Radiation Issues for NLC Injector LINAC to Damping Ring Transport Line (draft)

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April, 1998
Beam Parameters

Allowed beam power: \[ 500 \text{ GeV} - 10 \text{ MW} \]

2 GeV, 40 kW \( (1 \times 10^{12} \text{ e} / \text{pulse}) \) \( \text{ @ } 120 \text{ pps} \)

maximum credible beam power:

SLC D.R.: 1.19 GeV, \( \sim 1 \text{ kW} \) \( (4 \times 10^{10} \text{ e} / \text{pulse}) \) \( \text{ @ } 120 \text{ pps} \)

Beam losses:

1W/m continuous loss

maximum point loss: 10W

\( 1 \text{W/m} \times 100 \text{m} = 100 \text{W} \)

SLC D.R. \( \sim 1.5 \) \% of 1 kW

\( \text{Draft 2} \)
Personnel Protection System ;}
3PPS Stoppers  Stopper ST1  two Protection Ion
(stoppers like PEP-II  Stopper ST2  two Protection Ion
NIT/SIT last  Stopper ST3  two Protection Ion
PPS Stoppers  Chambers trip @100W
14 r.l. ~8”  Chambers trip @100W
power capability  Chambers trip @100W
200W)

3PPS Stoppers required by SLAC policy.
Beam Containment System
Radiation dose level at PPS gate for different running conditions
Normal running conditions

Radiation dose level in the PPS gate inside the beam pipe 1.6 mrem/hr

Outside the beam pipe $\rightarrow 0.0023$ mrem/hr

$N \begin{array}{l} 1.5 \\ 0.1 \end{array}$

$\gamma \begin{array}{l} 0.0018 \\ 0.0005 \end{array}$
Radiation dose level in the PPS gate

~9 mrem/hr

|   | N 7.0 | γ 2.0 |
The WORST scenario of PPS failure
Stopper ST1  ST2  out
Stopper ST3  in
100W  @ ST3

\[
\begin{array}{|c|c|}
\hline
N & 1.1 \\
\hline
\gamma & 6.0 \\
\hline
\end{array}
\]

7.1 rem/hr
= Residual radiation activity

1. 10W lost in a thick target, assuming 5 yrs continuous operation and after 1 hr shut-off

18.5 @ 1 m ~ 150 mrem/hr @ 30 cm for Cu target
10 @ 1 m ~ 110 mrem/hr @ 30 cm for Fe target
55 @ 1 m ~ 610 mrem/hr @ 30 cm for Ni target
6.8 @ 1 m ~ 75 mrem/hr @ 30 cm for Al target
SLC NDR maximum point loss ~ 30 W
40 kW lost in Dumb D1, assuming 5 yrs continuous operation and after 1hr shut-off

~ 0.17 rem/hr/kW @ 2 meters

~ 6.70 rem/hr @ 2 meters for 40 kW

Shield to 10 mrem/hr

\[
\frac{10 \text{ mrem/hr}}{6.7 \text{ rem/hr}} = 1.5 \times 10^{-3}
\]

Need 3’ concrete
Transmission of Dump (Al) Residual Activity through Concrete
Radiation Damage

- If a 10 W beam continuously lost one point, and hits a thick target,

  Gamma dose rate @ 90°, 5 cm away
  
  \[ = 6000 \text{ rad/hr} \]

- If a plastic component located @ 5 cm, 90 away from the beam lose point, using damage threshold \( \sim 10^8 \) rad

  \[ = 1.9 \text{ years lifetime} \]

- If this component located in forward direction to the beam-lose point, the lifetime will be shorter
Radiation Protection Scheme for NLC Electron Injection System (Draft)

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September, 1998
NLC Electron Injection System

Source

cio
dump
pps sys te

200 m

tun up dump

total 1400 m
tunnel 14' = 4.3 m
Damping Ring Area

Beam Parameters

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\( \Theta \, 120 \text{pps} \)

maximum credible beam power:

SLC D.R.: 1.19 GeV, \( \sim 1 \text{ kW} \) \( \left( 4 \times 10^{10} \text{e/pulse} \right) \)

\( \Theta \, 120 \text{ pps} \)

Beam losses: 1W/m continuous loss

maximum point loss: 10W

SLC D.R. \( \sim 1.5\% \) of 1 kW

RTL, LTR

a factor of 60.
Damping Ring Access: ST1 ST2 ST3 ST4 m
gate 1 gate 2 closed
beam to AR dump or other

Access to downstream of gate 3: ST5 ST6 ST7 m
gate 3 closed
beam to AR dump
3PPS Stoppers (stoppers like PEP-II and NIT/SIT last)  
PPS Stoppers  
14 r.l. ~8”  
power capability 200W)  

Stopper ST1  
Stopper ST2  
Stopper ST3  

two Protection Ion Chambers trip @100W  

3PPS Stoppers required by SLAC policy.
Aluminum Dump Shielding

• Beam is on:
  shield electronics  $1 \times 10^6$ rad
  shield soil for tritium issue

• Beam is off:
  shield residual activity
280 kW Water Dump Area
14 GeV
B am line