Summary of ILC Workshop on Positron Sources

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CERN

Brief overview

Schemes for e^+ sources

Polarization aspects and studies

Conclusion

Held at CCLRC Daresbury Laboratory (UK) from the 11th to the 13th of April 2005

Thursday 24 November 2005

Short overview of workshop

47 Delegates from the Europe, USA, Japan and Russia

- Plenary session
- Targets session
- Positron capture session
- Polarized positron session
- Operational aspects

http://www.astec.ac.uk/id_mag/IDMag_Helical_ILC_Positron_Production_Workshop.htm

L. Rinolfi, " Report on the Workshop on positron sources for the International Linear Colliders "

CARE/ELAN Document 2005-017

Thursday 24 November 2005

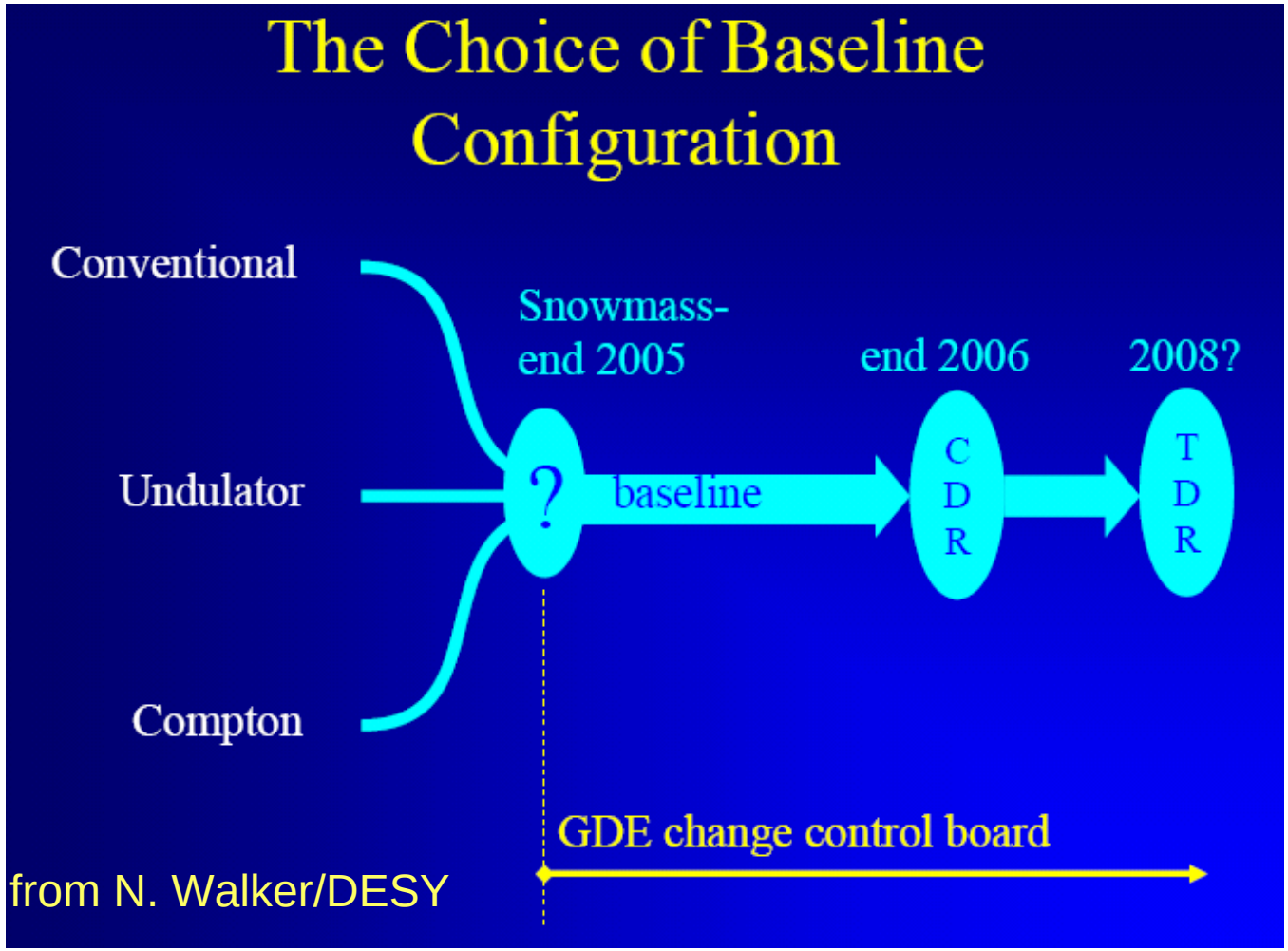
Aim of the workshop

The workshop :

- - discussed all of the possible positron source options for the ILC that are presently being considered,
- - assessed the outstanding R & D issues that will need to be addressed for each of them to become viable,
- - considered how the final selection and design of the ILC positron source should be made.

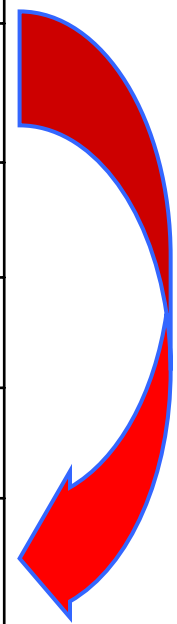
Routes towards a TDR

(Technical Design Report)



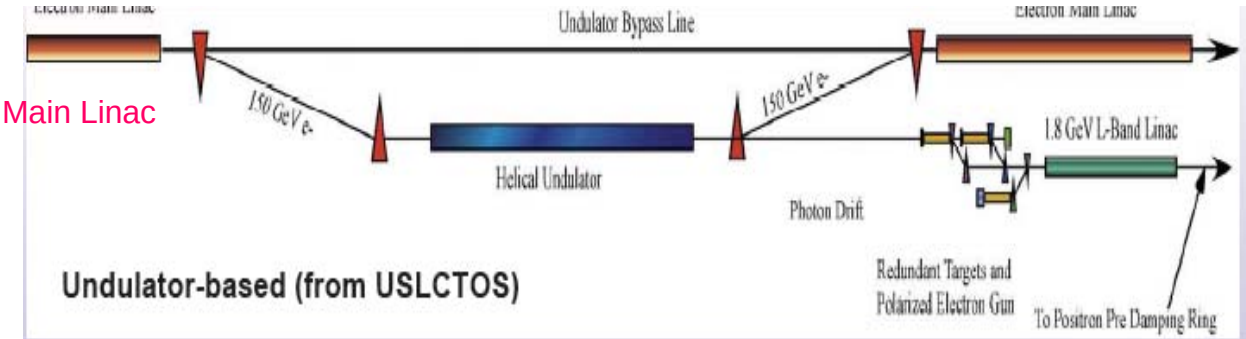
Positron charges for linear colliders

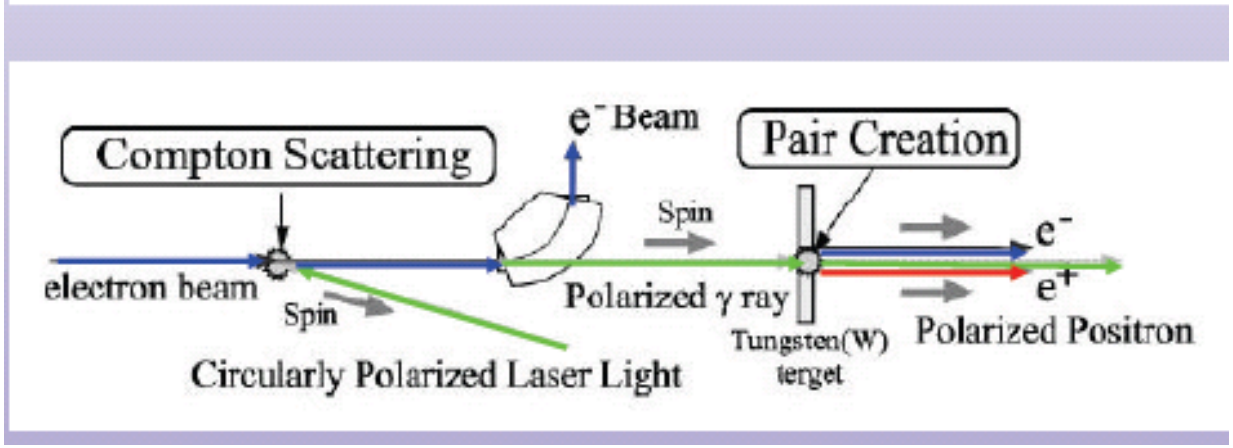
	Rep rate Hz	# of bunches per pulse	# of e^+ per bunch	# of e^+ per pulse
SLC	120	1	5.10^{10}	5.10^{10}
CLIC (3 TeV)	100	154	4.10^{9}	$61.6.10^{10}$
NLC	120	192	$0.75.10^{10}$	$1.4.10^{12}$
TESLA (TDR)	5	2820	2.10^{10}	$5.6.10^{13}$
ILC (Nominal)	5	2820	2.10^{10}	$5.6.10^{13}$
ILC (Upgrade)	5	5600	1.10^{10}	$5.6.10^{13}$



Three scheme for e^+ production

Electron Main Linac





Challenges for e^+ production

Target issues

Capture systems (Magnets and RF)

Remote handling

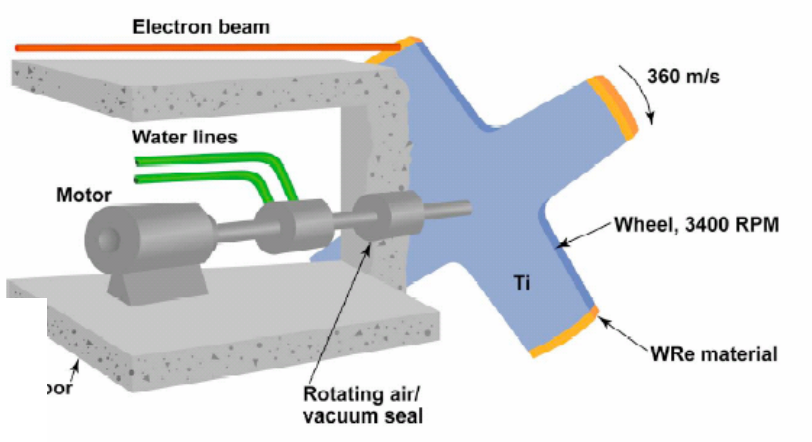
Reliability

(Pre)-Damping Ring acceptance

Cost estimate

Conventional target for ILC

- 5 pulses/second
- 2820 bunches/pulse (337 nano-seconds bunch time separation)
- $2x10^{10}$ electrons/bunch
- Electron energy is 6 Gev
- Beam spot radius is 2.0 mm
- Energy deposition in target is 56 kW
- Peak energy deposition is 0.7 J/g per bunch on back side of the target (Gaussian profile)

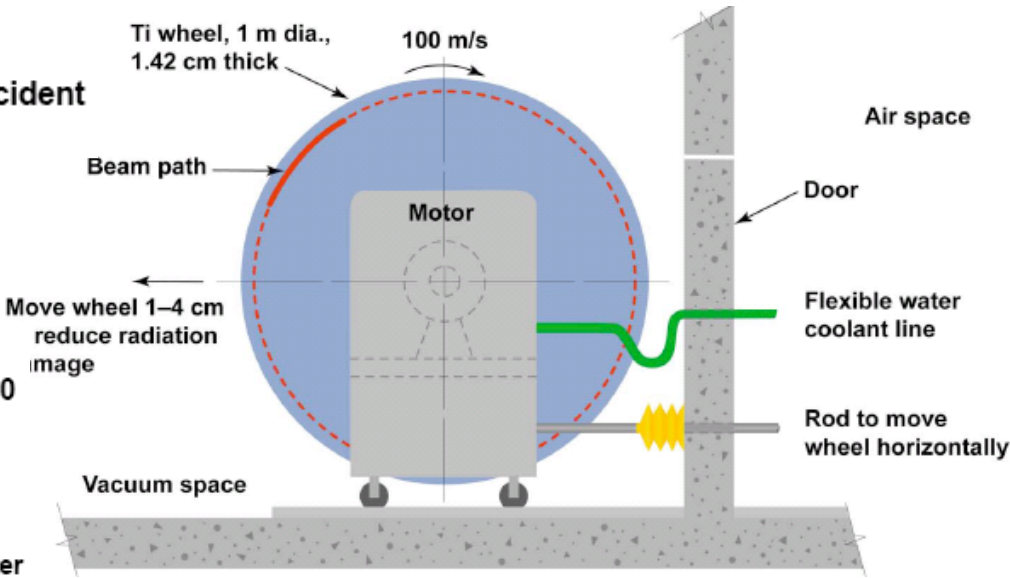


From W. Stein / LLNL

- Target material is W23Re
- Target is a wheel that rotates with a tip speed of 360 m/s
- Target thickness is 4.5 RL (1.5 cm)
- Target is cooled with water in flow channels
  - Water enters along a rotating shaft and flows radially to WRe target at perimeter of the wheel
- Target wheel shaft penetrates to adjacent air space. A rotating vacuum seal maintains vacuum.

Undulator-based photon target for ILC

- 5 pulses/second
- 2820 bunches/pulse (337 nano-seconds bunch time separation)
- $8x10^{12}$ photons/bunch
- photon energy is 22 Mev
- Beam spot radius is 0.75 mm
- Beam power is 220 kW
- Energy deposition in target is 18 kW
- Peak energy deposition is 1.45 J/g per bunch (9.58 J per incident bunch) on back side of the target (Gaussian profile)



From W. Stein / LLNL

- Target material is Ti alloy
- Target is a 1 m diameter wheel that rotates with a tip speed of 100 m/s (1800 RPM)
- Target thickness is 0.4 RL (1.4 cm)
- Target is cooled with water in flow channels
  - Water enters along the rotating shaft and flows radially to the perimeter of the wheel near the beam impact location
- Target wheel shaft penetrates to an adjacent air space. A rotating vacuum/air seal on the shaft maintains the target space vacuum.
- Target wheel could be 2 m diameter, with 100 m/s tip velocity. Temperatures, stress, and radiation damage would be proportionally lower.

State of the art for e^- polarization

Polarized e^- beam at SLAC:

SLC ~ 75%
Experiment E158 ~ 90%

Polarized e^- beam in Japan:
at Nagoya: ~ 90%

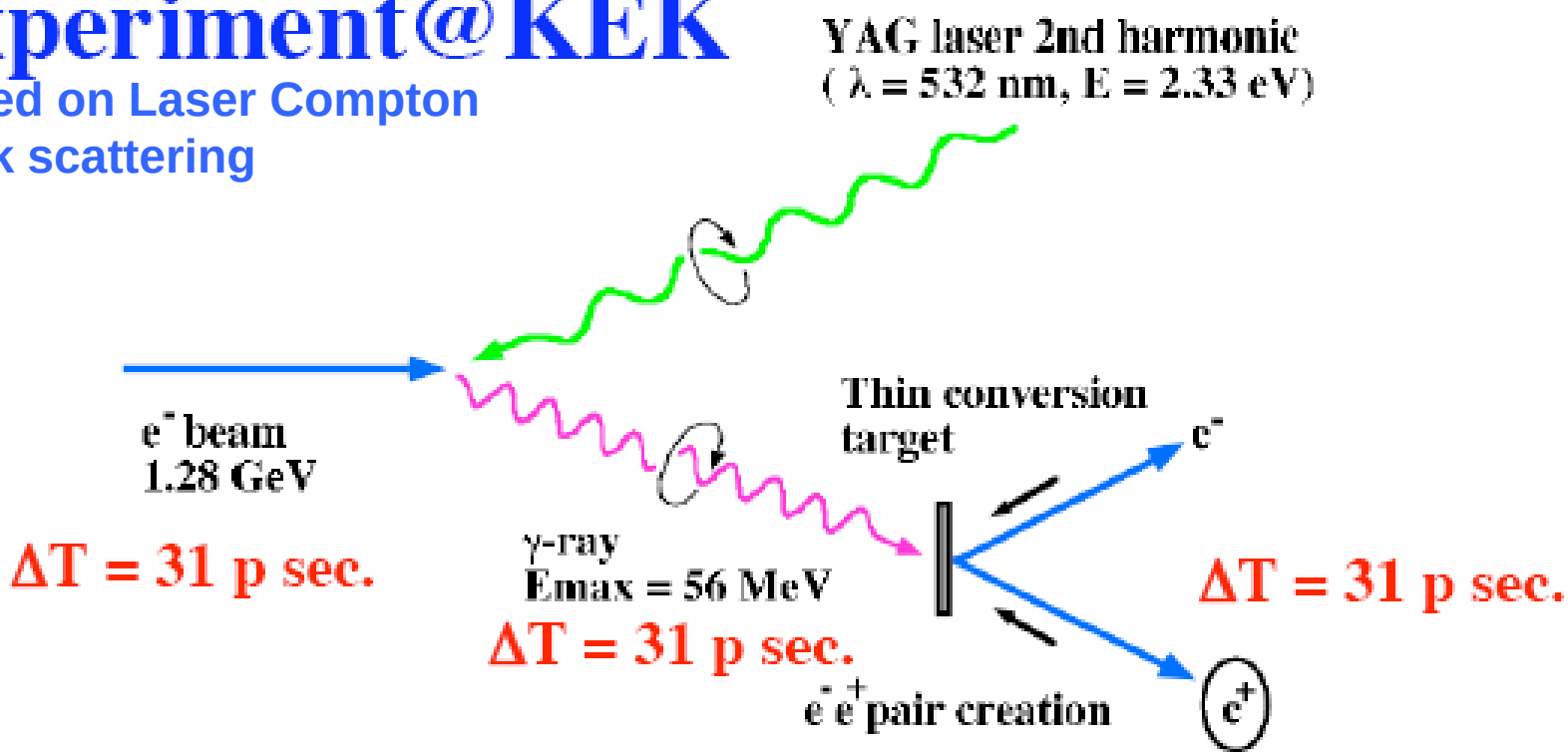
Physicists expect P (e^-) ~ 90% at ILC

Polarized e+ produced at KEK

From M. Kuriki / KEK

Experiment@KEK

based on Laser Compton back scattering

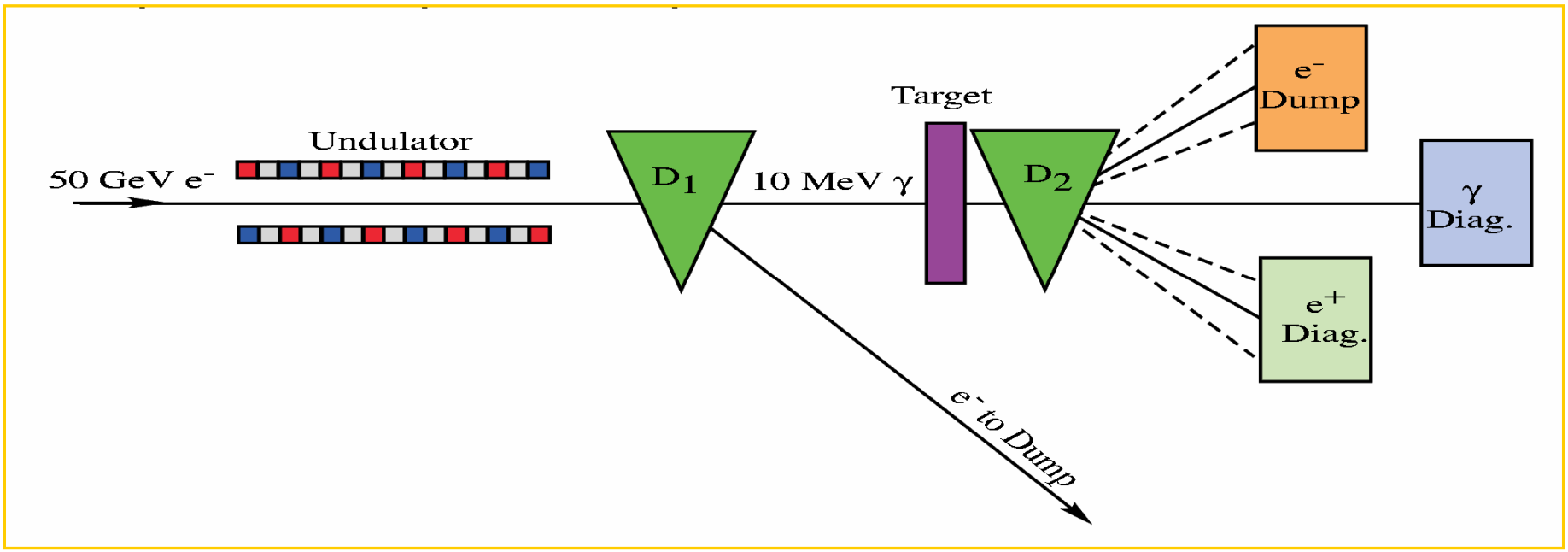


Measured polarization of e+ beam ~ 80 %

Polarized e+ produced at SLAC

from A. Mikhailichenko

Experiment E-166 based on helical undulator installed on the FFTB facility @ SLAC



Study for a SC helical undulator in UK

HeLiCal collaboration

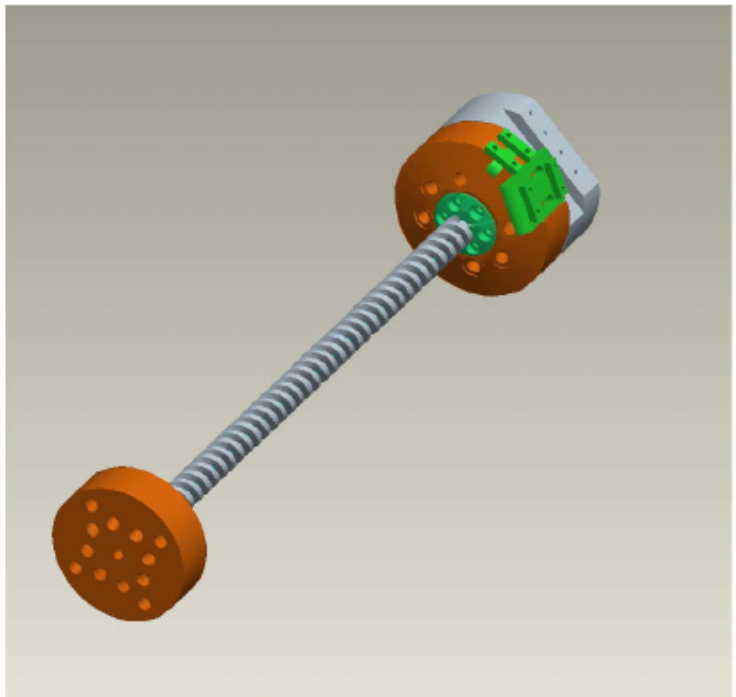
A first prototype built at RAL

Preliminary cold tests done with good results

Magnetic field measurements in preparation

Investigation to build 1 m-long undulator

3d design model of the undulator prototype.



Summary

Three concepts for e^+ production:

1) Conventional

2) Undulator-based

3) Laser Compton-based

Physics community should specify the arguments and the emphasis for polarized positrons

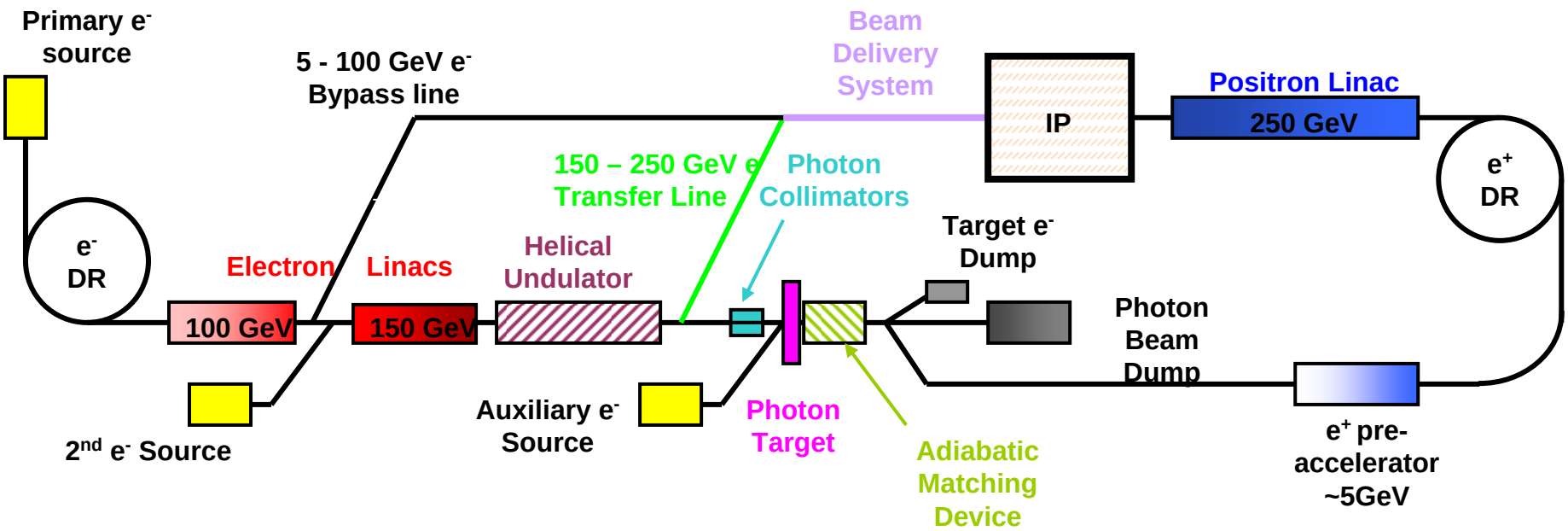
R&D challenges have been addressed for all technical issues

This workshop was on critical path to make a choice for the ILC Baseline configuration

(Snowmass in August 2005)

Recommended Baseline Layout at Snowmass 2005

From J. Clarke, M. Kuriki, , P. Piot and J. Sheppard



Undulator at end of electron main linac and with keep-alive source

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