ILC Positron Source Studies at ANL

Argonne Accelerator Institute Quarterly Meeting

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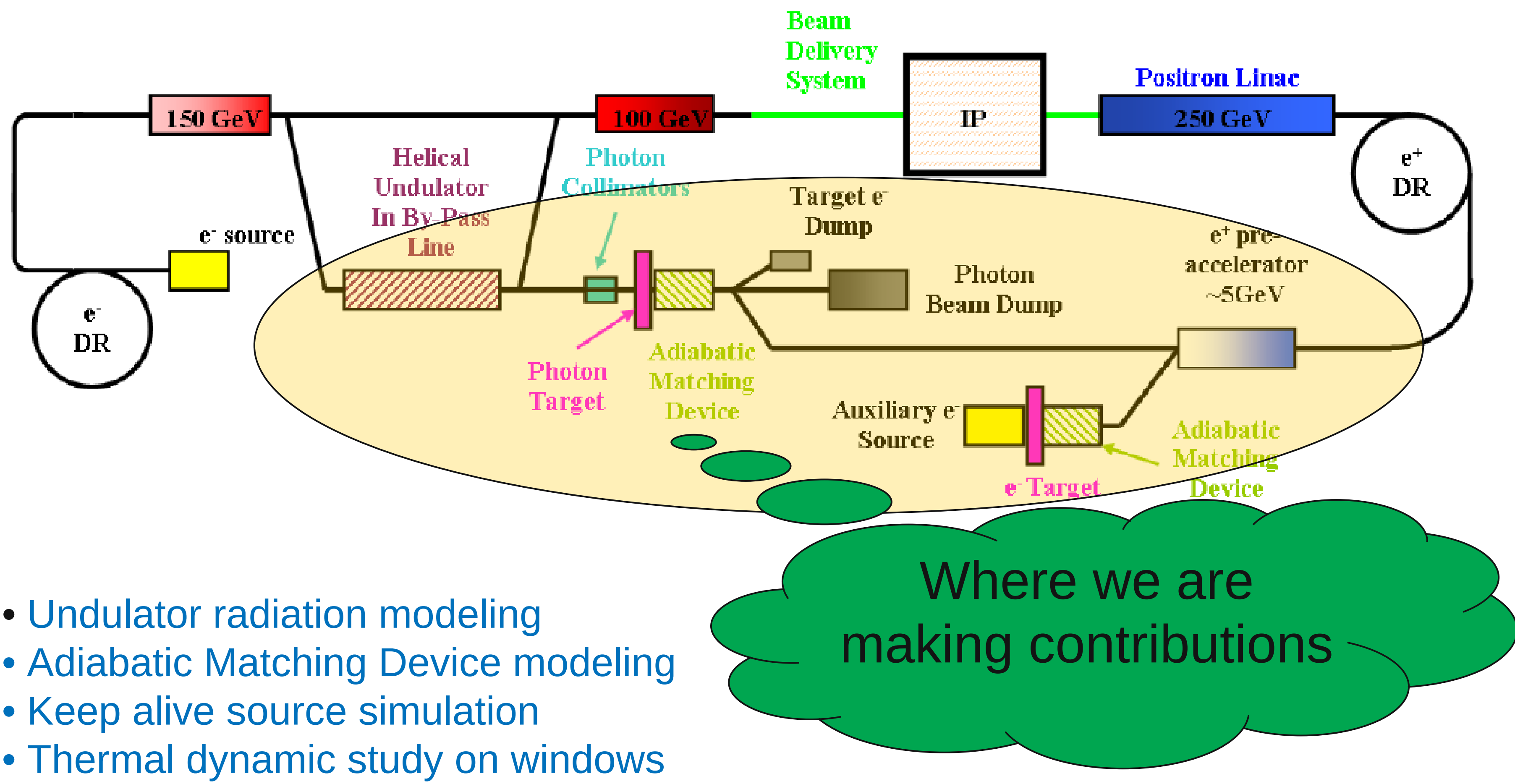
Where we are making contribution



- Undulator radiation modeling
- Adiabatic Matching Device modeling
- Keep alive source simulation
- Thermal dynamic study on windows
- Eddy current simulation
- Laser compton scheme positron production simulation for KEK/CLIC

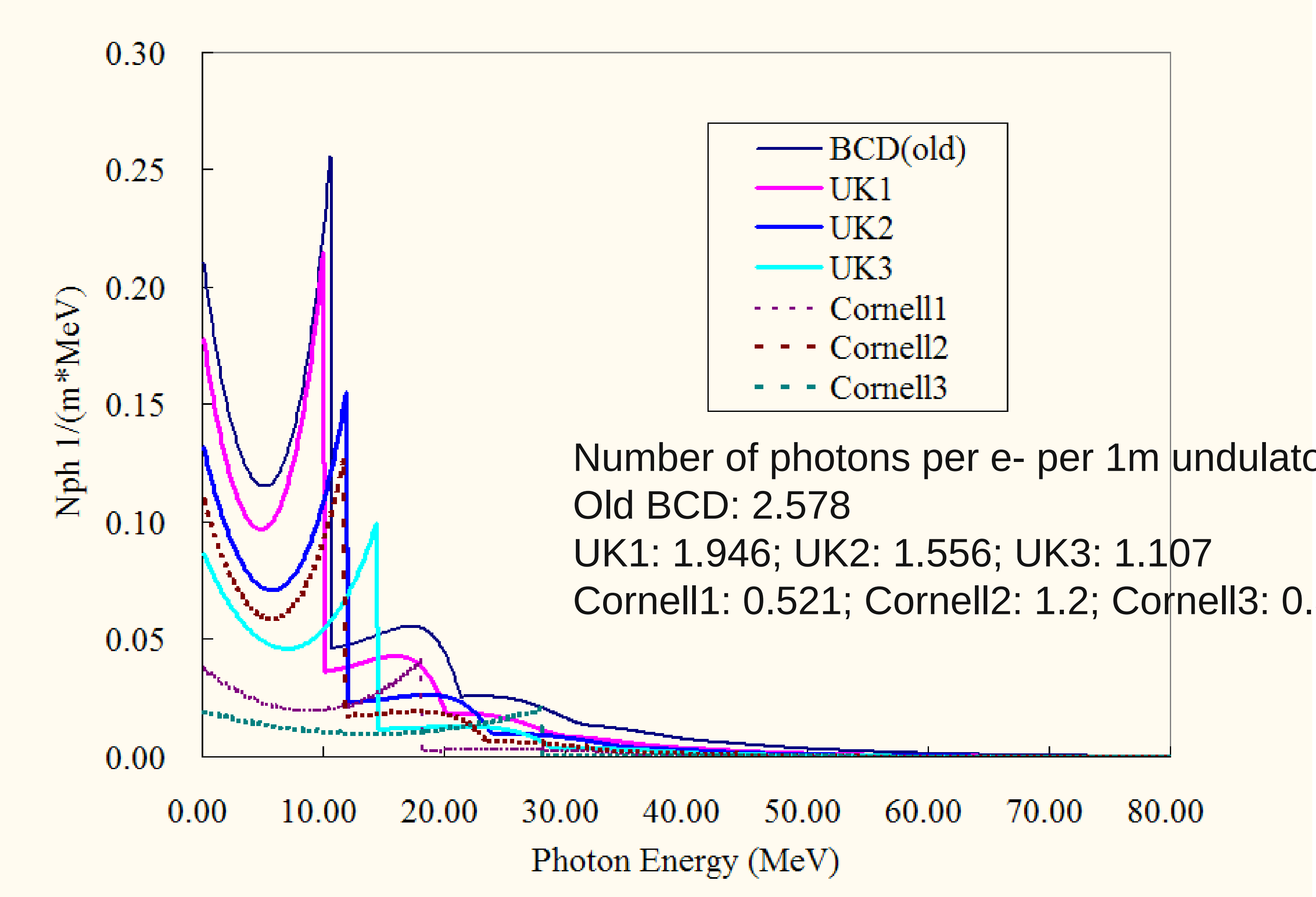
Comparison of positron yield from different undulators

	High K Devices				Low K Devices		
	BCD	**UK I**	**UK II**	**UK III**	**Cornell I**	**Cornell II**	**Cornell III**
Period (mm)	10.0	11.5	11.0	10.5	10.0	12.0	7
K	1.00	0.92	0.79	0.64	0.42	0.72	0.3
Field on Axis (T)	1.07	0.86	0.77	0.65	0.45	0.64	0.46
Beam aperture (mm)	Not Defined	5.85	5.85	5.85	8.00	8.00	
First Harmonic Energy (MeV)	10.7	10.1	12.0	14.4	18.2	11.7	28
Yield(Low Pol, 10m drift)	~2.4	~1.37	~1.12	~0.86	~0.39	~0.75	~0.54
Yield(Low Pol, 500m drift)	~2.13	~1.28	~1.08	~0.83	~0.39	~0.7	~0.54
Yield(Pol)	~1.1	~0.7	~0.66	~0.53	~0.32	~0.49	~0.44

Target: 1.42cm thick Titanium

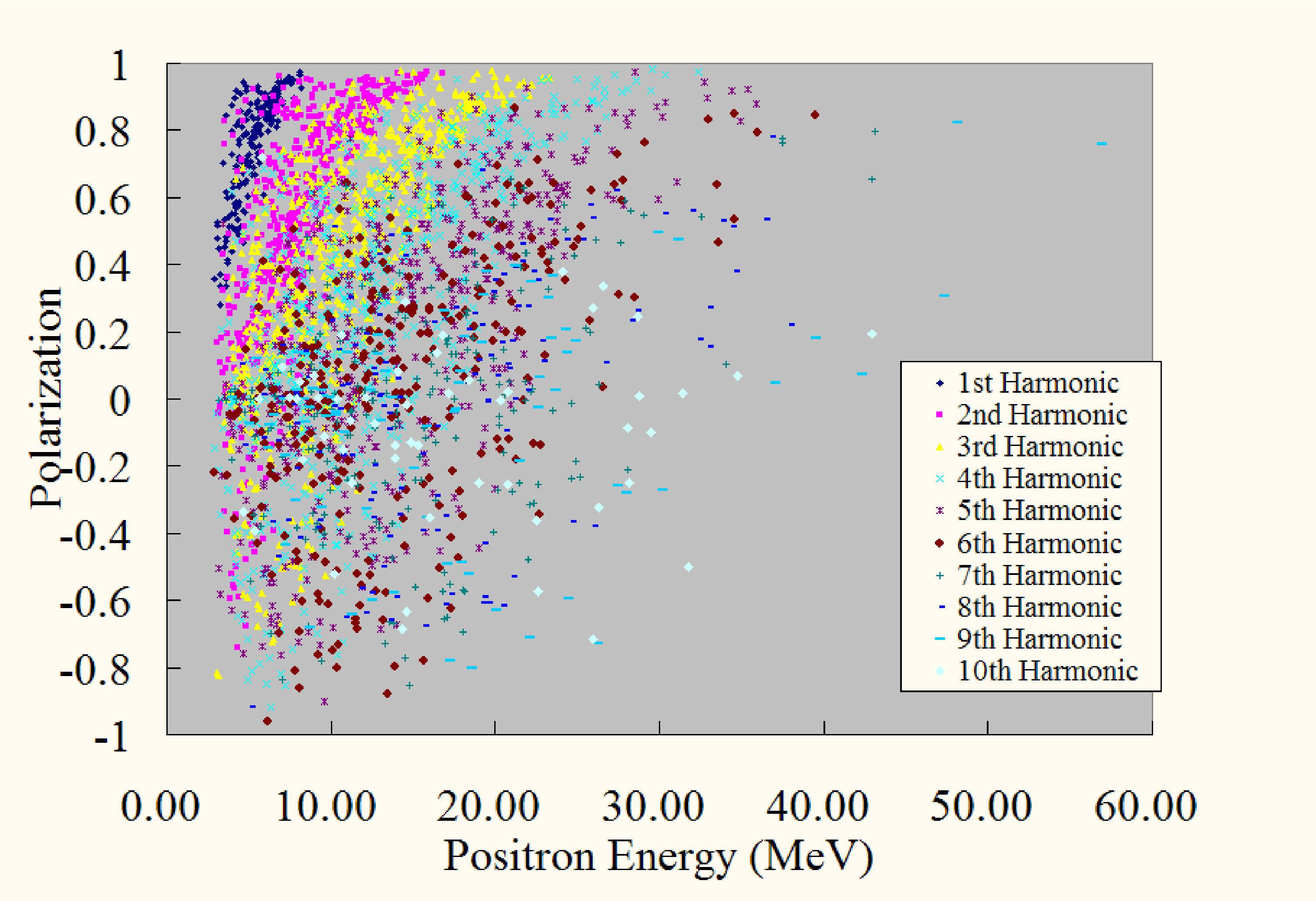
The new baseline

Photon Number Spectrum

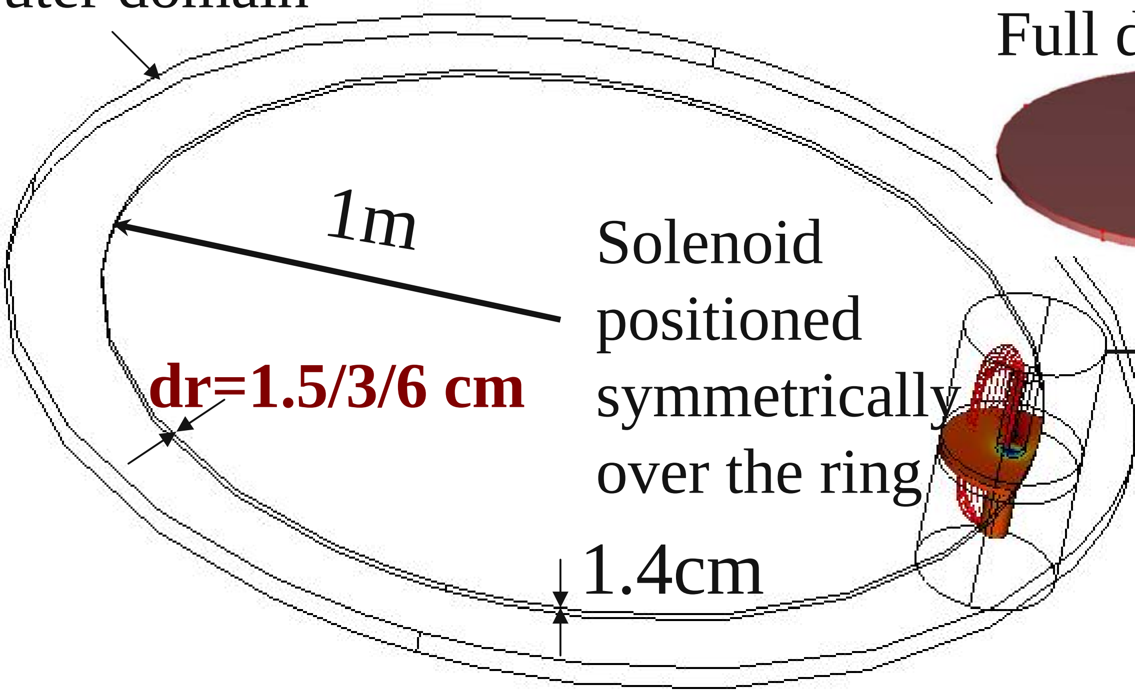


Number of photons per e- per 1m undulator:
Old BCD: 2.578
UK1: 1.946; UK2: 1.556; UK3: 1.107
Cornell1: 0.521; Cornell2: 1.2; Cornell3: 0.386

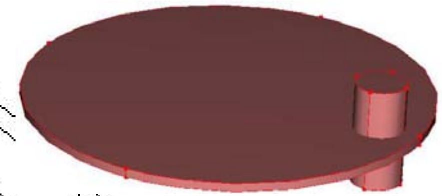
Initial Pol. Vs Energy of Captured Positron Beam



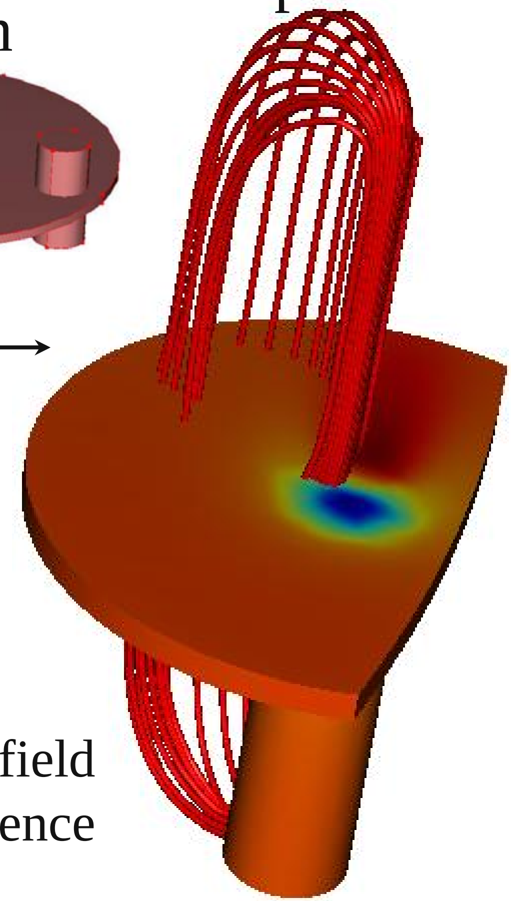
Simulation geometry



Full domain



Upper solenoid is not pictured

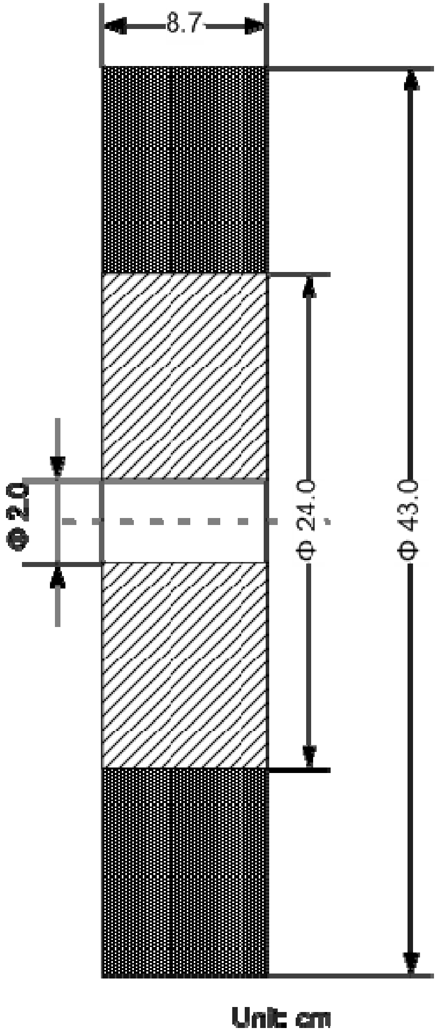


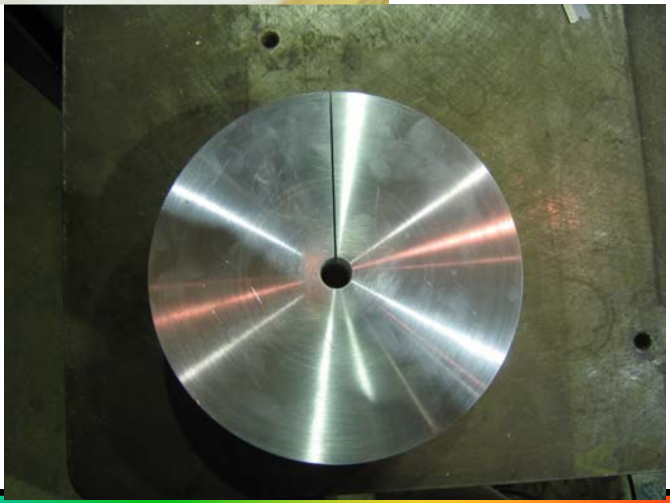
3/6/12cm

Typical simulation result: streamlines of solenoidal magnetic field (in simulation we consider returning flux – principal difference from the setup with magnet)

Color: induced magnetic field (produced by eddy currents) at some frequency of rotation, ω.

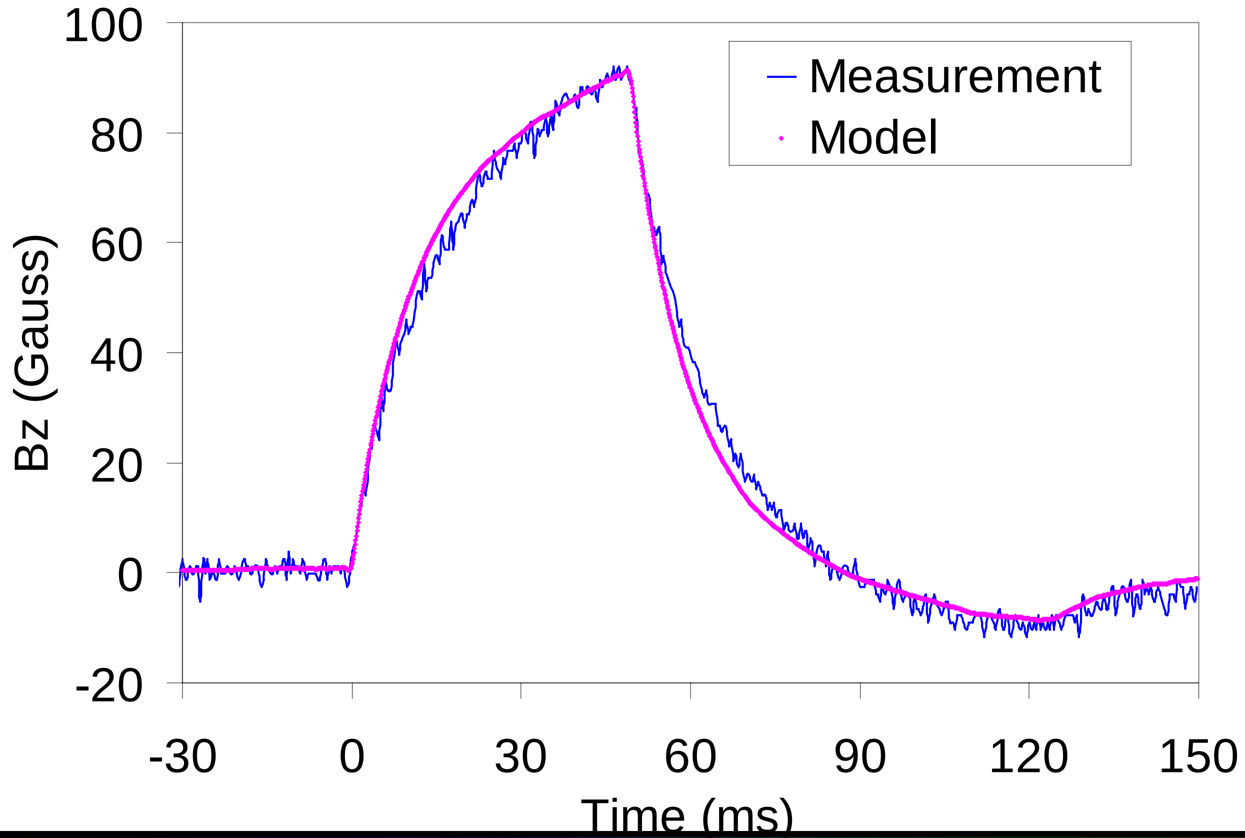
Prototype Flux Concentrator





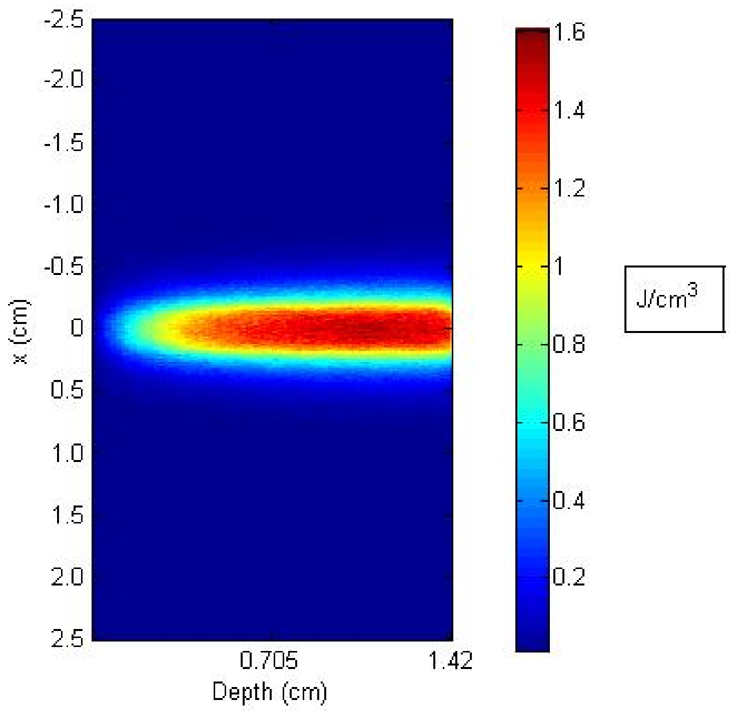
Comparison of Measured and Modeling results of transient magnetic field

With the same dimensions and material properties of the prototype structure, the transient magnetic field is calculated using the circuit model. A very good agreement is achieved.



Energy Deposition Profile and General Results

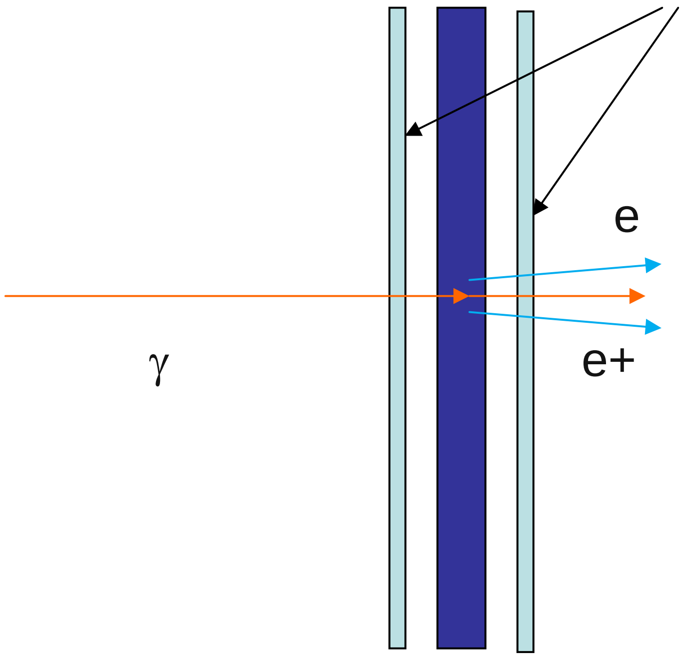
Energy deposition profile showing here is calculated per drive e- bunch



- Energy deposition in target per bunch is about 0.5255J
- Energy deposition per pulse: about 1482J
- Power deposition per pulse 1482(J)/0.874e-3(s) ~= 1.696MW
- Average power deposition: 1482*5=7.4KW

The data for this profile has been provided to LLNL for cooling and stress study.

Target chamber window thermal dynamic calculation



Beryllium window of 0.375mm thickness

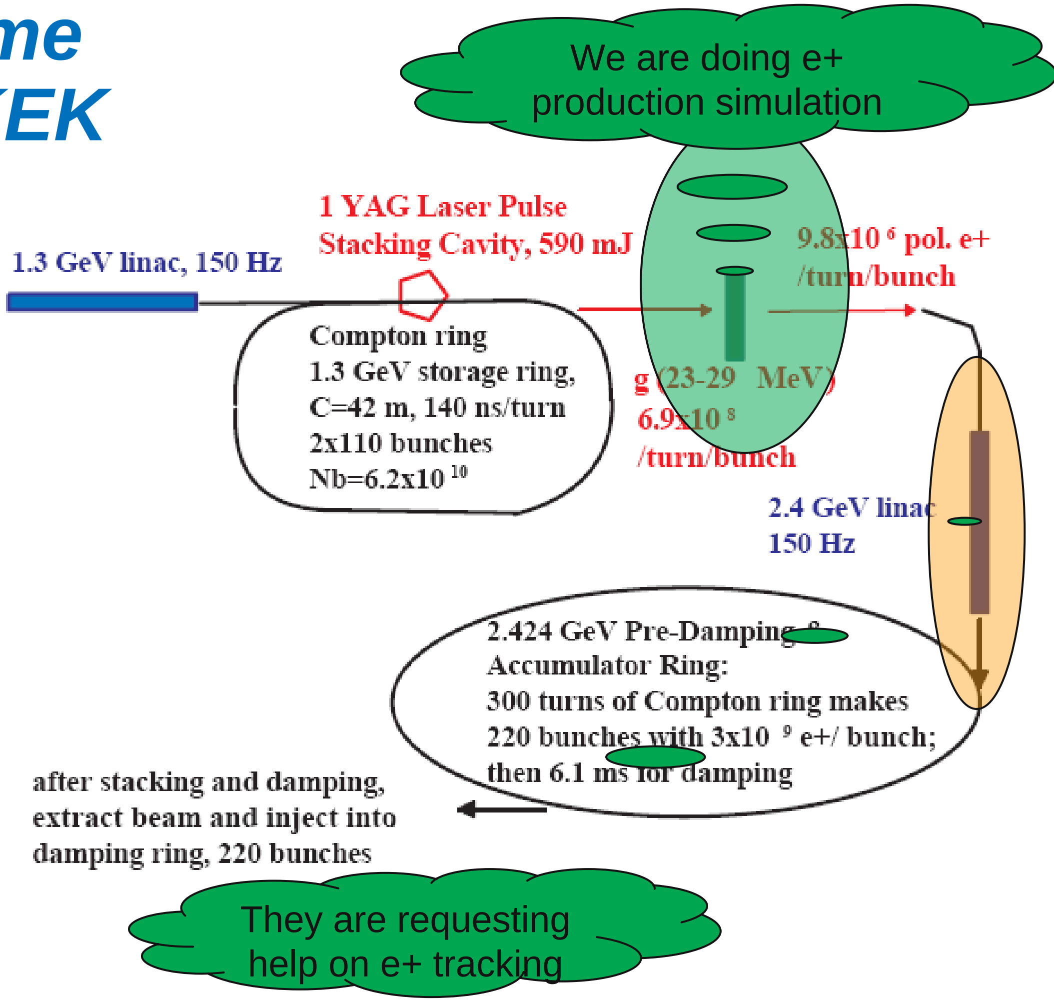
e-,e + and γ

Undulator: K=1 λu=1cm, 100m long with 150GeV 3nC electron drive beam. The size of electron drive beam is σx=0.1mm and the bunch length is about 2.5ps. The drift to the target is 500m

- **~0.32mJ per bunch deposited in upstream window**
- **~8.4mJ per bunch deposited in downstream window**

Laser Compton Scheme --Collaboration with KEK

Beside of doing undulator based positron source simulations, we are also doing simulations KEK/CLIC to help them on the Laser Compton Scheme positron source.



On going and immediate future plans

- Quarter-wave transformer capture studies: how well does this work? Essentially want zero field on target
- Energy deposition calculations for RAL material optimization: start with 5-D acceptance cut to estimate yield and feedback into production calculation to determine incident beam power
- Undulator→Target separation (yield versus spot size); also undulator→dump distance (how much drift is required to permit a window?)
- As part of system engineering team to perform EDR studies on: Target, transport, beam dumps and radiation activations.