EXTRACTION KICKER STRIPLINE MEASUREMENTS

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On behalf of:
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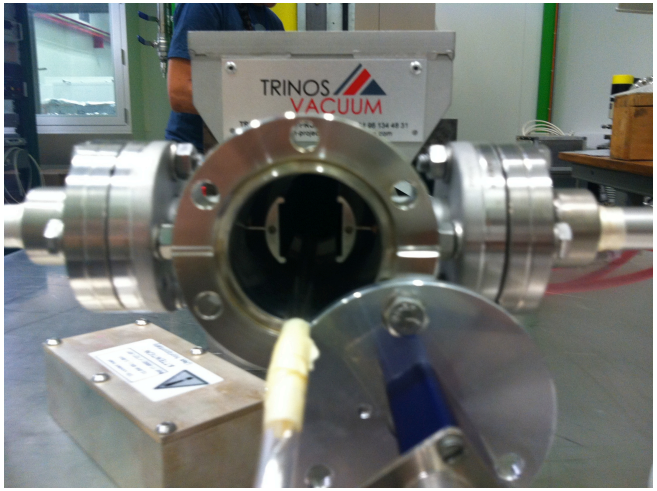
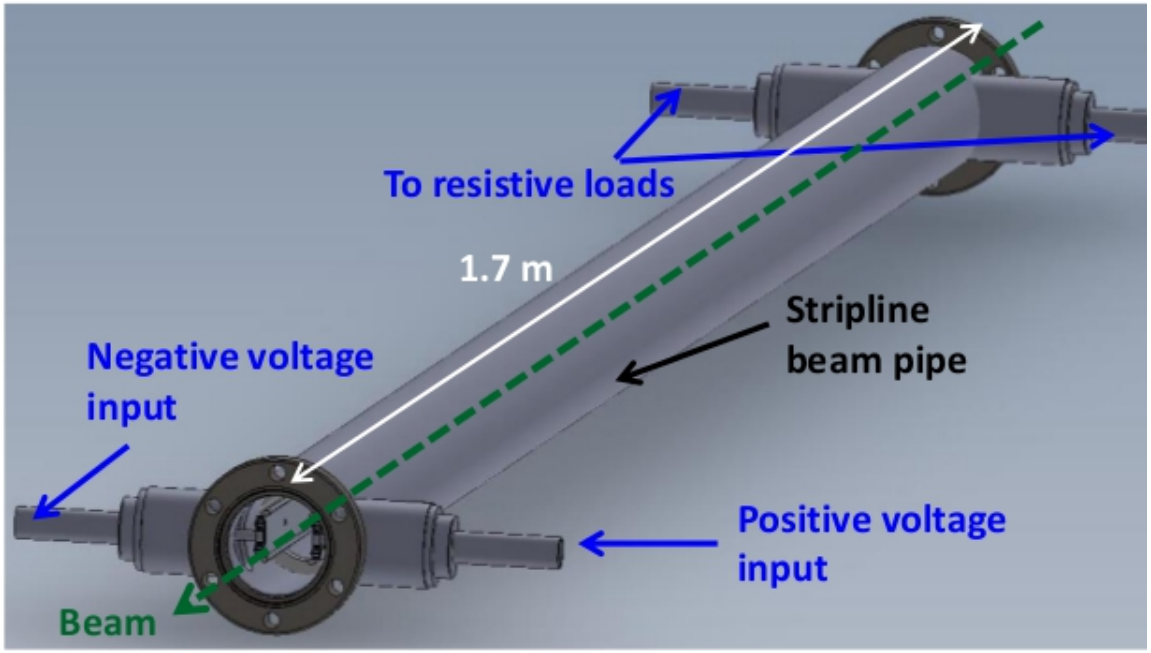
1) INTRODUCTION





The design of the striplines and their components has been published in the **PRSTAB 17, 071003** (July 2014).

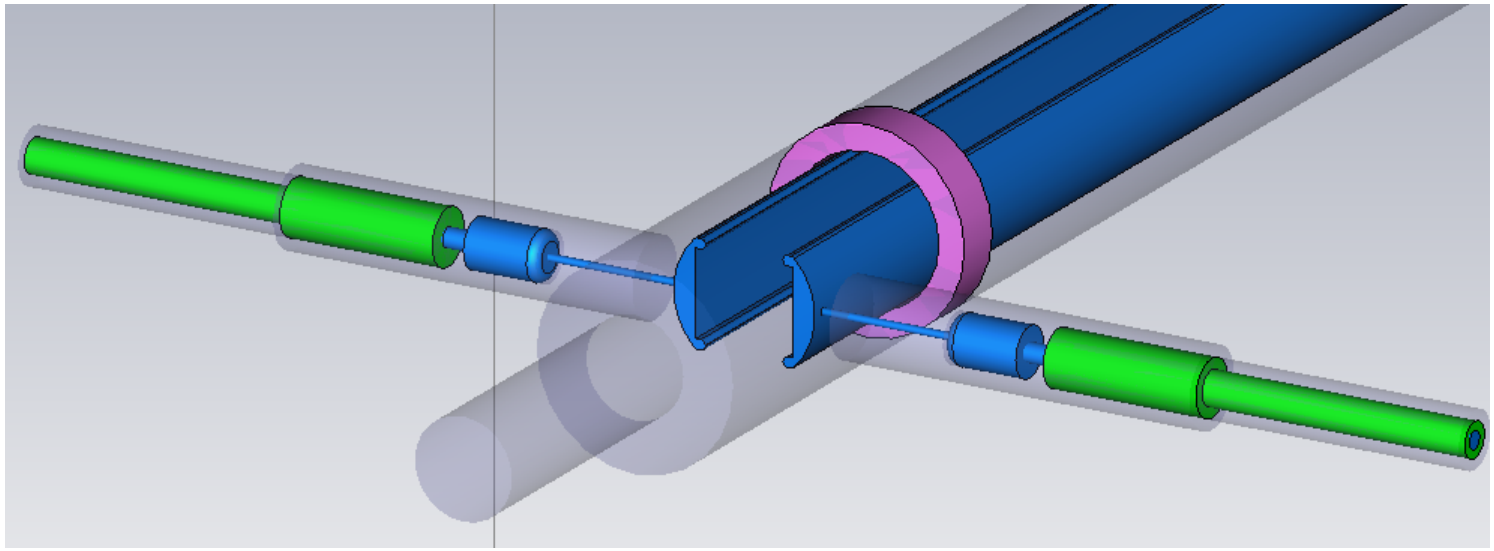
Laboratory tests:

- S-parameters
- Longitudinal beam coupling impedance
- Transverse beam coupling impedance
- HV Tests

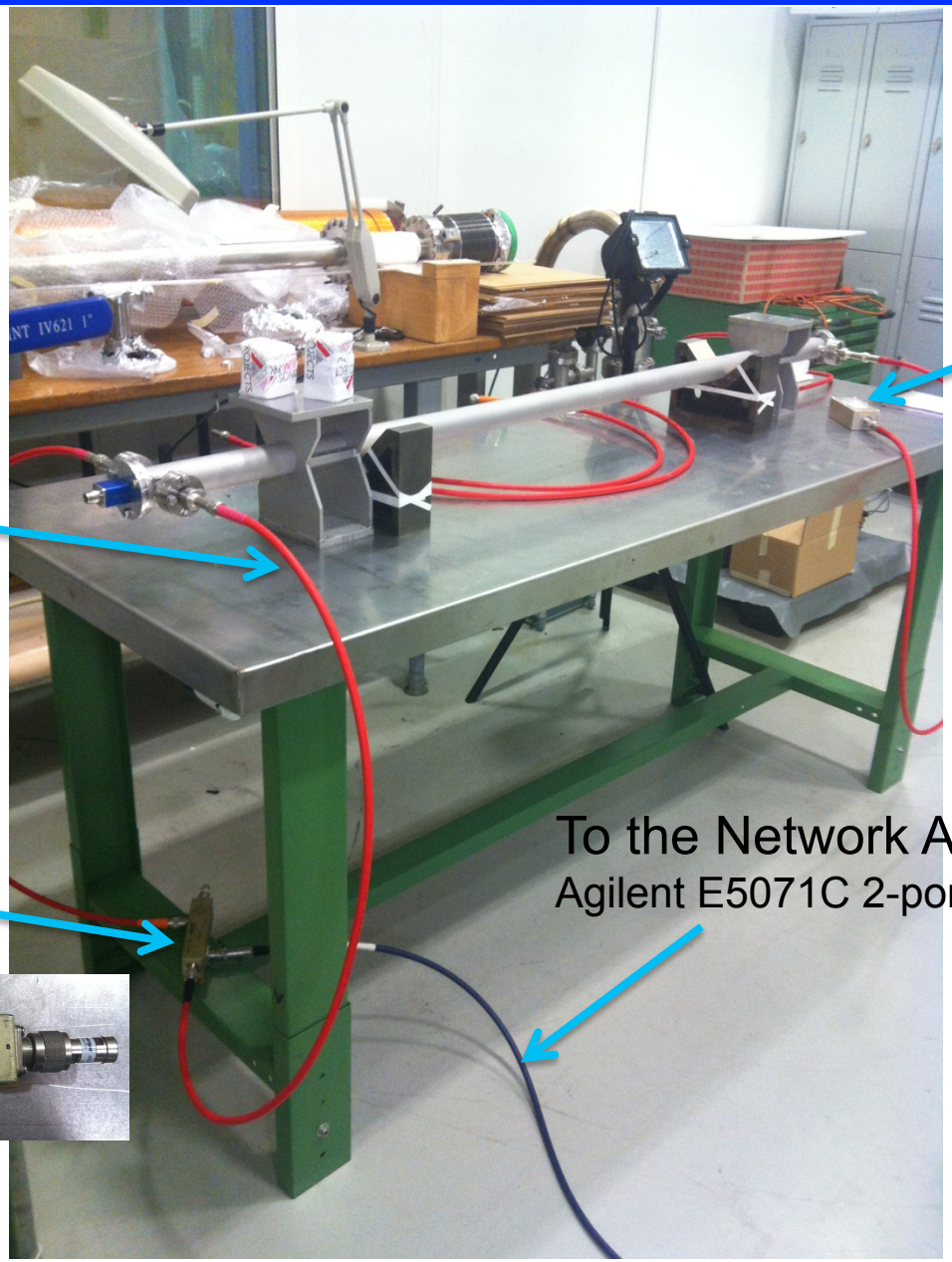
2) S_{11} PARAMETER MEASUREMENT

Three sources of impedance mismatch:

- The characteristic impedance of the connection between the electrode and the feedthrough is not constant.
- In the odd mode, the characteristic impedance is lower than 50 Ω.
- The presence of electrode supports increase the reflections



2) S_{11} PARAMETER MEASUREMENT



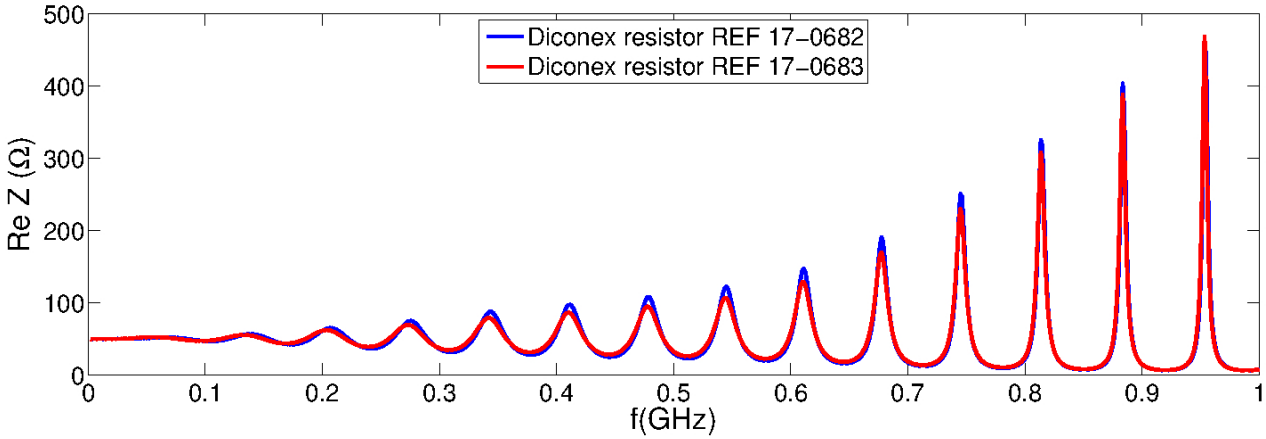
DICONEX TERMINATING RESISTOR

LOW-LOSS HTC-50-7-2 CABLES

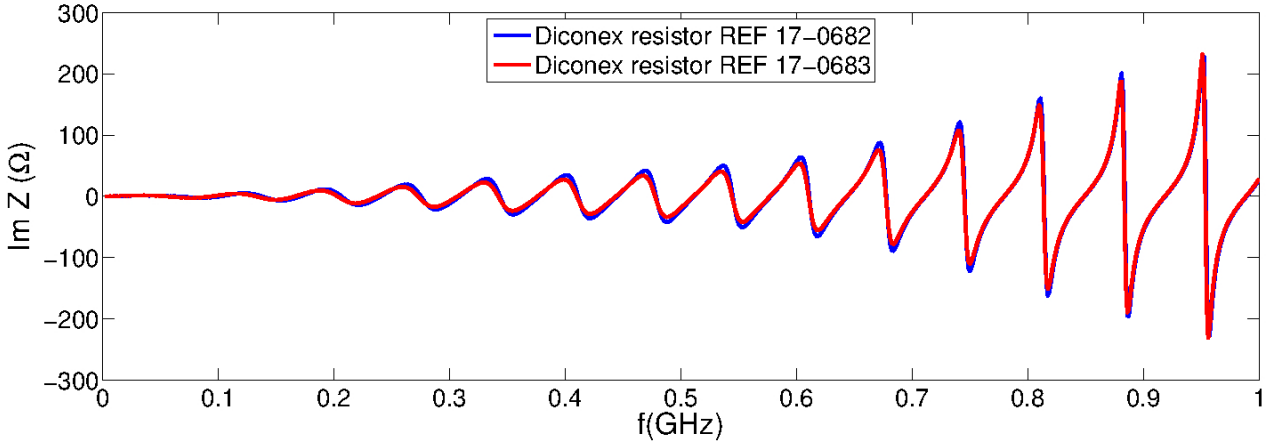
HYBRID SPLITTER

To the Network Analyzer (NA)
Agilent E5071C 2-port

- Diconex 50 Ω resistors are presently being used for HV testing of the inductive adder.
- The Diconex terminating resistors are not ideal, their value is frequency dependent.



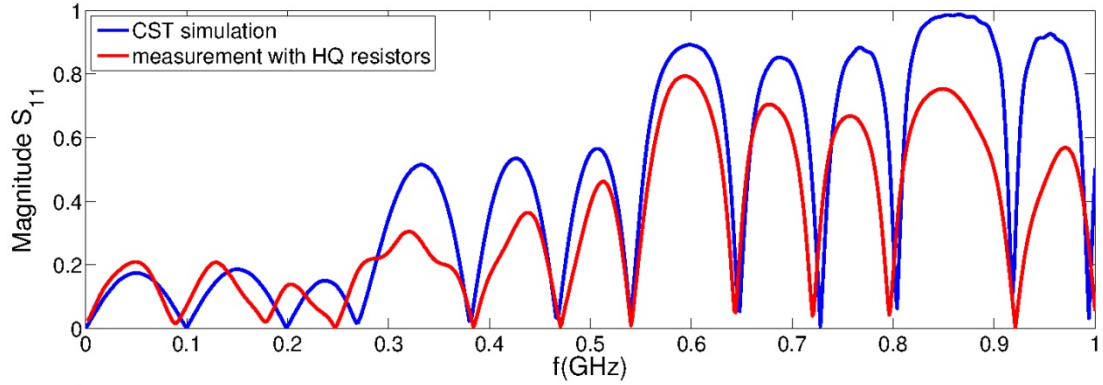
Frequency content of the driving pulse ≈ 0.01 GHz ➔resistor impedance variation of ± 0.2%.



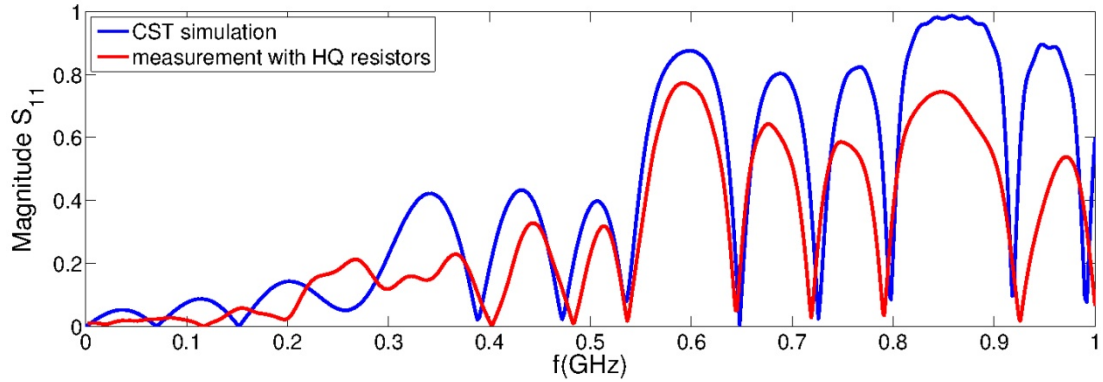
The impedance of the Diconex resistor is expected to be acceptable for the inductive adder.

HQ 50 Ω resistors were used from the calibration kit of the NA, with a ‘constant’ characteristic impedance.

S_{11} PARAMETER MEASURED AND SIMULATED

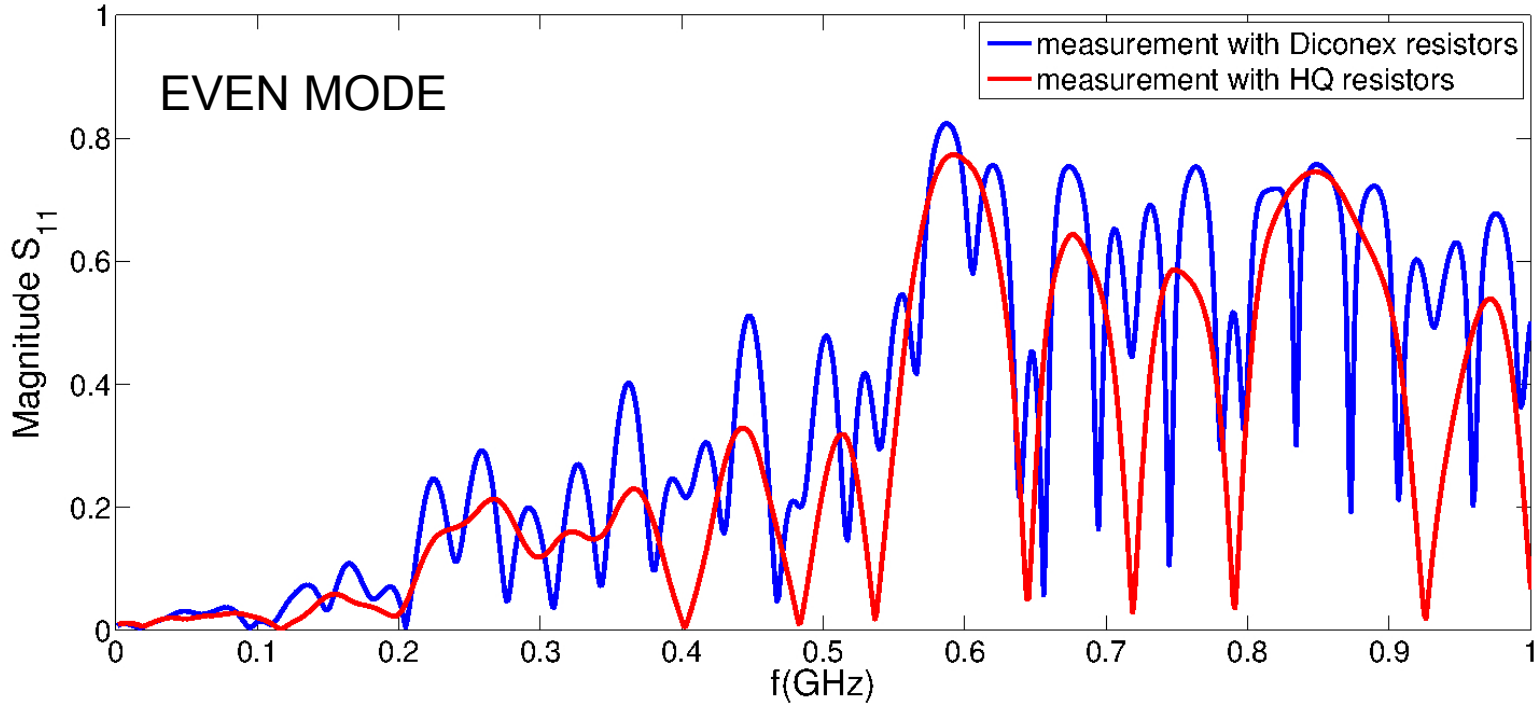


ODD MODE



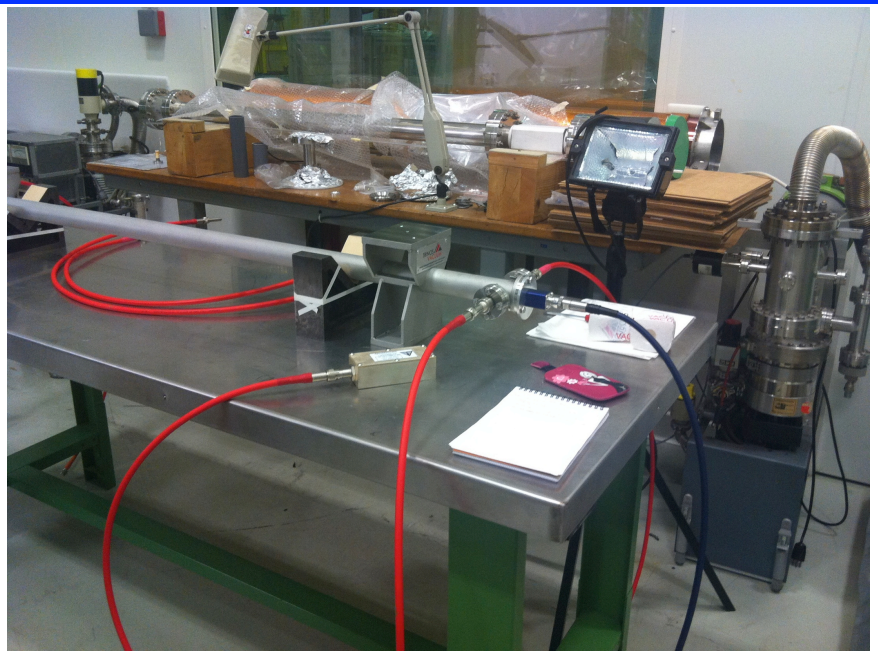
EVEN MODE

COMPARISON BETWEEN HQ RESISTORS AND DICONEX TERMINATING RESISTORS



- There are more resonances when the striplines are terminated with the Diconex resistors, at frequencies above ≈ 0.2 GHz.
- They are expected to influence the beam coupling impedance.

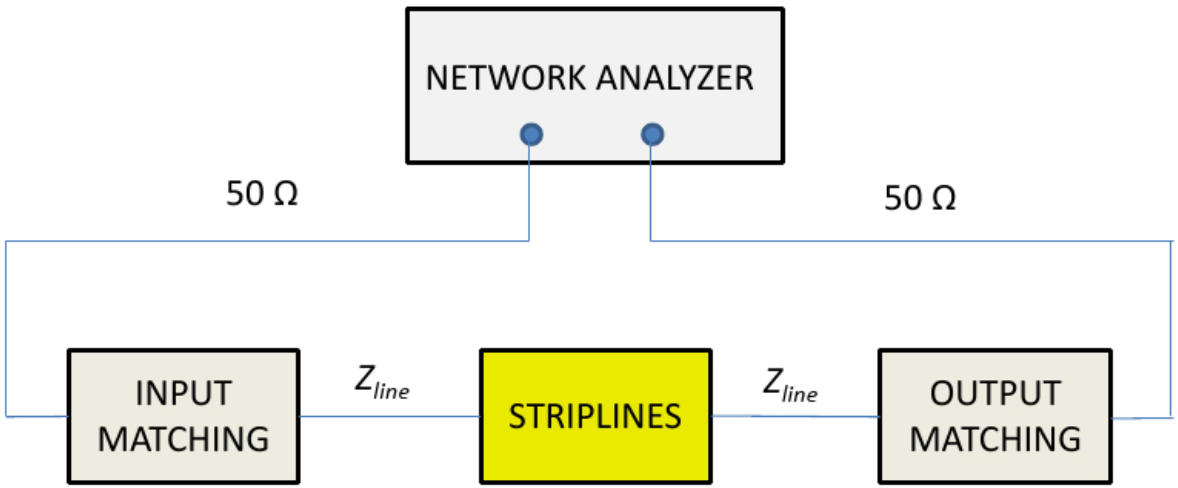
2) LONGITUDINAL BEAM COUPLING IMPEDANCE MEASUREMENT



- To measure the longitudinal beam coupling impedance, a single wire is inserted into the striplines aperture and the signal transmission (S_{21}) is measured, from which the longitudinal impedance can be calculated.

- The diameter of the wire used for the measurement should be as small as possible to obtain a high line impedance, which best reflects the fact that the beam acts as an ideal current source. For our measurements a 0.5 mm diameter wire made up of ‘soft copper’ has been used.

SINGLE WIRE TRANSMISSION METHOD



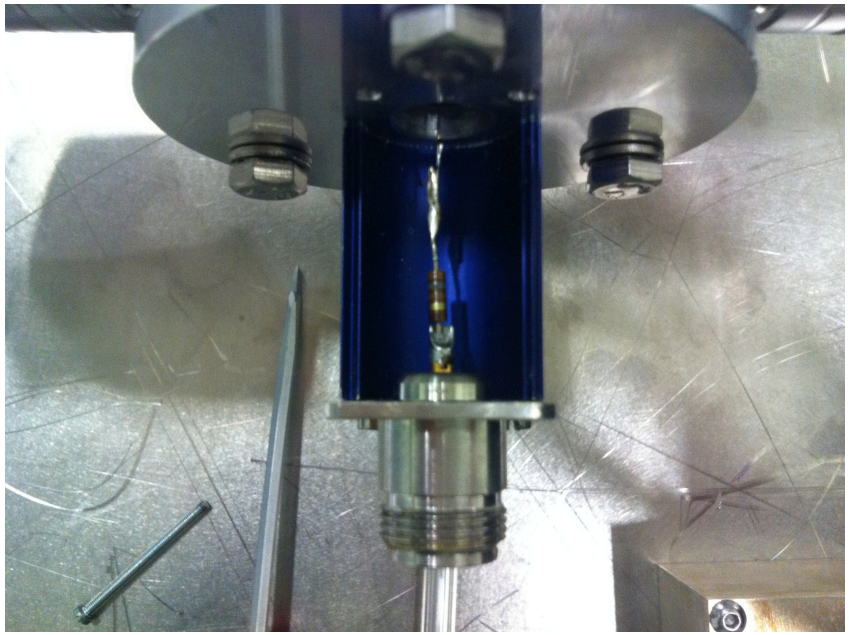
- The NA and the connecting coaxial cables have 50 Ω characteristic impedance, while the TEM line is composed of the wire and the striplines: these have impedance Z_{line}.

- For a wire between two parallel plates:

$$Z_{line}\ (\Omega) = 60\ ln\ (1.27D/d) = 235.7\ \Omega$$

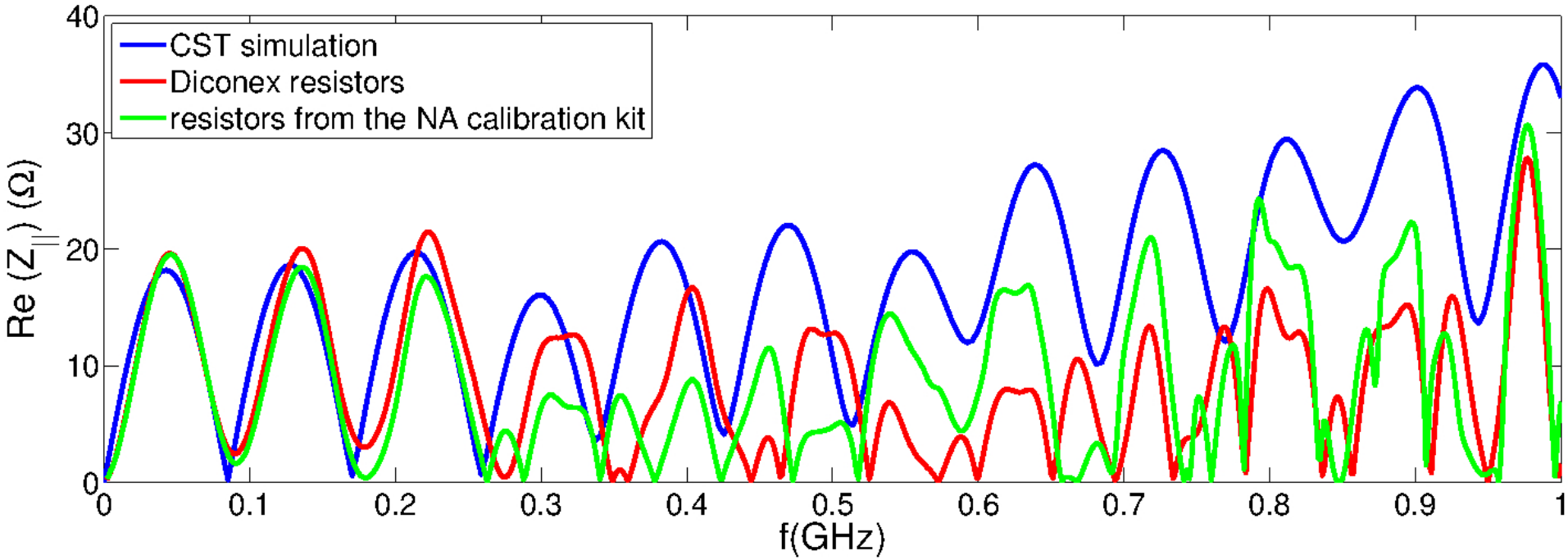
Matching of the line

- Matching of the characteristic impedance of the line Z_{line} to the system impedance Z_0 by means of a single series carbon resistor at both ends of the wire (R = 235.7 Ω – 50 Ω ≈ 185 Ω).



- For the calculation of the longitudinal impedance, from the measured S_{21} parameter, the log formula has been used:

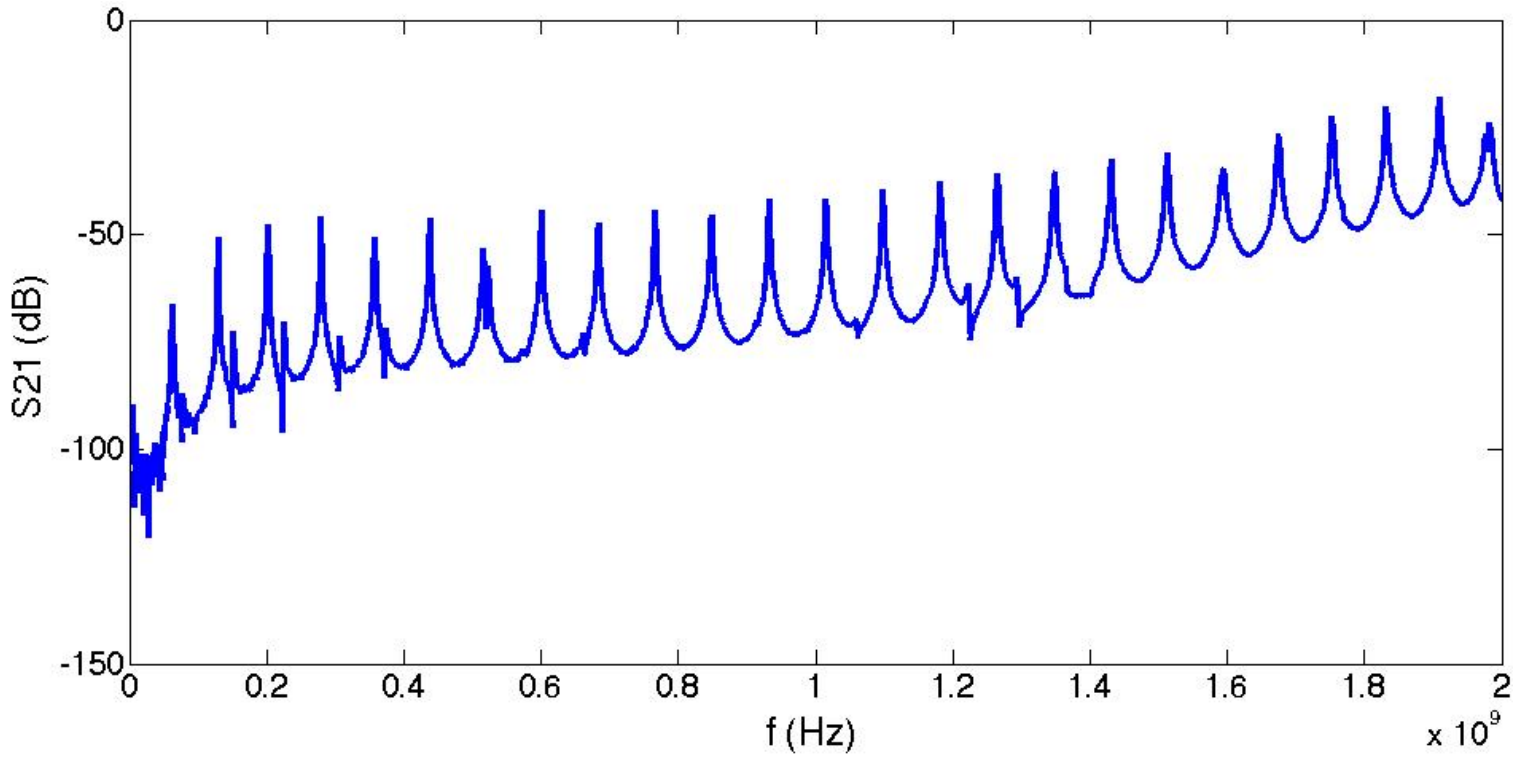
$$Z_{||} = -2Z_{line} ln(S_{21})$$



- The resistively matched measurements generally gives good results below a few hundred MHz but the residual mismatch in the system can cause large oscillations which mask the true impedance.

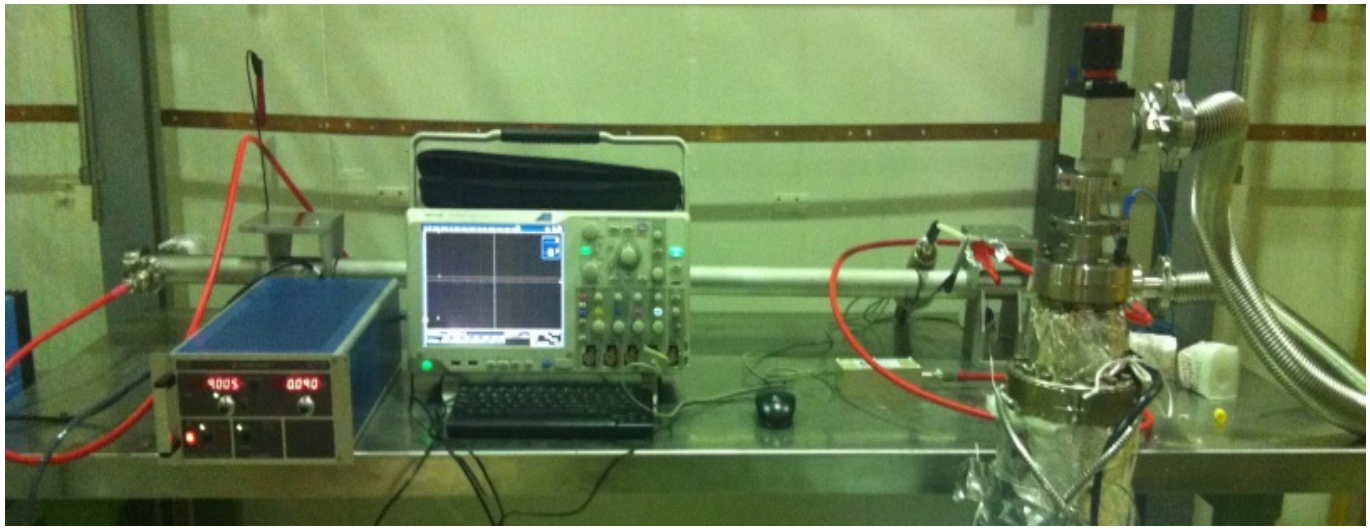
RESONANT METHOD

- The longitudinal beam coupling impedance measurements have been repeated, using the resonant method.
  - The TEM line adapted by replacing the connection of the wire to the inner conductor of the measurement lines by capacitive coupling.



3) HV TESTS

- DC HV power supply, with a maximum voltage of 12.5 kV: each stripline is powered with an equal but opposite polarity DC voltage.
- Vacuum level of ≈10^{-7} mbar.
- Method: a HV prove is connected to an oscilloscope in order to see the voltage drop due to a spark.



DETECTION OF ELECTRICAL BREAKDOWN

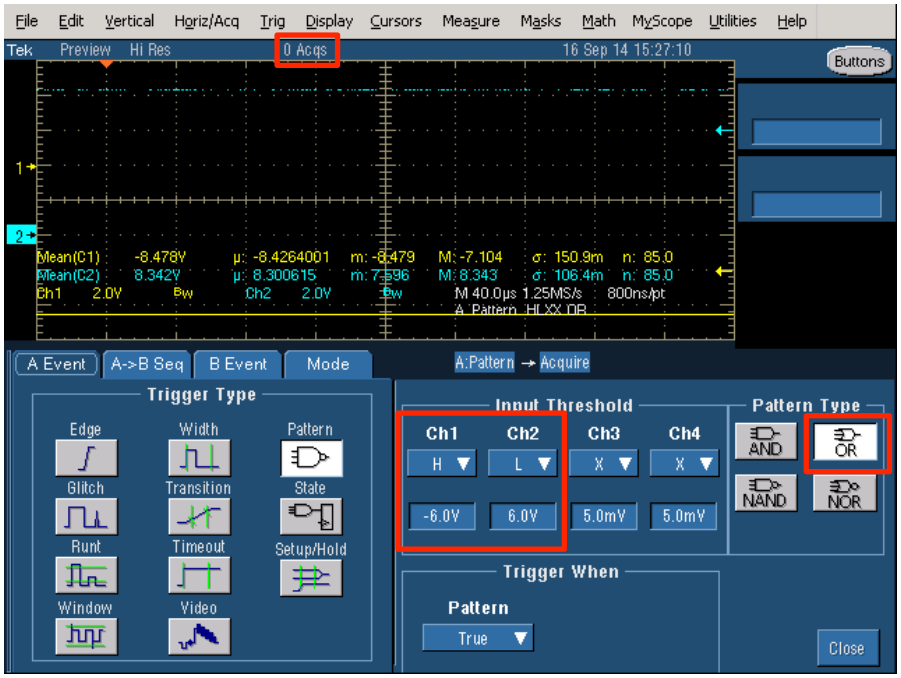
The oscilloscope is set up to trigger on either:

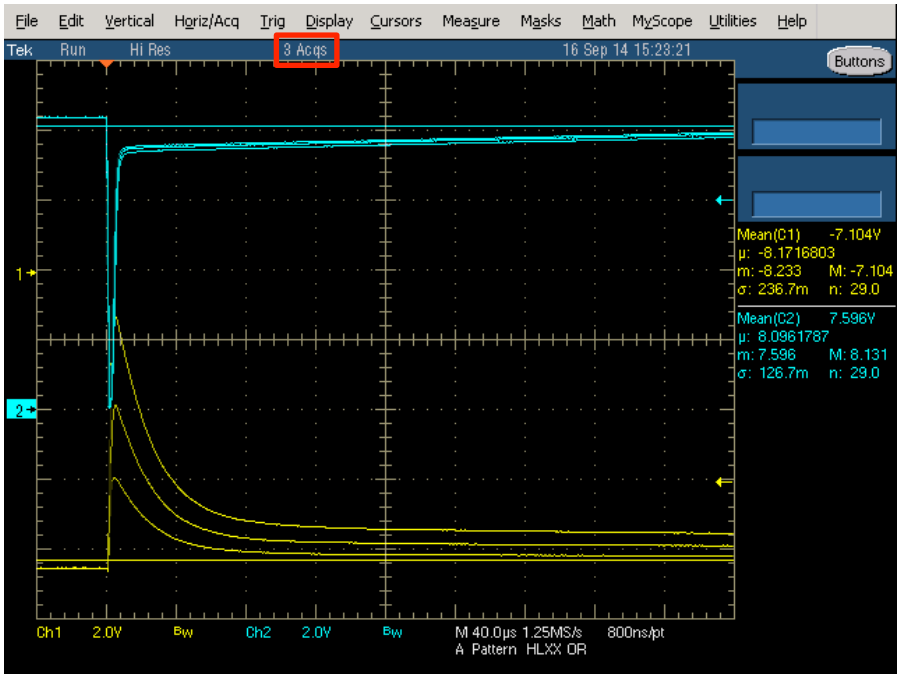
- Negative voltage (e.g. -8.5 kV) which increases through a threshold of -6 kV (CH1);

<u>OR</u>

- Positive voltage (e.g. +8.5 kV) which decreases through a threshold of +6 kV (CH2);

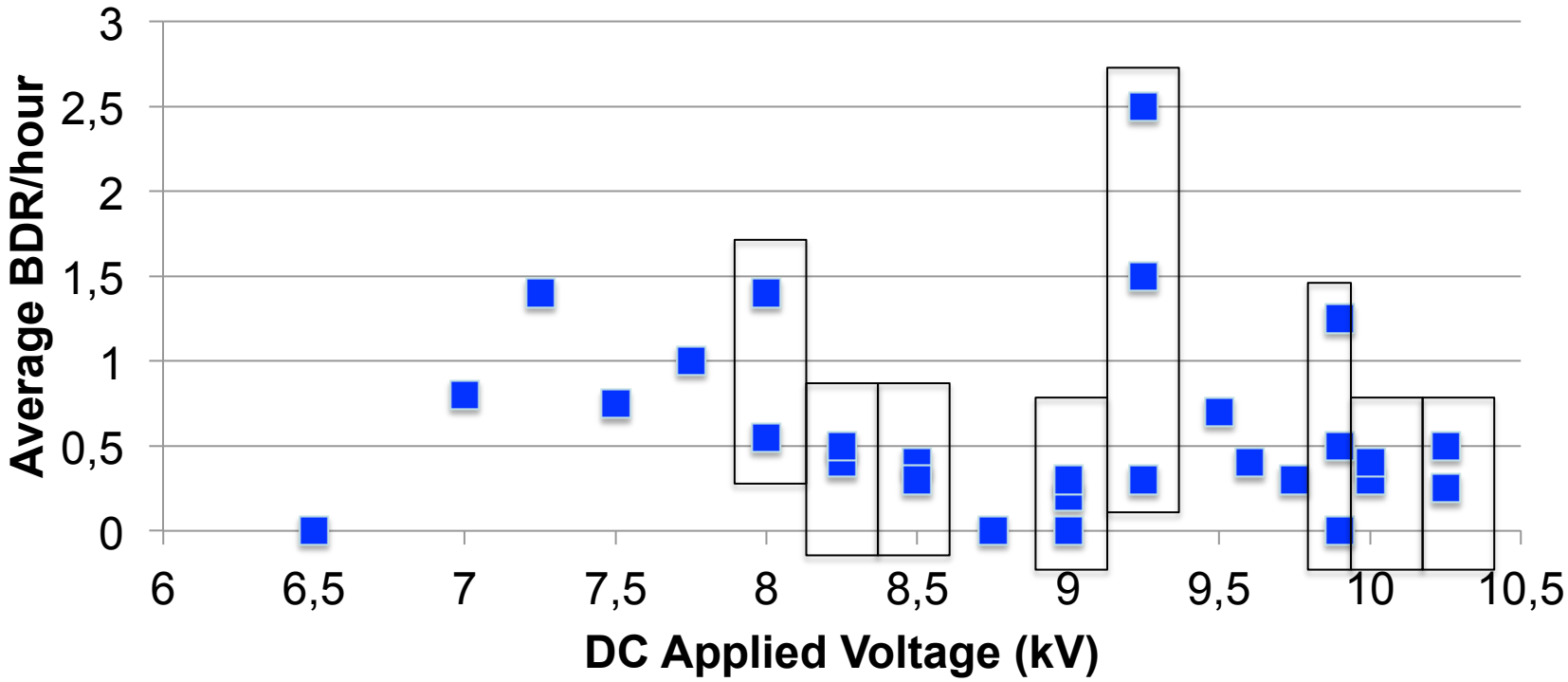
The number of triggers (acquisitions) is the total number of breakdowns.





PROCEDURE

- Both electrodes have equal but opposite polarity DC voltage applied.
- Increase voltages in small (few hundred volts) steps and wait for several hours and count number of electrical breakdowns.
- Occasionally reduce voltage, or repeat test at same voltage, to determine whether conditioning has occurred (i.e. breakdown rate has reduced).



4) CONCLUSIONS

- The laboratory tests of the CLIC DR extraction kicker have been done, without beam, in order to characterize the electromagnetic response of the striplines.

- The measurements carried out with the NA have been the S_{11} parameter and the longitudinal and transverse beam coupling impedance. In that case, a good agreement has been found between the laboratory tests and the CST simulations up to 0.25 GHz. Results for the resonant method and transverse beam impedance are being analyzed.

- DC HV tests have been carried out and analyzed. A maximum BDR/hour 0f 2.5 has been found with a voltage of 9.25 kV, which could be dangerous in the regions where the Macor rings are placed.