The ILC parameters and the demands on the positron source

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Workshop on Positron Sources for the ILC

CCLRC Daresbury Lab

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Contents

- ILC Luminosity & Working Parameters
- Challenges facing the e+ source
- The need for decisions
  - The current GDE planning & timeline

Luminosity Scaling

$$L \propto \frac{\eta_{RF} P_{AC}}{E_{cm}} \sqrt{\frac{\delta_{BS}}{\gamma \varepsilon_y}}$$

$$\beta_y^* \approx \sigma_z$$

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$$\sigma_y^* = \sqrt{\varepsilon_y \beta_y^*}$$

$$\beta_y^* \approx \sigma_z$$

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$$L \propto \frac{\eta_{RF} P_{AC}}{E_{cm}} \sqrt{\frac{\delta_{BS}}{\gamma \varepsilon_y}}$$

$$\delta_{BS} \propto \frac{N^2}{\sigma_x^2 \sigma_z}$$

$$\beta_y^* \approx \sigma_z$$

Luminosity Scaling

$$\eta_{RF} P_{AC} = P_{beam} \propto E_{cm} n_b N f_{rep}$$

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Luminosity Scaling

$$Luminosity \begin{cases} \propto n_b N f_{rep} \\ \propto \sqrt{\dfrac{N^2}{\sigma_x^2 \sigma_z}} \end{cases}$$

$$f_{rep} = 5\text{Hz (10 Hz?)}$$

$$\Delta t_b \approx 1000\mu\text{s}/n_b$$

ILC Parameters

Suggested ILC Beam Parameter Range

by Tor Raubenheimer (SLAC)

available from:
http://www-project.slac.stanford.edu/ilc/
http://ilc.desy.de
http://...

parameters discussion forum:

http://www-project.slac.stanford.edu/ilc/discussion/Default.htm

This document intended to provoke your feedback and comment!

Suggested ILC Parameter Sets

		nom	low N	lrg Y	low P	High L
N	$\times 10^{10}$	2	1	2	2	2
n_b		2820	5640	2820	1330	2820
Δt_b	ns	308	154	308	462	308
t_{pulse}	μs	870	870	870	615	870
$\varepsilon_{x,y}$	μm, nm	9.6, 40	10,30	12,80	10,35	10,30
$\beta_{x,y}$	cm, mm	2, 0.4	1.2, 0.2	1, 0.4	1, 0.2	1, 0.2
$\sigma_{x,y}$	nm	543, 5.7	495, 3.5	495, 8	452, 3.8	452, 3.5
δ_{BS}	%	2.2	1.8	2.4	5.7	7
σ_z	μm	300	150	500	200	150

Source Relevant (f_{rep} = 5 Hz)

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Positron Source

- Large amount of charge to produce
- Three concepts:
  - undulator-based (TESLA TDR baseline)
  - ‘conventional’
  - laser Compton based
- Hotly debated subject
  - perhaps one of the most contentious issues!

Existing / Proposed Positron Sources

	rep rate	# of bunches per pulse	# of positrons per bunch	# of positrons per pulse
TESLA TDR	5 Hz	2820	$2 \cdot 10^{10}$	$5.6 \cdot 10^{13}$
CLIC (3TeV)	100	154	×1000	$61.6 \cdot 10^{10}$
NLC	120 Hz	192	$0.75 \cdot 10^{10}$	$1.4 \cdot 10^{12}$
SLC	120 Hz	1	$5 \cdot 10^{10}$	$5 \cdot 10^{10}$
DESY positron source	50 Hz	1	$1.5 \cdot 10^{9}$	$1.5 \cdot 10^{9}$

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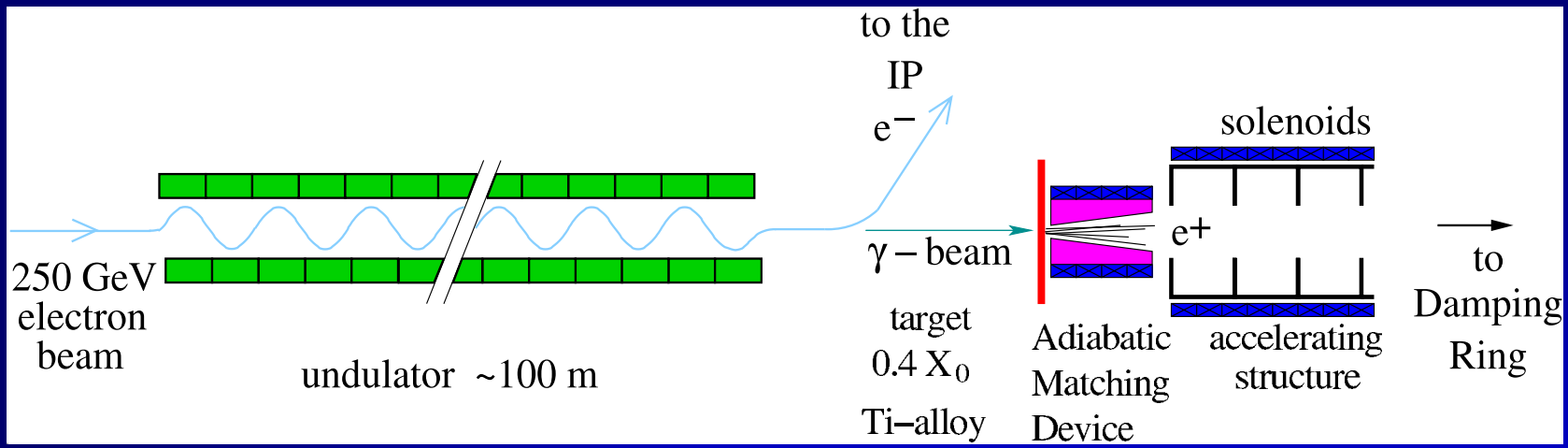
Undulator-Based



6D e+ emittance small enough that (probably) no pre-DR needed [shifts emphasis/challenge to DR acceptance]

Lower *n* production rates (radiation damage)

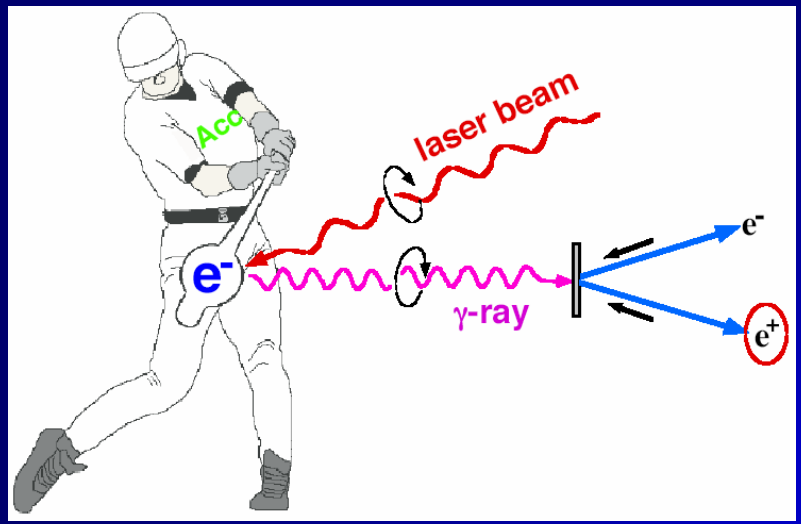
Need high-energy e- to make e+ (coupled operation) ☹
Impact on commissioning

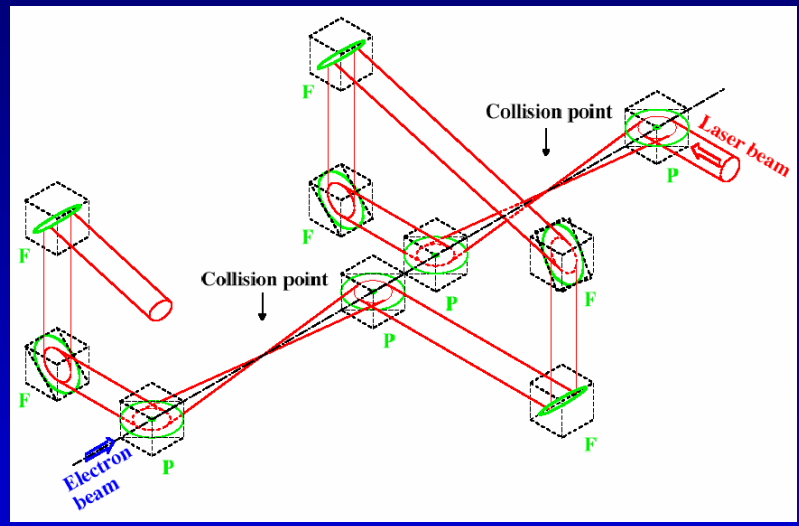
Polarised positrons (almost) for free ☺

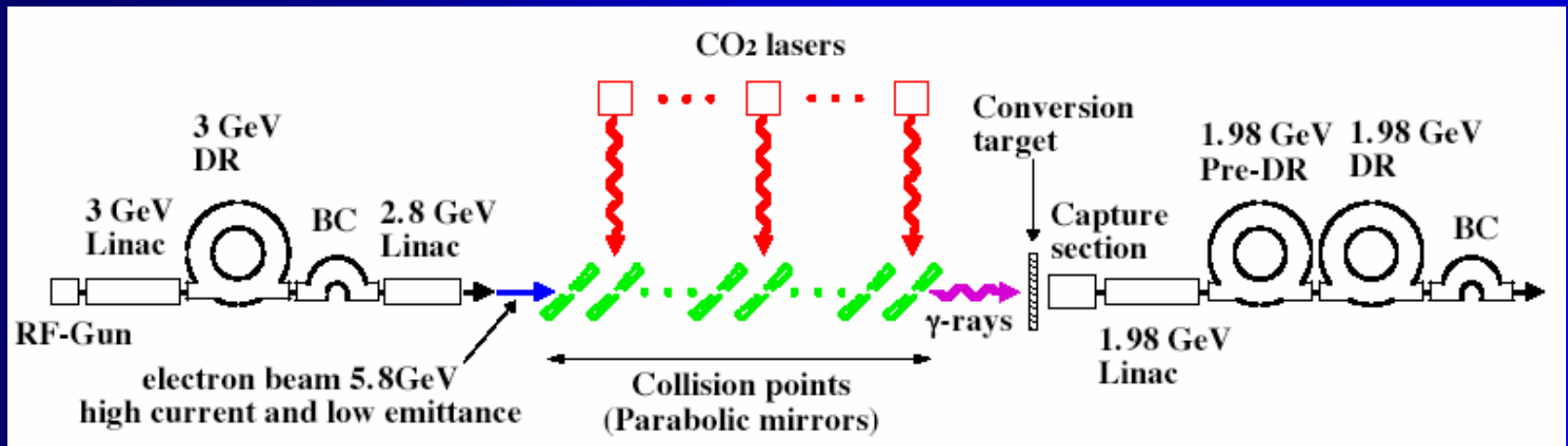
Conventional

- Extrapolation of existing methods
  - SLC e+ source
- Challenging for ILC pulse structure
  - feasibility (probably OK)
- Requires thick target(s)
  - High(er) n production – radiation damage a primary issue
  - Large e+ emittance probably means pre-DR needed.
- Completely de-couples e^+ from e^- machine ☺
  - greater flexibility ✓
  - operability ✓
  - commissioning ✓

Compton Source (KEK)







Decisions Must Be Made

- But first the right questions must be asked
- One parameter not so far discussed:

‘performance’ per $€¥ is critical!

The Right Questions

Feasibility

Engineering Challenges

Identify R&D

Impact on Layout (Civil Engineering)

Impact on other subsystems (eg. pre-DR?)

Impact on Operation (reliability)

Impact on Commissioning (strategy)

Impact on Physics Programme (energy scaling, polarisation)

The Right Questions

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Impact on Commissioning (strategy)

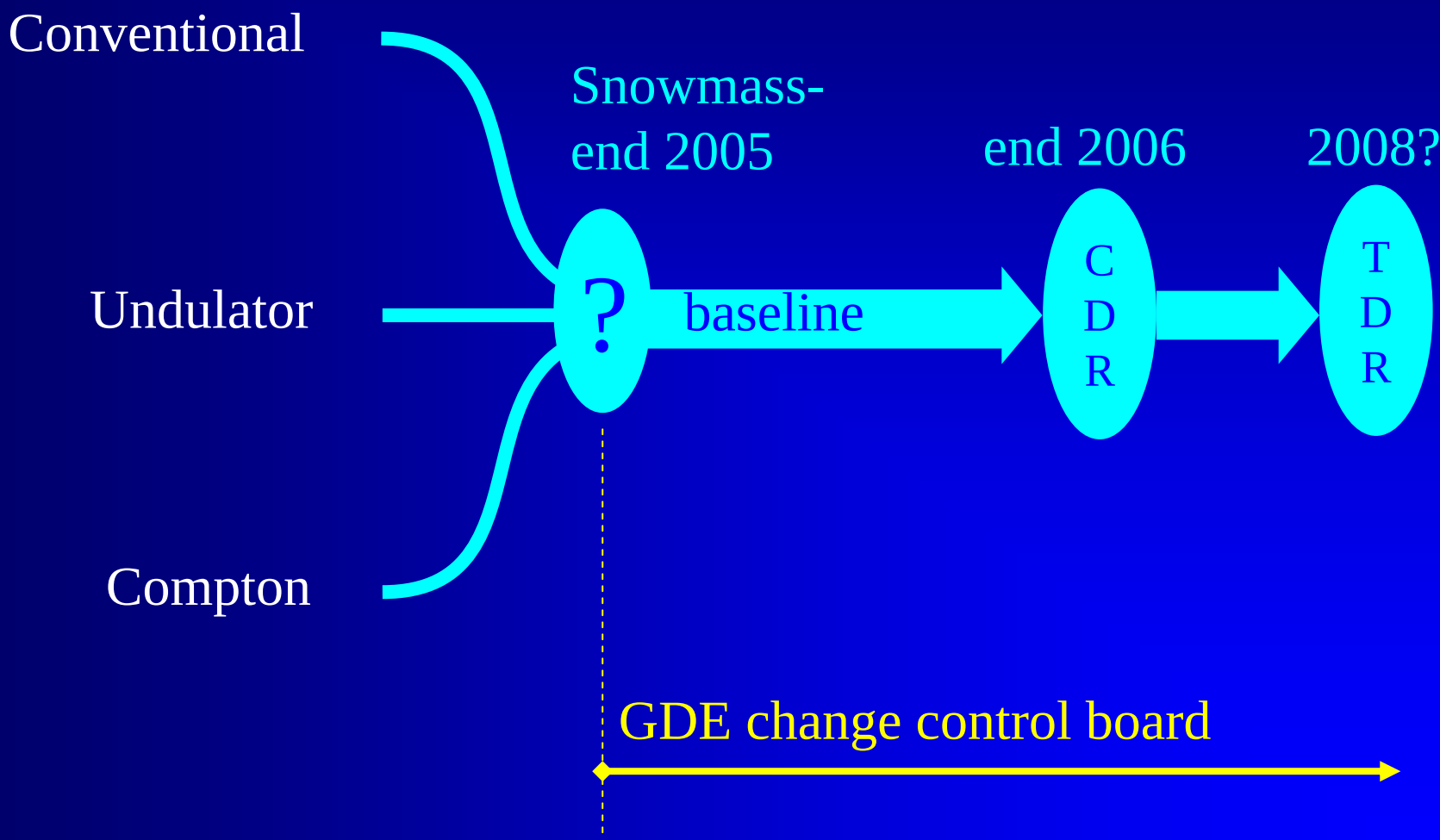
Impact on Physics Programme (energy scaling, polarisation)

GDE Goal for 2005

- Arrive at an internationally agreed upon BASELINE CONFGURATION by end of 2005.
  - Baseline configuration will form blue print for CDR+$€¥ due end 2006!
- Snowmass Workshop (14-27.08) critical to this process
  - we must attempt to agree on basic parameters by end of workshop
- Remainder of year will be needed to document decisions
  - parameter sets
  - basic layouts
  - lattice files etc…

Aggressive schedule makes *this workshop* critical!

The Choice of Baseline Configuration



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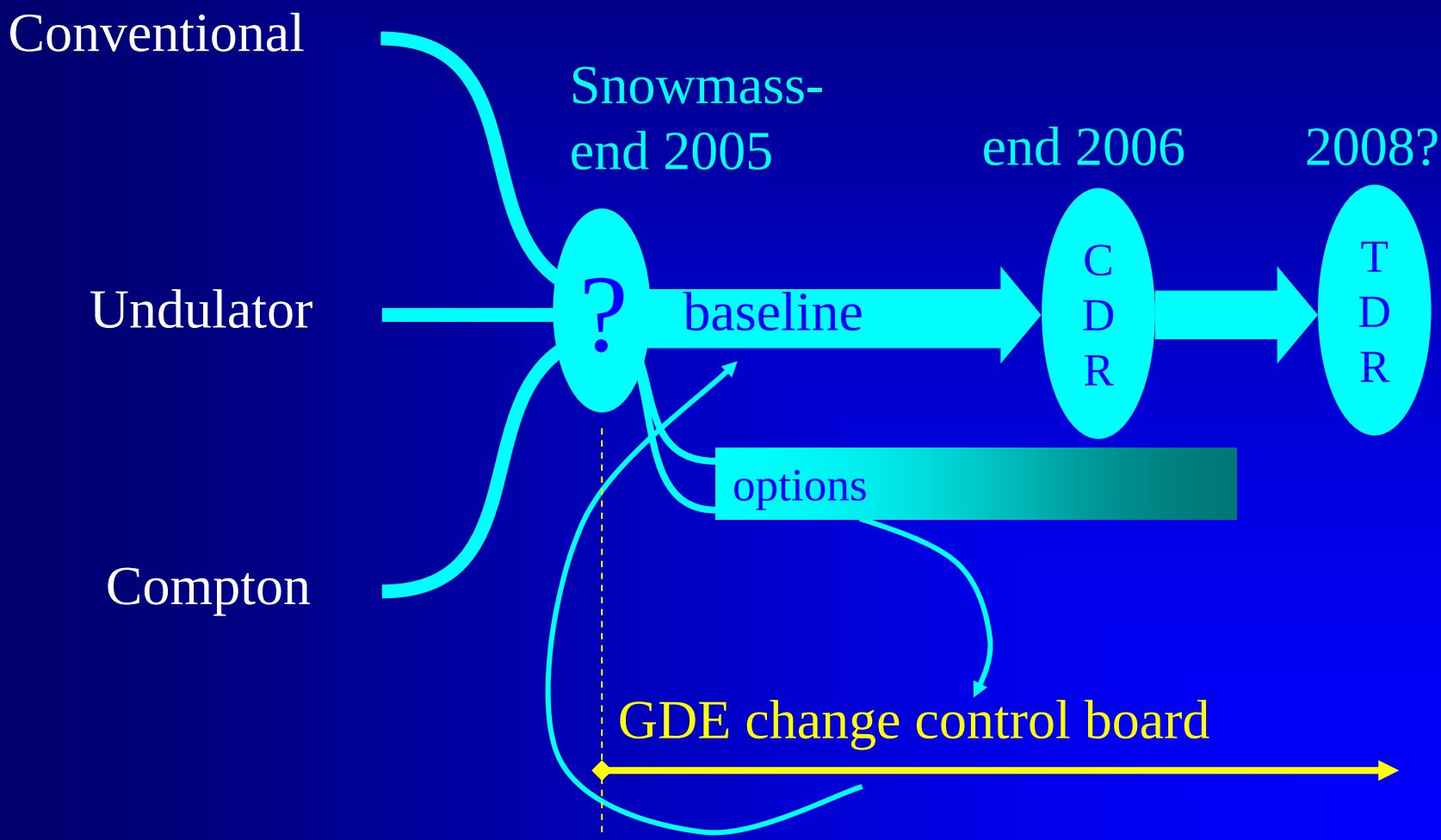

Polarisation

- It is up to the Physics Community to determine the emphasis placed on having polarised positrons
  - Accelerator experts can only advise on
    - relative merits of solutions
    - relative risks
    - (additional) cost!

Polarisation

- [my opinion] Compton Source seems ambitious
  - feasibility for ILC still a question
  - complexity raises reliability/operability and cost issues
  - Much R&D still required
    - but ‘independent’ polarised source is an attractive option.

Polarisation

- Undulator-based source currently seems the most viable option [my opinion]
- Questions have been raised over impact on operations *and* commissioning
  - particularly during early turn-on phase
- One scenario:
  - begin with conventional source (non-polarised)
  - Upgrade to undulator (polarised) source at a later date

Polarisation

- Polarisation no longer a (relatively) cheap option!
- In addition to cost of conventional source:
  - layout of machine must accommodate future possible undulator source
    - civil engineering (cost!)
    - photon dump
    - e+ transfer line
    - space for additional main linac overhead
    - …
- Additional overhead/cost must be evaluated
  - Is the additional cost justified?

Final Comments

- Must work towards a choice for the Baseline Configuration
  - preferably by Snowmass
  - certainly by end of 2005!
- This workshop will focus on technical issues of the proposed sources
- Decision on baseline option will also depend on broader issues
  - civil engineering impact
  - operability / commissioning
  - cost $$$
  - Physics priorities (i.e. need for polarisation)
- This workshop is on the critical path towards these decisions