SLC Upgrades

by Nan Phinney
PROPOSED SLC UPGRADES
FOR
LUMINOSITY & RELIABILITY

N. PHINNEY

SLD Collaboration Meeting

September 16, 1998
## Appendix A  Luminosity Improvements

<table>
<thead>
<tr>
<th></th>
<th>1998 parameters</th>
<th>Final Focus improvements only</th>
<th>Emittance improvements only</th>
<th>2000 parameters (All upgrades)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>I</strong></td>
<td>4.0 (10^{10})</td>
<td>4.0 (10^{10})</td>
<td>4.0 (10^{10})</td>
<td>4.0 (10^{10})</td>
</tr>
<tr>
<td>(\varepsilon^\text{FF}_x) ((10^{-5} \text{ m-rad}))</td>
<td>5.5</td>
<td>5.5</td>
<td>4.5</td>
<td>4.5</td>
</tr>
<tr>
<td>(\varepsilon^\text{FF}_y) ((10^{-5} \text{ m-rad}))</td>
<td>0.9</td>
<td>0.9</td>
<td>0.7</td>
<td>0.7</td>
</tr>
<tr>
<td>(\theta^*_x) ((\mu\text{rad}))</td>
<td>470</td>
<td>600</td>
<td>470</td>
<td>560</td>
</tr>
<tr>
<td>(\theta^*_y) ((\mu\text{rad}))</td>
<td>240</td>
<td>280</td>
<td>240</td>
<td>260</td>
</tr>
<tr>
<td>(\sigma^\text{IP}_x) ((\mu\text{m}))</td>
<td>1.5</td>
<td>1.1</td>
<td>1.3</td>
<td>1.0</td>
</tr>
<tr>
<td>(\sigma^\text{IP}_y) ((\mu\text{m}))</td>
<td>0.65</td>
<td>0.50</td>
<td>0.55</td>
<td>0.40</td>
</tr>
<tr>
<td>(Z_n) ((Z/\text{hr}))</td>
<td>10</td>
<td>18</td>
<td>15</td>
<td>26</td>
</tr>
<tr>
<td>(H_d)</td>
<td>1.9</td>
<td>2.2</td>
<td>2.3</td>
<td>2.4</td>
</tr>
<tr>
<td><strong>Luminosity</strong> ((Z/\text{hr}))</td>
<td>300</td>
<td>630</td>
<td>550</td>
<td>1000</td>
</tr>
<tr>
<td>((\text{cm}^{-2}\text{sec}^{-1}))</td>
<td>(2.8 \times 10^{30})</td>
<td>(5.8 \times 10^{30})</td>
<td>(5.1 \times 10^{30})</td>
<td>(9.3 \times 10^{30})</td>
</tr>
</tbody>
</table>

September 14, 1998
Appendix B - Luminosity Upgrades
(preliminary, detailed costs estimates not available)

<table>
<thead>
<tr>
<th>Description</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Decreased L* - move triplets closer to IP</td>
<td>~$50K</td>
</tr>
<tr>
<td>Fast feedforward Linac -&gt; IP</td>
<td>~$100K</td>
</tr>
<tr>
<td>Additional CCS bends to soften bend radius</td>
<td>50K</td>
</tr>
<tr>
<td>Additional power supplies for RTLs, SLTR tuning</td>
<td>40K</td>
</tr>
<tr>
<td>DR RF frequency ramp to lower emittance</td>
<td>20K</td>
</tr>
<tr>
<td>Higher polarization cathodes (also NLC)</td>
<td>20K</td>
</tr>
<tr>
<td>Feedback system upgrades</td>
<td>20K</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>&lt;$500K</strong></td>
</tr>
</tbody>
</table>
1998 FF OPTICS

PRESENT FF

NFF12: Inbound e− (06-OCT-1997) θ ≈ 50° θ ≈ 220° = θ_{2}
SLD2000 OPTICS
with TRIPLET FORWARD 70 cm.

NFF12: Inbound e− (06−OCT−1997)

SAME DIVERGENCES
θx = 500μrad
θy = 120μrad

ABOUT 15% MORE CLEARANCE IN X
20% MORE CLEARANCE IN Y

† SHORTER LEVER ARM FOR SYNCHRO RADIATION FROM TRIPLET
SLD2000 OPTICS
with TRIPLET REVERSED
(for T. Usher)

NFF12: Inbound e− (06–OCT–1997) 2.5 FEET CLOSER TO IP

TRIPLE REV Q 10% STRONGER

SAME UPGRADE BUT TRIPLET REVERSED

25% GAIN IN #
10% GAIN IN "$"

% CDC occ per INC. Ï

CDC occupancy per INC. Ï

Induce SR background

SR directly incident on M4 or M5 is BAD!

Distance Along Beam Line, Z [m]

large SR background must come

on Stan Hurtubash's SR
Current Configuration

NFF13 Standard Beam
Current Configuration

NFF13 Standard Beam

SR YS, standard beam, Y's stopping on...
Current Configuration

NFF13 Background Beam

SR 8's for large emittance (9x standard), large ΔE (1%) beam
Triplets Mapped

NFF16 Standard Beam

SR Y's for core of standard beam
Triplets Moved
NFF16 Standard Beam

SN's, standard beam, y's stopping on
Triplets Mouse

NFF16 Background Beam

SR 8's for large emittance (9x standard), large AE (10%) beam
Comparison of Current vs. Triplets Moved

<table>
<thead>
<tr>
<th>Aperture</th>
<th>Current</th>
<th>Triplets Moved</th>
<th>Improvement</th>
</tr>
</thead>
<tbody>
<tr>
<td>M2 North</td>
<td>138</td>
<td>92</td>
<td>1.5 x</td>
</tr>
<tr>
<td>M5 North</td>
<td>10</td>
<td>0</td>
<td>* (large)</td>
</tr>
<tr>
<td>M5 South</td>
<td>75</td>
<td>15</td>
<td>* 5 x</td>
</tr>
<tr>
<td>M2 South</td>
<td>4000</td>
<td>1300</td>
<td>3 x</td>
</tr>
</tbody>
</table>

- Biggest again in y plane
- > 5 improvement in critical M4/M5 region
- x-plane dominated by off-energy particles — perhaps can find way to fix this upstream
IP Position Jitter (May 1998)

SINGLE BEAMS IP-POSITION JITTERS

E- IP X position Jitter rms
IPBM, FB69, 1, DEAD, #1

E- IP Y position Jitter rms
IPBM, FB69, 1, DEAD, #2

E+ IP X position Jitter rms
IPBM, FB69, 2, DEAD, #1

E+ IP Y position Jitter rms
IPBM, FB69, 2, DEAD, #2

14-SEP-98 14:13:28
IP Position Jitter

SINGLE BEAMS IP-POSITION JITTERS
E- IP X position Jitter rms
IPBM, FB69, 1, DEAD, #1

e^- x
0.4/0.6 = 25%

E- IP Y position Jitter rms
IPBM, FB69, 1, DEAD, #2

e^- y
0.25/0.6 = 40%

E+ IP X position Jitter rms
IPBM, FB69, 2, DEAD, #1

e^+ x
25%

E+ IP Y position Jitter rms
IPBM, FB69, 2, DEAD, #2

e^+ y
0.15/0.6 = 25%

14-SEP-98 14:11:45
IP ANGLE JITTER

(MAY 1998)

SINGLE BEAMS IP-ANGLES JITTERS

\[
\begin{align*}
\text{E- IP X angle jitter rms} & \quad \text{IPBM, FB69, 1, DEAD, #3} \\
\text{E- IP Y angle jitter rms} & \quad \text{IPBM, FB69, 1, DEAD, #4}
\end{align*}
\]

\[
\begin{align*}
\text{E+ IP X angle jitter rms} & \quad \text{IPBM, FB69, 2, DEAD, #3} \\
\text{E+ IP Y angle jitter rms} & \quad \text{IPBM, FB69, 2, DEAD, #4}
\end{align*}
\]

IP ANGLE JITTER

SINGLE BEAMS IP-ANGLES JITTERS

E- IP X angle jitter rms
IPBM, FB69, 1, DEAD, #3

E- IP Y angle jitter rms
IPBM, FB69, 1, DEAD, #4

E+ IP X angle jitter rms
IPBM, FB69, 2, DEAD, #3

E+ IP Y angle jitter rms
IPBM, FB69, 2, DEAD, #4

14-SEP-98 14:12:26

\( e^\pm X \) 120/470 = 25\%

\( e^\pm Y \) 120/240 = 50\%

\( e^\pm X \) 150/470 = 20\%

\( e^\pm Y \) 80/240 = 33\%

\Rightarrow \text{INCREASES BEAM SIZE and EFFECTIVE DIVERGENCE}
LUMINOSITY LOSS DUE TO POSITION JITTER

Jitter Lum Corr HISTORY

IPBM FB69 1 LCOR

INTERVAL: 240
MEAN: .0609076
SIGMA: .0240413
MIN: 0.000000
MAX: .2828479
MAX-MIN: .2828479
14-SEP-98 14:02:42

~ CONSTANT OVER RUN

6%
IP SEPARATION JITTER, \( e^+e^- \) CORRELATION

BEAM-BEAM IP-SEPARATION JITTERS & CORRELATION
IP X Beam-Beam Separation Jitter rms
IPBM, FB69, 1, DEAD, #5

\[ x \times 0.6/1.6 = 30\% \]

IP X Beam-Beam jitter Correlation
IPBM, FB69, 1, DEAD, #6

\[ x \times \text{uncorrelated} \]

IP Y Beam-Beam Separation Jitter rms
IPBM, FB69, 2, DEAD, #5

\[ y \times 0.28/0.55 = 50\% \]

IP Y Beam-Beam jitter Correlation
IPBM, FB69, 2, DEAD, #6

IP SEPARATION RESOLUTION

BEAM-BEAM IP-SEPARATION RESOLUTIONS

IP X Beam-Beam Separation Resolution
IPBM, FB69, 1, DEAD, #7

IP X Theor-Measr Separation Correlation
IPBM, FB69, 1, DEAD, #8

Predicted - Measured
80-90% correlation

### Appendix C - Reliability Upgrades

*(preliminary, detailed costs estimates not available)*

<table>
<thead>
<tr>
<th>Description</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Source Laser</td>
<td>$150K</td>
</tr>
<tr>
<td>Arc vacuum chambers, pumps, valves</td>
<td>90K</td>
</tr>
<tr>
<td>Arc tunnel maintenance</td>
<td>20K</td>
</tr>
<tr>
<td>FF Plug doors, controls and mechanical</td>
<td>40K</td>
</tr>
<tr>
<td>FF Septum coils and CCS quad refurbishment + spares</td>
<td>90K</td>
</tr>
<tr>
<td>FF kicker power supply redesign</td>
<td>50K</td>
</tr>
<tr>
<td>Misc. maintenance due to SLC requirements</td>
<td>35K</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>~$500K</td>
</tr>
</tbody>
</table>

**OTHERS?**

- BSY WATER DISTRIBUTION
- MCC CONTROL ROOM MODS
- **DR & e+ SOURCE REFURBISHMENT** *(MOVE EARLIER)*

14 September 14, [ ]
8.3 Positron Dump Line

Final Focus

DUMP: FF11, 9990

Dump
PPS enclosure

PROF: FF11,9980

BPM: FF11,9900

TORO: FF11, 9785

TORO: FF11, 9780

Wizard vacuum chamber

COLL: FF11, 9720

BEND: FF11, 8750

BEND: FF11, 8650

BEND: FF11, 8550

BPM: FF11,8530

QUAD: FF11, 8450

XCOR: FF11, 8390

YCOR: FF11, 8380

BPM: FF11,8360

QUAD: F001, 8350

BPM: FF11,8260

QUAD : FF11,8250

YCOR: FF11, 8080

e- from north arc

5 SEPTA
All DIFFERENT HARD TO REPLACE

Septum
(Septa 2, 4, 6, 8, 9)

SMPS: FF11,8052,8054,8059 (Trims)

BPMS: FF11,8010

PROF: FF11,8005

e+ from IP

July 21, 1995

SLAC-I-040-20200-001

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# PEP-II / SLD Efficiency

## Mutual Efficiency for PEP-II with SLC/SLD in FY2000

<table>
<thead>
<tr>
<th></th>
<th>PEP-II only (hours/week)</th>
<th>SLC/SLD only (hours/week)</th>
<th>PEP-II with SLC/SLD (hours/week)</th>
<th>SLC/SLD with PEP-II (hours/week)</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Collisions for particle physics</td>
<td>91.2</td>
<td>100.0</td>
<td>78.8</td>
<td>73.9</td>
<td>12 min fill + 1.5 hrs collisions</td>
</tr>
<tr>
<td>PEP-II Injection</td>
<td>11.8</td>
<td>0.0</td>
<td>10.2</td>
<td>5.1</td>
<td>13% of PEP-II collision time</td>
</tr>
<tr>
<td>PEP-II accel studies-tuning</td>
<td>3.6</td>
<td>0.0</td>
<td>3.6</td>
<td>12</td>
<td>2 hours/day + 24 hours</td>
</tr>
<tr>
<td>SLC/SLD accel studies-tuning</td>
<td>0.0</td>
<td>24</td>
<td>1.0</td>
<td>24</td>
<td>4% of SLC collisions from PEP-II</td>
</tr>
<tr>
<td>Ineff. due to keep alive inj beam</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>3.0</td>
<td>4% of SLC collisions from PEP-II</td>
</tr>
<tr>
<td>Scheduled down</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>One repair shift per 2 weeks</td>
</tr>
<tr>
<td>Unscheduled down</td>
<td>15</td>
<td>20</td>
<td>15</td>
<td>20</td>
<td>W/o interference to other program</td>
</tr>
<tr>
<td>Unscheduled down</td>
<td>0</td>
<td>10</td>
<td>13</td>
<td>16</td>
<td>Interfering with other program</td>
</tr>
<tr>
<td>Unscheduled down</td>
<td>10</td>
<td>10</td>
<td></td>
<td></td>
<td>For both programs equally</td>
</tr>
<tr>
<td>Total hours</td>
<td>168.0</td>
<td>168.0</td>
<td>168.0</td>
<td>168.0</td>
<td>One week = 168 hours</td>
</tr>
<tr>
<td>Downtime fraction</td>
<td>0.17</td>
<td>0.26</td>
<td>0.25</td>
<td>0.30</td>
<td>SLC/SLD loses 27% to PEP-II</td>
</tr>
<tr>
<td>Collision fraction</td>
<td>0.54</td>
<td>0.60</td>
<td>0.47</td>
<td>0.44</td>
<td>PEP-II loses 13% to SLC/SLD</td>
</tr>
</tbody>
</table>

Presented by J. Seeman
To EPAC 9/2/98
# PEP-II / SLD Efficiency

## Mutual Efficiency for PEP-II and SLC/SLD in FY2000

<table>
<thead>
<tr>
<th></th>
<th>PEP-II only</th>
<th>SLC only</th>
<th>PEP-II with SLC</th>
<th>SLC with PEP-II</th>
</tr>
</thead>
<tbody>
<tr>
<td>Collisions for physics</td>
<td>100.1</td>
<td>100.0</td>
<td>95.1</td>
<td>87.0</td>
</tr>
<tr>
<td>PEP-II injection</td>
<td>14.9</td>
<td>0</td>
<td>14.4</td>
<td>4.2</td>
</tr>
<tr>
<td>PEP-II accel studies/tuning</td>
<td>24</td>
<td>0</td>
<td>24</td>
<td>8</td>
</tr>
<tr>
<td>SLC accel studies/tuning</td>
<td>0</td>
<td>30</td>
<td>1.5</td>
<td>30</td>
</tr>
<tr>
<td>Ineff. due to keep alive beam</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.8</td>
</tr>
<tr>
<td>Scheduled down</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Unscheduled down (1 program)</td>
<td>15</td>
<td>20</td>
<td>15</td>
<td>20</td>
</tr>
<tr>
<td>Unscheduled down (both)</td>
<td>10</td>
<td>14</td>
<td>14</td>
<td>14</td>
</tr>
<tr>
<td>Total down</td>
<td>29</td>
<td>38</td>
<td>33</td>
<td>38</td>
</tr>
<tr>
<td>Total hours</td>
<td>168</td>
<td>168</td>
<td>168</td>
<td>168</td>
</tr>
<tr>
<td>Downtime</td>
<td>17%</td>
<td>23%</td>
<td>20%</td>
<td>23%</td>
</tr>
<tr>
<td>Collisions</td>
<td>60%</td>
<td>60%</td>
<td>57%</td>
<td>52%</td>
</tr>
<tr>
<td>Ratio</td>
<td></td>
<td></td>
<td><strong>95%</strong></td>
<td><strong>87%</strong></td>
</tr>
</tbody>
</table>

*Assume 1/4 Hz*

*No interference*