• Overview of the existing Booster MPS system.

• The 2GeV requirements.

• LIU baseline: The “POPS” style alternative.

• Technical alternatives.
Booster MPS load characteristic

16 periods, 4 rings

<table>
<thead>
<tr>
<th>Magnets quantity</th>
<th>Total resistance [mOhms]</th>
<th>Total inductance [mH]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dipoles outer ring</td>
<td>64</td>
<td>172</td>
</tr>
<tr>
<td>Focusing quadrupoles</td>
<td>128</td>
<td>74</td>
</tr>
<tr>
<td>Reference magnet</td>
<td>4</td>
<td>10</td>
</tr>
<tr>
<td>Defocusing quadrupoles</td>
<td>64</td>
<td>51</td>
</tr>
<tr>
<td>Dipoles inner ring</td>
<td>64</td>
<td>172</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>324</strong></td>
<td><strong>479</strong></td>
</tr>
</tbody>
</table>
Booster MPS circuit

1.4GeV margins:
- MPS voltage: -2%
- MPS peak current: -2%
- MPS rms current: 3%
- TRIM A peak current: 40%
- TRIM Q peak current: 0%

1.4 GeV cycle (2267A_{RMS})

- Inner Ring Current [A]
- Load voltage [V]
- Load power [kW]
Booster MPS: the eighties
Booster MPS: 1998 consolidation

Automation & firing

Trims
• Overview of the existing Booster MPS system.

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LIU project scaling factors

• From 1.4 GeV to 2 GeV.  
  B-field: x1.3

• Considering some saturation effect, margin for B-field regulation and operation.  
  Peak Current: x1.4

• Power dissipation in the magnets with today’s ramp rate  
  Power: x2
  *Far from design margins (20-30%)…*

• Power dissipation in the magnets with existing MPS at maximal ramp rate.  
  Power: x1.8
  *Better but not enough…*

New magnets and/or new MPS needed in any case
The existing Booster MPS at 2 GeV

Upgrade scaling on one cycle
MPS peak current: +30%
MPS rms current: +35%
18kV apparent power: +77%
18kV peak power: +45%
TRIM A peak current: +540%
TRIM Q peak current: +40%

2 GeV cycle with 3.6kV limitation (3062A_{RMS})

- Inner Ring Current [A]
- Load voltage [V]
- Load power [kW]
Impact on the 18kV Meyrin network

Fast transients with 2GeV cycle which can not be compensated by Meyrin SVC.

50% increase of active power, 30% increase of reactive power
• Overview of the existing Booster MPS system.

• The 2GeV requirements.

• LIU baseline: The “POPS” style alternative.

• Technical alternatives.
“POPS” basic principles

The energy to be transferred to the magnets is stored in capacitors.

- DC/DC converters transfer the power from the storage capacitors to the magnets.
- Four flying capacitors banks are not connected directly to the mains. They are charged via the magnets.
- Only two AC/DC converters (called chargers) are connected to the mains and supply the losses of the system.

Power to the magnets:

Power from the mains:

Chargers

Flying capacitors
LIU Baseline: Fast cycle

Upgrade scaling on one cycle

MPS peak current: +30%
MPS rms current: +3%
18kV apparent power: -26%
18kV peak power: -78%
Benefits

- Overall voltage available increases and would allow a reduction of the RMS current using a faster ramping.
- The capacitor bank totally absorbs the peak power on the 18kV network. Meyrin SVC would then become optional.
- Spare sharing between MPS A and B and eventually with POPS.
- Only a few new cables needed between the reference magnet (BCER) and the MPS.
- New B-field regulation to minimize eddy currents and saturation effects impact at higher current and acceleration rate.

Drawbacks

- Cost.
LIU-PSB 5.2 WU– MPS civil engineering

<table>
<thead>
<tr>
<th>physics</th>
<th>LS1</th>
<th>physics</th>
<th>LS2</th>
<th>physics</th>
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<tr>
<td></td>
<td>Civil engineering pre-study completed</td>
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<td>Civil engineering designed</td>
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<td>Civil engineering heavy workload done</td>
<td>2015</td>
<td>Building infrastructure &amp; services ready</td>
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<td>2018</td>
<td></td>
<td>2019</td>
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</tbody>
</table>

With this new building:
- We can install and commission during Booster operation.
- We have a backup power supply during the first years.
- Easy connection to existing cables and cooling services.
Building 245 - Preliminary Drawing

Designed by Nigel Baddams
• Overview of the existing Booster MPS system.

• The 2GeV requirements.

• LIU baseline: The “POPS” style alternative.

• Technical alternatives.
Existing MPS with new magnets

- Preliminary design of the magnets by TE-MSC: $R=0.52\Omega$, $L=0.42\,\text{H}$, $I_{\text{nom}}@2\,\text{GeV}=3500\,\text{A}$.
- Simulation shows that the existing MPS could be reused (consolidation sill needed!).
- Stress on the meyrin 18kV network similar to what is measured today at 1.4GeV.
New MPS with new magnets

- Allows fast cycle and significant reduction of the RMS current in the magnets.

- Cost of an adapted POPS style MPS to be compared to the consolidation cost of the existing one.
Comments on Power Consumption

- Values plotted below are based on the existing magnets, 5000 hours of operation per year and 0.051CHF/kWh (average price in 2010).
- In any cases several MCHF would be saved on a new supply and/or on electricity consumption with new magnets.
- **Does not include a foreseeable increase of the price per kWh.**
THANK YOU FOR YOUR ATTENTION!