



Planning the Experiment

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9mA Experiment mini-workshop

16.01.2009



Planning “The Experiment”

- No more beam-time between now and dedicated run
- Several ‘sub-systems’ we had originally hoped to test out and have operational will get “first look” during the run
- No “dress rehearsal” as originally planned
 - **September was “it”!**



Goal for this session

- Develop a strategy and interim goals for the dedicated run
- Plan out what needs to be done to achieve them, allocate a number of shifts to them
- Formulate a list of ‘experiments’ that we want to do, what data will be recorded
 - **Invasive tuning experiments**
 - **In addition to achieving the primary demonstration goals**



Constraints

- **People!**
 - **How best to populate shifts**
 - **This will at some level determine the detailed programme**
 - **Not enough ‘experts’ to run 24/7 → overall strategy**
- **Do not expect detailed planning today, but propose to produce a tentative block schedule**
 - **Realistic shift coverage**
 - **Understand how many shifts we really need**
 - **Possibility of including other studies**



Goals of 9mA test (summary)

- Demonstrate energy stability $<0.1\%$ (LLRF) with high beam-loading
 - **Bunch to bunch**
 - **Pulse to pulse**
 - **Over many hours (~ shift)**
- Evaluate operation close to cavity limits
 - **Quench limits**
 - **Impact of LFD, microphonics etc.**
- Evaluate LLRF performance
 - **Required klystron overhead**
 - **Optimum feedback / feedforward parameters**
 - **Exception handling (development)**
 - **Piezo-tuner performance etc.**
- Evaluate HOM absorber (cryoload)
- Controls/LLRF development
 - **Software & algorithm development for ATCA (XFEL) LLRF system**

“hands-off” running
(monitoring)





Categories of Activities

- Machine set-up & commissioning
- Achieving long-pulse 9mA beam pulse with high-gradient
- Dedicated experiments



Machine Set-up & Commissioning

- Assumptions: set-up 3nC immediately and maintain for entire run
- Careful gun, injector set-up, matching, optics and steering
 - **Loss-free transmission to dump**
- Commissioning (~new hardware)
 - **3MHz laser operation**
 - **SIMCON DSP system**
 - **Tests and experience with new dump-line instrumentation / hardware**
 - Critical: need to convince ourselves it is safe to go to high beam powers



Achieving Long Pulses

- Primary goal
- Requires a strategy
 - **Step-wise approach to ultimate performance goal**
 - **Start at ~700 MeV and step up in energy**
 - energy states
 - **Establish long bunch trains and stable operation (1MHz, 3MHz,...)**
- Each energy state (potentially current state) defines an interim experimental goal
 - **Once achieved, maintain for ~shift (monitor)**
 - **Perform dedicated experiments / measurements at this state**



A 3 Shift Cycle Proposal

- Afternoon Shift
 - Achieve required energy/current state and tune machine (LLRF)
- Night Shift
 - Operations only (expert on call)
 - Maintain configuration (quiet running, hands-off)
 - Monitor all signals (DAQ, needs definition)
- Day Shift
 - Initial analysis of night-shift (stability achieved, problems, etc.)
 - Programme of invasive experiments at this energy/current state
 - Decision to go to next energy/current state
- 5 such cycles would be 5 days

9mA team & FLASH experts required for 2 shifts (day & evening)

Night shift left to ops to 'run beam'

Not without risk (high beam power!)



Dedicated Experiments

- “Dedicated” = well-defined and specific experiments
 - **Scan some parameter, make some measurement**
 - **Test software / scripts / automation**
 - **Hardware modifications, adjustments, ...**
- Should be focused on ‘goals’ list
 - **Beyond long-term stability studies**
- Understand/catalogue required beam and machine conditions
 - **Repeat at each energy/current state (“standard measurements”)**
 - **Requires a specific state or different state altogether.**
- Previous scenario: these would be scheduled on day shifts



Additional Time

- “The best-laid plans of mice and men often go awry”
- Contingency required
 - **Expect the unexpected**
 - **Possible down-time (hardware failures)**
 - **Protracted tuning**
- “brick wall”
 - **Not able to make progress for some limiting reason (shall we take bets?)**
 - **Need plan Bs**
- ⇒ despite well scheduled plan, flexibility will be mandatory
 - **Team meeting every day 8AM**



Parasitic / Other Experiments

- In principle, the machine time can support other accelerator studies
- Once we have our block schedule with intermediate goals/objectives defined, we can evaluate proposals
- 9mA experiment takes priority
 - **No retuning of the machine!**
 - **Experiments must make use of (our) existing beam conditions**
- During night shift, only parasitic experiments
- Note these should be treated as guidelines, not strict rules
 - **All rules have exceptions if merited!**



How long? (Needs Discussion)

	Guess
3nC gun / injector / RF (long pulse) set-up (1MHz) <30 bunches	3 shifts
Dump line instrumentation commissioning / characterisation / thresholds	3 shifts
3MHz beam (<30 bunches)	2 shift
SIMCON DSP work (closed loop, commissioning)	3 shifts
Achieve long pulse operation (3 shift cycles)	15 shifts
Additional experiments (not included in above)	3 shifts
Contingency	5 shifts
Total guesstimate	34 shifts