

# Mini-Breakdown Rate Calculator

Procedure to create and treat DAQ data on RF pickup signal

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PPS, 27.04.2023

# Getting Data from DAQ

PITZ GUI → tools → DAQbrowser

The image shows two overlapping windows from the PITZ Control system. The background window is the 'PITZ Control' interface, which includes a menu bar (File, View, Help) and a status bar (463Mb/30208Mb). It features several sections: 'beam inhibit system' with 'adc modules', 'diagnostic', 'interlock', 'laserbeamline', 'MBI', 'Pharos', and 'magnets'; 'radiation protection', 'vacuum', 'water / temperature', and 'other alarms / fire alarm'; 'IBPC' with 'operating time: 24028 86501259'; 'plasma cells', 'climate overview', 'logbook PITZ', 'gun conditioning info', 'timing', and 'settings to logbook'; and 'tools', 'watchdog', 'system', 'Save&Restore - Tool', and 'Snapshot to logbook PITZ'. The foreground window is titled 'tools\_main.xml' and contains a 'TOOLS' menu with categories: 'Open MATLAB 16b with Standard Measurement Scripts', 'MATLAB 2021b', 'Emittance measurements tools' (Fastscan test, Fastscan, Emittance window), 'Shift tools' (MeasureQE, MeasureCharge, DAQbrowser, Print summary, iLILI), and 'Miscellaneous' (Data to SPS-21, History Tool, oceanoptics).

The image shows the 'DAQ browser' window. At the top, it says 'Getting data...'. Below this are fields for 'Start time: 2023-04-06 09:00:00' and 'Stop time: 2023-04-06 12:00:00', along with buttons for 'Delete entry', 'Add entry', 'Get data', 'Plot data', 'Save data...', and 'Save pruned data...'. The main area is divided into two columns: 'DAQ names' and 'DOOCS addresses'. The 'DAQ names' column lists various probe and limiter identifiers. The 'DOOCS addresses' column lists corresponding DOOCS paths, with 'PITZ.UTIL/TRANSLATOR/PROBE\_VFORW.AMPL/LOCAL\_SPECTRUM' highlighted. To the right of the DOOCS addresses, there are labels for data types: 'scalar' and 'spectrum'. At the bottom, there is a status bar with the text 'GUN\_PROBE\_VFORW.AMPL <<=> PITZ.UTIL/TRANSLATOR/PROBE\_VFORW.AMPL/LOCAL\_SPECTRUM <<=> spectrum'.

# Getting Data from DAQ

## DAQbrowser

The screenshot shows the DAQ browser window with the title "Getting data...". It features a control panel with "Start time" (2023-04-06 09:00:00) and "Stop time" (2023-04-06 12:00:00) fields, and buttons for "Delete entry", "Add entry", "Get data", "Plot data", "Save data...", and "Save pruned data...". Below the control panel are two columns: "DAQ names" and "DOOCS addresses". The "DAQ names" column lists various probe-related entries, with "GUN\_PROBE\_VFORW.AMPL" highlighted. The "DOOCS addresses" column lists corresponding addresses, with "PITZ.UTIL/TRANSLATOR/PROBE\_VFORW.AMPL/LOCAL\_SPECTRUM" highlighted. A third column on the right shows the data type for each address, with "spectrum" listed for the highlighted address. At the bottom, a summary bar shows the selected DAQ name, DOOCS address, and data type.

DAQ names	DOOCS addresses	Data Type
CAVBOO_PROBE1AMPLLIMITER_20170512	PITZ.RF/LLRF.CONTROLLER/CAV.BOO/PROBE1.AMPL.LIMITER	scalar
CAVBOO_PROBE1AMPLPRE_LIMITER_20170512	PITZ.RF/LLRF.CONTROLLER/CAV.BOO/PROBE1.AMPL.PRE_LIMITER	scalar
CAVBOO_PROBE1AMPLSAMPLE_20170512	PITZ.RF/LLRF.CONTROLLER/CAV.BOO/PROBE1.AMPL.SAMPLE	scalar
CAVBOO_PROBE1LIMIT_DIS_20170512	PITZ.RF/LLRF.CONTROLLER/CAV.BOO/PROBE1.LIMIT_DIS	scalar
CAVBOO_PROBE2AMPLLIMITER_20170512	PITZ.RF/LLRF.CONTROLLER/CAV.BOO/PROBE2.AMPL.LIMITER	scalar
CAVBOO_PROBE2AMPLPRE_LIMITER_20170512	PITZ.RF/LLRF.CONTROLLER/CAV.BOO/PROBE2.AMPL.PRE_LIMITER	scalar
CAVBOO_PROBE2AMPLSAMPLE_20170512	PITZ.RF/LLRF.CONTROLLER/CAV.BOO/PROBE2.AMPL.SAMPLE	scalar
CAVBOO_PROBE2LIMIT_DIS_20170512	PITZ.RF/LLRF.CONTROLLER/CAV.BOO/PROBE2.LIMIT_DIS	scalar
GUN_PROBE_PFORW.AMPL	PITZ.UTIL/TRANSLATOR/PROBE_PFORW.AMPL/LOCAL_SPECTRUM	spectrum
<b>GUN_PROBE_VFORW.AMPL</b>	<b>PITZ.UTIL/TRANSLATOR/PROBE_VFORW.AMPL/LOCAL_SPECTRUM</b>	<b>spectrum</b>
GUN_PROBE_VFORW.PHASE	PITZ.UTIL/TRANSLATOR/PROBE_VFORW.PHASE/LOCAL_SPECTRUM	spectrum

1. DAQ names: GUN\_PROBE\_VFORW.AMPL
2. Start / Stop dates: Not longer than 4 hours!
3. Press Button "Get Data"
4. Wait until "Data collected"

# Saving Data from DAQ

## DAQbrowser

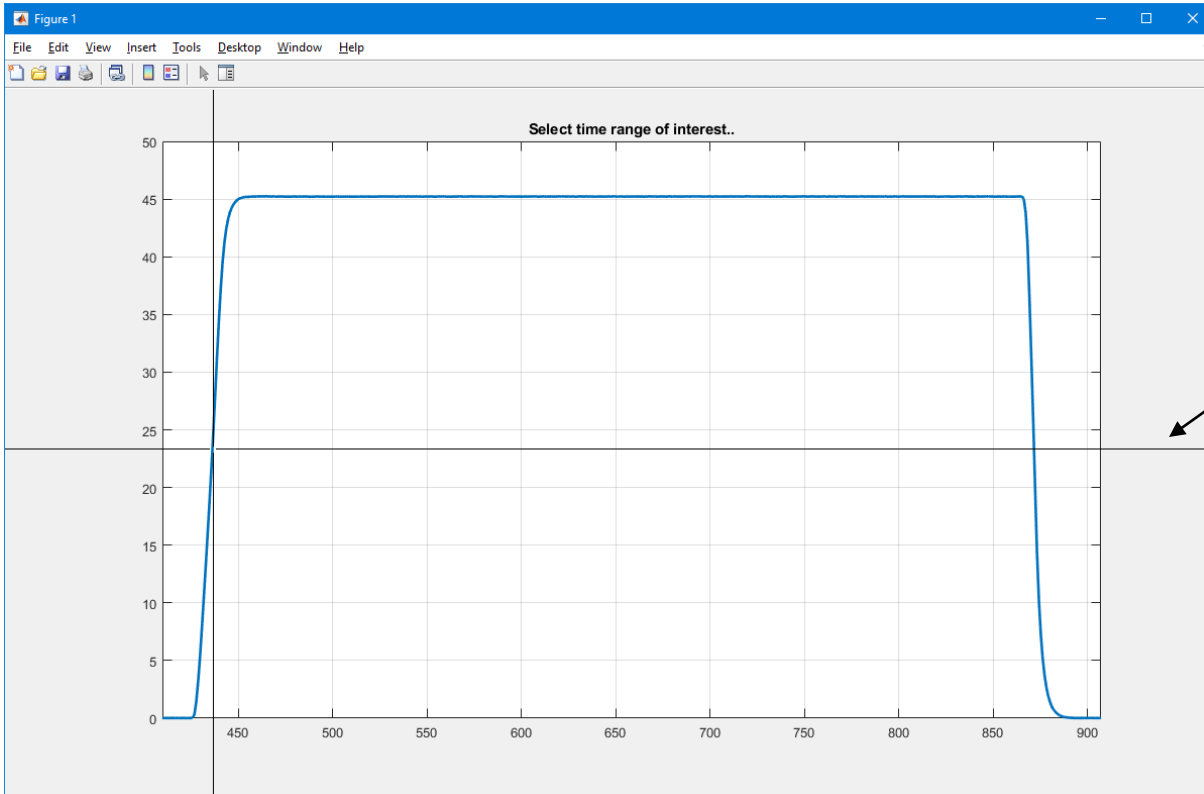
The screenshot shows the DAQ browser software interface. At the top, it displays "Data collected" in green. Below this, there are controls for "Start time" (2023-04-06 09:00:00) and "Stop time" (2023-04-06 12:00:00). Buttons for "Delete entry", "Add entry", "Get data", "Plot data", "Save data...", and "Save pruned data..." are visible. The main area is divided into two columns: "DAQ names" and "DOOCS addresses". The "DOOCS addresses" column is expanded to show a tree structure under "PROBE", with "PITZ.UTIL/TRANSLATOR/PROBE\_VFORW.AMPL/LOCAL\_SPECTRUM" selected. A "Select File to Write" dialog box is open, showing a file tree with "2023" selected under the "\_Gun" folder. The "File Name" field is empty, and "Files of Type" is set to "MAT files (\*.mat)".

### “Data collected”

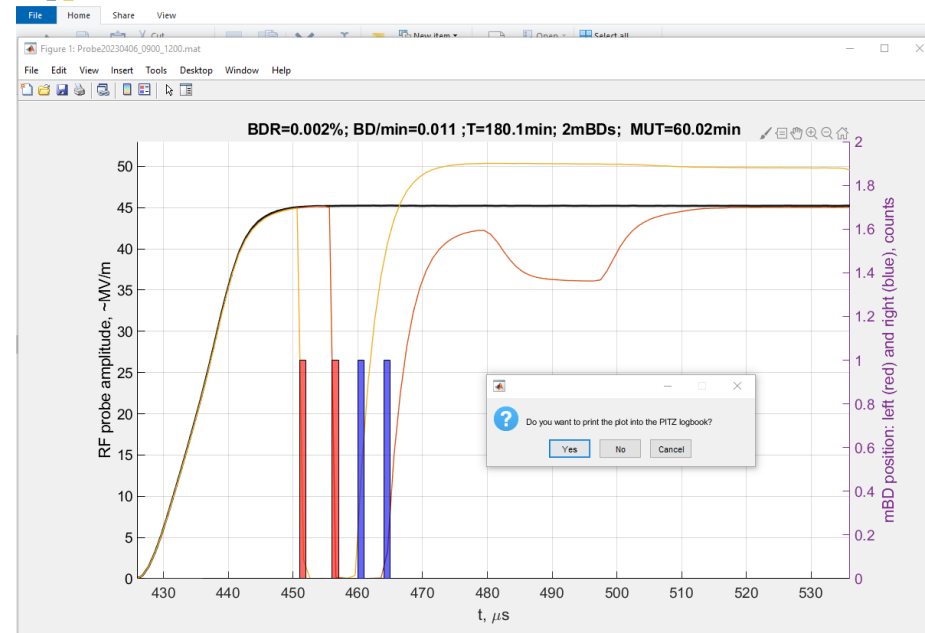
5. Press Button “Save Data”
6. Measure(at afs)→Conditioning→\_Gun→2023→shift
7. File name starting with “Probe...”, e.g.,  
*Probe20230406\_0900\_1200*
8. Wait while “Saving Data” until “Data saved to file”

# Calculate with Matlab Script

## DAQbrowser



9. Start Matlab
  10. Load: nfs→Measure→scripts→Development→  
→BDRcalculator→plotProbe\_DAQ\_BDUNI.m
  11. Start it (F5)
  12. Open DAQ file e.g.,  
*Probe20230406\_0900\_1200.mat*
  13. Wait while loading the dsta
  14. Dialog “Select time range of interest”
  15. Select 2 points (~FWHM)
  16. Running (ccont is incrementing)
  17. Ready
- NB: sometimes printing is not working properly



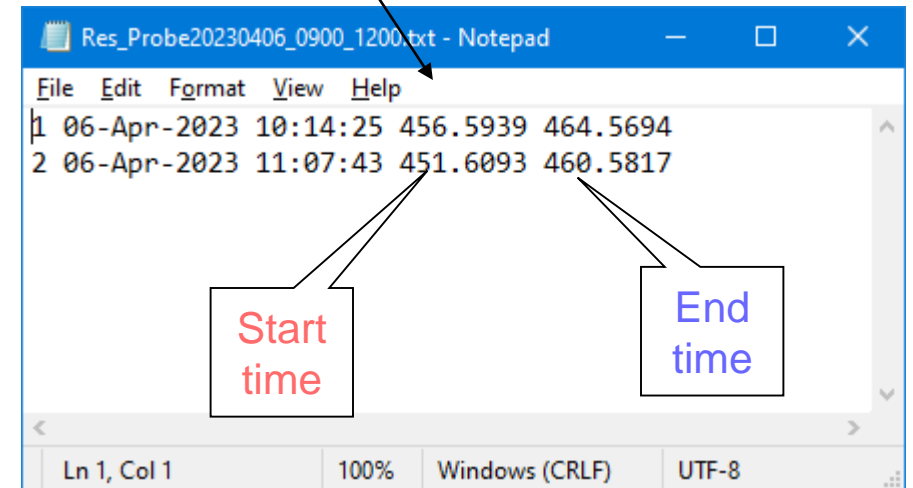
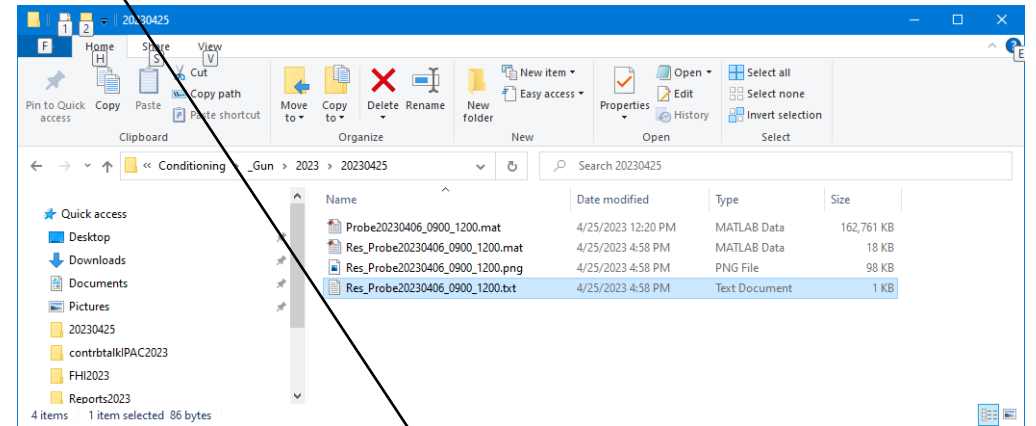
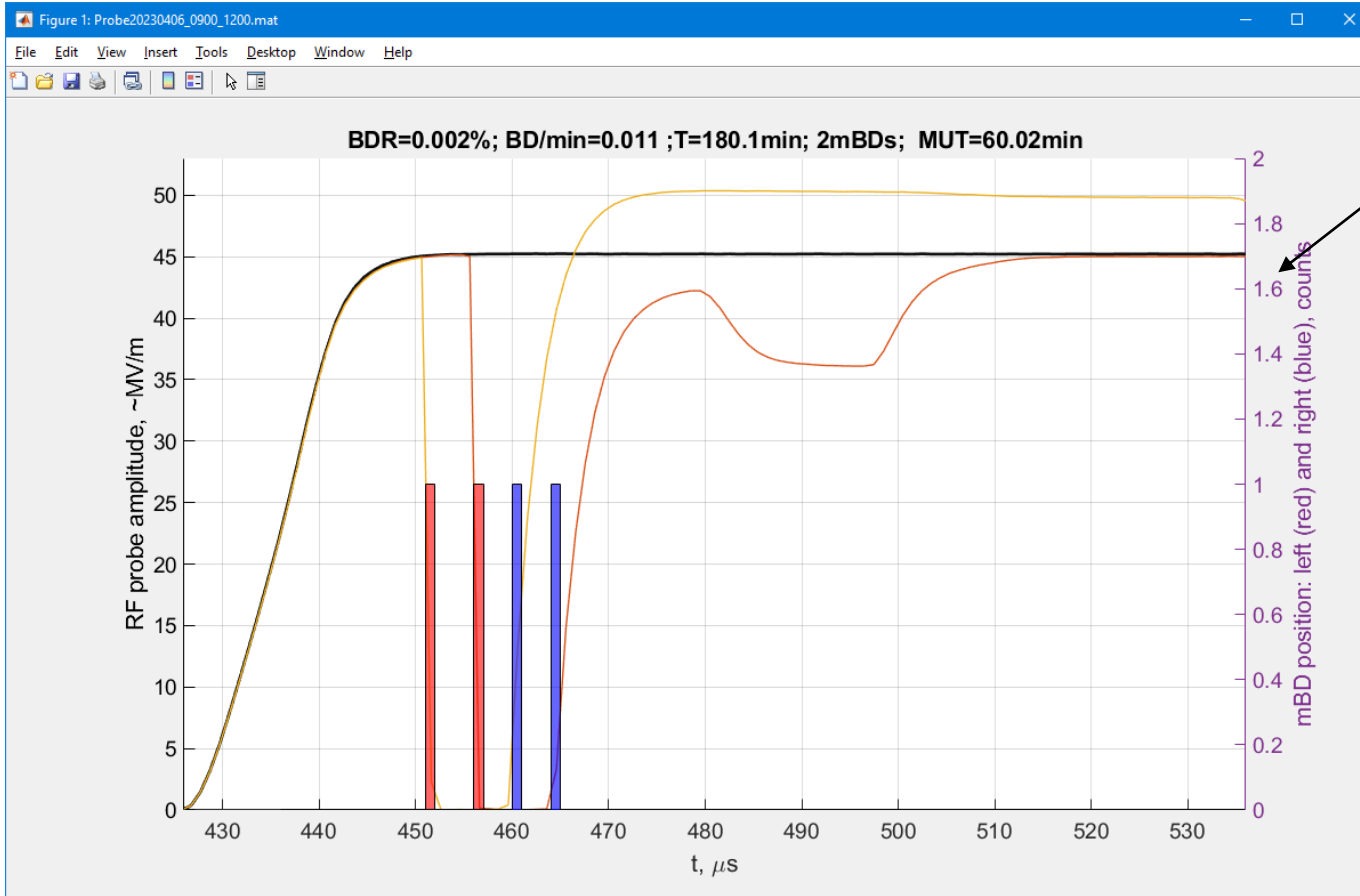
# Calculate with Matlab Script

Results (NB: FB=ON)

Input: Probe20230406\_0900\_1200.mat

Output:

- Res\_Probe20230406\_0900\_1200.png
- Res\_Probe20230406\_0900\_1200.txt



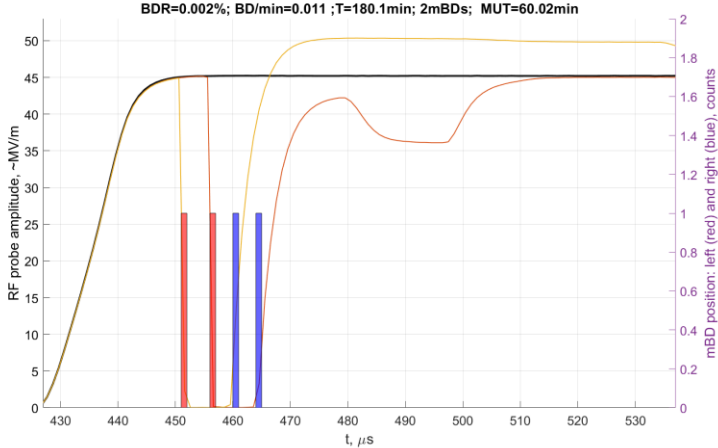
$$BDR = \frac{\text{number of corrupted pulses}}{\text{total number of pulses}}$$

$MUT = \text{mean unperturbed time}$

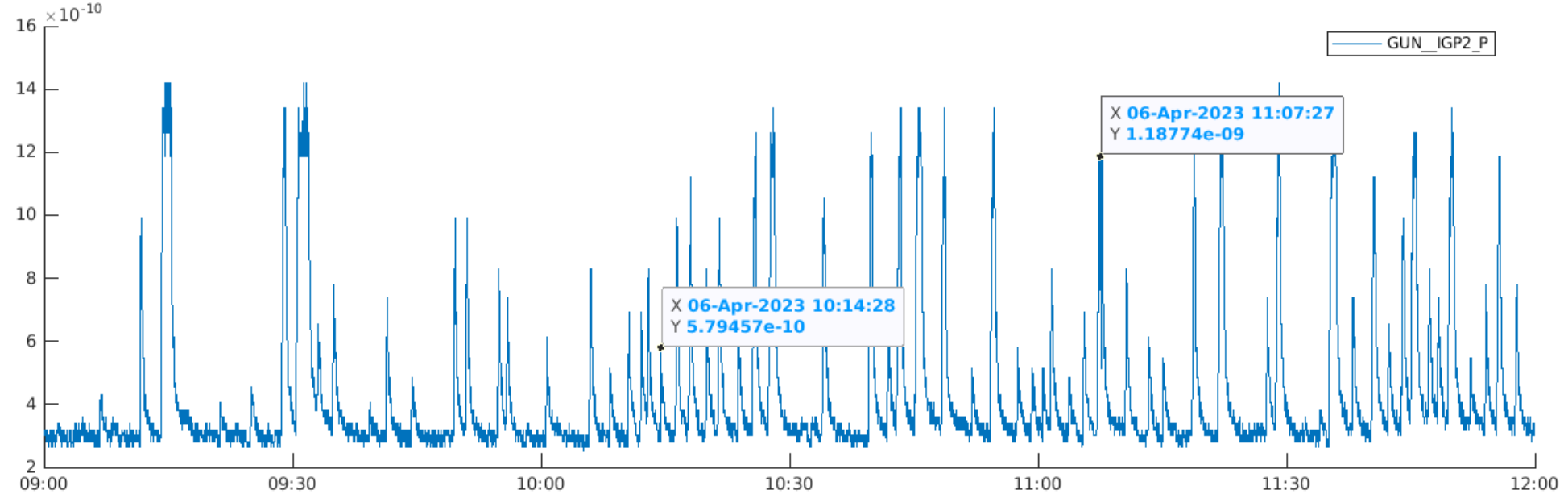
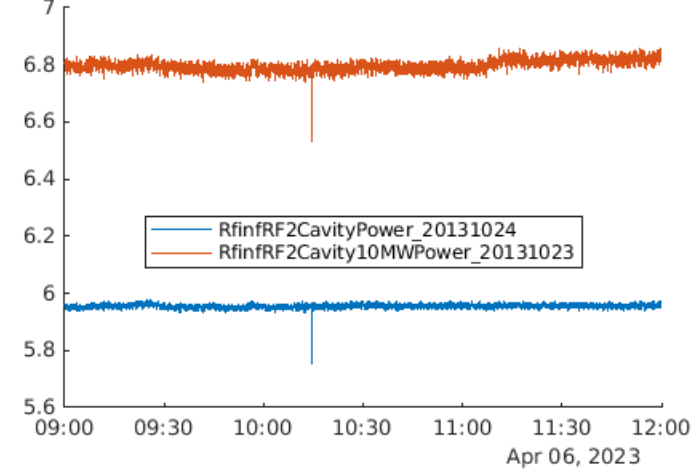
$$BDR/min = \frac{\text{number of corrupted pulses}}{\text{measurement time in min}}$$

# Conditioning Check

Problems → many vacuum mini spikes correlated to WG2 VVW PMT, not to mBDs



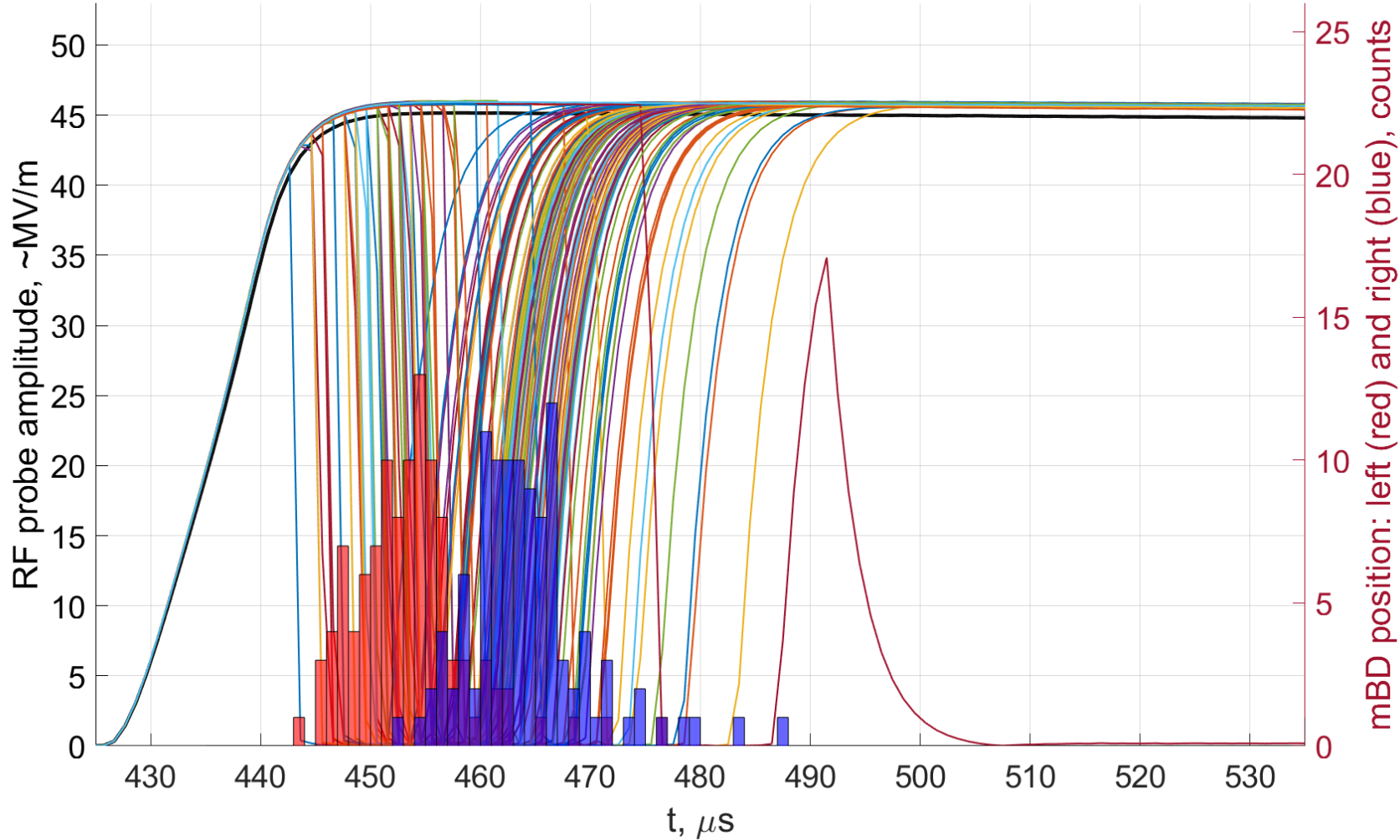
```
Res_Probe20230406_0900_1200.txt - Notepad
File Edit Format View Help
1 06-Apr-2023 10:14:25 456.5939 464.5694
2 06-Apr-2023 11:07:43 451.6093 460.5817
```



# Another (old) example

04.06.2022 23:00- 05.06.2022 02:00

**BDR=0.103%; BD/min=0.618 ;T=178.0min; 110mBDs; MUT=1.60min**



Ln	Col 1	Col 2	Col 3	Col 4	Col 5	Col 6	Col 7
1	04-Jun-2022	23:09:21	457.5909	465.5663			
2	04-Jun-2022	23:17:49	450.6124	460.5817			
3	04-Jun-2022	23:18:25	456.5939	465.5663			
4	04-Jun-2022	23:30:16	462.5755	476.5325			
5	04-Jun-2022	23:30:47	456.5939	467.5602			
6	04-Jun-2022	23:33:02	450.6124	460.5817			
7	04-Jun-2022	23:42:43	454.6001	464.5694			
8	04-Jun-2022	23:45:14	450.6124	460.5817			
9	04-Jun-2022	23:55:20	451.6093	461.5786			
10	04-Jun-2022	23:55:34	453.6031	463.5725			
11	04-Jun-2022	23:57:36	448.6185	459.5847			
12	05-Jun-2022	00:01:47	456.5939	466.5632			
13	05-Jun-2022	00:03:16	455.597	467.5602			
14	05-Jun-2022	00:03:47	452.6062	463.5725			
15	05-Jun-2022	00:05:44	456.5939	468.5571			
16	05-Jun-2022	00:08:24	453.6031	463.5725			
17	05-Jun-2022	00:08:45	448.6185	458.5878			
18	05-Jun-2022	00:09:46	451.6093	461.5786			
19	05-Jun-2022	00:10:37	454.6001	464.5694			
20	05-Jun-2022	00:11:55	453.6031	464.5694			
21	05-Jun-2022	00:12:32	460.5817	469.554			
22	05-Jun-2022	00:12:59	454.6001	464.5694			
23	05-Jun-2022	00:13:18	446.6246	458.5878			
24	05-Jun-2022	00:13:38	447.6216	455.597			
25	05-Jun-2022	00:18:36	451.6093	463.5725			
26	05-Jun-2022	00:21:20	449.6154	460.5817			
27	05-Jun-2022	00:22:33	447.6216	459.5847			
28	05-Jun-2022	00:22:48	451.6093	460.5817			
29	05-Jun-2022	00:25:31	452.6062	461.5786			
30	05-Jun-2022	00:27:23	461.5786	473.5417			
31	05-Jun-2022	00:30:34	454.6001	461.5786			
32	05-Jun-2022	00:32:10	450.6124	460.5817			
33	05-Jun-2022	00:33:04	450.6124	462.5755			
34	05-Jun-2022	00:34:27	447.6216	457.5909			
35	05-Jun-2022	00:35:44	445.6277	454.6001			
36	05-Jun-2022	00:36:27	446.6246	456.5939			
37	05-Jun-2022	00:40:18	471.5479	483.5111			
38	05-Jun-2022	00:41:03	453.6031	464.5694			
39	05-Jun-2022	00:41:12	457.5909	468.5571			
40	05-Jun-2022	00:42:12	462.5755	474.5387			
41	05-Jun-2022	00:43:14	446.6246	456.5939			
42	05-Jun-2022	00:43:33	449.6154	460.5817			
43	05-Jun-2022	00:43:38	468.5571	479.5233			
44	05-Jun-2022	00:44:24	449.6154	460.5817			
45	05-Jun-2022	00:46:45	457.5909	470.551			
46	05-Jun-2022	00:48:17	456.5939	466.5632			
47	05-Jun-2022	00:48:43	455.597	464.5694			
48	05-Jun-2022	00:49:41	452.6062	463.5725			
49	05-Jun-2022	00:50:13	443.6338	452.6062			
50	05-Jun-2022	00:50:31	458.5878	471.5479			
51	05-Jun-2022	00:52:13	447.6216	456.5939			
52	05-Jun-2022	00:52:47	454.6001	465.5663			



# Status Gun 5.1: Mini-Breakdown Studies

*M. Krasilnikov for the PITZ team, presented at PITZ Collaboration Meeting, Zeuthen 14.12.2022*

# Gun5.1 Mini-Breakdown Rate (BDR) Studies

## Dependence on various parameters

$$BDR = \frac{\text{number of corrupted pulses}}{\text{total number of pulses}}$$

**MUT = Mean Unperturbed Time ( $\propto$  "MTBF"):**

$$MUT = \frac{T_{meas}}{\text{number of corrupted pulses}} \sim \frac{1}{BDR}$$

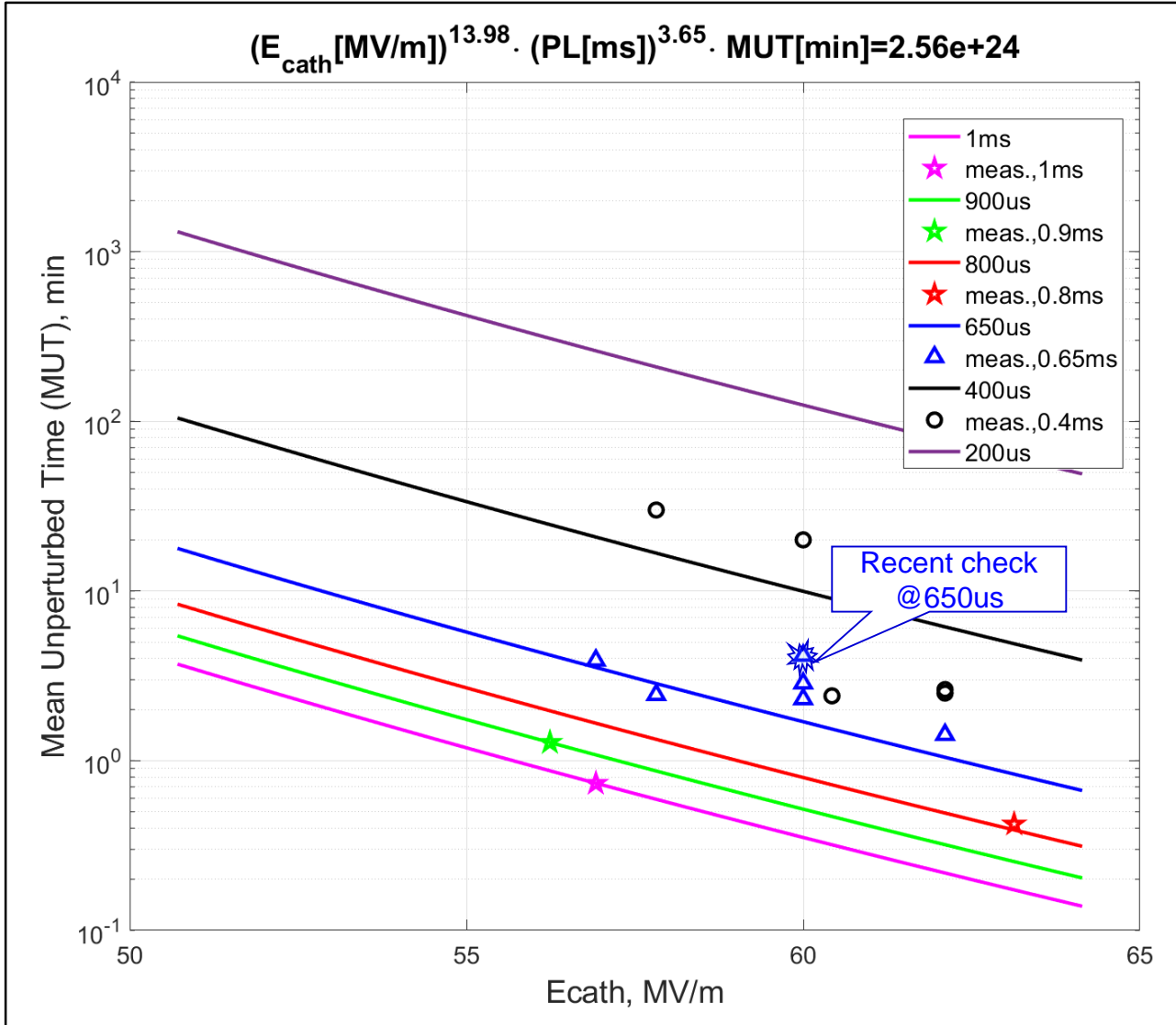
NB: Beam momentum based gun power ( $E_{cath}$ ) calibration

PHYSICAL REVIEW SPECIAL TOPICS - ACCELERATORS AND BEAMS 12, 102001 (2009)

New local field quantity describing the high gradient limit of accelerating structures

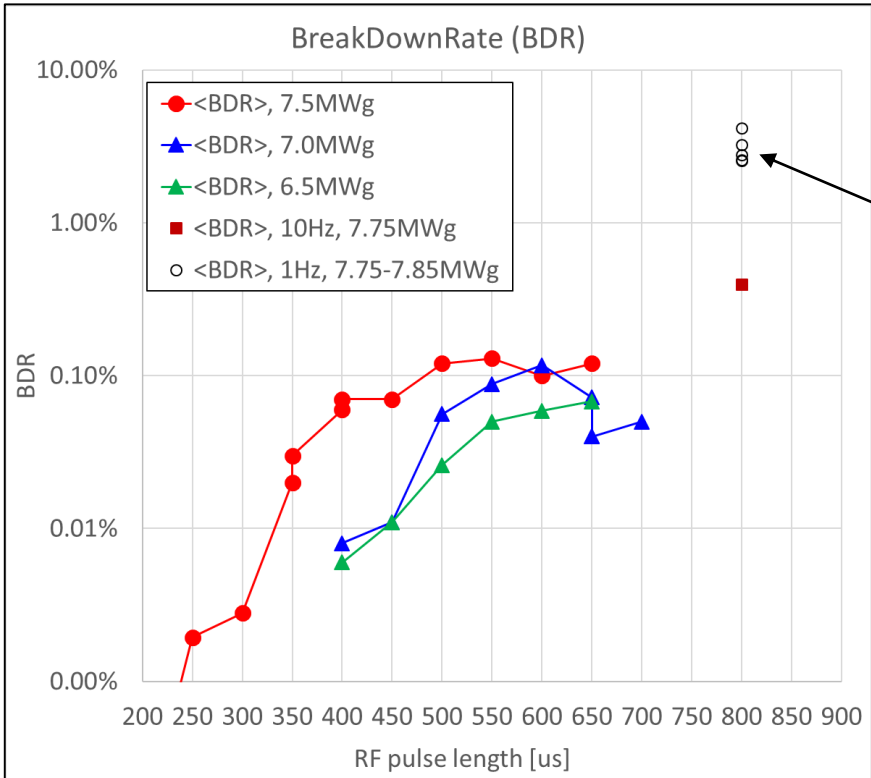
A. Grudiev, S. Calatroni, and W. Wuensch  
 CERN, CH-1211 Geneva-23, Switzerland  
 (Received 28 January 2009; published 26 October 2009)

$$\frac{E_0^{30} \cdot \tau^5}{BDR} = \text{const},$$



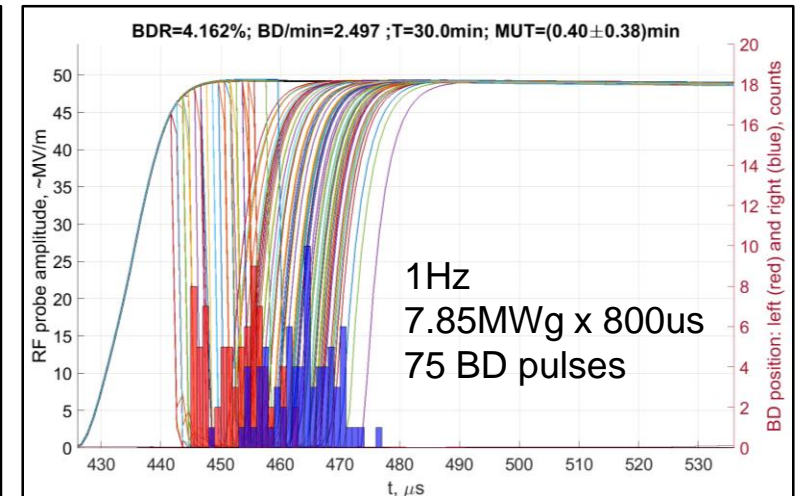
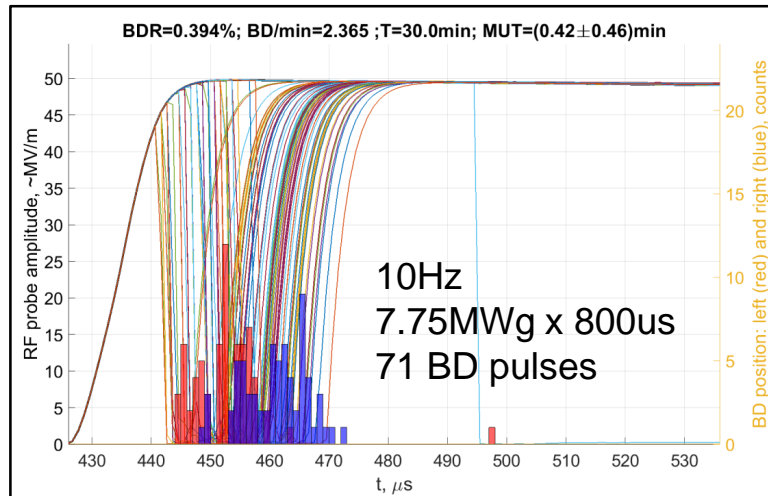
# Gun5.1 Mini-Breakdown Rate (BDR) Studies

Dependence on RF peak power in the gun, RF pulse length (PL) and repetition rate (RR)



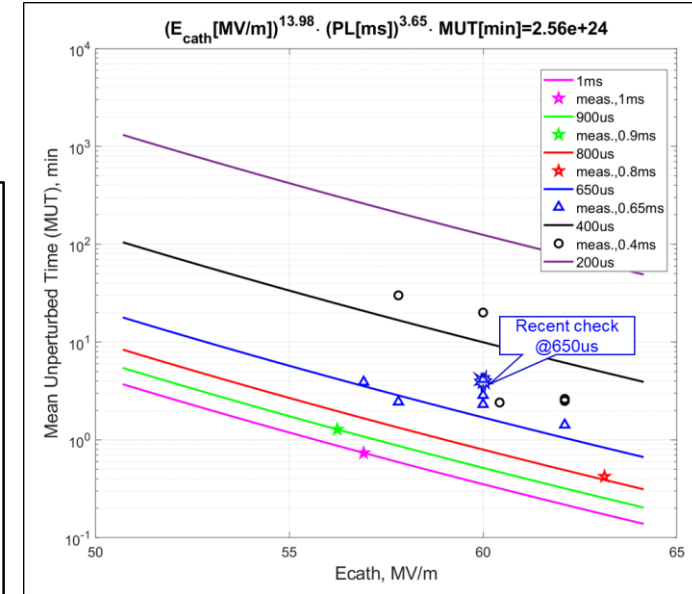
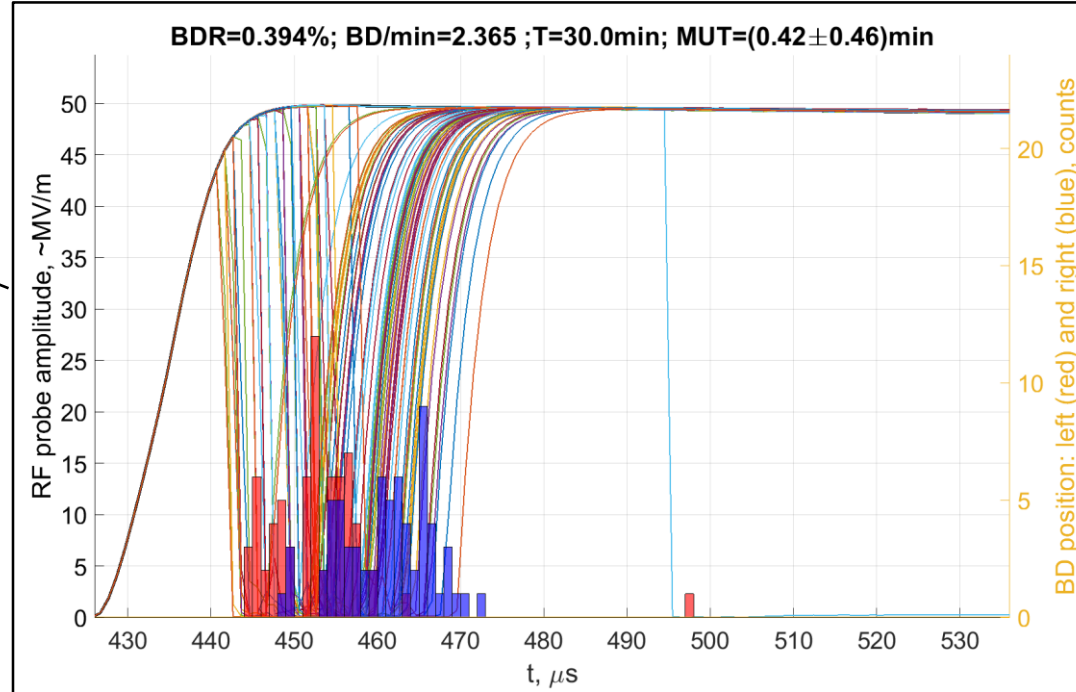
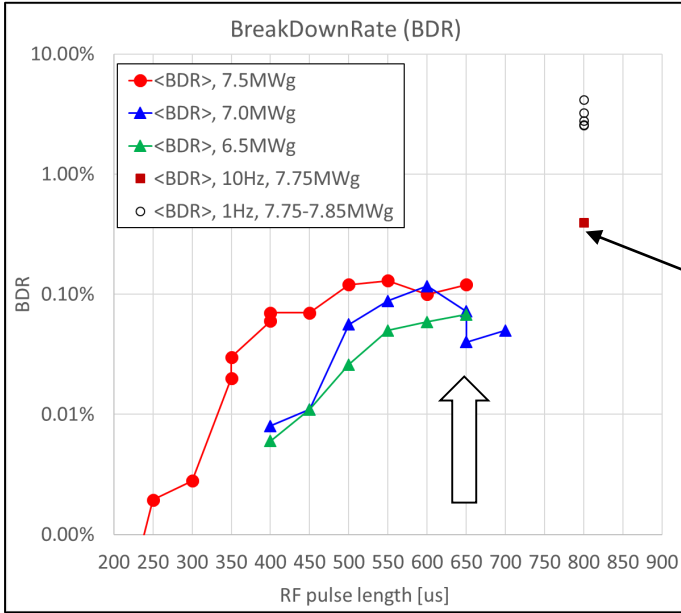
## Mini-Breakdown Rate $BDR(P_{RF,gun}, PL, RR)$ :

- Starts at PL~350us for 7.5MW in gun
- “Saturates” at PL~500.550us
- Sometimes even slightly reduced at PL~550..600us
- For identical conditions the rate (BD/min) goes slightly down with **1 Hz** compared to **10 Hz** (not dramatically), but the **<BDR>** (% of pulse number) for **1Hz** is ~x6 higher than for **10Hz**!



# Conditioning Check

## Measurement program for week18 / 2023?



1h → 36000 pulses  
 BDR=0.1% → 36 corrupted pulses

1. PL=650us, 10Hz, no FB
2. 6MWg → 1h run → mBD rate →
3. 6.5MWg → 1h run → mBD rate →
4. 6.75MWg → 1h run → mBD rate →
5. 7.0MWg → 1h run → mBD rate →
6. 7.25MWg → 1h run → mBD rate →
7. 7.5MWg → 1h run → mBD rate →

- I main:
- 0A
  - Sweep
  - 360-380A

# Thank you!

## Contact

Deutsches Elektronen-  
Synchrotron DESY

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