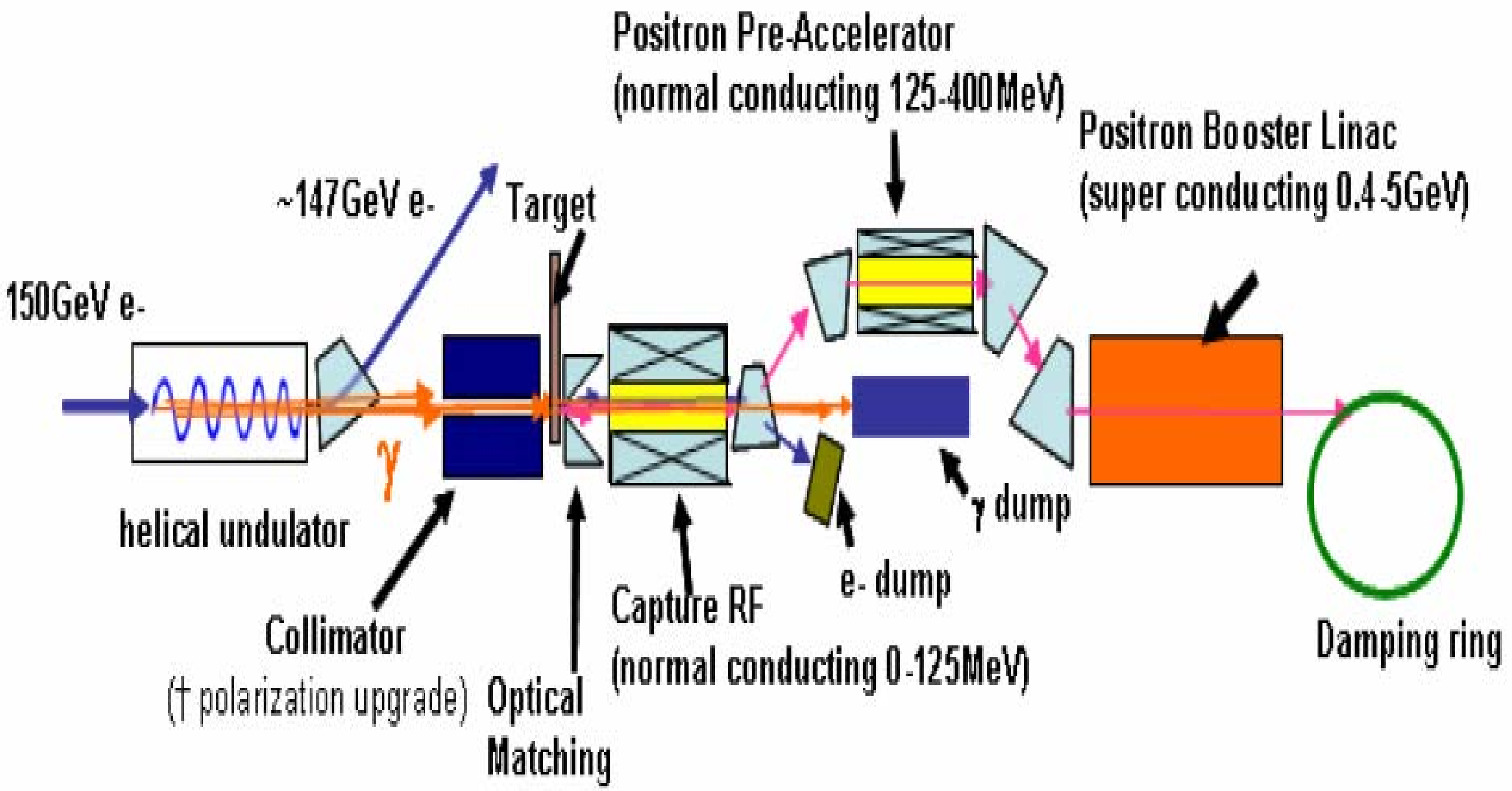
S5 Positron Source

Jim Clarke
ASTeC
Daresbury Laboratory

ILC Positron Sources Group

- Group considers all possible source schemes
- First 3 day meeting of all interested parties at RAL, UK in September 2006
  - Improved coordination of source studies
  - http://www.te.rl.ac.uk/ILC_Positron_Source_Meeting/ILC Meeting.html
- Second 3 day meeting of group in Beijing last week
  - Many thanks to our hosts for their excellent organisation and hospitality
  - Moving from RDR to EDR
  - Much of this talk is effectively a summary of this meeting
  - http://hirune.kek.jp/mk/ilc/positron/IHEP/
- Next meeting at Argonne ~August 07

Undulator based source - RDR Design



Layout of ILC Positron Source: January 2007

- Photon production at 150 GeV electron energy
- K=0.92, λ=1.15 cm, 147 m long helical undulator, UK design
- One e+ production station (no backup-- fast target exchange) + KAS
- Pulsed OMD (shielded target)
- Reduced number of BPM electronics and correctors in transport lines
- Keep alive auxiliary source, 10% intensity

  (500 MeV, 2.05×10^{10} e-/bunch, 2625(?) bunches/pulse,

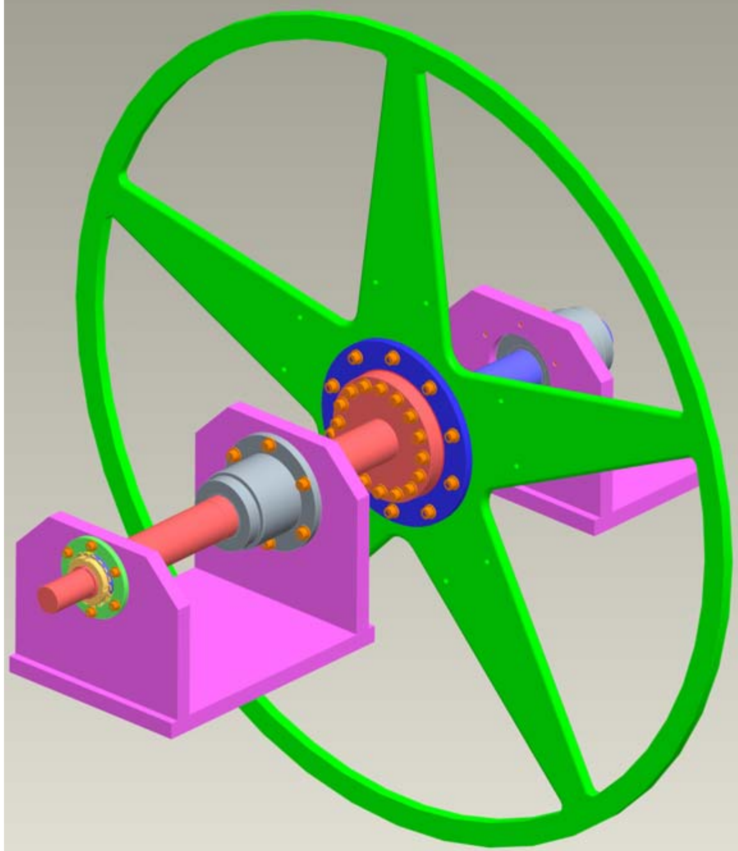
  5 pulses/s into ~4 r.l. W-Re spinning target, collection system same as for main positron production, 400 MeV e+ preBoost, inject into e+ 5 GeV Booster)

John Sheppard

Recent Progress

- Target
- Undulator
- Low Energy Polarimeter
- 30% Polarisation
- Alternative Source

Target Wheel



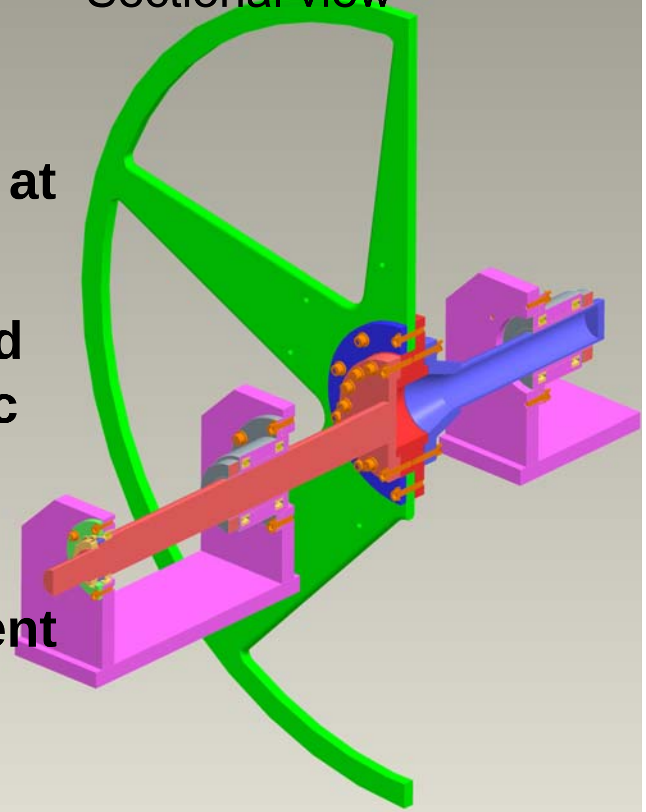
Titanium Alloy

Rotates at 100m/s at rim

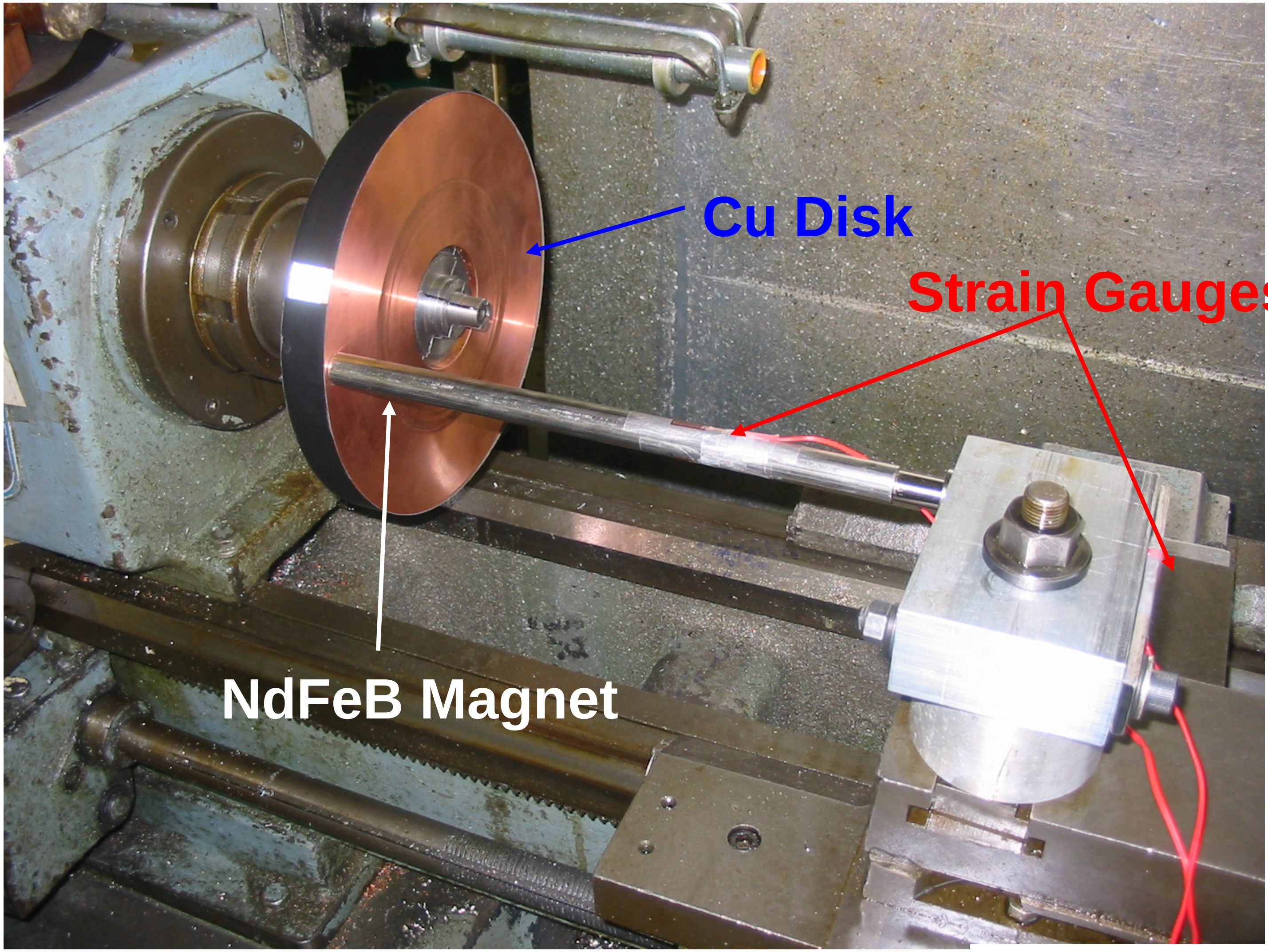
If can be immersed in strong magnetic field then capture more positrons

Strong Eddy current effects

Sectional view

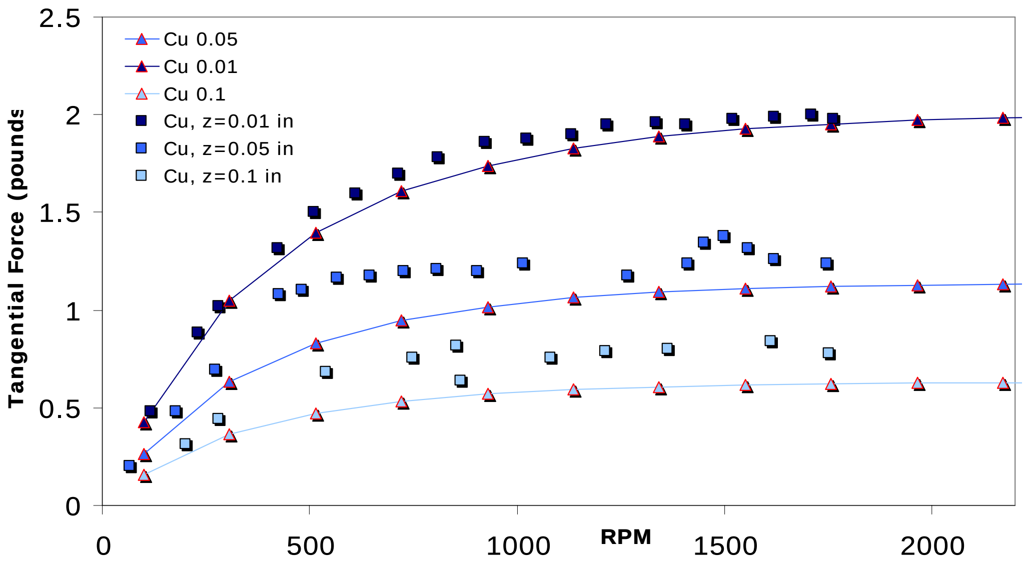


Positron System Spinning Disk Exp & Simulations: ANL, LLNL, SLAC, RAL



John Sheppard

Theory vs Experiment



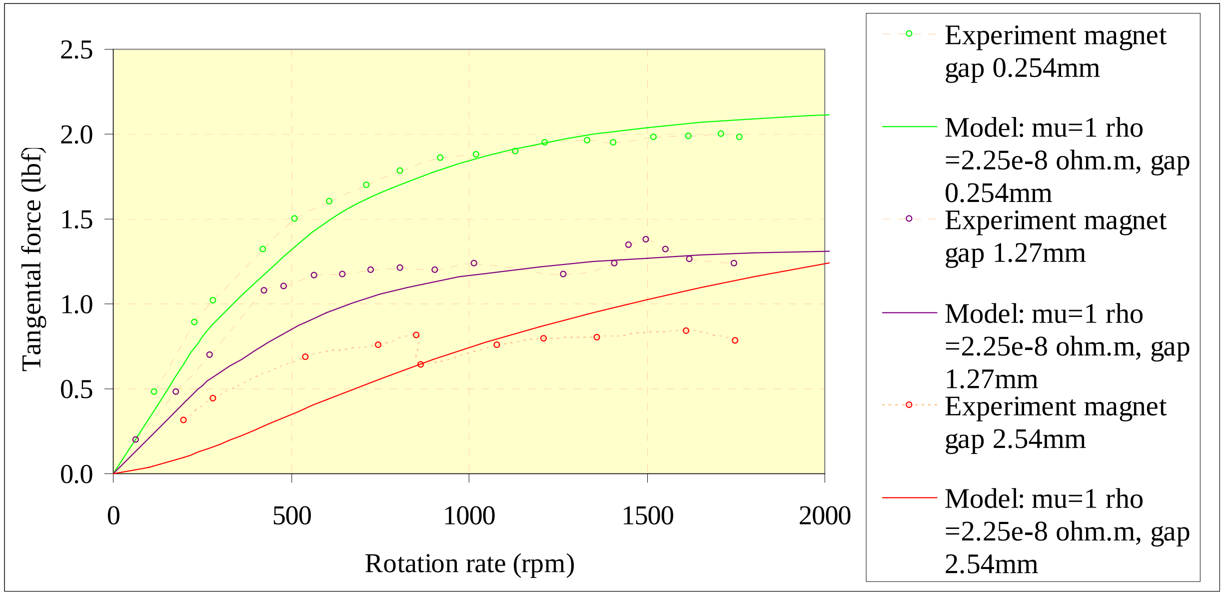
Variable is distance between the magnet and the disk

ANL

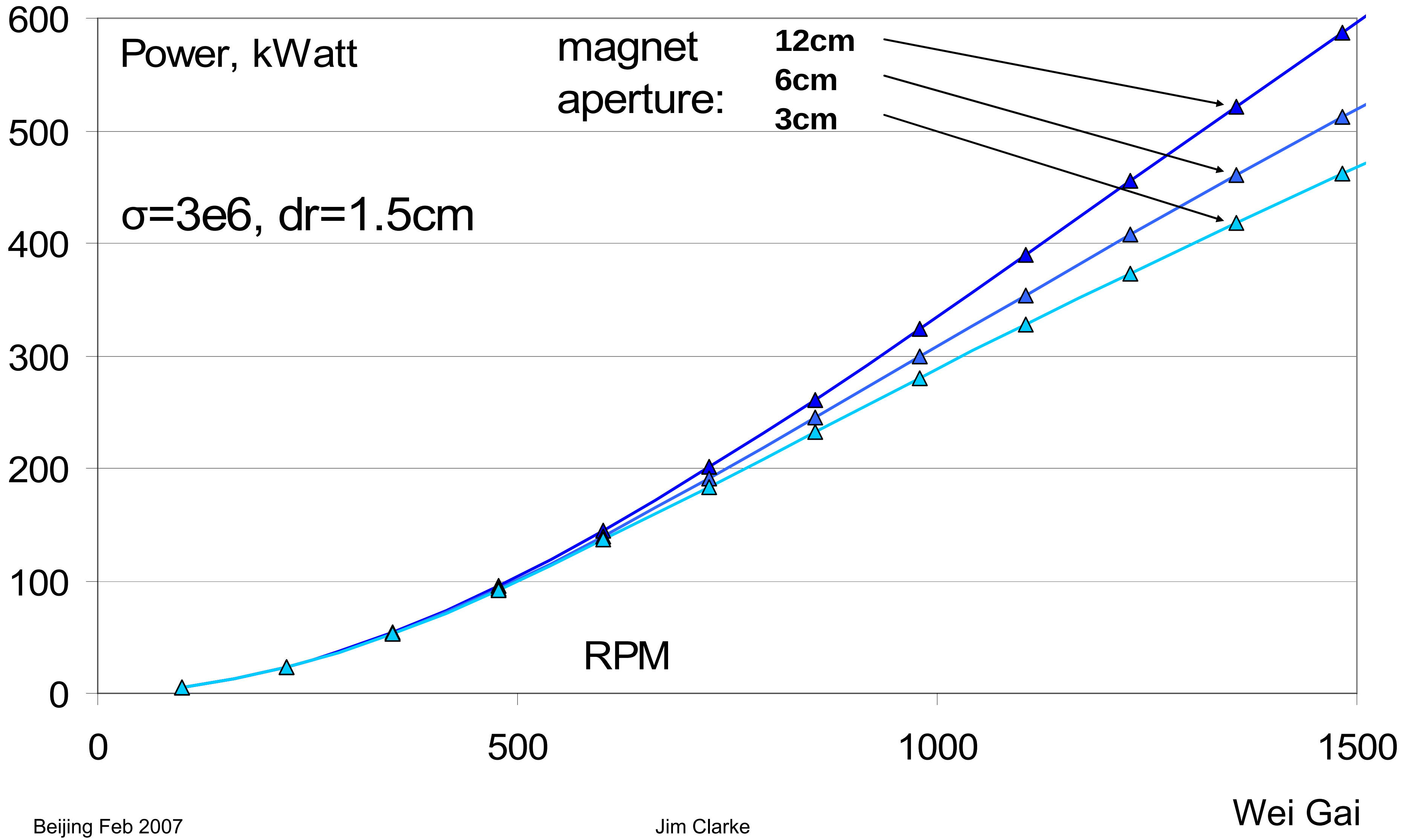
Wei Gai

RAL

Jim Rochford

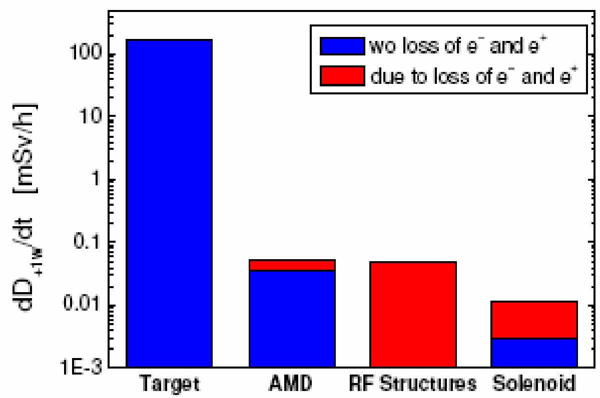


Results for actual target in 5T field



Target Activity

Andriy Ushakov



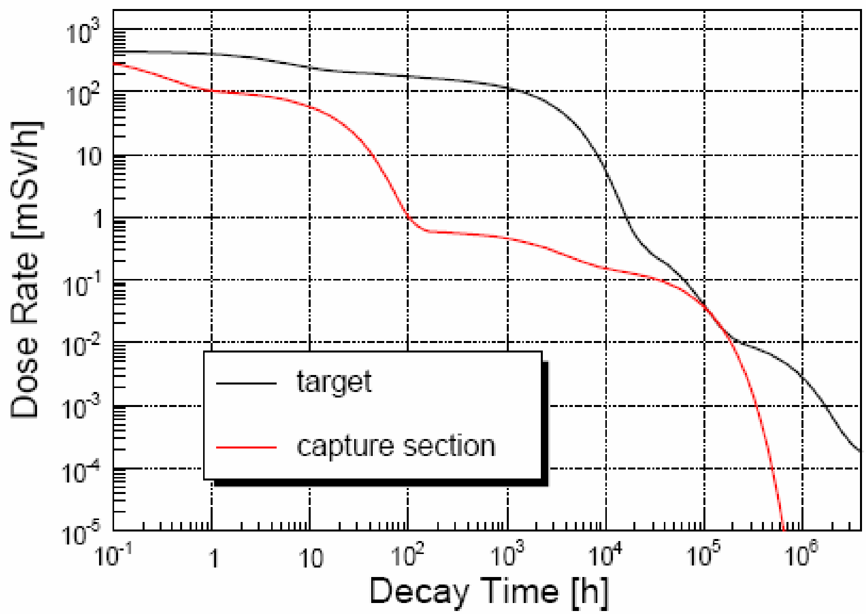
Dose rate after 5000 h of source operation and 1 week shutdown

Source part	$\dot{D}_{1w}$ [mSv/h]
Target	$167 \pm 9.5\%$
AMD	$0.077 \pm 100\%$
RF Structures	$0.109 \pm 82\%$
Solenoid	$0.024 \pm 100\%$

Target dose rate remains high for ~ 1 year

20mSv/hr is typical limit for manual handling

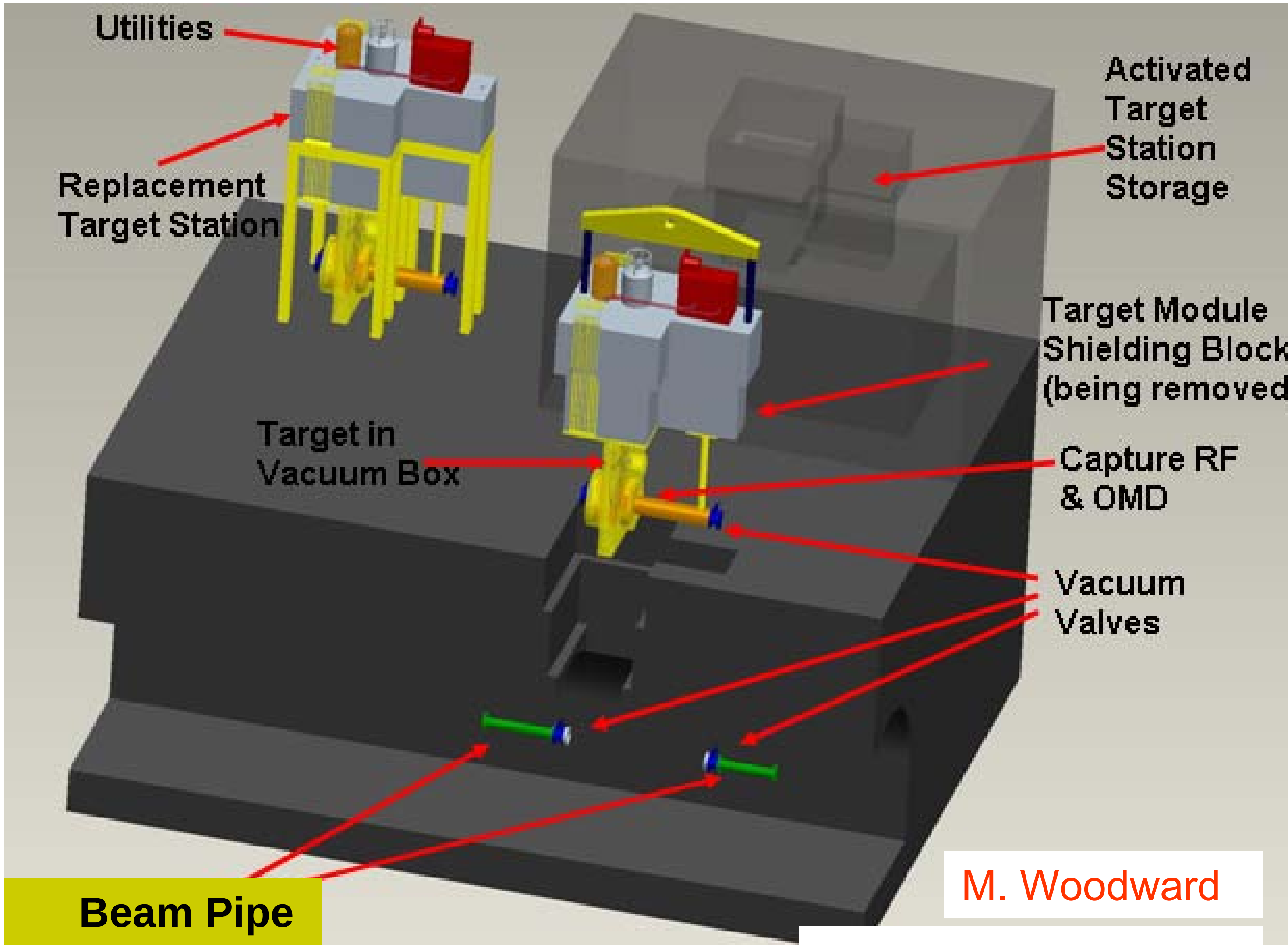
Remote handling essential



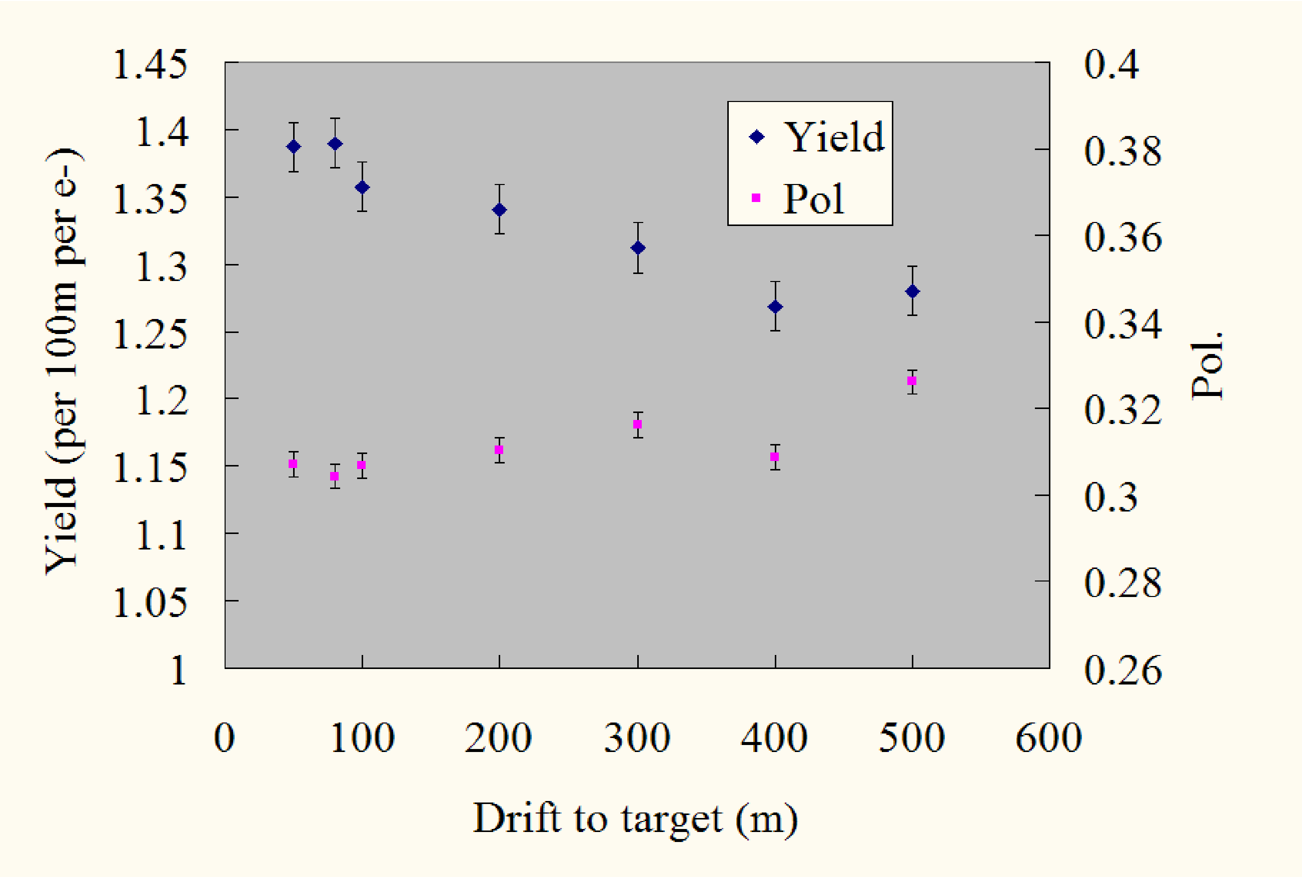
Target Removal/Replacement Showing Storage Cell

Time to change targets estimated at 53 hours

Important because 2nd target removed



~30% Polarisation Available for Free



60% polarisation requires additional undulator

Wei Gai

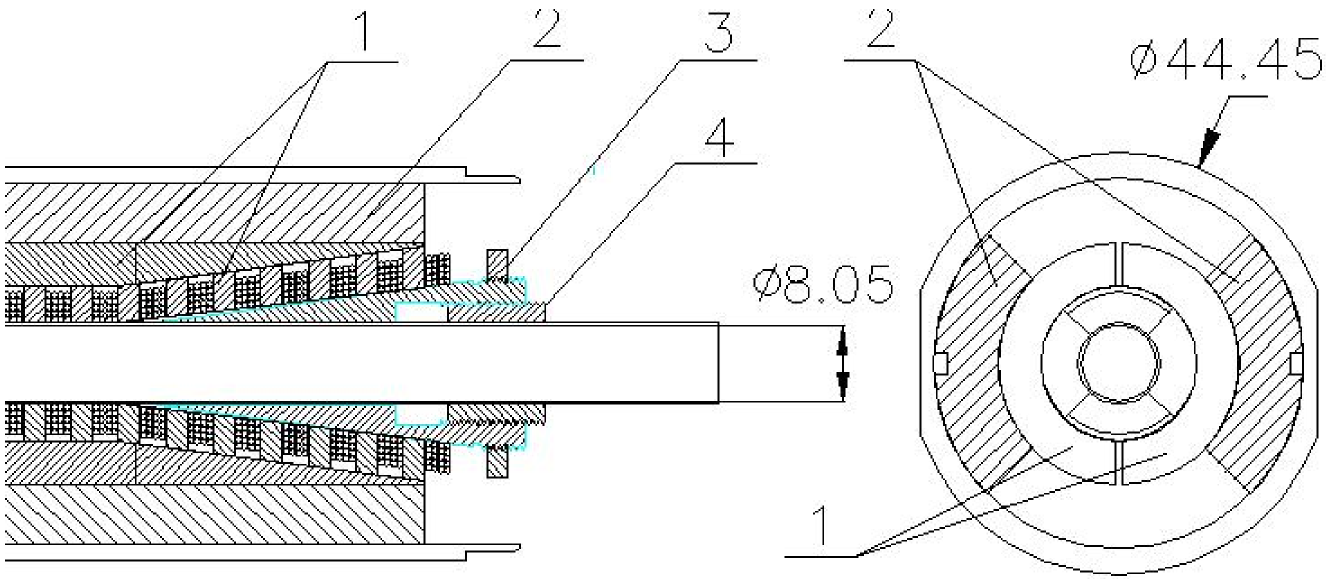
Example Enhancements to Physics

- Updated summary table is in progress (led by Gudi Moortgat-Pick)
- 30% provides significant gains so should ensure it can be transported and measured at IP

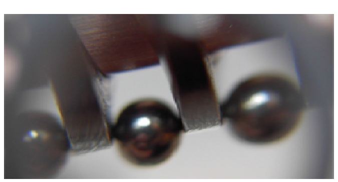
$(P(e^-), P(e^+))$	Effects for $P(e^-) \longrightarrow P(e^-)$ and $P(e^+)$	Gain w.r.t. (80%,0%)& Requirement (80%,60%)	(80%,30%)
Statistics:			
P_{eff}	V,A processes	95%	88%
$\Delta A_{LR}/A_{LR}$	due to error propagation	×3	×2
Standard Model:			
top threshold	Electroweak coupling measurement	× 3	× 2
$t\bar{q}$	Limits for FCN top couplings improved	× 1.8	× 1.4
CPV in $t\bar{t}$	Azimuthal CP-odd asymmetries give access to S- and T-currents up to 10 TeV	$P^{\mathrm{T}}_{e-} P^{\mathrm{T}}_{e+}$	$P^{\mathrm{T}}_{e-} P^{\mathrm{T}}_{e+}$ ×0.8
W^+W^-	TGC: error reduction of $\Delta\kappa_\gamma$, $\Delta\lambda_\gamma$, $\Delta\kappa_Z$, $\Delta\lambda_Z$	×1.8	
	Specific TGC $\tilde{h}_+ = \mathrm{Im}(g_1^{\mathrm{R}} + \kappa^{\mathrm{R}})/\sqrt{2}$	$P^{\mathrm{T}}_{e-} P^{\mathrm{T}}_{e+}$	$P^{\mathrm{T}}_{e-} P^{\mathrm{T}}_{e+}$
CPV in γZ	Anomalous TGC $\gamma\gamma Z, \gamma Z Z$	$P^{\mathrm{T}}_{e-} P^{\mathrm{T}}_{e+}$	$P^{\mathrm{T}}_{e-} P^{\mathrm{T}}_{e+}$
HZ	Separation: $HZ \leftrightarrow H\bar{\nu}\nu$	×4	× 2
	Suppression of $B = W^+\ell^-\nu$	×1.7	
$t\bar{t}H$	Top Yukawa coupling at $\sqrt{s} = 500$ GeV	×2.5	×1.6

Sabine Riemann

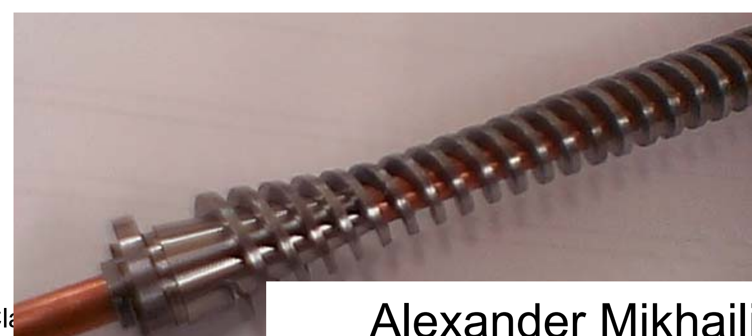
Cornell Undulator design



Details of design. 1–Iron yoke, 2–Copper collar, 3, 4–trimming Iron nuts. Inner diameter of Copper vacuum chamber is 8mm clear.

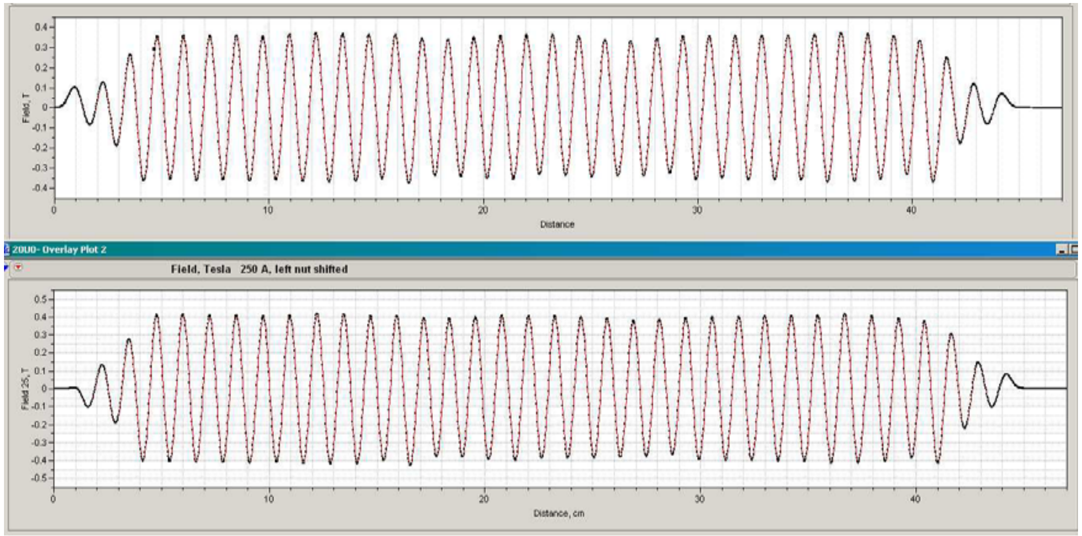


Period kept even



Alexander Mikhailichenko

10 and 12 mm period Cornell undulators

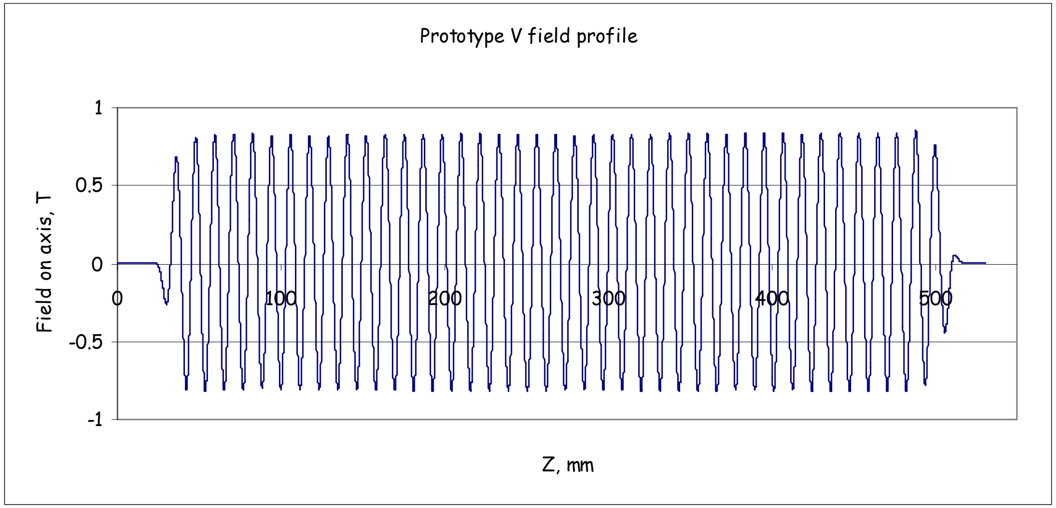


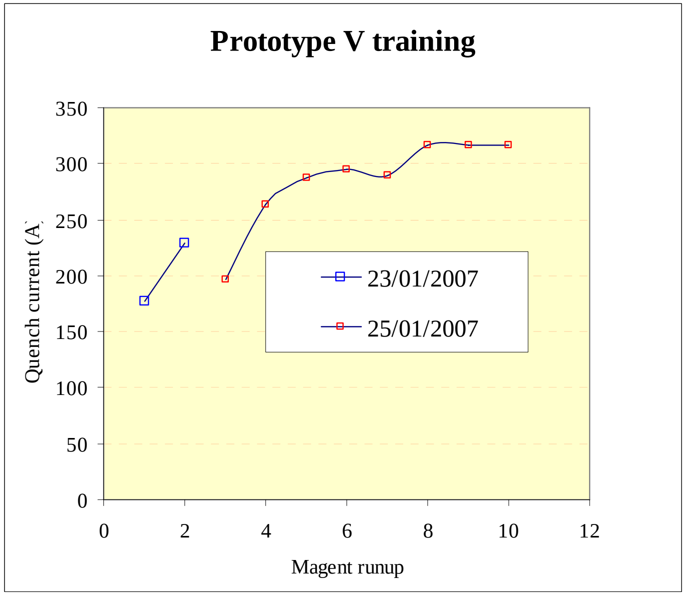
10 (12) mm period undulator prototype has achieved field just before quench of 0.45 (0.64) T.

Alexander Mikhailichenko

UK Undulator Prototypes

1st results from prototype 5 at RAL





Measured field at 200A

0.822 T +/- 0.7 %
(spec is +/- 1%)

Prototype 5 details

Period : 11.5 mm
Magnetic bore: 6.35 mm
Configuration: Iron poles and yoke

Quench current 316A

Equates to a field of 1.1 T in bore

RDR value is 0.86 T

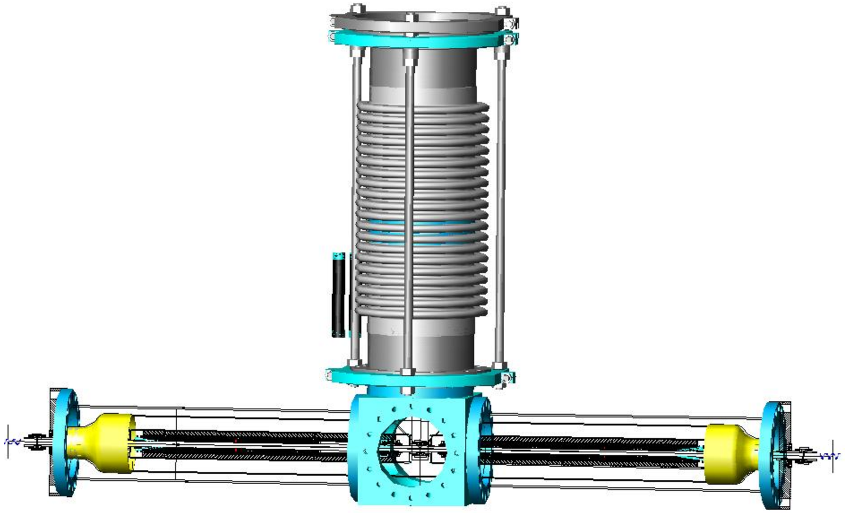
80% of critical current (proposed operating point) would be 0.95 T

Jim Clarke

Jim Rochford

Cornell FY2008 Project Activities and Deliverables

Optimization of prototype(s) having 8 mm aperture and 10 mm period. Calculations of emittance and alignment perturbations in the undulator will be completed in this year. Materials and equipment required for fabrication and test of 2x30 cm long models will be obtained and used for prototype shown in Figure below



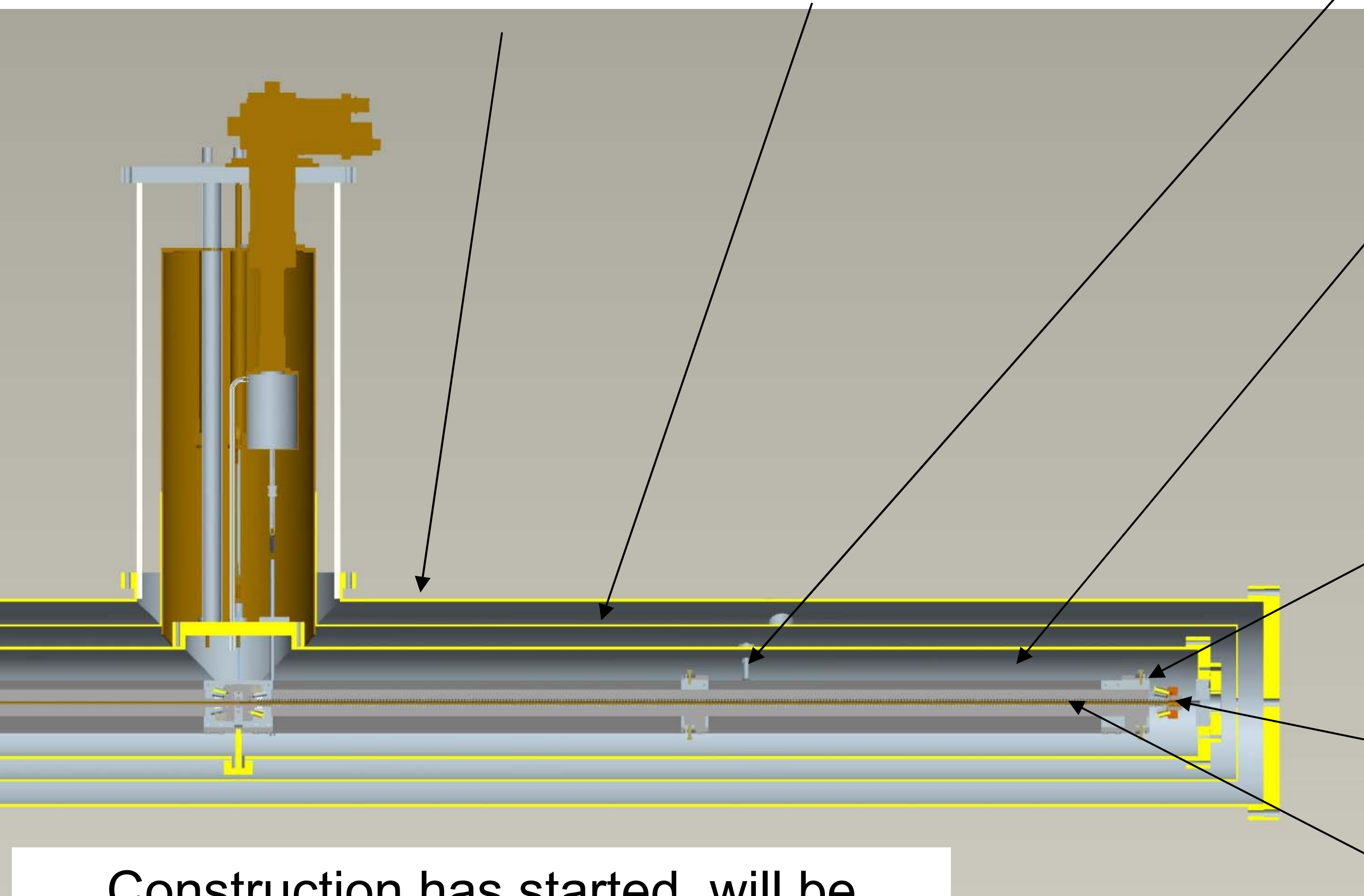
FY2009 Project Activities and Deliverables

Fabrication and assembling the 4-6-m long section will be accomplished in this year.
Design of Hall probe system for the field measurements in 6-m long module will be accomplished.
Note that the field measurements must be done in vacuum at cryogenic temperature.

Alexander Mikhailichenko

UK 4m Prototype Module

Jim Rochford



Construction has started, will be complete by Autumn 07

Positron yields from different 100m undulators

	BCD	UK I (RDR)	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(60% Pol)	~1.1	~0.7	~0.66	~0.53	~0.32	~0.49	~0.44

Target: 1.42cm thick Titanium

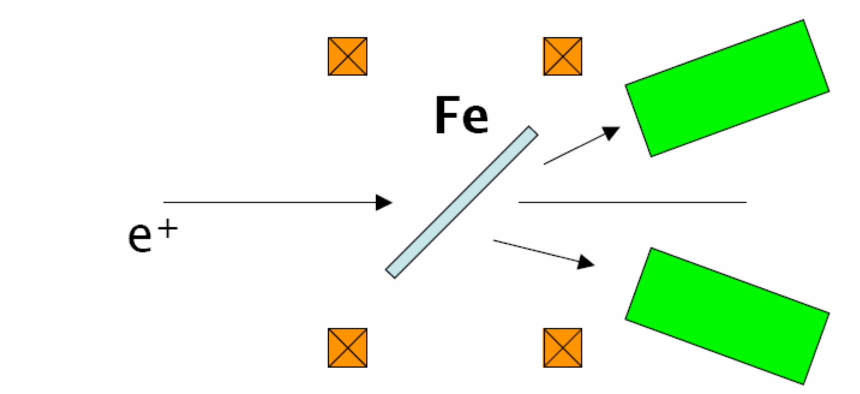
Wei Gai

Low Energy Polarimeter - Considered Processes

- Laser Compton Scattering
- Compton Transmission Experiment
- Mott Scattering
- Synchrotron radiation
- **Bhabha/Møller**

magnetized iron target;

e- polarization in Fe: ~7%, angular distribution of scattered particles corresponds to e+ polarisation

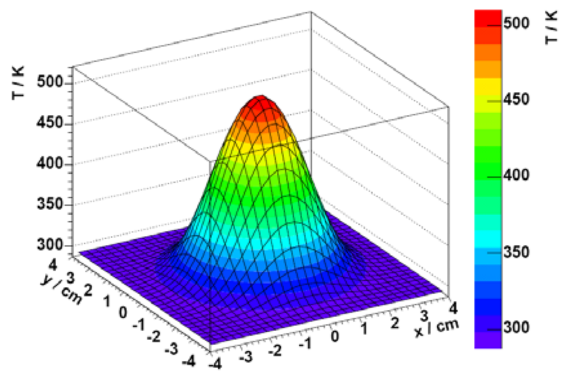


Sabine Riemann

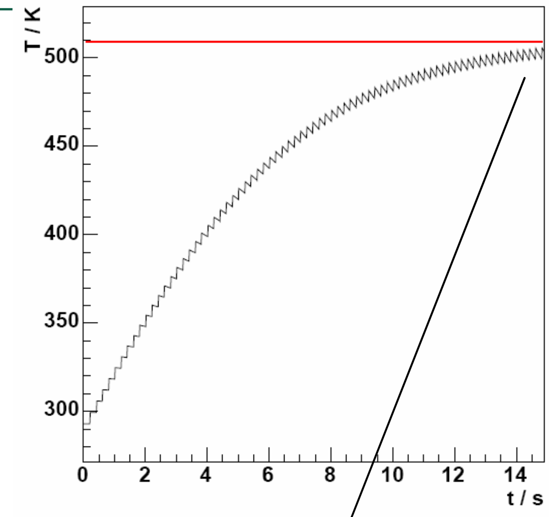
Magnetized Iron Target

Heating of the target -> Magnetization decreases

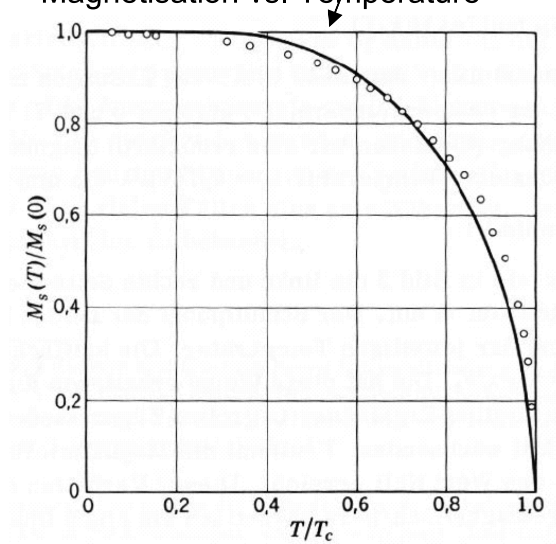
- Simulation for 30 µm
- Cooling by radiation
- T_C (Fe) = 1039 K; melting point 1808 K



Target temperature vs. time



Magnetisation vs. Temperature



Ongoing considerations on target layout

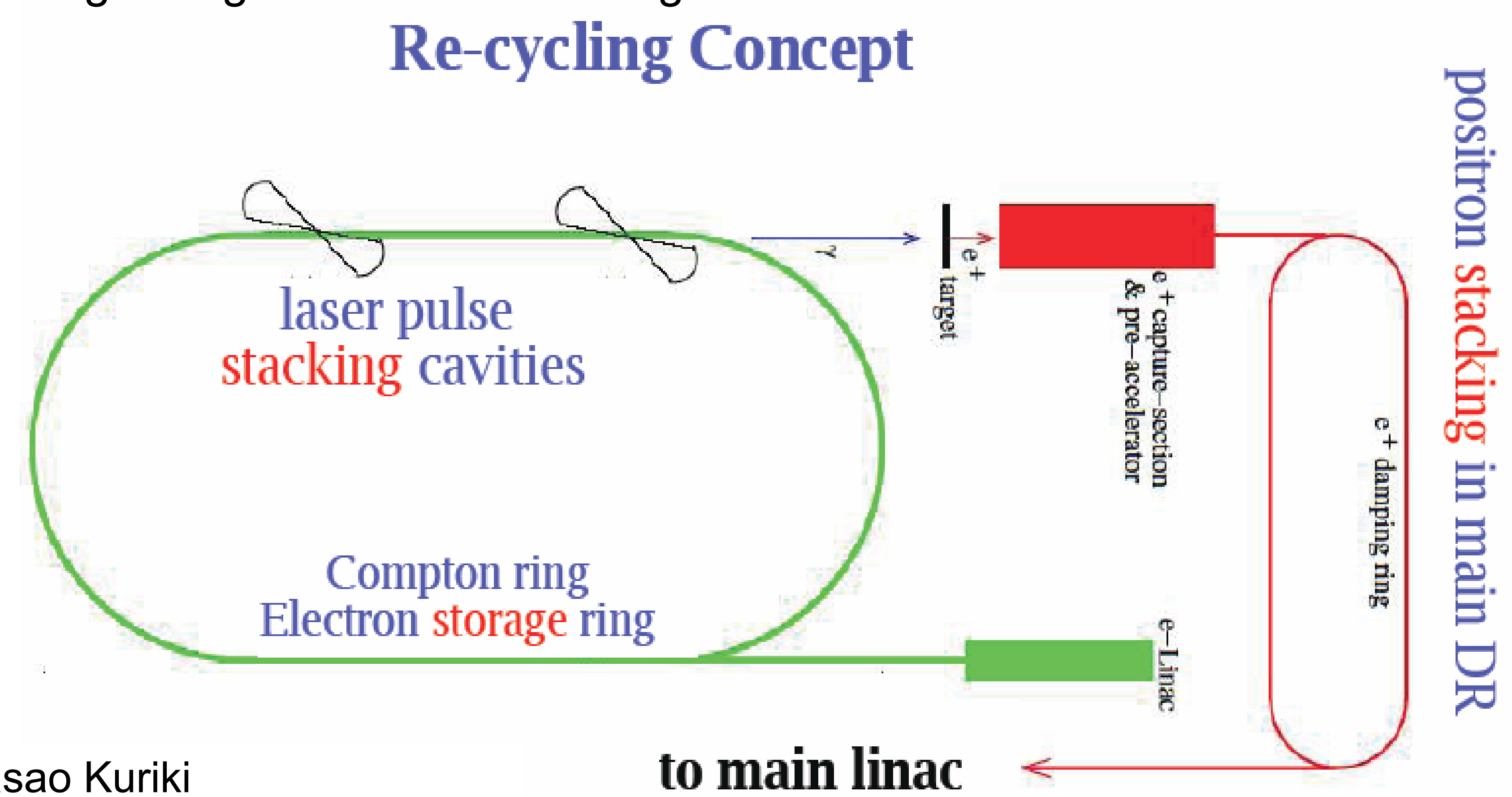
- ΔT → ΔM → ΔP → ΔAsy
- Magnetization (monitoring, tilted target?)
- Cooling in real

ACD Positron Source - Laser Compton Scheme

R & D also ongoing on laser compton source

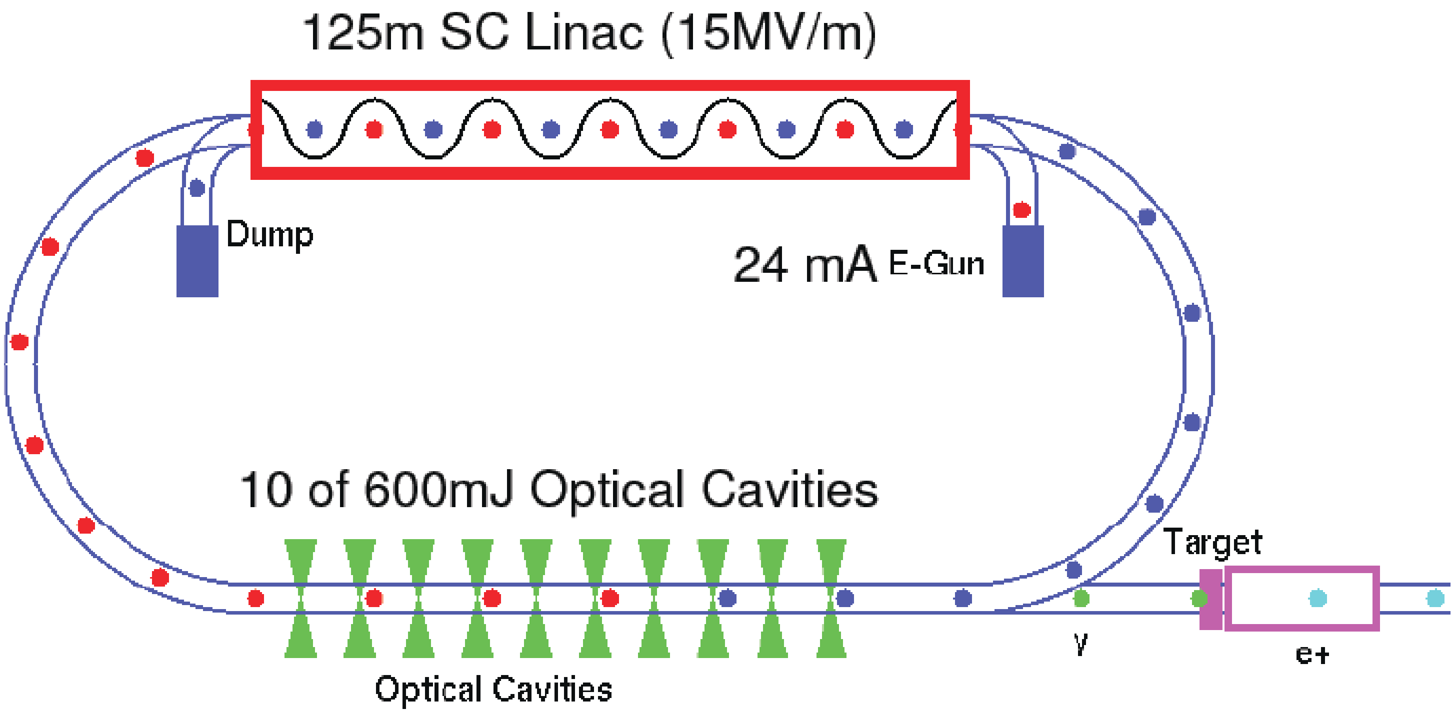
3 different schemes under consideration:

Storage Ring Based with stacking in DR



ERL Based Compton Source

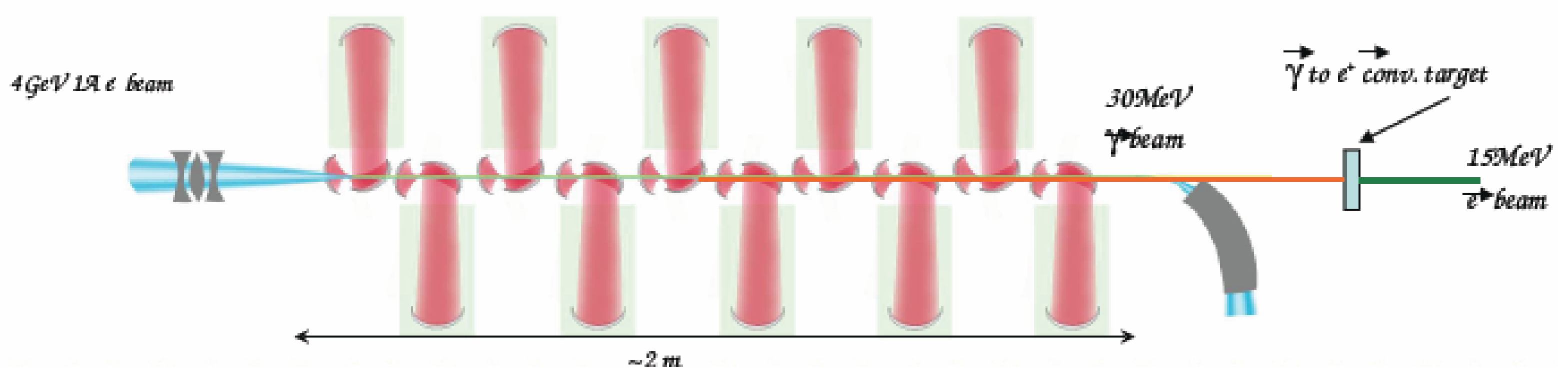
Energy Recovey Linac Based with stacking in DR



Masao Kuriki

Linac Based Scheme – no stacking in DR

- polarized - ray beam is generated in the Compton back scattering inside optical cavity of CO_2 laser beam and 4 GeV e-beam produced by linac.
- The required intensities of polarized positrons are obtained due to 10 times increase of the e-beam charge (compared to non polarized case) and 5 to 10 CO_2 laser system IPs.
- Laser system relies on the commercially available lasers but need R&D for the new mode of operation
- 5ps 10J@0.05 Hz CO_2 laser is operated at ATF



Undulator based source - EDR Design

All major items are being studied
(& others not highlighted here)

Now need to produce a fully engineered, self-consistent, system