



Plasma breakdown - IC

WPSA General Meeting 4-6 May 2022

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on behalf of CREATE and CNR-ISTP teams



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☐ IC-2021

☐ IC-2022

- ☐ Magnetic analysis:
 - **PFC 50%**
 - After request by QST, calculation for first plasma operation was carried out with **25% of the nominal current on CS/EF and with 100% Toroidal Field**
 - Aim to check/benchmark QST « backup » scenario

- ☐ EC Absorption calculation (first harmonic – waveguide):
 - PFC 50% $B_0 = 2.25$ T for 82GHz
 - PFC 25% $B_0 = 2.25$ T for 82GHz

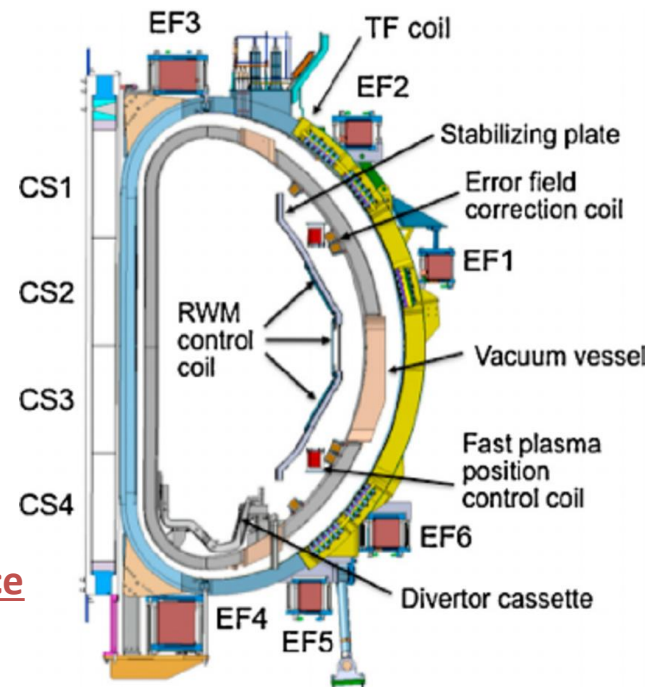
- ☐ Provided results on JT-60SA presentation by Yoshida at last EPS conference
 - PFC 25% - 82GHz

- ☐ Magnetic analysis:
 - Investigations of BD scenarios in the presence of degraded performance of the CS coils (electromagnetic analysis)



Preliminary investigations of BD scenarios in the presence of degraded performance of the CS coils (electromagnetic analysis)

- **Scenario JT60SA_BD_HC_noCS1**: Half current in the central solenoid but zero current in CS1 module, full maximum total voltage on coils (5kV).
- **Scenario JT60SA_BD_HC_0d3_Vtot2kv**: Half current in the central solenoid, reduced total voltage on coils (2kV).



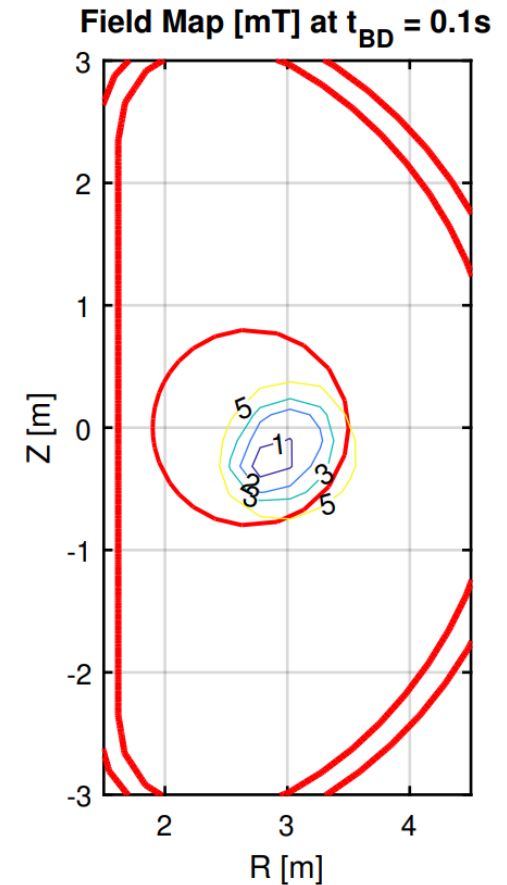
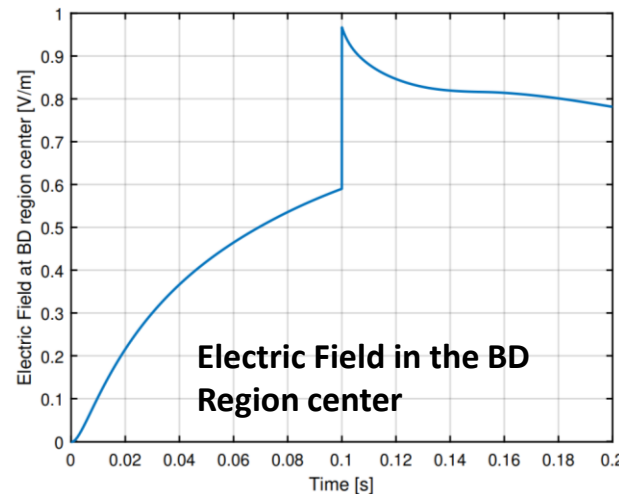
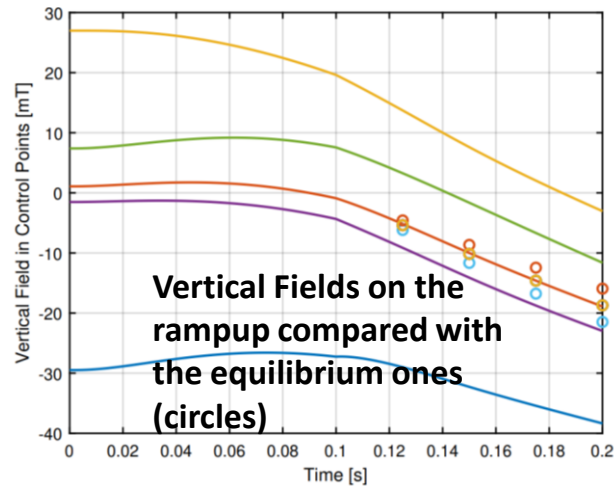
Tool available to optimize the following quantities in the presence of constraints:

- *Voltages on converters*. Voltage waveforms are optimized assuming piecewise linear functions (time step = 5-10 ms)
- *Initial current in the PF coils*. The distribution of currents in the active coils at time 0 is left partially free for possible optimizations
- *Switching Networks Resistors modules*
- *Breakdown time t_{BD}*

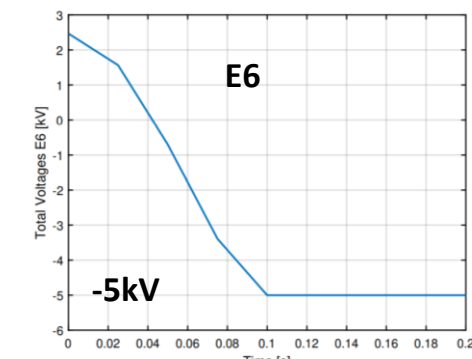
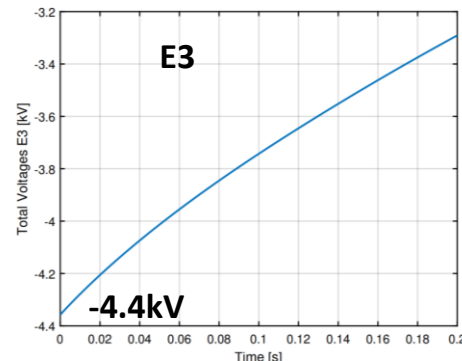
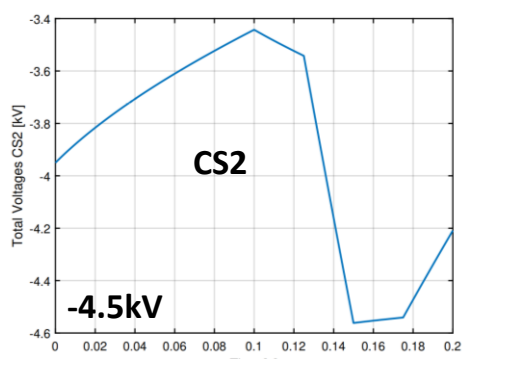
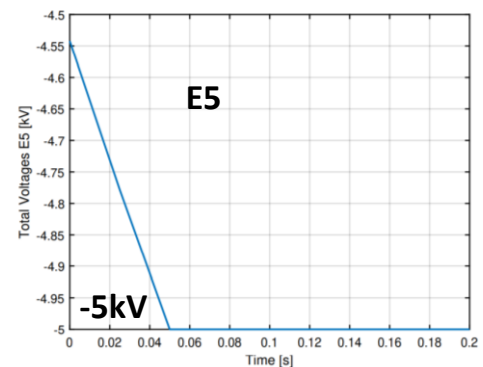
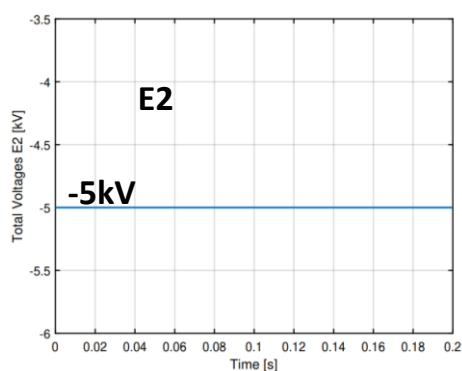
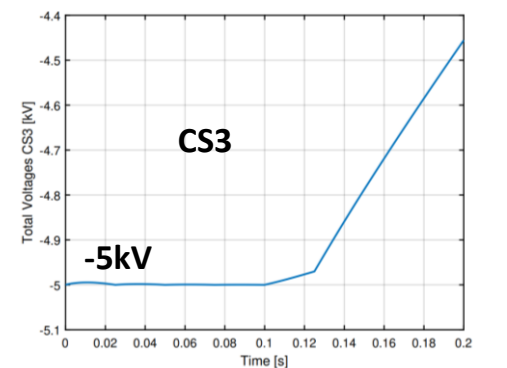
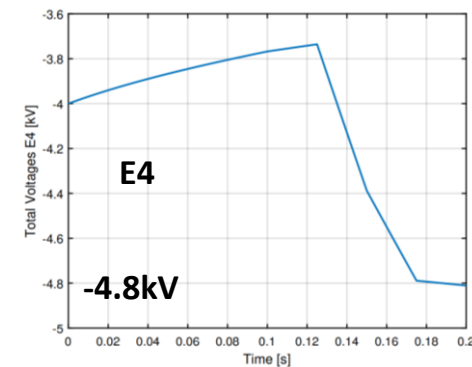
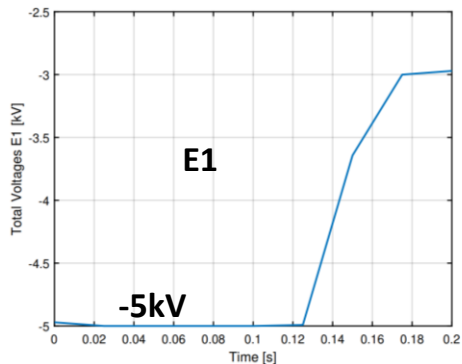
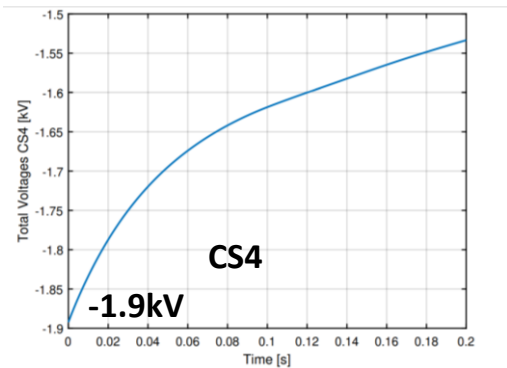


Conclusions on Scenario JT60SA_BD_HC_noCS1

electric field can be 0.6 V/m but the null region becomes very small and is shifted outwards. Plasma formation maybe possible but **the ramp up would be quite difficult to achieve** or should be studied with a new scenario design in a different region (or smaller plasma)



IC Activities done in 2022 / Scenario Optimization

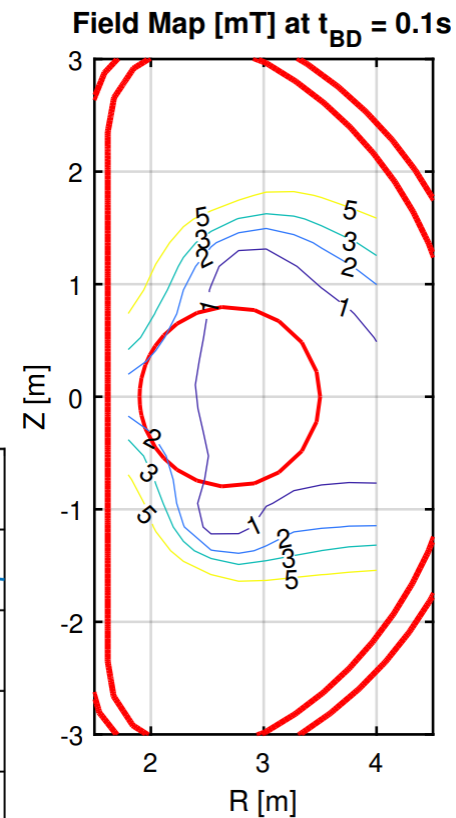
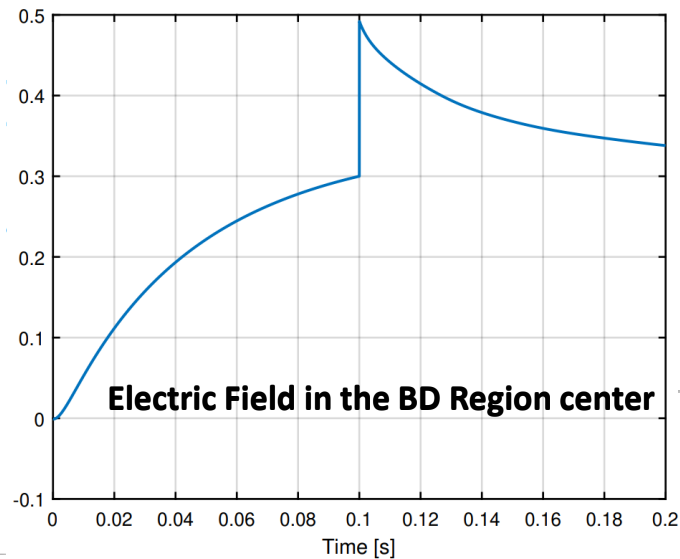
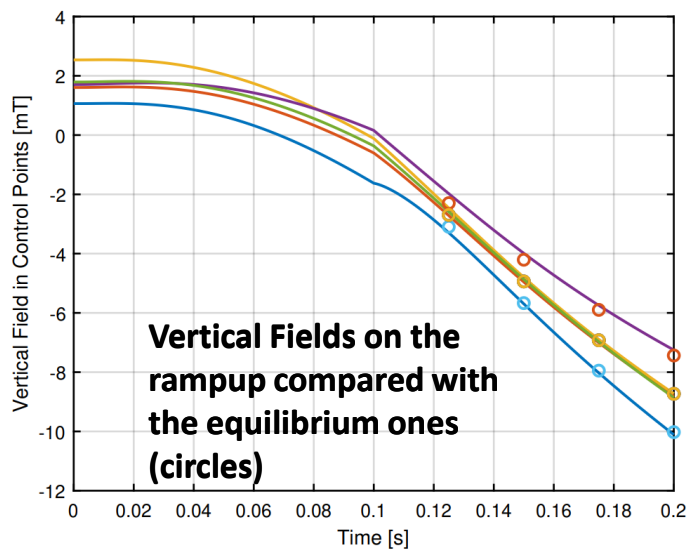




Conclusions on Scenario JT60SA_BD_HC_0d3_Vtot2kv

The electric field can be **max 0.3 V/m**.

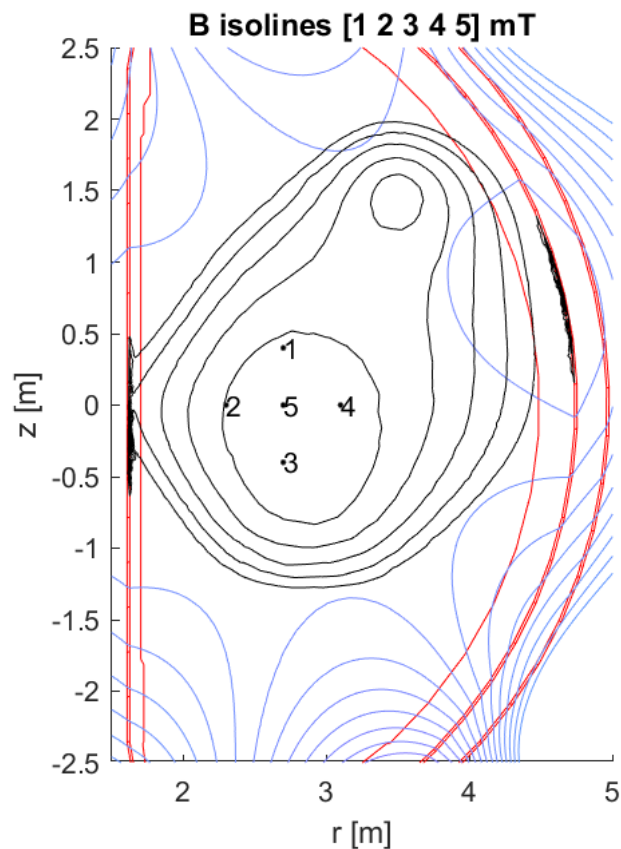
The null region is ok and the plasma current ramp up seems doable



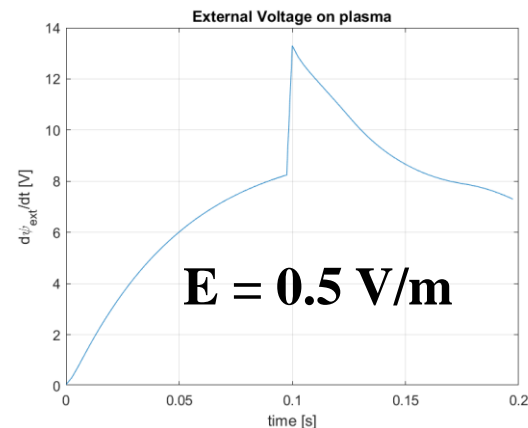
Term of comparison – nominal at 25% of the CS currents



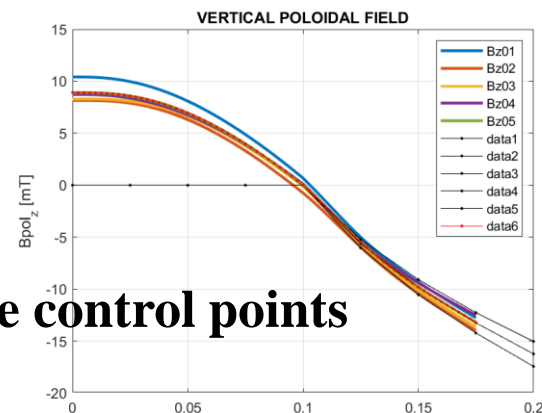
- Maximum current in circuits: 5kA in CS circuits, 5 kA in E1-E6 circuits
- Maximum Voltage on Circuits 5kV
- Power supplies can guarantee 5kV on EF2, EF3, EF4, EF5, 0kV on EF1, EF6, CS1, CS2, CS3, CS4 (non concurrent PS+SNU)



Vloop > 8.5V @BD



Bz in the control points





- Support offsite
 - Preparation of new breakdown scenarios under QST request
 - Data analysis for breakdown
- Support for onsite activities
- New methodologies for simulations and optimization have been developed as will be presented by D.Ricci in the next presentation.