Overview of Positron Source Design

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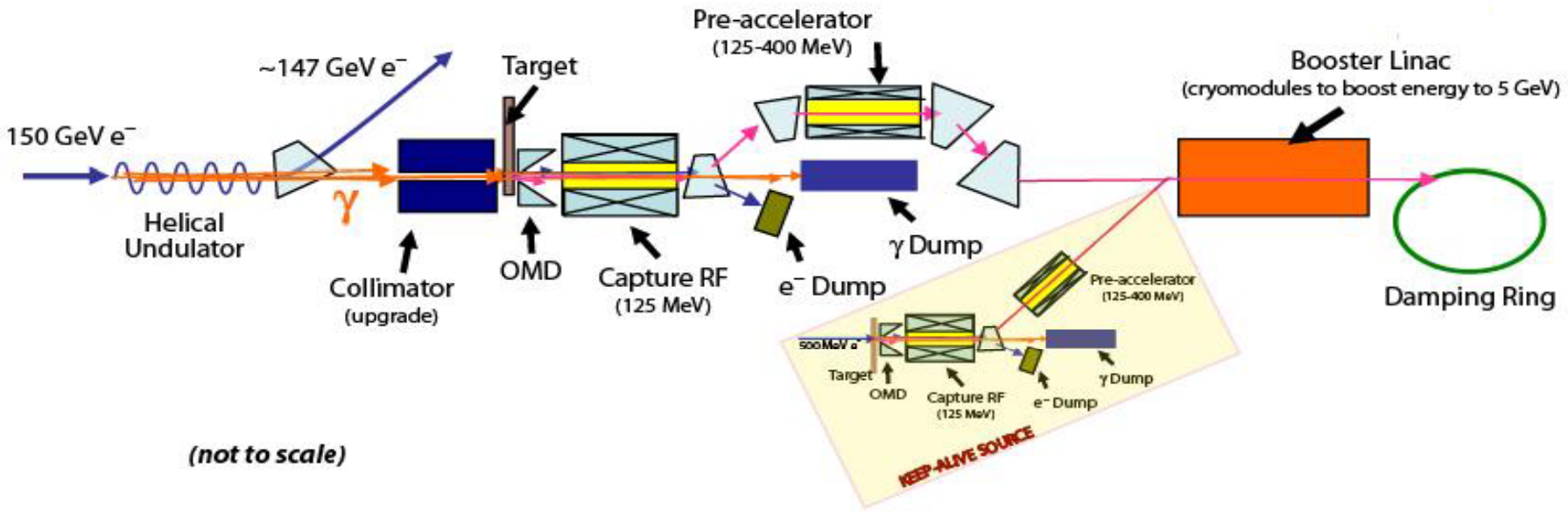
The RDR Parameters

Nominal Positron Source parameters († upgrade values).

Beam Parameters	Symbol	Value	Units
Positrons per bunch at IP	n_b	2×10^{10}	number
Bunches per pulse	N_b	2625	number
Pulse repetition rate	f_{rep}	5	Hz
Positron energy (DR injection)	E_0	5	GeV
DR transverse acceptance	$\gamma(A_x+A_y)$	0.09	m-rad
DR energy acceptance	δ	$\pm$ 0.5	%
DR longitudinal acceptance	A_l	$\pm3.4 \times \pm25$	cm-MeV
Electron drive beam energy	E_e	150	GeV
Electron beam energy loss in undulator	ΔE_e	3.01	GeV
Positron polarization †	P	~60	%

- Positron overhead of 50% after the target
  - ➔ 3 x 10^{10} e^+ per bunch at 400 MeV
- Positron overhead of 25% at the Damping Ring
  - ➔ 2.5 x 10^{10} e^+ per bunch within the DR acceptance

RDR Source Layout



Key Points

- Photon ‘drive beam’ generated in helical superconducting undulator at 150 GeV
- Photon beam transported ~400m beyond undulator and then impinges on Ti alloy target (0.4 rad lengths, 1.4cm)
- Positrons captured with OMD, accelerated with NCRF Linac with solenoidal focussing to 125 MeV
- Any electrons and remaining photons are then separated
- Positrons further accelerated with NCRF Linac with solenoidal focussing to 400 MeV
- Transported at 400 MeV for ~5km
- Accelerated to 5GeV in SCRF Linac and injected into DR

Keep Alive Source (KAS)

- A KAS is incorporated into the design
- KAS uses 500 MeV electron drive beam which impinges on W-Re target
- Positrons from KAS are accelerated to 400 MeV and then share common SCRF Linac to reach 5 GeV
- KAS designed to generate 10% bunch intensity for full bunch train (2625 bunches) at 5Hz

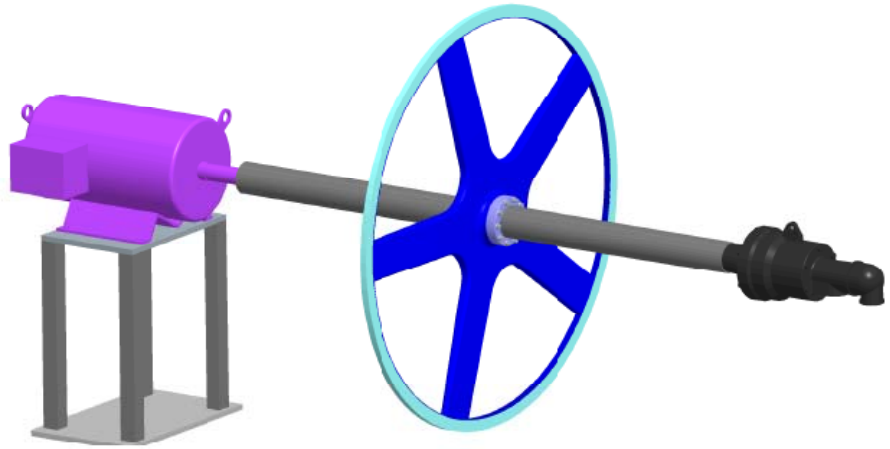
Undulator

- 42 x 4m cryomodules (42 x 3.5 = 147m active length)
- Vacuum pumps, photon collimators, quads, BPMs installed every 3 cryomodules in room temp sections
- Corrector magnets in every cryomodule

Undulator Parameters	Symbol	Value	Units
Undulator period	λ	1.15	cm
Undulator strength	K	0.92	
Undulator type		helical	
Active undulator length	L_u	147	m
Field on axis	B	0.86	T
Beam aperture		5.85	mm
Photon energy (1^{st} harmonic cutoff)	E_{c10}	10.06	MeV
Photon beam power	P_γ	131	kW

Target

- 1m diameter spinning wheel
- Rim & spokes not disk to mitigate eddy current effects
- Designed for operational life of 2 years



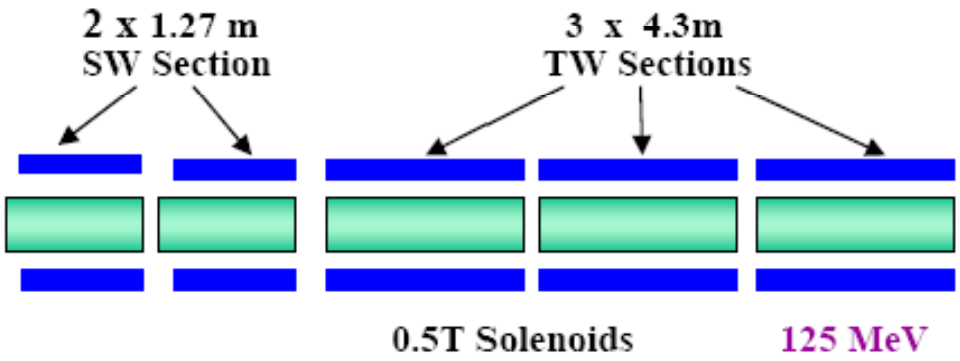
Target Parameters	Symbol	Value	Units
Target material		Ti-6%Al-4%V	
Target thickness	L_t	0.4 / 1.4	r.l. / cm
Target power adsorption		8	%
Incident spot size on target	σ_i	> 1.7	mm, rms

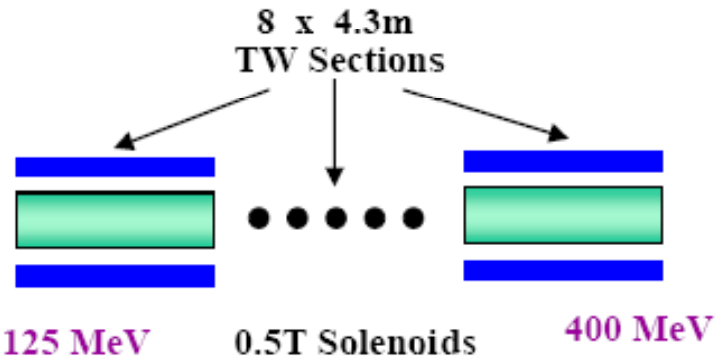
Optical Matching Device

- Increases capture efficiency by ~ factor 2
- Solenoidal Peak field close to target of 5T
- Tails off to 0.5T (over 20cm) to match linac solenoids
- NC Flux Concentrator

NC RF Linacs

- Standing wave structure first (15 MV/m)
- Travelling wave structures second (8.5 MV/m)
- All surrounded by 0.5 T NC Solenoids (high power)
- All RF is 1.3 GHz



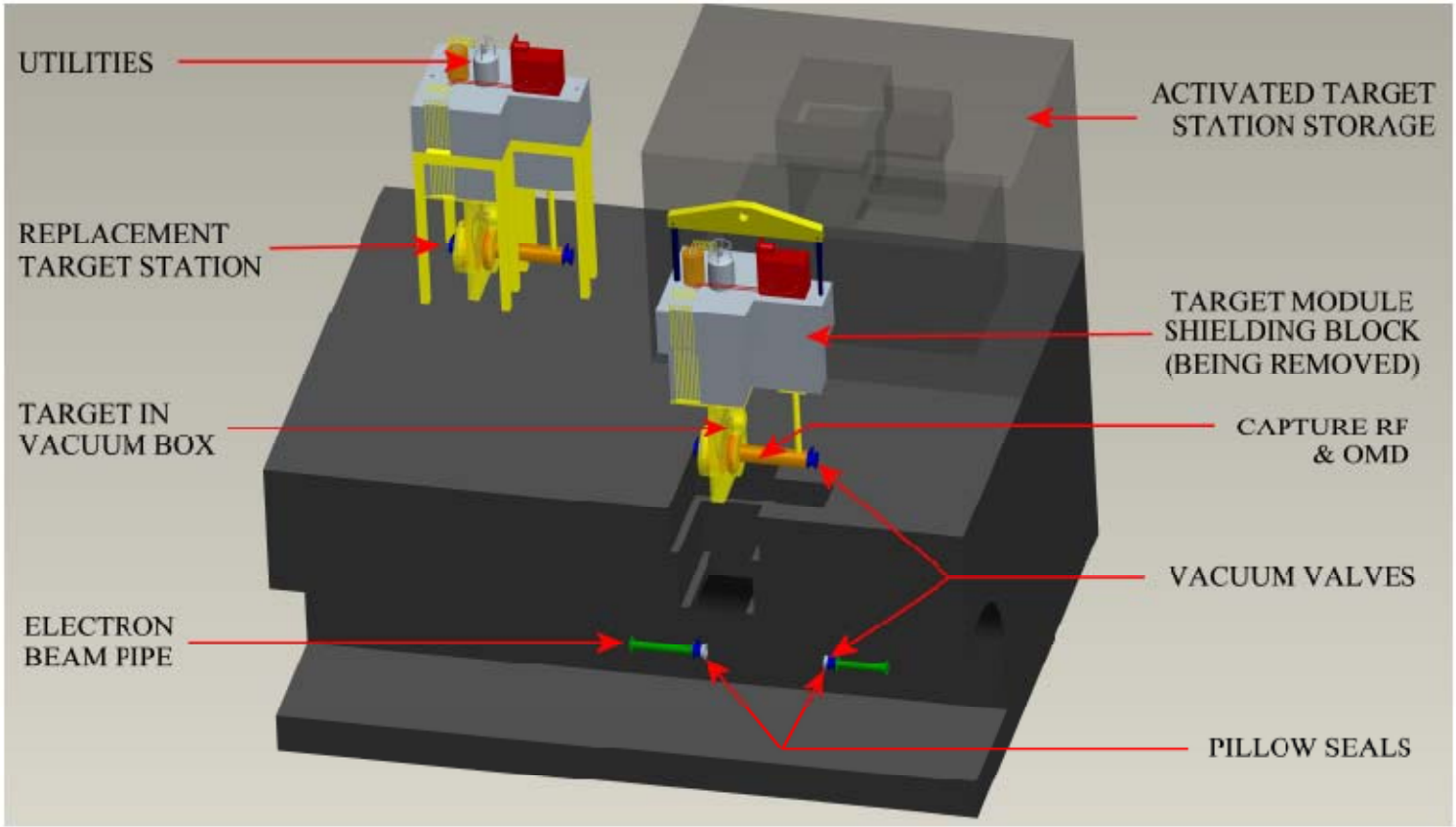


Dumps

- 9 dumps in the source
- Tune-up dump at pre-undulator extraction point (150 GeV)
  - ➔ 100 bunch per train limit, 240 kW
  - ➔ Also acts as abort dump for one full train of electrons
- Tune-up dump at 5GeV pre-DR technically identical to the one above
- Photon dump, post-target
  - ➔ 300kW photon beam power (upgrade value)
  - ➔ 150m dowstream of target
- Other dumps are low power and present no major challenges

Remote Handling

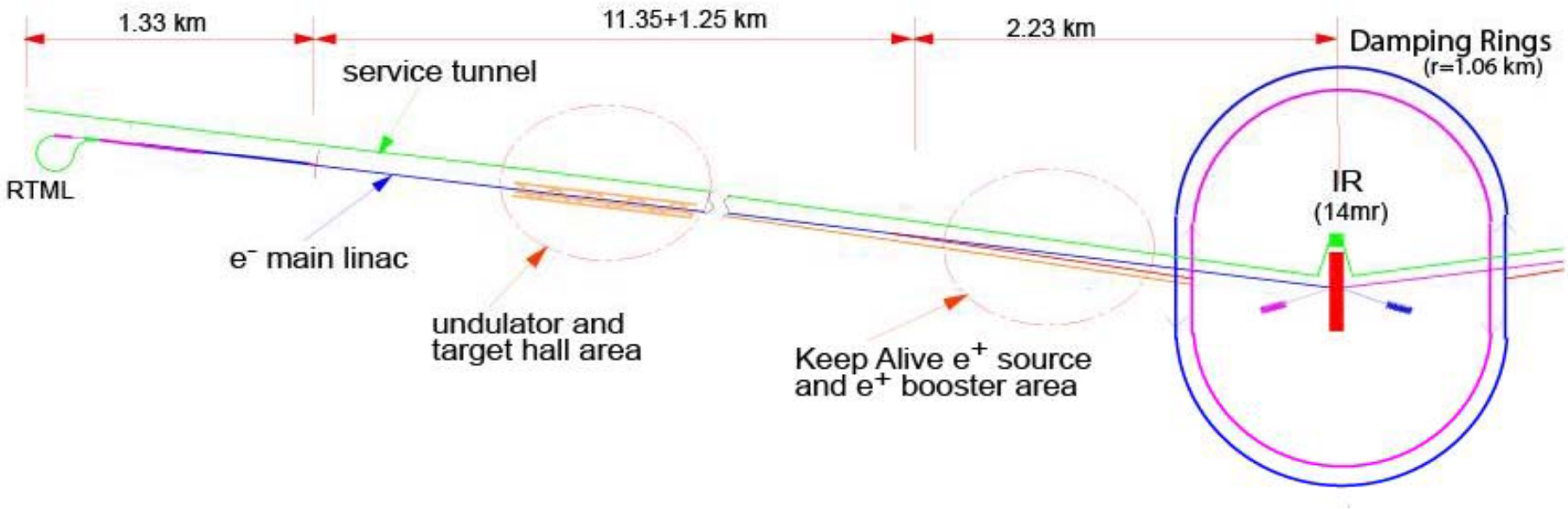
- Needed for target, OMD, NCRF linacs
- Change over time for target ~ 2days
- Also needed for KAS Target



5GeV SCRF Linac

- Three types of cryostat used
- 4 x non-standard up to 1.083 GeV
  - ➔ 6 (9-cell) cavities & 6 quads
- 6 x non-standard up to 2.626 GeV
  - ➔ 8 cavities & 2 quads
- 12 x standard up to 5 GeV
  - ➔ 8 cavities & 1 quad

CF&S Layout



Area	Length (meters)
Undulator chicane insert	1257
Undulator center to target	500
Undulator insert length	200
Target Hall length	150
400 MeV long transport line	5032
Total RF acceleration length	350
Damping Ring injection line	431

Issues Raised at Last Meeting

- Undulator
  - ➔ Completion of 4m prototypes with magnet measurements – Cornell and RAL
  - ➔ Generation of “real” spectrum and angular distribution from undulator system in form suitable for target/capture simulations – Daresbury
  - ➔ Write undulator electron beam test proposal – Daresbury/RAL
- Target
  - ➔ Continue Eddy current work
  - ➔ Stress analysis to cover Cornell pressure concerns
  - ➔ Definitive evaluation of feasibillity of windows with rotating target

Issues Raised at Last Meeting

- OMD
  - ➔ No mature solution yet
  - ➔ QWT proposed for baseline since thought to be most feasible but capture efficiency reduces from 21 to 15%
  - ➔ Li Lens proposed (~40%) – Cornell to report
- KAS
  - ➔ Eliminate or reaffirm spec
- Remote Handling
  - ➔ What else needs RH in ILC?
  - ➔ Define what exactly needs RH in positron source
  - ➔ Check cooling water activation
- Compton
  - ➔ Also include polarimetry needs

Issues Raised at Last Meeting

- Acc Phys
  - ➔ Optics needs tolerancing & diagnostics spec
  - ➔ Check activation of photon collimators in undulator
  - ➔ Summary of spin tracking results needed
- Polarisation
  - ➔ Scheme needed for 5Hz spin flip
  - ➔ Source group only responsible up to DR
  - ➔ Ensure polarisation upgrade included in all our work