Planning the Experiment

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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**

Categories of Activities

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

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!)

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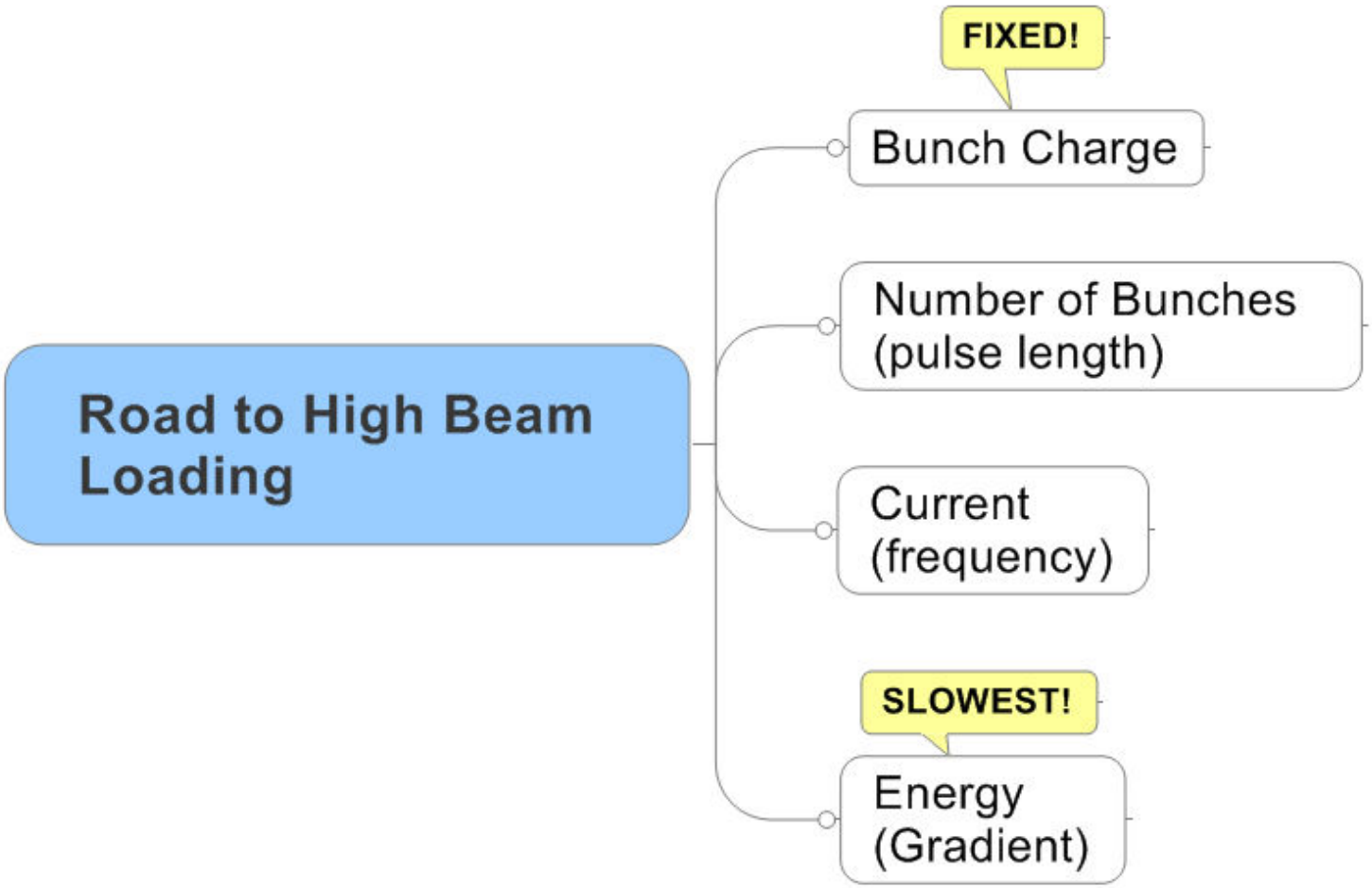
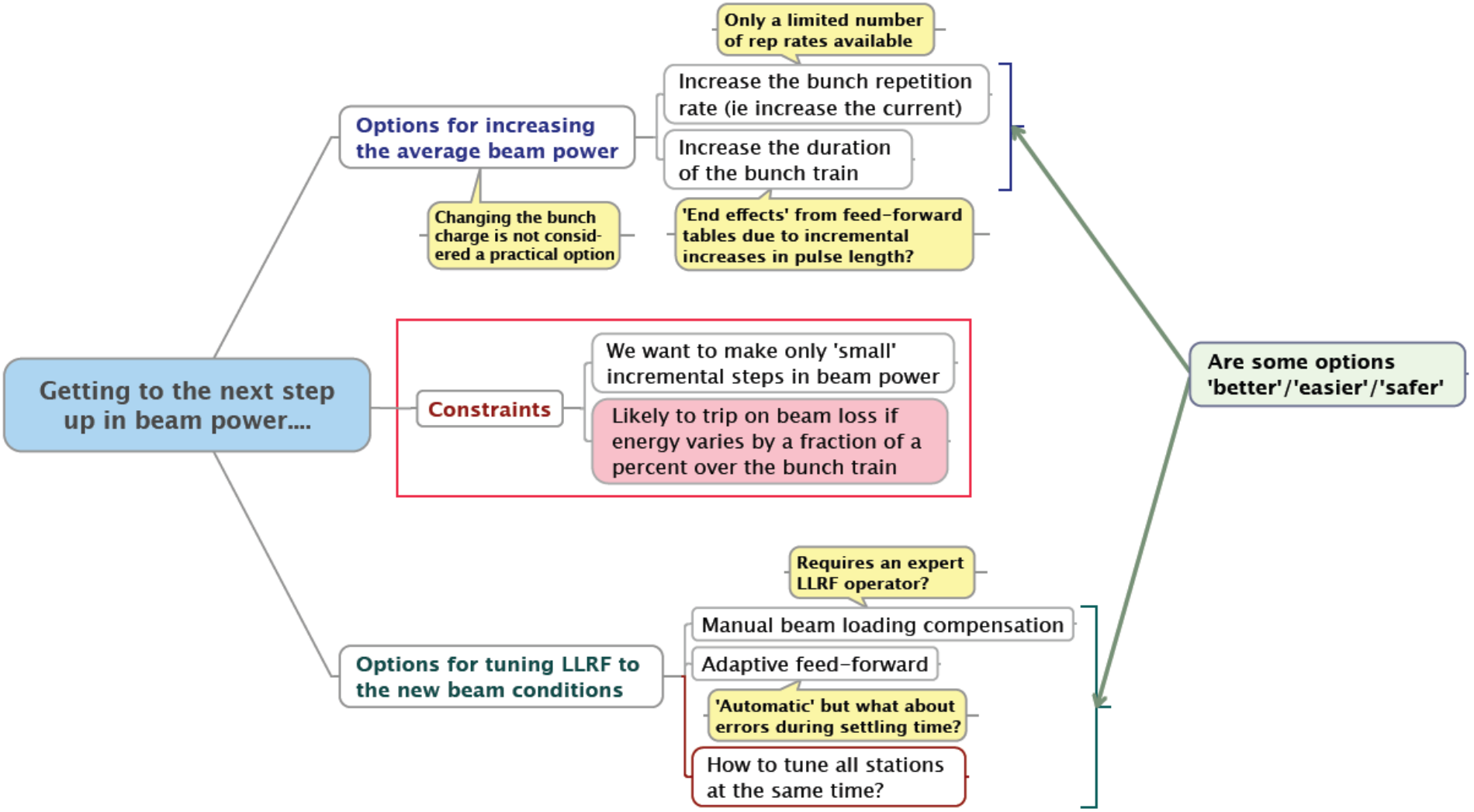
Achieving Long Pulses

- 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**

Available “Knobs”

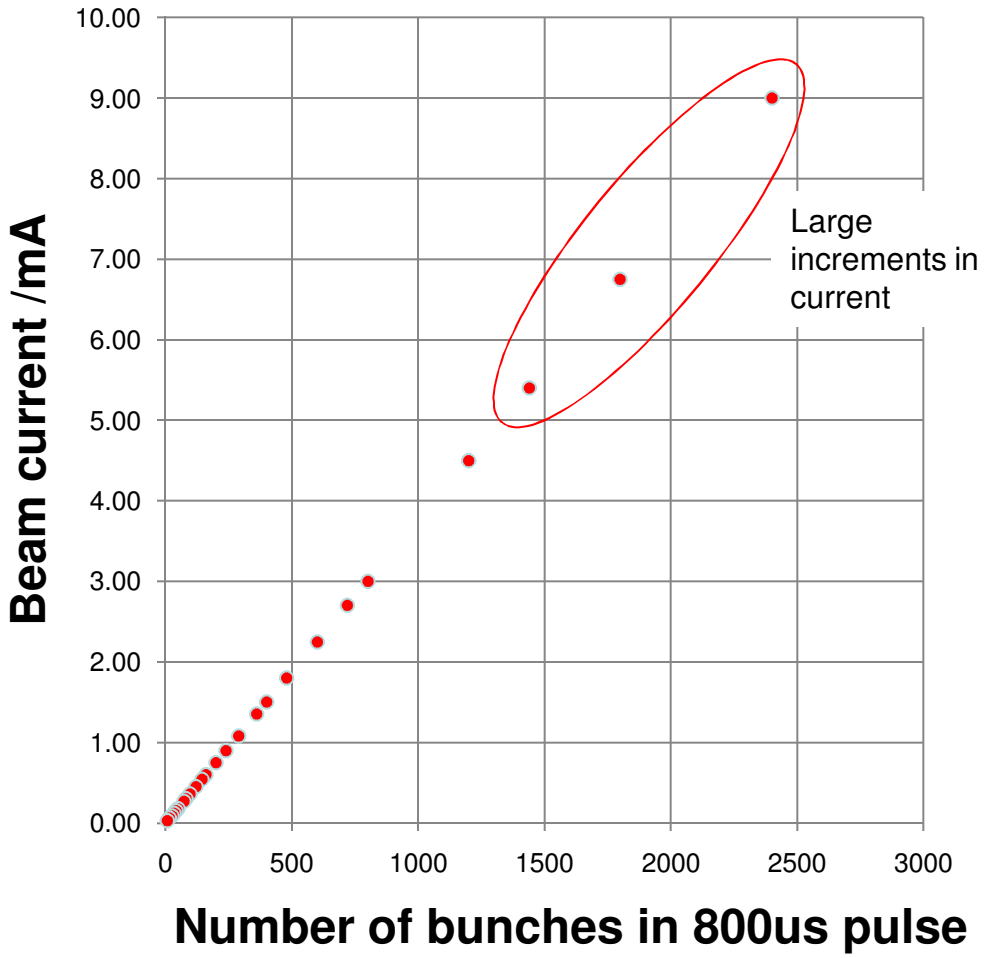


Incremental Approach



Control over Current

		divider combinations					
9000 kHz		2	2	3	3	5	5
4500		x					
3000				x			
2250		x	x				
1800						x	
1500		x		x			
1000				x	x		
900		x				x	
750		x	x	x			
600				x		x	
500		x		x	x		
450		x	x			x	
360						x	x
300		x		x		x	
250		x	x	x	x		
200				x	x	x	
180		x				x	x
150		x	x	x		x	
120				x		x	x
100		x		x	x	x	
90		x	x			x	x
60		x		x		x	x
50		x	x	x	x	x	
40				x	x	x	x
30		x	x		x	x	x
20		x		x	x	x	x
10		x	x	x	x	x	x



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

What do we measure?

- Standard
  - **Scripts to produce set of "standard plots" after night shift (DAQ data)**
    - Examples:
      - energy stability vs time
      - Correlations (probe vs energy etc.)
      - Beam loss and 'trip' analyses
      - …
  - **Can we generate a list of these and start writing this scripts now?**
- Characterisation
  - **e.g. methods to monitor/quantify phase drifts**

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!**

Next Steps

- Generate list of standard analysis packages (DAQ data)
- Solicit proposals for experiments
  - **Review & prioritise**
- Identify a set of interim goals
  - **Strategy to achieve them**
- Increasing the energy
  - **When?**