Analysis and Measurements of the extraction kicker with half size bus-bar and new ferrite

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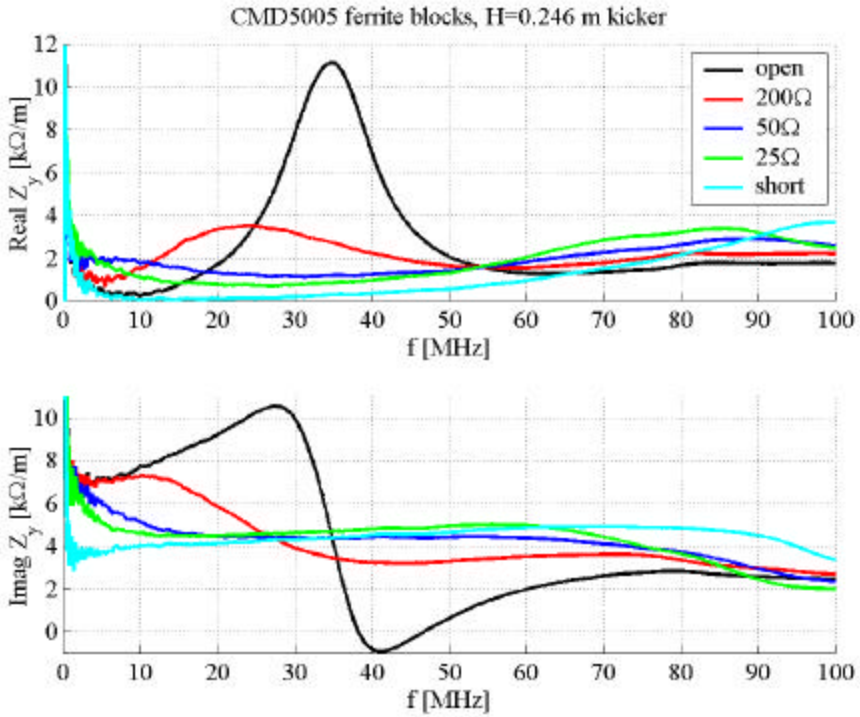
Motivations:

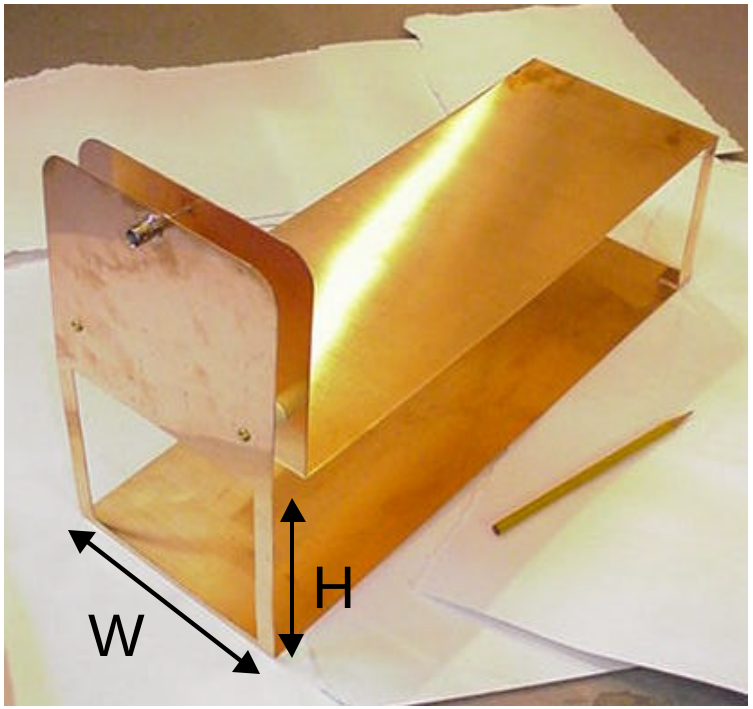
- Present impedance budget for the kickers is based on a scaling law (ratio of the squared bus-bar height)→ Measurements on the kicker with a half-size bus-bar were performed to check that law.
- Low-μ ferrite blocks (C2050 type, μ_i=100, etc) have been used to find a possible reduction of the coupling impedance.

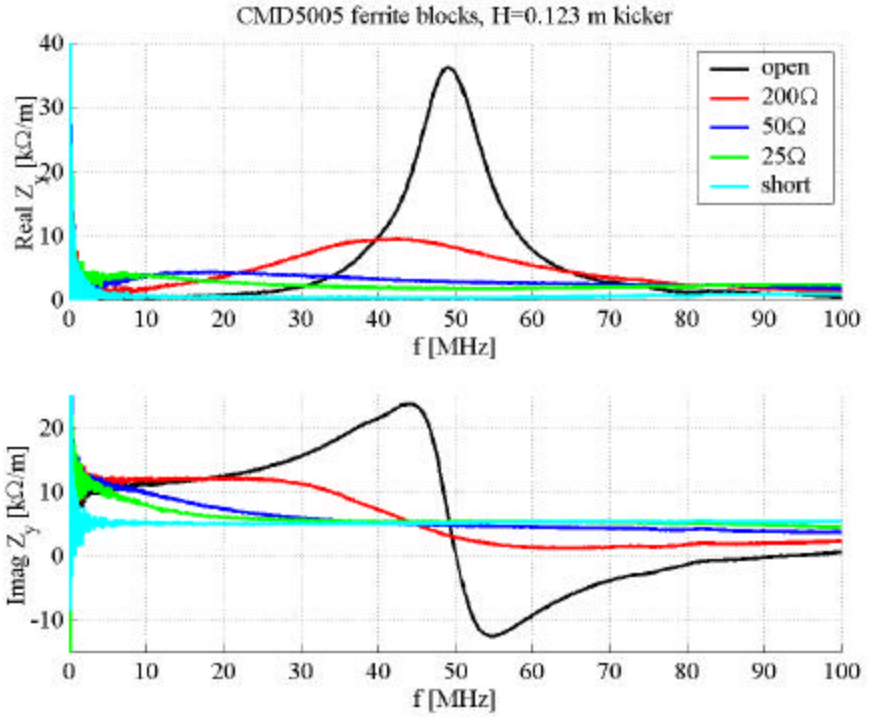
Vertical transverse impedance (CMD5005, full size bus-bar):

- Open termination has a resonance at 35 MHz (w/o feed-thru).
- External resistor damps the resonance.
- Short-circuit termination has the lowest impedance.
- With 25Ω termination, Zy is about 2.1kΩ/m at 5MHz.



Vertical transverse impedance (CMD5005, HALF size bus-bar, H=12.2 cm):





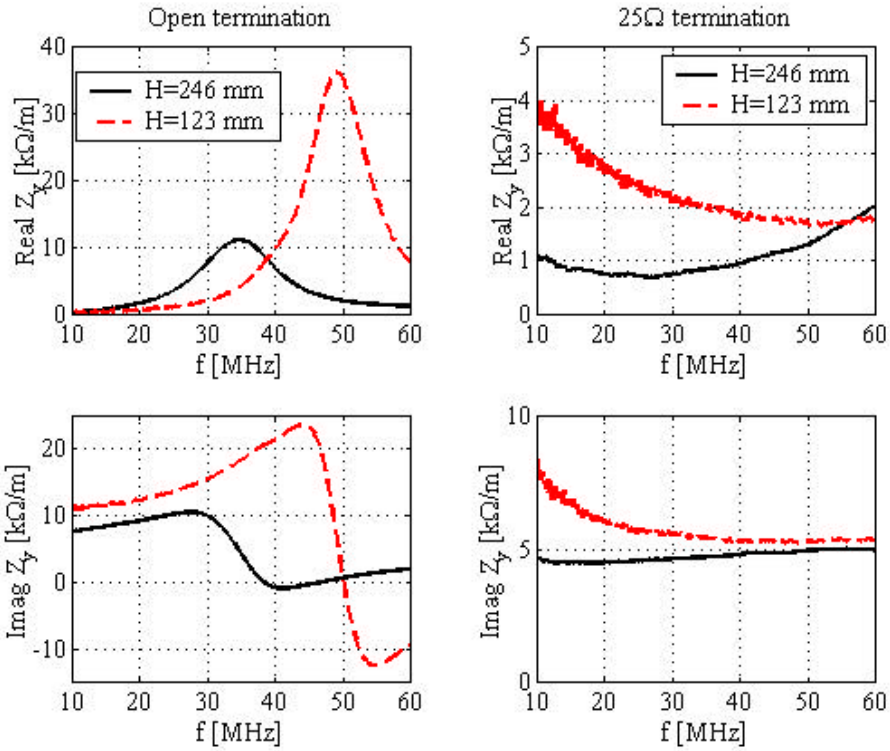
- Open termination has a resonance at 48 MHz.
- ($L \sim \mu_0 * H * l / w$ and $H_{hs}=H/2 \rightarrow L_{hs}=L/2 \rightarrow f_{hs}=f_0$ sqrt(2)).
- All the impedances are higher (expected).

Comparison of vertical transverse impedance (CMD5005):

- Scaling law:

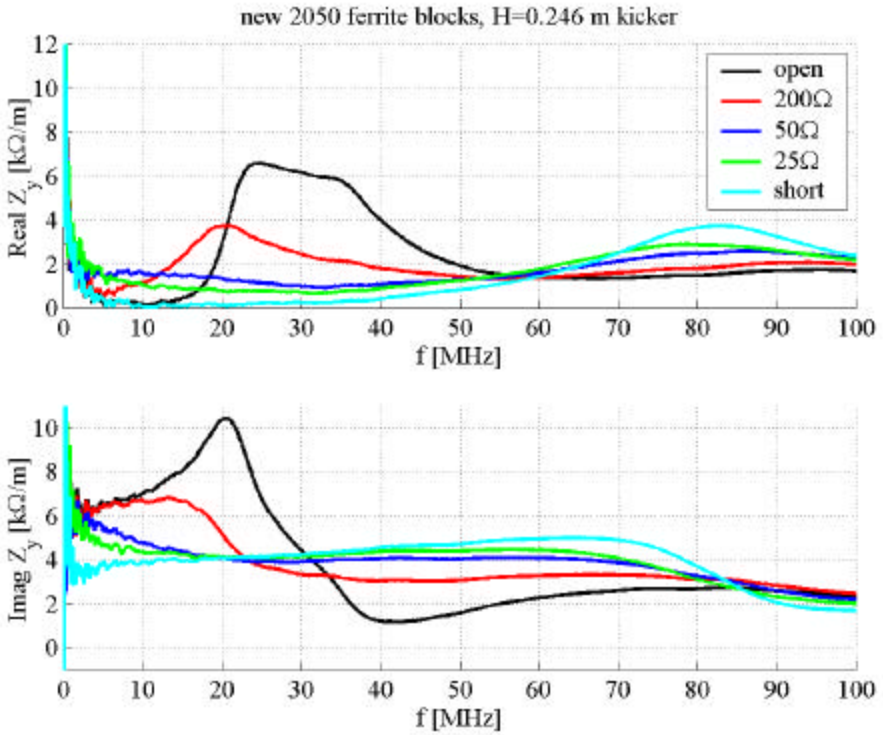
$$Z_{\wedge 1} / H_1^2 = Z_{\wedge 2} / H_2^2$$

- Error for 25Ω termination is negligible up to 30 MHz.
- Error in the peak for open termination is 15% (real part, still very good!).
- Imaginary parts: L is the half in one case.
- The measurements were performed on 10/11/01 and 4/17/02 !!!

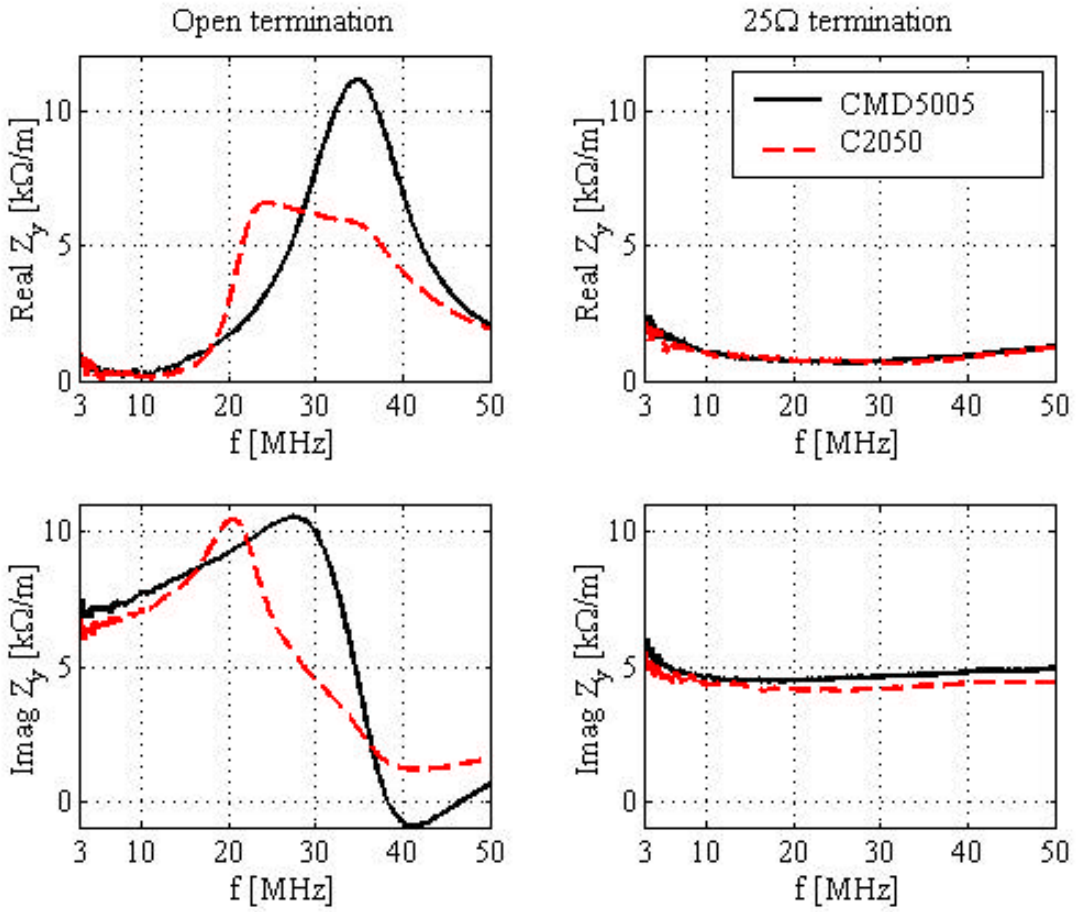


New ferrite: Vertical transverse impedance (2050, full size bus-bar):

- Open termination → the peak is damped by a factor two.
- External resistor still damps the resonance.
- Short-circuit termination has the lowest impedance.
- The picture at low frequency is not changed…
- 25Ω termination has about 2.1k Ω /m at 5MHz (no significant reduction).



New ferrite: Vertical transverse impedance (2050, full size bus-bar):



New ferrite: Comments…

- As foreseen, the impedance at low frequency is mainly driven by the external load → no change with new ferrite.
- For the low-μ ferrite, the resonance peak of the open termination case is reduced by almost a factor 2, which seems in contrast with the better loss factor property, but which can be explained by a sheared permeability due to the air-gap (N is the fraction of the air gap in the magnetic circuit):
  - $\mu_{eff} = \mu_0 (\mu' - j\,\mu'') / [1 + N(\mu' - j\,\mu'')]$
  - $\mu_{eff} = \mu_0 \{\mu' / (1 + N\mu') - j\,\mu'' / (1 + N\mu')^2\}$
- This fact points to the possibility of resonance damping for open-terminated kickers, but with a 25Ω resistive termination the coupling impedance is unchanged.

Conclusions:

- Measurements on the kicker with a half-size bus-bar confirmed with a good precision the scaling law used for the impedance budget.
- Measurements with C2050 ferrite blocks did not change the transverse impedance with resistive termination at low frequency (f<20 MHz).