A proposal for a pulsed surface heating experiment in a CLIC accelerating structure using variable pulse length

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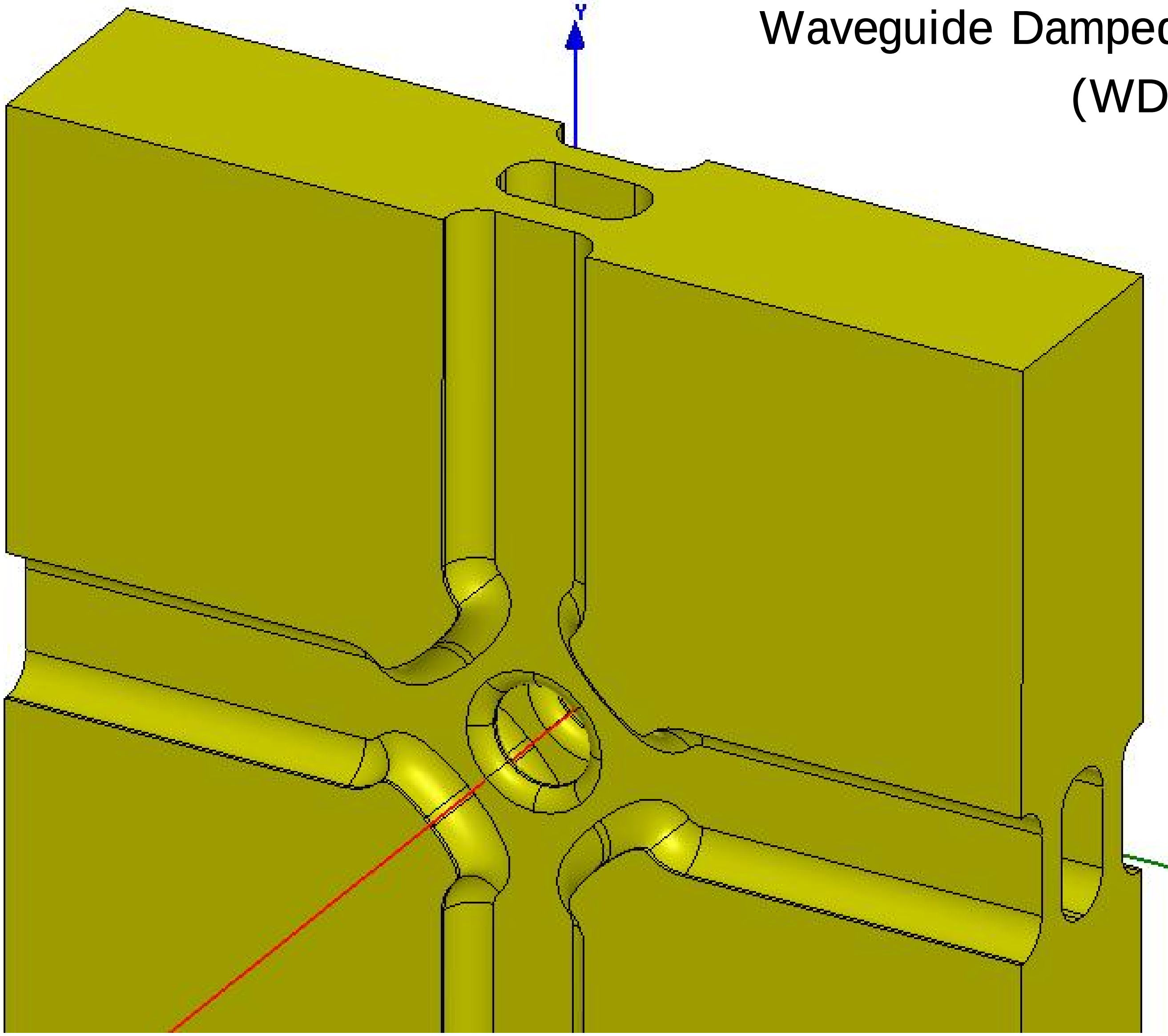
CLIC baseline: WDS cell

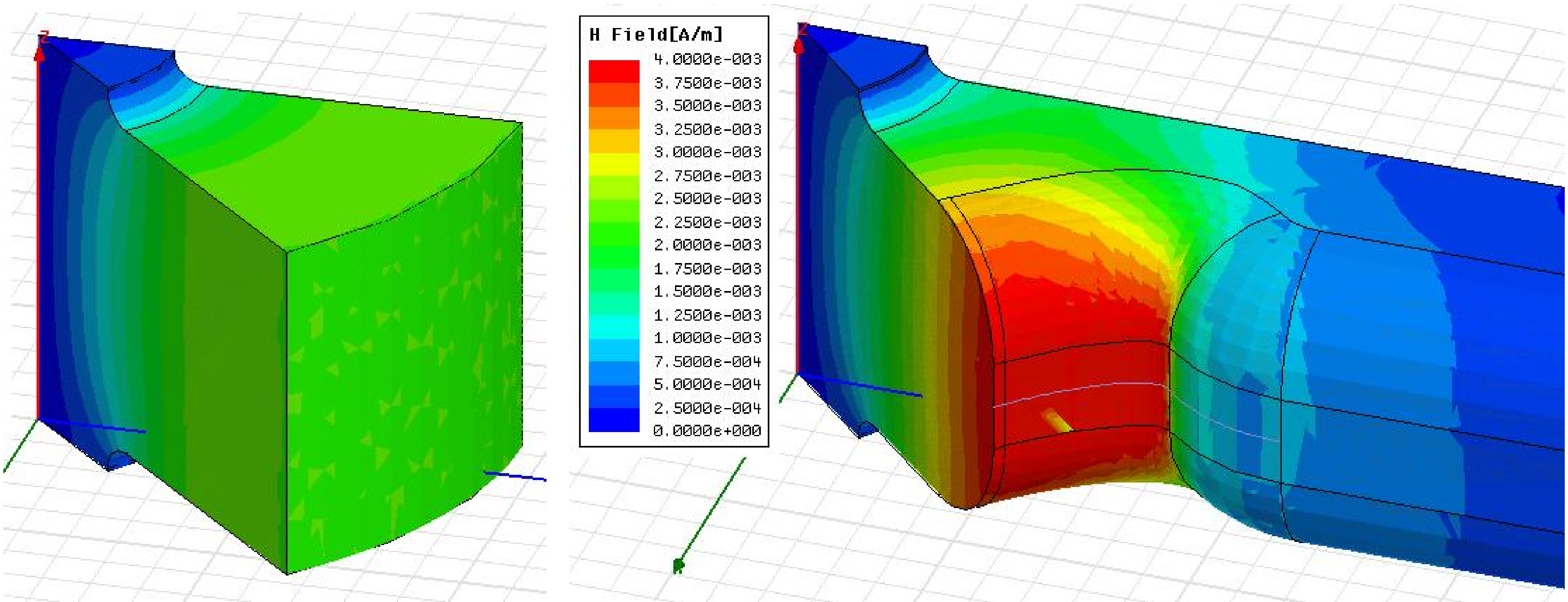
Waveguide Damped Structure (WDS) 2 cells



- Minimize E-field
- Minimize H-field
- Provide good HOM damping
- Provide good vacuum pumping

CLIC

Magnetic field enhancement in WDS



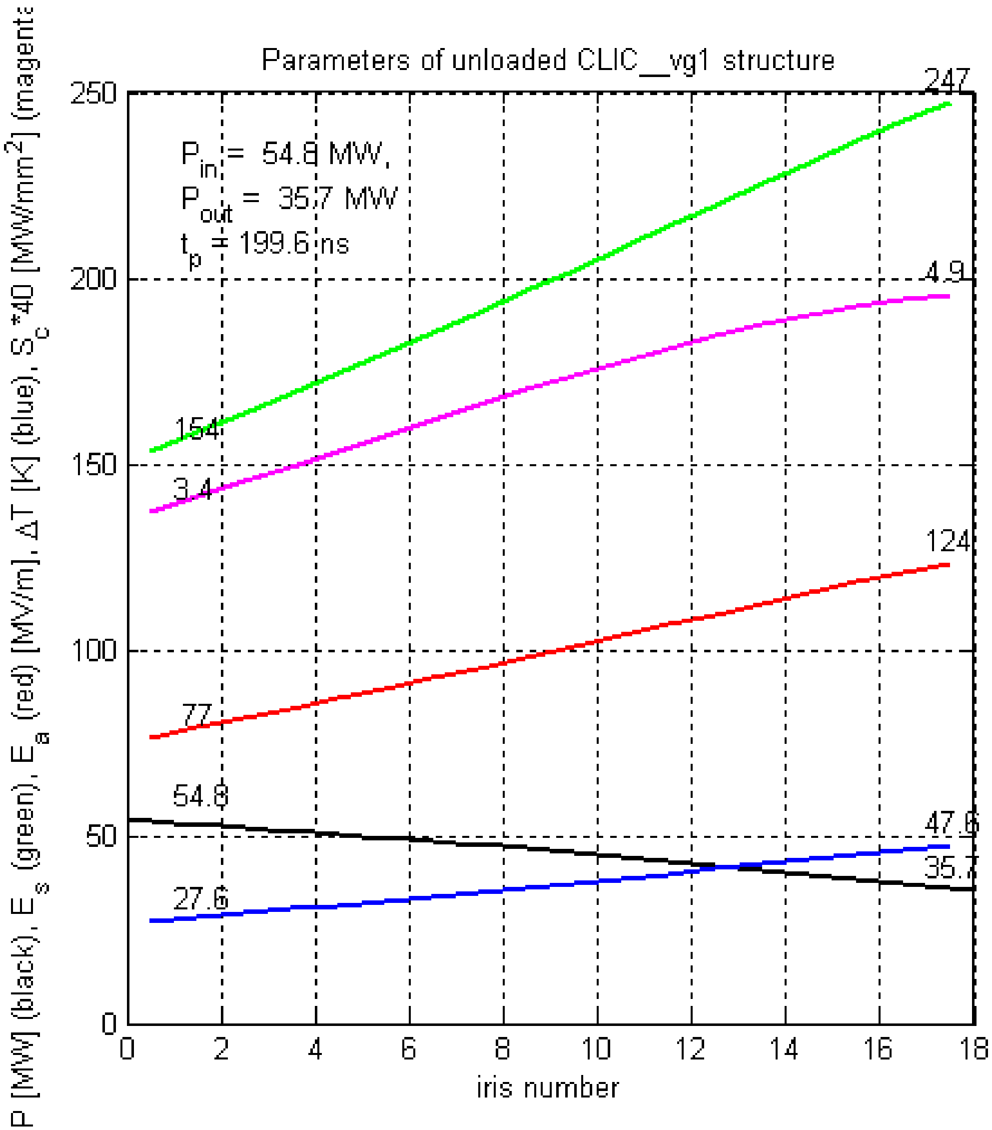
NDS

H_{surf}^{max}/E_{acc} = 2.5 mA/V

WDS

H_{surf}^{max}/E_{acc} = 4.0 mA/V

Parameters of CLIC_vg1_quad



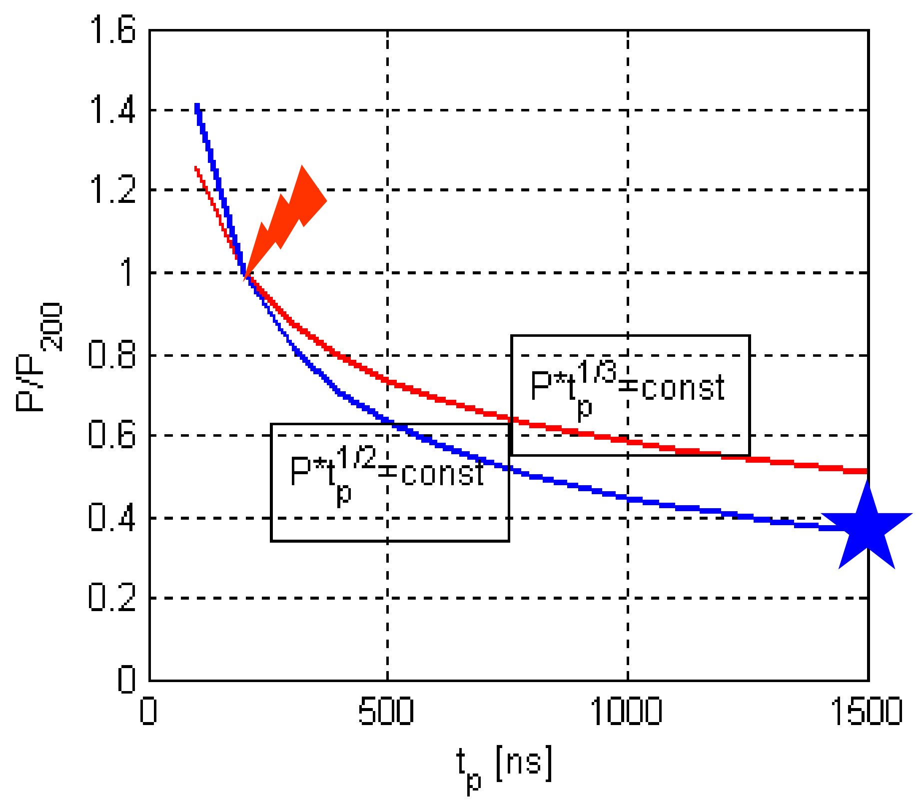
100 MV/m - unloaded accelerating gradient averaged over 18 regular cells (no couplers included)

Pin = 55 MW, tp = 200ns

~12.5 WU

$\Delta T = 27.6 \div 47.6$ K

Variable pulse length experiment



1. Condition the structure up to 200 ns
2. Measure BDR at 200 ns and a certain gradient E_{200}
3. Increase pulse length up to maximum (1.5 μs) and reduce power to reach the same ΔT.
4. In this case, BDR will be lower by ~$(200/1500)^{15/6}$ = 0.0065. This will allow to fatigue the surface without too many rf breakdowns.
5. Go to 200 ns and gradient E_{200} and measure BDR again.
6. Compare BDR before and after fatiguing the structure

Using a biperiodic pulse train to elucidate the breakdown trigger

R. Zennaro

Let's assume that we do not know anything about breakdowns

What we experimentally know is:

1) if we have a train of pulses of a parameter called *RF power* we have from time to time effects called *breakdowns*

2) the rate of breakdowns is related to the value of the RF power

↓

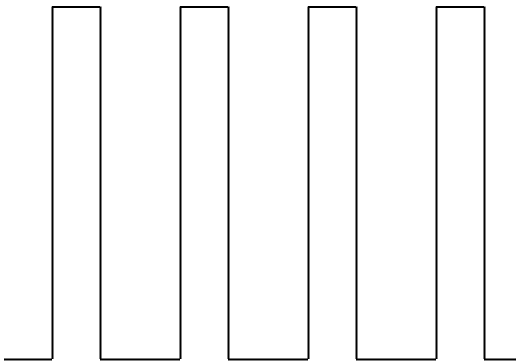
First (and basic) question: the breakdown is a statistic phenomenon or not?
(A moperiodic test can not give an answer)

↓

we do not know clearly the physics of the breakdown, in particular we do not know if the breakdown process is dominated by pure statistic phenomena (no pulse to pulse memory, or by phenomena that require a modification of the surface properties (pulse to pulse memory).
Normally we measure the BDR with a train of identical pulses (monoperiodic train), in this way the statistic and the "memory" effects are completely coupled.
To uncoupled the two effects a biperiodic train of pulses could be used

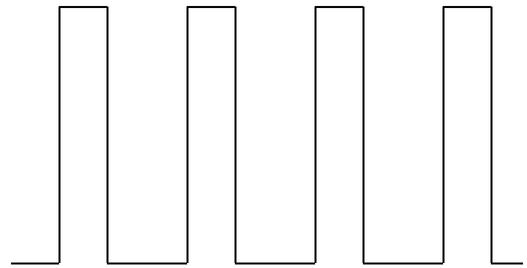
Monoperiodic TEST1 (E_1)

E_1; 10^{-4} BDR

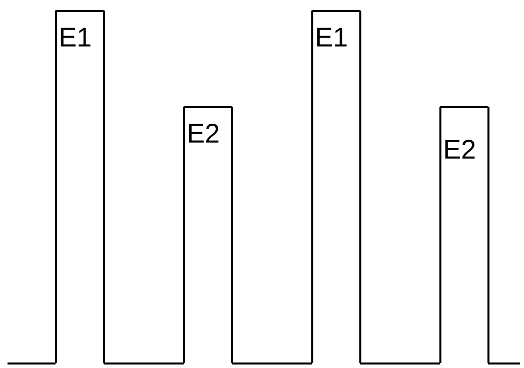


Monoperiodic TEST2 (E_2)

E_2~0.86*E1; 10^{-6} BDR (E~$BDR^{-1/30}$)



Biperiodic TEST3 (E_1, E_2)



In the case of TEST3 a single test provides two BDR values, one for each family of pulses (E1 & E2).

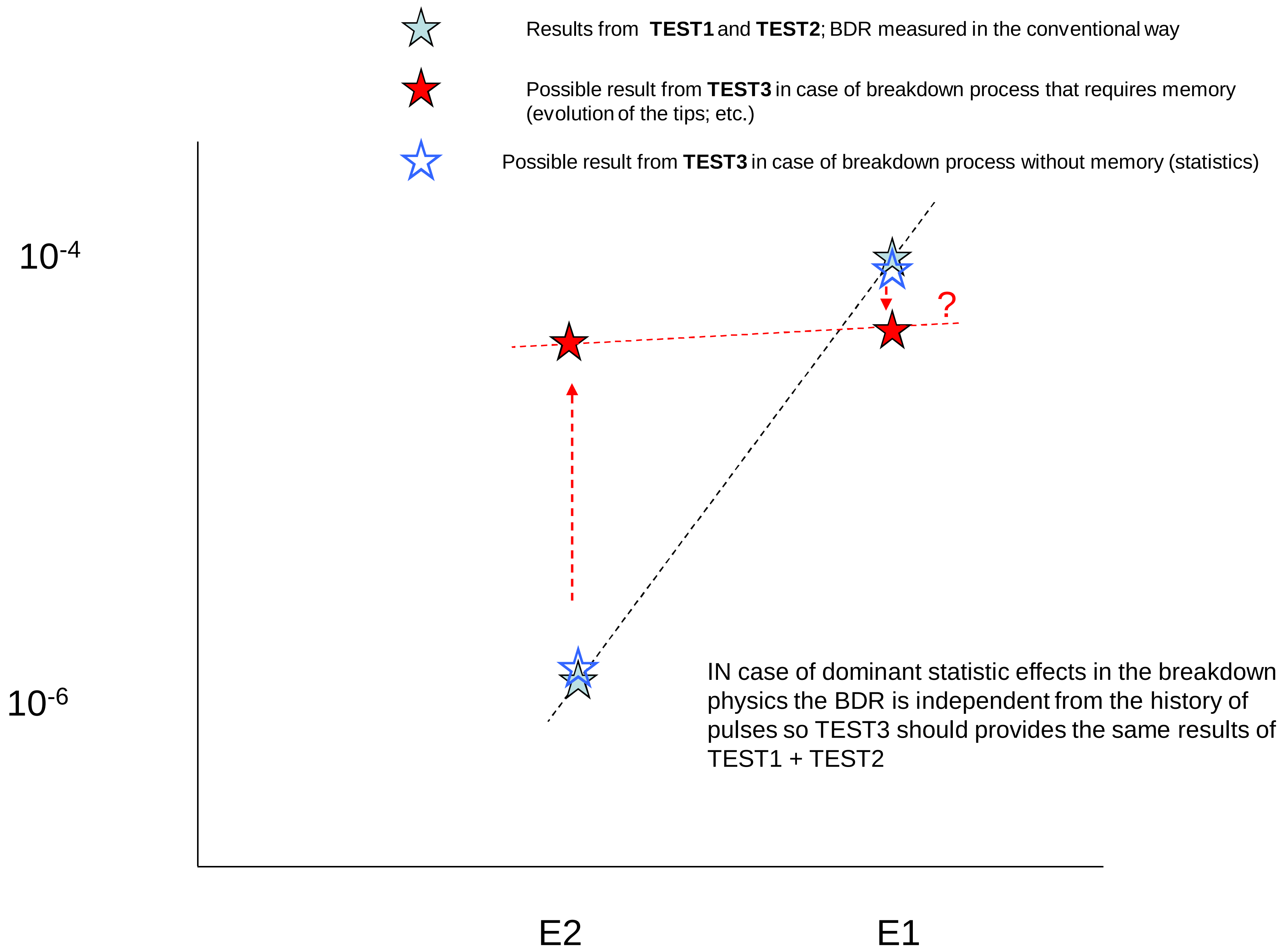
The BDR for the E1 pulses is simply:

(number of breakdowns for E1)/(N/2)

And for E2:

(number of breakdowns for E2)/(N/2)

Where N is the total number of pulses of TEST3


Results from **TEST1** and **TEST2**; BDR measured in the conventional way
Possible result from **TEST3** in case of breakdown process that requires memory (evolution of the tips; etc.)
Possible result from **TEST3** in case of breakdown process without memory (statistics)
10^{-4}
10^{-6}
?
IN case of dominant statistic effects in the breakdown physics the BDR is independent from the history of pulses so TEST3 should provides the same results of TEST1 + TEST2
E2
E1

BDR measurement in mismatched structure