ILC: From RDR to EDR
or
“How to Spend the Money”

Nick Walker
GDE

Contents

- Evolution (status) of the baseline design for the RDR
- Transitioning to an Engineering Design Phase
  - **What's needed for the Engineering Design Report (EDR)**
- Global R&D
  - **GDE global coordination efforts**
  - **Test Facilities**

The Evolving ILC Baseline

- Frascati 11.2005: Fundamental ILC Baseline for costing agreed upon.
- Vancouver 2006: First tentative Cost Estimate Available
- Beijing 2007: Publication of RDR baseline machine with tentative cost estimate.

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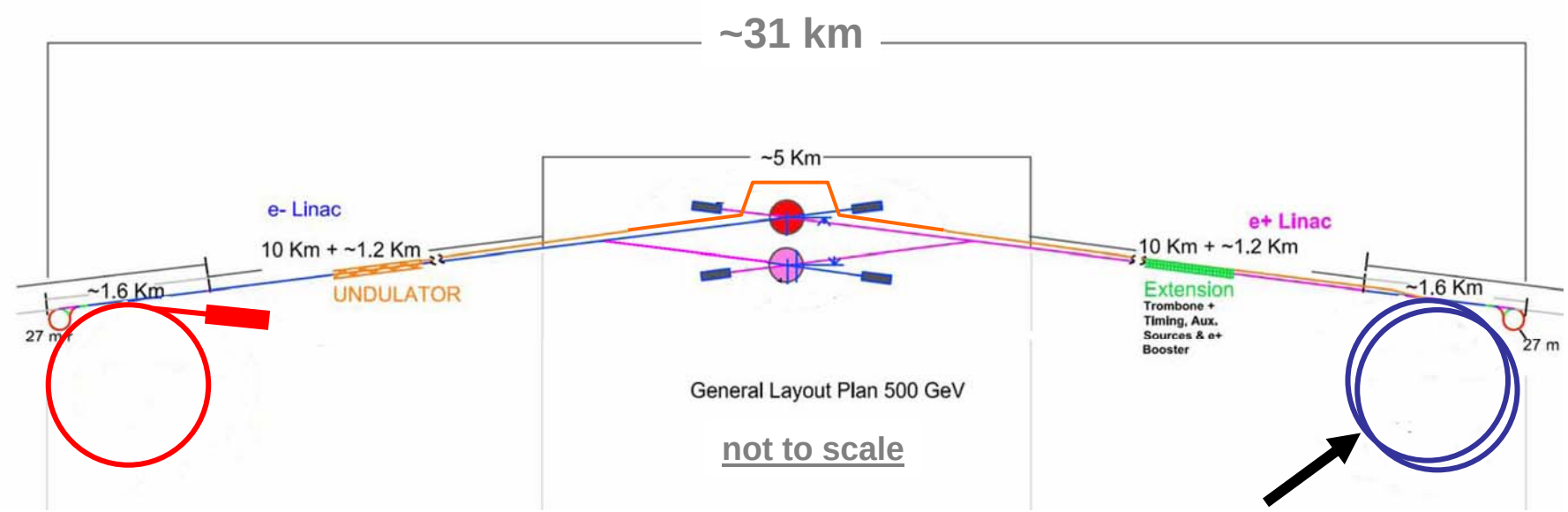
- Frascati 11.2005: Fundamental ILC Baseline for costing agreed upon.
  - **International RDR design teams formed (so-called RDR matrix)**
- Vancouver 2006: First tentative Cost Estimate Available
  - **Cost too high. Begin major cost reduction iterations**
  - **Many cost-driven design modifications implemented**
- Beijing 2007: Publication of RDR baseline machine with tentative cost estimate.

The Evolving Baseline

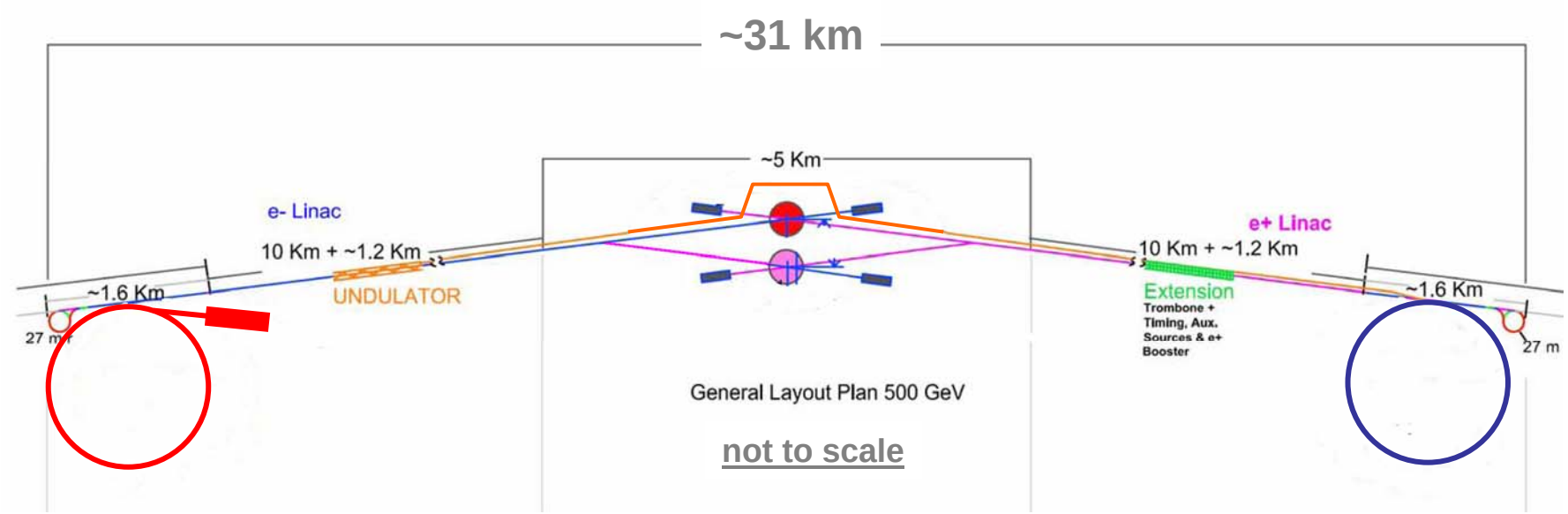
Baseline Configuration



Removal of second e+ ring

Damping Ring

Baseline Configuration

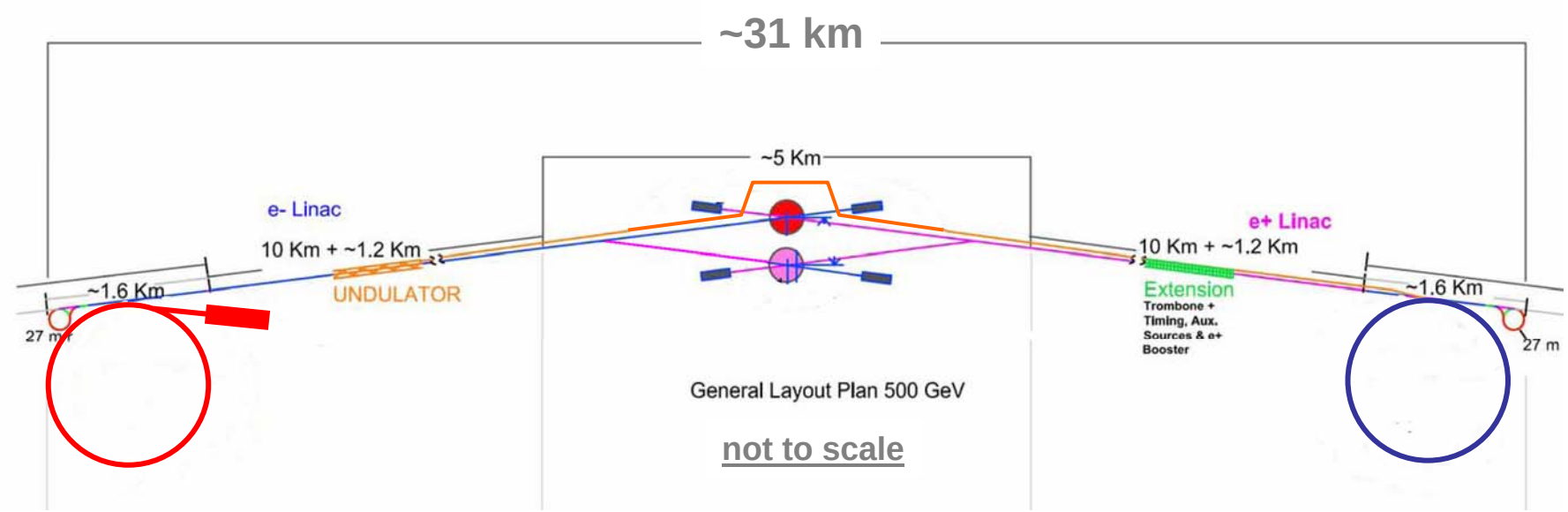


Removal of second e+ ring

simulations of effect of clearing electrodes on **Electron Cloud** instability suggests that a **single e+ ring** will be sufficient

Damping Ring

Baseline Configuration

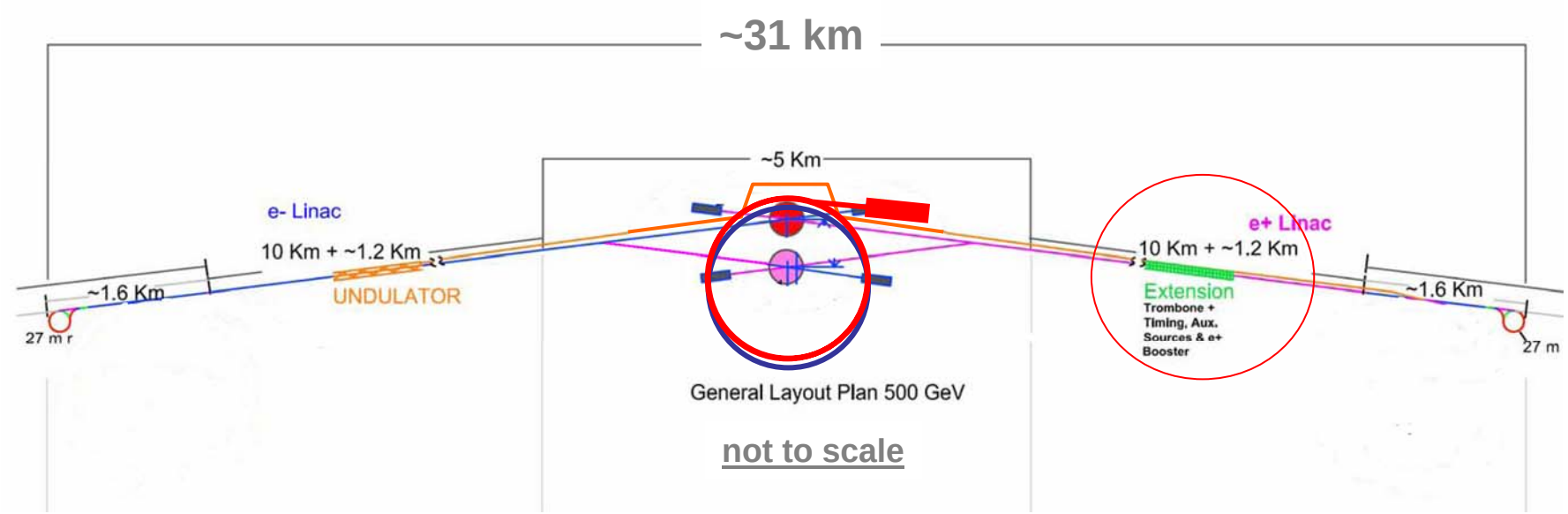


Centralised injectors

Place both e+ and e- ring in single centralized tunnel

Damping Ring

Baseline Configuration



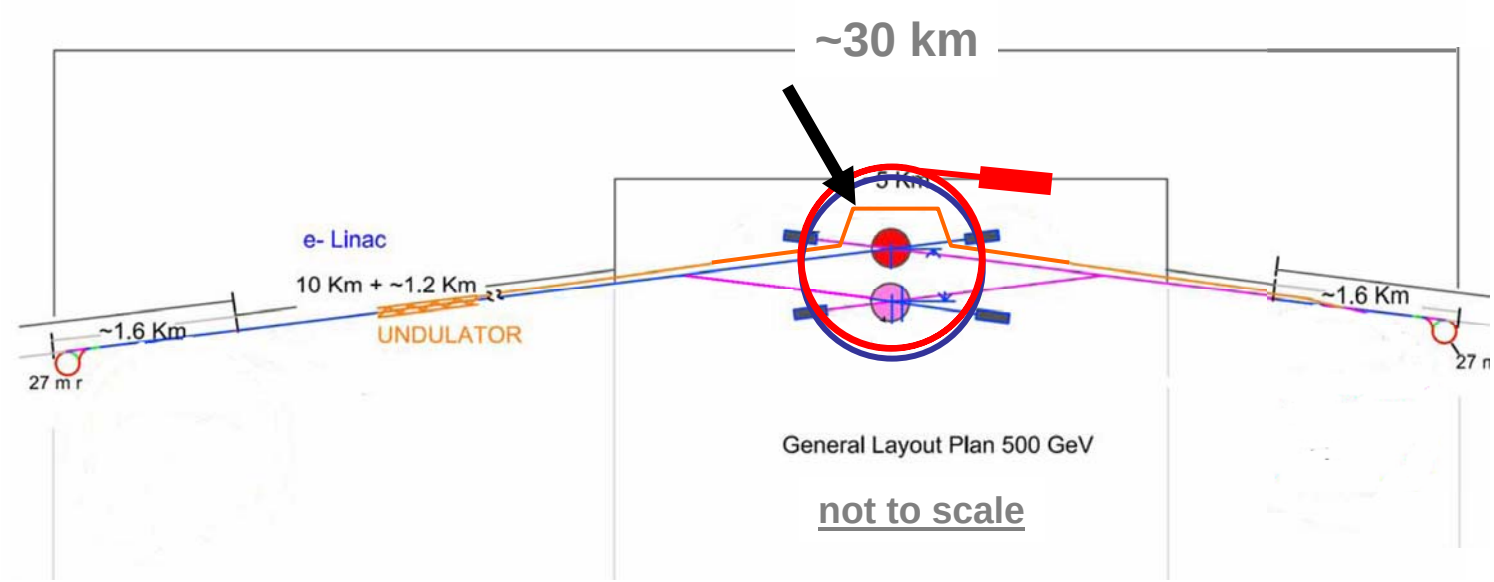
Centralised injectors

Place both e+ and e- ring in single centralized tunnel

Adjust timing (remove timing insert in e+ linac)

Damping Ring

Baseline Configuration



Centralised injectors

Place both e+ and e- ring in single centralized tunnel

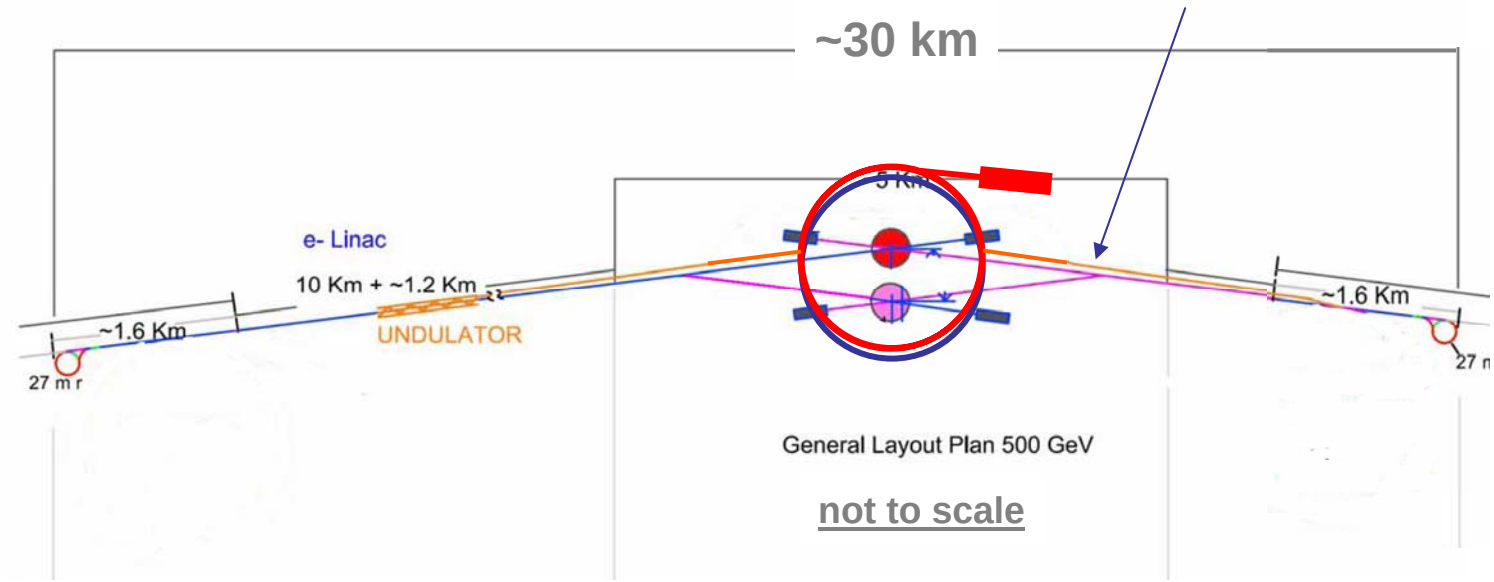
Adjust timing (remove timing insert in e+ linac)

Remove BDS e+ bypass

Damping Ring

Baseline Configuration

Long 5GeV low-emittance transport lines now required



Centralised injectors

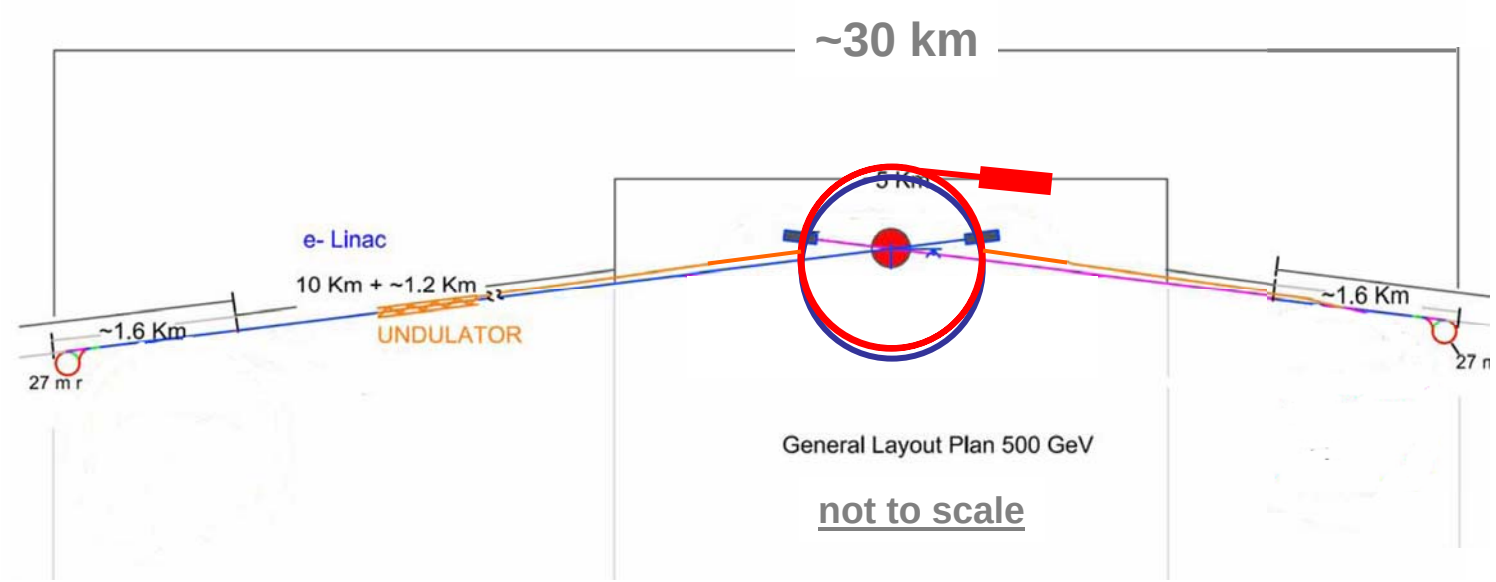
Place both e+ and e- ring in single centralized tunnel

Adjust timing (remove timing insert in e+ linac)

Remove BDS e+ bypass

Single IR with Push-Pull Detector

Baseline Configuration



Final RDR baseline

RDR Status

- Design and cost estimate frozen
- Cost *methodology* reviewed complete at 2.5 day meeting in December (SLAC)
- RDR 'written report' currently being drafted
- Cost estimate being refined
  - **No major adjustments**
  - **Cost will be reviewed this week here by ILC MAC**
- On course to *go public* at Beijing Workshop (Feb '07).
  - **Final publication of RDR document mid 2007**

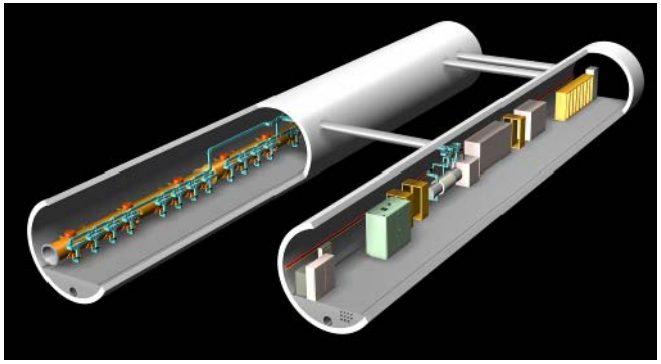
What Happens after Beijing?

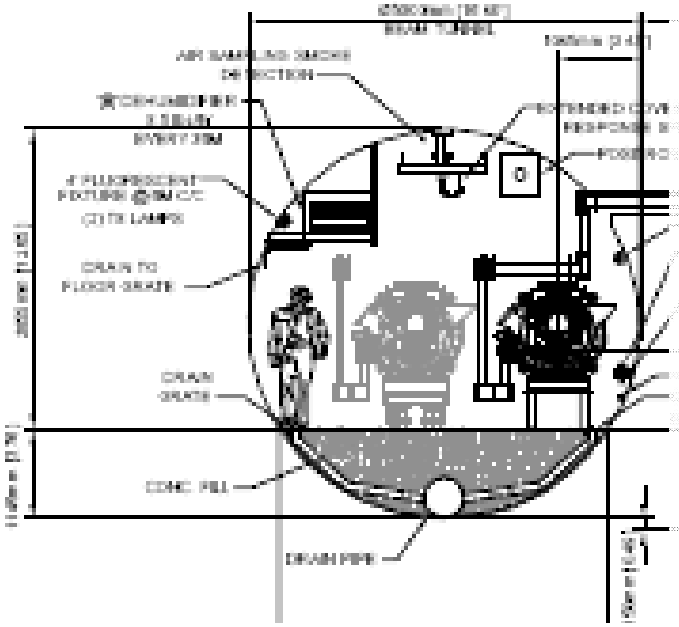
- Enter into **Engineering Design Phase**
  - **Planning underway internally**
  - **Probably some reorganization of GDE to include stronger project management and work package responsibility.**
  - **Design will evolve through value engineering and R&D program (value engineering; R&D results; etc)**
  - **Cost of EDR will be consistent with RDR**

- General Goal is to have Construction Proposal ready by **2010**

Is there a difference between “R&D” and “Engineering”?

Engineering Phase





Main Linac tech. and Civil Engineering remain primary cost drivers (over 50%)

Basic Engineering required to refine and (hopefully) reduce the cost of the machine

RF; Magnets & Power Supplies; Vacuum systems; Instrumentation; Controls; Water cooling; cryogenics; Civil Engineering …

Sound engineering and design required
→ Focus on Baseline

Need Well Defined Project Structure

The Critical Role of “R&D”

- Develop state-of-the-art technologies
- Bring to maturity selected alternative designs which could reduce cost and/or increase performance
- Reduce risk in the baseline design
- Understand overall performance issues

The Critical Role of “R&D”

- Develop state-of-the-art technologies

High-gradient programme remains key to ILC success (cost driver)

However: many development areas exist which are not cost drivers, but are critical to achieving performance:
DR kickers; e+ source undulator; diagnostics; controls etc…

The Critical Role of “R&D”

- Develop state-of-the-art technologies
- Bring to maturity selected alternative designs which could reduce cost and/or increase performance

Single-cell ICHIRO cavities at KEK (50 MV/m achieved)

Solid-state (Marx) modulator development at SLAC

The Critical Role of "R&D"

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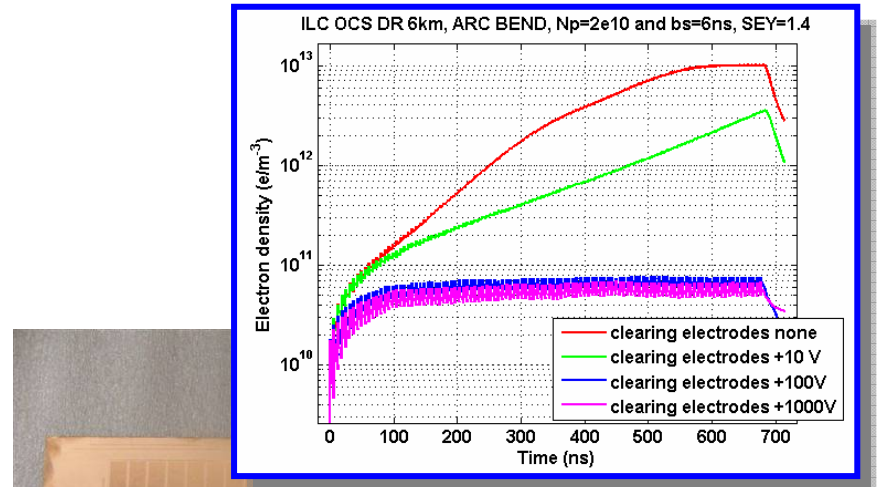

Suppression of e-cloud effect in the e^+ DR

(SLAC, LBNL, CERN, CCLRC, …)

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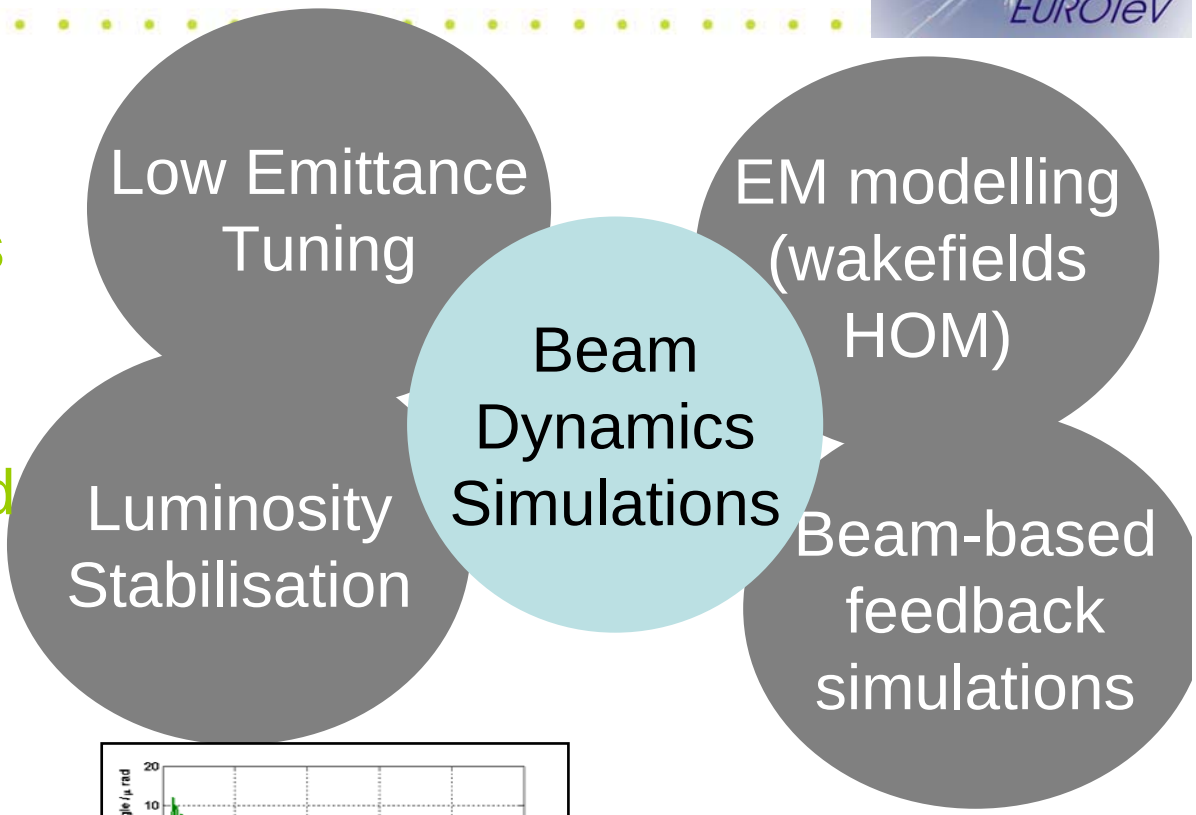
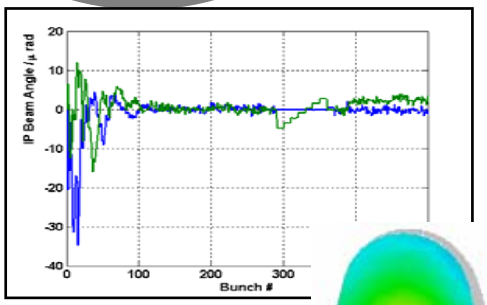
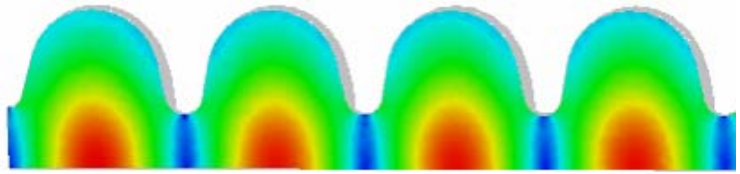




Beam-based trajectory feedback



Cavity HOM

The Critical Role of “R&D”

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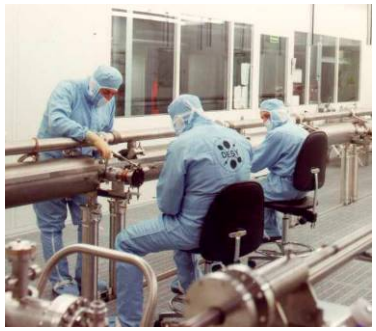
- Understand overall performance issues

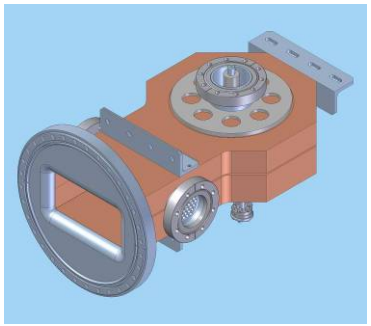
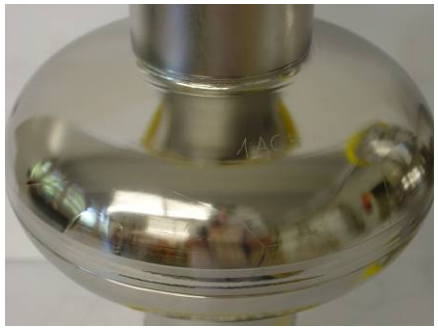
Must be focused on ‘cost reduction’ and/or ‘performance enhancement’

Must keep 2010 milestone in mind

Limited resources requires clear priorities to be set

ILC Global R&D and the GDE: "Driving the Money"

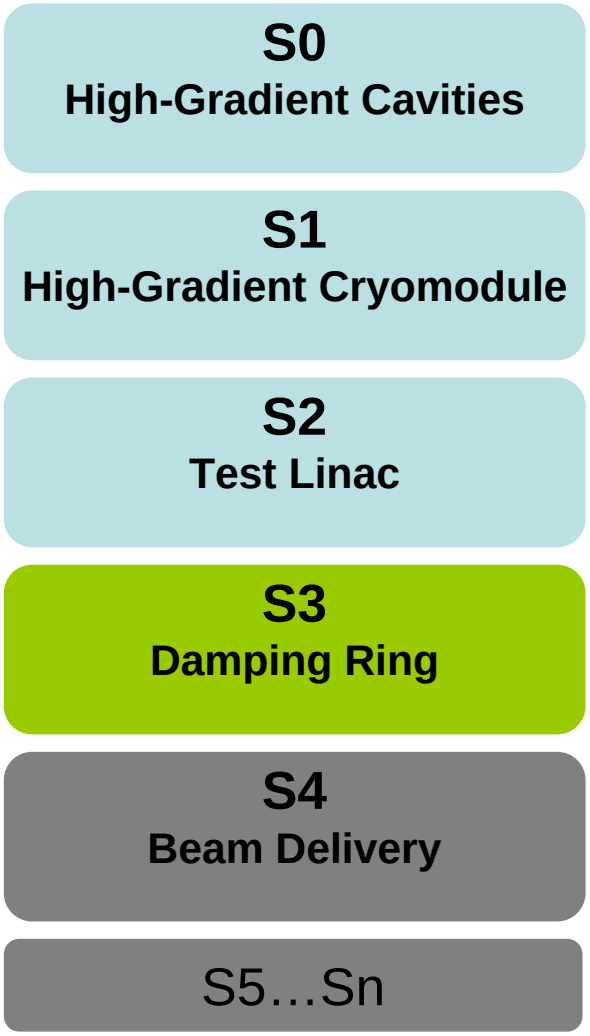



Mission of the Global R&D Board

- Coordinate worldwide, prioritized, proposal- driven, R&D efforts
- The goal is clear, the detailed means required resolution by the RDB of issues, for example:
  - **Level of coordination**
  - **Parallel efforts coordination, Regional needs**
  - **“Reviewing” role: Ideal vs specific R&D Program**
  - **Balance ILC/ILC Detectors issues**
  - **Goals, Timelines**
  - **Interfaces, RDB/DCB, RDB/Industrialization…**
- RDB have already successfully interfaced with US (DoE) and UK (PPARC) ILC R&D proposals.

The ‘S’ R&D Task Forces



Priority: high

To address priority R&D items, RDB has convened several ‘task forces’.

The ‘S’ R&D Task Forces

S0
High-Gradient Cavities

S1
High-Gradient Cryomodule

S2
Test Linac

S3
Damping Ring

S4
Beam Delivery

S5…Sn

- Addresses current ‘poor’ yield for EP cavities
- Primary goal: establish parameters for routinely producing 35 MV/m EP’d cavities
  - **required ≥ 80% yield**

H. Hayano, T. Higo, L. Lilje, J. Mammosser, H. Padamsee, M. Ross, K. Saito

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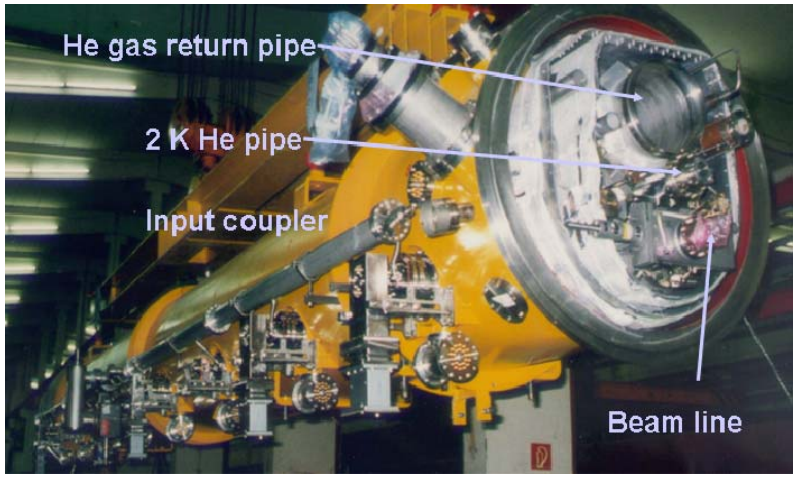

- Achieve 31.5 MV/m at a $Q_0=10^{10}$ as operational gradient
- in more than one module of 8 cavities
- including e.g. fast tuner operation and other features that could affect gradient performance

H. Hayano, T. Higo, L. Lilje, J. Mammosser, H. Padamsee, M. Ross, K. Saito

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S5…S?

- Define requirements for ‘string tests’
  - **minimum: 1 RF unit**
- How many units required?
- Scope of string test

Hasan Padamsee (Co-Chair), Tom Himel (Co-Chair), Bob Kephart, Hitoshi Hayano, Nobu Toge, Hans Weise,

Consultants: Nagaitsev, Nikolai Solyak, Lutz Lilje, Marc Ross, Daniel Schulte

The ‘S’ R&D Task Forces

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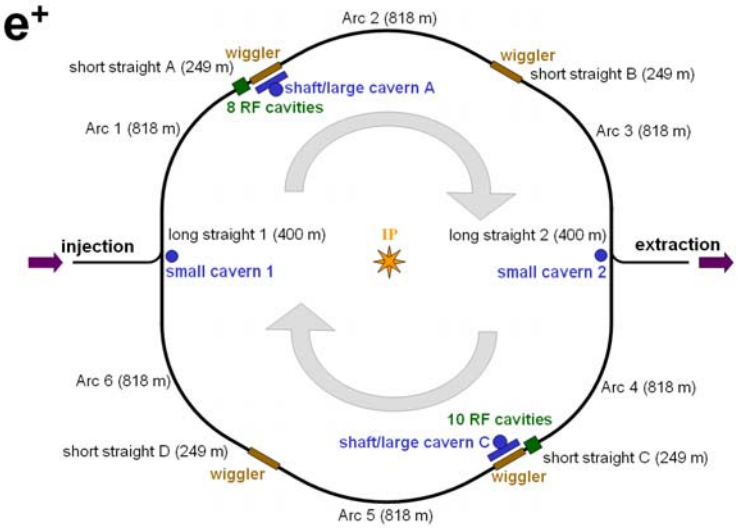

- Identification and prioritisation of DR related critical R&D
- Includes evaluation of available (and proposed) test facilities.

Elsen, Gao, Guiducci, Mattison, Palmer, Pivi, Urakawa, Venturini, Wolski, Zisman

The ‘S’ R&D Task Forces

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S5 … Sn

High Priorities

- 2.1.1.1 Lattice design for baseline positron ring
- 2.1.1.2 Lattice design for baseline electron ring
- 2.1.4.3 Demonstrate < 2 pm vertical emittance
- 2.2.1.2 Characterize single-bunch impedance-driven instabilities
- 2.2.3.1 Characterize electron-cloud build-up
- 2.2.3.2 Develop electron-cloud suppression techniques
- 2.2.3.3 Develop modeling tools for electron-cloud instabilities
- 2.2.3.4 Determine electron-cloud instability thresholds
- 2.2.4.1 Characterize ion effects
- 2.2.4.2 Specify techniques for suppressing ion effects
- 3.5.1.1 Develop fast high-power pulser for injection/extraction kickers

Test Facilities

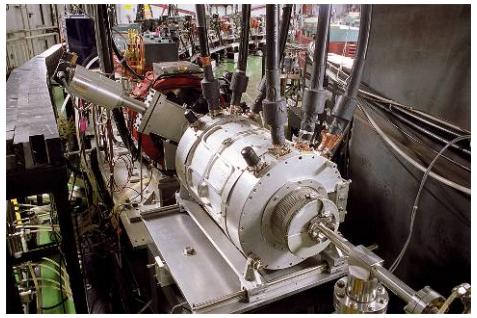
- ‘Global’ Test Facilities will be critical to ILC R&D effort
  - **Will form central ‘hub’ around which (distributed) R&D will take place**
- Current/Planned ‘Test Facilities’ fall into 3 categories
  - **SCRF (high-gradient programmes, RF power...)**
  - **‘Available’ storage rings (DR R&D)**
  - **Test beams (instrumentation, controls etc.)**

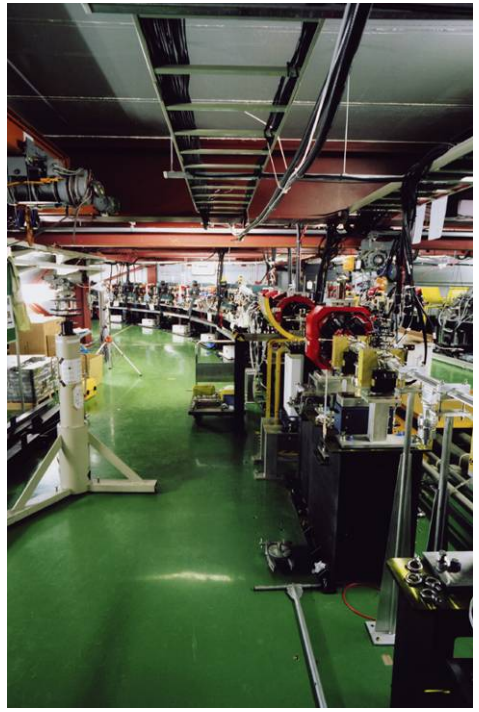
Test Facilities: SCRF

- DESY (TTF/XFEL)
- KEK (STF)
- FNAL (ILCTF)
- Others
  - **Cornell**
  - **JLAB**
  - **ANL**
  - **…**
- Future (?)
  - **CERN**
  - **CCLRC**

ATF I & II @ KEK

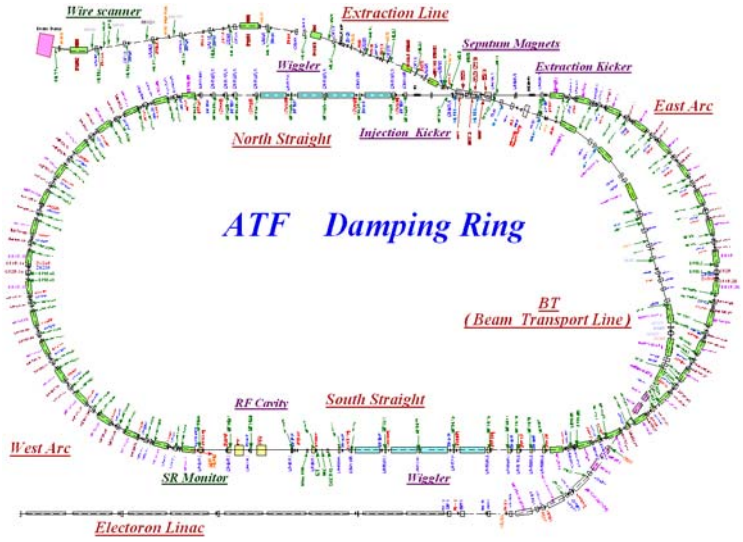
- ATF
  - **DR R&D (instabilities, emittance)**
  - **Diagnostics (laser wire etc.)**
  - **Fast-kicker development etc.**
- ATF II
  - **FF optics test bed**
  - **Diagnostics**
  - **International project**



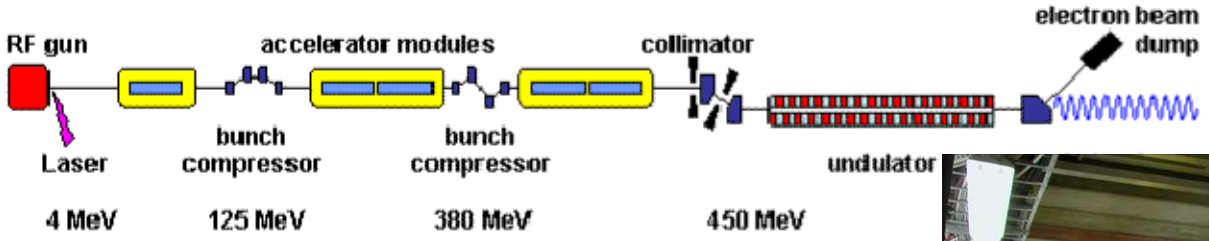


A unique facility in the world

ATF II begins construction this year



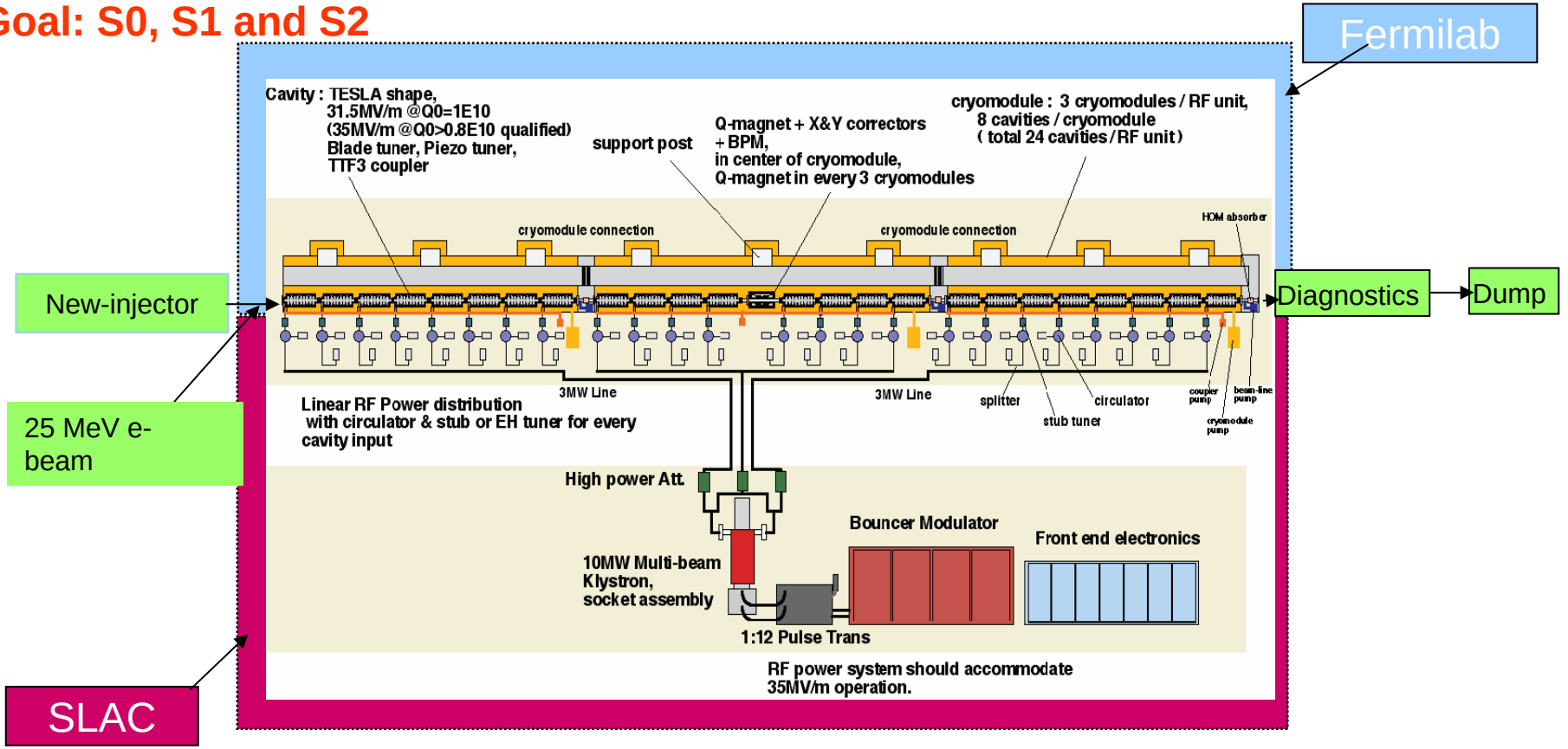
TTF (FLASH) @ DESY



- ILC-like bunch train
- Integrated systems test
  - **LLRF test bed**
- High-gradient tests
  - **Operational**
- New Module Test Stand now available
  - **Currently testing module 6 (high-gradient module)**

ILCTA @ Fermilab (plans)

Goal: S0, S1 and S2



Components provided by US and International Collaborators

1st RF Unit Integrated by US Laboratories and Universities

2nd RF Unit Produced and Integrated by ILC laboratories, Universities and Industries

ILC LLRF, Control, Instrumentation, Feedback etc. ILC Institutions

Other R&D 'Centres'

- SLAC End Station A
  - **Beam diagnostics test area**
- SLAC RF Power test area
  - **Modulator development (Marx)**
  - **Klystron test**
  - **RF distribution**
  - **...**
- DR sites
  - **existing storage rings, possible use as DR experimental areas under discussion → S3 task force**
    - CESR at Cornell
    - HERA e- ring @ DESY
    - ALS @ LBNL
    - DAΦNE @ INFN

Summary

- GDE will shortly achieve its first major milestone with the publication of the **RDR** and associated **cost estimate**
  - **The ILC is now in a transition phase**
- Post-RDR **Engineering Phase** will require a significant ramp-up of the **global engineering and design resources**
  - **GDE planning better global project structure with distributed Work Packages**
- R&D already well established but requires better global coordination
  - **Clear priorities have been set by the GDE**

- Many exciting challenges ahead
  - **…and not all of them technical ones!**