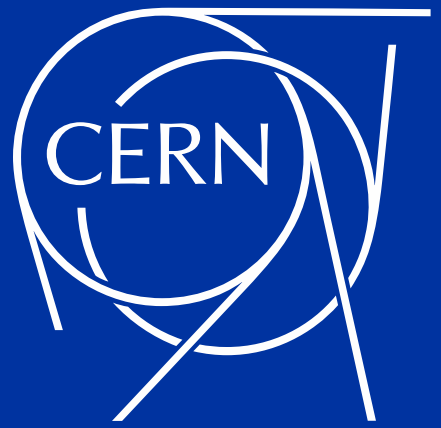


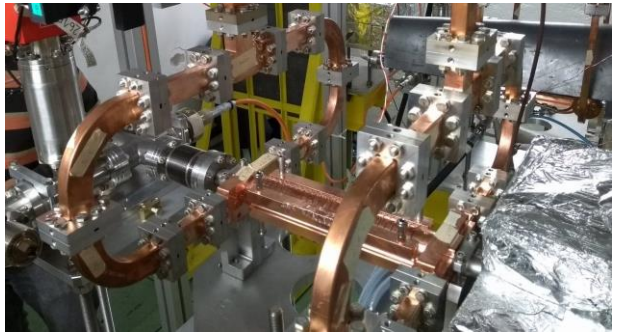
High-gradient breakdown studies of an X-band accelerating structure operated in the reversed taper direction

Xiaowei Wu on behalf of the Xbox team at CERN (xiaowei.wu@cern.ch)

25-MAY-2021

The reversed structure of “42T”

T24 in test slot



T24 is an X-band traveling-wave structure similar to “CLIC-G” design but without damping waveguide

working at 11.994 GHz, $2\pi/3$ mode, iris-**T**apered **24** cell structure (T24)

previous tests showed breakdowns concentrated in the front part of the structure NOT in the end cells which have higher field

limited power to feed the structure above 100 MV/m

Flip the structure and retest it at high power→ “42T”

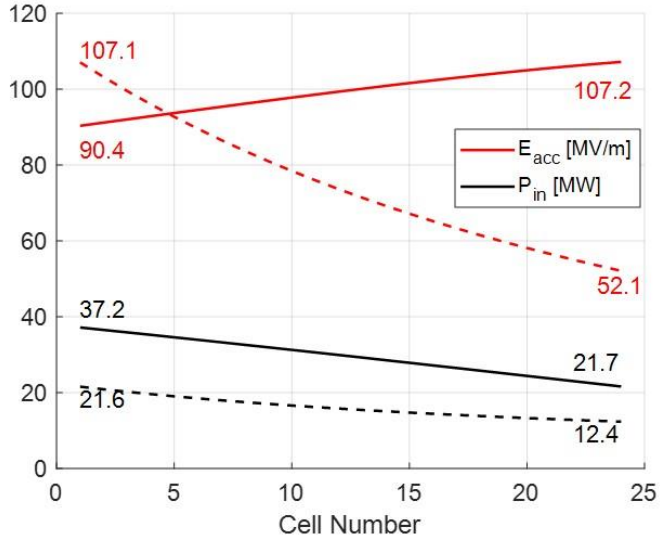
T24 (solid line):

- average gradient of 99.43 MV/m @ 37.2 MW
- gradient along structure: 90.4 MV/→107.2 MV/m

Reversed T24→“42T” (dash line):

- average gradient of 75.05 MV/m @ 21.6 MW
- gradient along structure: 107.1 MV/m→52.1 MV/m

Field profiles of T24 and 42T



High-power test-stand of Xbox-3

42T was tested at Xbox-3 in CERN

Half of the Xbox-3 was sent to Melbourne University

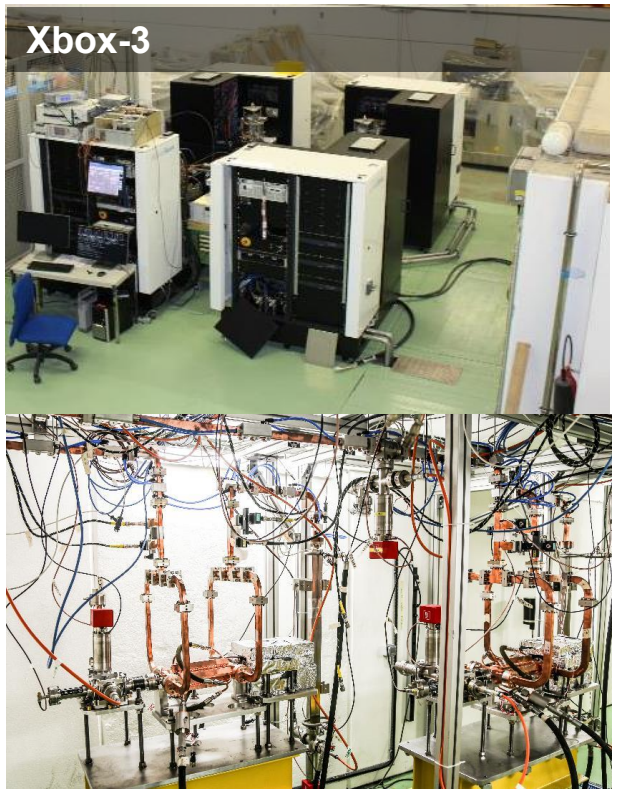
4x Toshiba 6MW 5us klystron→ 2x Toshiba 6MW 5us klystron

4x Scandinova Modulators→ 2x Scandinova Modulators

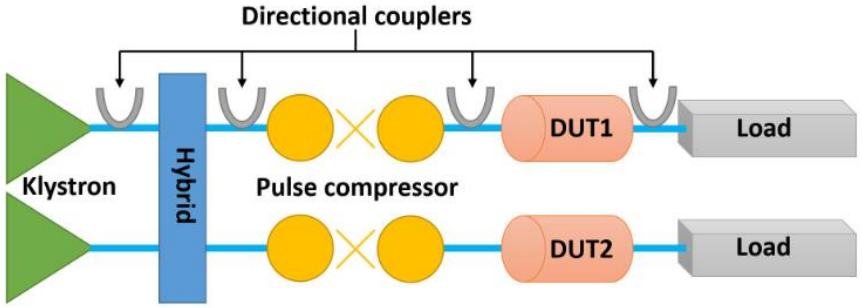
Combining two klystrons with a hybrid to feed two test slots

A maximum peak power of 45 MW for 200 ns at Rep Rate of 400 Hz

Phase ramp modulation in the pulse compressor to get flat-top



Layout of Xbox-3



High-power test history plot of 42T

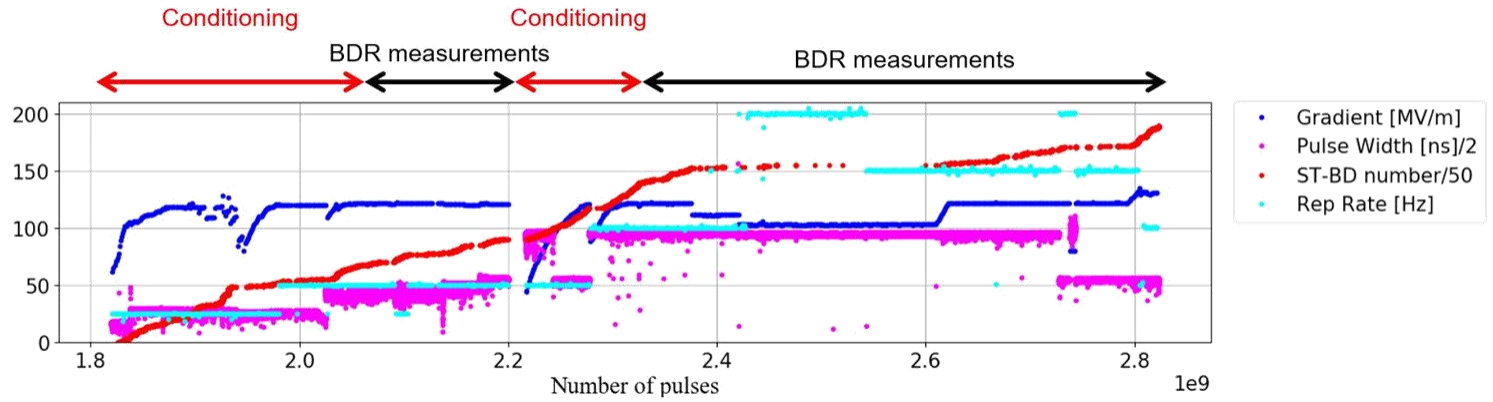
Reflection signals and Faraday cup signals were used for breakdown detection

Conditioning followed by breakdown rate measurements

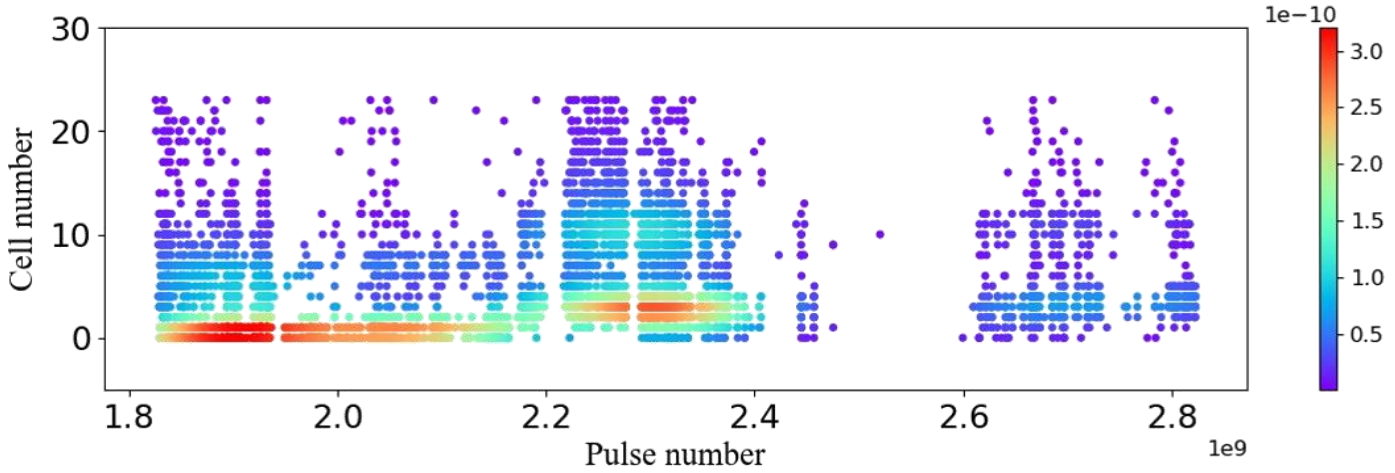
Reached **130 MV/m** in the first cell of the structure

Breakdowns are concentrated in the front of the structure which has higher field

History plot



Breakdown location



Breakdown rate measurements

Breakdown rate (BDR) measurements were conducted at different power levels and pulse widths

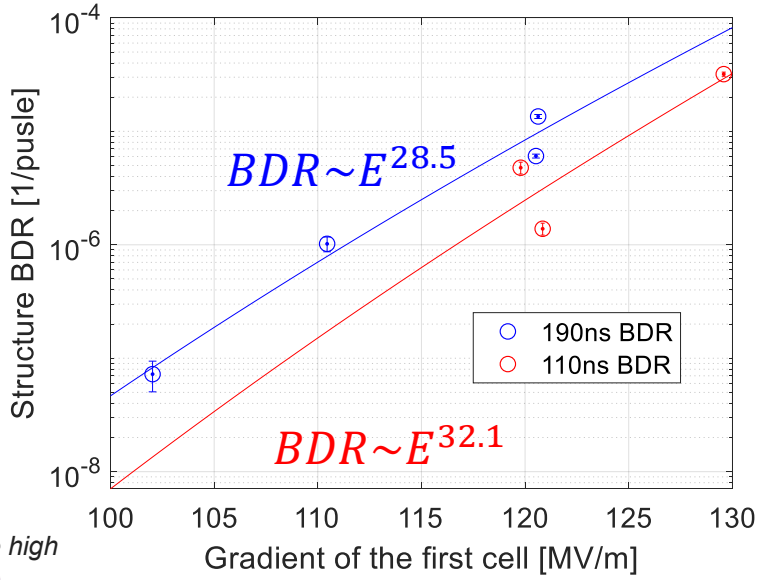
$BDR \sim E^{30}\tau^{5}$ was found in previous study[1]

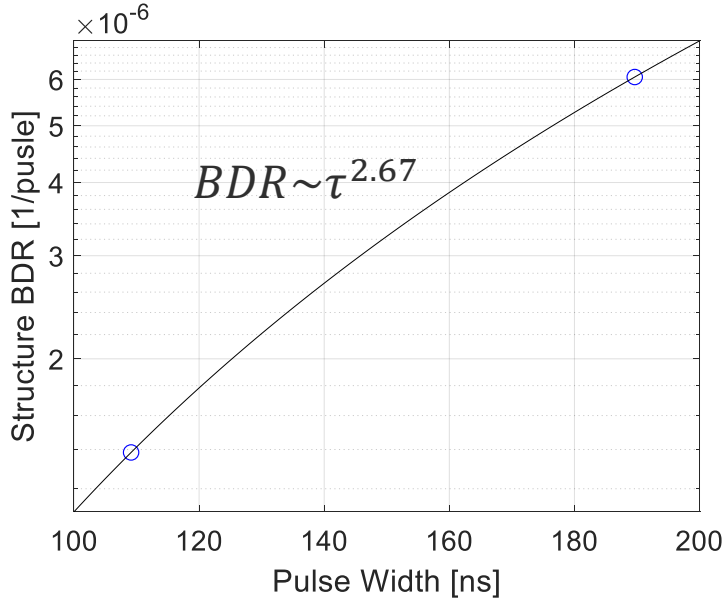
The factors over E are 28.5 and 32.1 in 190 ns and 110 ns BDR measurements

The factor over τ is 2.67 from the fitting of BDR5 and BDR6 measurements

Summary of the BDR measurements

	gradient in first cell [MV/m]	pulse width [ns]	breakdown number	pulse number
BDR1	119.8	109.6	70	1.465e7
BDR2	120.8	192.3	610	4.511e7
BDR3	110.4	190.4	45	4.413e7
BDR4	102.0	188.5	11	1.519e8
BDR5	120.5	189.6	638	1.053e8
BDR6	120.8	109.1	69	4.985e7
BDR7	129.6	109.6	591	1.757e7





[1] A. Grudiev, S. Calatroni, and W. Wuensch, *New local field quantity describing the high gradient limit of accelerating structures*, Phys. Rev. Accel. Beams **12**, 102001 (2009).

Thank you!