9mA webex meeting
3rd July 2012

- **Updates on FLASH activities**
- **'Missing Measurements' for Sept 9mA program**

‘Missing Measurements’: studies program for Sept 9mA shifts

- **Context**
  - ILC Global Design Effort formally coming the end
  - Technical Design Report is being written
  - Sept 9mA studies will be the last before formal completion of the ILC Global Design Effort

  - *The most important ILC studies – shows that an ILC can be built and actually work*

- **What should we try to accomplish in Sept…?**

Key Results

- **Beam operation with 800us/4.5mA bunch trains, and…**
  - Gradients of all cavities in vector sum flat within +/-0.3%,
  - All cavities in vector sum operating within 5-10% of quench

- **First experience of 'high gradient operations management'**
  - Quench detection / exception handling
  - Gradient 'soft limiter' to dynamically prevent quenching
  - Data-point of running machine into quench with 800us/4.5mA

- **Beam operation with 800us/4.5mA bunch trains, and..**
  - RF forward power within ~7% of klystron saturation

- **Ramp-up from ~zero to 800us/4.5mA pulses without quenching**
- **Rapid recovery ('crash test'): 800us/4.5mA -> trip -> 800us/4.5mA**

if we stopped now…
System Tests with Beam at FLASH

High beam power and long bunch-trains *(Sept 2009)*

Metric	ILC Goal	Achieved
Macro-pulse current	9mA (5.8mA)	9mA
Bunches per pulse	2400 x 3nC (3MHz)	1800 x 3nC 2400 x 2nC
Cavities operating at high gradients, close	31.5MV/m +/-20%	4 cavities > 30MV/m

Already a compelling demonstration that we could run an ILC at the specified parameters

Gradient oper[illegible] *(updated following Feb 2012 studies)*

Metric	ILC Goal	Achieved
Cavity gradient flatness (all cavities in vector sum)	2% ΔV/V (800μs, 5.8mA) (800μs, 9mA)	<0.3% ΔV/V (800μs, 4.5mA) *First tests of automation for Pk/Ql control*
Gradient operating margin	All cavities operating within 3% of quench limits	Some cavities within ~5% of quench (800us, 4.5mA) *First tests of operations strategies for gradients close to quench*
Energy Stability	0.1% rms at 250GeV	<0.15% p-p (0.4ms) <0.02% rms (5Hz)

Pushing the parameters beyond what we already have achieved (*A yet stronger demo)*

- **We're not quite there with the demo that we can operate within ILC gradient margins**
  - Gradient margins themselves
  - Running at the ILC current (now 5.8mA)
  - Definitely want to spend some time understanding how to use the soft limiters wrt quench limits
  - Can we dynamically recover from marginally starting to quench

- **We also not quite there demonstrating operation with minimal klystron power overhead**
  - Only one datapoint so far

- **Conclusion: demo context, we should push further with what we did in Feb**

- **What about any tests related to Klystron Cluster Scheme..?**

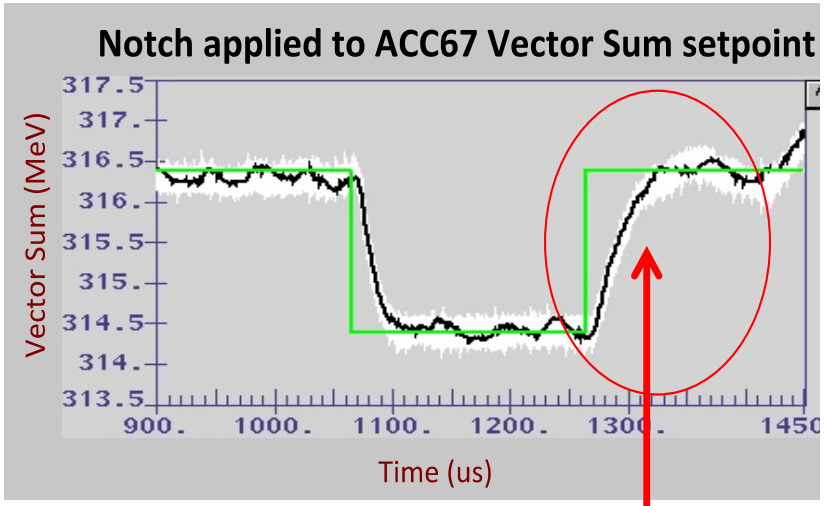
Characterization context

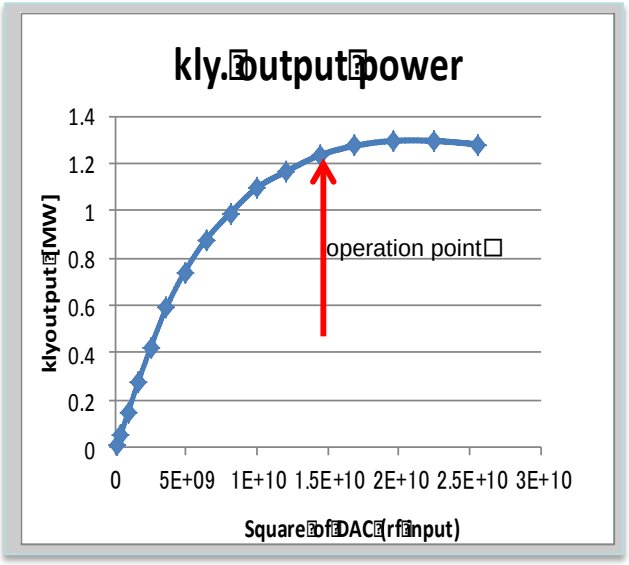
- **What can we do now that we'd want to include in the 9mA journal article(s)…?**

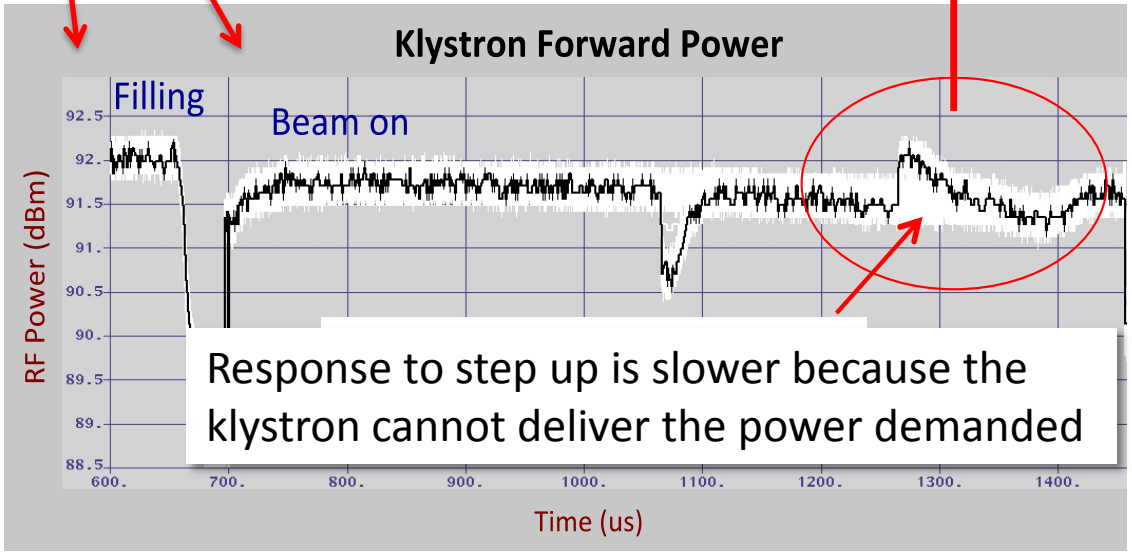
- **(My view) – we would want to show an understanding of the issues and limitations**
  - Characterize operation close to gradient margins
  - Characterize operation close to power limits

Evaluating rf power overhead requirements (4.5mA/800us bunch trains)

- Klystron high voltage was reduced from 108KV to 86.5KV so that the rf output just saturated during the fill
- The required beam-on power ended up being ~7% below saturation

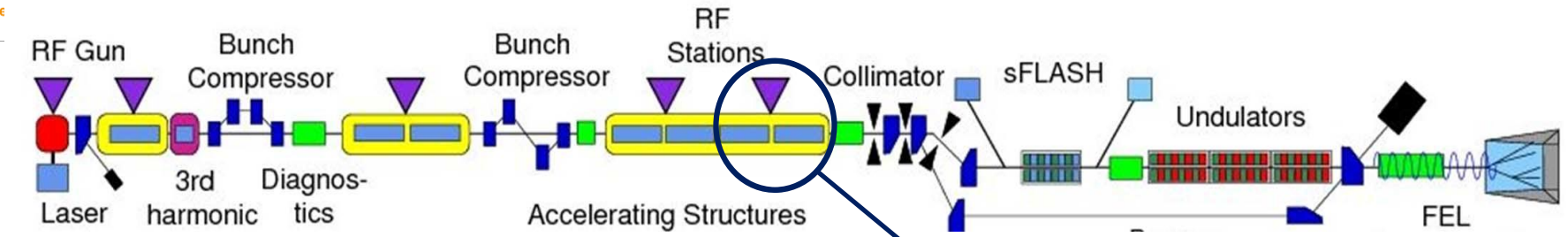






Response to step up is slower because the klystron cannot deliver the power demanded

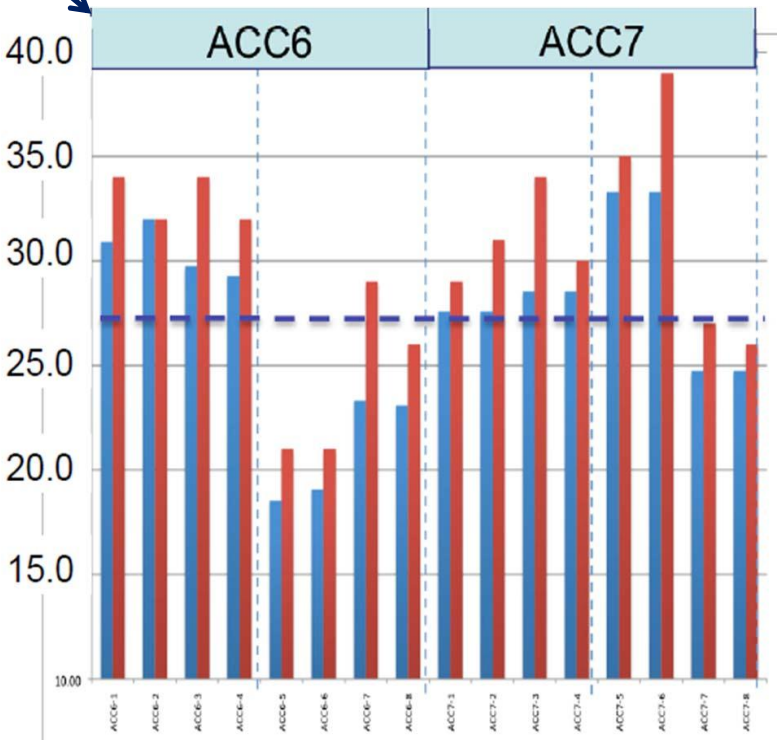
TTF/FLASH layout 9mA Experiment



- Operation with gradient spread from a single source
  - operating gradient spread for ACC67 around +/-25%
- Operation with high beam current

An issue for studying gradient margins: not all cavities reach their quench limits at the same time (impact of being close to quench may not be visible on VS)

  - Q_L motors



How to characterize operation close to quench…?

- ***Questions (still) to be answered***
  - *How does stability change as we get closer to quench limits*
  - *Is there a knee or a hard threshold on how close we can run?*
  - …

- **Conditions**
  - Reduce number of cavities in VS to get some number of cavities all very close to the quench limits (VS dominated by cavities close to quench)

How to characterize operation close to klystron saturation…?

- ***Questions (still) to be answered***
  - *How does stability change as we get closer to quench limits*
  - *Is there a knee or a hard threshold on how close we can run?*
  - *How much benefit do we get from klystron linearization?*

- **Conditions**
  - Beam-on power as high as possible (above the fill power)
  - Run klystron down till we can no longer reach the VS setpoint with the beam power
  - Use Klystron linearization function in LLRF controller?

- **What else…?**
- **Proposals for additional measurements to strengthen material for 9mA journal article(s)**
- **….discussion**