Update on Undulator based positron source for CLIC

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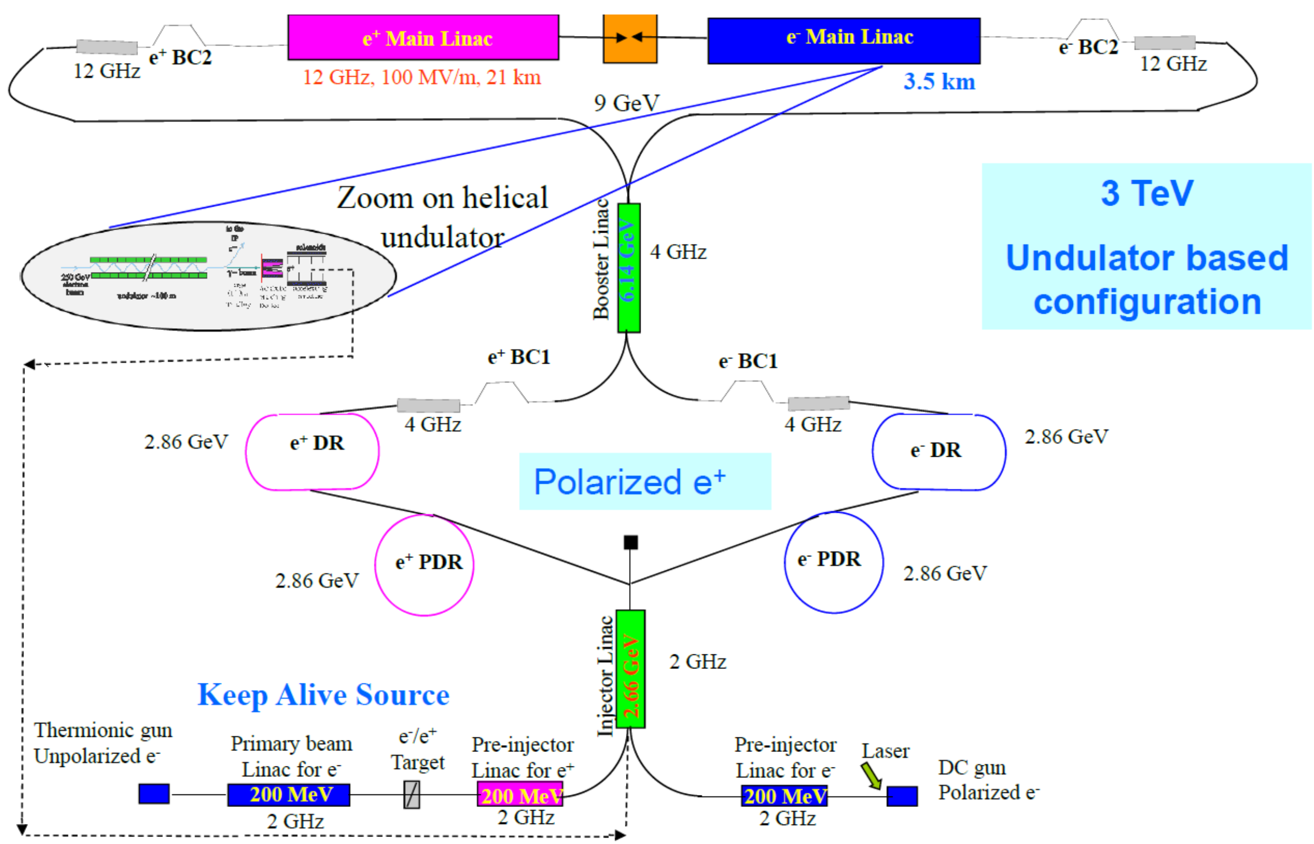
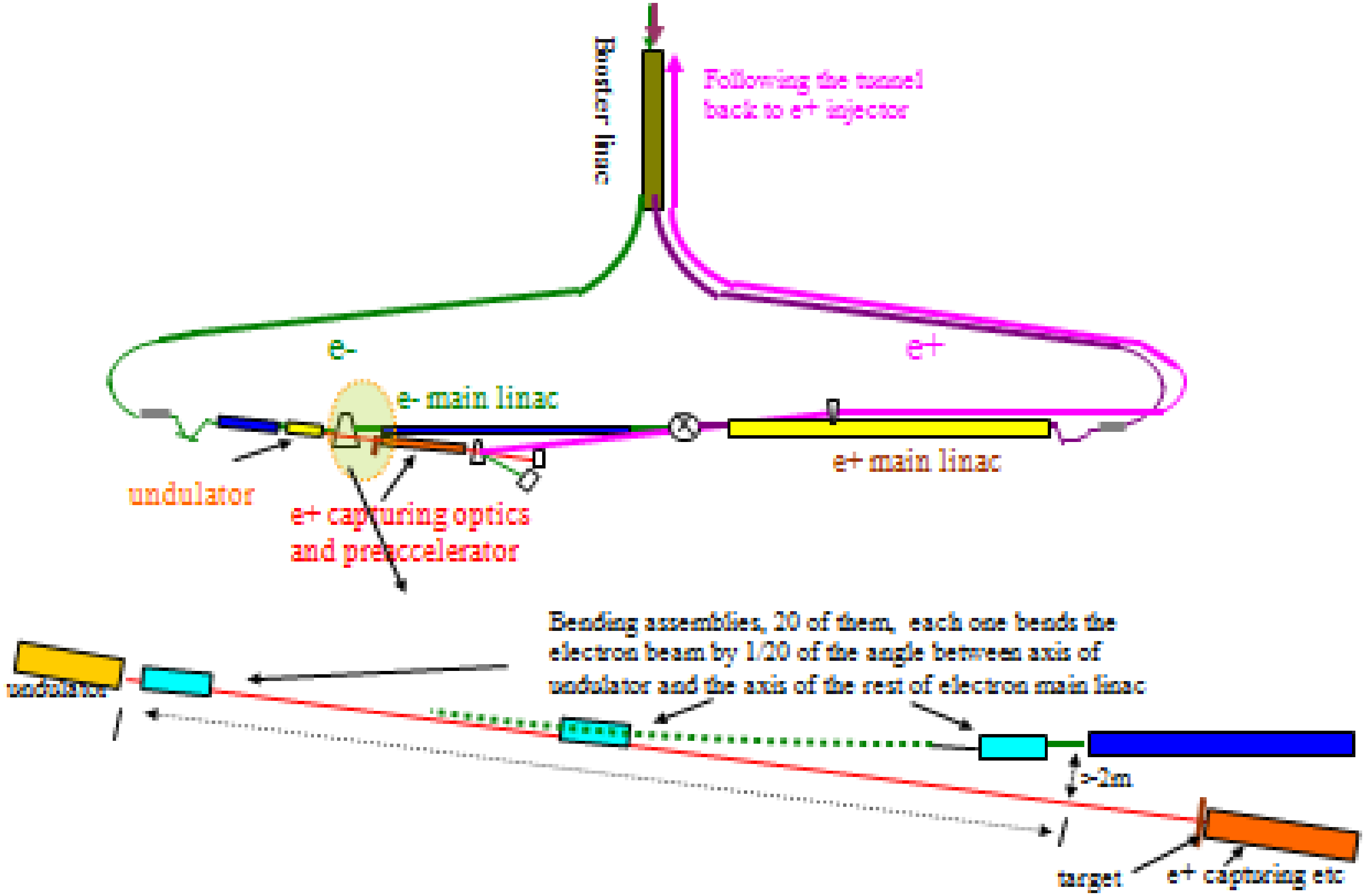
Proposed Undulator Based e+ source for CLIC



Undulator parameter: K=0.75, λu=1.5cm

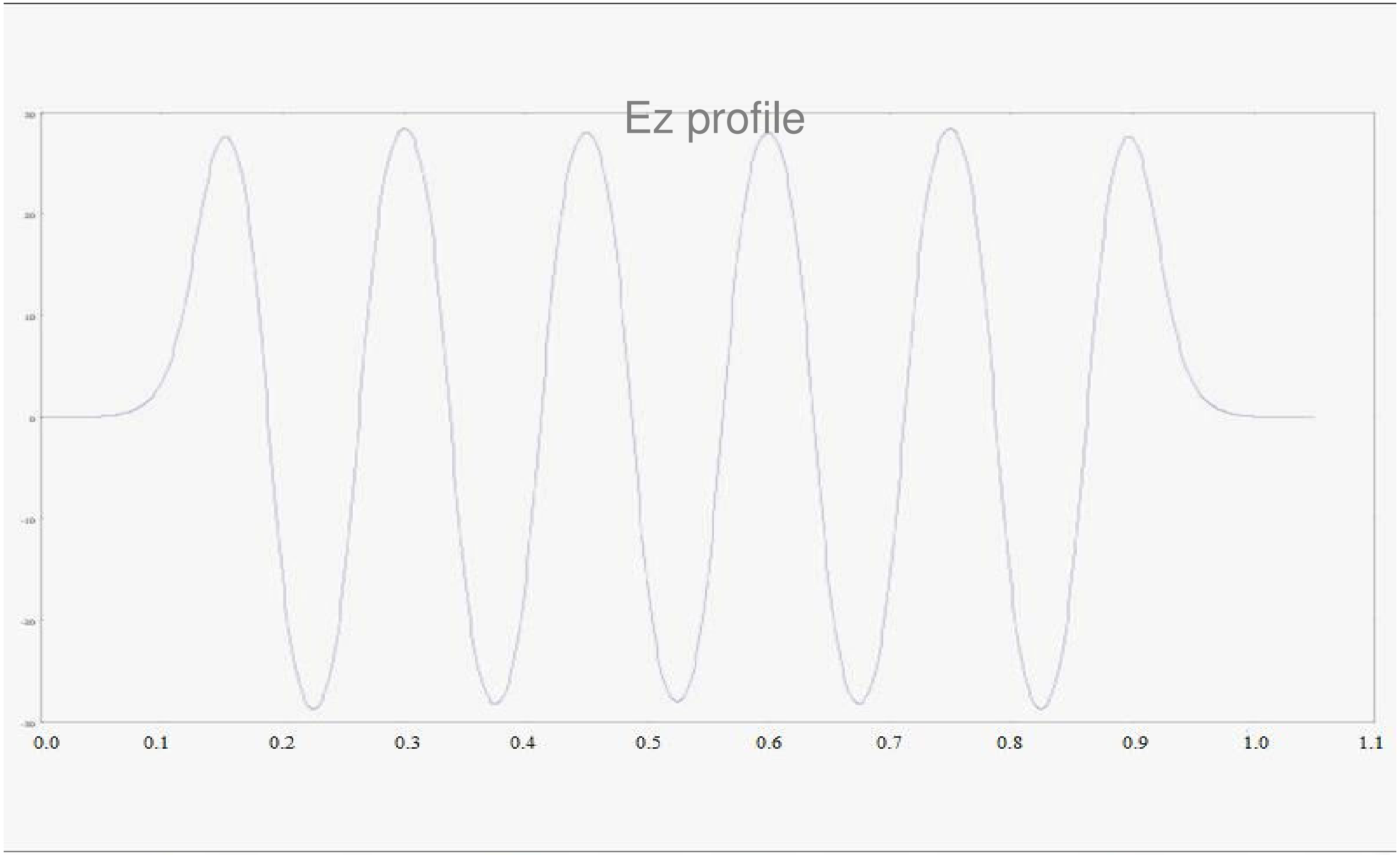
A possible CLIC complex layout with undulator based e+ source

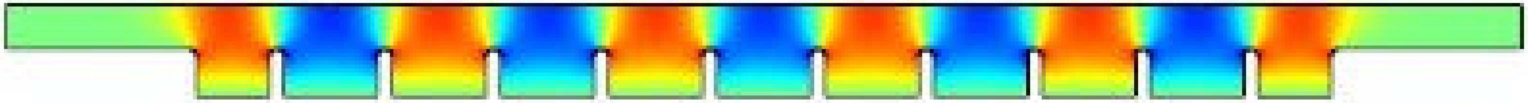


Parameters for comparing tracking with 1.3GHz RF and 2.0GHz RF

- Undulator:
  - K=0.75, □u=1.5cm
- AMD: 7T-0.5T in 20cm (immersed)
- RF: 2GHz, 25MV/m
- Photon collimator: None
- Target: 0.4 rl Titanium immersed
- Yield is calculated as Ne+ captured/Ne- in drive beam.
- Positron capture is calculated by numerical cut using damping ring acceptance window: +/-7.5 degrees of RF(2GHz), ex+ey<0.09 m.rad,1% energy spread with beam energy ~2.4GeV
- Yield is evaluated at 250MeV before injector

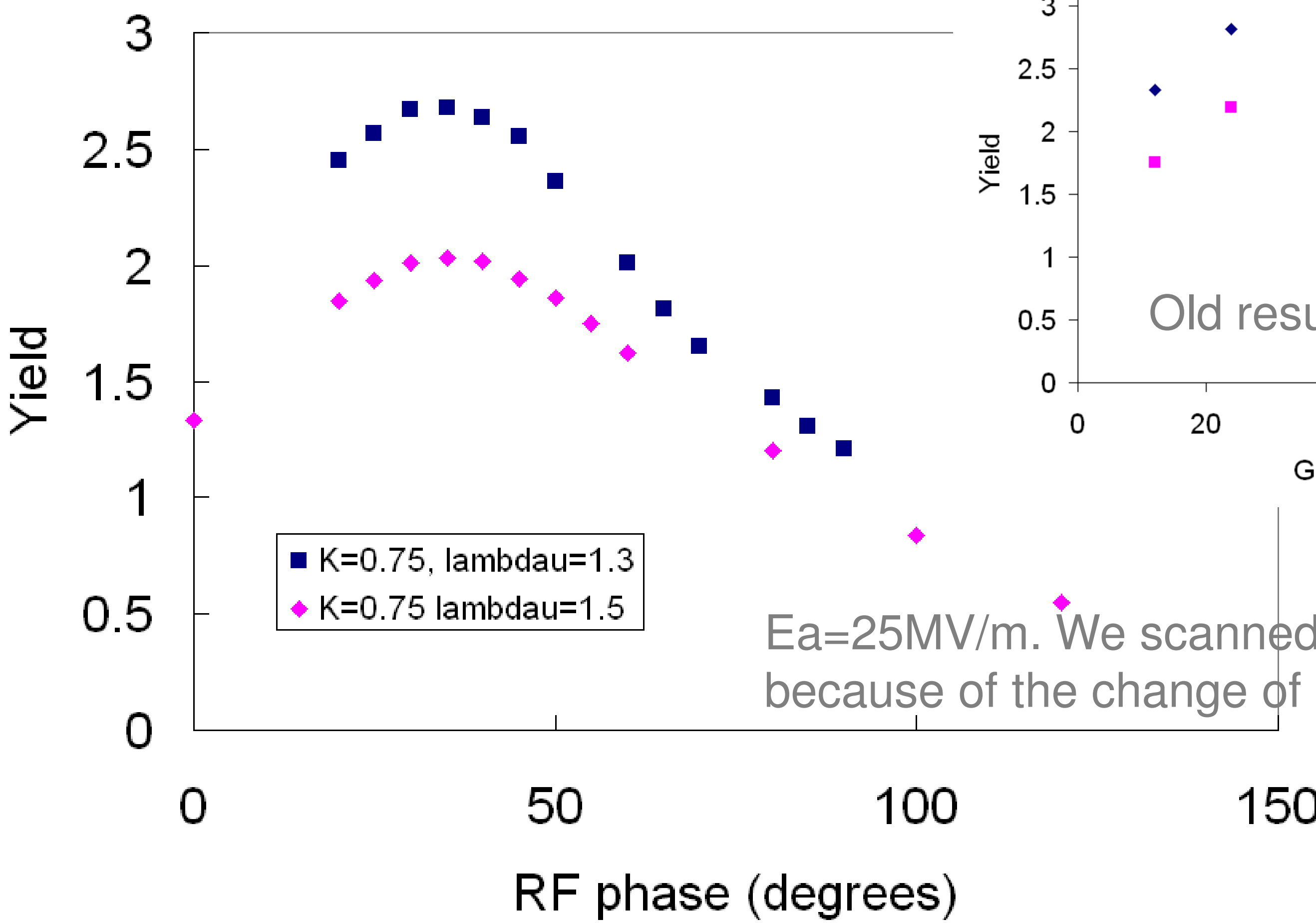
2.0GHz RF Linac (a=3cm)

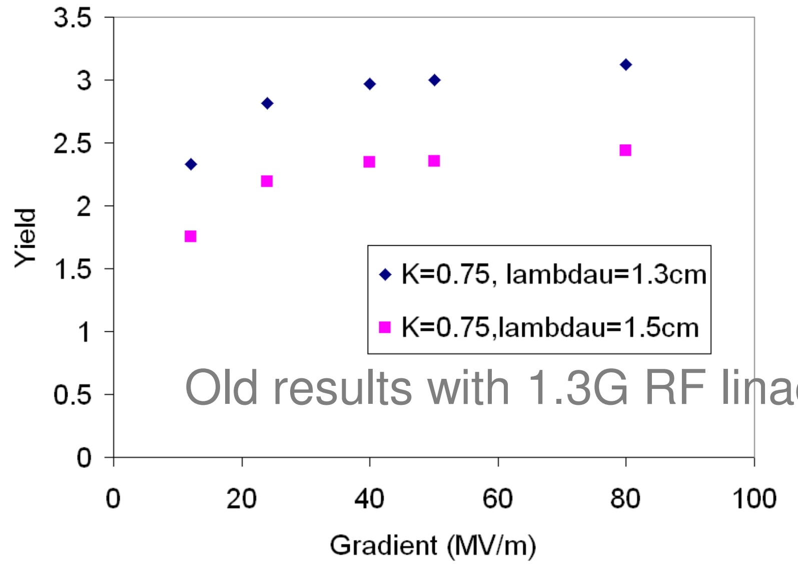




Transit time factor=0.75

Comparing with old simulation results with 1.3GHz RF





Old results with 1.3G RF linac

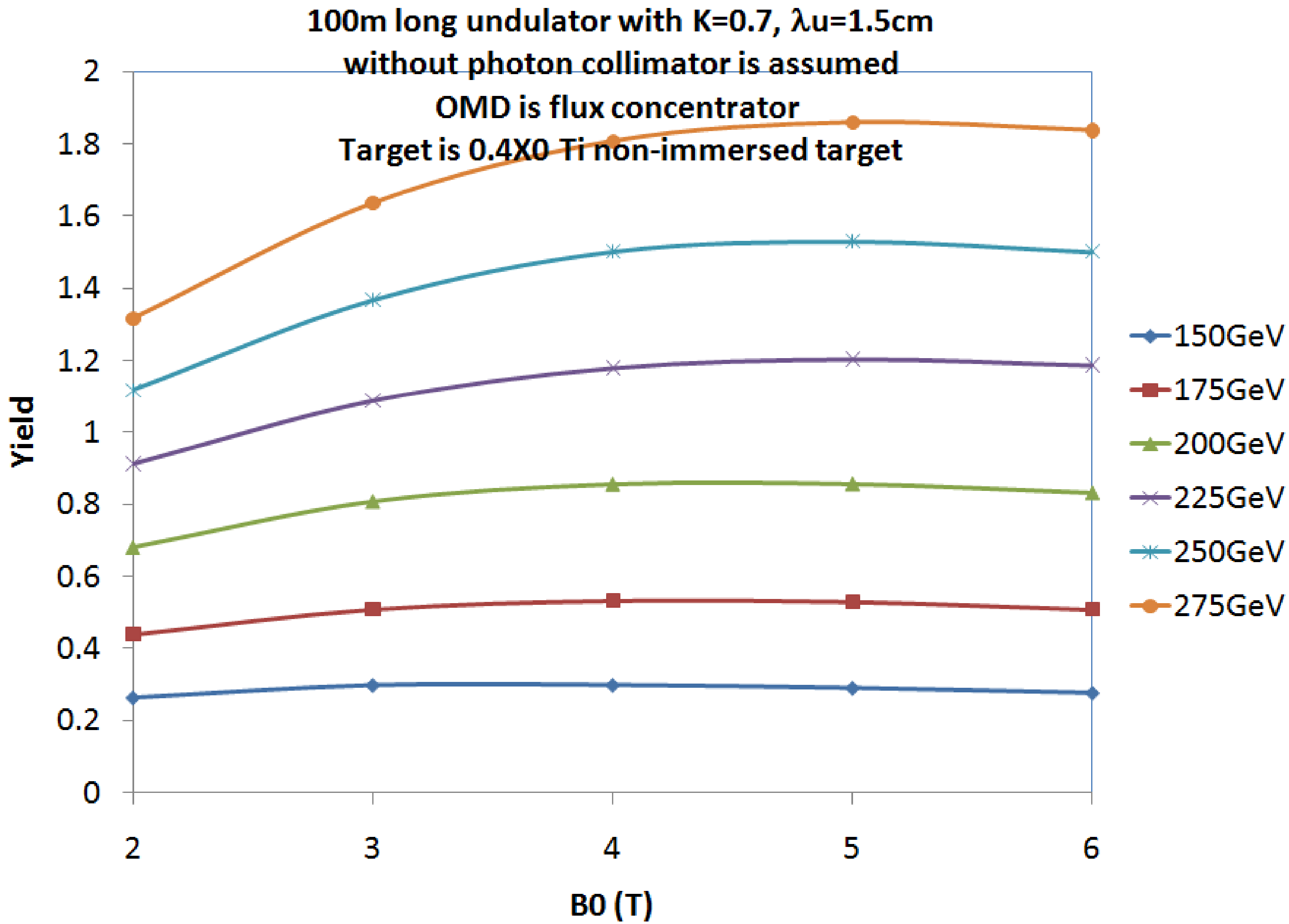
Ea=25MV/m. We scanned the phase because of the change of beamline.

Comparing with the old result with 1.3GHz RF, the yield lowered slightly when using 2GHz RF.

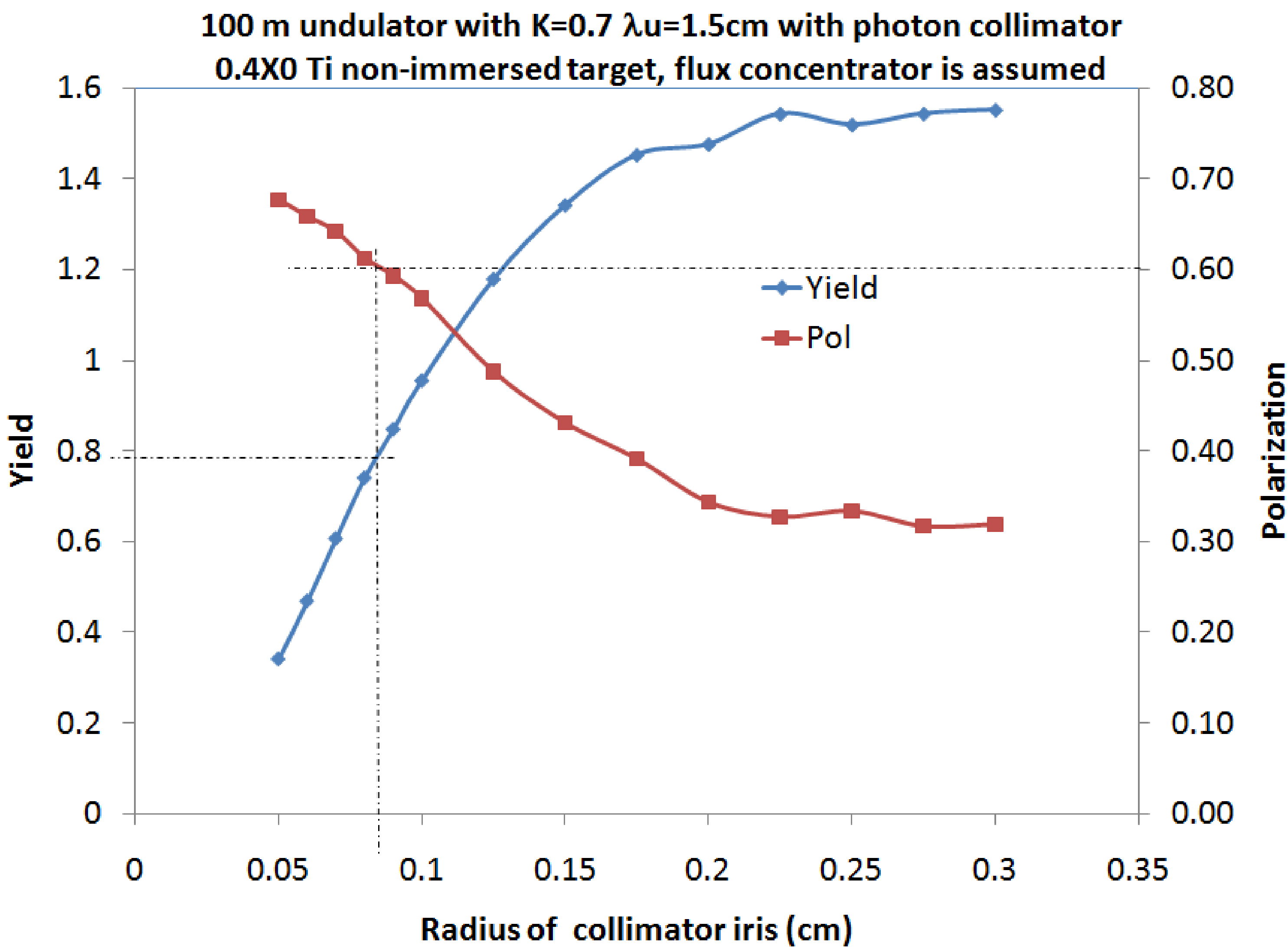
Parameters for drive beam energy scan and photon collimator iris scan

- Undulator:
  - K=0.75, λu=1.5cm
- RF: 2GHz, 25MV/m
- Target: 0.4 rl Titanium, or 0.5 rl liquid lead, Non-immersed
- Yield is calculated as Ne+ captured/Ne- in drive beam.
- Positron capture is calculated by numerical cut using damping ring acceptance window: +/-7.5 degrees of RF(2GHz), $\varepsilon x+\varepsilon y<0.09\pi$.m.rad,1% energy spread with beam energy ~2.4GeV
- Yield is evaluated at 250MeV before injector

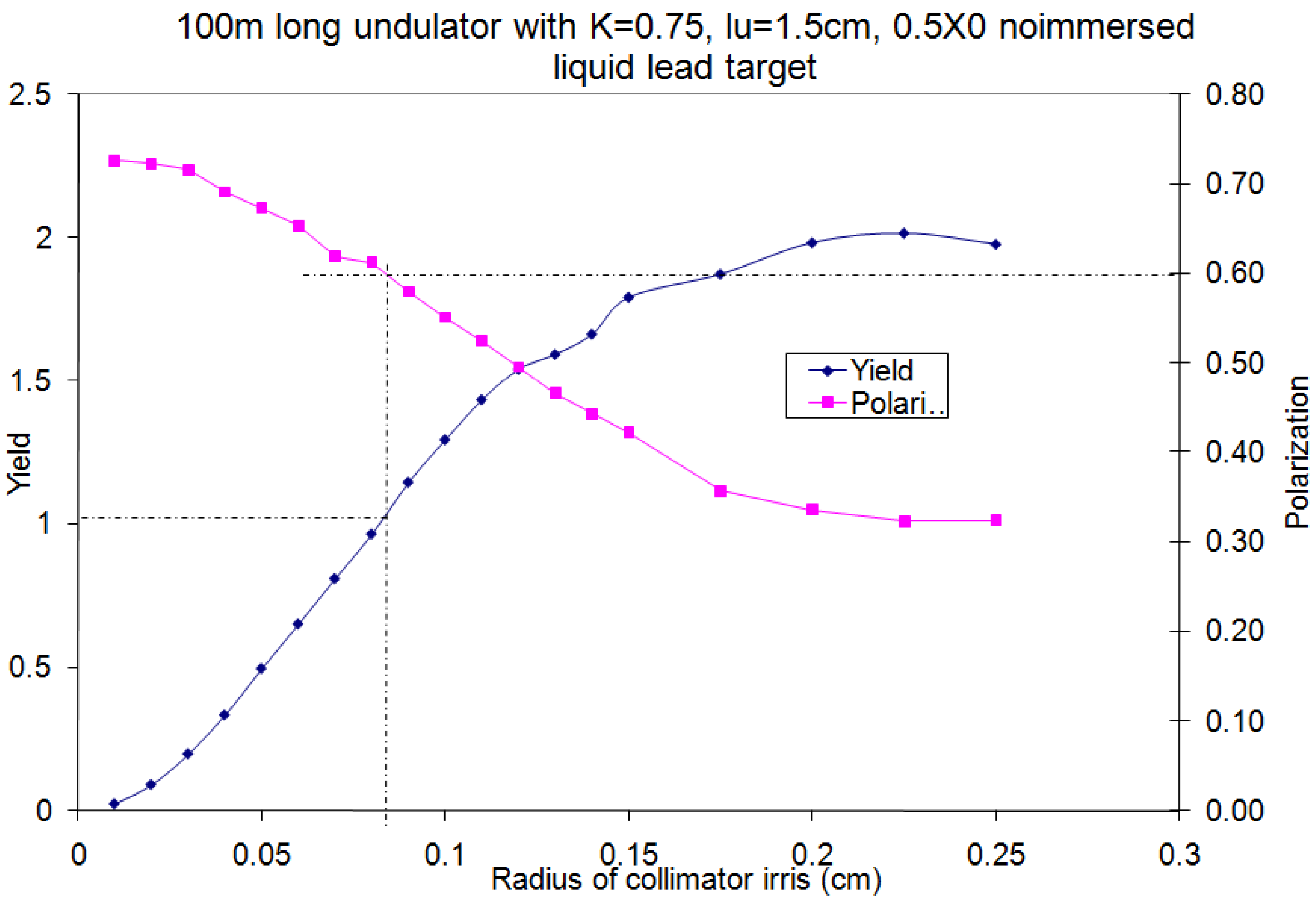
Yield vs OMD for different drive beam energy



Polarization and yield

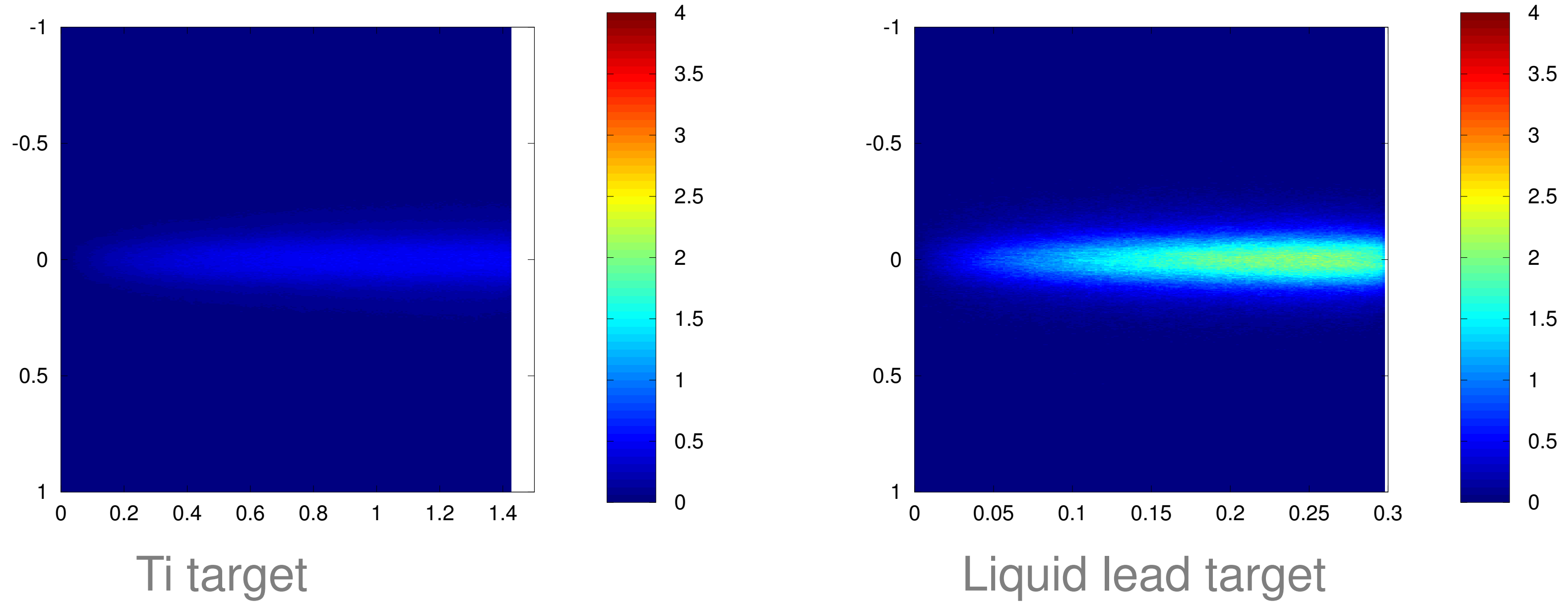


Liquid lead target, Polarization and yield



Energy deposition comparing between Ti target and liquid Lead target

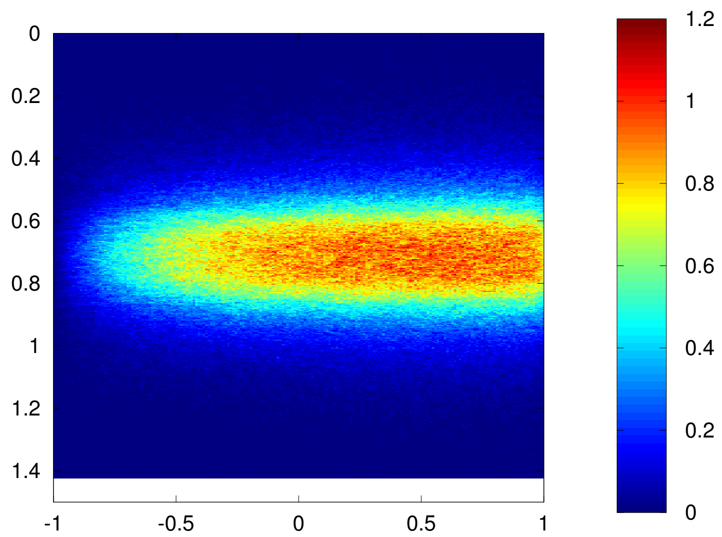
- For 1 positron captured, 81 MeV will be deposited in target for CLIC e+ source with Ti non-immersed target while 43.1 MeV will be deposited in target for CLIC e+ source with liquid lead target. Assuming 3.72e9 positrons per bunch , then energy deposition will be 0.049J per bunch for Ti target and 0.0257J per bunch for liquid lead target.   But energy density for liquid lead target will be about 4 times higher than that for Ti target.



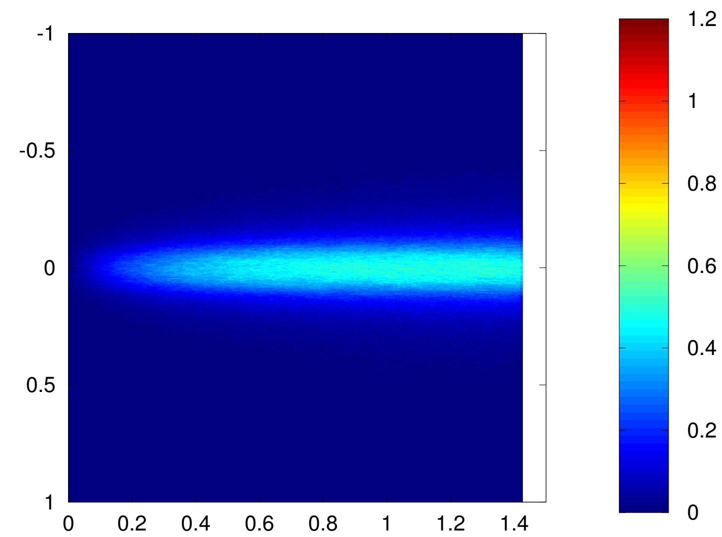
Energy deposition, comparing between ILC and CLIC undulator based e+ source

Comparing with ILC undulator based RDR e+ source, the density of energy deposition per bunch for CLIC undulator based e+ source is only half of ILC RDR baseline.

Since CLIC has only 312 bunches per train, the thermal loading on the target should not be an issue.



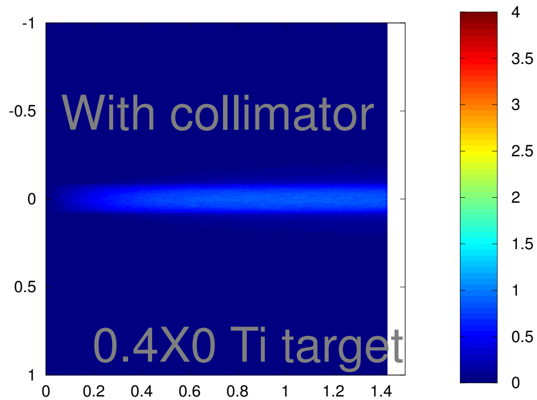
ILC

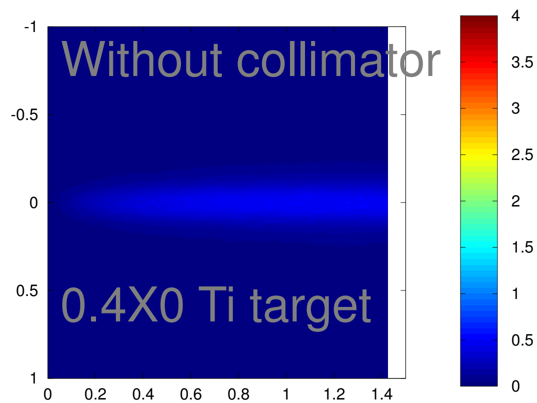


CLIC

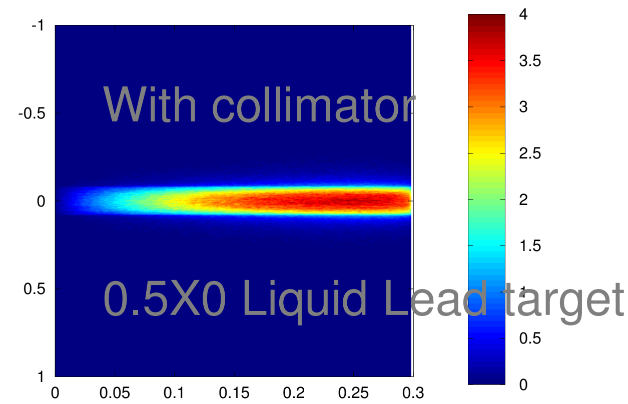
Energy deposition comparing between polarized (60%) and low polarized (~30%) e+ source

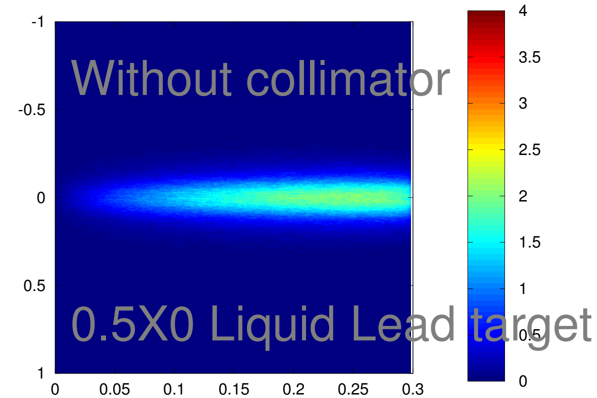
- When a photon collimator with a iris of 0.8mm in radius is applied, the captured positrons will have a polarization of ~0.6 otherwise the polarization will be ~0.3.
- Assuming 3.72e9 positrons captured for both cases.



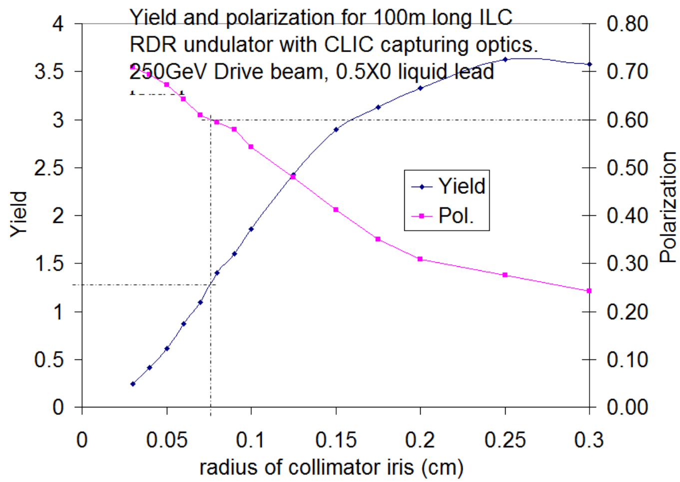


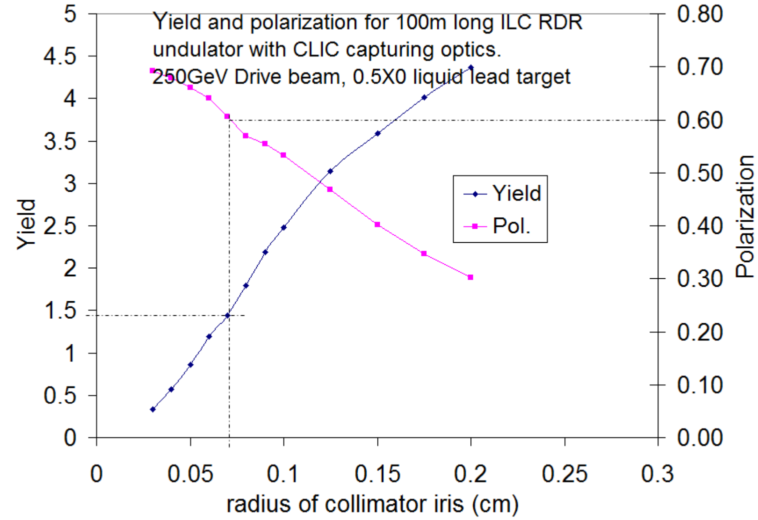
The density of deposit energy per bunch nearly doubled for polarized e+ source. But it is still smaller than ILC RDR baseline e+ source.

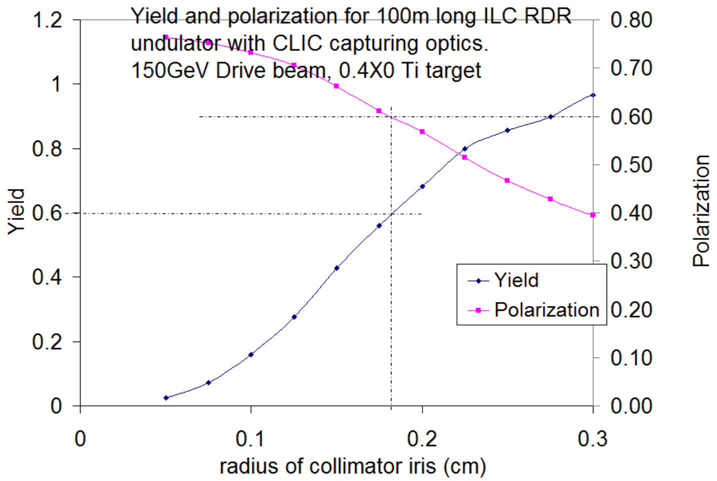


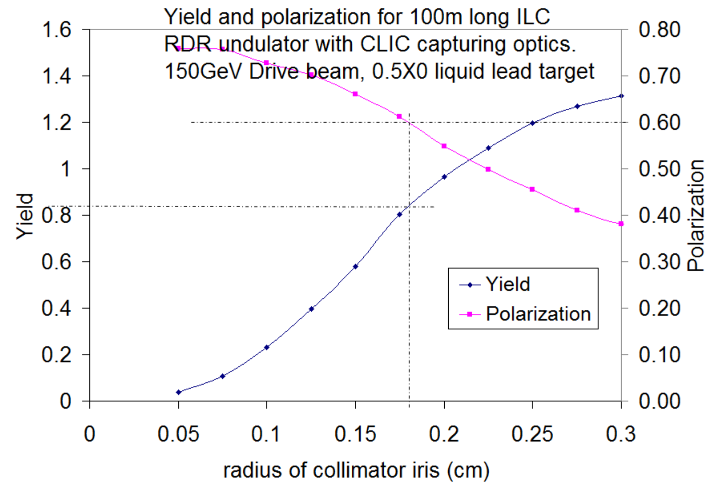


Using ILC RDR undulator with CLIC capturing optics









Future works

Capturing studies:

- Systematic Parameter studies of undulator parameters and polarizations for different drive beam energy.
- Different capturing optics , QWT, Flux concentrator and immersed OMD.

Particle tracking:

- Conceptual design of the e+ transport beamline from end of capture to the injector linac/damping ring
- Particle tracking with e+ transport beamline

Target:: Cooling power requirement and radiation deposition. Radiation activations.

Drive beam: Emittance and energy spread evolution passing through the undulator and bending magnets.

Need to develop an overall layout of the CLIC undulator based e+ scheme.

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- For Ti target the average power deposit into target is 764W, the peak power of the bunch train is 98MW For Pb target the average power deposit into target is 400W, the peak power of the bunch train is 51.4MW For 60% polarization cases, the power deposit into Ti target is 81.4MW per bunch train and 634.9W on average.
- For 60% polarization case, the power deposit into Pb target is 40.8MW per bunch train and 318.2W on average