



# GDE Issues & Minimum Machine

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(for the Project Management)

Positron Source Workshop  
STFC Daresbury Laboratory 29.10.2008



# Content

- Project Management Update
  - Recent events
  - R&D Plan
  - Oversight
- Minimum Machine Concept
  - **Special Relevance for Positron Source Work**
- CLIC-ILC collaboration
  - **CLIC / ILC positron sources**



# A Look Back to Zeuthen (April 08)



## Making Positrons in the Technical Design Phase Era as seen from the GDE Project Management

Marc Ross  
Nick Walker

Positron Source Collaboration Meeting  
DESY-Zeuthen, 7.04.2008

Global Design Effort

<http://ilcagenda.linearcollider.org/getFile.py/access?contribId=2&sessionId=0&resId=0&materialId=slides&confId=2639>

Today: fundamentally unchanged  
More detailed refinement (R&D report)  
“Minimum Machine” concept better defined

- Outline evolving strategy for Technical Design Phase I and II

- Focus on

- **Critical risk-mitigating R&D**

- SCRF gradient
- Electron-cloud
- ...

- **Cost reduction / confinement via “value engineering” and review of the machine design**

- **Beam test facilities**

- ATF – ATF2 – CsrTA



# Recent Events (since Zeuthen)

- SCRF Review (FNAL, April 21-25)
  - In-depth critical review of global ILC SCRF programme
- Cost Management Group Meeting (DESY, May 5-7)
  - Focused on consolidation of RDR documentation and VALUE estimate data
- JINR (Dubna) GDE Workshop (June 4-6)
  - Thematic meeting
  - CFS focused
    - Including proposed Russian ILC site
  - Included initial discussions on “Minimum Machine” (*see later*)
  - Very focus on cost!
- ILC DR 08 Workshop (Cornell 8-11 July)
  - CesrTA workshop (kick-off)
  - DR R&D review
- EUROTev workshop (Uppsala 26-28 Aug)
  - Last scientific workshop of successful program
- ILC-Highgrade Kick-off Meeting (DESY, 29 Aug)
  - European ILC “Preparatory Phase” funding
- CLIC workshop (CERN 14-17 Oct)
  - ILC participation via CLIC-ILC collaboration (*see later*)
- ILCSC Project Advisory Committee (PAC) 1st meeting/review (Paris, 19-20 Oct) *see later*
- TESLA Technology Collaboration Meeting (New Dehli, 20-23 Oct)

Technical Meetings /  
Workshops



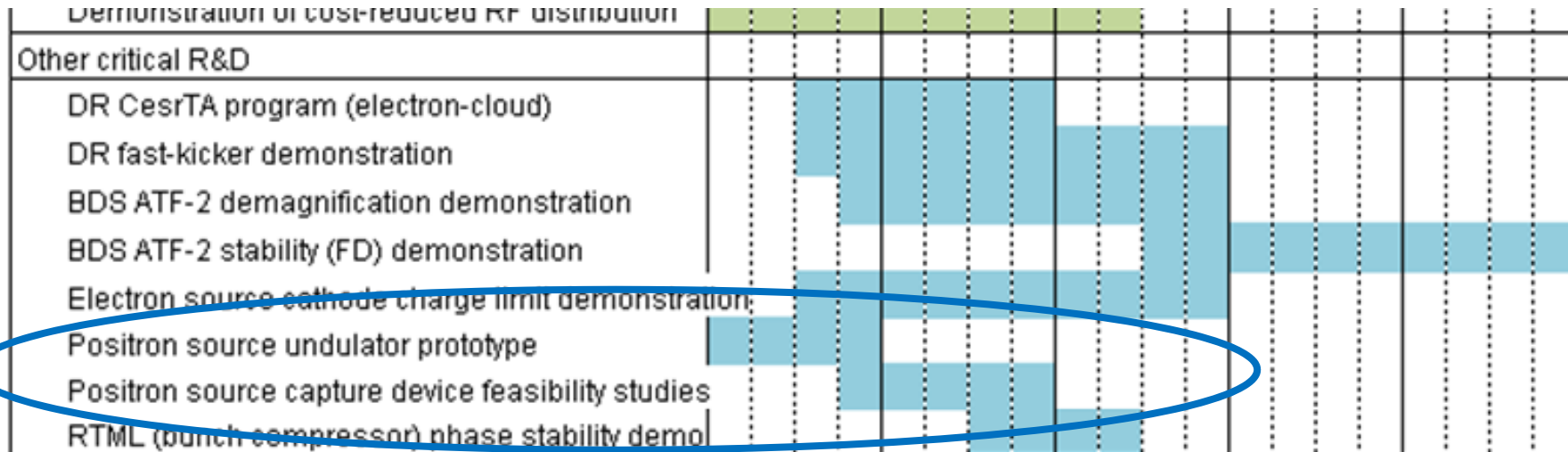
# TD Phase R&D Plan



- Formally published in June (release 2)
- Top-level management milestones & goals for TD Phase I & II
- Global resources tables
  - **Appendix A**
  - **Primarily for FALC-RB**
- Work package descriptions / deliverables
  - **Appendix B**
- Review & update now due
  - **Rel 3 end of 2008**



# Positron Source Specifics



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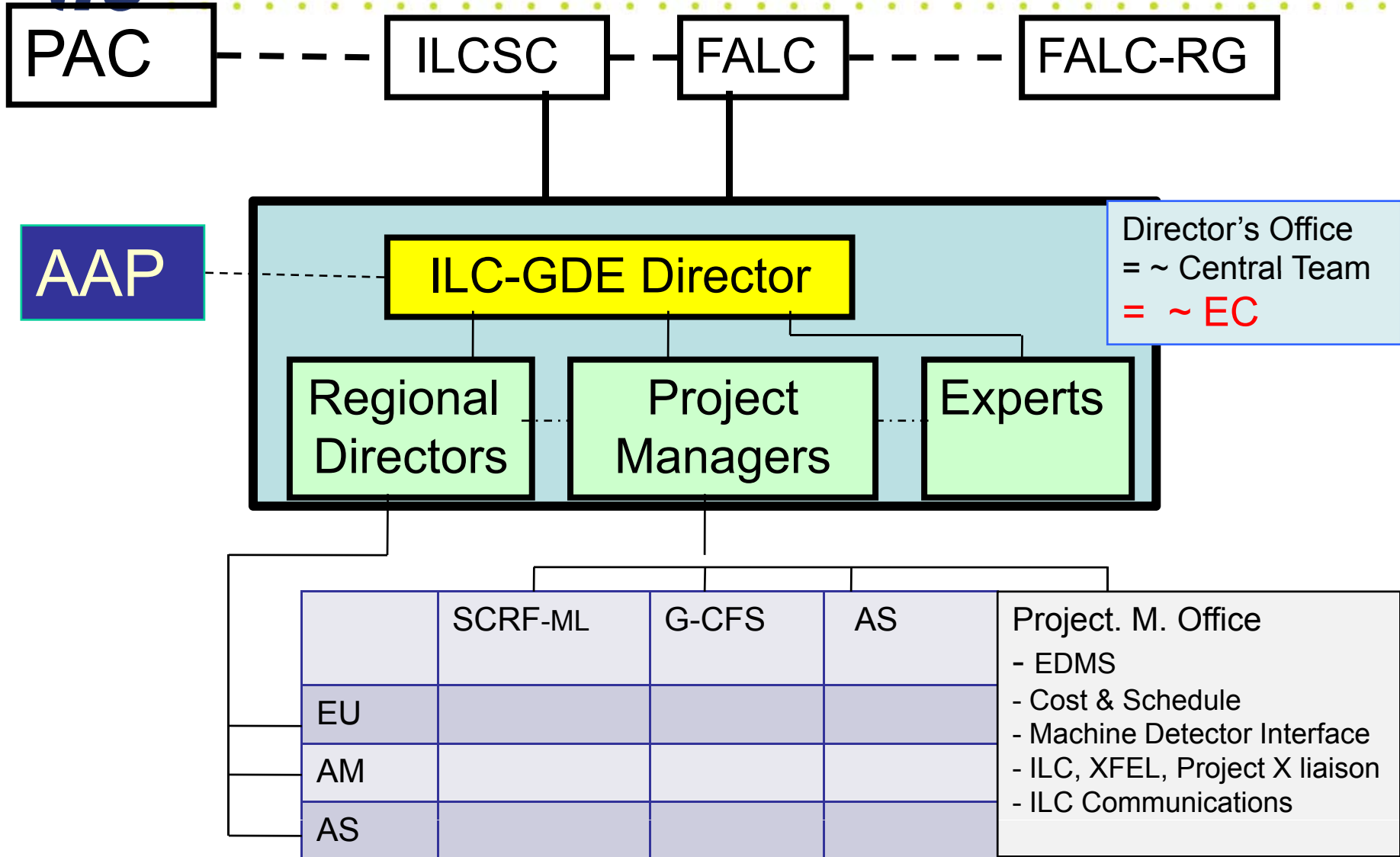
- 3.2.1 Undulator System
- 3.2.2 Target System
- 3.2.3 Capture Magnet
- 3.2.4 RF Capture System
- 3.2.5 Dumps & Collimators
- 3.2.6 Polarisation Issues
- 3.2.7 Auxiliary Source
- 3.2.8 Remote Handling
- 3.2.9 System Integration
- 3.2.10 Lattice Design
- 3.2.11 Alternative Compton Source
- 3.2.12 Magnets
- 3.2.13 Power Supplies
- 3.2.14 Beamline Vacuum
- 3.2.15 Beamline Instrumentation

15 Work Packages

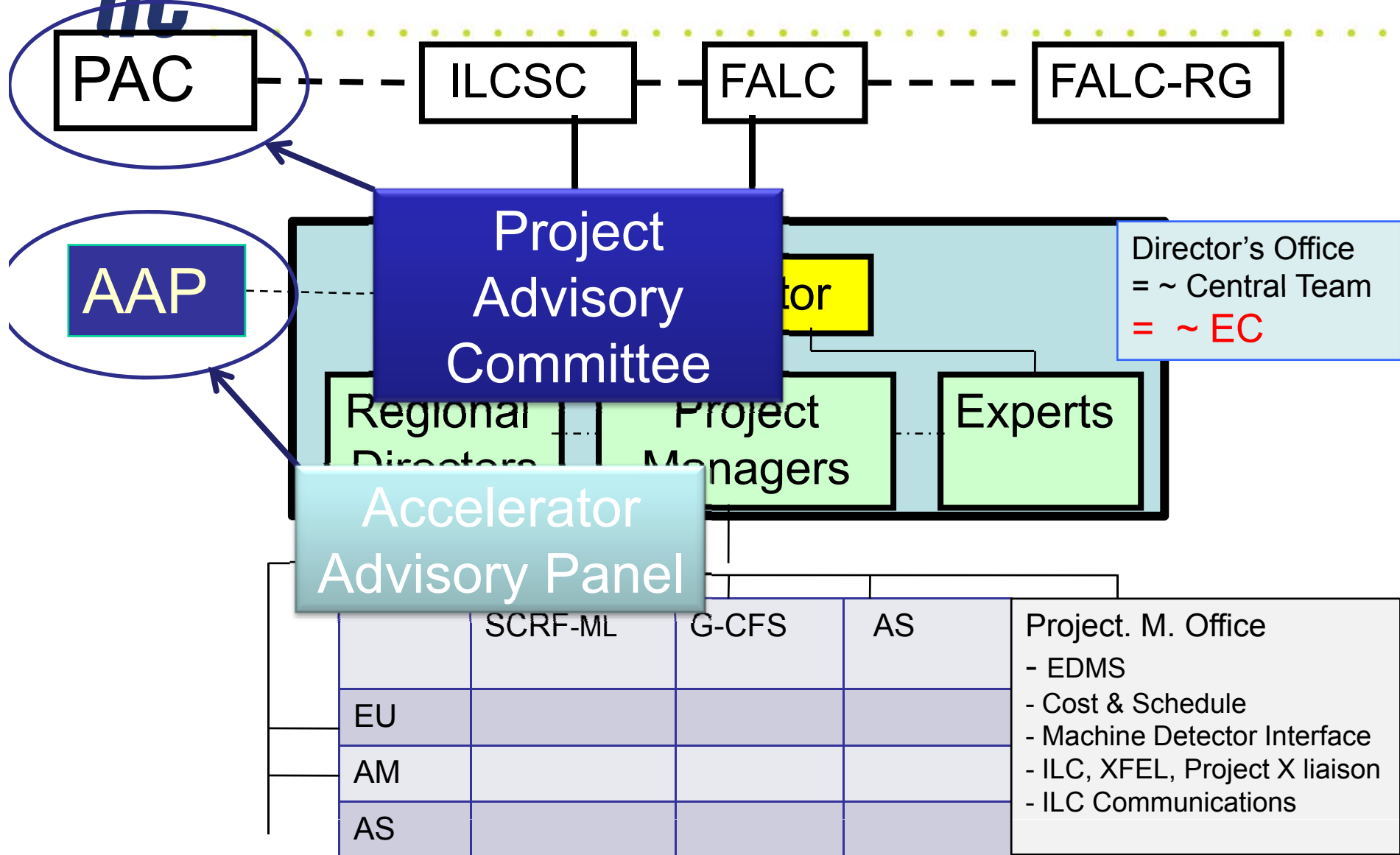
Requires review / consolidation



# ILC-GDE Organization Chart



# ILC-GDE Organization Chart



Director's Office  
= ~ Central Team  
= ~ EC





# Oversight

- Two standing Advisory bodies:
  - **PAC: commissioned by ICFA / ILCSC**
  - **AAP: commissioned by GDE Project Director**
- Accelerator Advisory Panel
  - **Chair: Bill Willis (Columbia) / co-chair Eckhard Elsen (Desy)**
  - **Panel members linked to Technical Areas to ensure steady communication**
    - they receive updates concerning ongoing program
    - they provide advice on strategic direction, etc
  - **Formal, tradition-style review annually (April 2009)**
- Regional / Institutional / Programmatic reviews managed through RD and Institutional Managers
  - **e.g. : Annual Americas Regional Team DoE/NSF Review**



# 1<sup>st</sup> PAC Review (19-20 Oct)

Sunday 19 October 2008

<http://ilcagenda.linearcollider.org/conferenceDisplay.py?confId=2846>

08:30	Executive Session (1h00')		
09:30	Welcome (05')		
09:35	GDE Overview (1h00')	FALC Annual Report 2007 ILC MOU Slides	Barry Barish (GDE)
10:35	break		
10:50	Accelerator Advisory Panel (AAP) (45')	Slides	Eckhard Elsen (DESY)
11:35	Coordination and Management (45')	Project Management Plan Slides Technical Design Phase R&D Report	Marc Ross (FNAL)
12:20	Executive Session (30')		
12:50	lunch		
13:50	Superconducting RF (45')	ASC Presentation EPAC08 Presentation Slides	Akira Yamamoto (KEK)
14:35	Final Focus and Damping Ring Test Facilities (45')	Slides	Junji Urakawa (KEK)
15:20	break		
15:40	Machine Design and Cost-reduction Activities (50')	Slides draft report	Nicholas Walker (DESY)
16:30	Project Implementation Plan (40')	Slides	Brian Foster (University of Oxford)
17:10	Executive Session (2h00')		

1.5 day review (1 day GDE, 0.5 day detector)  
Mostly management level review  
Initial feedback very positive – full report to be made public soon



# AAP “Internal” Review

## First Review – Coarse Schedule

Friday Day 0	Saturday Day 1	Sunday Day 2	Monday Day 3	Tuesday Day 4
Plenaries	Management	Acc. Facilities ATF, FLASH	e-cloud	Plenaries
	Conventional Facilities & Siting	SRF	Accelerator Systems ILC Project	

- The review will concentrate on TD phase 1 in its technical scope.

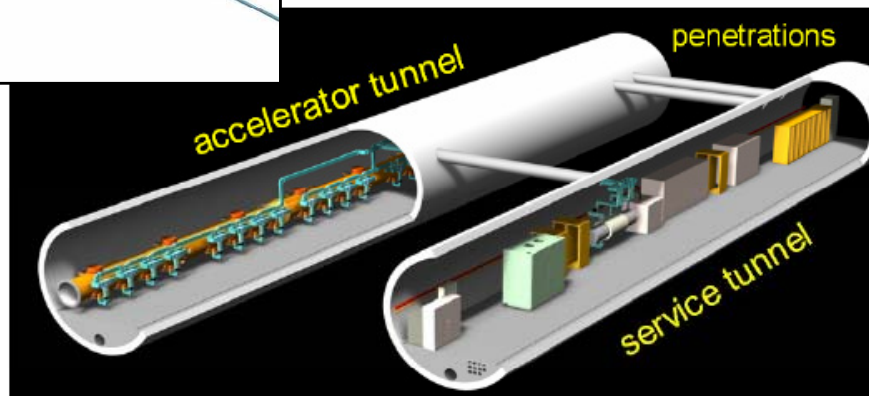
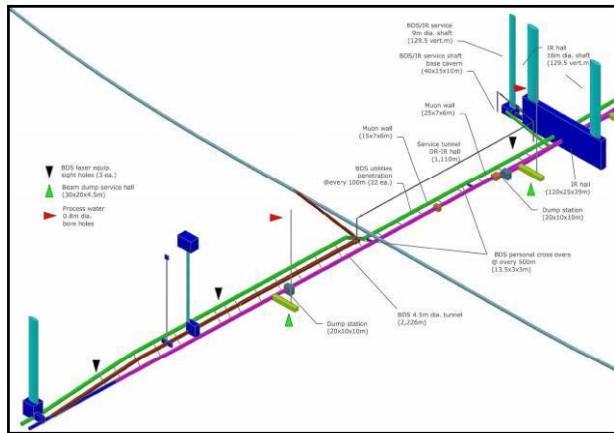
e+ source will be featured here

Planning for this review begins at ILC08 next month.

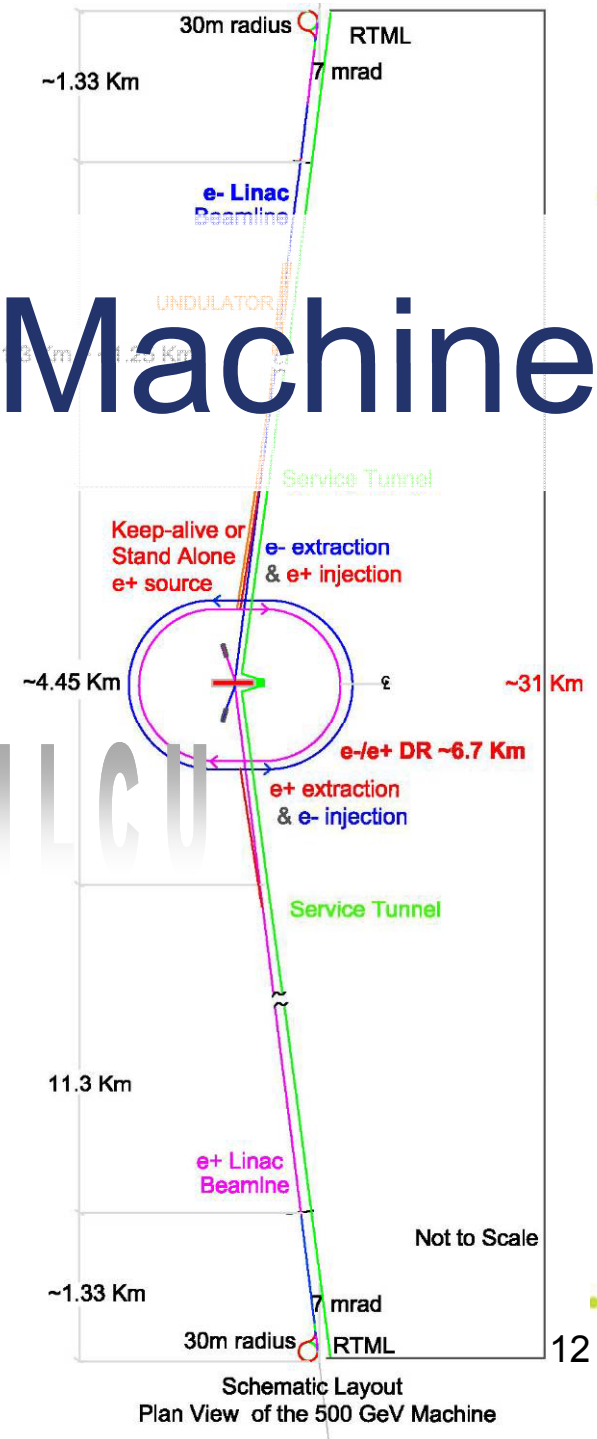
- Focus of April 09 GDE Meeting (KEK)
- First Full, in-depth technical review
  - 3 days
- Agenda evolving around primary R&D Plan themes
  - SRF
  - Beam Test Facilities
  - Cost Reduction (CFS, Minimum Machine)
  - Critical R&D



# The Minimum Machine



6.7 Billion ILCU





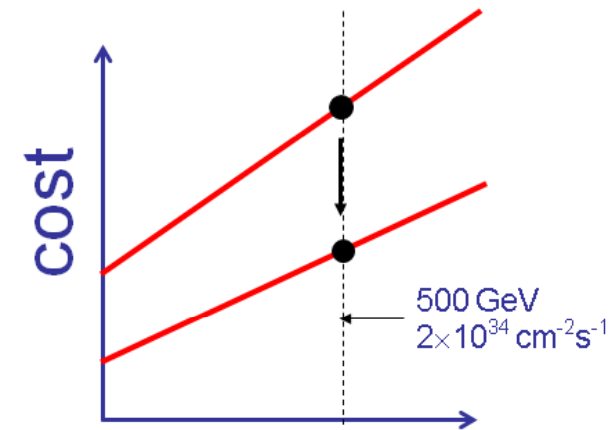
## Minimum Machine: Current Definition

- “Minimum Machine” now refers to a set of identified options (*elements*) which may prove cost-effective
- Not a *minimum* in a definable sense
  - **But a potential reduced-cost solutions...**
  - **with a potentially less margin (performance)**
- An alternative design for study purposes
  - **Comparison with RDR baseline**
  - **Cost (not performance) driven**
  - **options which were not studied during RDR phase**
- Important to restrict options to manageable levels
  - **available resources**

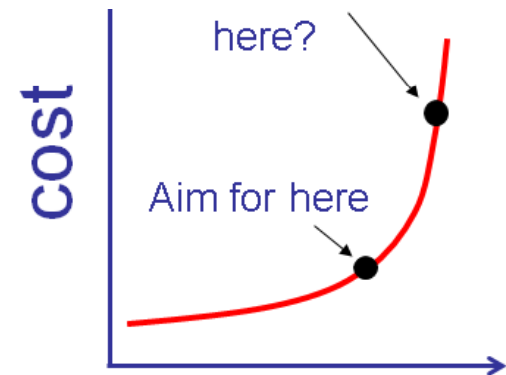


# “Minimum Machine” Philosophy

- *Direct* performance
  - **considered a physics ‘figure of merit’**
    - centre-of-mass energy or
    - peak luminosity.
  - **Understanding the derivatives of the direct cost of these physics performance parameters**
- *Indirect* performance
  - **into which we place margin, redundancy, etc.**
  - **tend to impact operational aspects or performance risk**
    - potentially affecting integrated luminosity within a given time frame
- Concentrate on Indirect
  - **Do not change basic physics parameters**



Physics “figure of Merit”  
(*direct* performance)



Margin, risk reduction,  
redundancy, ...  
(*indirect* performance)



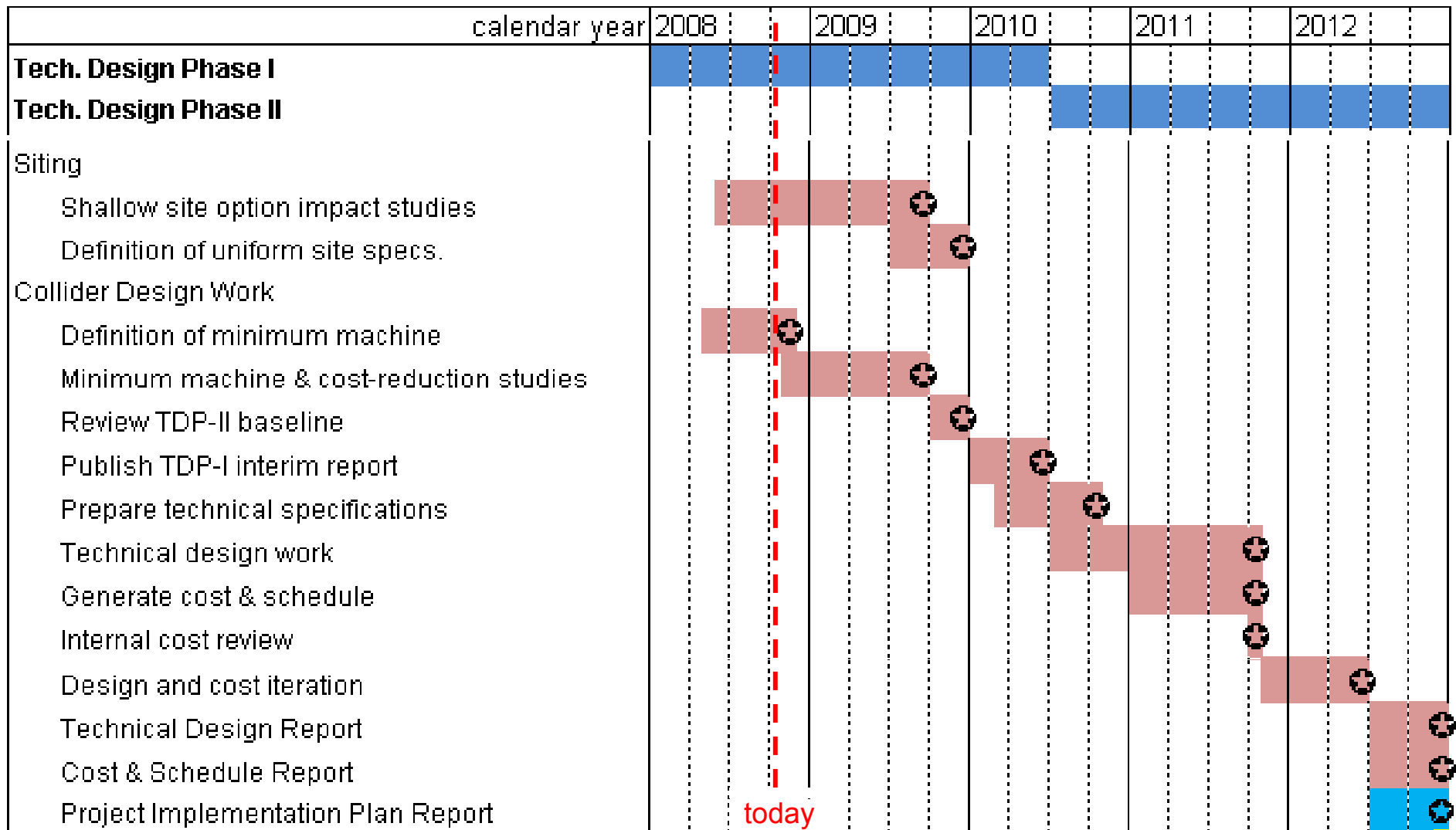
# ILC Requirements

- $E_{\text{cm}}$  adjustable from 200 – 500 GeV
- Luminosity:  $\int L dt = 500 \text{ fb}^{-1}$  in 4 years
  - **Peak at max. energy of  $2 \times 10^{34} \text{ cm}^{-2} \text{ s}^{-1}$**
  - **Assume  $1/\gamma$  L scaling for  $< 500 \text{ GeV}$**
- Energy stability and precision below 0.1%
- Electron polarization of at least 80%
- The machine must be upgradeable to 1 TeV
- Two detectors
  - **Single IR in push-pull configuration**
  - **Detector change-over in not more than 1 week**

ILCSC  
Parameters  
group



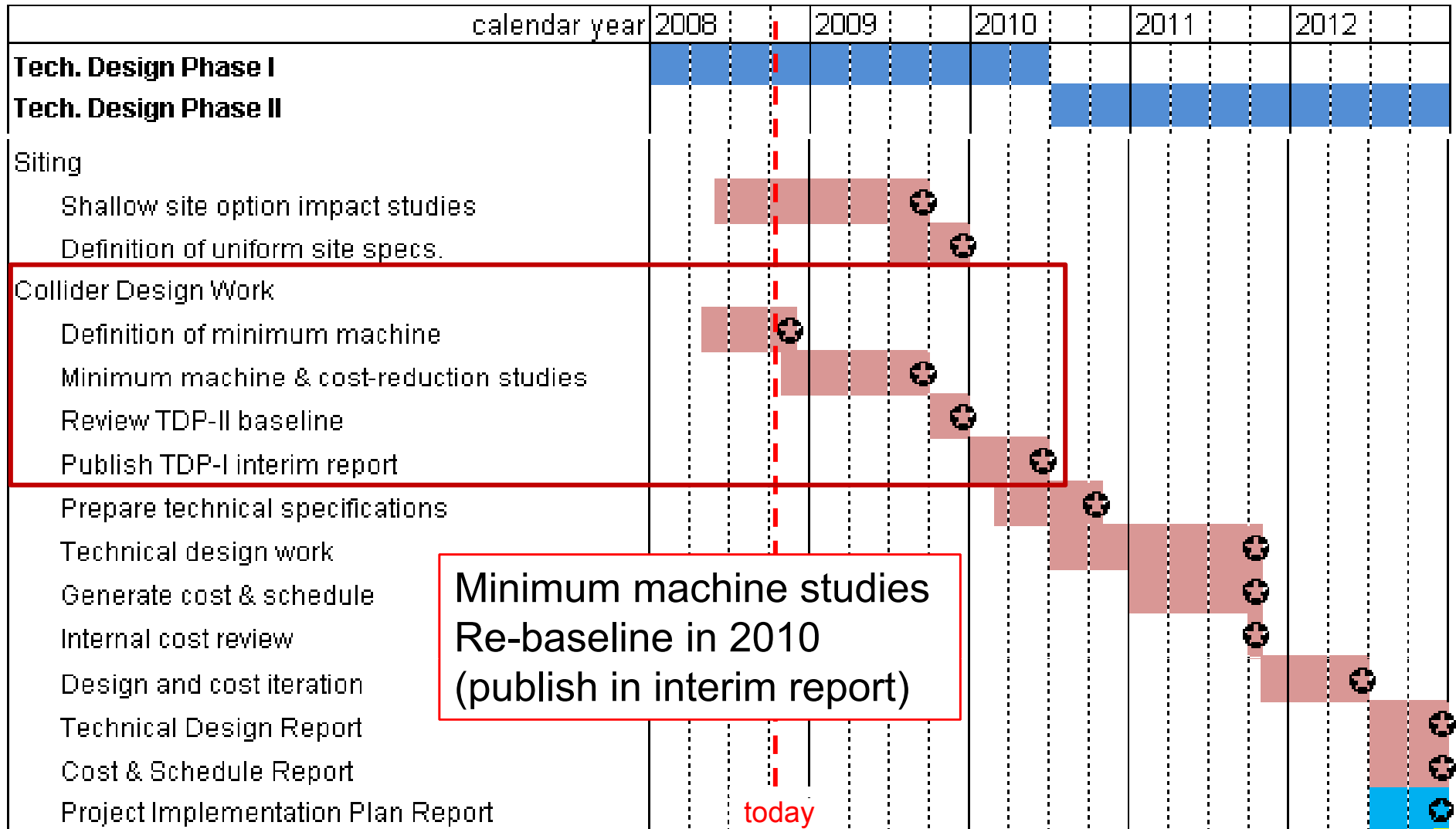
# Published Top-Level Schedule





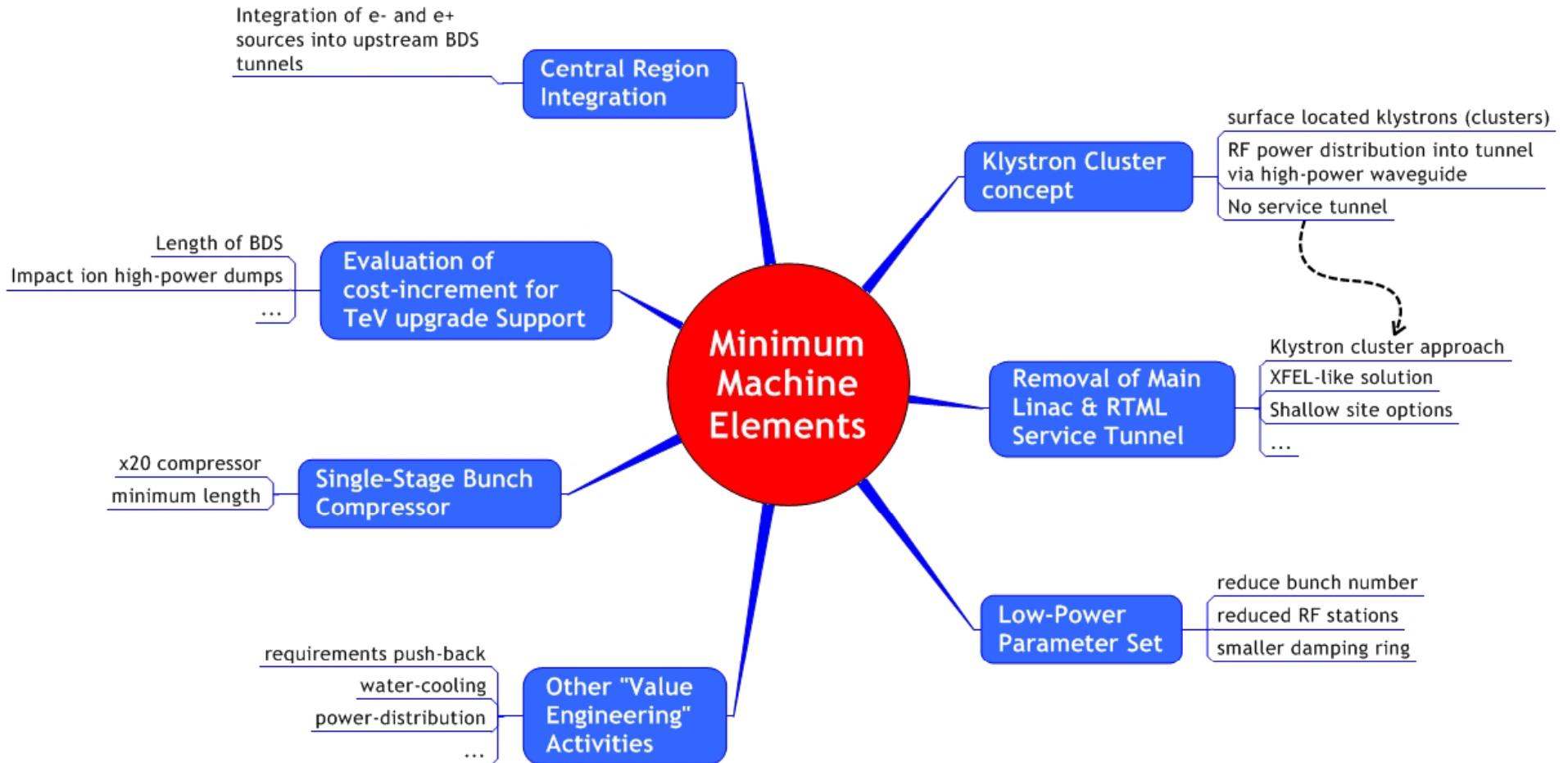


# Published Top-Level Schedule





# Identified Minimum Machine Elements





# Minimum Machine Elements

1. Single-tunnel solution(s)
2. Klystron Cluster concept
3. Central region integration
4. Low beam power option
5. Single-stage compressor
6. Quantify cost of TeV upgrade support
7. “Value engineering”



# Minimum Machine Elements

1. Single-tunnel solution(s)
2. Klystron Cluster concept
3. **Central region integration**
4. Low beam power option
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6. Quantify cost of TeV upgrade support
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# Central Region Integration

- Undulator-based positron source moved to end of linac (250 GeV point)
- e+ and e- sources share same tunnel as BDS
  - **upstream BDS (optimised integration)**
  - **Including 5GeV injector linacs**
- Removal of RDR “Keep Alive Source”
  - **replace by few % ‘auxiliary’ source using main (photon) target**
  - **500 MV warm linac, also in same tunnel**
- Damping Rings
  - **in BDS plane but horizontally displaced to avoid IR Hall**
  - **Injection/Ejection in same straight section**
  - **Circumference**
    - 6.4 km (current RDR baseline)
    - 3.2 km (possible low-P option)

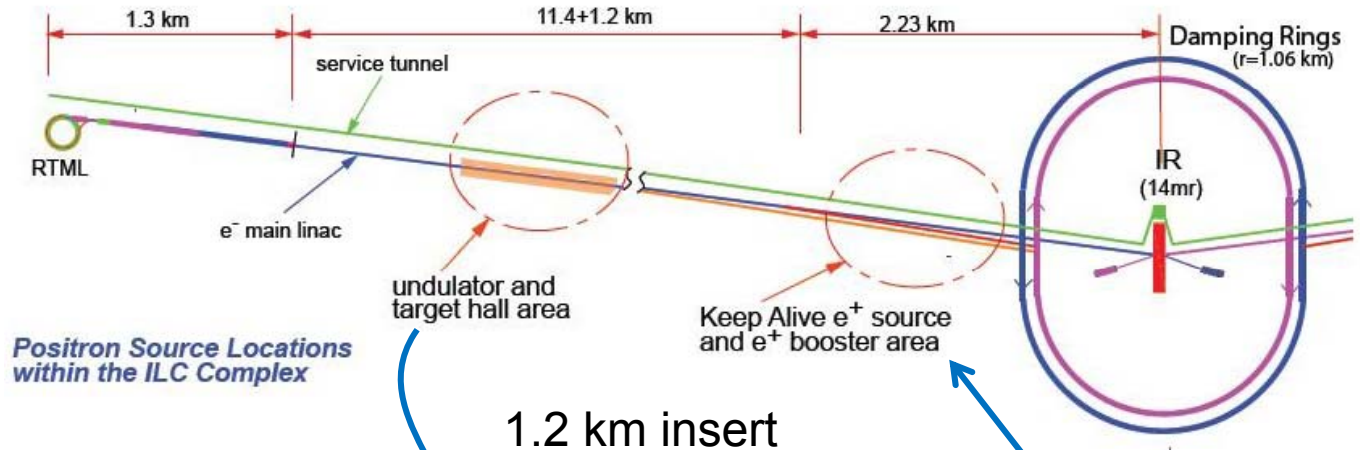
} **alternative options**



# ILC Reference Design

## Positron production

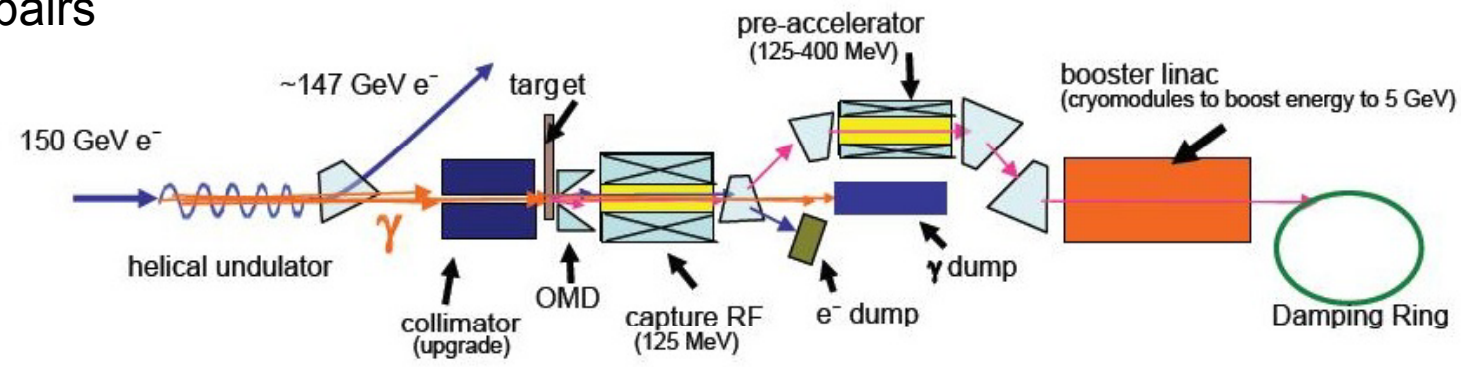
150 GeV primary e-beam used to generate gammas via a helical undulator. Thin-target conversion into e+e- pairs



Positron Source Locations within the ILC Complex

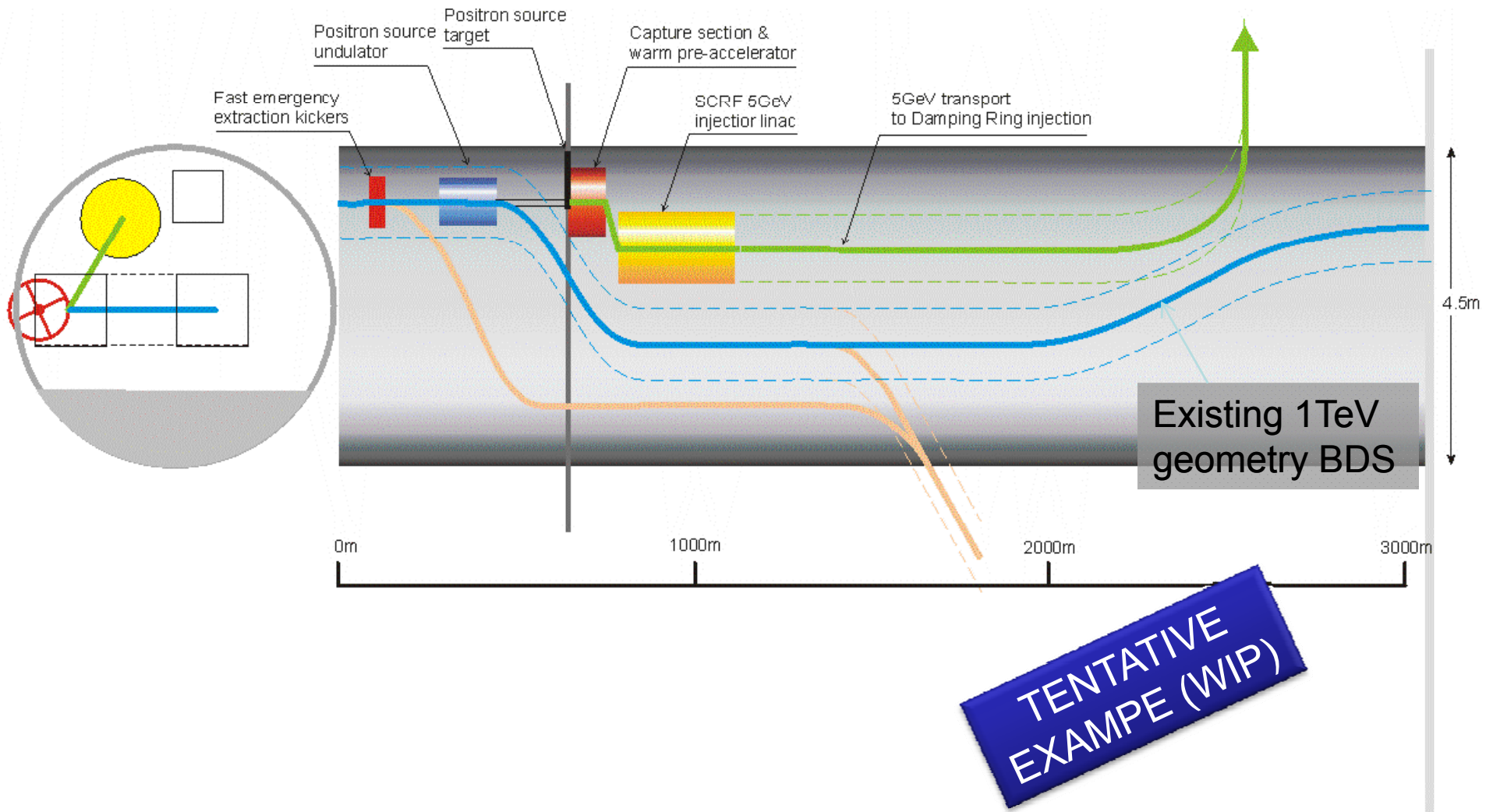
1.2 km insert into main SCRF linac

Additional "keep-alive" independent thick-target source (10% nominal)





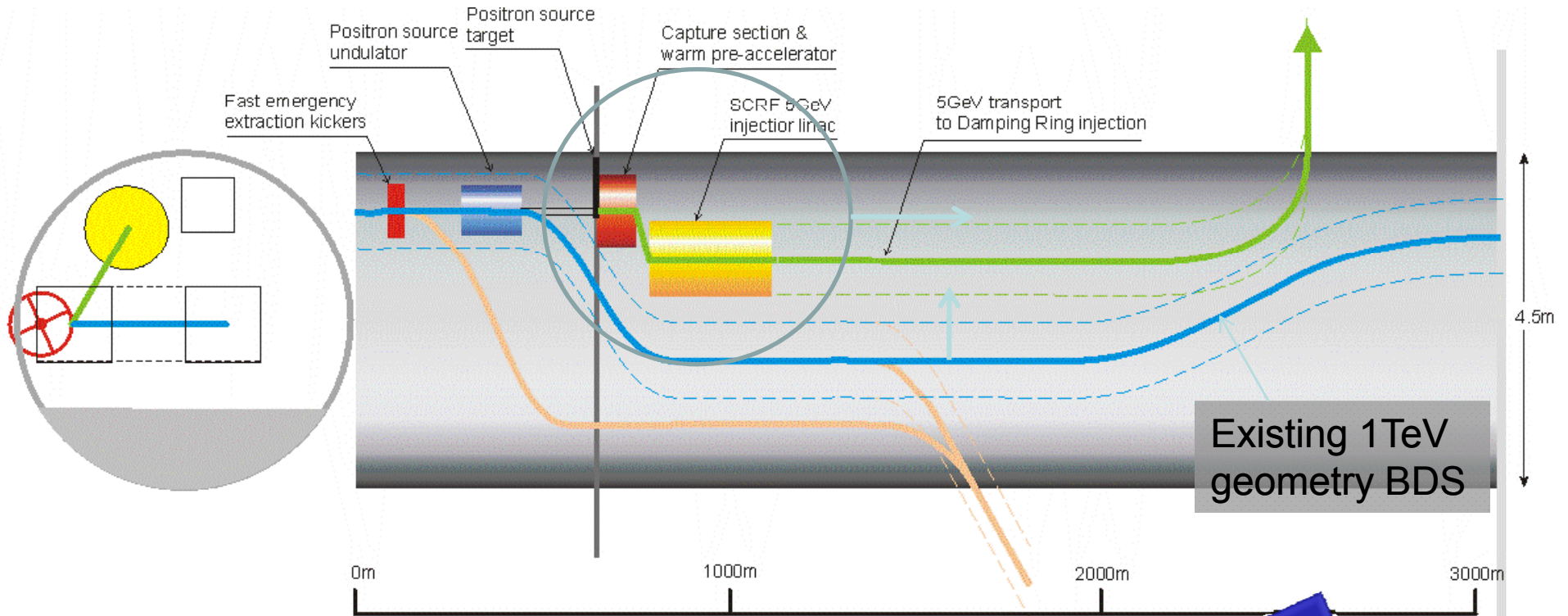
# Positron Source & BDS integration







# Positron Source & BDS integration



Some optimisation is available  
Longer photon drift to target would facilitate smaller transverse offset of primary e- dogleg

**TENTATIVE  
EXAMPE (WIP)**





# Minimum Machine Elements

1. Single-tunnel solution(s)
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# RDR Parameters Reviewed

	Nom. RDR	Low P RDR	new Low P
$E_{\text{CM}}$ (GeV)	500	500	500
Particles per bunch, $N$ ( $\times 10^{10}$ )	2.0	2.0	2.0
Bunches per pulse, $n_b$	2625	1320	1320
Pulse repetition rate (Hz)	5	5	5
Peak beam power, $P_b$ (MW)	10.5	5.3	5.3
$\gamma\epsilon_x$ ( $\mu\text{m}$ )	10	10	10
$\gamma\epsilon_y$ (nm)	40	36	36
$\beta_x$ (cm)	2.0	1.1	1.1
$\beta_y$ (mm)	0.4	0.2	0.2
Traveling focus	No	No	Yes
$\sigma_x$ (nm)	640	474	474
$\sigma_y$ (nm)	5.7	3.8	3.8
$\sigma_z$ ( $\mu\text{m}$ )	300	200	300
Beamstrahlung* $\delta E/E$	0.023	0.045	0.036
Luminosity* ( $\times 10^{34} \text{ cm}^{-2}\text{s}^{-1}$ )	2.0	1.7	1.9

SLAC



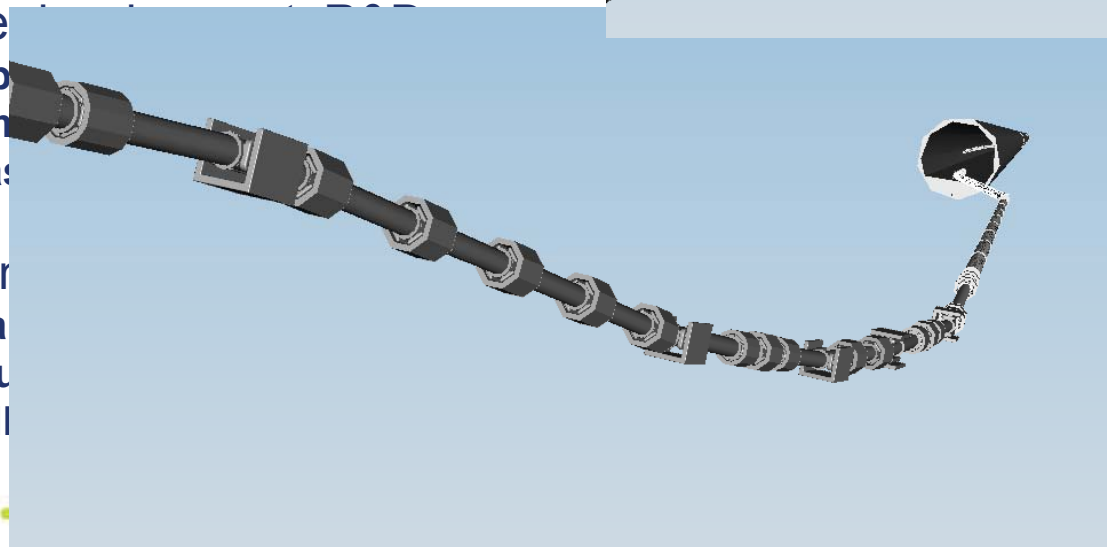
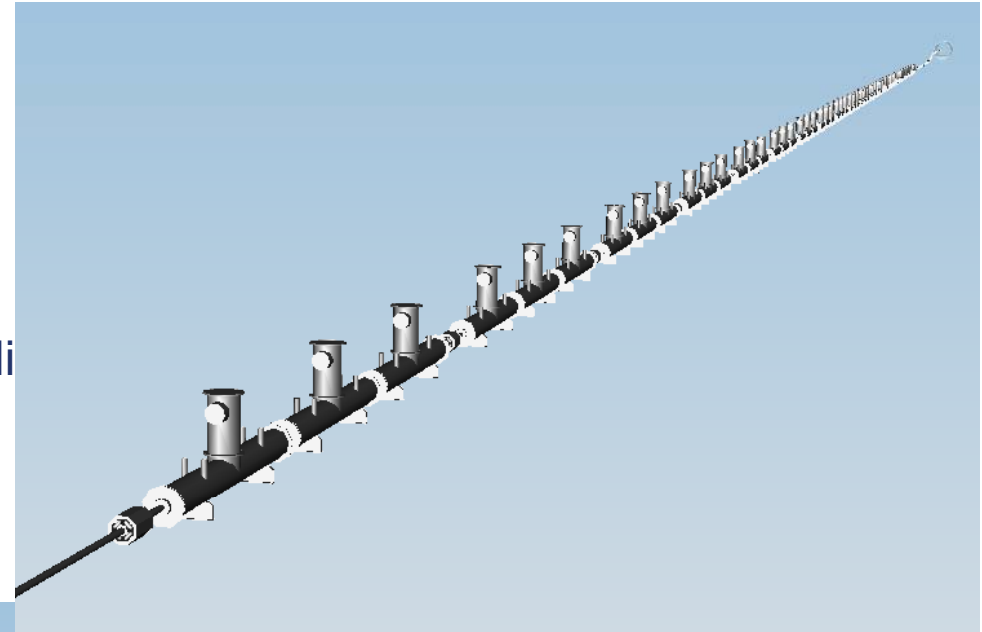
# Types of Studies (2009)

- Interference / Integration
  - Lattice layouts
  - Tunnel cross-section models (CAD)
  - (Installation related)
  - Component placement *etc*
- Operations, Commissioning, Availability
  - Less independent machine operation
  - Reliability issues (accessibility)
  - Commissioning strategies *etc.*
- Hardware development, R&D
  - High-power RF distribution concept
  - Marx modulator (on-going)
  - Increased RF pulse length (low-P)
- Beam Dynamics
  - Emittance preservation
  - BDS tuning
  - Travelling focus 'stability'
  - ...



# Types of Studies (2009)

- Interference / Integration
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  - Emitta
  - BDS tu
  - Travell
  - ...



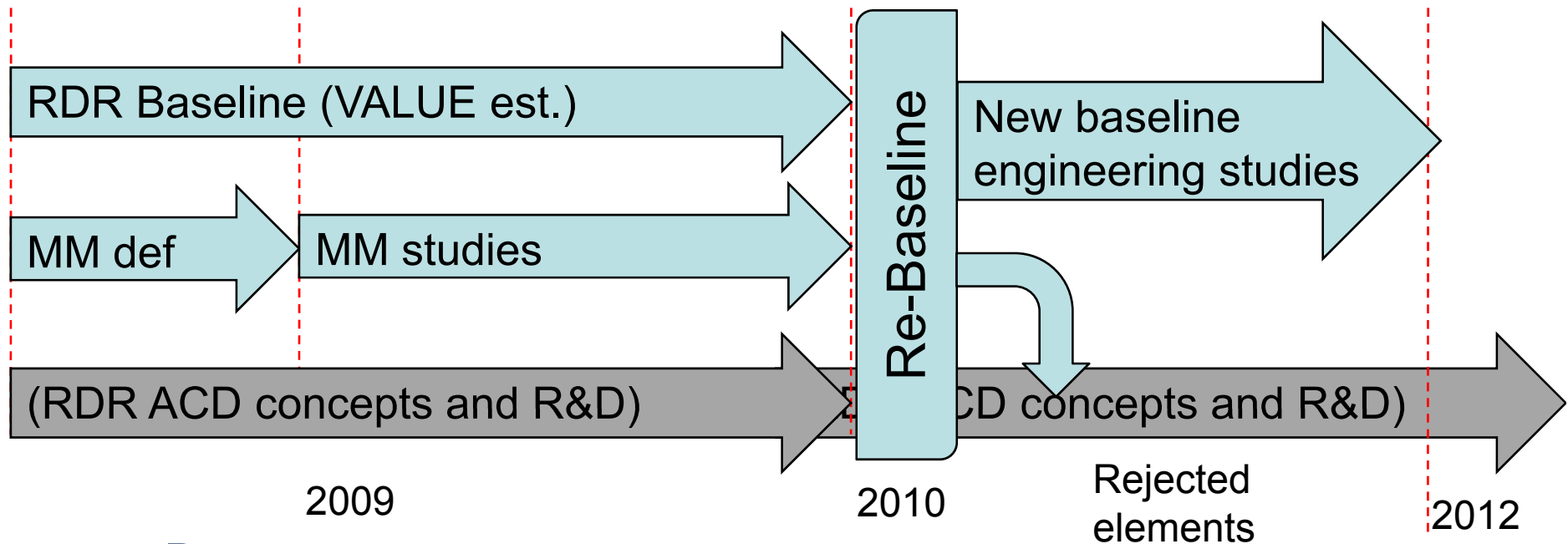


# Particular Issues for e+ Source

- General integration into post-LINAC / BDS region
  - Treat as a **single design problem**
  - **Move away from modular design concept (for AS)**
  - **Central region “team” must now work closely together**
- Operational issues & physics impact
  - **Operation no longer at constant e- beam energy**
  - **(Re-)optimisation of parameters & layout**
    - Additional constraints
  - **Low energy running (low Ecm) issues**
- Availability / Reliability
  - **Removal of 10% KAS**



# Towards a Re-Baselining in 2010



- Process
  - **RDR baseline & VALUE element are maintained**
    - Formal baseline
  - **MM elements needs to be studies/reviewed international**
    - Regional balance in the AP&D groups involved
    - Regular meetings and discussions
    - (but top-down control from PM)
  - **Formal review and re-baseline process beginning of 2010**
    - Exact process needs definition (a PM action item for 2009)
    - Community sign-off mandatory



# Minimum Machine Document in Preparation



## *The ILC Minimum Machine Definition*

Release 1

November 2008

Prepared by the Technical Design Phase Project Management

- Draft document is preparation
- (draft available on PAC website)
- (One) Focus of ILC08 workshop
  - **Study planning**
  - **Resources**
- Final publication end of year



# Collaboration with CLIC / CERN

- Formulated (Barish/Aymar) 11.2007
  - **Established in 02.2008; initially 4 working groups**
    - 5 including detectors
- ‘Exclusive’ strategy:
  - **pick and choose efforts with strong commonality; optimize use of resources**
  - **startup philosophy: choose tasks more likely to succeed**
- Promoting communication / links between the two groups
  - **will facilitate discussion and consensus building between teams**
  - **improving the credibility of both**
- Common costing methodology / basis is a collaboration priority





# CLIC-ILC “Contact Groups”

- CFS
- BDS / MDI
- Beam Dynamics (LET)
- Cost & Schedule

CLIC & ILC “points of contact established

Groups working together

- Sources (spec. e+)
- Damping Rings

To be formally established by ILC08



# Sources (CLIC / ILC)

		<b>CLIC 2008 (0.5 TeV)</b>	<b>CLIC 2008 (3 TeV)</b>	<b>ILC (0.5 TeV)</b>
N	$10^9$	7	3.72 - 4	20
$n_b$	-	312	312	2625
$\Delta t_b$	ns	0.5	0.5 (6 RF periods)	369
$t_{\text{pulse}}$	ns	156	156	968925
$f_{\text{rep}}$	Hz	50	50	5

- CLIC collaboration looking a several options
  - **Conventional**
  - **Crystal production**
  - **Compton-based**
  - **Undulator (most mature)**
- All have overlap/synergy with ILC
  - **But parameter space / challenges are different**

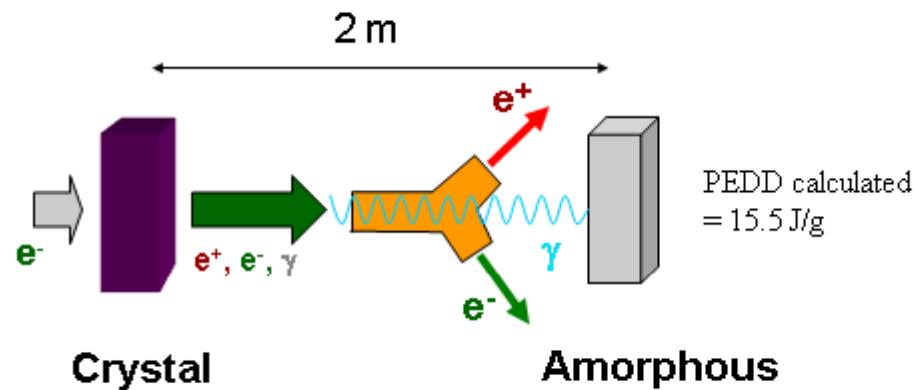


# CLIC e<sup>+</sup> source R&D



## PRELIMINARY CONCLUSIONS for 3 TeV

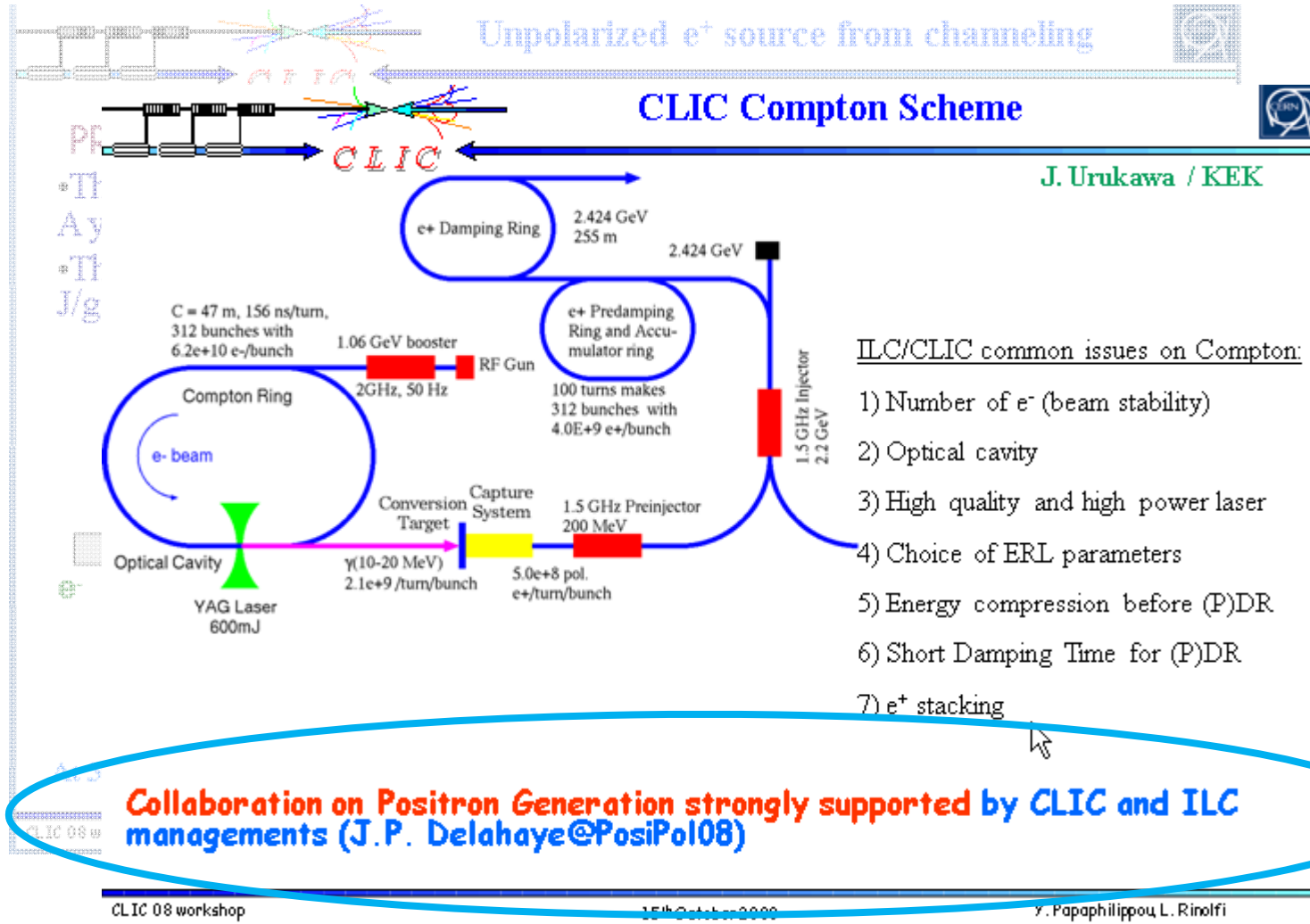
- The hybrid positron source provides the needed yield for CLIC.
- A yield  $>1$  e<sup>+</sup>/e<sup>-</sup> is reachable using only photons coming from the crystal
- The Peak Energy Density Deposition remains under the critical value of 35 J/g (for W) both for the thin crystal and the thick amorphous target.



At 500 GeV, charge is doubled => Study if a double target stations could be avoided ??

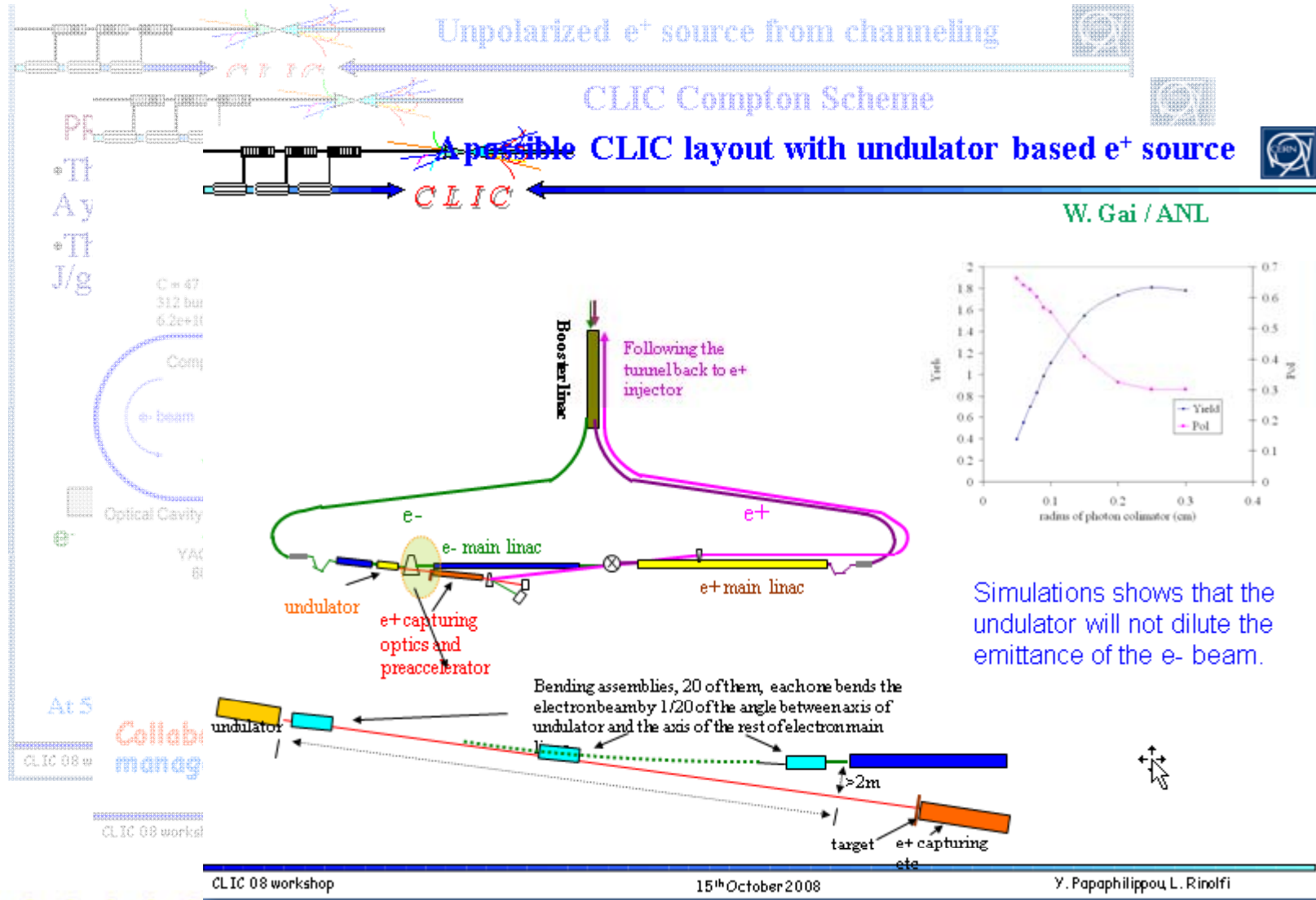


# CLIC e+ source R&D





# CLIC e+ source R&D



Simulations shows that the undulator will not dilute the emittance of the e- beam.



# Summary

- R&D Plan now well established
  - **Already due for review**
- Main focus themes defined
  - **SCRF (cryomodule design / gradient)**
  - **Risk mitigating R&D (e.g. electron cloud)**
  - **Beam Test Facilities**
  - **Cost reduction / containment (Minimum Machine)**
- Minimum Machine studies will formed focus of ILC 'design' activities in 09
  - **Significant impact on positron source**
  - **Integration efforts critical component**
- CLIC-ILC collaboration will bring R&D focus to source work
  - **Importance of working together as a community**