SLC Performance and Future Potential

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- Present Performances
- Luminosity Expectations for the next 100 days
- Possible Upgrades for a 1999 Run
IN THE 1987 RUN SEVERAL GOALS HAVE BEEN ACHIEVED:

- DEEPER UNDERSTANDING OF THE SEVERAL SLC SUBSYSTEMS
- BETTER TUNING METHODS
- SOLID, ANALYTIC PROCEDURE TO REACH HIGH PERFORMANCES

- 10000 z/week "ROUTINE"
- 3000 z/day PEAK \[ \frac{1}{2} \text{ SLC "DESIGN" } \]
- 200 z/h PEAK \{ LUMINOSITY \}
LUMINOSITY SUMMARY

E- TMIT (Xscan)
IPBM, FB69, 1.TMTX

COUNT
300
200
100
0

0 10 20 30 40 10^3

E+ TMIT (Xscan)
IPBM, FB69, 2.TMTX

COUNT
140
120
100
80
60
40
20
0

0 10 20 30 40 10^3

Z's per Hour
IPBM, FB69, 1.ZPHR

COUNT
50
40
30
20
10
0

0 100 200 300 400

Normalized Z's per 10**10
IPBM, FB69, 2.ZPHR

COUNT
60
40
20
0

0 2 4 6 8 10 12 14

Run

Number:
State:
Trigger:
Started:
Ended:

Events logged:
not logged:

Last pause:
Last continue:

Time running:
paused:

Event size:
Event rate:

SLC

Luminosity:
intensity:
intensity:

Polarization:
-- 1.4%

While: SLD Running

Found:
Eff.: 1.0:
Eff.: 3.8:

Compared with the SLC Eff. luminosity
MAIN ACCOMPLISHMENTS:

- DAMPING RINGS
  - STEADILY MAINTAINED "TOP PERFORMANCES"
    EMITTANCES
- RING TO LINAC TRANSFER LINES
  - LESS BEAM LOSSES
  - BUNCH PRECOMPRESSION
  - DIFFERENT OPTIC
- CONSTANT EMITTANCE TUNING
- LINAC
  - BETTER CONTROL OF THE ENERGY PROFILE
  - BETTER STEERING ALGORITHM
  - BETTER TUNING STRATEGY
  - LESS JITTER
- ARCS
  - "STAY CLEAR" OPTIMIZATION
  - MORE CAREFUL OPTIMIZATION OF THE EMITTANCE GROWTH
  - CONSTANT MONITORING OF THE ARC PROPERTIES
- FINAL FOCUS
  - EMITTANCES CONSTANTLY OPTIMIZED AT THE ENTRANCE OF THE FINAL FOCUS
- NEW OPTICS \{ \text{smaller X spot sizes} \}
  \{ \text{lower background} \}
- NEW TUNING METHODS \{ \text{"LINDA" Dithering} \}
  \{ \text{dispersion matching} \}

- BACKGROUND
- THEORETICAL UNDERSTANDING
- BETTER TUNING
MAIN PROBLEMS STILL THERE . . .

- RELIABILITY
  BIGGEST OFFENDERS
  - NORTH DAMPING RING RF SYSTEM =>
    LONG DOWNS
    LOW CURRENT
  - MAGNET FAILURES ESPECIALLY IN THE
    FINAL FOCUS (E.G. SEPTA MAGNETS)
  - VACUUM FAILURES
  - CONTROLS

SLC IS AGING
- Positron Yield
  - Average ~ 90% (in the past we have had 100%)
- Positron system not fully understood
- Ring to linac transport lines
  - Still about 25% horizontal emittance growth for both beams
    (we think related to wakefields)
  - Tuning not optimal
- Background
  Although the big improvements in the background optimization, it is
  still the limiting factor for the optimal setup for the luminosity
  (limiting the horizontal spot size)
WHAT TO WE PLAN FOR THE REST OF THE RUN

- ATTACK SOME OF THE PROBLEMS

RELIABILITY

WE CONSTANTLY MONITOR ALL THE SYSTEMS AND TAKE IMMEDIATE ACTION AT THE FIRST HINT OF FAILURES.

HOWEVER WE DO NOT EXPECT A BETTER UPTIME FOR THE REST OF THE RUN.

POSITRON YIELD

- A TASK FORCE IS WORKING TO COME UP WITH MORE WAYS TO IMPROVE THE POSITRON THROUGH

- IN DECEMBER, DUE TO HARDWARE PROBLEMS, WE COULDN'T GET THE FULL BENEFITS OF THE "BUNCH RENCOMPRESS" IN THE SOUTH RING.

THERE IS A POTENTIAL 7% GAIN IN PYIELD HIDDEN THERE
Several measurements seem to indicate that the 25% horizontal emittance dilution is due to wakefields in the near future we plan to shield the bellows in the beam line to significantly reduce the impedance of the system background.

We have just implemented a new optic in the final focus that has a potential better background. In the next few weeks we will evaluate the impact.

New toys in the final focus.

We are almost ready to install 2 octupoles to decrease the aberrations in the vertical plane. There is a potential 30% increase in the luminosity.
NFF13 Triplet Reversed, 1% Energy Spread, 9 x emittance

Diagram showing the behavior of particles in a triplet at different positions along the Z-axis, with marked energy spread and emittance parameters.
Normalized Luminosity

\begin{align*}
\text{Normalized luminosity [Z/h]} & \\
\text{Y-divergence [urad]} & \\
\end{align*}

- **EXPECTED LUMINOSITY**

  **WITH OCTUPOLES ONLY UPGRADE**
PERMANENT OCTUPOLE
X/Y ADJUST SUPPORT STAND
SLC FF NORTH/SOUTH
CURRENTS

- Given some long stretch of good running condition, we could "adiabatically" increase the beam current.

Unfortunately the amount of beam that is deposited on the machine components increase exponentially, limiting the life time of the system.

$4.2 \times 10^{10}$ $\mu$ at the IP is probably the upper limit for this year.

The biggest gain is in the yield especially considering that the disruption enhancement benefits from even beam intensities.
Potential gains in the luminosity:

- Less emittance growth in RTIs +15%
- Positron yield +15%
- FF octupoles +25%
- Improved background +10%

Total 65%

We should reasonably expect a 30% improvement in the machine peak performances so we hope to have:

- 13,000 ε/week "routine"
- 20,000 ε/week "peak"

5,000 ε/day peak \( \frac{1}{2} \) SLC "design" luminosity

300 ε/h peak

Moreover we should expect about 65 good days [about 2,000 ε/day]

Bringing the total number of εs for the 1997/8 run somewhere between 250,000 \( \rightarrow \) 300,000
LOOKING FOR A 1993 RUN

WE ARE ACTIVELY STUDYING SEVERAL SOLUTIONS TO IMPROVE THE MACHINE PERFORMANCES IN AN EVENTUAL NEXT RUN. THERE ARE TWO MAIN TOPICS:

- RELIABILITY

  EACH DOWN A BIG EFFORT IS DEVOTED TO IDENTIFY ALL THE POSSIBLE SOURCES OF FAILURES AND DO PREVENTIVE WORK (WE HAVE ALREADY A LIST OF COMPONENTS THAT SHOULD BE REFURBISHED).

  HOWEVER WE CANNOT EXPECT BETTER UPTIME THAN THIS RUN....

- UPGRADES

  THERE IS STILL ROOM FOR IMPROVING THE LUMINOSITY, EVEN ON A LOW COST/SHORT TIME BASIS.
DAMPING RINGS:

- THE HORIZONTAL EMITTANCE CAN DECREASE ABOUT 25% BY CHANGING THE RF FREQUENCY (100 kHz) IN THE MIDDLE OF THE STORE

FEASIBILITY STUDY IN PROGRESS

- THERE IS ABOUT 5-10% EMITTANCE DILUTION AT THE EXTRACTION

WE ARE STUDYING THE POSSIBILITY OF ADDING AN ADDITIONAL EXTRACTION KICKER OR A "SLOW KICK" SCHEME

RING TO LINAC

- INDEPENDENT POWER SUPPLIES FOR BETTER OPTICS ⇒ 5% MORE THRU PUT

LINAC

- NEW FEEDBACK ALGORITHMS TO IMPROVE THE ORBIT STABILITY
LINAC TO FINAL FOCUS:

FEED FORWARD FROM THE END OF THE LINAC TO THE FINAL FOCUS - FINAL TRANSFORMER TO CANCEL THE BEAM SITTER ON A SHOT BY SHOT BASIS =>

- 15% "EFFECTIVE" EMITTANCE REDUCTION IN BOTH PLANES

- MUCH FEWER "CDC FLIERS"

A FEASIBILITY STUDY HAS BEEN MADE ALREADY IN 1992....

FINAL FOCUS:

- PROVIDE THE SEXTUPOLES WITH MOVERS => BETTER TUNING & LESS ABERRATIONS

WE ARE STUDYING THE POSSIBILITY OF SAVAGING THE FFTB ONES

- ADD MORE BENDS IN THE CHROMATIC CORRECTION SECTION (CCS) TO DECREASE THE SPOT SIZE DILUTION DUE TO SYNCHROTRON RADIATION => 20% MORE LUMINOSITY

WE HAVE ALREADY BENDS & POWER SUPPLIES
Move the detectors 0.5 meters closer to the IP, removing BPM1 & the luminosity monitor.

Redesign the "M2" mask →
30% more luminosity and/or
2-4 times less background

Studies are in progress.
NFF16 1% Triplet Reversed, Energy Spread, 9 x emittance
Potentially luminosity gains:

- Damping ring RF ramp: +20%
- Double DR extrac. kicker: +5%
- Better RTL optic: +5%
- Jitter feed forward: +15%
- More bends in final focus: +20%
- Triplets closer to IP: +30%
- Better tuning: +10%

Total: 105%

More disruption: \( \times 1.5 \)

Total: 160%

There is a potential for about 700 \( \Xi / \text{sec} \) -
again we should reasonably expect to achieve peaks of about 500 \( \Xi / \text{sec} \) and probably about 25000 \( \Xi / \text{week} \) "routine".

If the upgrade list is fully implemented
2) Present ADS Summary - March 30

\begin{align*}
\text{e}^- \text{ CURRENT} & \quad 4.0 \times 10^{10} \\
\text{e}^+ \text{ CURRENT} & \quad 3.7 \times 10^{10} \\
\Sigma_x & \quad 2.2 \mu\text{m} \\
\Sigma_y & \quad 1.1 \mu\text{m} \\
\phi \text{ NORMALIZED} & \quad 8 \text{ Z/h} \\
H_0 & \quad 65 \% \\
\text{LUMINOSITY} & \quad 180 \text{ Z/h}
\end{align*}

b) Potential with RTL Bellows Shield & FF Octopoles

\begin{align*}
\Sigma_x & \quad 2.0 \mu\text{m} \\
\Sigma_y & \quad 0.9 \mu\text{m} \\
\phi \text{ NORMALIZED} & \quad 12 \text{ Z/h} \\
H_0 & \quad 90 \% \\
\text{LUMINOSITY} & \quad 300 \text{ Z/h}
\end{align*}

c) Possible Targets for a 1984 Run if All the Upgrades are Implemented

\begin{align*}
\Sigma_x & \quad 1.6 \mu\text{m} \\
\Sigma_y & \quad 0.7 \mu\text{m} \\
\phi \text{ NORMALIZED} & \quad 18 \text{ Z/h} \\
H_0 & \quad 110 \% \\
\text{LUMINOSITY} & \quad 600 \text{ Z/h}
\end{align*}

\begin{align*}
\text{"THEORETICAL"} \\
1.4 \mu\text{m} \\
0.55 \mu\text{m} \\
26 \text{ Z/h} \\
130 \% \\
1000 \text{ Z/h}
\end{align*}

\[140 \times 200\]