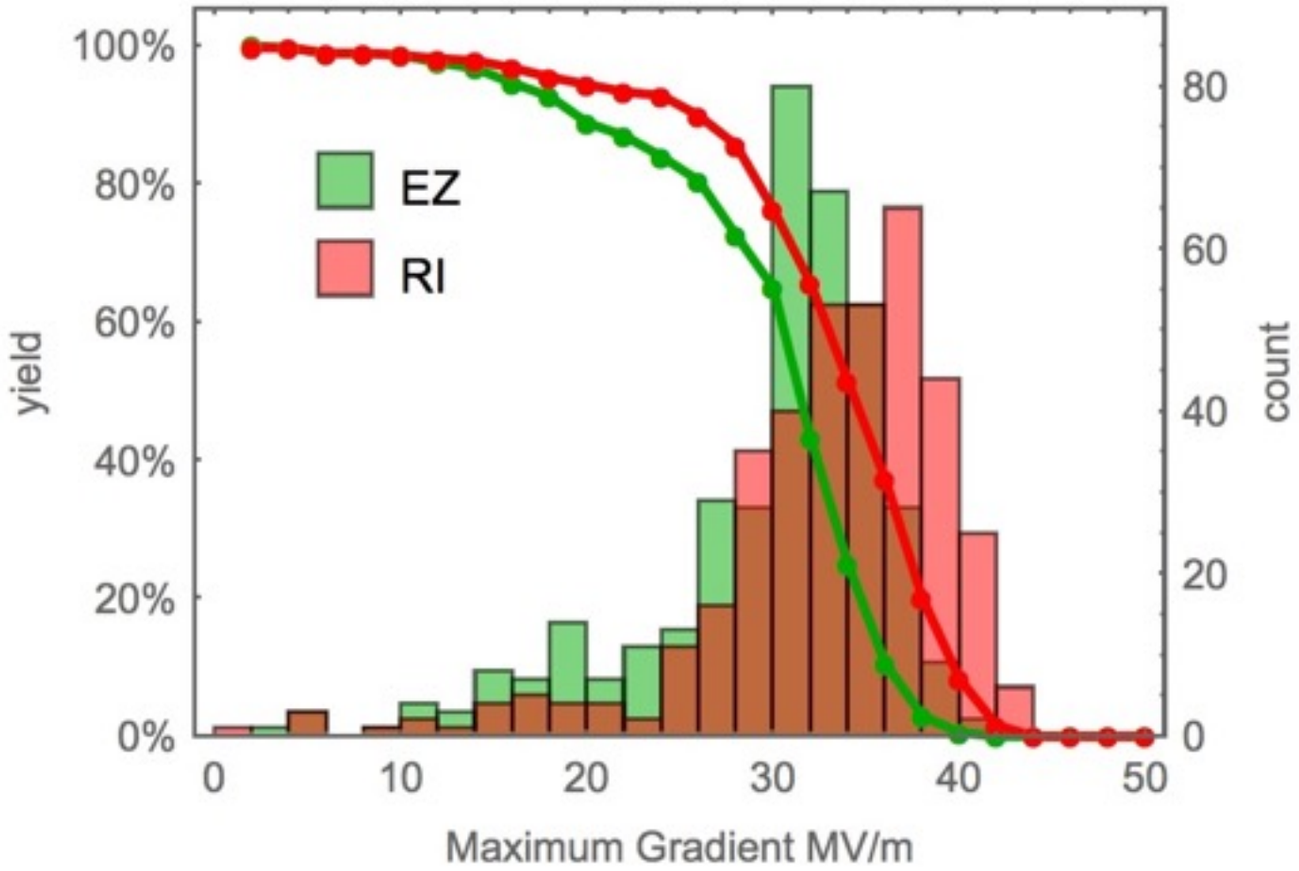
XFEL ILC-recipe VT results (RI)

Nick Walker - DESY

TTC 2016 - CEA Saclay 7.07.16

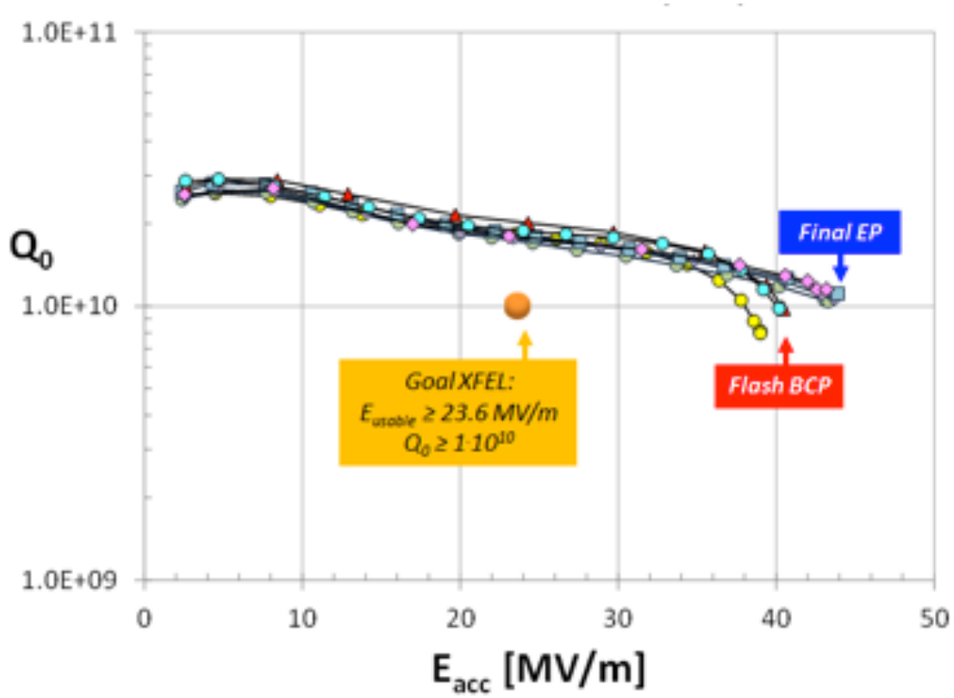
Test results: MAX GRADIENT



	RI	EZ	Total
Tests	375	368	743
G_{AVG} (MV/m)	33.	29.8	31.4
G_{RMS} (MV/m)	6.6	6.6	6.8
yield @ 20MV/m	94%	89%	92%
yield @ 26MV/m	90%	80%	85%
yield @ 28MV/m	86%	73%	79%

"As received" test

Clearly see difference between RI (final EP) and EZ (flash-BCP)



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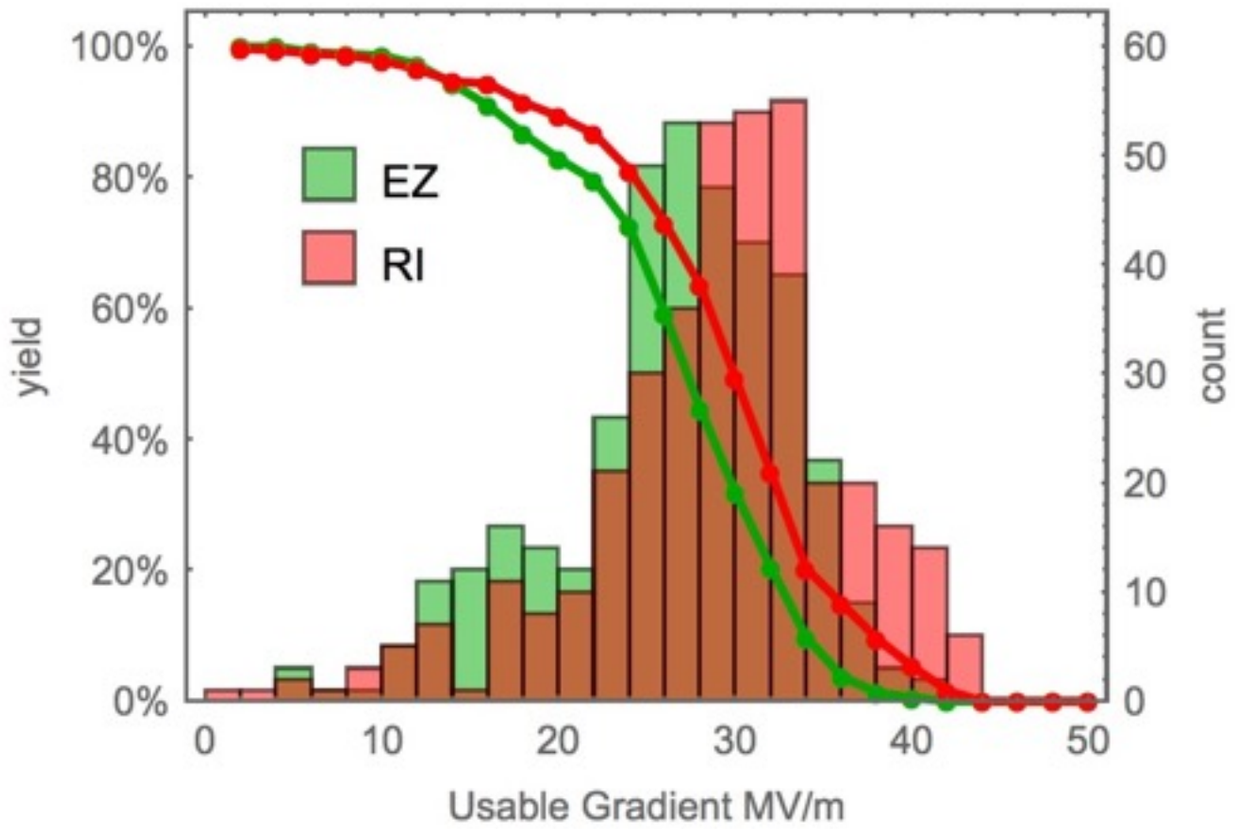
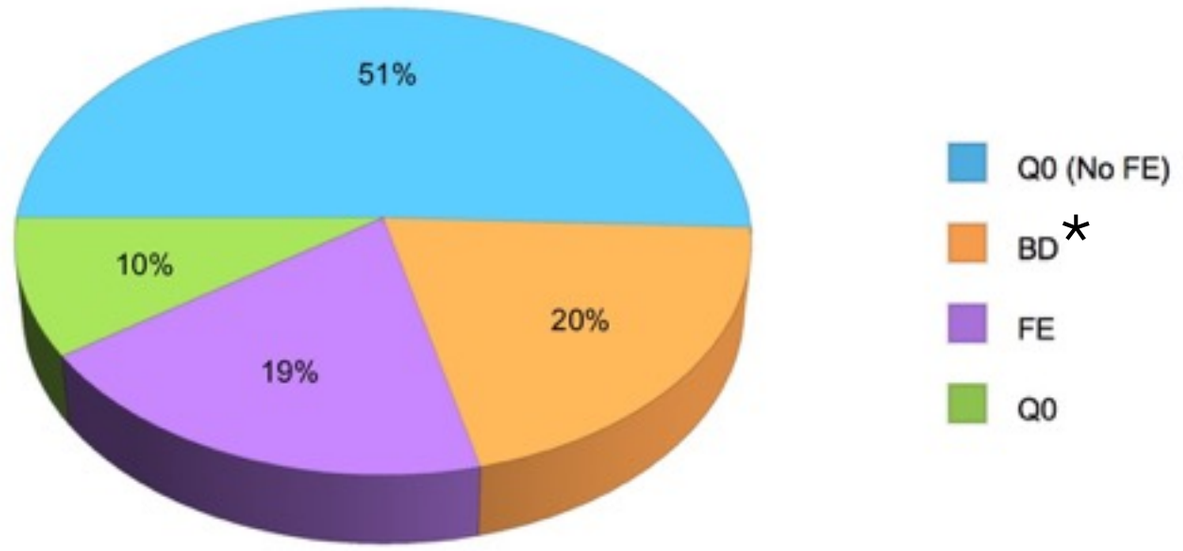
Test results: USABLE GRADIENT



"As received" test



* few cases of power limitation, HOM coupler heating etc.

	RI	EZ	Total
Tests	375	367	742
G_{AVG} (MV/m)	29.1	26.4	27.8
G_{RMS} (MV/m)	7.4	6.6	7.1
yield @ 20MV/m	89%	83%	86%
yield @ 26MV/m	73%	59%	66%
yield @ 28MV/m	63%	45%	54%

Average loss from max: ~4 MV/m

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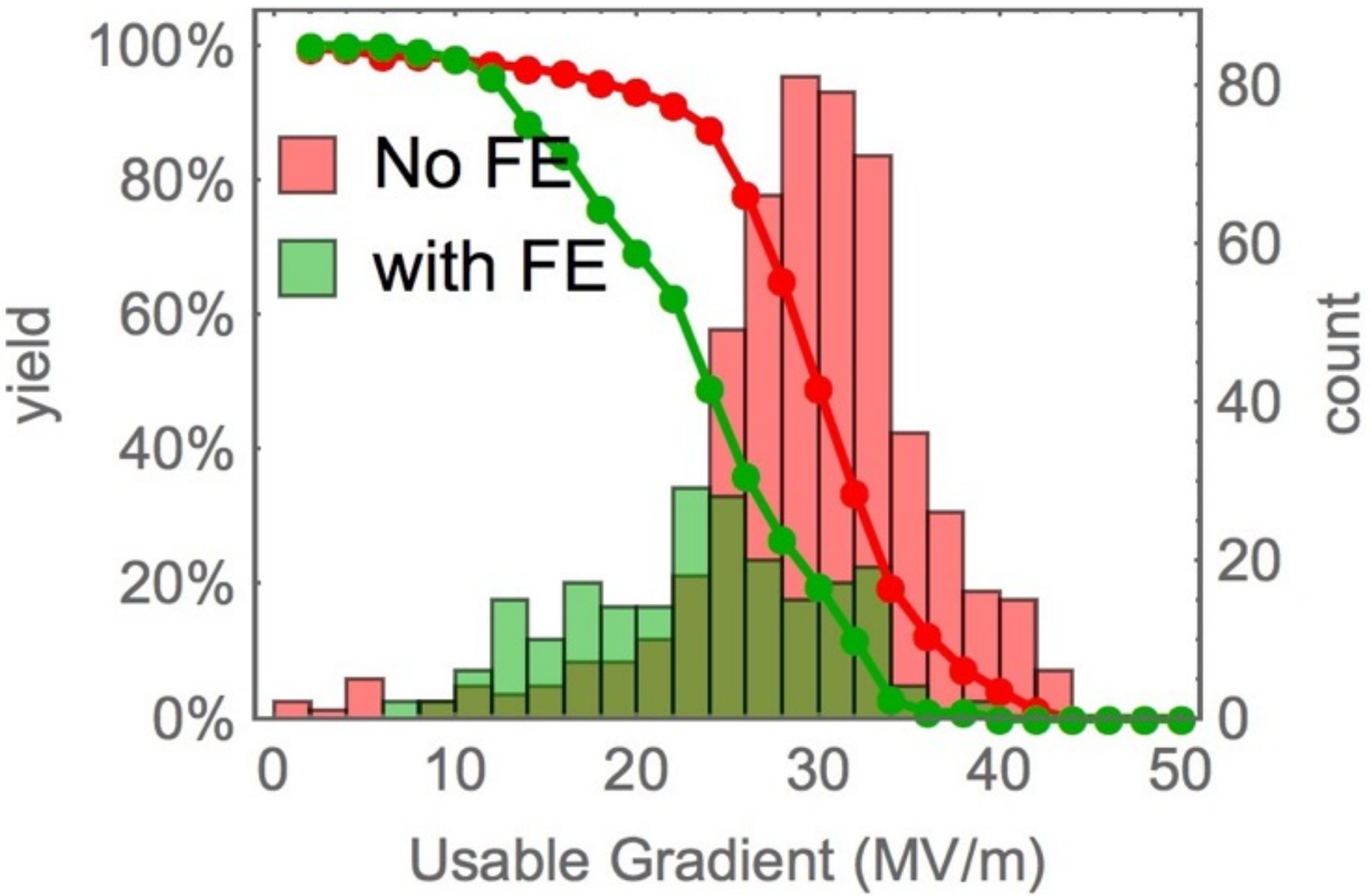
Usable Gradient (all cavities)

"As received" test



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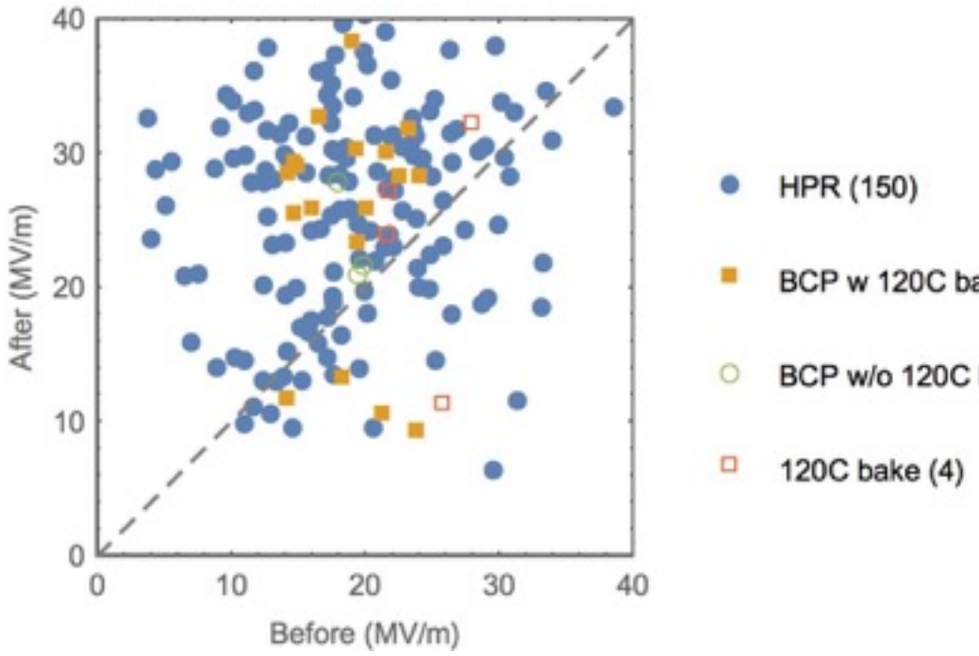
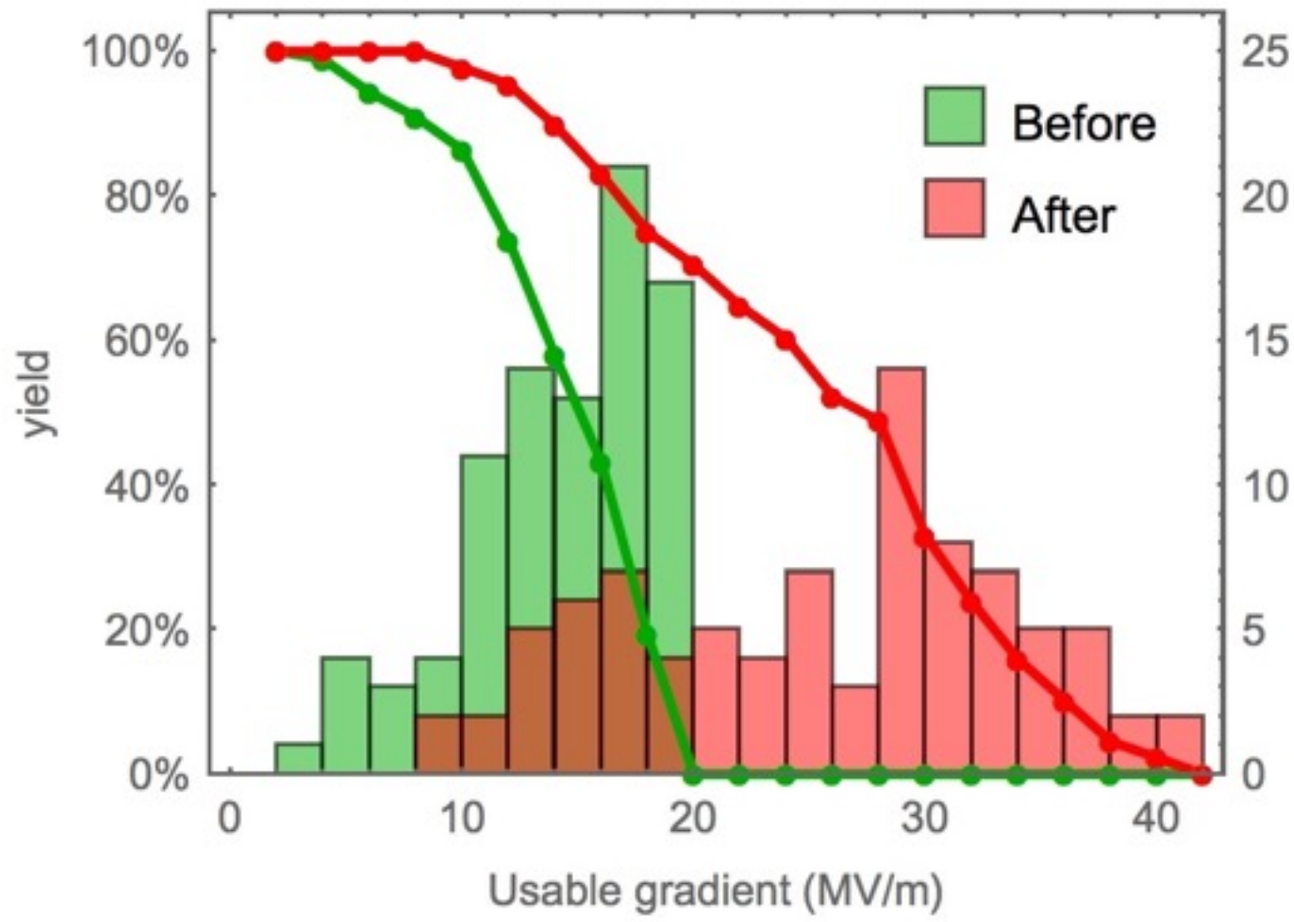
Impact of re-treatment (G_u <20 MV/m)

All retreatments



	Before	After
Tests	88	88
G_{AVG} (MV/m)	14.3	25.5
G_{RMS} (MV/m)	4.1	8.2
yield @ 20MV/m	0%	70%
yield @ 26MV/m	0%	52%
yield @ 28MV/m	0%	49%



1st test yield @20: 86%
2nd test yield @20: 70%

1st+2nd yield @20: 95%

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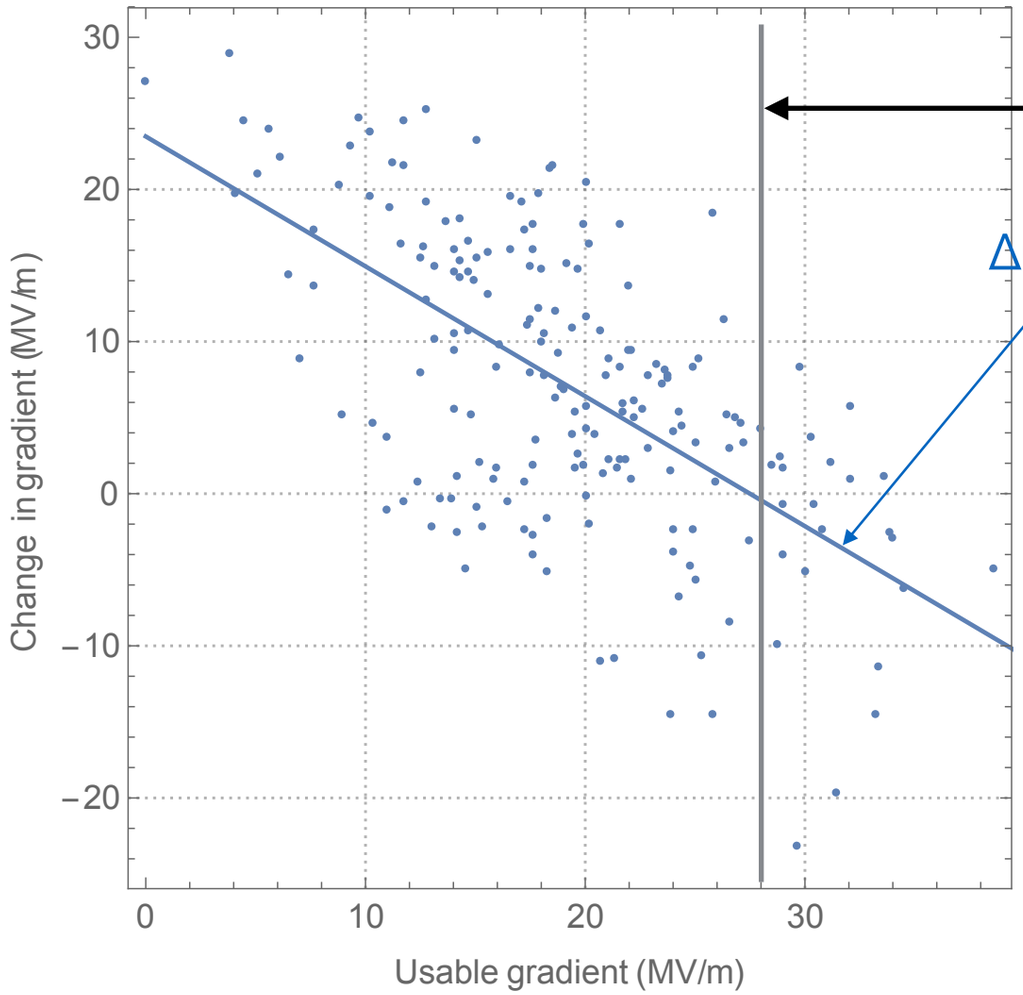
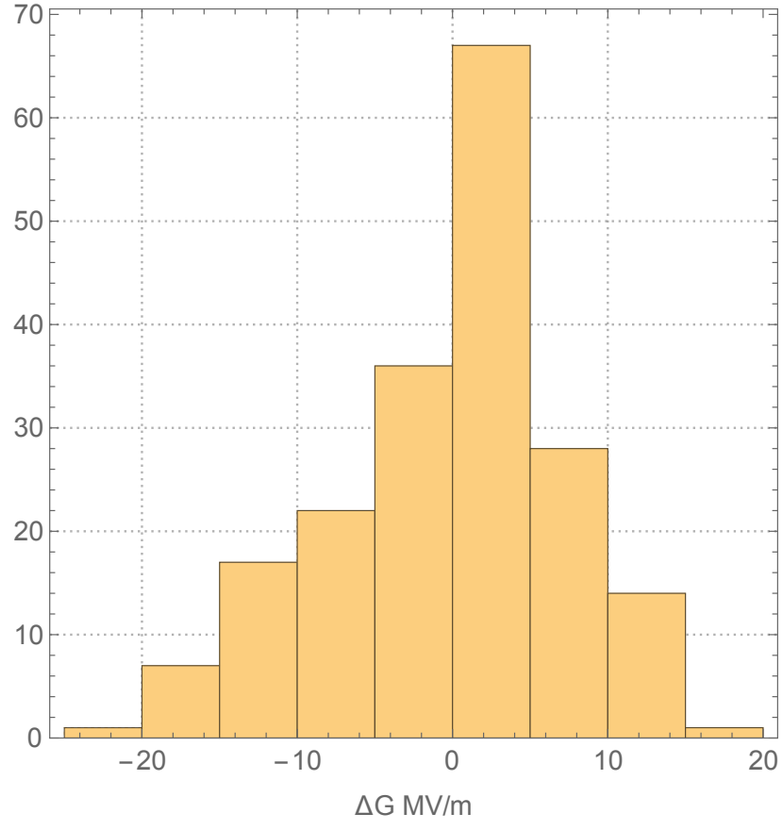
Retreatment model (monte carlo)



ILC acceptance

$\Delta G = 23.5 – 0.85\ G_{inital} + \mathcal{D}_{resid}$

residuals



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Extrapolation to ILC - VT

- ILC TDR assumed VT acceptance > 28MV/m (XFEL >20 MV/m)
  - Average of 35 MV/m (XFEL 26 MV/m)
  - Assumed first-pass yield: 75%
  - 25% cavities retreated to give final yield of 90% >28 MV/m (35 MV/m average)
    - ➡ 10% over-production assumed in value estimate

RI results only (ILC recipe)

		ILC TDR (assumed)	XFEL max	XFEL usable
First-pass	Yield >28 MV/m	75%	85%	63%
	Average >28 MV/m	35 MV/m	35.2 MV/m	33.5 MV/m
First+Second pass	Yield >28 MV/m	90%	94%	82%
	Average >28 MV/m	35 MV/m	35.0 MV/m	33.4 MV/m
First+Second+third pass	Yield >28 MV/m	-		91%
	Average >28 MV/m	-		33.4 MV/m

✔ ✘ *but close!*

More re-treatments - but mostly only HPR
Number of average tests/cavity increases from 1.25 to 1.55 (1^{st}+2^{nd}) or
20% over-production or additional re-treat/test cycles ➡ $$$

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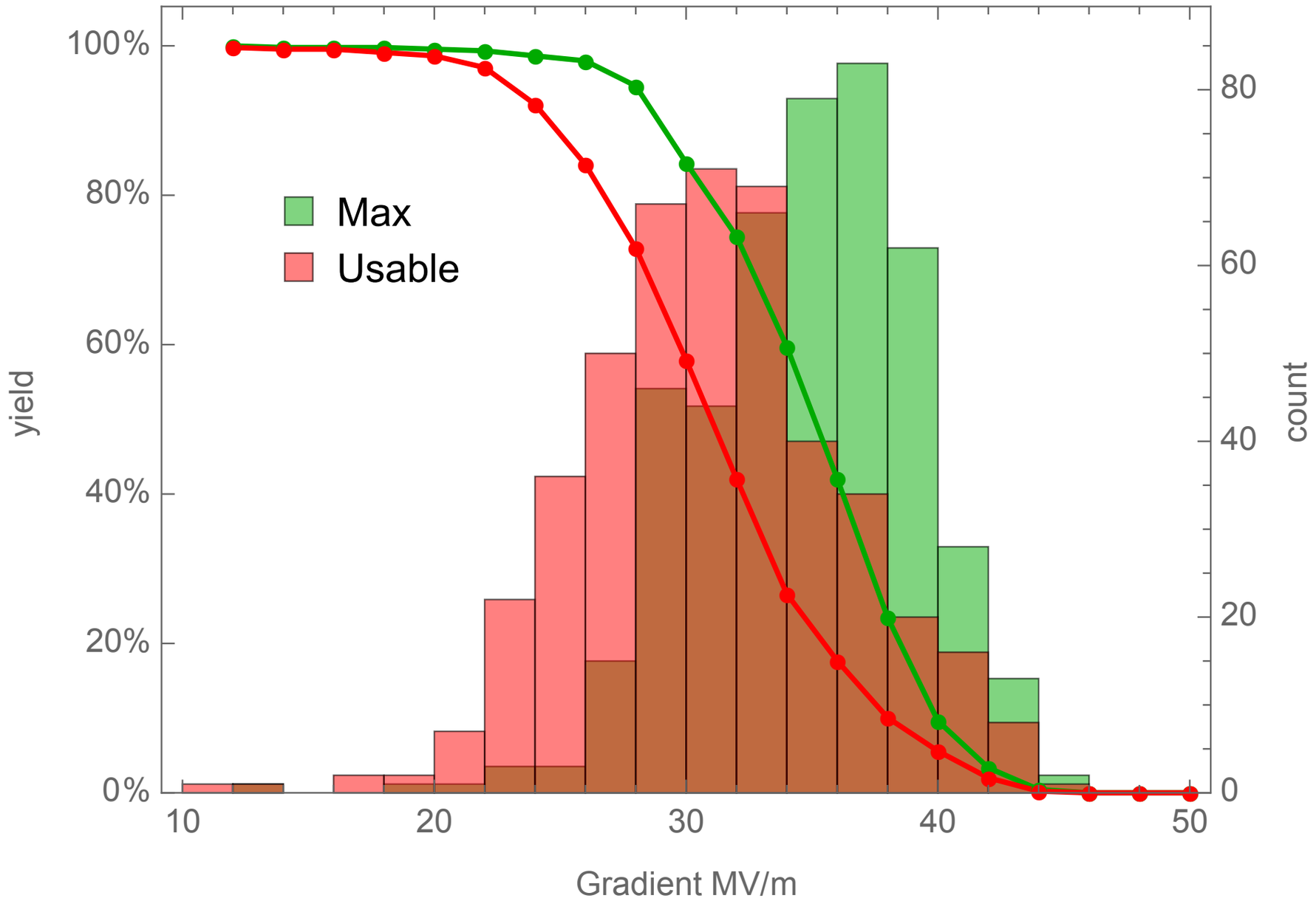
RI cavities: Maximum field

Let's ignore field emission (probably not a good idea 🤔)



accepted cavities incl. retreated cavities

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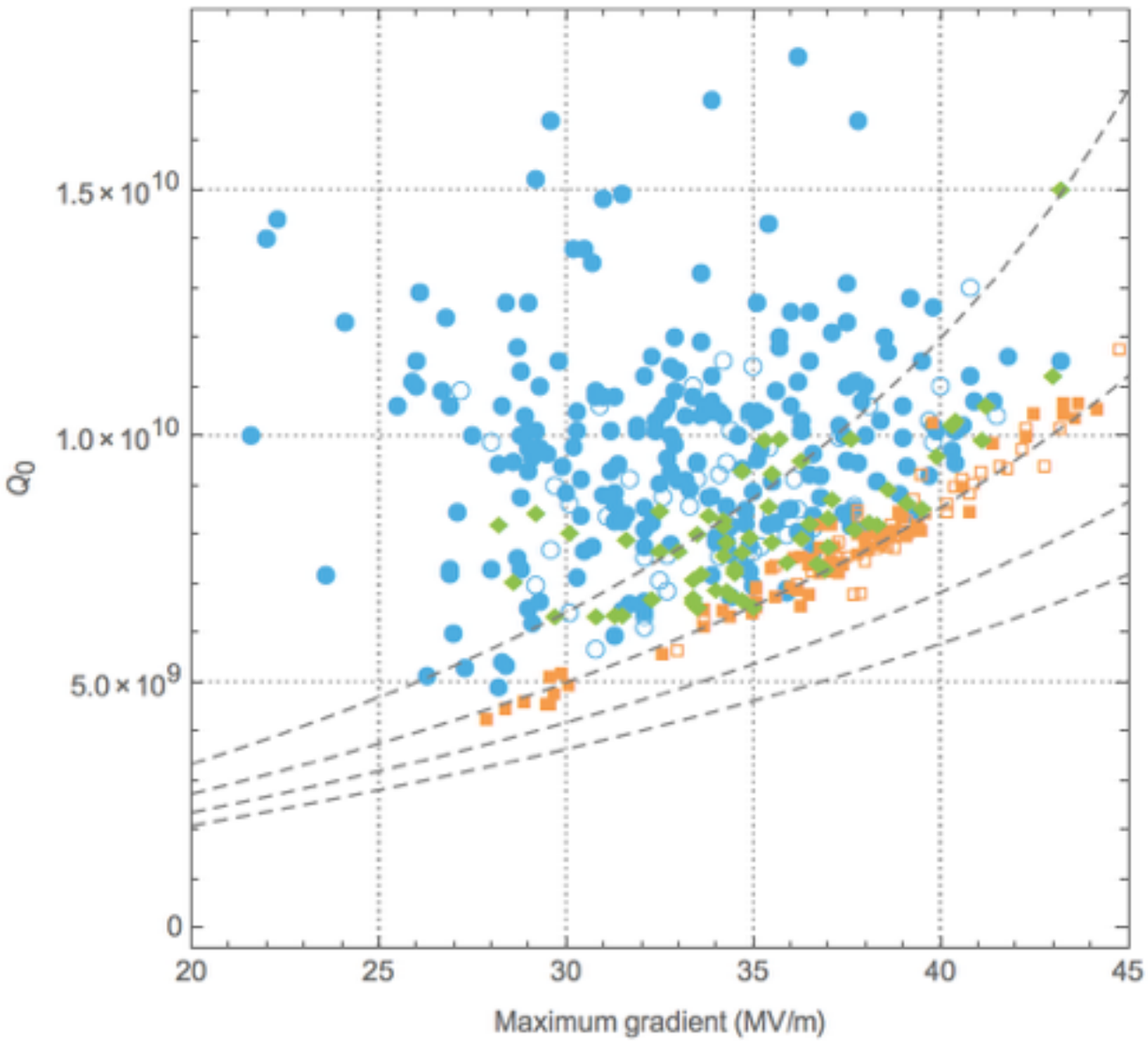
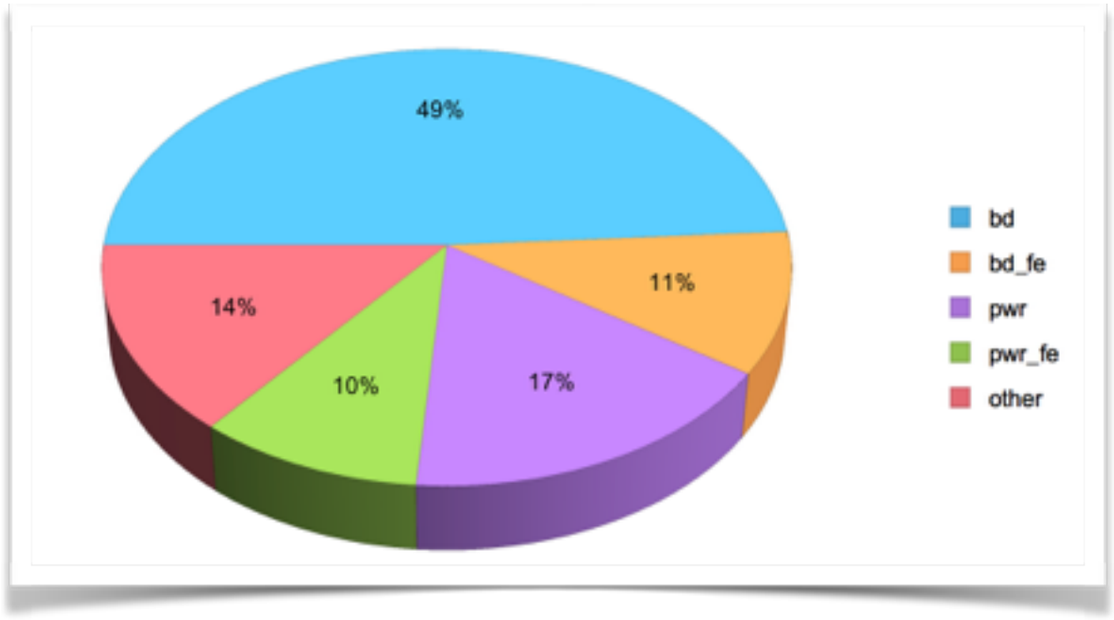
RI cavities: Maximum Field





~50% limited by quench

accepted cavities incl. retreated cavities

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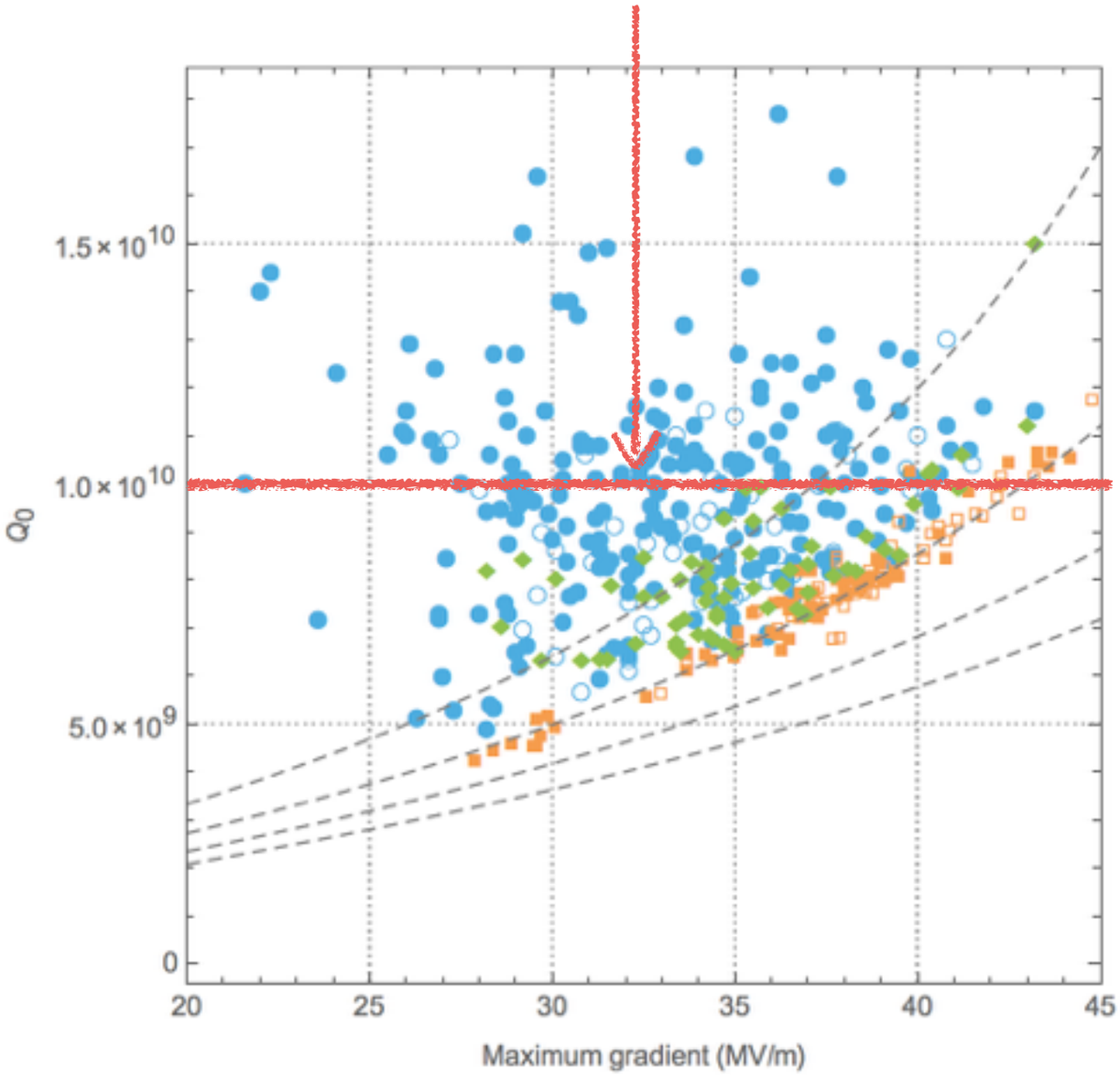
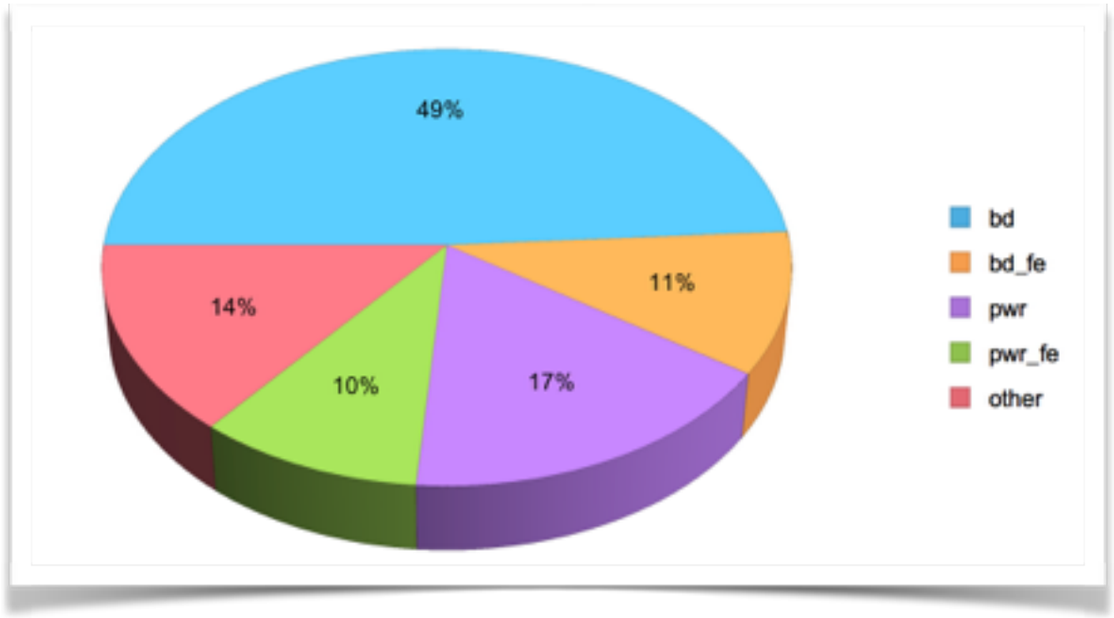
RI cavities: Maximum Field

Usable
Gradient limit





~50% limited by quench

accepted cavities incl. retreated cavities

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RI XFEL: Maximum Gradient Yield (2D)

RI XFEL cavities accepted for module assembly
(includes those cavities which have been retreated)

$\geq G_{max}$ MV/m

$\geq Q_0$	20	25	30	35	40	45
0.	100%	98%	84%	51%	10%	0%
$5.\times10^{9}$	98%	97%	84%	51%	10%	0%
$1.\times10^{10}$	31%	30%	25%	15%	6%	0%
XFEL						
1.5×10^{10}	1%	1%	1%	1%	0%	0%
$2.\times10^{10}$	0%	0%	0%	0%	0%	0%

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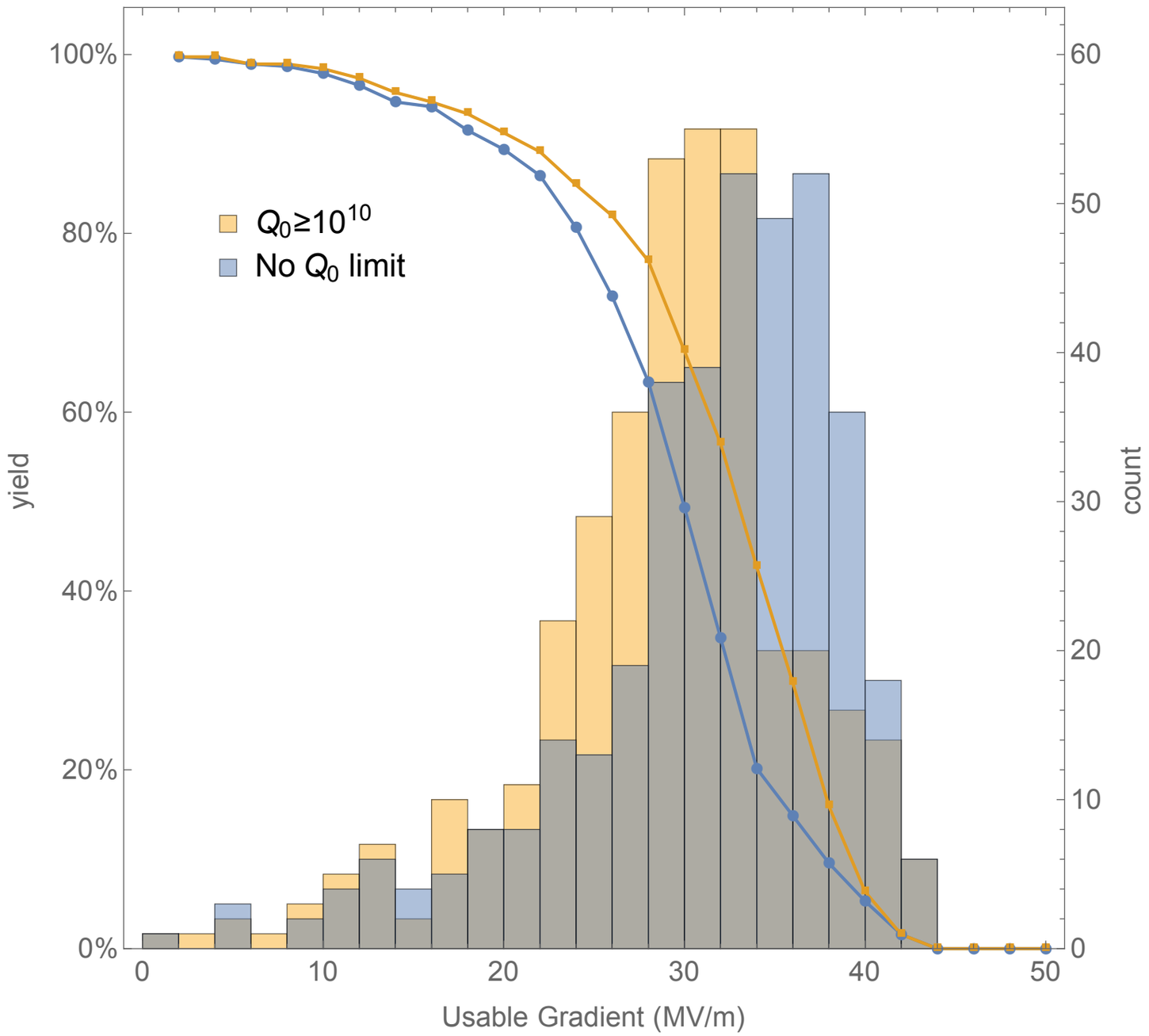
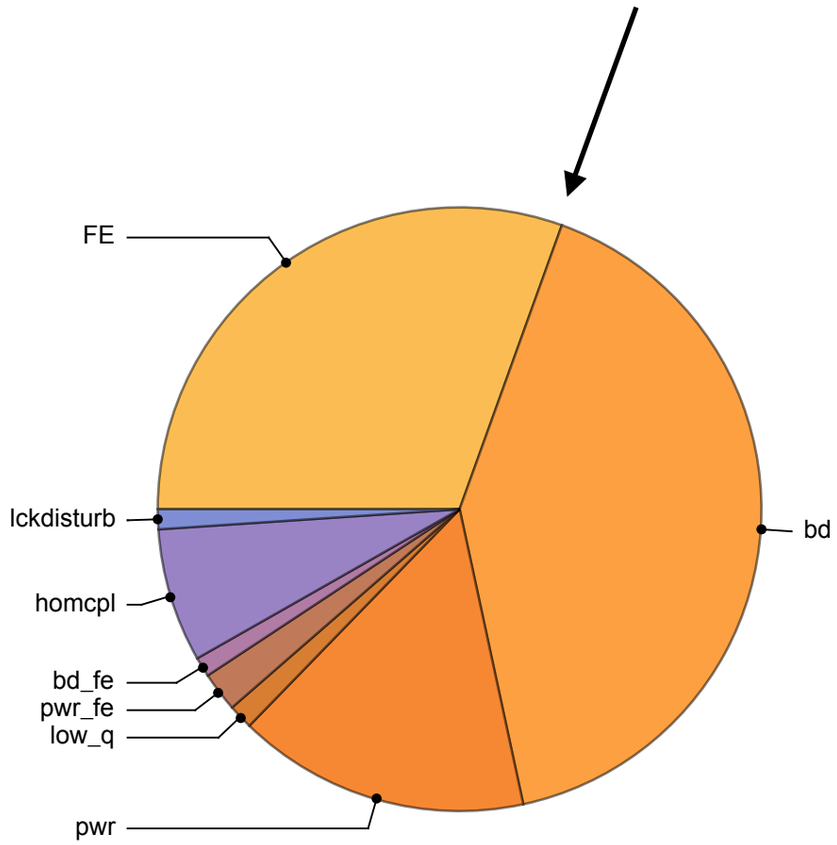
Influence of Q_0 limit on usable gradient



	$Q_0 \geq 10^{10}$	No Q_0 limit
# tests	377	377
⟨G⟩ (MV/m)	29.	31.4
G_{RMS} (MV/m)	7.4	7.5
yield @ 26 MV/m	73%	82%
yield @ 28 MV/m	63%	77%
yield @ 35 MV/m	18%	36%



RI cavities “as received"

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