

Greatness Perimeter Analog

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Introduction

Klystron operation selection is a prevalent problem for the operators here at LCLS. Deciding which stations are currently running the most efficiently is difficult because there is a lot to be taken into consideration. For example, jitter and fault counts are especially important to check, as they, in certain cases, affect the results of user experiments. To clarify this complication, I have created a rating scale for the stations that can be quickly observed by operators to choose the optimum stations. (To create a simplified view for the graphs that are used to describe individual deduction, the stations are number 1-83, where station 20-5 is number 1)

Research

In order to summarize the goodness of a station in a single number, many factors have to be considered. These factors include (but are not limited to) phase jitter, beam voltage, and trip rate performance. The Greatness Parameter Analogs attempt to do this by assigning each klystron along LCLS a rating 0 to 4, where they receive varying deductions based on their efficiency. The deductions are as follows:

Phase Jitter Deduction:

- Max Deduction is 1 point
- Illustrates which station are running with the most precise phase
- Normalized on a relative percentage

The Phase Jitter Deduction is calculated using the current phase jitter divided by the set phase jitter high limit, where the limit denotes how high the jitter can be before the station needs attention. The Phase Jitter Deduction is rescaled to provide a better comparison between the stations. If the ratio of the jitter and the high limit is greater than 1:1, the deduction is still 1. This deduction was chosen for the overall klystron rating because seeing an phase displacement in the beam can be disruptive for user observations.

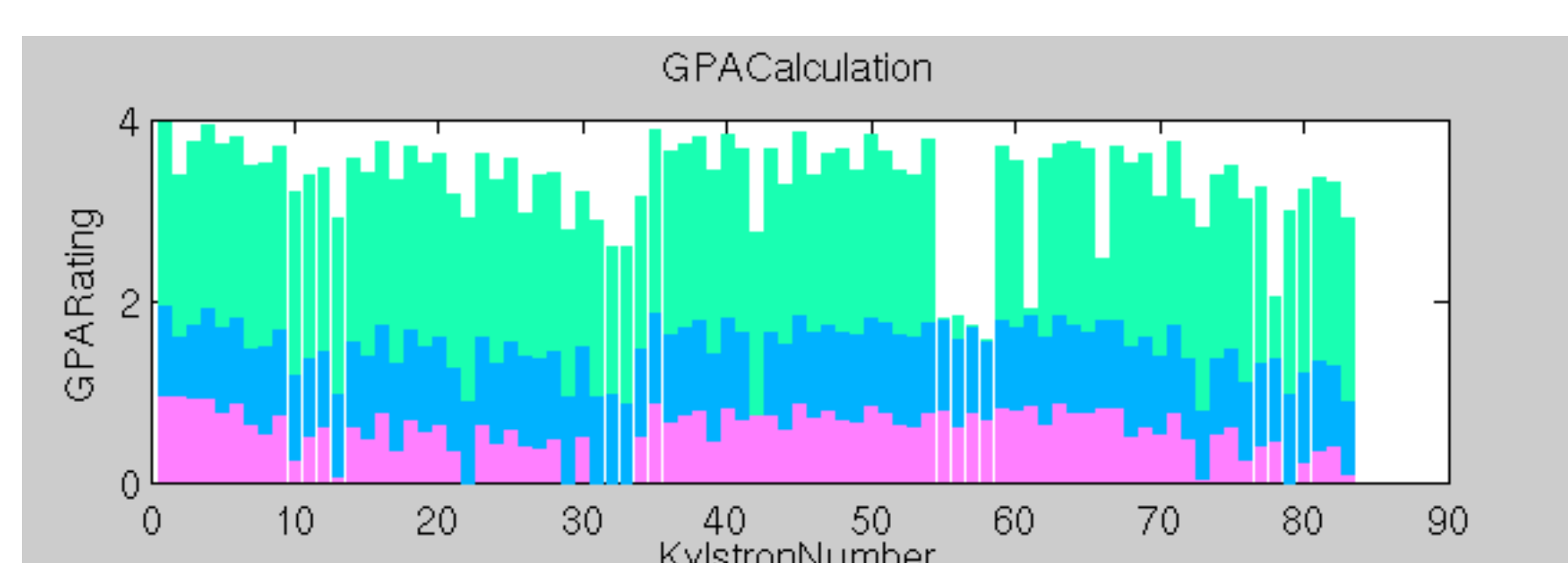


Fig 1. Full G.P.A calculation. Stations with the highest rating bar were found to be working the smoothest, while lower bars indicate that the station may require maintenance attention.

Beam Voltage Deduction:

- Max Deduction is 1 point
- Rescaled for relativity
- Shows stations with least varied beam voltage delivery

The Beam Voltage Jitter Deduction is represented by the ratio of the current beam voltage jitter and the beam voltage high limit. The limits were calculated using mean+3*std from 8 weeks of data for each station individually. This jitter is rescaled so that all the values are relative to each other to better show which stations would work the best by comparison to the others. If the ratio of the jitter and the high limit is greater than 1:1, the deduction is still 1. This deduction is important to include in an overall klystron rating, because essential to deliver the beam at the precise requested voltage.

Trip Rate Deduction:

- Maximum Deduction is 2 points
- Normalized on a scale of 0-2
- Includes stations' fault history and current status

The Trip Rate Deduction is calculated based on a ratio of the amount of trips in the past two days to the total amount of trips in the two previous weeks of shifts. This will help show which stations are currently working smoothly even if they have been faulty in the past. The maximum deduction is two points because this is the most important component of the calculation, as it shows which stations might require maintenance and therefore should be put into stand-by.

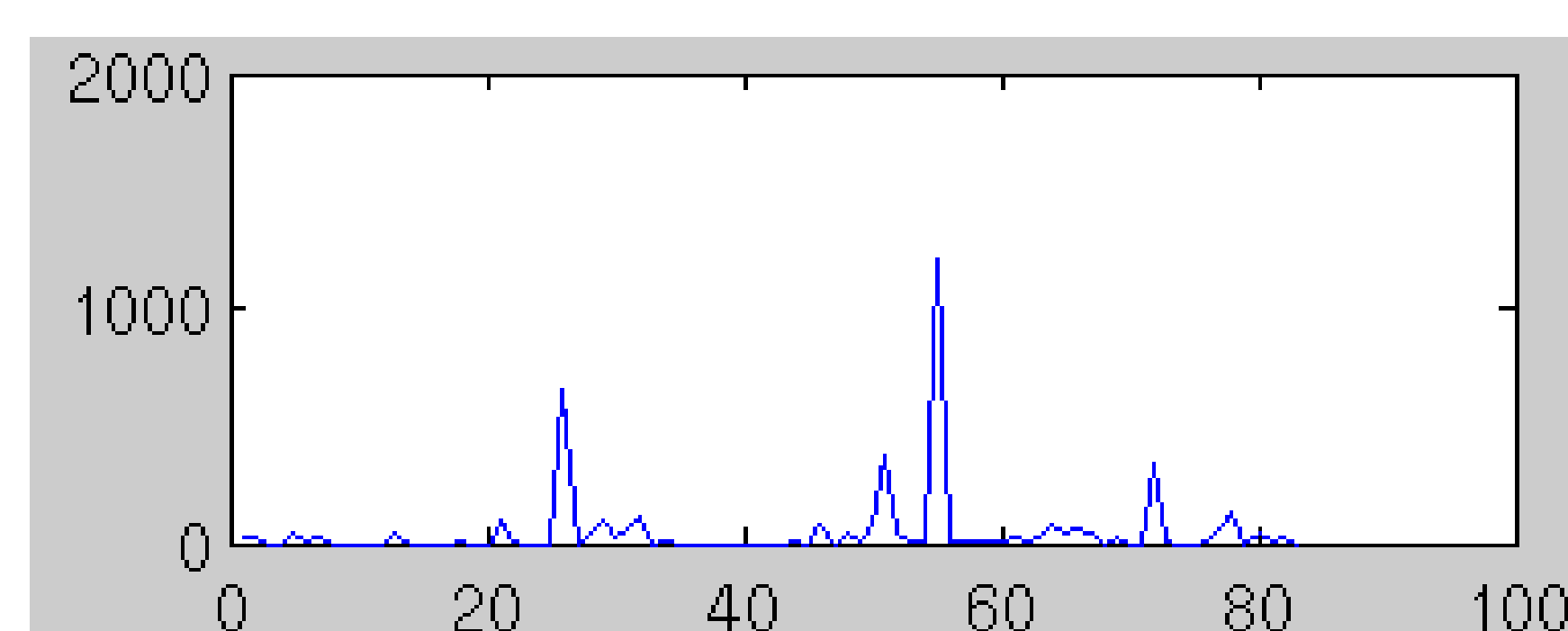


Fig 2. This plot shows the amount of trips each station had in a time period of 2 days. It can be seen that while almost all stations had some sort of error, some had much more than others. To reduce stigma towards certain stations that may have been faulty in the past but have recently been repaired, the more recent data is calculated in a ratio with the number of faults that the station had in the past two weeks. This deduction is especially important because it can help minimize the amount of down time that users experience during their beam time.

Power Savings

Klystron Power Conservation - Greatness Parameter Analogs													
K-22-1	2.4	K-23-1	2.3	K-24-1	2.0	K-25-1	2.6	K-26-1	2.5	K-27-1	3.0	K-28-1	2.9
K-22-2	3.6	K-23-2	3.0	K-24-2	3.7	K-25-2	3.8	K-26-2	3.9	K-27-2	4.0	K-28-2	3.7
K-22-3	3.6	K-23-3	3.6	K-24-3	3.5	K-25-3	3.8	K-26-3	3.8	K-27-3	4.0	K-28-3	3.7
K-22-4	3.6	K-23-4	3.6	K-24-4	3.2	K-25-4	3.5	K-26-4	3.8	K-27-4	4.0	K-28-4	3.3
K-22-5	3.6	K-23-5	3.7	K-24-5	3.0	K-25-5	3.9	K-26-5	3.8	K-27-5	4.0	K-28-5	3.6
K-22-6	3.7	K-23-6	3.2	K-24-6	3.3	K-25-6	3.8	K-26-6	3.7	K-27-6	4.0	K-28-6	3.8
K-22-7	3.7	K-23-7	3.3	K-24-7	3.7	K-25-7	3.7	K-26-7	3.8	K-27-7	4.0	K-28-7	3.5
K-22-8	2.6	K-23-8	2.5	K-24-8	2.6	K-25-8	2.7	K-26-8	2.8	K-27-8	3.0	K-28-8	2.9

Fig 3. The GPA rating appears under the GPA tab in the Klystron Power Conversation page from the LCLS EPICS home menu. This page shows each individual klystron's current calculation being done through the series of process variables mentioned.

K21-3	3.7	K22-3	3.6	K23-3	3.6	K24-3	3.5	K25-3	3.8	K26-3	3.8	K27-3	4.0
Mod HV ON	ON	Mod HV ON	OFF	Mod HV ON	OFF	Mod HV ON	OFF	Mod HV ON	OFF	Mod HV ON	OFF	Mod HV ON	OFF
STANDBY													
K21-4	3.4	K22-4	3.6	K23-4	3.6	K24-4	3.2	K25-4	3.5	K26-4	3.8	K27-4	4.0
Mod HV ON	ON	Mod HV ON	OFF	Mod HV ON	OFF	Mod HV ON	OFF	Mod HV ON	OFF	Mod HV ON	OFF	Mod HV ON	OFF
STANDBY													
K21-5	3.7	K22-5	3.6	K23-5	3.7	K24-5	3.0	K25-5	3.9	K26-5	3.8	K27-5	4.0
Mod HV ON	ON	Mod HV ON	OFF	Mod HV ON	OFF	Mod HV ON	OFF	Mod HV ON	OFF	Mod HV ON	OFF	Mod HV ON	OFF
STANDBY													
K21-6	3.4	K22-6	3.7	K23-6	3.2	K244 PSV BLACK		K25-6	3.8	K26-6	3.7	K27-6	4.0
Mod HV ON	ON	Mod HV ON	OFF	Mod HV ON	OFF			Mod HV ON	OFF	Mod HV ON	OFF	Mod HV ON	OFF
STANDBY													
K21-7	3.7	K22-7	3.7	K23-7	3.3	PSV		K25-7	3.7	K26-7	3.8	K27-7	4.0
Mod HV ON	ON	Mod HV ON	OFF	Mod HV ON	OFF			Mod HV ON	OFF	Mod HV ON	OFF	Mod HV ON	OFF
STANDBY													
K21-8	2.0	K22-8	2.6	K23-8	2.5			K25-8	2.7	K26-8	2.8	K27-8	3.0
Mod HV ON	ON	Mod HV ON	OFF	Mod HV ON	OFF			Mod HV ON	OFF	Mod HV ON	OFF	Mod HV ON	OFF
STANDBY													

Fig 4. A grid has been set up as shown to display each klystron's current state on the beam. A color is also given to each station depending on their GPA rating, where 3-4 is green and 2-3 is yellow.

Conclusions

It is imperative that a wide variety of factors be taken into consideration when deciding to put a station into stand-by. The Station GPA calculation system attempts to group the most important diagnostics into a single rating and arrange the scores into a comprehensible fashion. While this computation provides an overall estimate of each station's ability, there are still several components that can be added into the system that could improve its practicality.

The full code for the calculation is under: [/home/physics/jhoover/CalcGPA.m](http://home/physics/jhoover/CalcGPA.m)

More information can be found at: http://adops.slac.stanford.edu/wiki/index.php/Station_GPA#Beam_Voltage_Jitter_Deduction

Acknowledgments

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