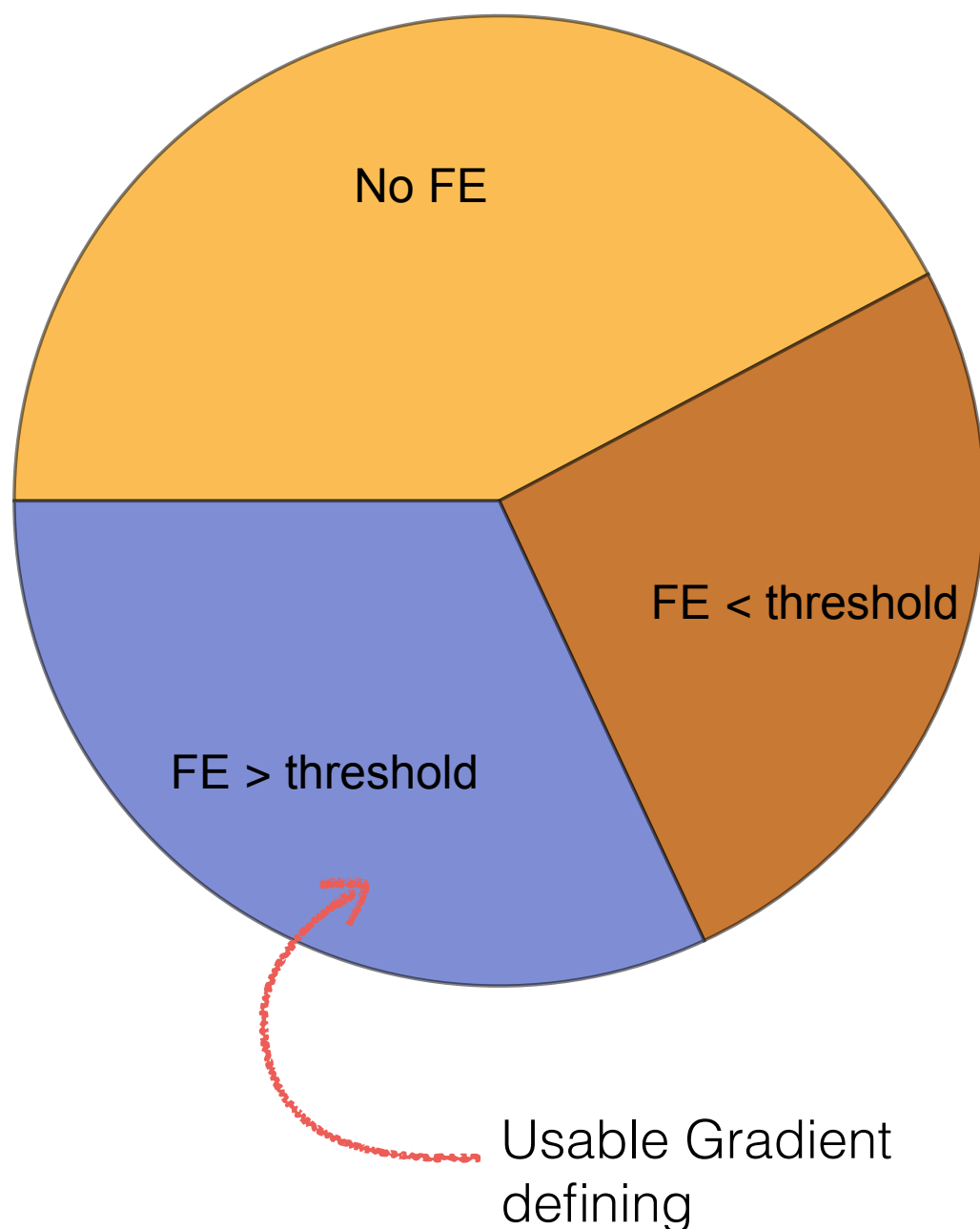


FE in XFEL cavities (vertical test)

Nick Walker - DESY
TTC 2015 - SLAC - 3.12.15



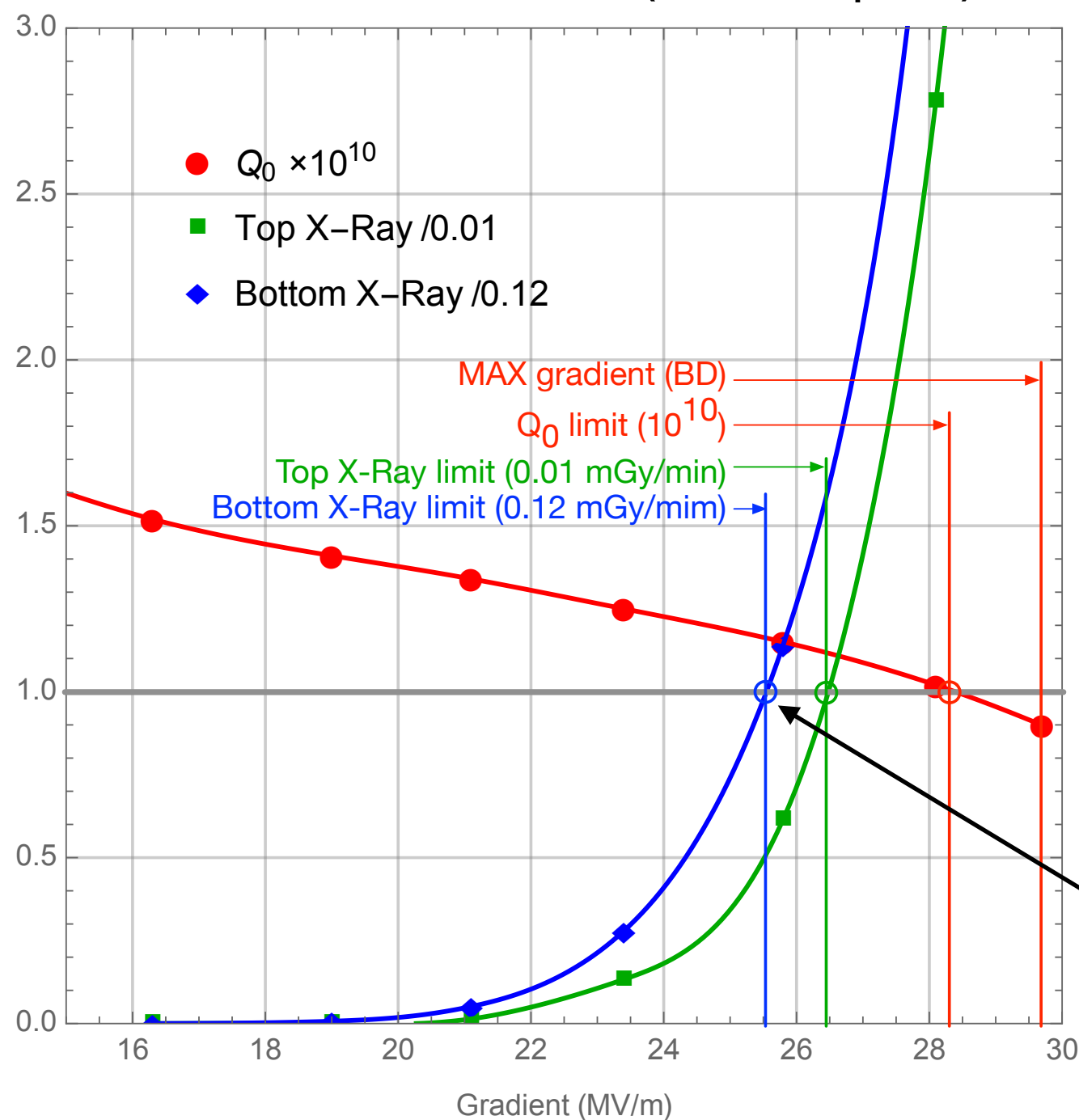
By cavity



- FE observed via X-ray signals (top and bottom)
- Thresholds for allowed FE (X-ray) specified as
 - X-ray 1 (Top): 0.01 mGy/min
 - X-ray 2 (Bot): 0.12 mGy/min
- Top value (0.01) is historical
 - Hall 3 & FLASH experience
- Bottom value (0.12) has been cross-calibrated with top sensor
- FE < threshold defined as any non-zero signal on either sensor.
 - Noise floor $\sim 10^{-4}$ mGy/min for AMTF integration time



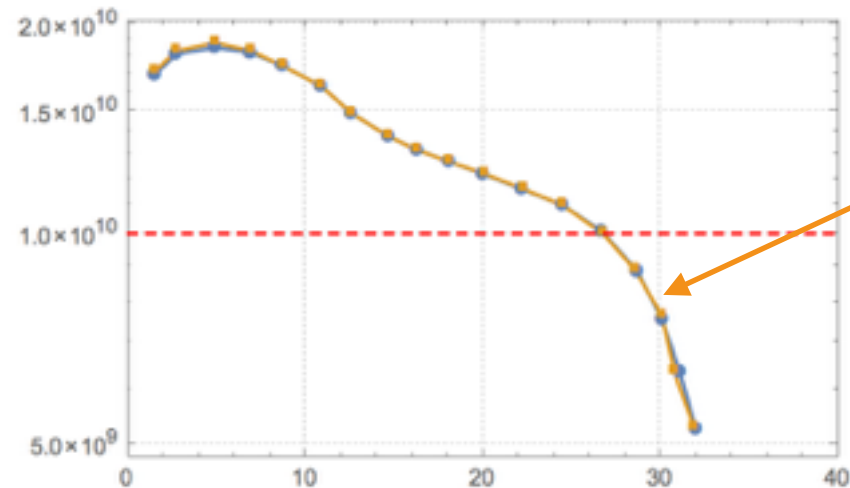
VT Power Rise (example)



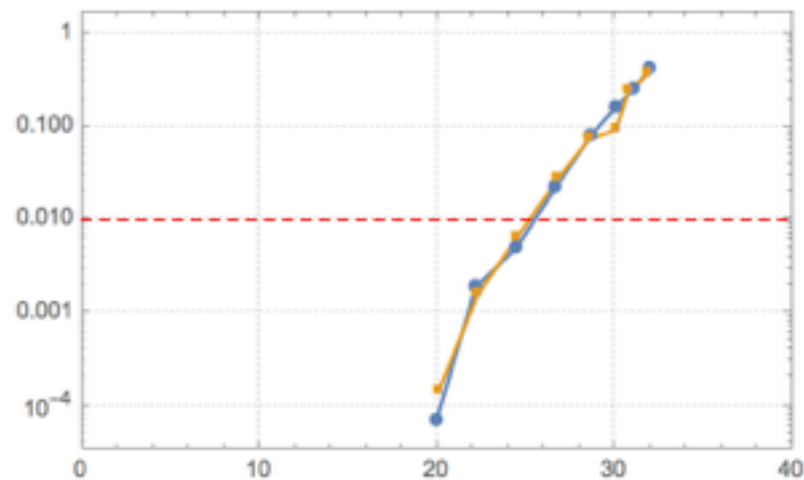
(Random) examples of power rise data

CAV00679

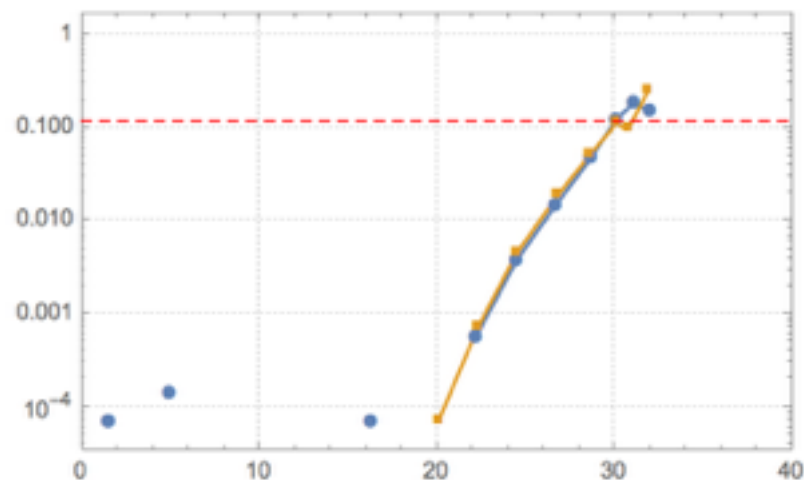
Q_0



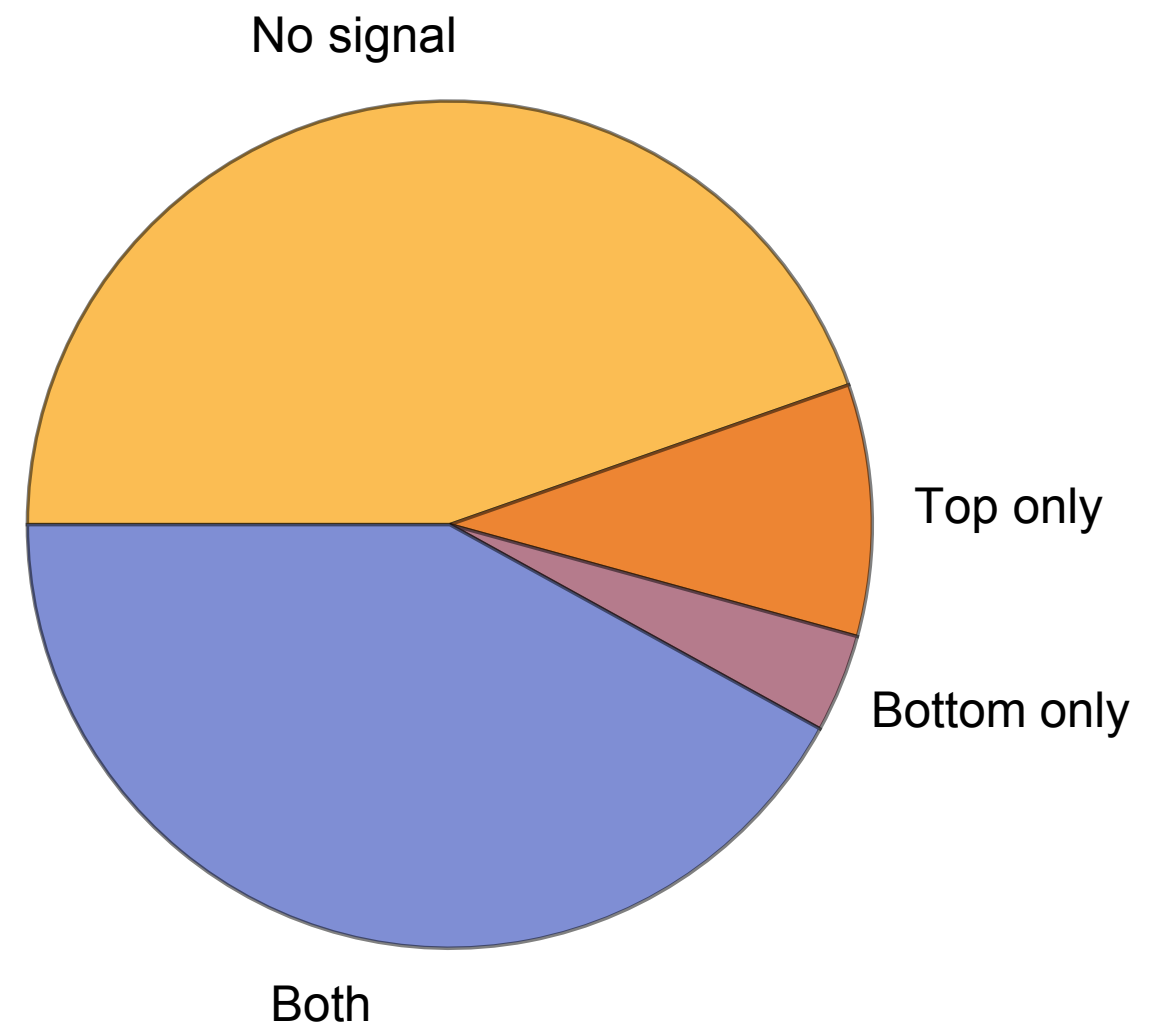
Top X-ray



Bottom X-ray

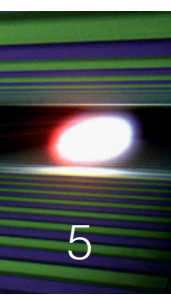


2 identical Q v E curves needed
last one used for performance values



By vertical test

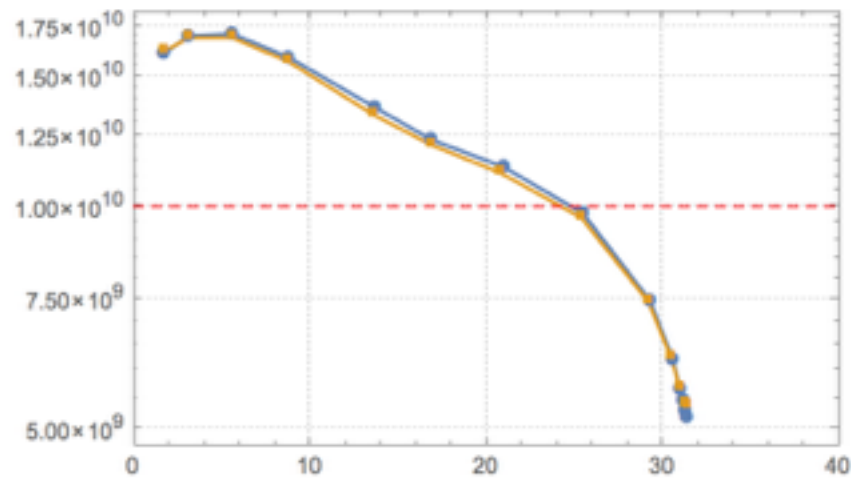
(Random) examples of power rise data



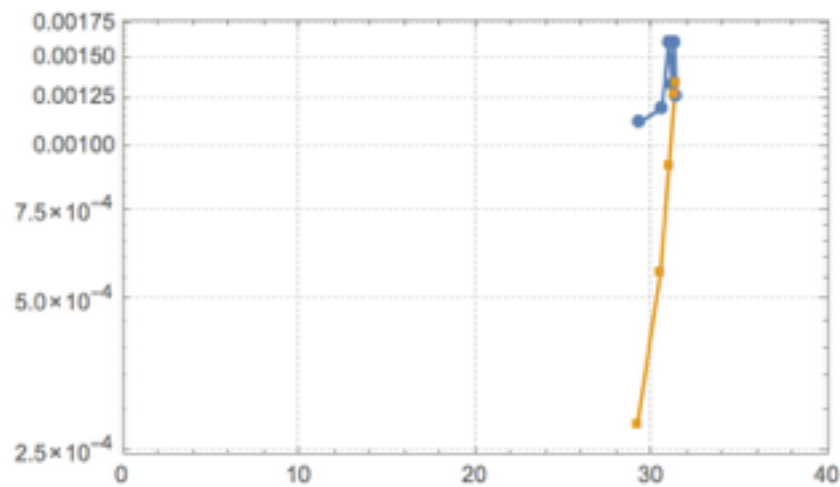
5

CAV00908

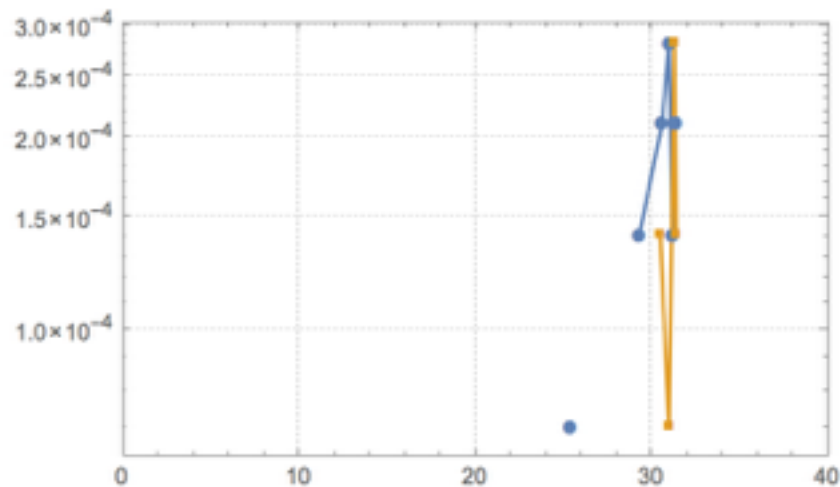
Q_0



Top X-ray

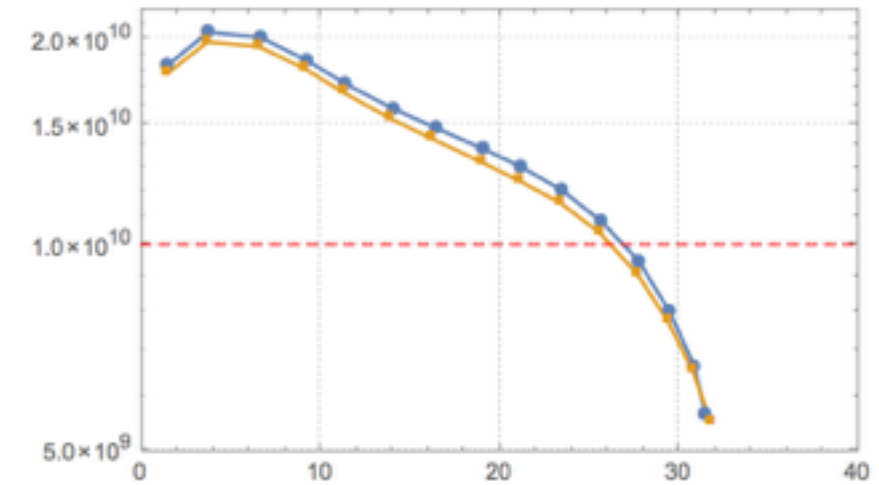


Bottom X-ray

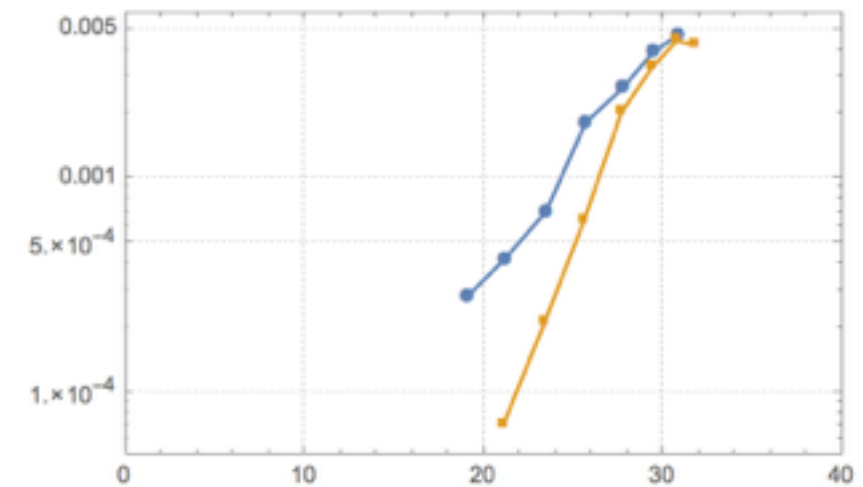


CAV00649

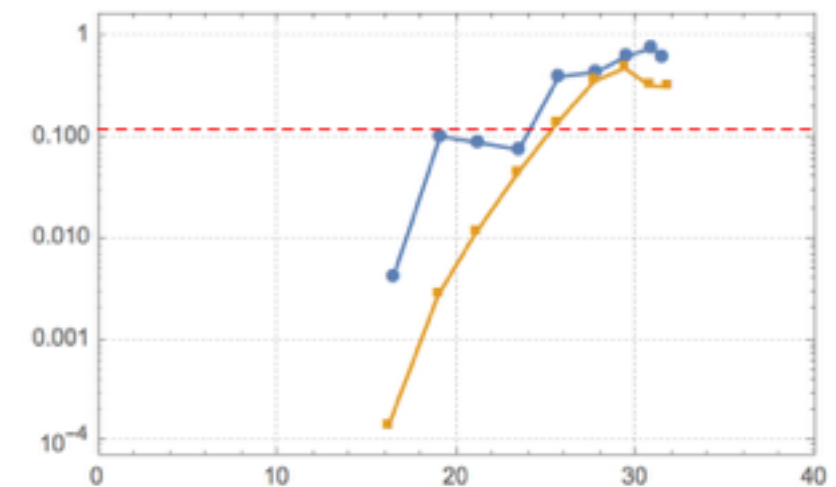
Q_0



Top X-ray



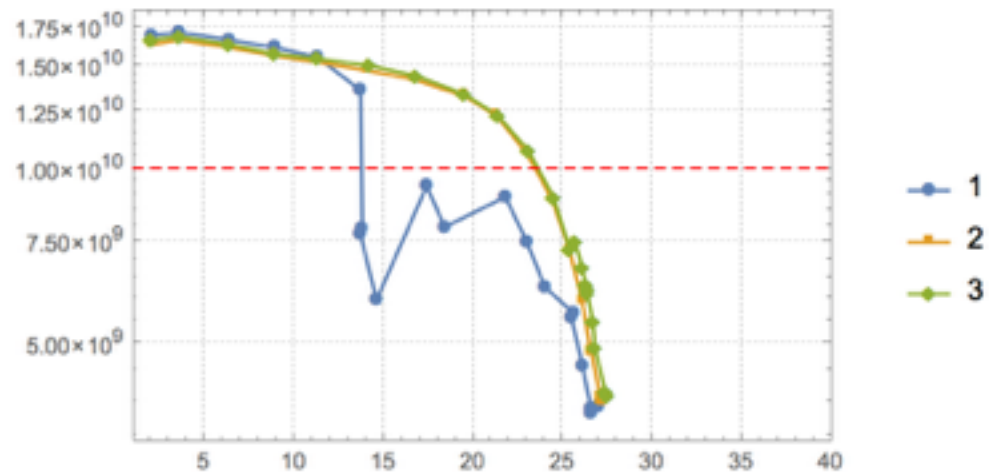
Bottom X-ray



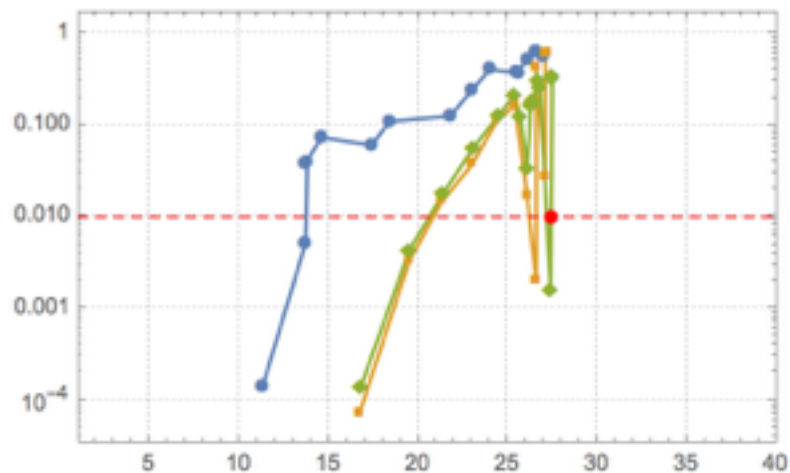
(Random) examples of power rise data

CAV00847

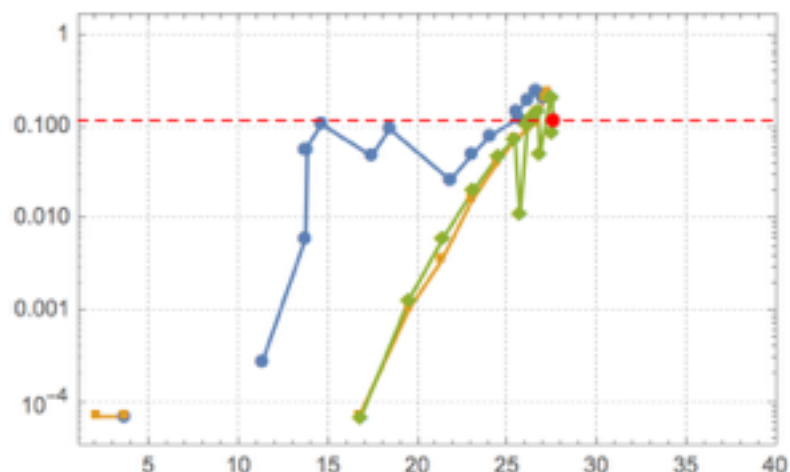
Q_0



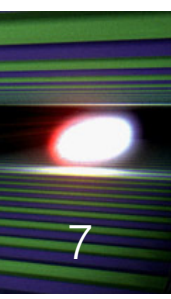
Top X-ray



Bottom X-ray

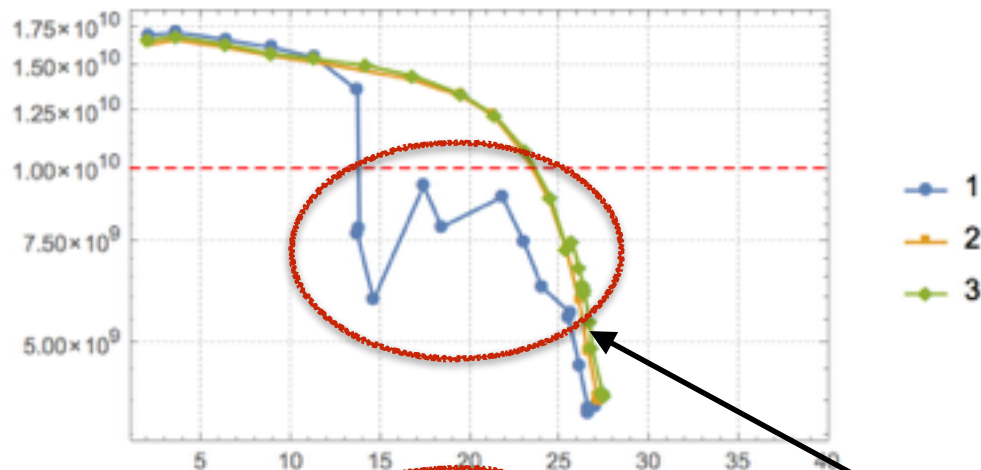


(Random) examples of power rise data

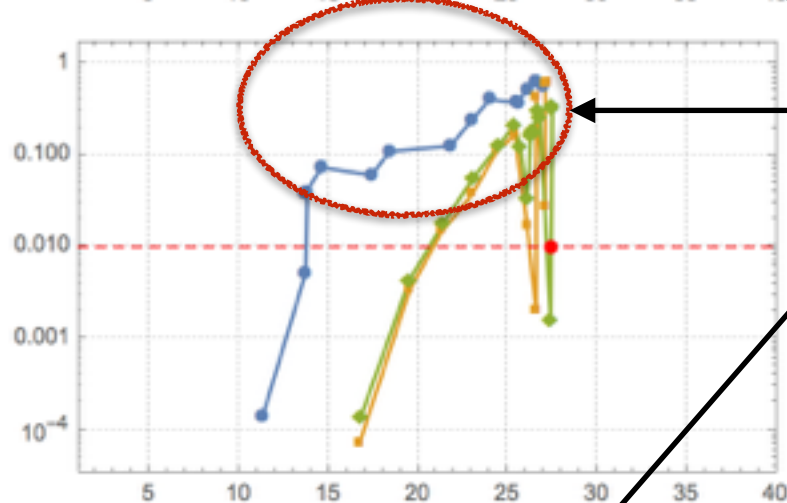


CAV00847

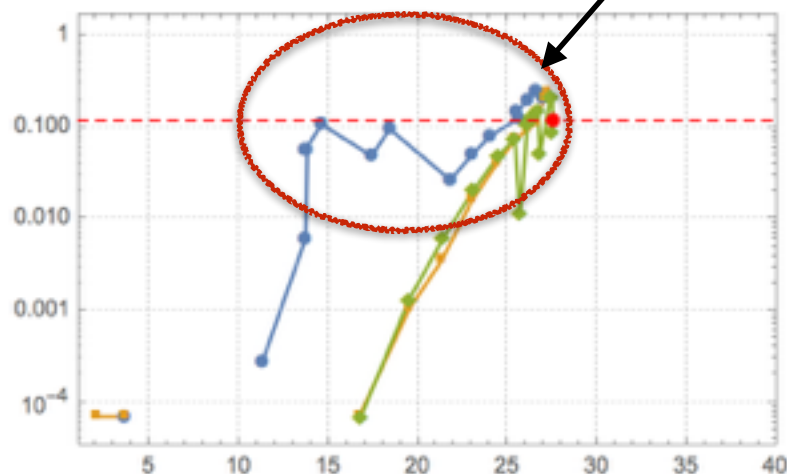
Q_0



Top X-ray



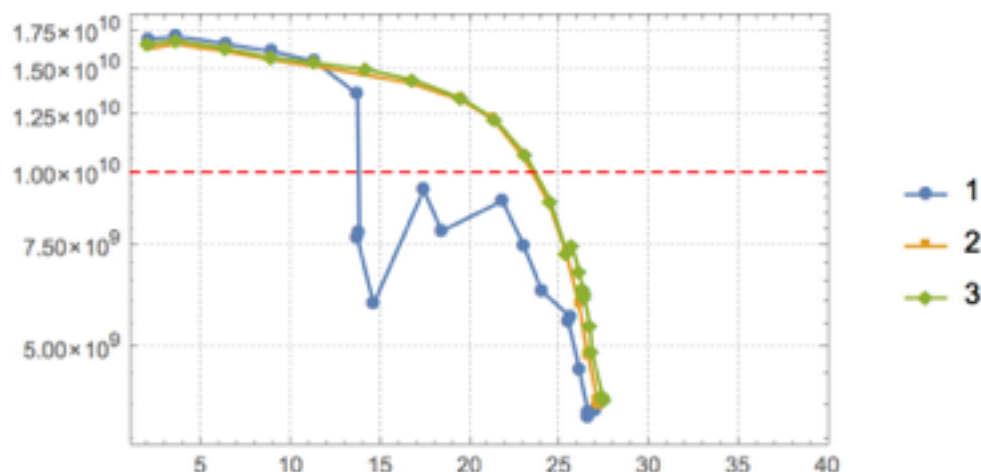
Bottom X-ray



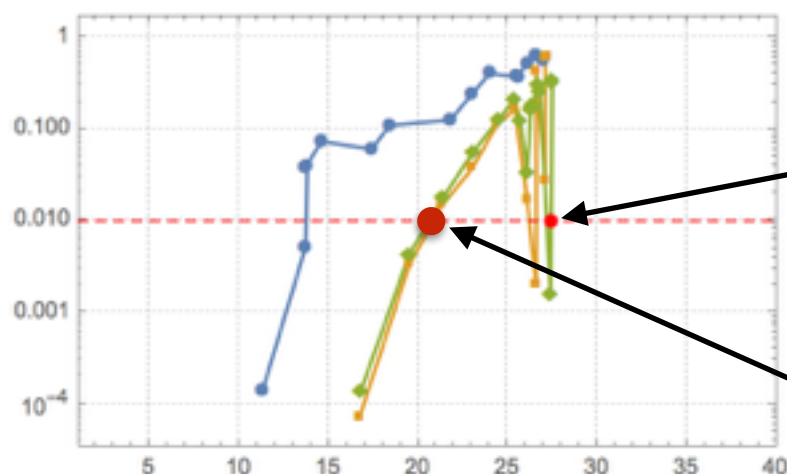
Processing

(Random) examples of power rise data

CAV00847

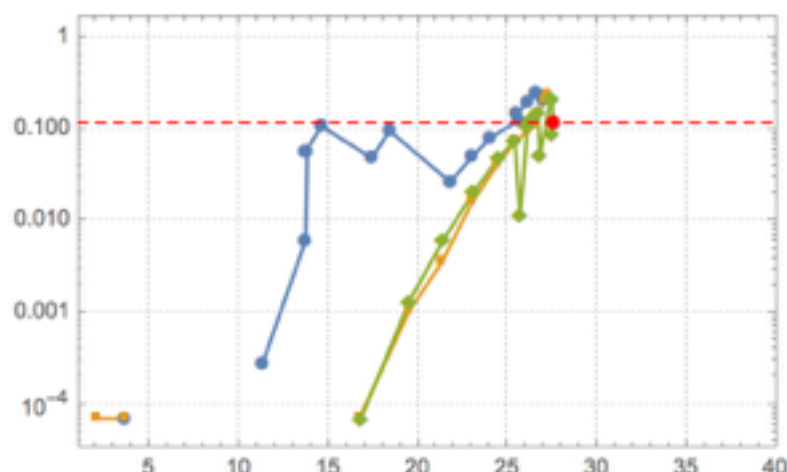
 Q_0 

Top X-ray



Database algorithm picks this point for threshold limit

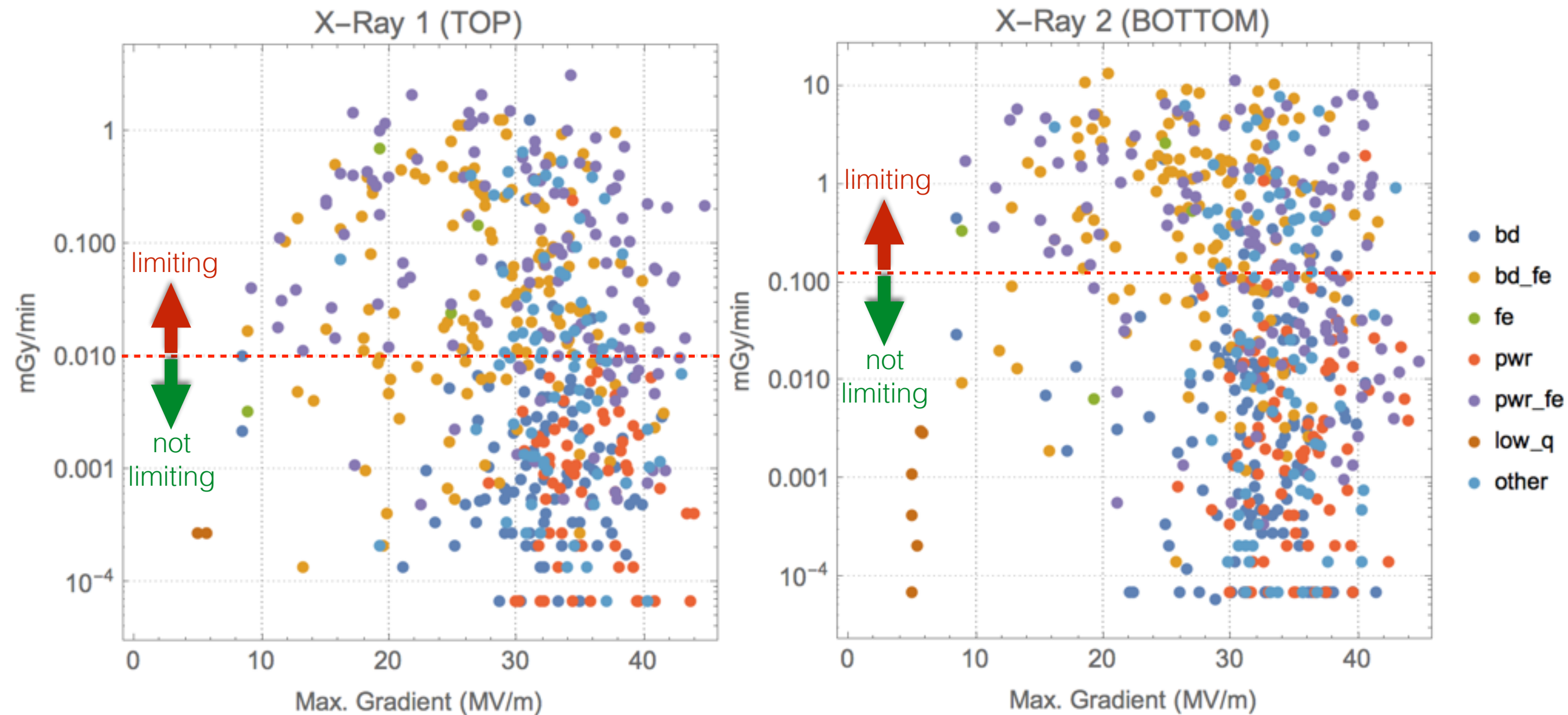
Bottom X-ray



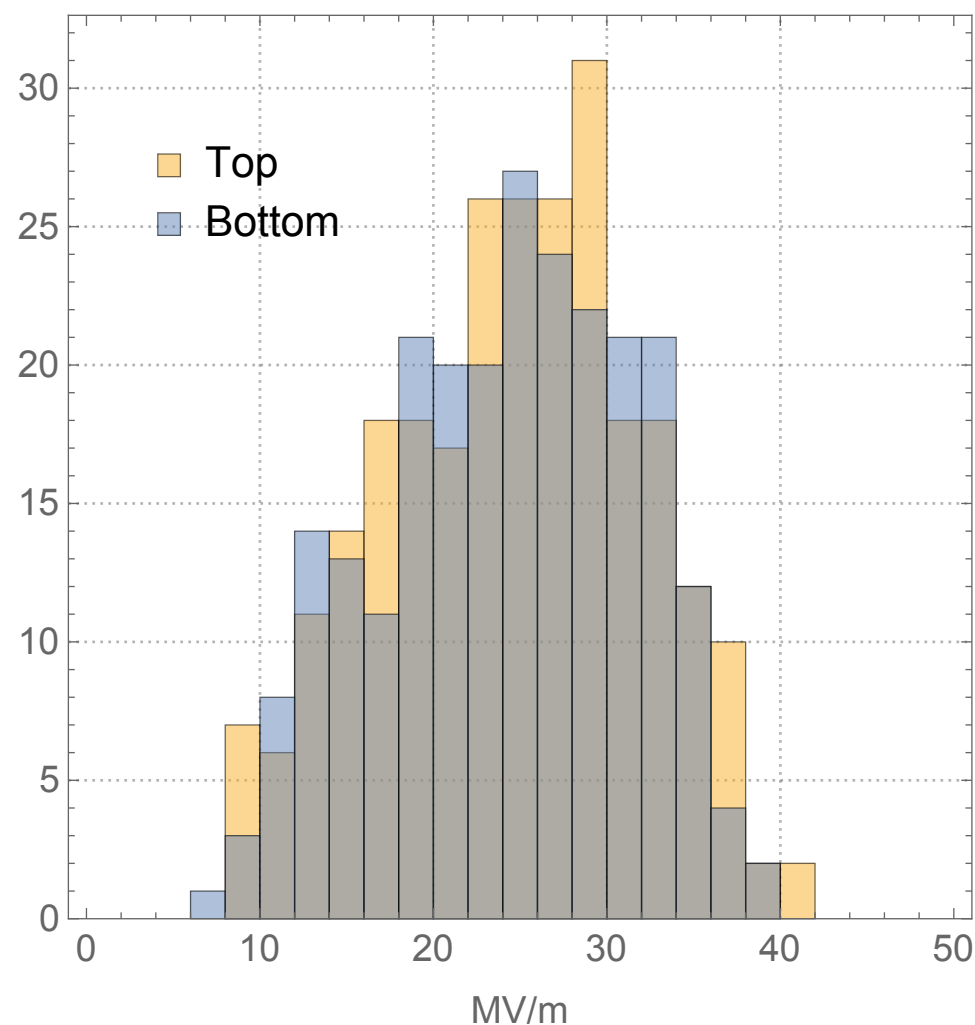
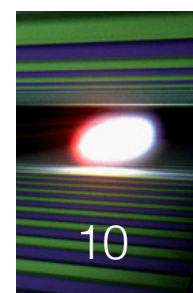
Arguably should be here

Difficult to find robust automated algorithm (humans are better :-)

X-ray signal at Maximum Gradient

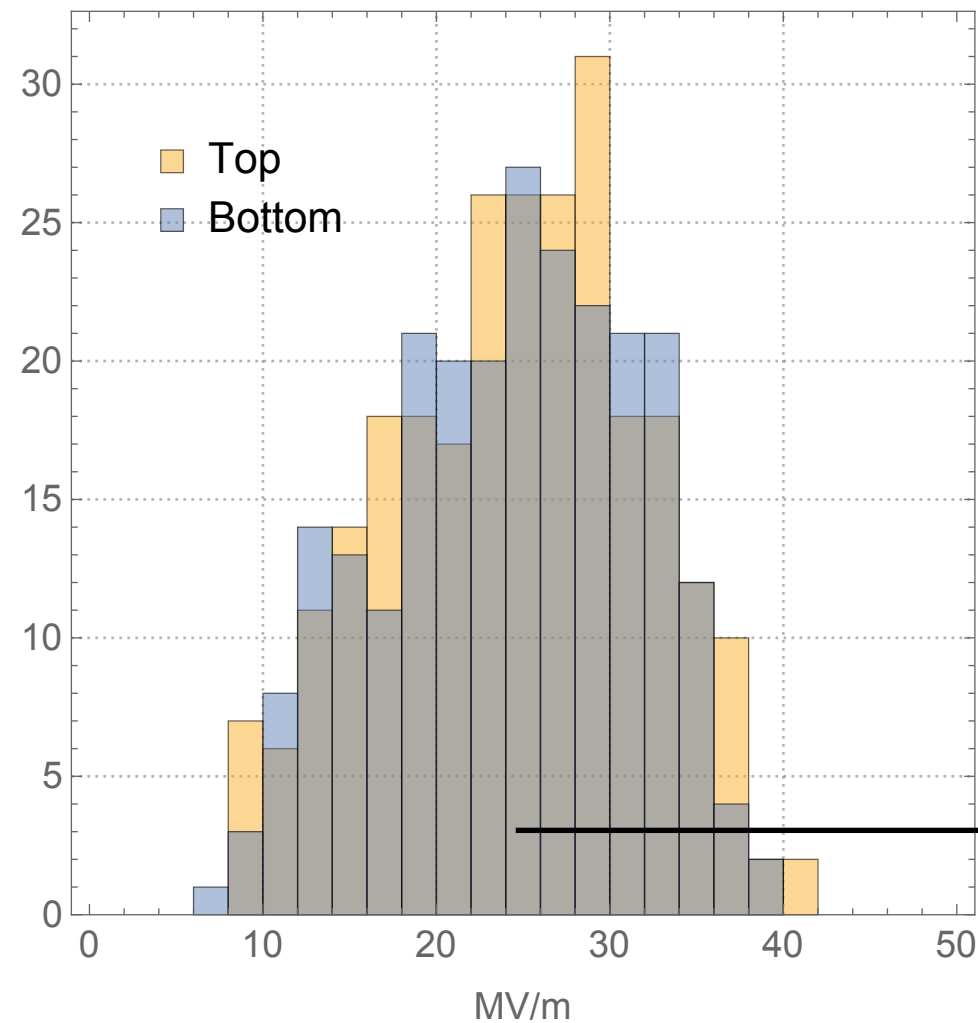


Gradient at FE (X-ray) thresholds

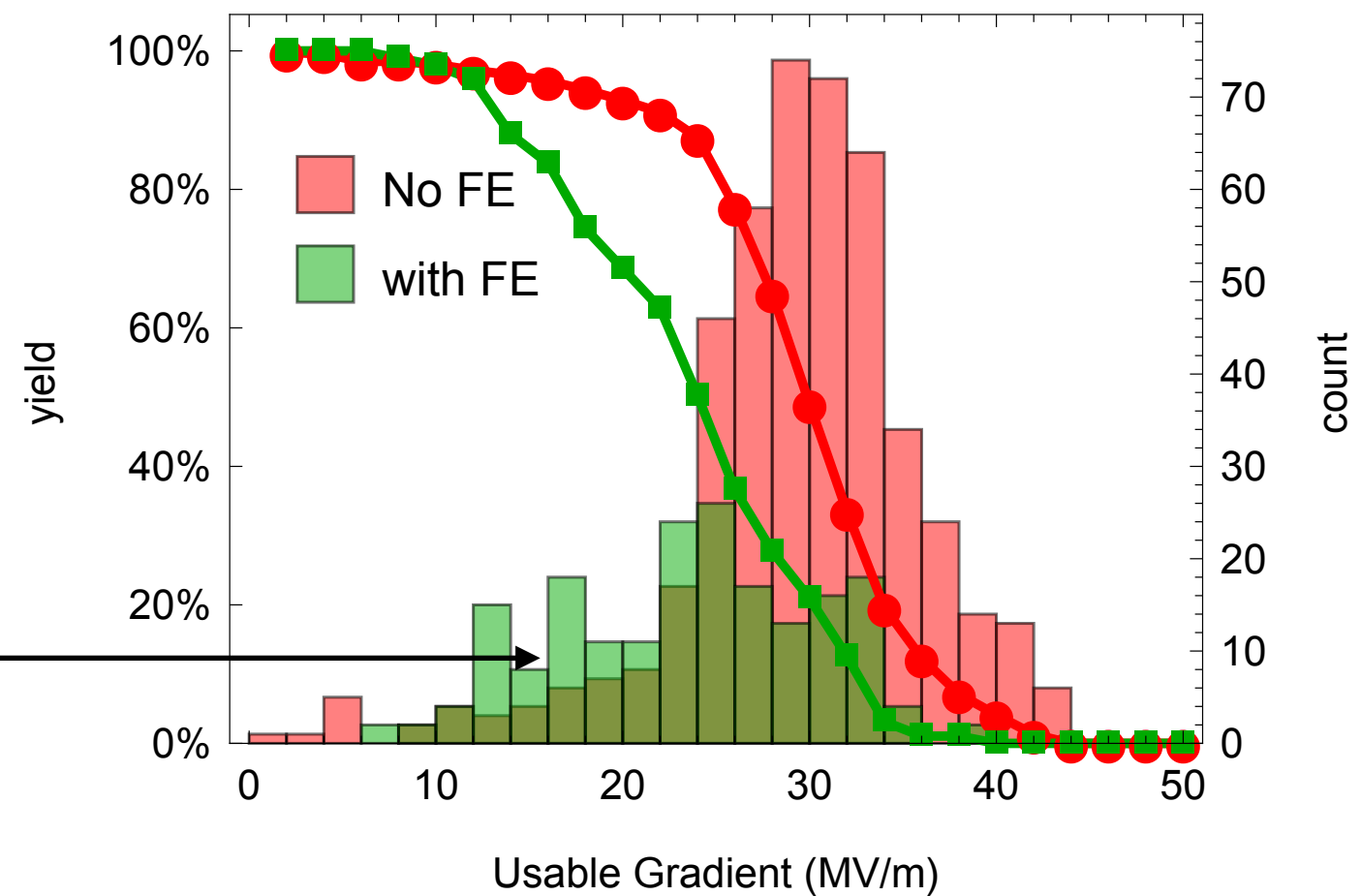


- FE 'threshold' has a large onset range
 - $10 \leq G_{\text{FE}} \leq 40 \text{ MV/m}$
- No significant difference between top and bottom sensor

Gradient at FE (X-ray) thresholds



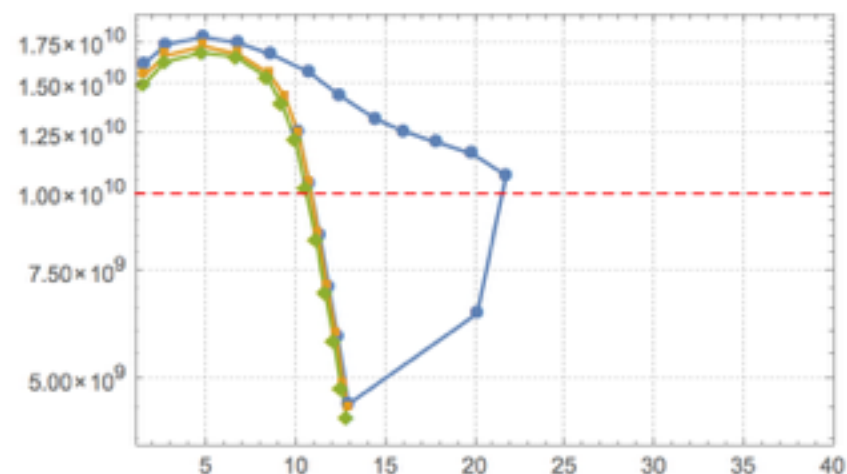
All “as received” cavities



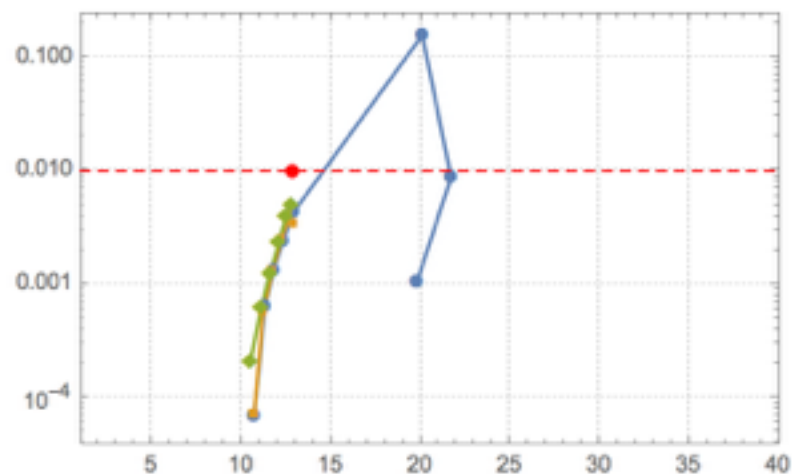
Degraded performers during VT?

CAV00577

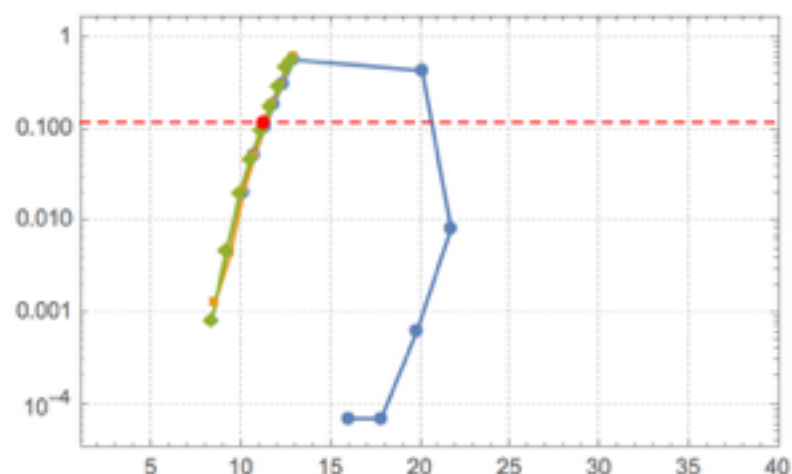
Q_0



Top X-ray

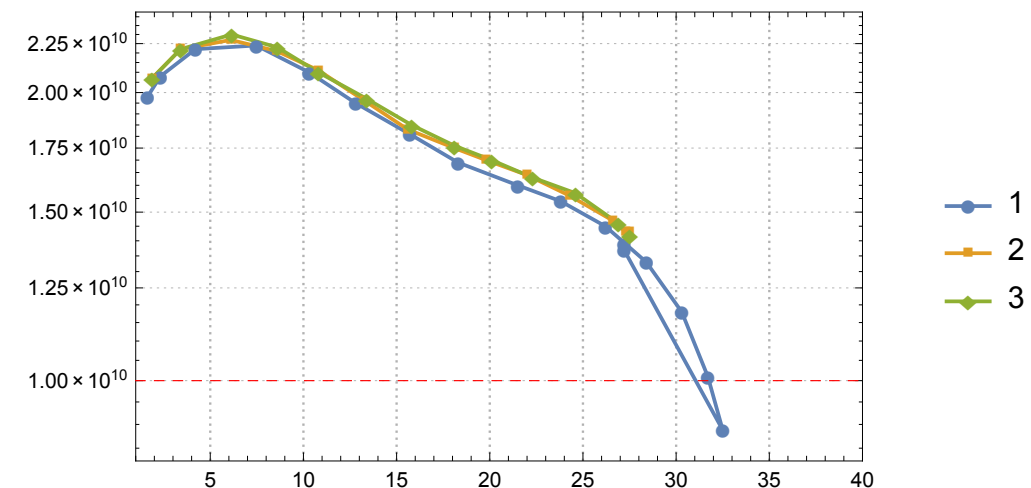


Bottom X-ray

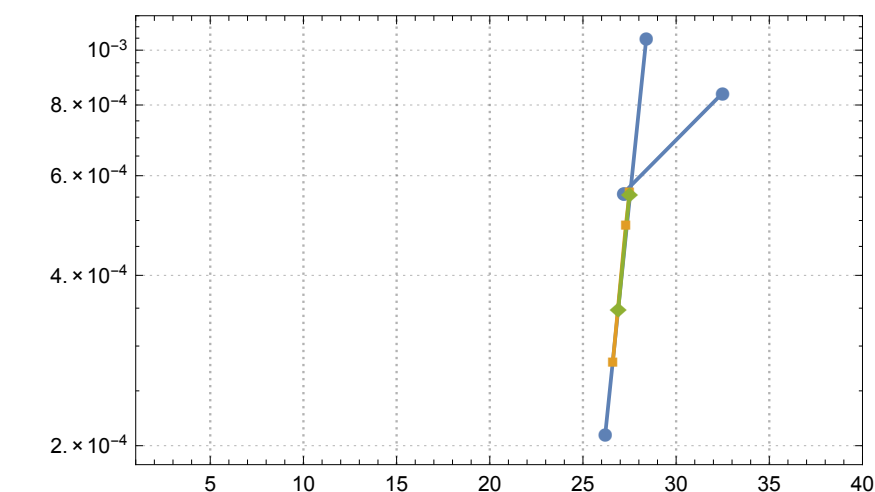


CAV00630 test 1.0

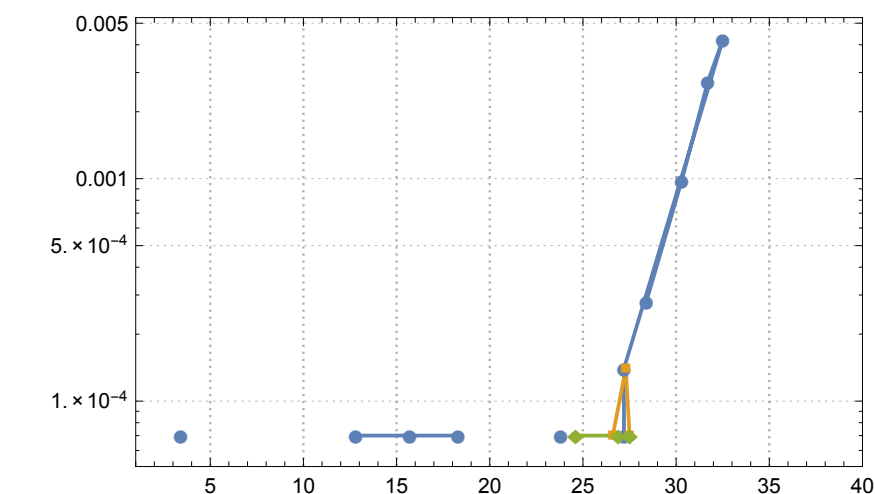
Q_0



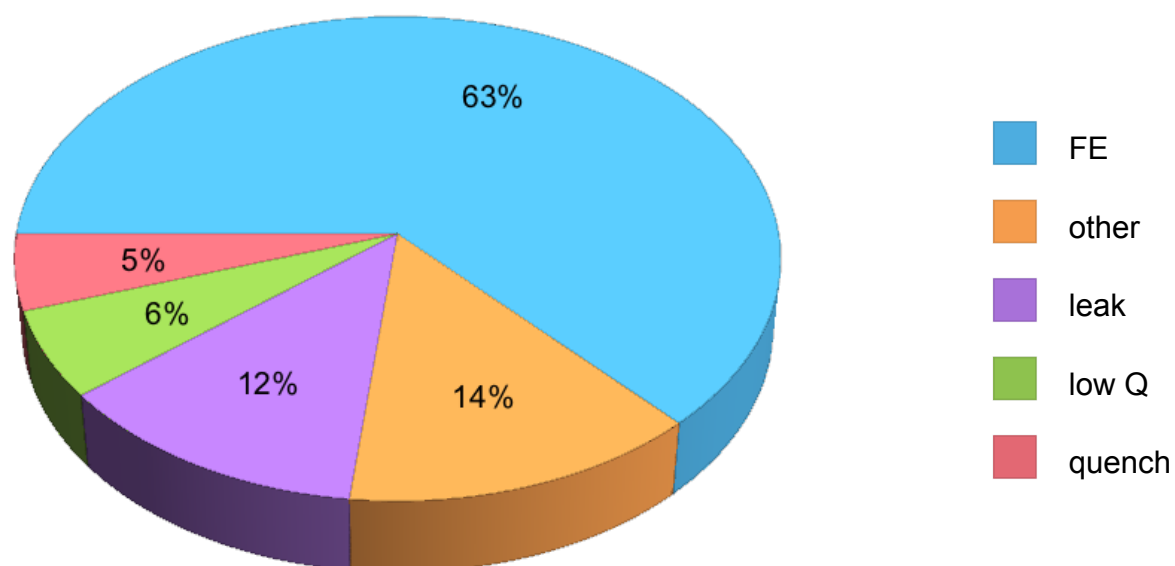
Top X-ray



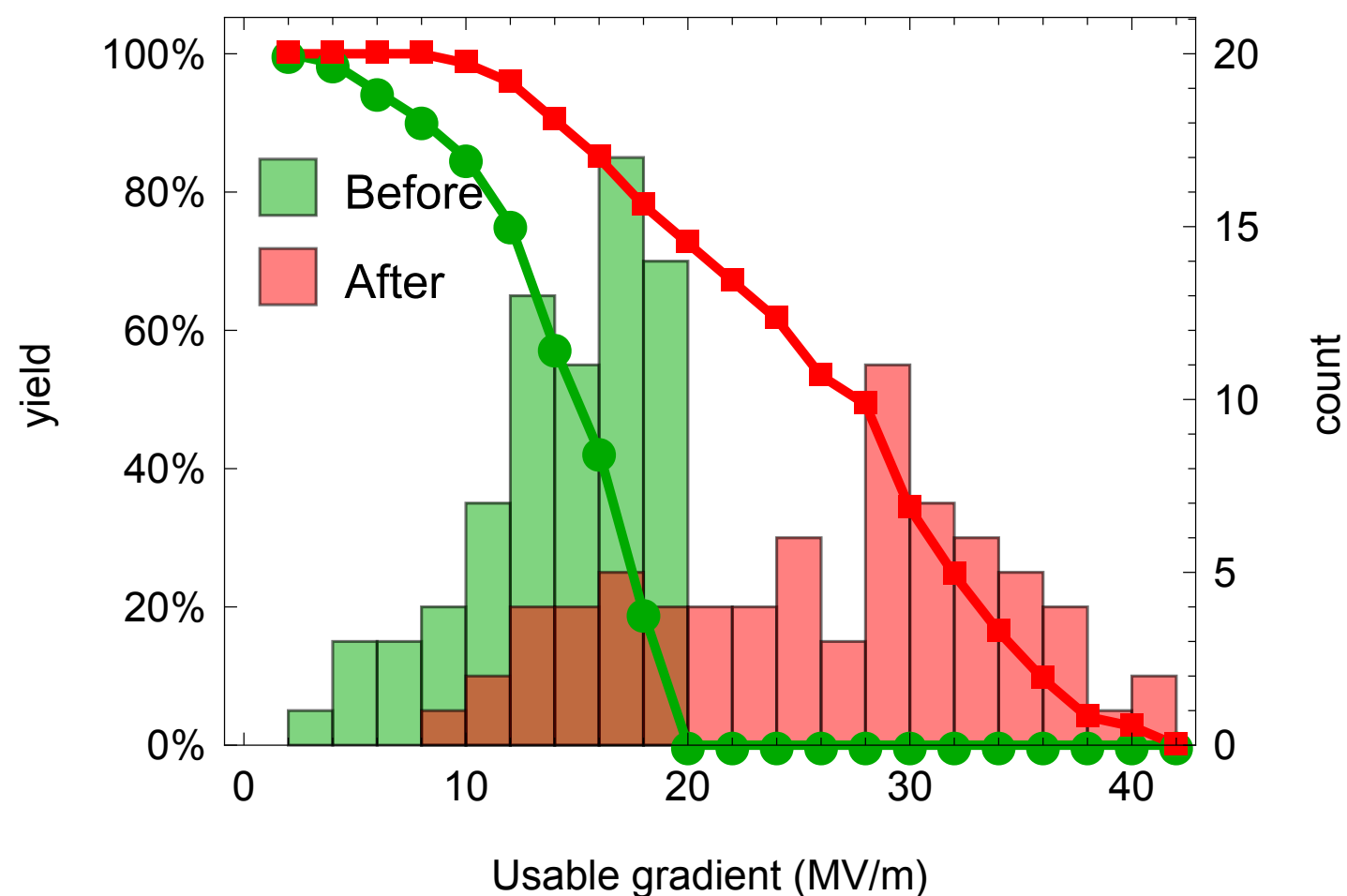
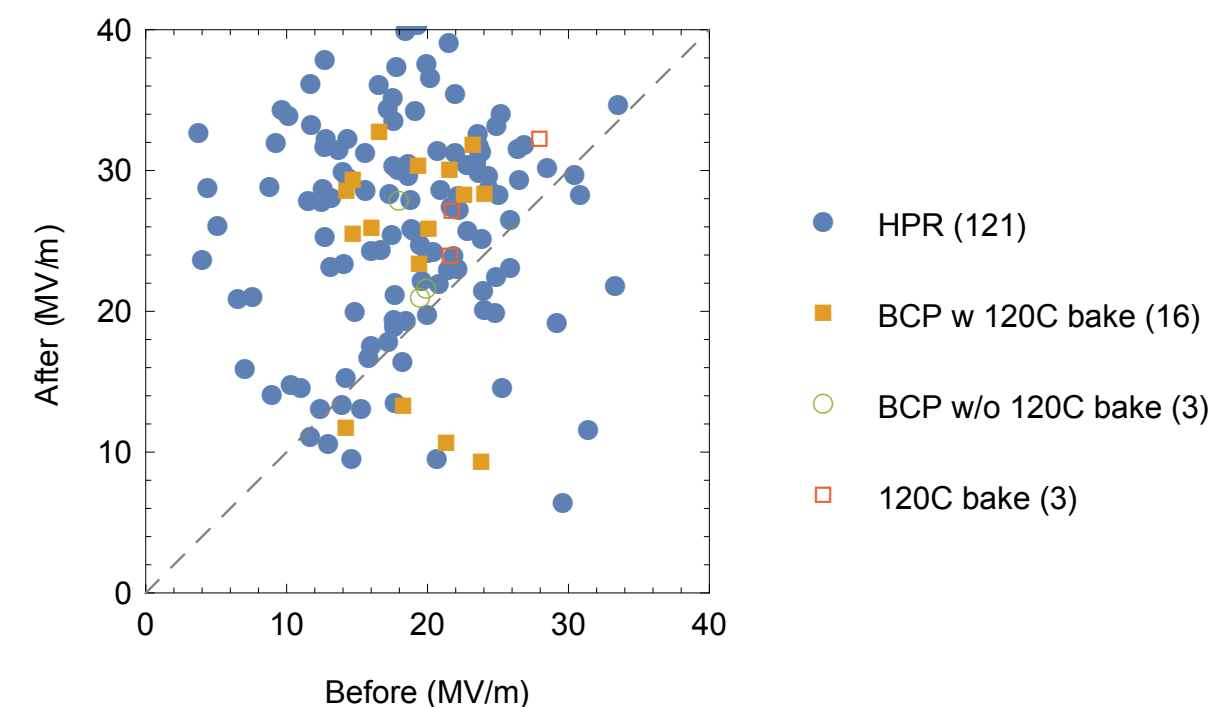
Bottom X-ray



Reasons for pretreatment



- ~20% cavities retreated
 - last year ~10%
- FE dominates (63%)
- HPR very effective



2 X-ray monitors (both ends of module on beam axis)

Threshold for “usable gradient” = 0.01 mGy/min

Very difficult to correlate to VT values

Usable gradient comparison

limit		N _{data}	VT results		CM results		Δg	Δg/g _{VT} (%)	N _{SE}
VT	CM		⟨g⟩	σ _g	⟨g⟩	σ _g			
XRAY	MAX[pwr]	207	30.3	3.8	31.	0.3	0.7	2.2	2.5
XRAY	MAX[bd]	115	29.3	4.	24.7	4.2	-4.6	-15.6	8.4
XRAY	XRAY	96	29.8	3.5	24.5	4.8	-5.4	-18.	8.9
MAX[bd]	MAX[bd]	53	29.	4.6	25.2	4.3	-3.8	-13.1	4.4
MAX[bd]	MAX[pwr]	26	36.6	2.3	31.	0.	-5.6	-15.3	12.2
MAX[bd]	XRAY	6	29.5	3.8	21.4	3.	-8.1	-27.3	4.
MAX[pwr]	MAX[pwr]	4	43.3	0.5	31.	0.	-12.3	-28.4	45.1
MAX[pwr]	XRAY	1	0	0	0	0	0	0	0
MAX[lckdisturb]	MAX[pwr]	1	0	0	0	0	0	0	0
MAX[homcpl]	MAX[pwr]	1	0	0	0	0	0	0	0
MAX[bd_fe]	MAX[pwr]	1	0	0	0	0	0	0	0