EmaxOps vs Operational Values

Gradient Management

Clyde Mounts, et al

SRF Commissioning

- Emax – maximum gradient achieved
- EmaxOps – maximum gradient which may be achieved for this cavity when all eight in a cryomodule are operating.

CED definitions

- MaxGSET (GSET.DRVH):
  - Maximum gradient EPICS will allow
- OpsGsetMax:
  - Set by Ops or LLRF via cavity history files in response to recent behavior
- Q0 (HTQ):
  - Used to calculate how much heat a given gradient will produce; lem outputs zone sum to Cryo app
- Qexternal:
  - Used by lem to calculate needed klystron power and limit gradient if insufficient available, e.g. Varkly tap setting
- TripOffset:
  - The gradient at which the trip interval in a C25 statistical model causes one trip every eight hours. Used instead of intercept to make file more human readable.
- TripSlope: slope of statistical

C25 vs C50/100 rules of definition

- For C50 and C100 modules:
  - MaxGSET (aka GSET.DRVH) = EmaxOps, (adjusted for gradient calibration)
- For C25 cavities:
  - MaxGSET (aka GSET.DRVH) = average (Emax, EmaxOps) to get headroom for short interval fault data

Why do Operational gradients differ from EmaxOps?

- C25
  - Gradients are scaled to lower arc trip rates – should not attain EmaxOps
  - Component degradation/failure
- C50
  - Control system limitations
  - Probe Q changes require removal of 3 dB pad for better control
  - Component degradation/failure
- C100
  - Learning curve for FCC control loop settings
  - RF low level vs SRF commissioning conditions
  - Heater configuration
    - Originally 4 heaters used. Connected all 8.
    - Single power supply for all 8 heaters – fix in progress

And “Lost Gradient”…

What is “Lost Gradient”?

- C25
  - Operational Arc rate adjustments
    - Until the gradient model is updated, the cavities are “hard” limited by OpsGsetMax

- All modules
  - Diagnostics processes
  - Program “requirements”
  - Cavity History not updated after repair/recovery

- For C50/100 modules, Operational gradients should always equal EmaxOps; if not -
  - Fix the problem
  - Revisit cavity Emax value

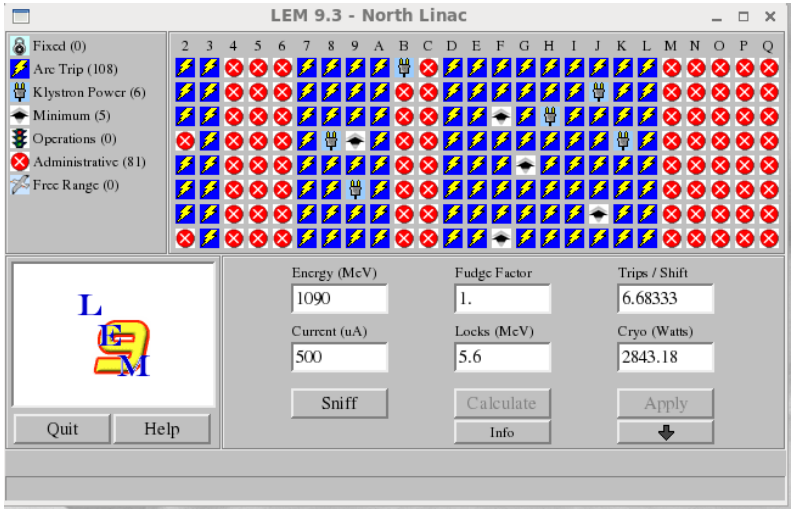
It basically boils down to record keeping…

Mitigation - Gradient Management

- Resolve C100 issues to realize full gradient potential
  - Scheduled for this summer – in progress
- Jay presently handles updating arc rate models (C25)
  - Calculates trip offset and slope for predicting arc trips
  - Sets MaxGSET in CED for LEM
- Weekly analysis and report of gradient reductions
  - Tools being developed to extract information across CED and Cavity History
  - Validate gradient reduction, put hardware causes into queue for repair/maintenance – can predict maintenance days
- More useful tools for fault reporting, de-rating cavities
  - Ops centric, automated if possible…

Gradient = Gold

The goal is to realize full potential of available gradient and to maintain cavity accelerating voltages over the course of an experimental run. In the 12 GeV era it is critical that each de-rated cavity be evaluated so that appropriate actions can be taken to mitigate impact on the experimental programs.



Linac	Type	$<E_{maxOPS}>$ (MV)	2014-Feb <GMES> (MV)	2014-Feb $\frac{<GMES>}{E_{maxOPS}}$ (MV) (%)	2014-Apr <GMES>	2014-Apr $\frac{<GMES>}{E_{maxOPS}}$
NL	C20	8.61	7.19	84	5.26	61
NL	C50	11.71	11.03	94	10.11	86
NL	C100	20.86	17.59	84	17.78	85
SL	C20	9.09	7.05	78	6.70	74
SL	C50	11.55	10.06	87	9.16	79
SL	C100	19.77	16.66	84	15.90	80

Table 8: $<E_{maxOPS}>$ commissioning values from Table 2, <GMES> values from the two sample Spring 2014 configurations (Tables 3 and 7) and their ratio.

Acknowledgements

Thanks to Jay Benesch for providing definitions, and to Arne Freyberger for letting me steal a slide