ILC e^+ source modeling up to 1 TeV

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Outline

- Generation of undulator photons in e^+ source with 4.3 cm period NbTi undulator and 500 GeV e^-
  - Photon yield
  - Photon energy
  - Photon spot size on target
- e^+ polarization for source at 500 GeV e^-
  - without photon collimator
  - with photon collimator
- Yield and polarization of 9 mm period, high field Nb3Sn undulator

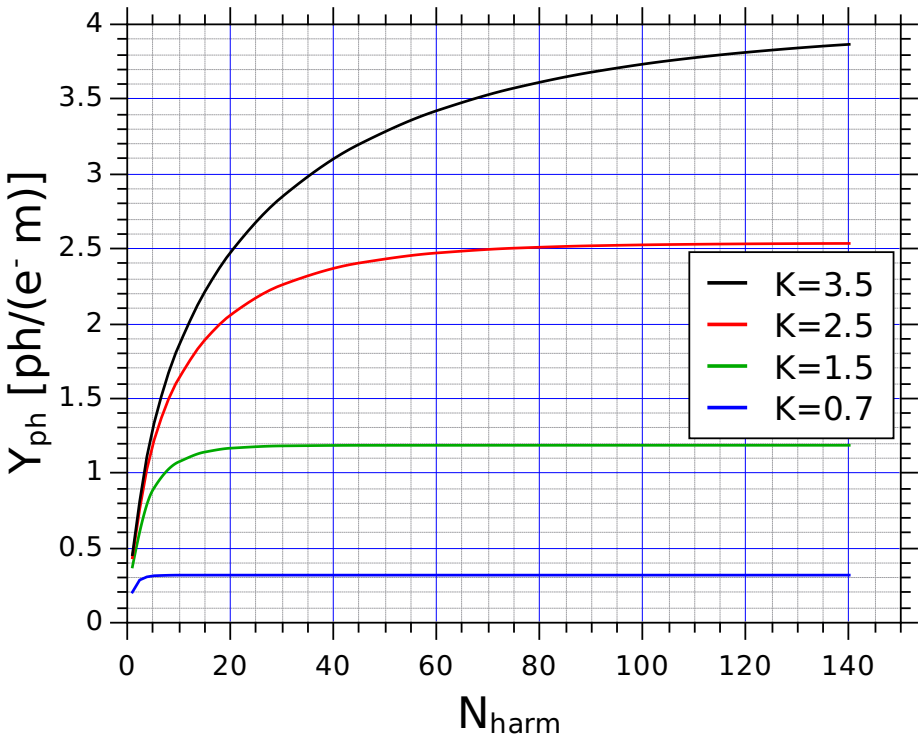
Upgrade of e^+ Source for 1 TeV Center-of-Mass Energy

- NbTi undulator with period of 4.3 cm
- K is varied ($K = 1 \Leftrightarrow$ B-field = 0.25 T)
- Space between the end of undulator and target is 412 m
- Maximal active undulator length is 231 m
- Active length of undulator module is 11 m

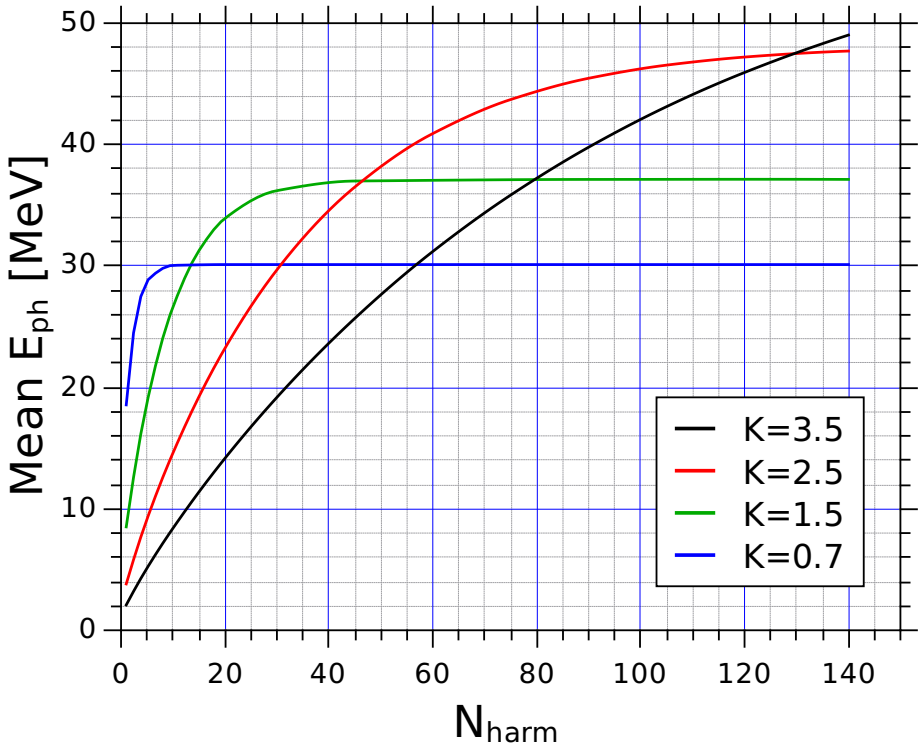
- Ti6Al4V target with thickness of 0.4 X_0
- Pulsed flux concentrator: max. field on axis is 3.2 T
- DR acceptance:
  - long. bunch size $\leq$ 34.6 mm
  - $\epsilon_x + \epsilon_y \leq$ 70 mm rad

Yield and Energy of Undulator Photons vs Number of Harmonics

Photon Yield vs
Number of Harmonics



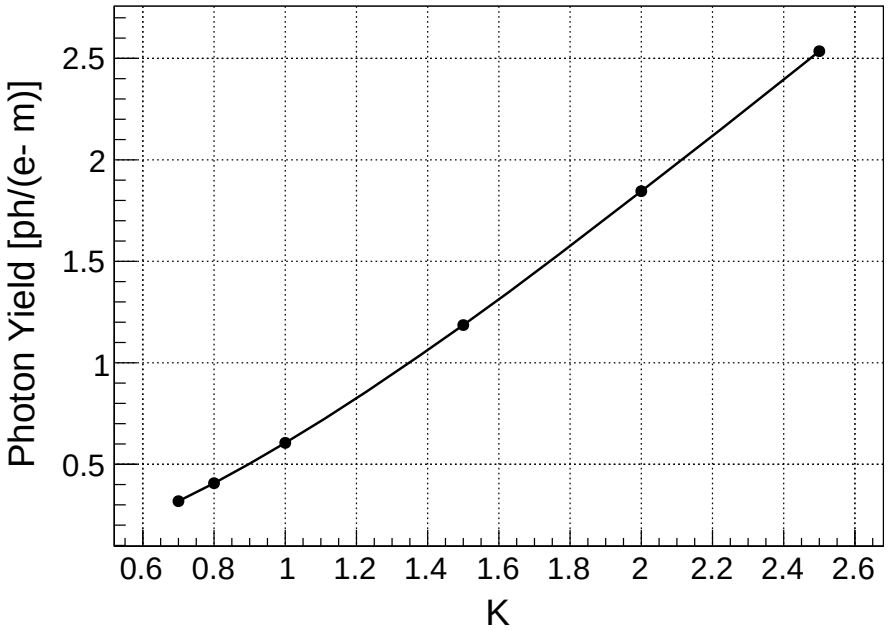
Photon Energy vs
Number of Harmonics



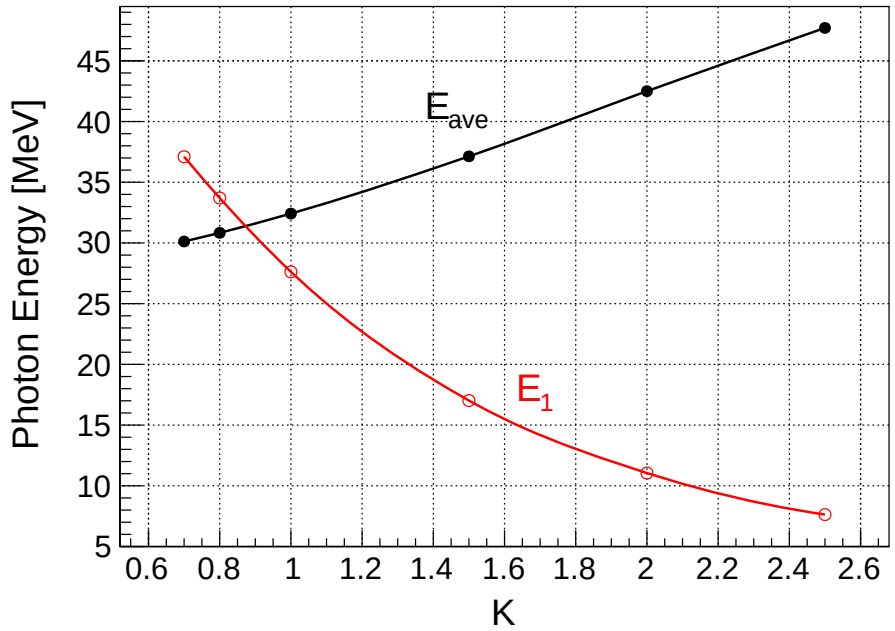
Highest K value for 140 harmonics is about 2.5

Photon Yield and Energy vs K-value

Photon Yield vs K-value

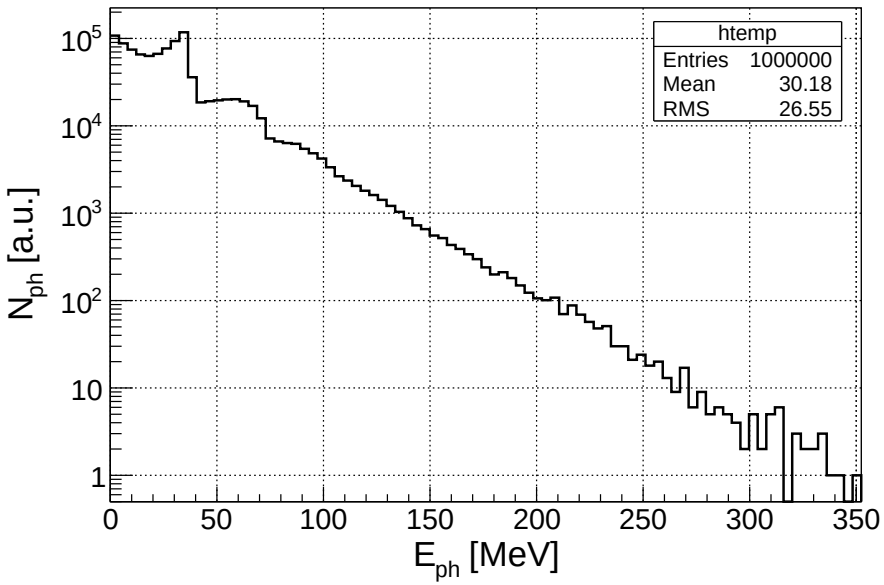


Photon Energy vs K-value

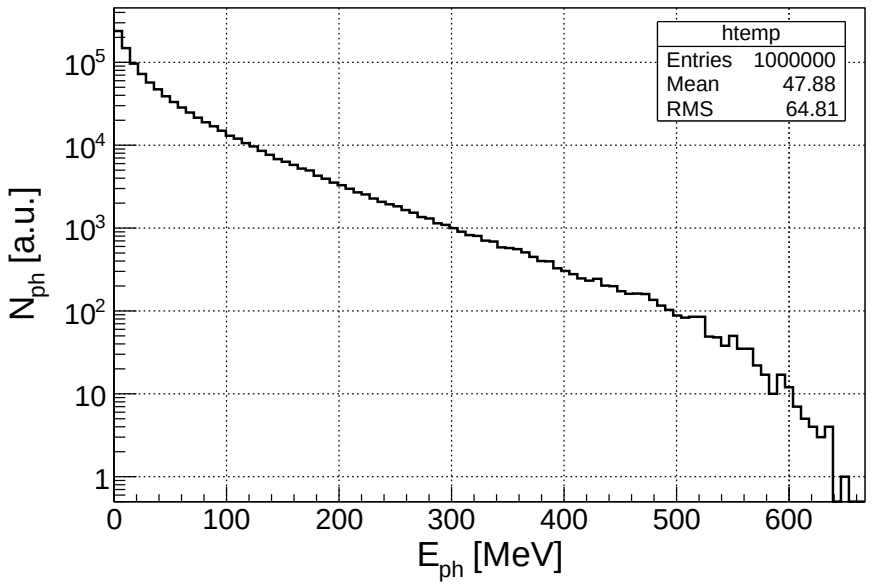


Photon Energy Spectra vs K-value

Energy Distribution for K = 0.7

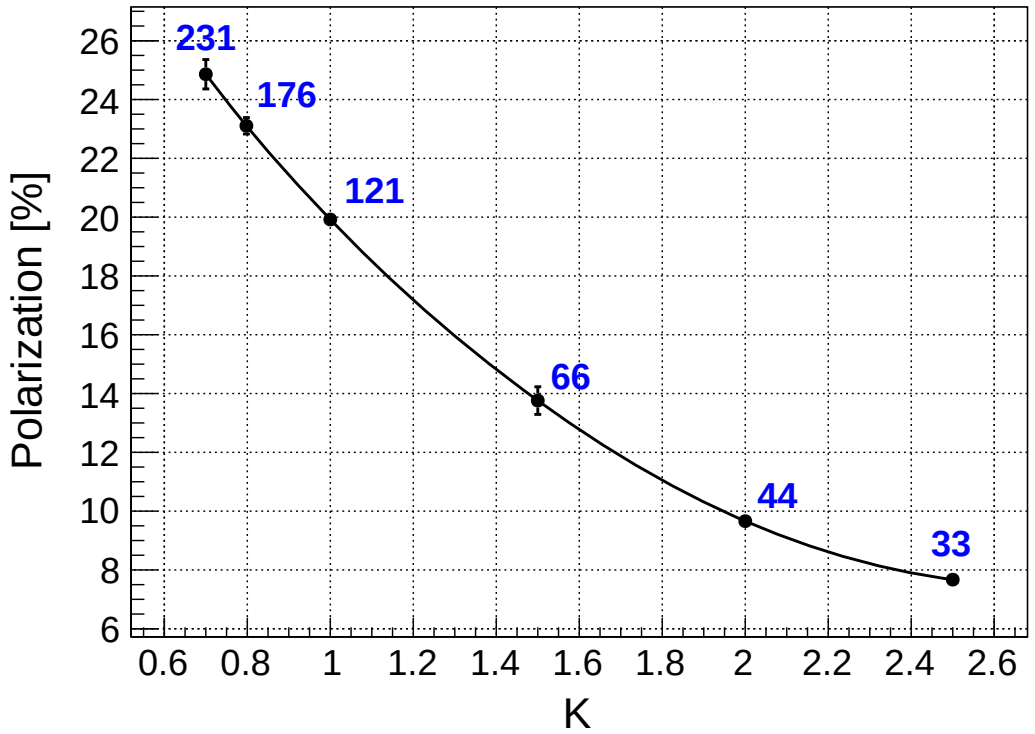


Energy Distribution for K = 2.5



e^+ Polarization vs K for Source wo Photon Collimator

Yield ≈ 1.5 e^+/e^-



K	# Modules	e+ Yield [e+/e-]
0.7	21	1.564
0.8	16	1.500
1.0	11	1.521
1.5	6	1.586
2.0	4	1.655
2.5	3	1.688

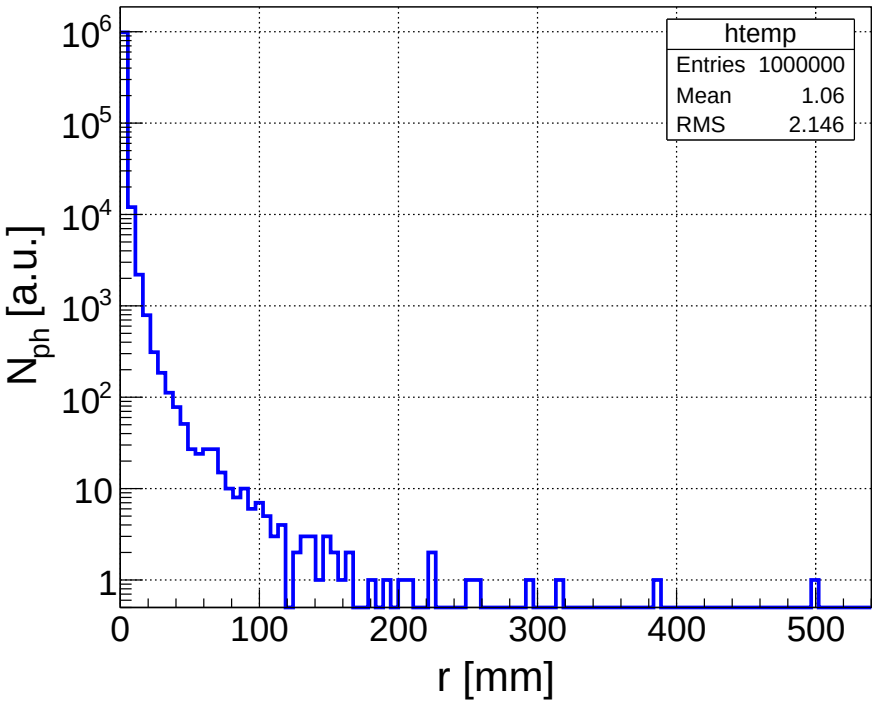
Length of undulator module is 11 m

blue numbers – required active undulator length [m]

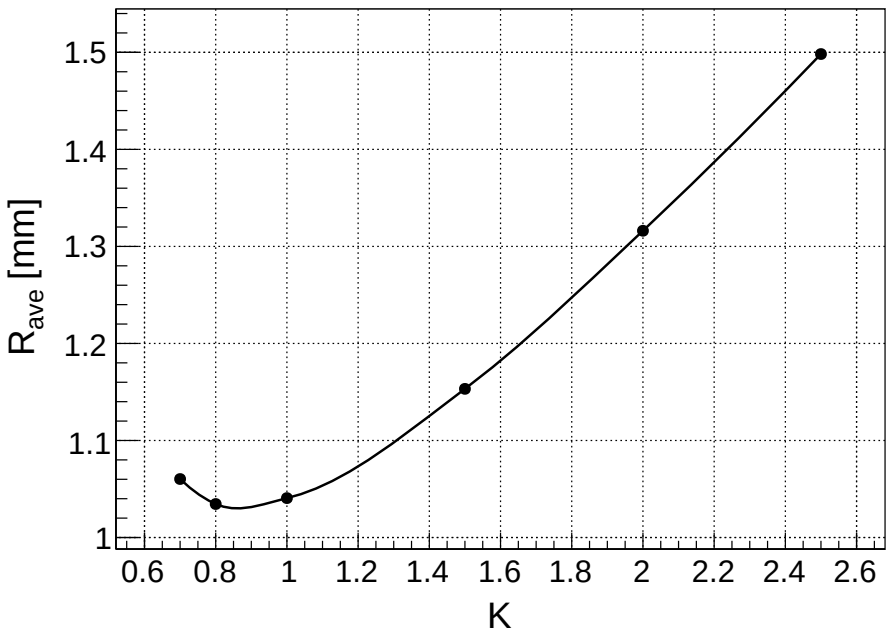
Max. polarization without collimator is about 25% for $K = 0.7$

Photon Beam Radius vs K wo Collimator

Radial Distribution of Photons
($K = 0.7$)



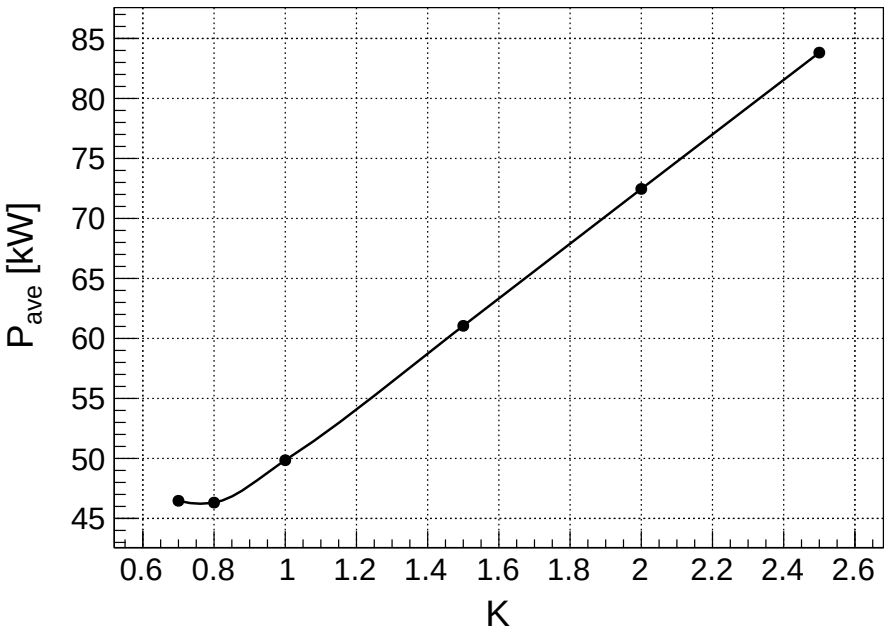
Mean Photon Beam Radius vs K



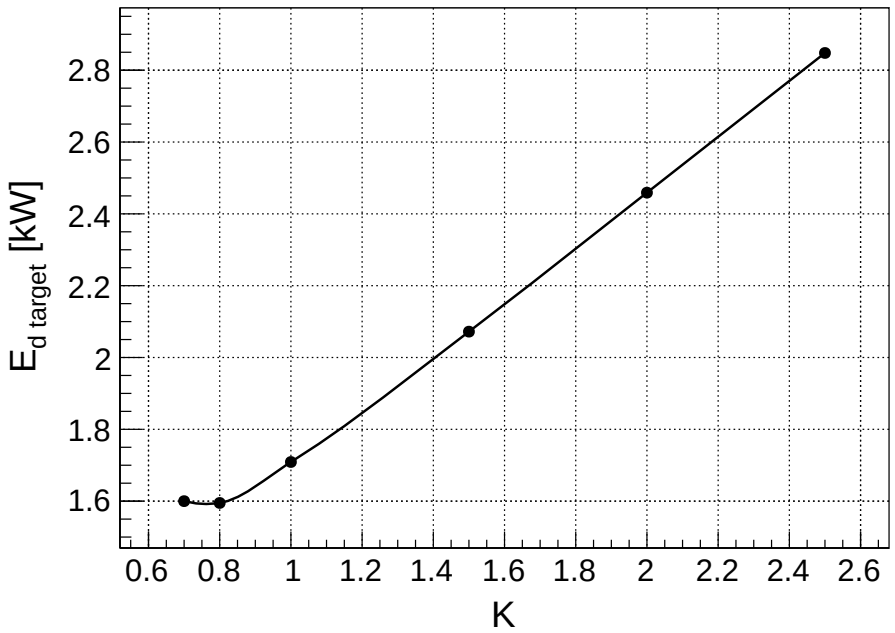
Photon Power and Energy Deposited in Target

$2 \cdot 10^{10}$ e^-/bunch, 1312 bunches/train, 5 Hz, 1.5 e^+/e^- at DR

Photon Beam Power



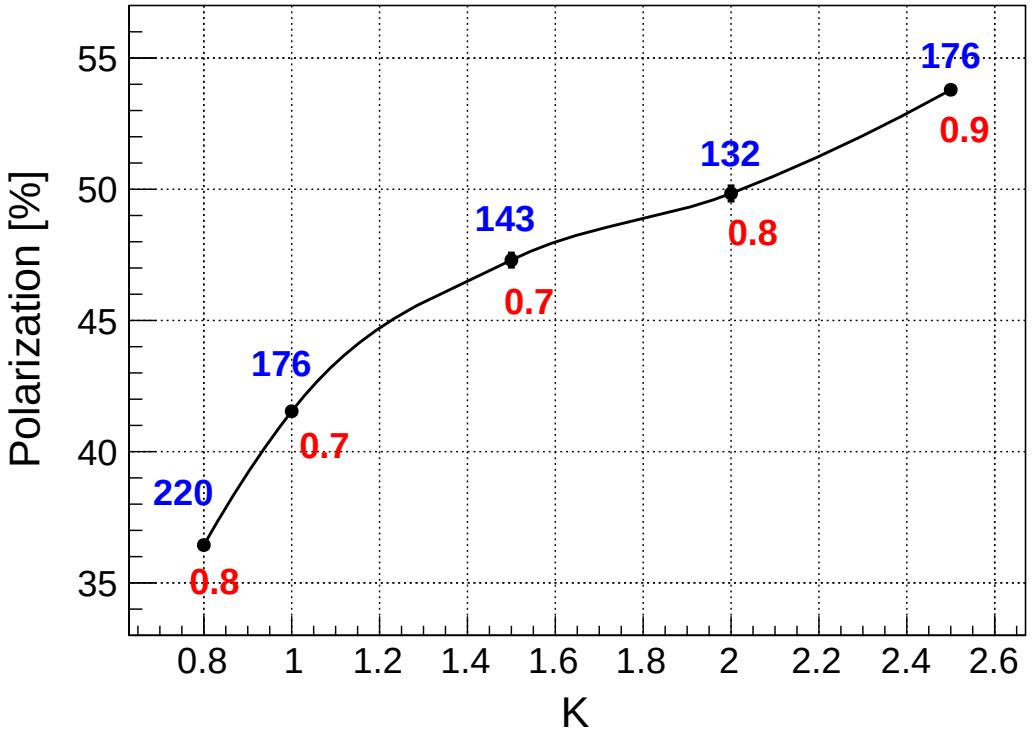
Total Energy Deposited in Target



PEDD in target and thermal stress have to be studied

Polarization vs K for Source with Photon Collimator

Yield $\approx$ 1.5



K	# Modules	e+ Yield [e+/e-]
0.8	20	1.556
1.0	16	1.507
1.5	13	1.523
2.0	12	1.499
2.5	16	1.511

blue numbers – required active undulator length [m]
red numbers – aperture radius of collimator [mm]

54% e^+ polarization can be achieved for source with $K = 2.5$ and $r_{coll} = 0.9$ mm

Short Period/High Field Undulator Based e^+ Source

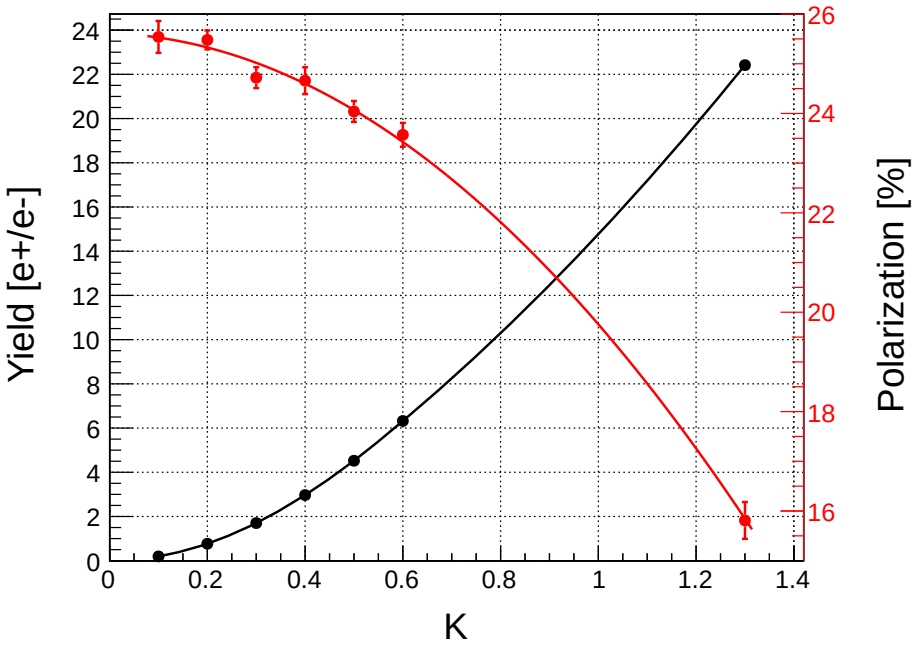
- Nb3Sn undulator with period of 0.9 cm
- Max B-field on axis 1.54 T $\Rightarrow$ $K \simeq 1.3$
- Maximal active undulator length is 231 m
- Space between the end of undulator and target is 412 m
- Ti6Al4V target with thickness of 0.4 X_0
- Pulsed flux concentrator: max. field on axis is 3.2 T
- DR acceptance:
  - long. bunch size $\leq$ 34.6 mm
  - $\epsilon_x + \epsilon_y \leq 70$ mm rad

e^+ Yield and Polarization

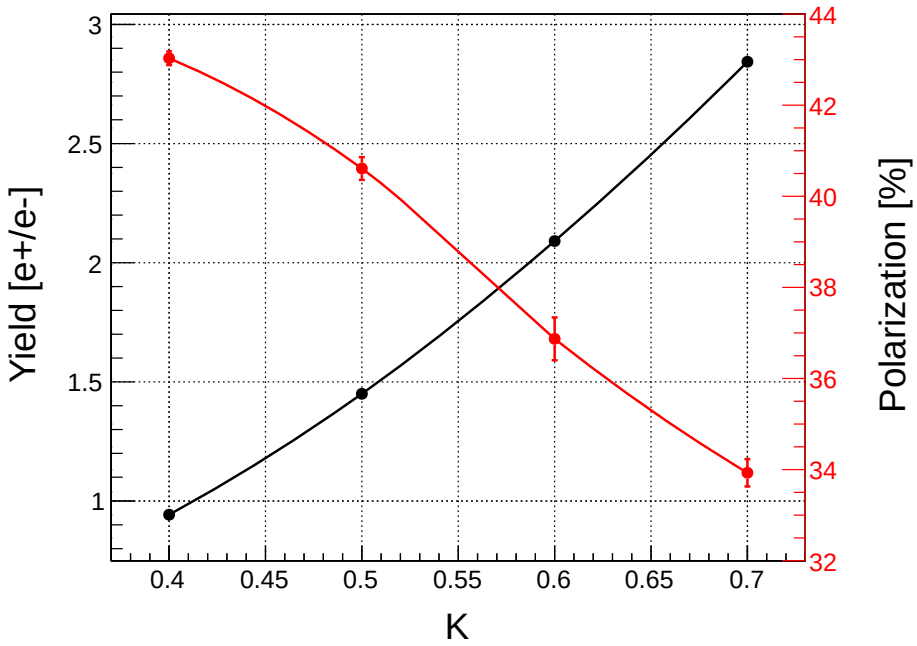
231 m Undulator Length

What B-field (K-value) is needed for getting 1.5 e^+/e^-?

250 GeV e^-



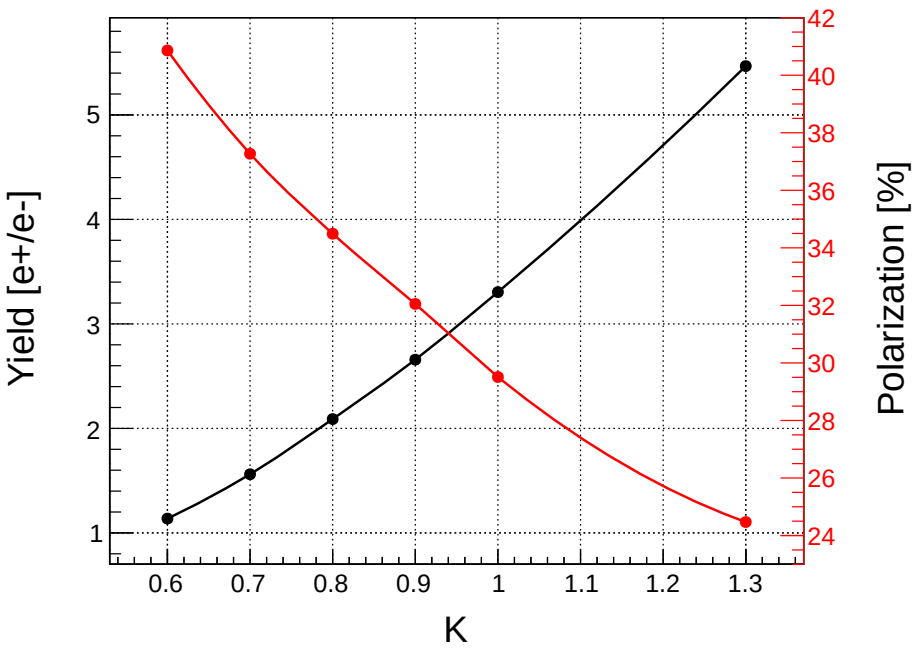
150 GeV e^-



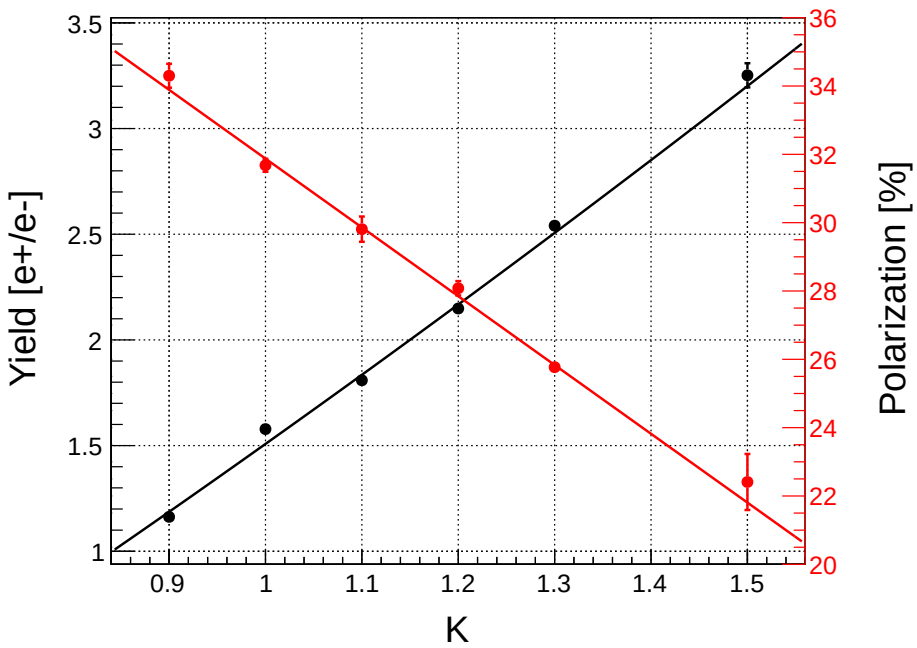
e^+ Yield and Polarization at Low Energies

231 m Undulator Length

125 GeV e^-



100 GeV e^-



231 m undulator with $K \cong 1$ is able to provide 1.5 e^+/e^- at 100 GeV

Summary

- Max. e^+ polarization of source at 500 GeV e^- and an helical undulator (NbTi, 231 m long) having 4.3 cm period:
  - 25% for $K = 0.7$, without collimator,
  - 54% for $K = 2.5$, with collimator
- Source with a low period, high field Nb3Sn undulator can be used down to 100 GeV (at 5 Hz)
- Studies of heat load and thermal stress in target (photon collimator) have to be performed