Power Incident on the ILC Helical Undulator Walls

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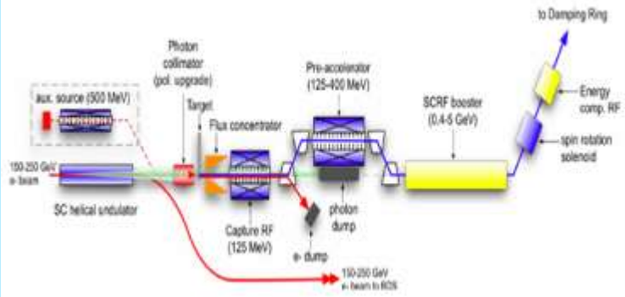
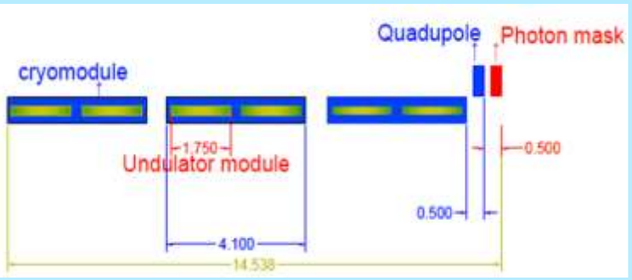
Introduction

- The International Linear Collider (ILC) positron source baseline is a helical undulator [1].
- The most important benefits of using a helical undulator is to produce polarized positrons.
- A high-energy electron passes through the helical undulator to generate circularly polarized photons, and these photons then hit a thin metal target. The result is a longitudinally polarized positron beam. The positrons are captured and accelerated to the required energy.



- The photon opening angle is determined by the electron energy; it is proportional to 1/gamma.
- The power deposition along the undulator walls must be below 1~W/m [2]. This can be reached by inserting masks along the undulator line.
- A previous study: using different parameters [2].
- This study uses:
  - The actual parameters for ILC250
  - Provided more details
  - Both ideal and non-ideal helical undulators

Helical Undulator Structure and Parameters



Prototype:

Electron beam energy (GeV)	128
Bunches per pulse	1312
Photon energy (first harmonic) (MeV)	7.8
Active undulator module number	132
Required undulator field (T)	0.79
undulator period length (cm)	1.15
Undulator inner diameter (cm)	0.585
undulator K	0.85
Undulator Active length (m)	231
Total Undulator length (m)	320

Simulation Software

- HUSR: **H**elical **U**ndulator **S**ynchrotron **R**adiation [3]:
  - Developed at Cockcroft Institute by **David Newton.**
  - Can simulate photon spectra produced by a Helical Undulator :B field with **errors.**
  - Errors measured from undulator prototypes at Rutherford Appleton Laboratory.
  - HUSR can calculate **the photon polarization.**
- FLUKA was used to simulate the energy deposition at masks.

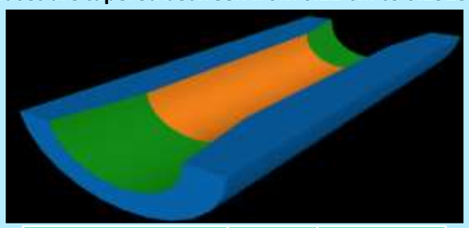
Photon Mask Design

- **The power deposited at masks was studied, [4].**
- **Materials used here: Copper Cu, Iron Fe and Tungsten W.**

Atomic Number: Cu= 29, Fe=26, W= 74

Radiation length: Cu= 1.4, Fe=1.8, W=0.35

- **Mask: a cylindrical geometry, 30 cm length, the inner radiuses are tapered between from 0.22 cm to 0.2925 cm.**



Cu Mask	Ideal	Realistic
Dep. Power (W)	335	361
Average Incident photon energy (MeV)	2.01	2.14
PEDD (J/g/Pulse)	8.07	9.03
Temperature (K/Pulse)	21	24

Power Deposited on Undulator Walls

- **Since the ILC undulator:**
  - Superconducting and to achieve the vacuum specifications of ~ 100 nTorr, the power deposited on walls must be below 1 W/m.

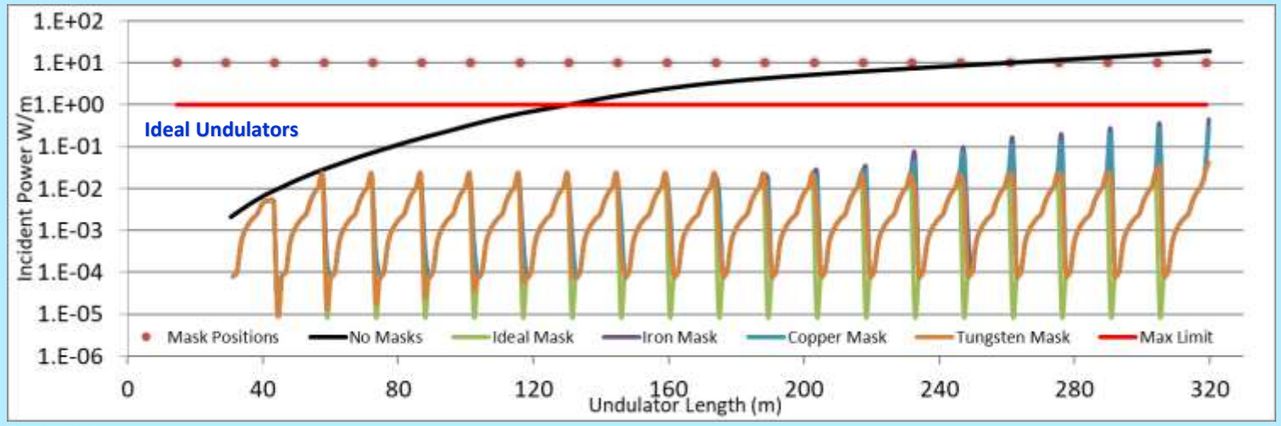
• The incident power calculated by increasing the distance between observation points and the undulator per meter.

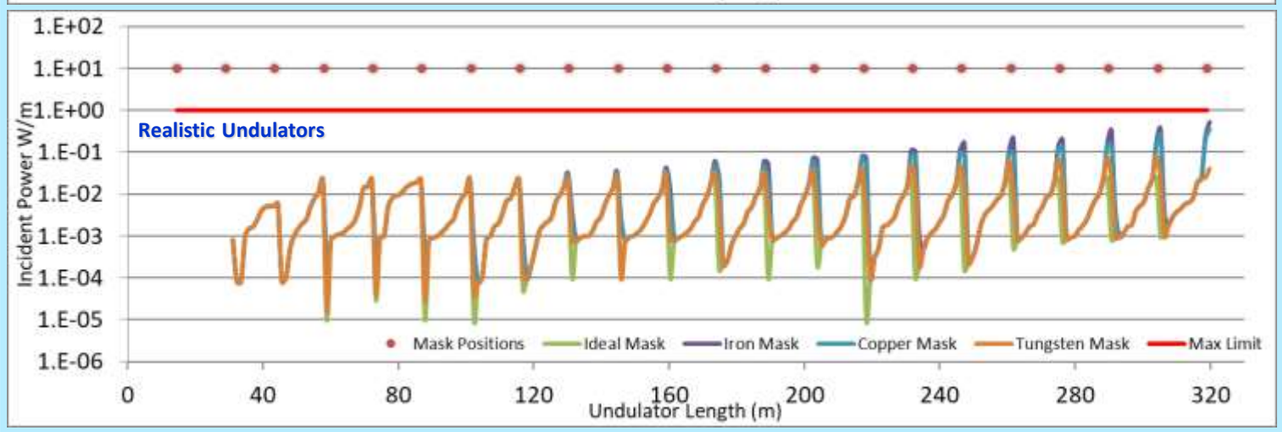
• HSUR is too time consuming to calculate the photon spectrum: when the distance below 25 m .

• So results at distance above 25 m have been considered.

- **Incident primary photon power:**
  - Maximum Power deposited is above 20 W/m.
  - 22 photon masks must placed along the line.
  - Ideal Masks: Max deposited power is 0.022W/m.
- **Incident Secondary Particles Power:**
  - Photons back-scattered
  - Secondary particles left masks and deposit on walls.

	Max power deposited after mask-21 (W/m)	
Mask	Ideal	Realistic
Ideal	0.022	0.025
Iron	0.310	0.360
Copper	0.220	0.260
Tungsten	0.034	0.035





CONCLUSION

• The total power deposited at walls for 250 GeV center-of-mass energy have been studied with three different mask materials for both ideal and realistic undulators.

• Iron, Copper and Tungsten are stopped 97.5%, 98.5% and 99.5% of the incident power, respectively.

• Power deposited on undulator walls due to primary photons and secondary particles studies proved that for these particular beam parameters, the maximum deposited power is below the limit.

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