

# Achievement of DC 1 MV insulation in high-voltage power supply for ITER Neutral Beam Test Facility

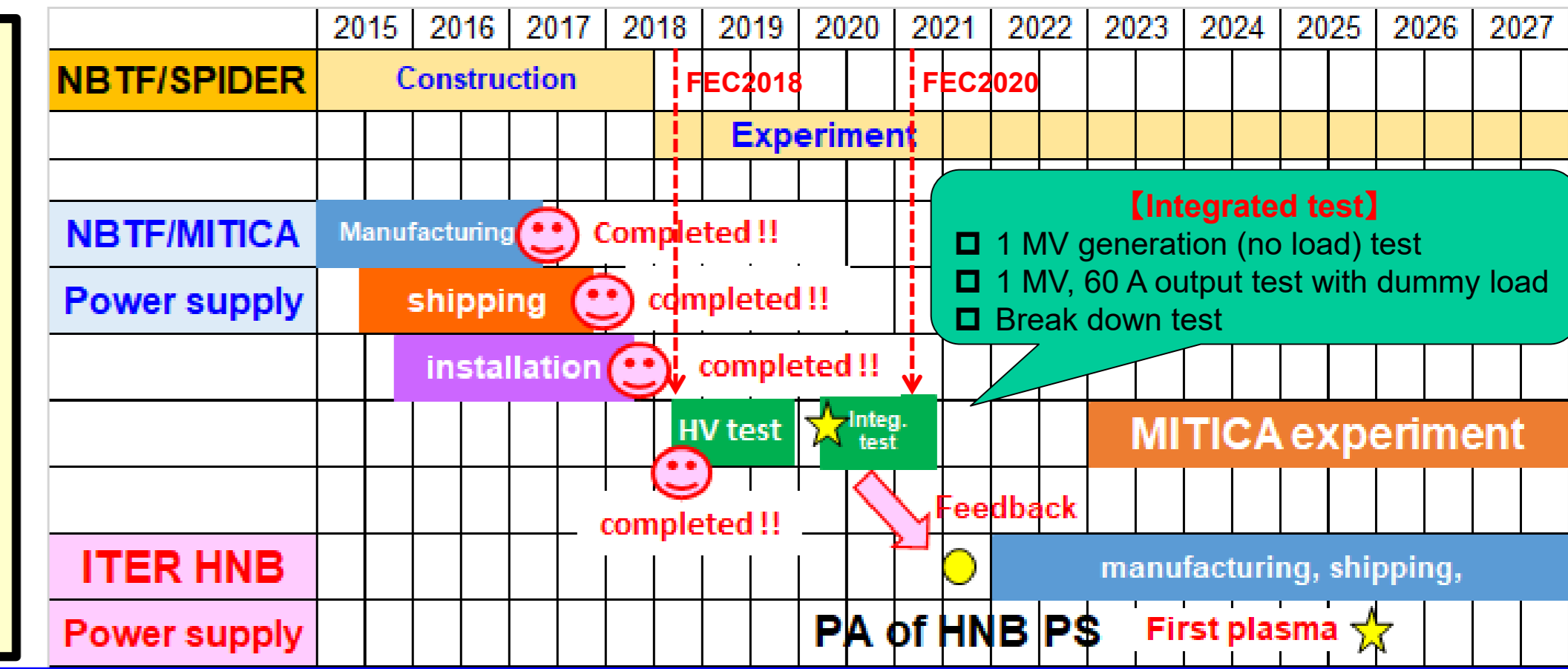
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## (Summary)

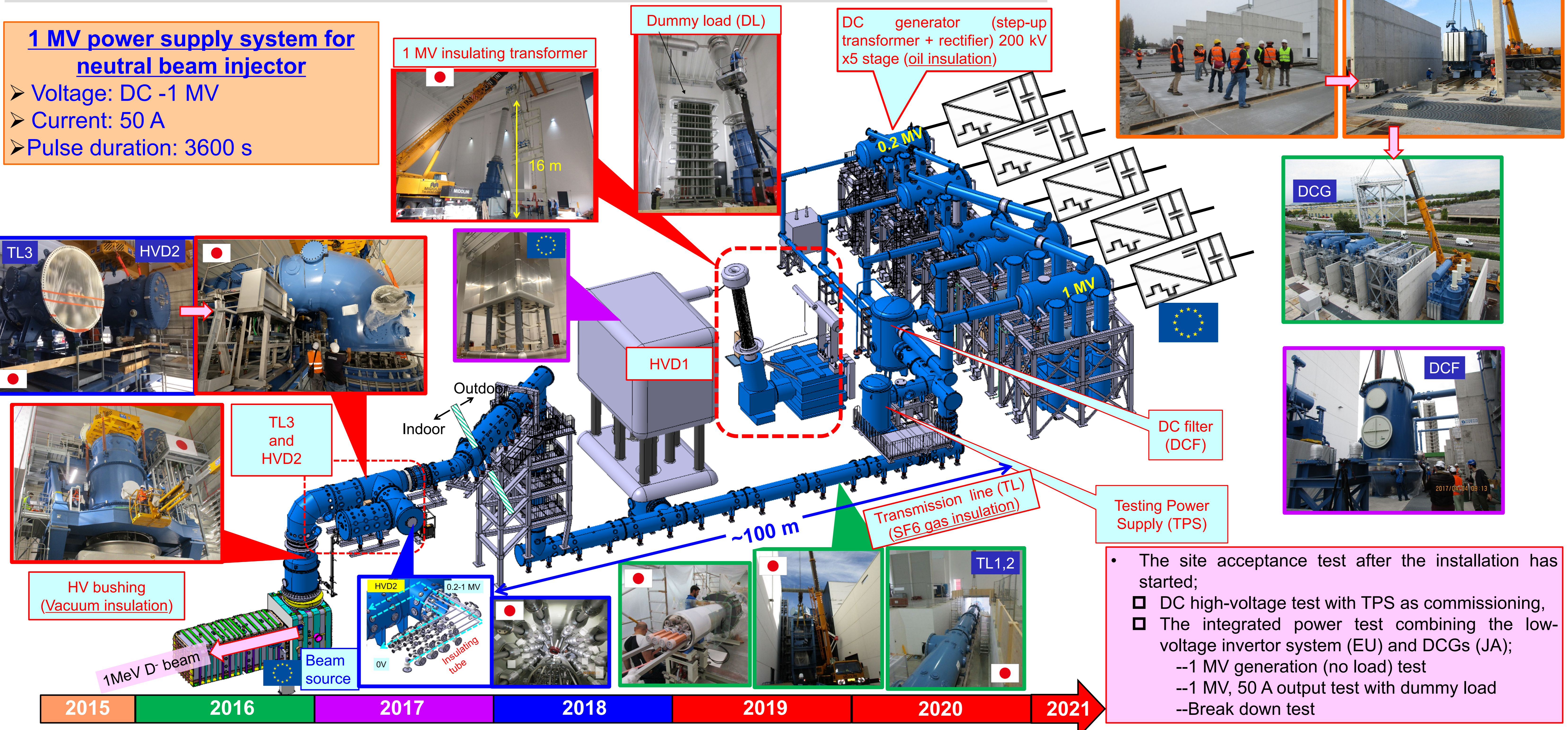
- Construction of the ITER Neutral Beam Test Facility (NBTF) in Padova, Italy to verify 1 MeV, 40 ampere D<sup>-</sup> beam acceleration technology has been completed.
- DC high-voltage test with Testing Power Supply (TPS) as a commissioning has been successfully completed in November 2019. Insulation design of all components has been confirmed.
- Integrated test with the inverter and the DC Generator (DCG) has started making full use of the remote/real-time communication between Japan and Italy. Functionality and current output from the combined system of inverter and DCG successfully was confirmed for the first time.



## Progress on ITER Neutral beam test facility (NBTF) in Padova

### 1 MV power supply system for neutral beam injector

- Voltage: DC -1 MV
- Current: 50 A
- Pulse duration: 3600 s

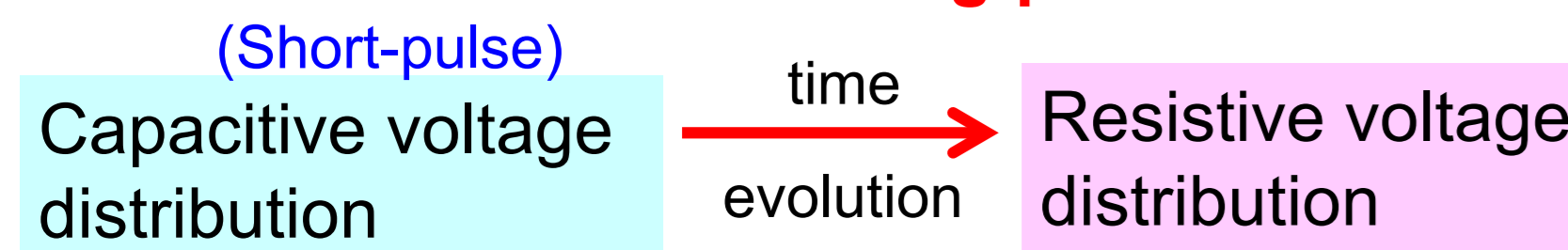


- The site acceptance test after the installation has started;
  - DC high-voltage test with TPS as commissioning.
  - The integrated power test combining the low-voltage inverter system (EU) and DCGs (JA);
    - 1 MV generation (no load) test
    - 1 MV, 50 A output test with dummy load
    - Break down test

## Progress on DC high-voltage test with TPS

### Verification of insulation design

AC insulation ≠ DC long-pulse insulation



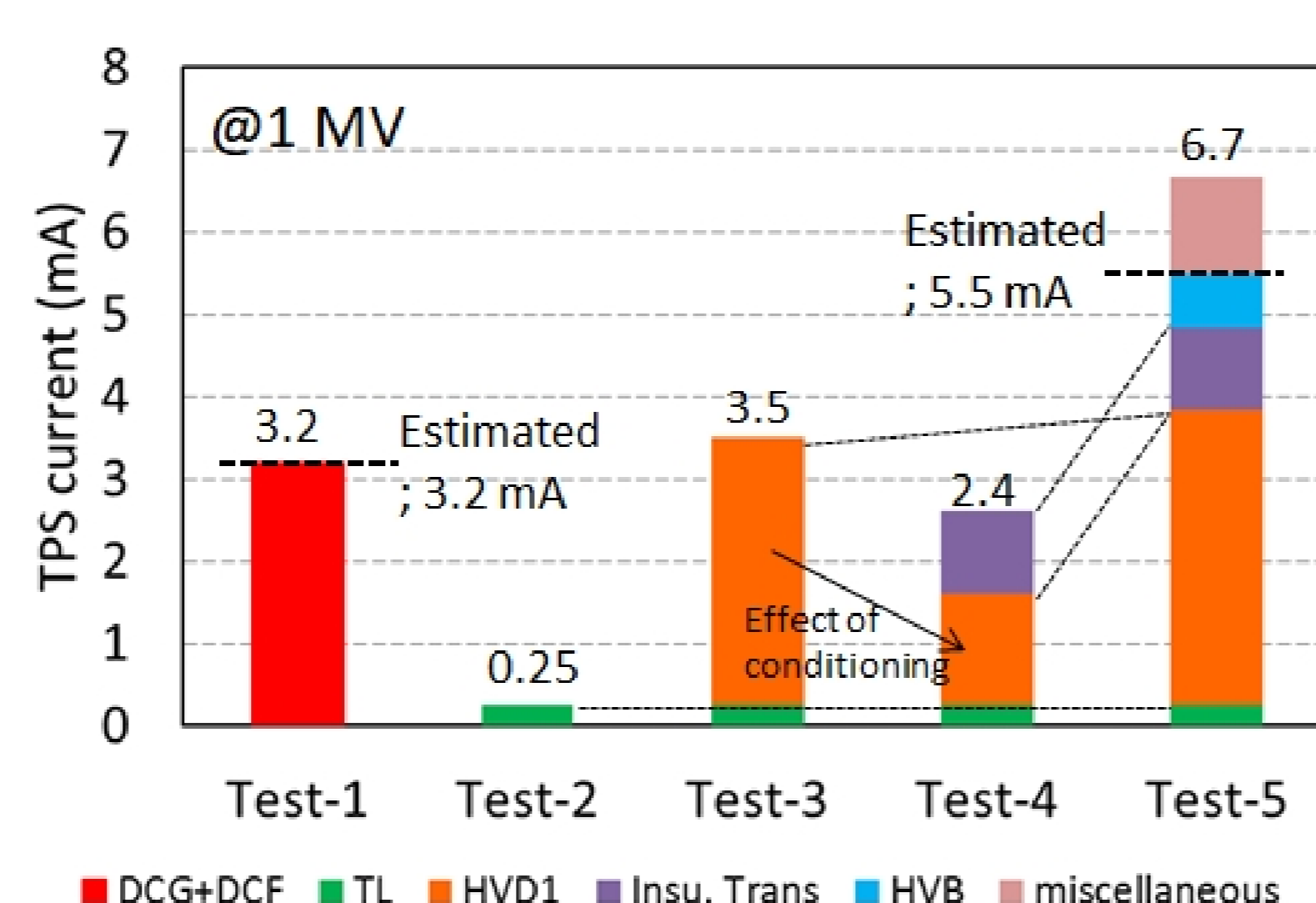
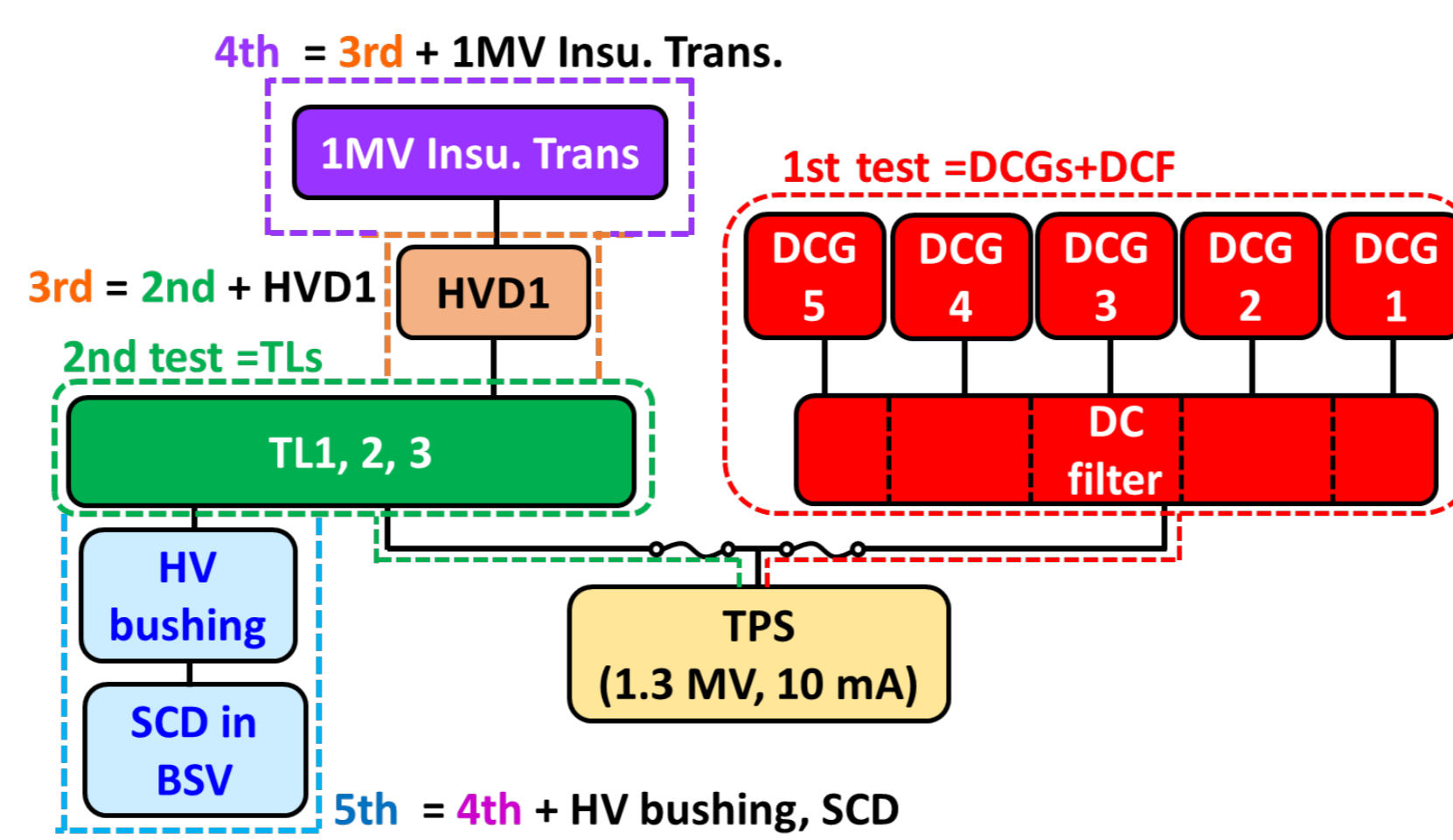
- Higher electric field area shifts on material on higher resistivity.
- Time constant until the charge up on insulating material is the critical parameter.

Material	Time constant
Oil-immersed paper	5 h
Epoxy insulator	5 h

No.	Condition	Remark
1	1.2 MV for 1 h	120 % of rated voltage for rated pulse duration
2	1.06 MV for 5 h	long-pulse insulation
3	1.06→1.265 MV, 5 times	repetitive saw tooth ramp-up simulating over-voltage at breakdown

### Strategy on Test sequence

To verify the insulation design and also risk mitigation, the **five tests** were performed step by step by dividing the test area.

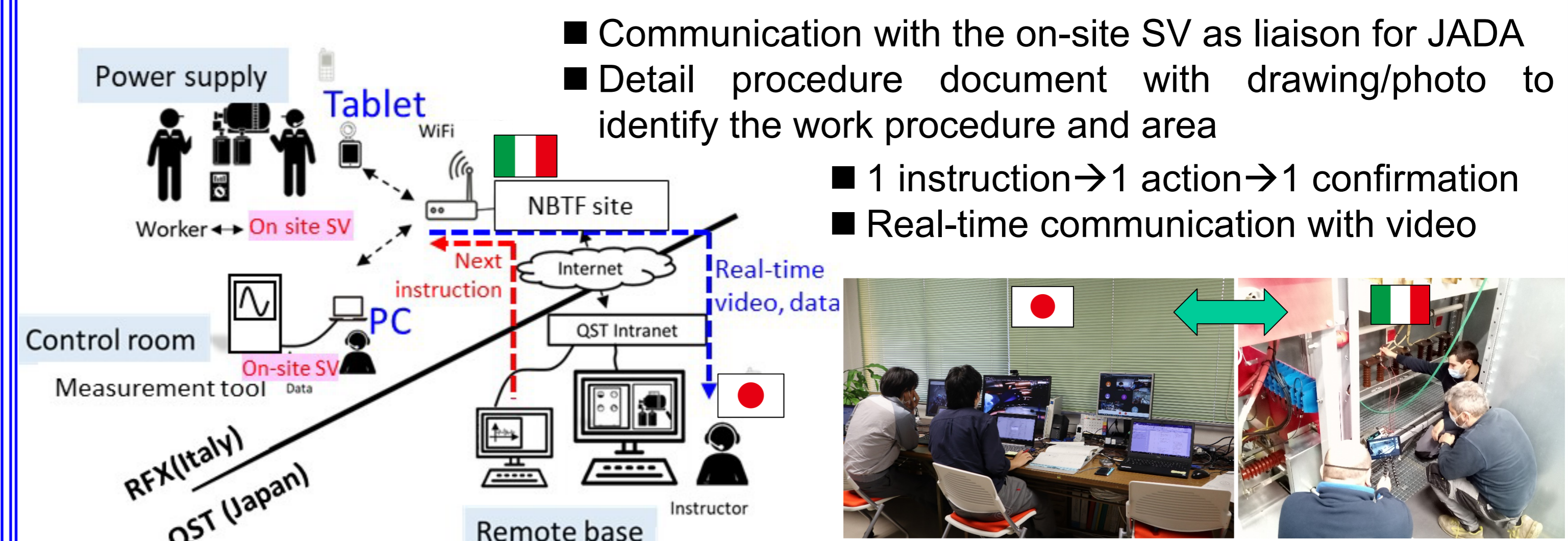


All high-voltage tests have been successfully completed in Nov 2019.  
 →Verification of insulation design combined with oil, gas and vacuum insulation

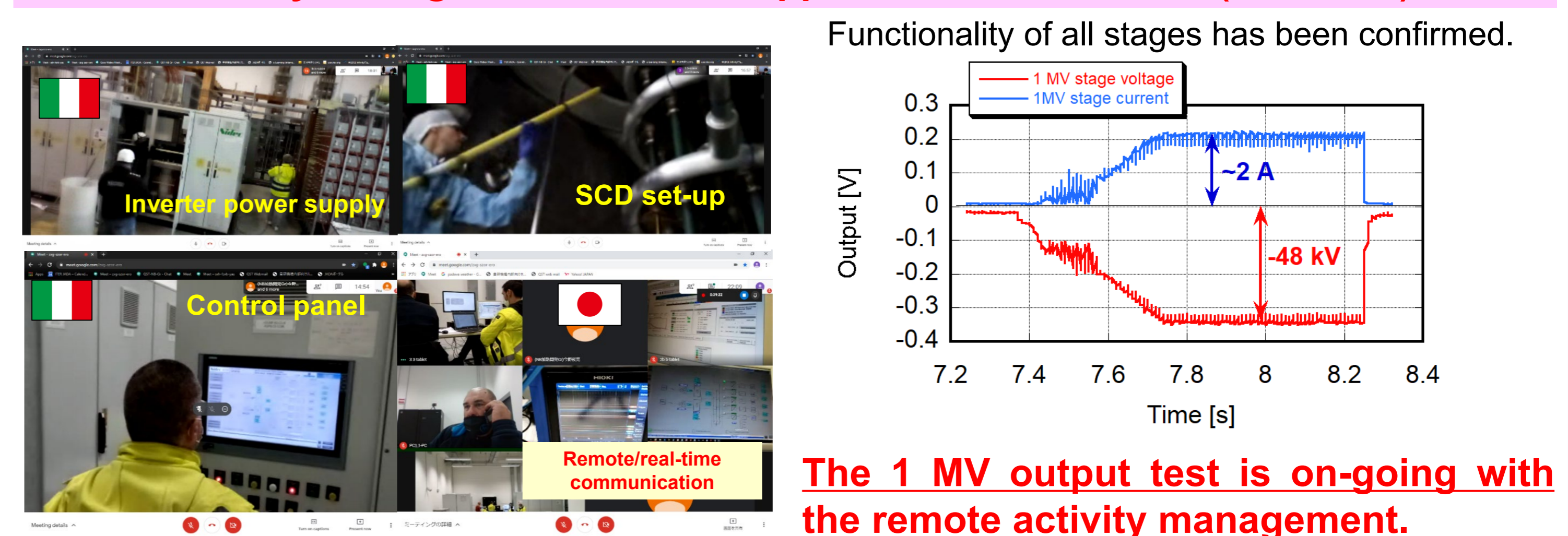
## Progress on Integrated power test

- As the final site acceptance test, the integrated power test with the inverter system and DCG, DCF and TLs has started.
- Technical assistance on site by JADA/QST and the manufacturer was absolutely essential for the assembly of the complicated power supply system and testing. However, due to COVID-19 pandemic, the on-site joint work is difficult to perform.

### Establishment of remote activity management



Remote activity management has been applied to the functional (feedback) test.



The 1 MV output test is on-going with the remote activity management.