Wire Measurements on the LHC wire scanner

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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: $\approx 1.5 \, k\Omega$; replaced be 2.2 $k\Omega$ resistor for ease of handling

Longitudinal Measurements

Ferrites could be installed on the side facing the beam as well as on the cavity side.
Potential problems

- In parking position, the wire is sitting in a cavity; excited modes may burn it ⇒ 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
Fork fully in, i.e. in far-away parking position

Transmission from beam to fork ($\Sigma$ mode)

Weaker transmission for $\Delta$ 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
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
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.