DIAGNOSTICS OF RF BREAKDOWNS

IN HIGH-GRADIENT ACCELERATING STRUCTURES

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DIPAC 2011

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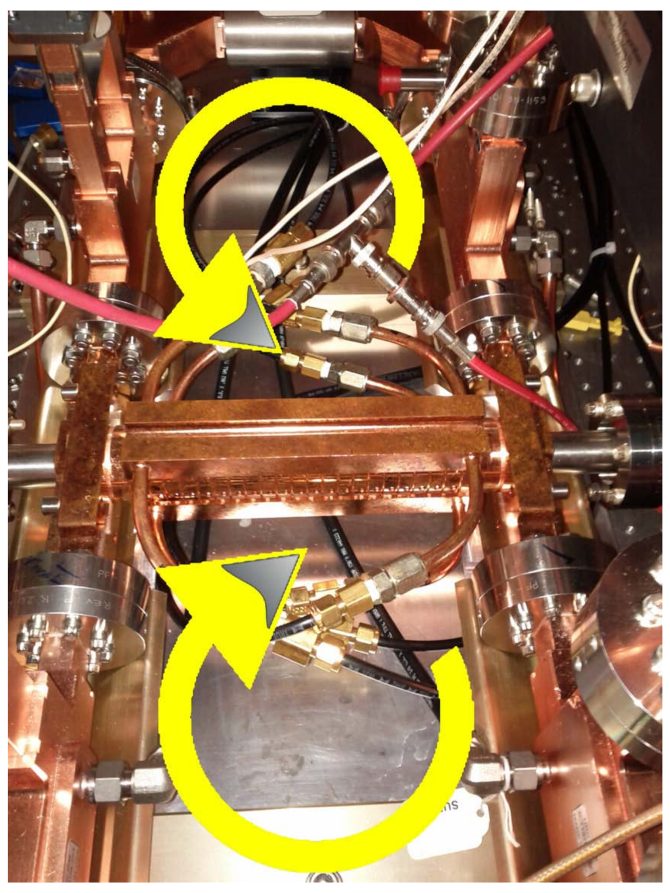
The resonant ring at ASTA allows high power structure testing in a two-arm wave guide loop meant to recirculate the field such that it constructively interferes with itself increasing the power level in the structure at every turn.

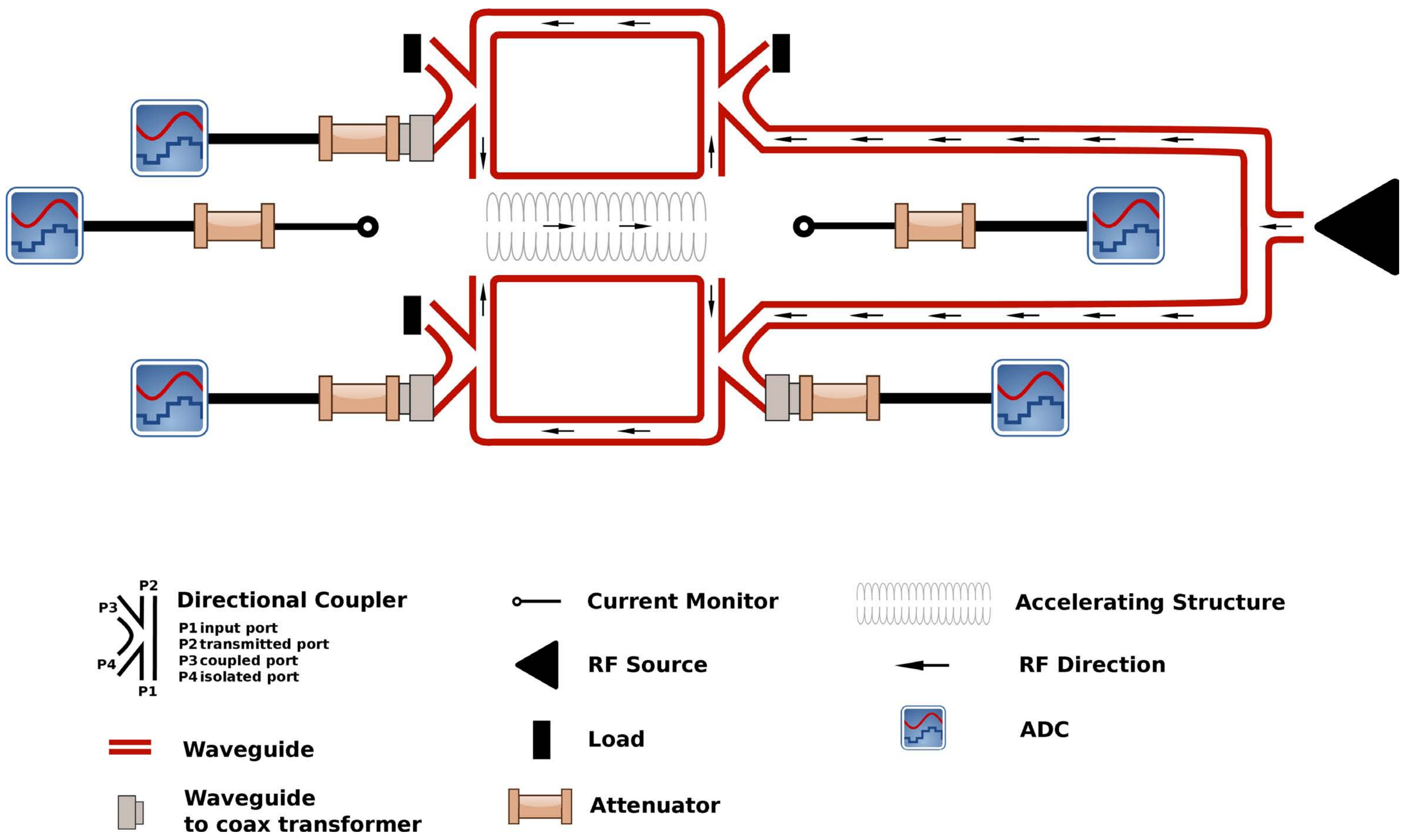


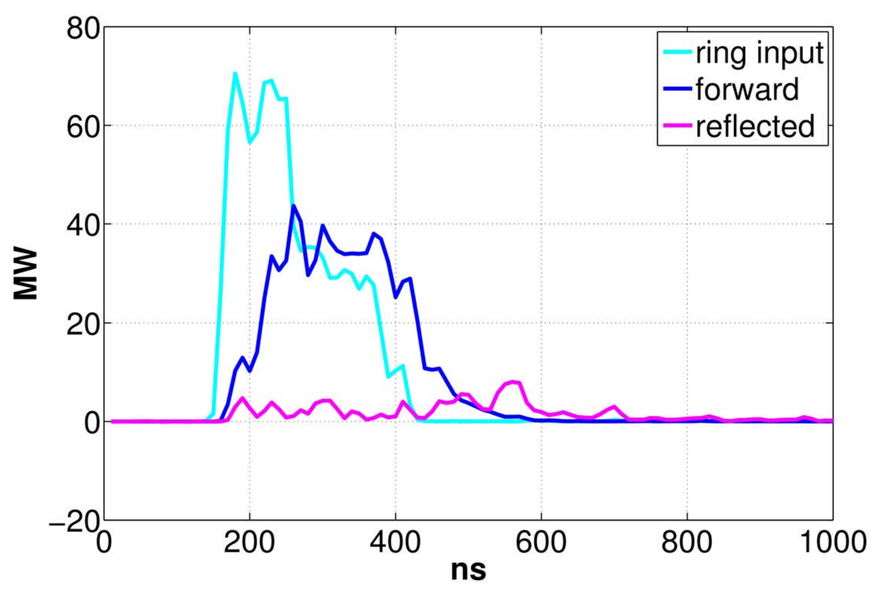
T18 structure tested at ASTA resonant ring at SLAC

The T18_vg2.6_disk is a 2π/3 travelling wave X-band structure based on CLIC requirements (100 MV/m). It is the result of the CERN-SLAC-KEK collaboration.

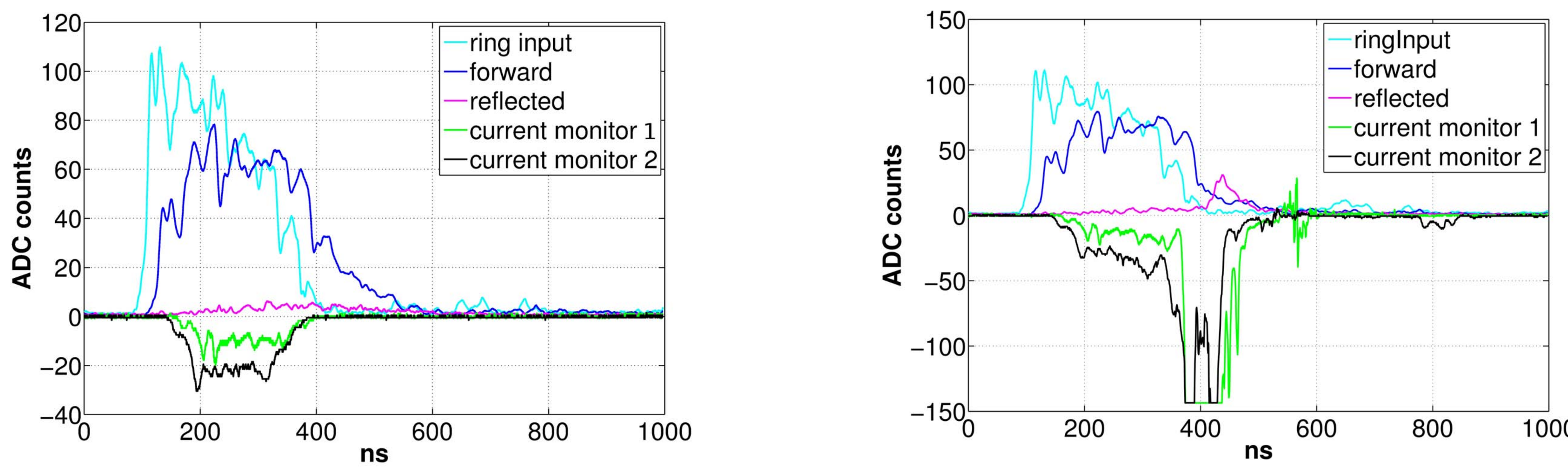
The diagnostics built for the resonant ring allows power level and field measurements as well as the measurement of currents emitted during and after a breakdown.

RF signal processing (IQ demodulation and envelope detection) is numerically realized off-line.





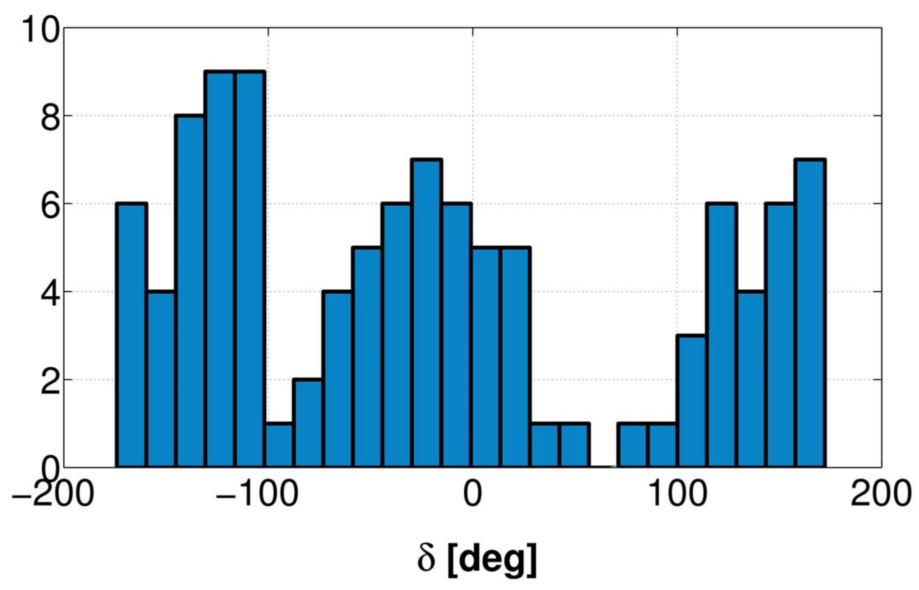
power level measurements



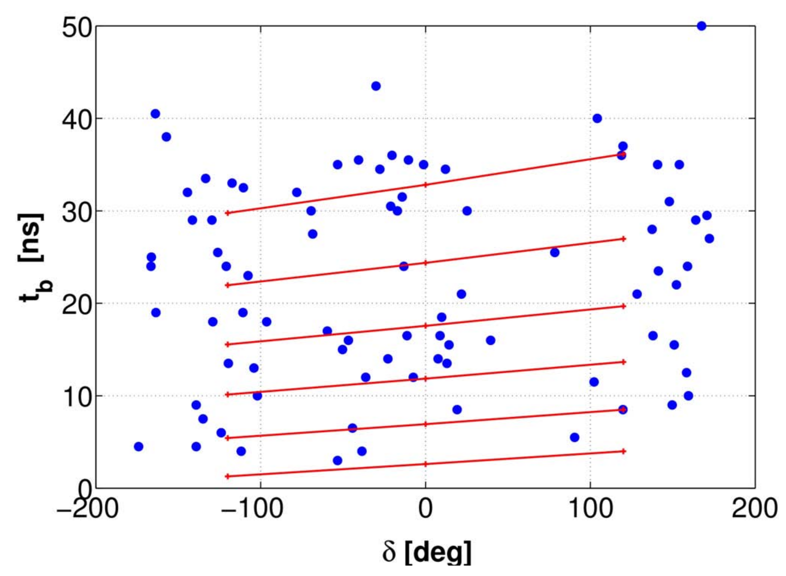
field and current measurements before (left) and during (right) a breakdown

Estimation of the breakdown locations in the structure using phase and time information from RF measurements

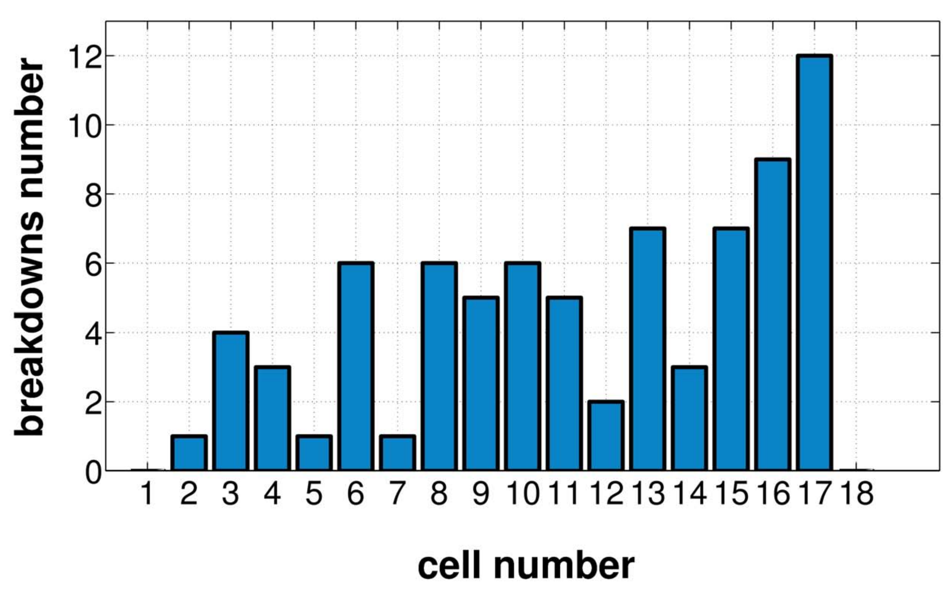
The phase difference between forward and reflected field tells us the breakdown location in the structure short of an integer number of wavelengths.
Time information given by the instant at which the reflected field appears and the instant at which the forward field measurement shows missing power together with phase information uniquely determines the breakdown location in the structure.



phase difference between forward and reflected RF



phase and time information for each breakdown event compared with the position of each cell (red crosses)



breakdowns distribution along the structure

Can we say something about the properties of the object reflecting RF during a breakdown?

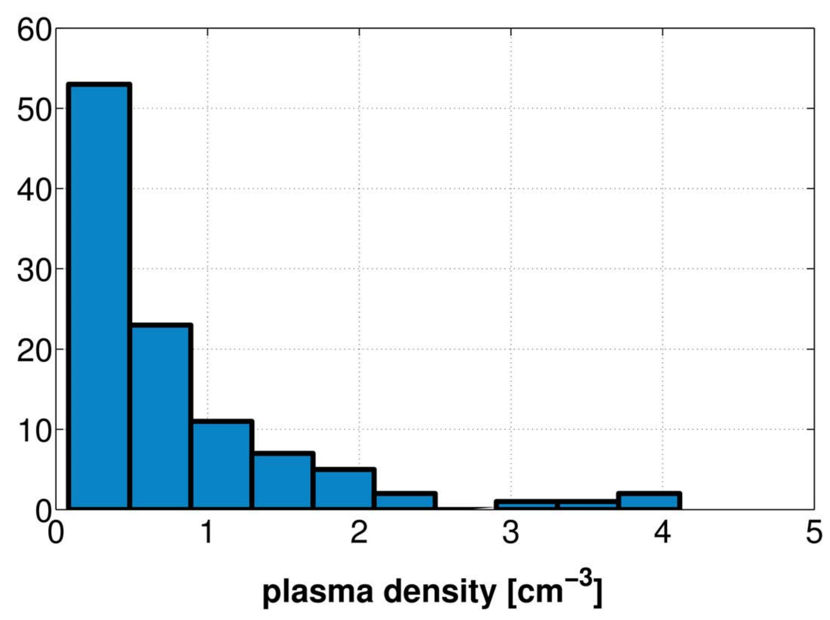
The RF reflection measured during a breakdown can be thought as the reflection due to a mismatched load of normalized impedance z_L in a microwave circuit.

Assuming that the object responsible for the reflection is characterized by the complex permittivity ε and by a unitary magnetic permeability,

$z_L = \sqrt{\varepsilon} = (1-\Gamma) / (1+\Gamma)$

where Γ is the reflection coefficient.

Exploring the possibility that the RF reflection is caused by a plasma (non-collisional and quasi-neutral) with permittivity ε grown in the structure during the breakdown, suggests that its density would be about 5 10^{15} electrons per cubic centimetre.



Supported by the Royal Swedish Academy of Science and the Knut and Alice Wallenberg foundation.

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