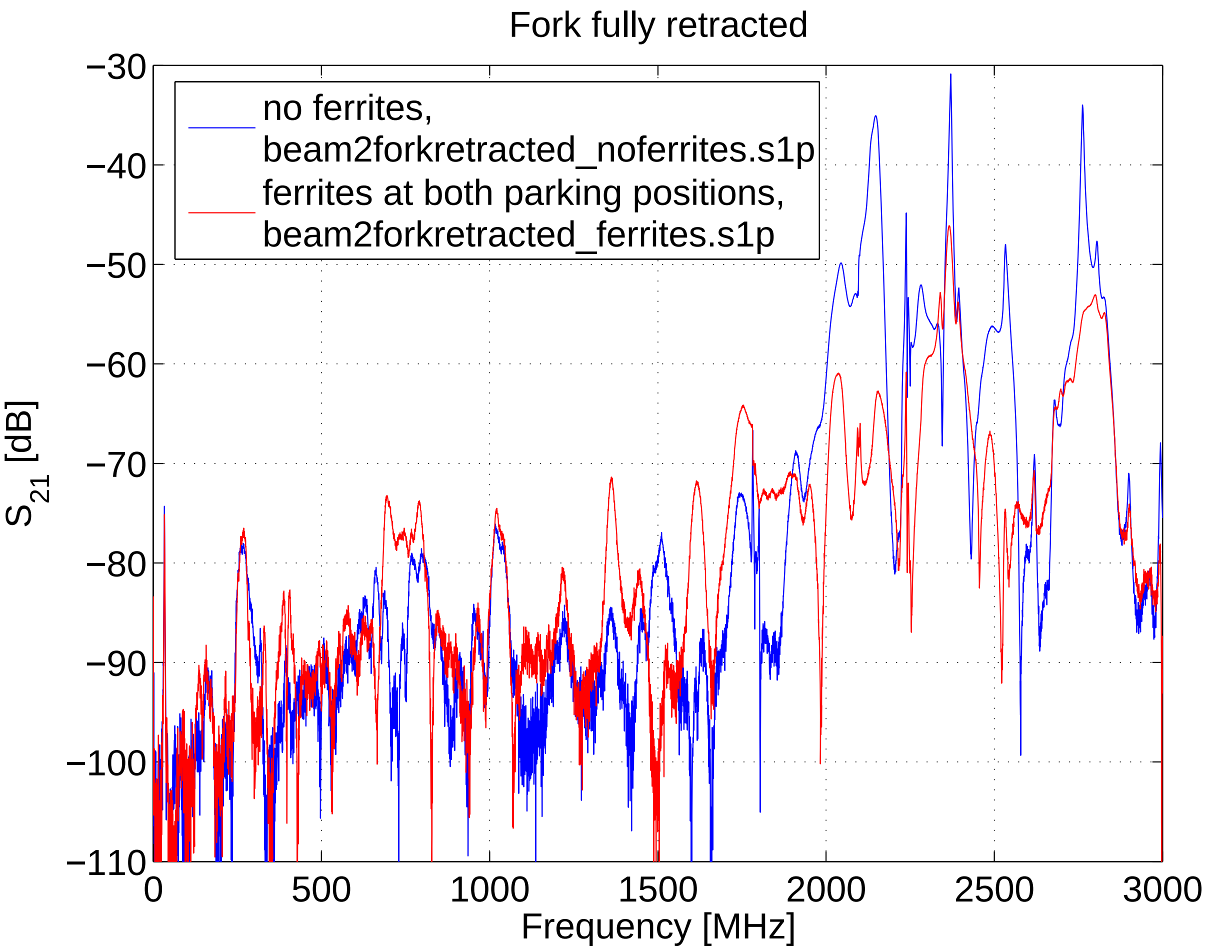
- 10 mm diameter silver coated steel rod used as inner conductor
- Precise absolute measurement of the longitudinal impedance
- Ferrites inserted at different positions

- Ferrites facing the beam cause high impedance, in the range of 10 Ω per wire scanner port ⇒ heating etc ⇒ should be avoided
- Ferrites inside the wire scanner parking slot cause little impedance; could be further reduced by retracting or repositioning ferrites
- When the irises are turned parallel to the beam, the impedance gets close the stainless steel pipe's



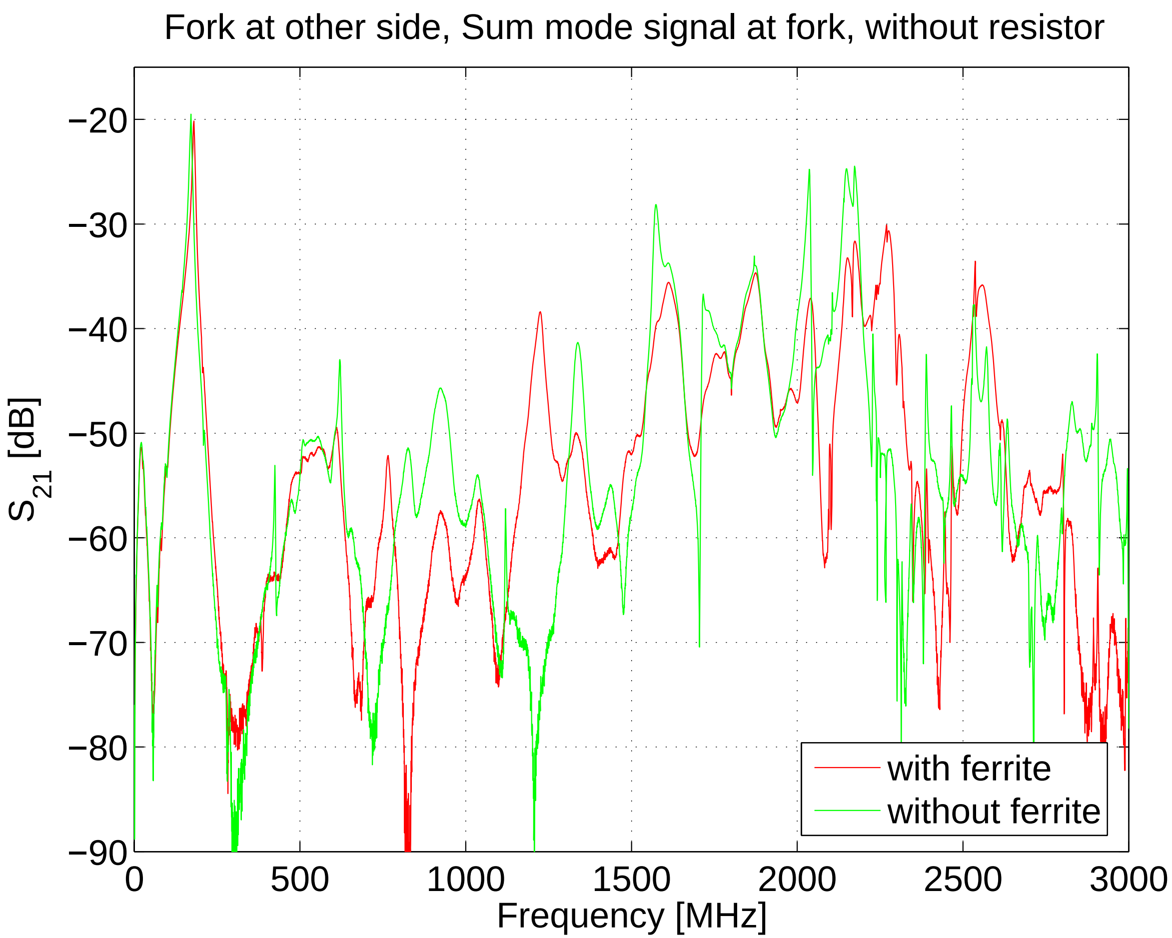
Signal coupled to the wire scanner parking cavity

- Fork fully retracted to parking position
- Transmission from beam to fork (Δ mode)
- Similar result for Σ mode
- Low transmission below 2 GHz
- Good coupling on from λ/2 length of iris; similar to slot-coupled waveguides; changing the iris' thickness or width does not have a big impact on coupling...
- Ferrites inside the wire scanner cavity provide sufficient damping



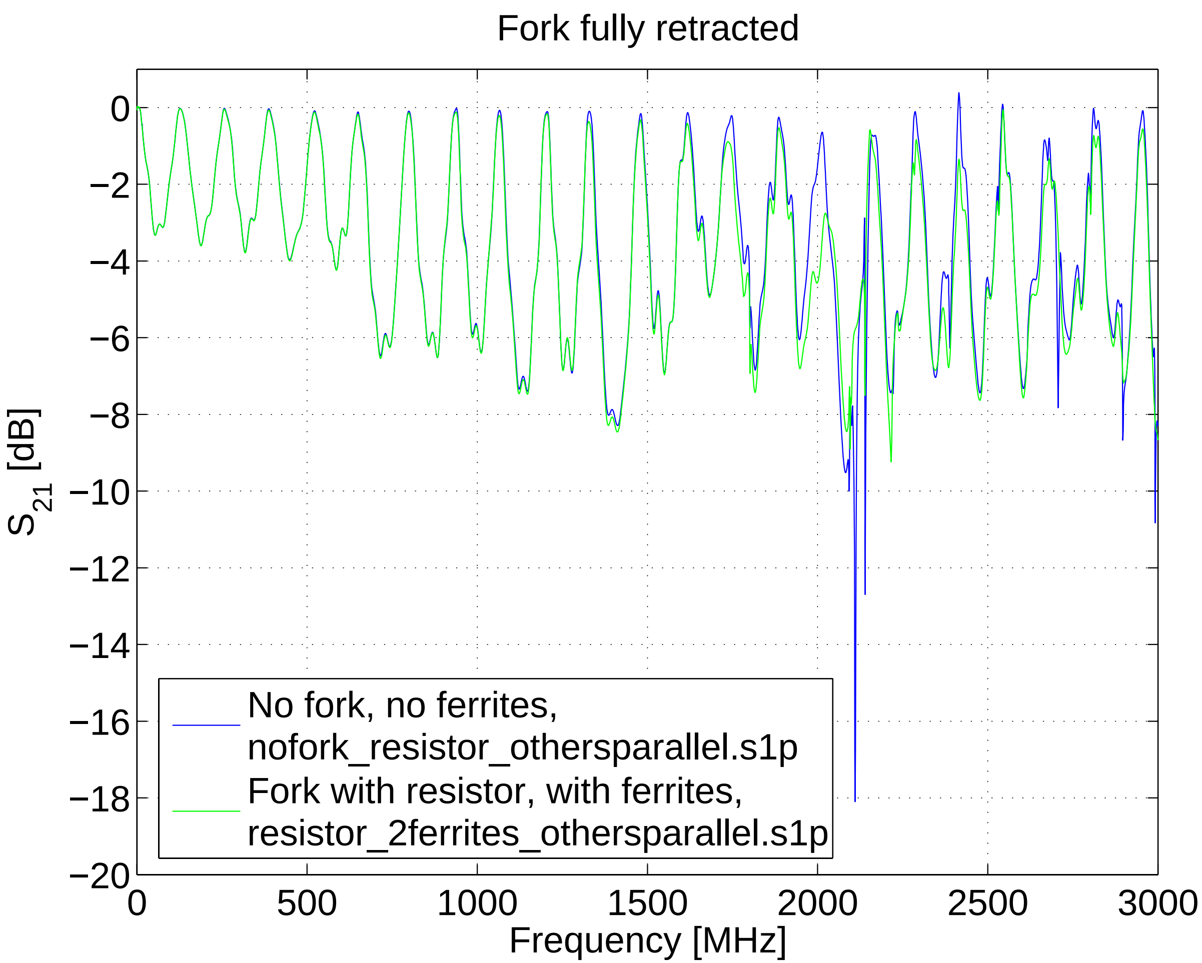
Signal coupled to the wire scanner parking cavity

- Fork fully in, i.e. in far-away parking position
- Transmission from beam to fork (Σ mode)
- Weaker transmission for Δ mode $\Rightarrow$ mostly capacitive coupling $\Rightarrow$ fork acting as a capacitive pick-up
- First strong resonance at $\approx$180 MHz, more resonances above 1.5 GHz
- Ferrites do not damp the 180 MHz resonance
- Fork should be terminated RF-wise, otherwise a considerable current will flow over the carbon wire



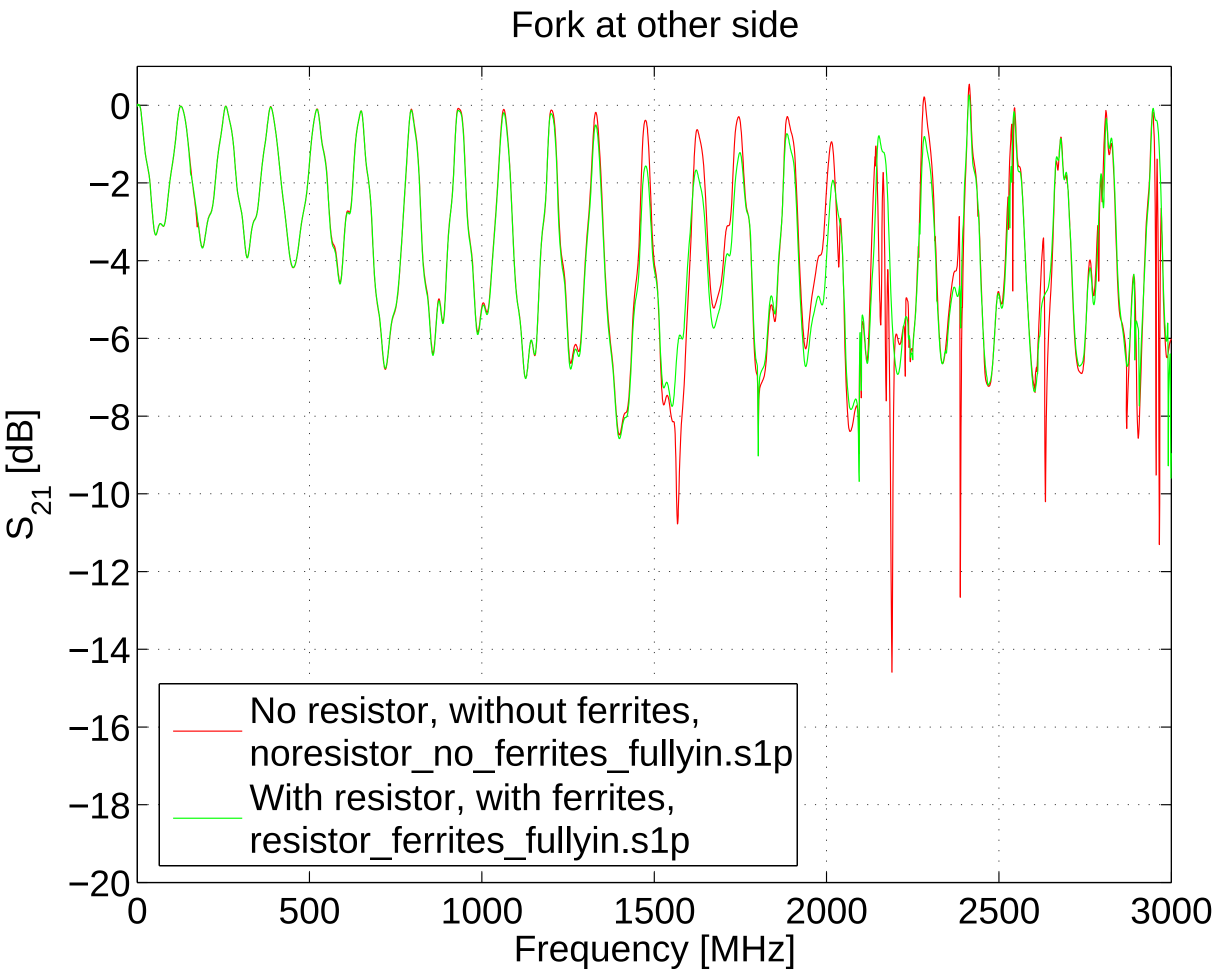
Resonances in the longitudinal impedance - Fork retracted

- Corresponding to the signal induced in the fork, resonance dips can be seen in the transmission response through the pipe above 2 GHz
- These resonances are sufficiently damped by ferrites on the inside of the parking cavities
- The beam hardly sees the wire scanner cavity below 1.5 GHz



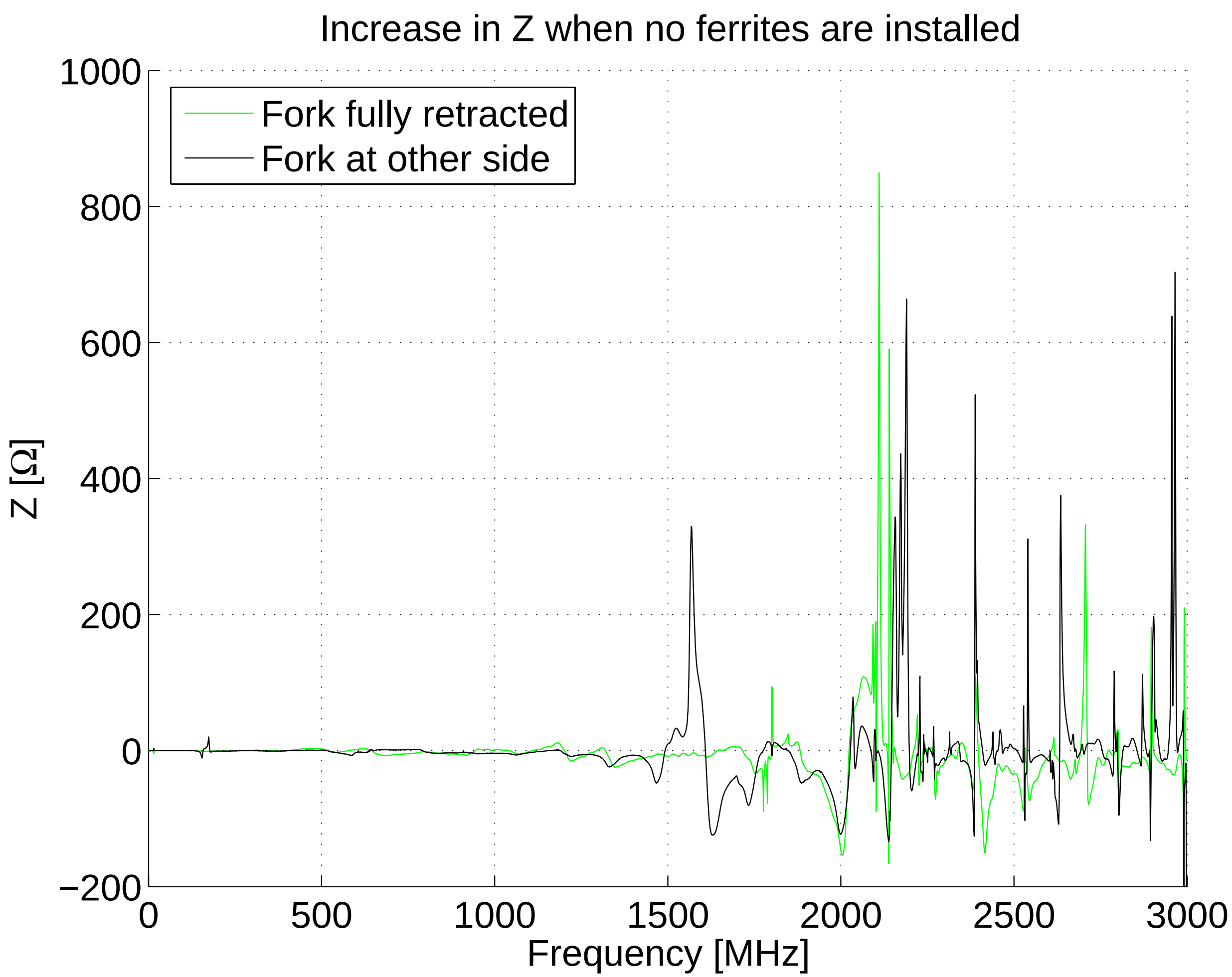
Resonances in the longitudinal impedance - Fork fully in

- As expected, when the fork is in the parking position on the other side, resonances are seen already above 1.5 GHz
- Again, these resonances are sufficiently damped by ferrites on the inside of the parking cavities
- However, a few additional smaller resonances appear when ferrites are used
- Below 1.2 GHz, even with the fork on the opposite side, the coupling to the beam is weak



Resonances in the longitudinal impedance - Z

- Impact of ferrites in terms of Z
- Rather small effect below 1.5 GHz
- Above 1.5 GHz, sharp resonances are smoothed
- At a few locations broad-band impedance increases somewhat



Conclusion

- Resonator measurements showed that ferrites facing the beam are not an option; fortunately there are not really needed, either.
- On the other hand, ferrites inside the parking cavities are necessary to dissipate coupled power and protect the wire.
- When the fork is on the opposite side of the beam pipe, it may pick up a significant signal in spite of ferrites; the fork should be terminated with a matched load to prevent dissipating this signal in the carbon wire.
- With these two precautions taken, the wire should not suffer too much from beam-induced signals.
- With no ferrites directly facing the beam, the longitudinal impedance should be rather low