

Optimizing Source Parameters

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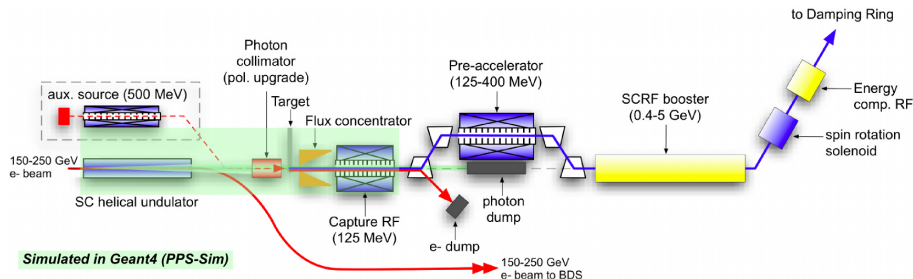


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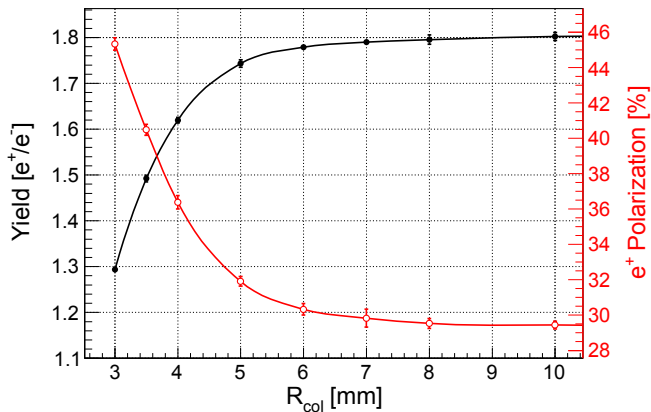
e^+ Source Scheme



Undulator-based source (RDR helical undulator) can be used at 250 GeV center-of-mass energy (more details in [my LCWS13 talk](#))

- 231 m active magnet length of undulator *is required*
- 3.2 T **Flux Concentrator** with 8.5 mm minimal aperture radius *is recommended* (LLNL prototype of FC has 6.5 mm aperture radius)

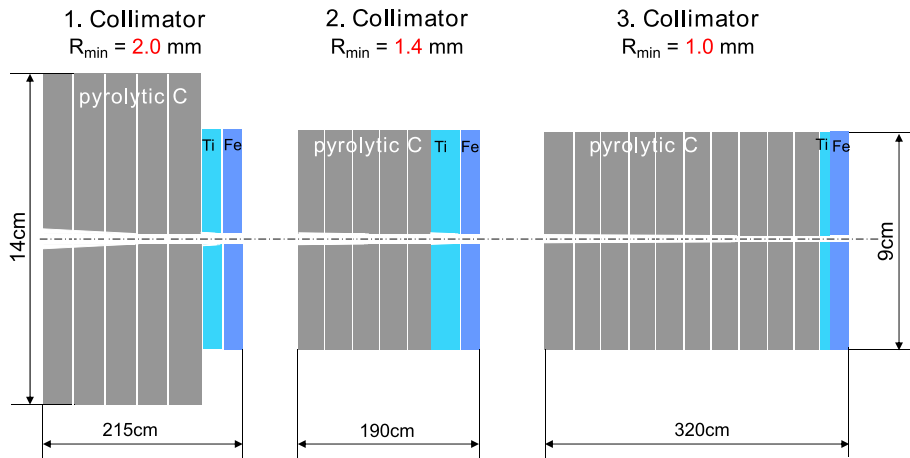
e^+ Polarization at 120 GeV e^-



e^+ polarization of source at 120 GeV e^- :

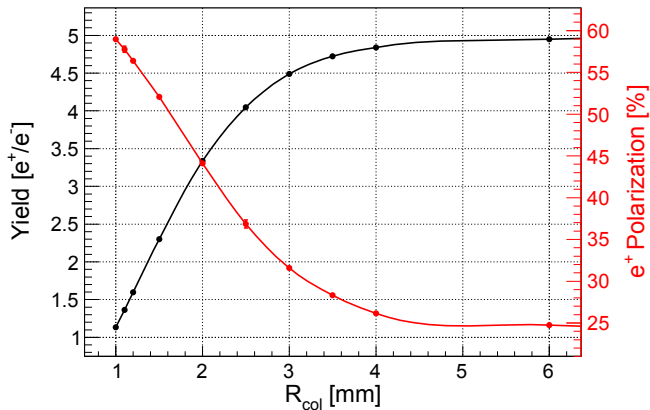
- $P_{e^+} \simeq 40\%$ for $R_{\text{col}} = 3.5$ mm and $L_u = 231$ m, $K = 0.92$
- $P_{e^+} \simeq 31\%$ without collimator and $L_u = 231$ m, $K = 0.84$

Design of Photon Collimator* (DESY Zeuthen)



* ILC Technical Design Report, 2013

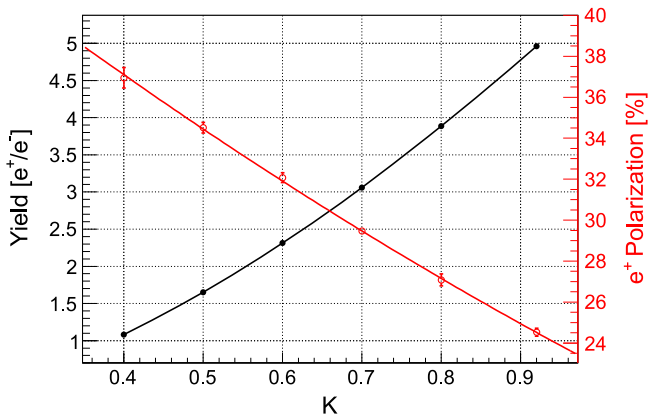
e^+ Polarization with Photon Collimator at 175 GeV e^-



e^+ polarization of source at 175 GeV e^- (with photon collimator):

$$P_{e^+} \simeq \mathbf{56\%} \text{ for } R_{\text{col}} = 1.2 \text{ mm}, L_u = 220 \text{ m}, K = 0.92$$

e^+ Polarization without Photon Collimator at 175 GeV

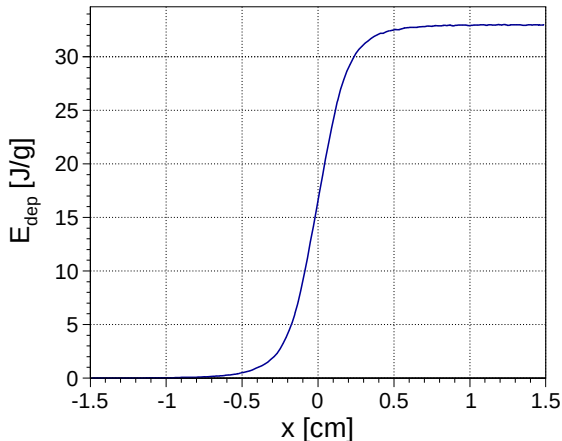


e^+ polarization of source at 175 GeV e^- (without photon collimator):

$$P_{e^+} \simeq \mathbf{35\%} \text{ for } L_u = 231 \text{ m, } K = 0.47$$

Energy Deposition in Target at 175 GeV e^-

70 m undulator with $K = 0.92$, 100 m/s rotating speed, 554 ns bunch spacing



$$\langle E_{ph} \rangle = 14.5 \text{ MeV}$$

$$\langle E_{dep} \rangle = 1 \text{ MeV/ph}$$

1312 bunches/pulse,
5 Hz repetition rate:

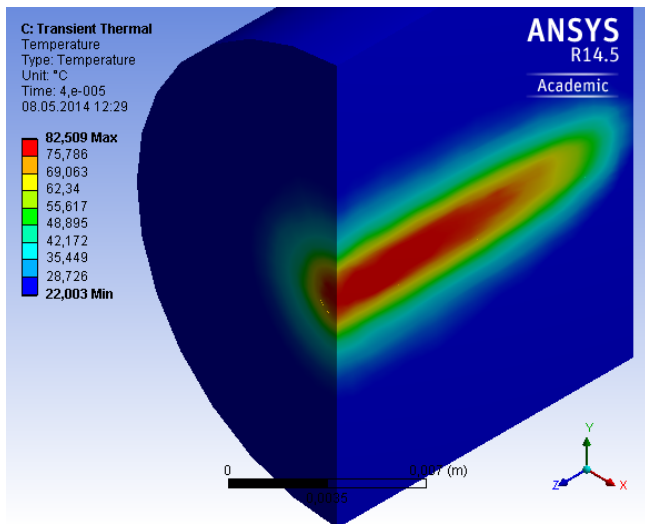
$$\langle P \rangle \approx 3 \text{ kW}$$

per Bunch: PEDD = 0.5 J/g $\Rightarrow \Delta T \approx 1 \text{ K}$

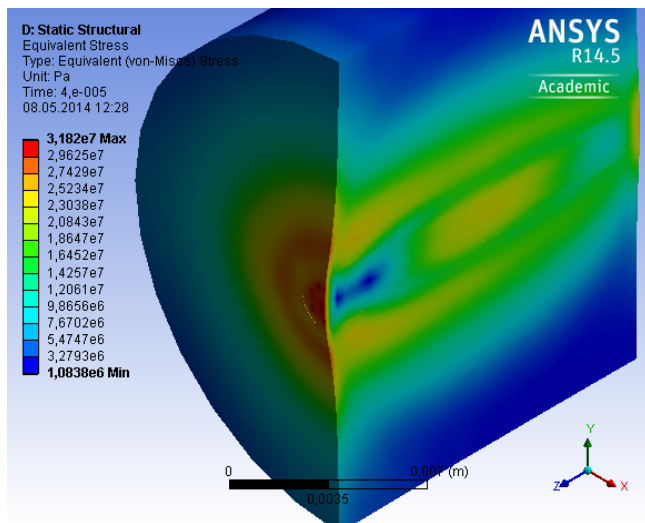
per Pulse: PEDD = 33 J/g $\Rightarrow \Delta T = 63 \text{ K}$

66 bunches/pulse

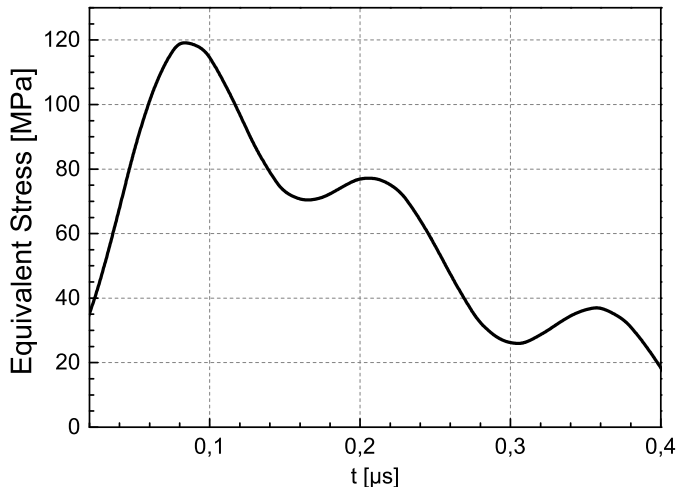
Temperature Distribution after Bunch Train at 175 GeV



Distribution of Quasi-Static Stress at 175 GeV



Time Evolution of Dynamic Stress at 175 GeV



$\sigma_{\max} \approx 120 \text{ MPa}$ on back side of target at beam center

(at 120 GeV e^- $\sigma_{\max} \approx 140 \text{ MPa}$; fatigue strength for Ti6Al4V is 510 MPa)

Summary

- e^+ source at 175 GeV e^- and 231 m active undulator length has much more “freedom” for *polarization upgrade* in comparison to 120 GeV
- e^+ polarization without using photon collimator is **35%** at $K = 0.47$
- Photon collimator with 1.2 mm aperture radius will allow to increase P_{e^+} up to **56%**
- At 175 GeV the maximal dynamic thermal stress in target induced by bunch train is $\approx$ **120 MPa**. It is approx. 4 times less then the fatigue strength.

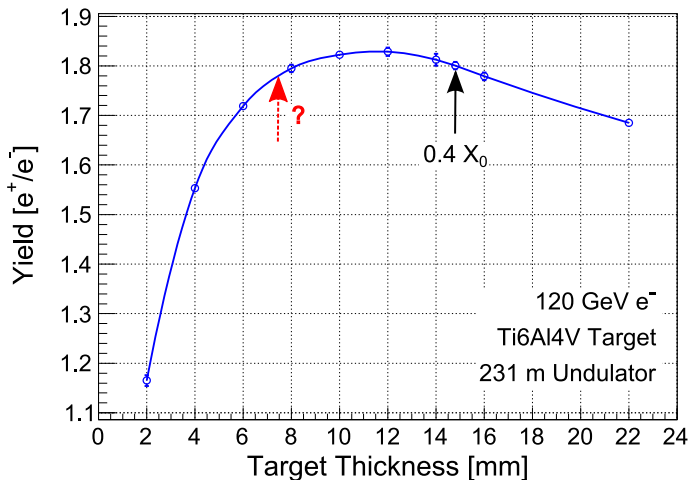
Can rotation speed at 175 GeV be reduced 4 times?

The eddy currents, mechanical stress due to rotation and material properties degradation due to radiation damage have to be studied.

At nominal ILC operation mode (1312 bunches/train, 554 ns bunch spacing): **66 bunches** per pulse are crossing the same target area.

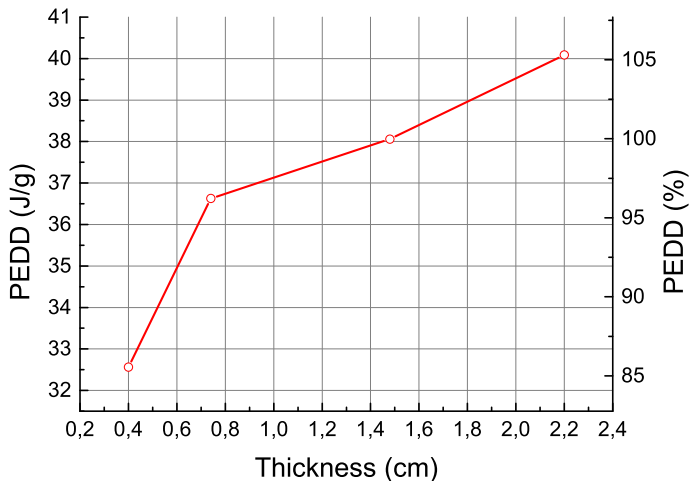
Total average deposited by beam power in target is **3 kW**

Yield vs Target Thickness



Can target be made **2 times thinner**? (P. Sievers)

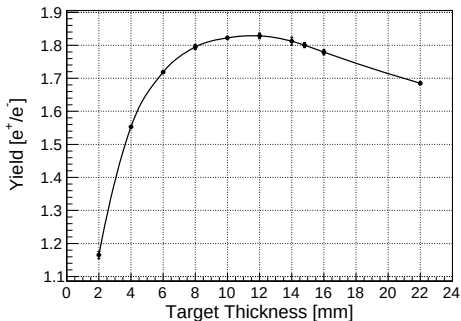
PEDD vs Target Thickness (120 GeV e^-)



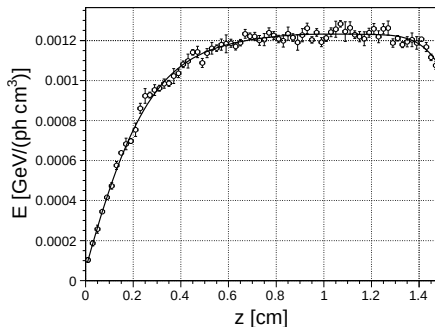
$0.4X_0 \rightarrow 0.2X_0 \Rightarrow -4\% \text{ PEDD}$

Energy Deposition Density on Beam Axis (120 GeV e^-)

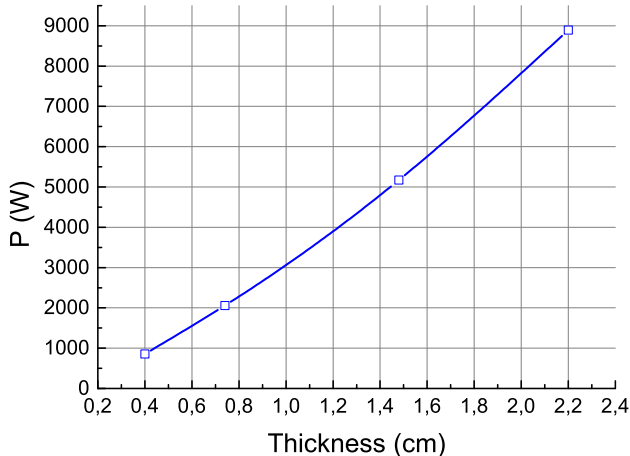
Yield vs Target Thickness



Profile of Energy Deposition Density



Total Average Deposited Power (120 GeV e^-)



$0.4X_0 \rightarrow 0.2X_0 \Rightarrow$ **-60% Total Deposited in Target Energy**

Topic of future study: Can, for example, $0.2X_0$ W25Re target be used without active (water) cooling, just using **radiative cooling** only?