JUSTIFICATION FOR THE REPLACEMENT OF LINAC 2
BY A 120 MEV H⁺ LINAC

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A preliminary study took place in 2001 to propose and compare means of upgrading the flux of protons delivered by the CERN complex of accelerators [1]. The two schemes described below are outlined as the most promising. The main users who will benefit of such an improvement are ISOLDE for the PSB and CNGS for the SPS. For the other users, the selected scheme may reduce the availability of PS cycles.

1. Scheme 1: the 120 MeV linac

The most powerful solution (case #2.1 in Table 2 of [1]) has the following components:

a) a new 120 MeV H- linac injecting directly into the PS Booster,
b) modification of the PSB injection system for H- charge exchange injection,
c) PSB upgrade for regular acceleration of $5 \times 10^{13}$ protons per pulse (today’s record $\sim 4 \times 10^{13}$ ppp)
d) PS upgrade for regular acceleration of $4.8 \times 10^{13}$ protons per pulse (today’s record $\sim 3.5 \times 10^{13}$ ppp)
e) improvement of the PS 200 MHz RF system used for rebunching before transfer to the SPS
f) replacement of the 5 turns ejection system (today “Continuous Transfer”) in the PS by a lower loss system
g) SPS upgrade for the capture and acceleration of $8.6 \times 10^{13}$ protons per pulse and $\sim 2 \times 10^{10}$ protons per bunch (today $4.8 \times 10^{13}$ ppp in fixed target mode and up to $1.1 \times 10^{11}$ ppb for the LHC nominal beam)
h) upgrade of the SPS-CNGS target to handle $8.6 \times 10^{13}$ protons per pulse (nominally $4.8 \times 10^{13}$ ppp)

The proton flux on target could then be brought up to $1.43 \times 10^{13}$ protons per second, or 1.8 times the nominal CNGS value of $0.8 \times 10^{13}$ protons per second. The total cost of this solution is estimated at approximately 70 MCHF, with the 120 MeV linac contributing for $\sim 64$ MCHF.

The 120 MeV linac is the room temperature part of the proposed SPL [2]. Having it built would drastically advance the SPL project, spreading construction and cost over more years. With this 120 MeV part available, the full SPL could be completed faster and with less resources.

The beam brightness (number of protons per bunch / transverse emittance) required for the ultimate luminosity in LHC could be easily guaranteed out of the PS. Moreover, higher brightnesses would be within reach, opening the door to upgrades of the LHC performance beyond the present ultimate values [3, 4].
2. Scheme 2 : doubled PSB cycling rate

A less performing and less versatile solution (case #1.2 a in Table 2 of [1]) can be considered as an alternative with the following ingredients:

a) cycling the PSB at a 0.6 s repetition period (today 1.2 s), and accumulating 2 PSB batches in the PS,

b) modifications d) to h) listed in the preceding scheme.

The proton flux on target could be brought up to \(1.3 \times 10^{13}\) protons per second, or 1.63 times the nominal CNGS value of \(0.8 \times 10^{13}\) protons per second. However, because of the 0.6 s injection flat porch in the PS, the availability of the PS for other users is reduced by \(\sim 10\%\). The total cost of this solution is estimated at approximately 4 MCHF.

The operating mode of the PS complex is more complicated and pushes the PSB and the PS further to their limits with no operational margin.

3. Summary

Table 1 summarises the arguments developed in the first two paragraphs. Reaching these gain values requires improvements in all the accelerator chain. It is clear that the benefits will be faster achieved for the PSB and PS than for the SPS-CNGS users.

<table>
<thead>
<tr>
<th>Scheme 1: 120 MeV linac</th>
<th>Gain for ISOLDE</th>
<th>Gain for SPS-CNGS</th>
<th>Comments</th>
<th>(\sim) Cost (MCHF)</th>
</tr>
</thead>
<tbody>
<tr>
<td>~ 2</td>
<td>1.8</td>
<td>• Increased operational margin and flexibility (“easy” generation of the ultimate beam brightness for LHC, potential for exploring schemes to upgrade LHC performance, reduced LHC filling time)</td>
<td>~ 70</td>
<td></td>
</tr>
<tr>
<td>Scheme 2: doubled PSB rate</td>
<td>2</td>
<td>1.6</td>
<td>• Increased complexity • PS and PSB pushed to their limits • Reduced (0.9) availability of the PS for other users</td>
<td>~ 4</td>
</tr>
<tr>
<td>Combined schemes</td>
<td>~ 4</td>
<td>1.8*</td>
<td></td>
<td>~ 70</td>
</tr>
</tbody>
</table>

* Because of the saturation of the PS and SPS, no further gain is expected for SPS-CNGS by combining both schemes.

REFERENCES
[1] Increasing the Proton Intensity of PS and SPS, R. Cappi (editor), CERN/PS 2001-041