Towards an International Linear Collider

Barry Barish

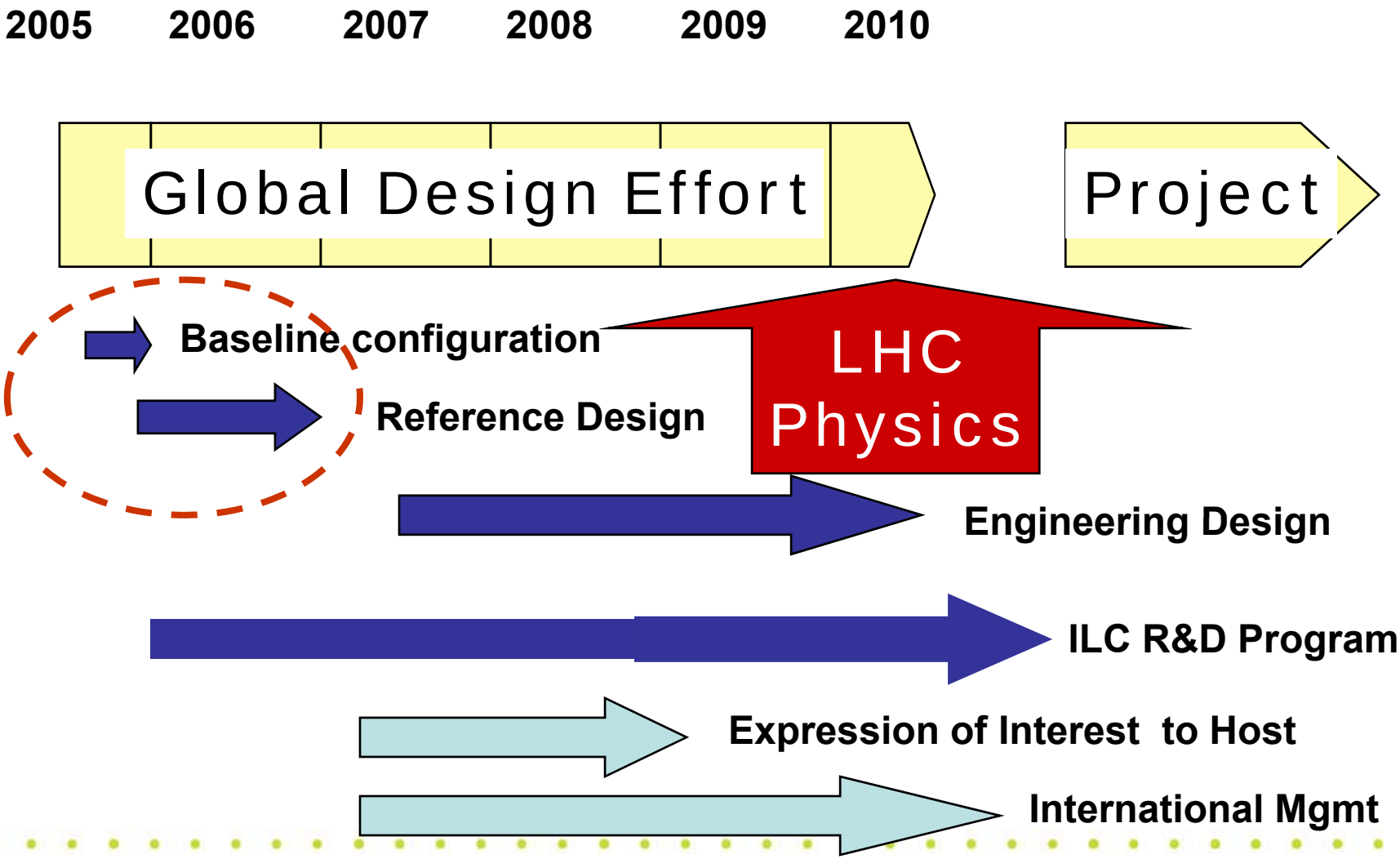
GDE

6-June-07

40th Fermilab Users Meeting
June 6-7, 2007

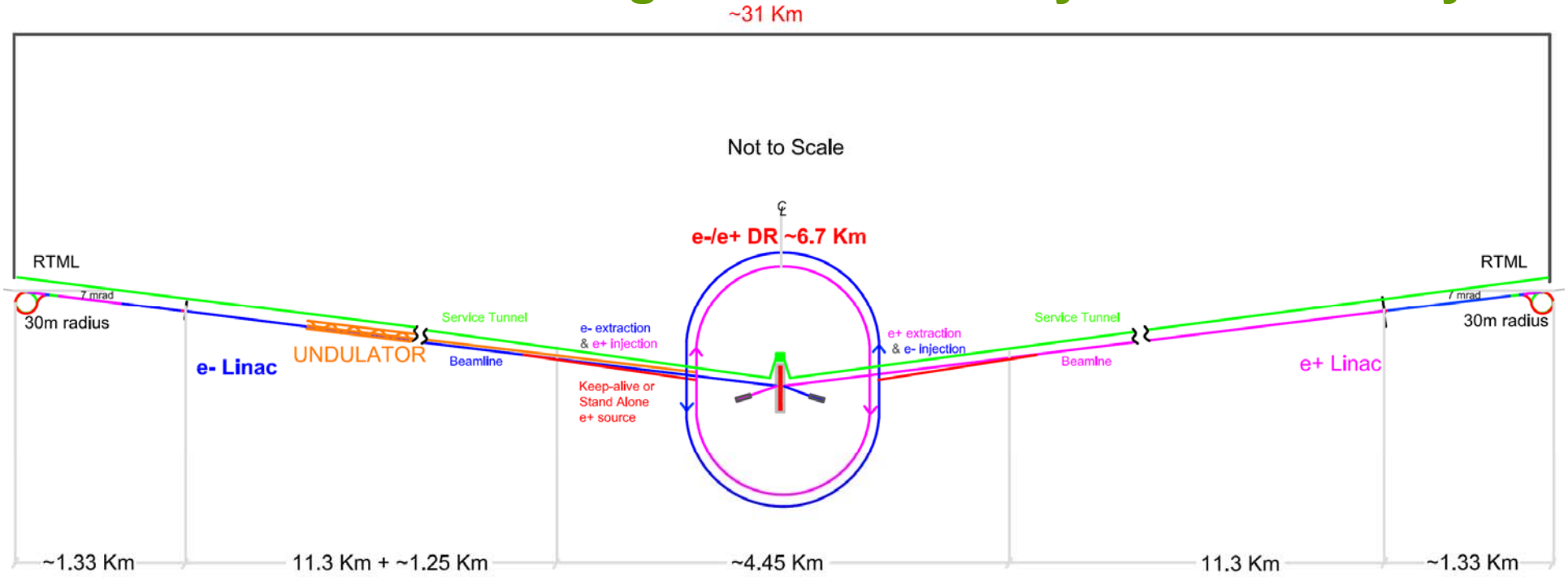
1967 — 2007 Ramsey Auditorium, Fermilab, Batavia, IL

The GDE Plan and Schedule



RDR ILC Schematic

- **11km SC linacs operating at 31.5 MV/m for 500 GeV**
- **Centralized injector**
  - Circular damping rings for electrons and positrons
  - Undulator-based positron source
- **Single IR with 14 mrad crossing angle**
- **Dual tunnel configuration for safety and availability**



RDR Design & "Value" Costs

The reference design was "frozen" as of 1-Dec-06 for the purpose of producing the RDR, including costs.

It is important to recognize this is a snapshot and the design will continue to evolve, due to results of the R&D, accelerator studies and value engineering

The value costs have already been reviewed twice

- 3 day "internal review" in Dec
- ILCSC MAC review in Jan

Σ Value = 6.62 B ILC Units

Summary
RDR "Value" Costs

Total Value Cost (FY07)

4.80 B ILC Units Shared

+

1.82 B Units Site Specific

+

14.1 K person-years

("explicit" labor = 24.0 M person-hrs @ 1,700 hrs/yr)

1 ILC Unit = $ 1 (2007)

Assessing the RDR

- **Reviews (5 major international reviews + regional)**
  - **The Design:** "The MAC applauds that considerable evolution of the design was achieved … the performance driven baseline configuration was successfully converted into a cost conscious design."
  - **The R&D Plan:** "The committee endorses the approach of collecting R&D items as proposed by the collaborators, categorizing them, prioritizing them, and seeking contact with funding agencies to provide guidelines for funding.
  - **International Cost Review (Orsay):** Closeout by Lyn Evans (chair) supported the costing methodology; considered the costing conservative in that they identify opportunities for cost savings; etc.

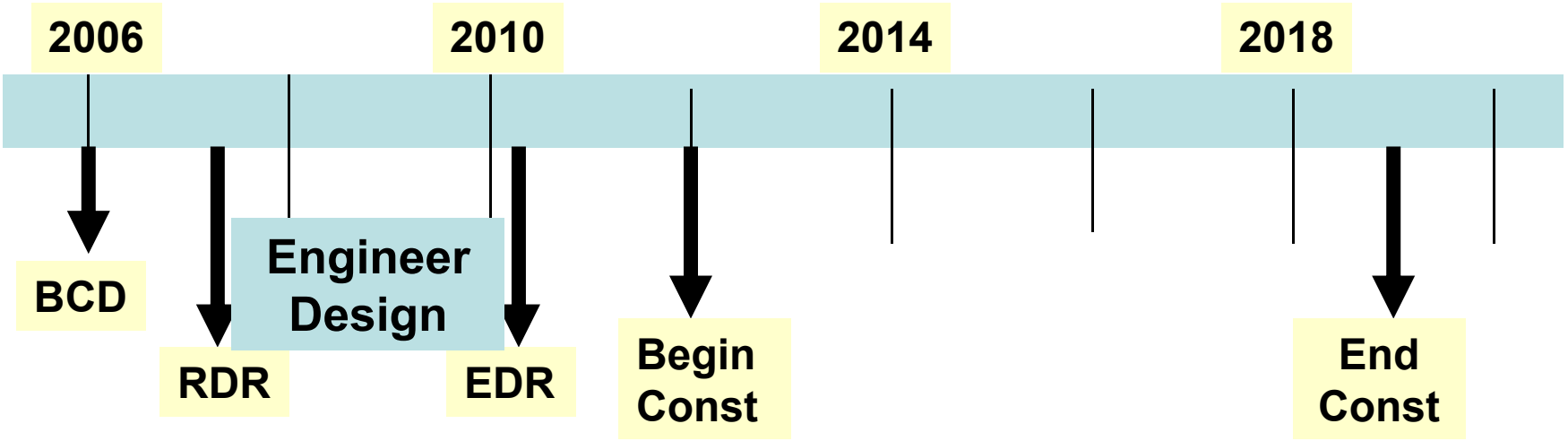
- **Final Steps**
  - The final versions of Executive Summary, Reference Design Report and Companion Document will be submitted to FALC (July), ILCSC and ICFA (August).

On track … but what about Orbach?

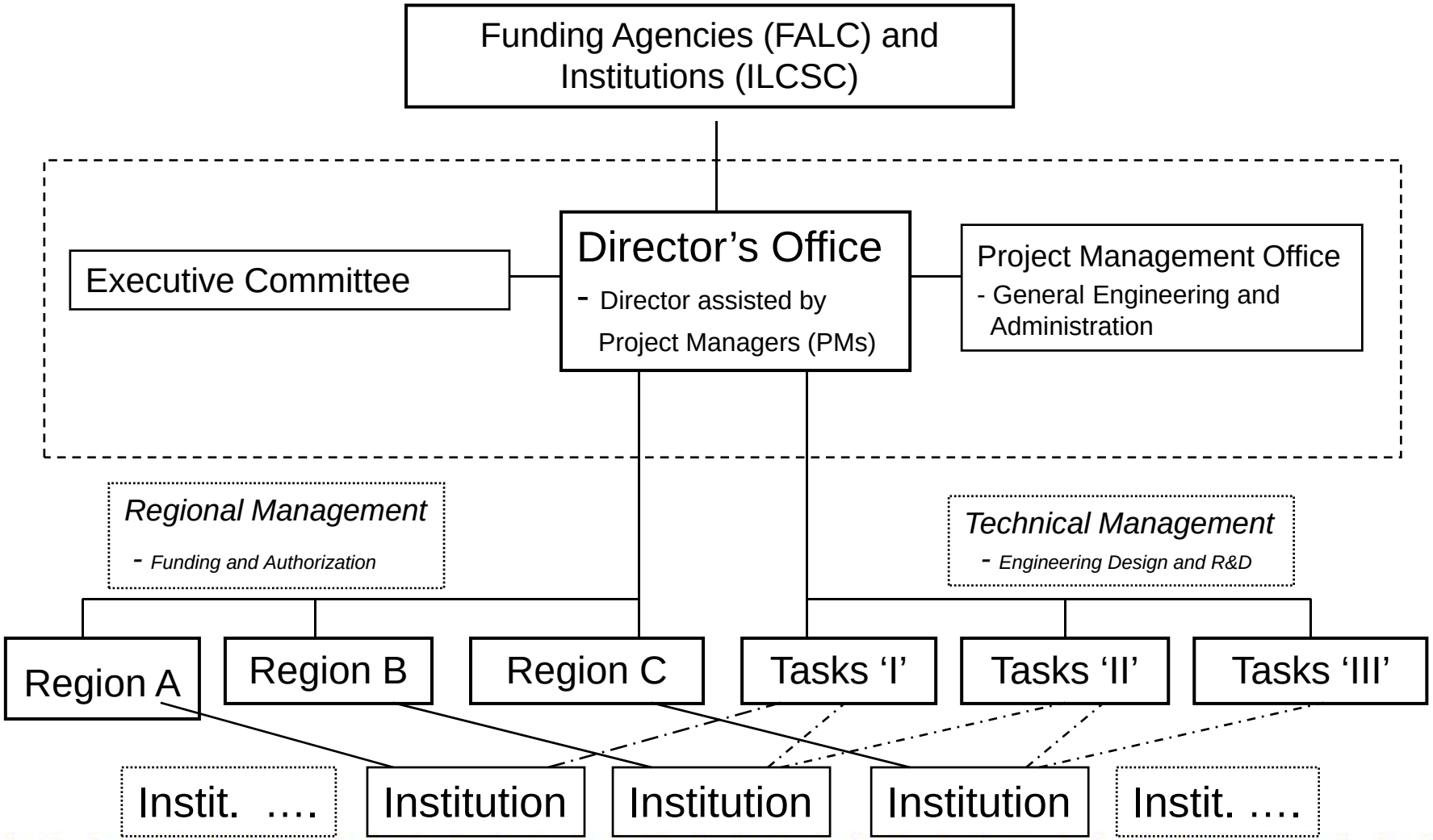
"Completing the R&D and engineering design, negotiating an international structure, selecting a site, obtaining firm financial commitments, and building a machine could take us well into the mid-2020s, if not later,"

- **Our technically driven timeline is**
  - **Construction proposal in 2010**
  - **Construction start in 2012**
  - **Construction complete in 2019**
- **What do we need to do to achieve our timeline?**

Technically Driven Timeline

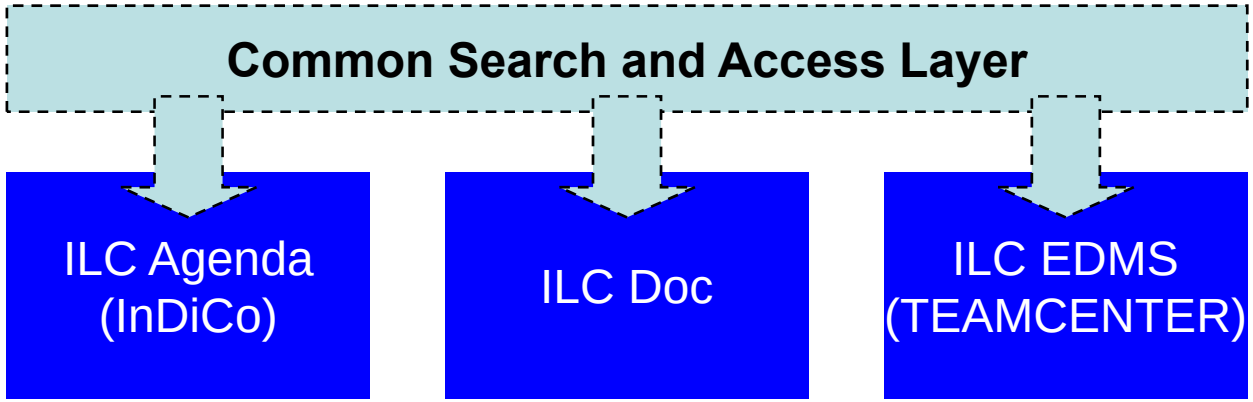


ILC EDR Organization



E-Document Systems at ILC

- Recommendations from the GDE EDMS committee have been implemented
- Status: ILC Agenda and ILC Doc in operation, ILC EDMS is launched at LCWS DESY, tools for common access to be added subsequently



Important **global collaboration tool** for the EDR phase

(under PM office)

EDMS tutorials available this workshop

- agendas
- meeting minutes
- presentations

ilcagenda.linearcollider.org

- ILC notes
- publications
- illustrations

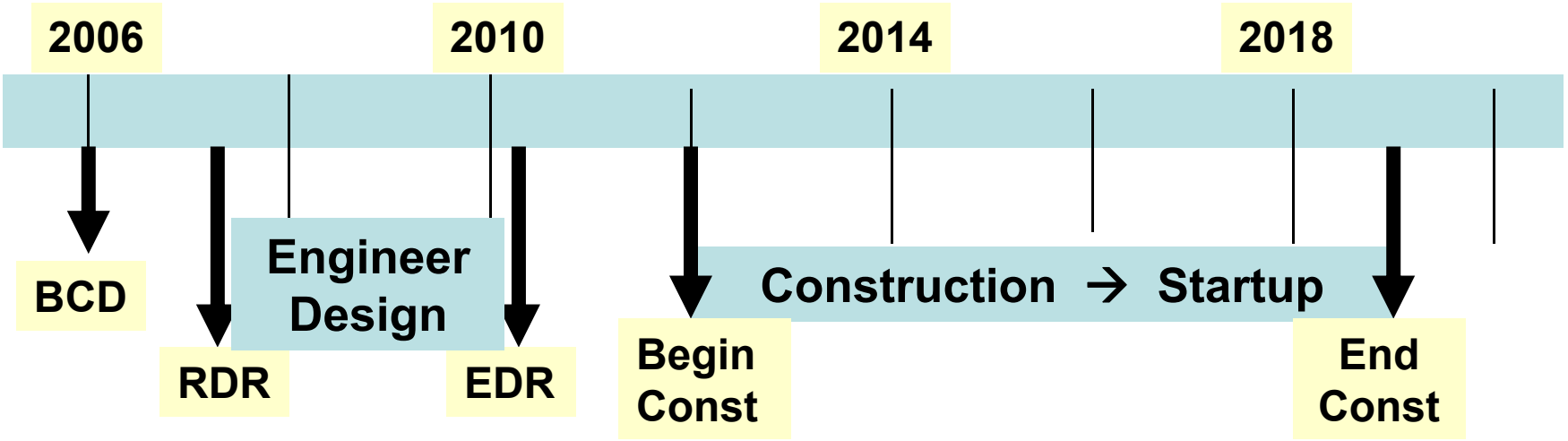
ilcdoc.linearcollider.org

- specifications
- technical reports
- drawings
- 3D CAD models

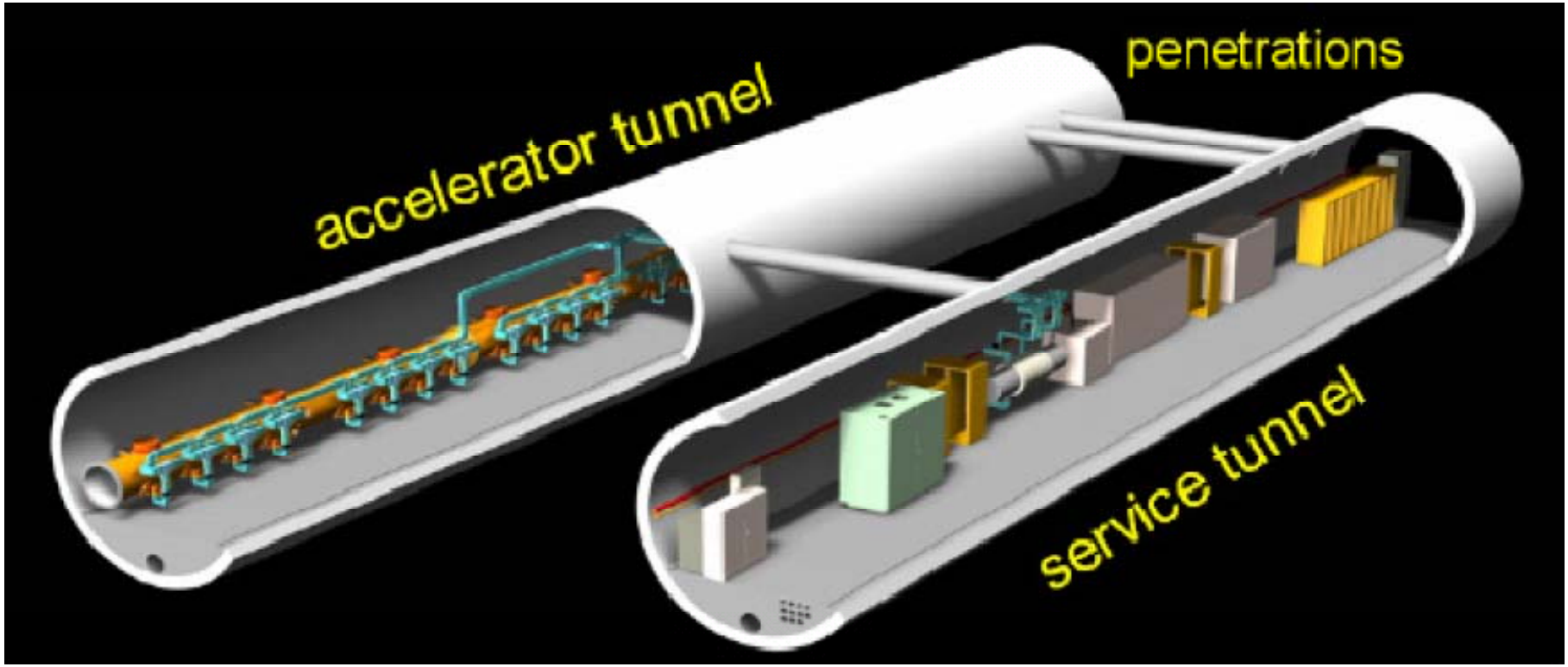
Engineering Design Phase

- **ILC Engineering Design**
  - **We have a solid design concept in the reference design, but it is immature and needs engineering designs, value engineering, supporting R&D and industrialization.**
- **GDE will be reorganized around a Project Management Office to reach this goal**
  - **M. Ross, N. Walker and A Yamamoto – PM "Troika" + high level engineering managers in the project office**
  - **Central management will have authority to set priorities and direct the work**
  - **Resources for the engineering design and associated R&D appears feasible**
  - **Investments toward Industrialization and siting**
  - **Anticipate LHC results by about 2010. We must be ready!**

Technically Driven Timeline



Double Tunnel



- Three RF/cable penetrations every rf unit
- Safety crossovers every 500 m
- 34 kV power distribution

Conventional Facilities

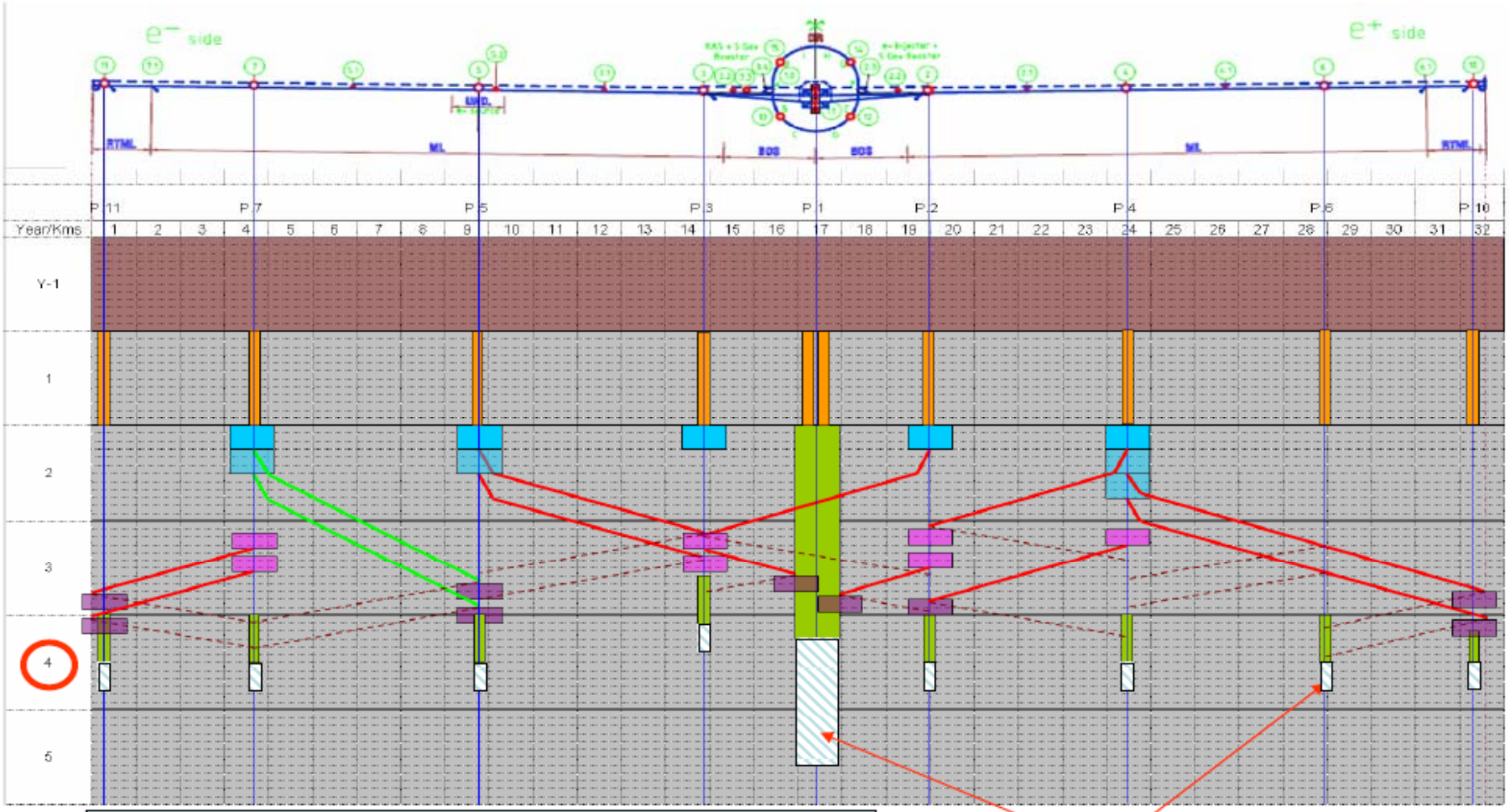
72.5 km tunnels ~ 100-150 meters underground

13 major shafts ≥ 9 meter diameter

443 K cu. m. underground excavation: caverns, alcoves, halls

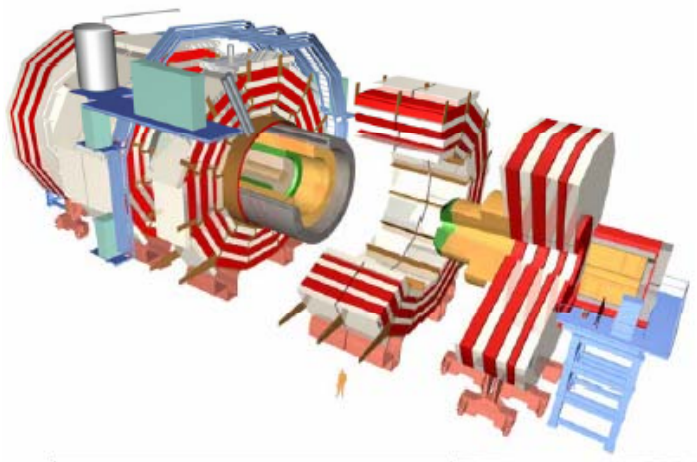
92 surface “buildings”, 52.7 K sq. meters = 567 K sq-ft total

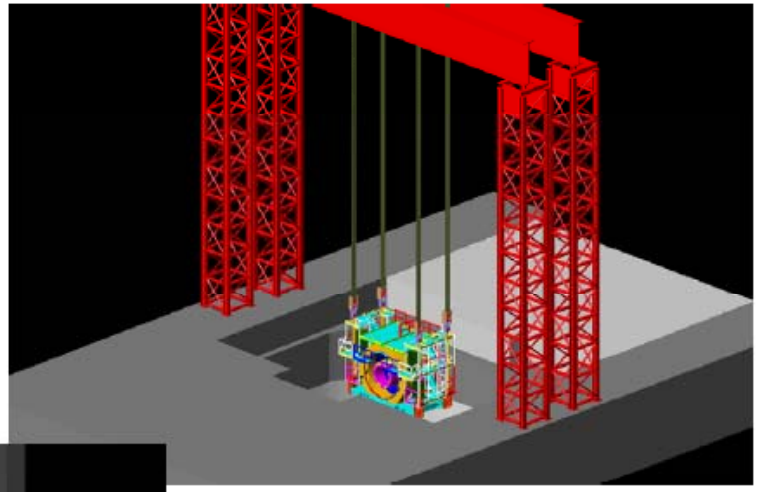
Civil Construction Timeline

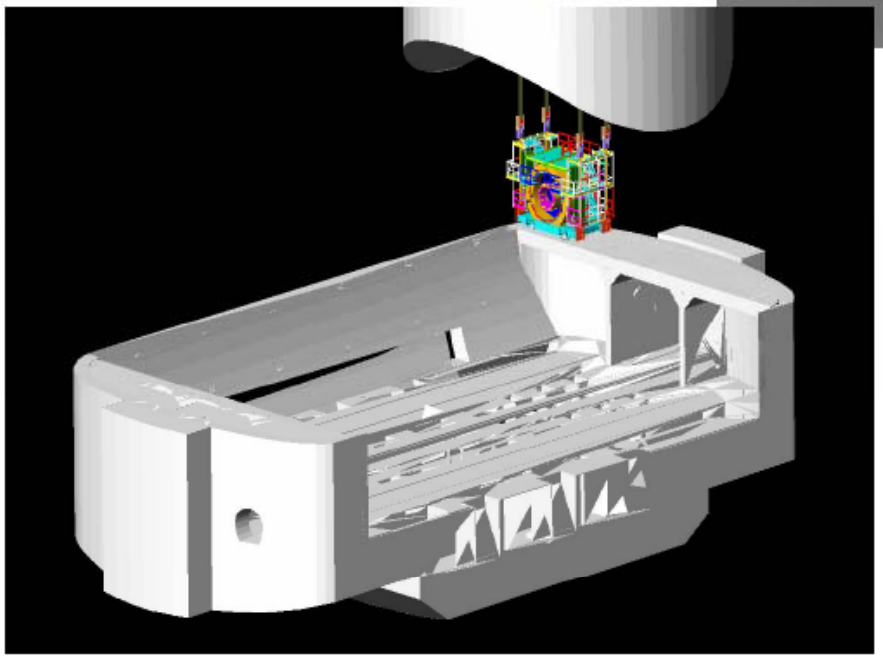


On-surface Detector Assembly

CMS approach



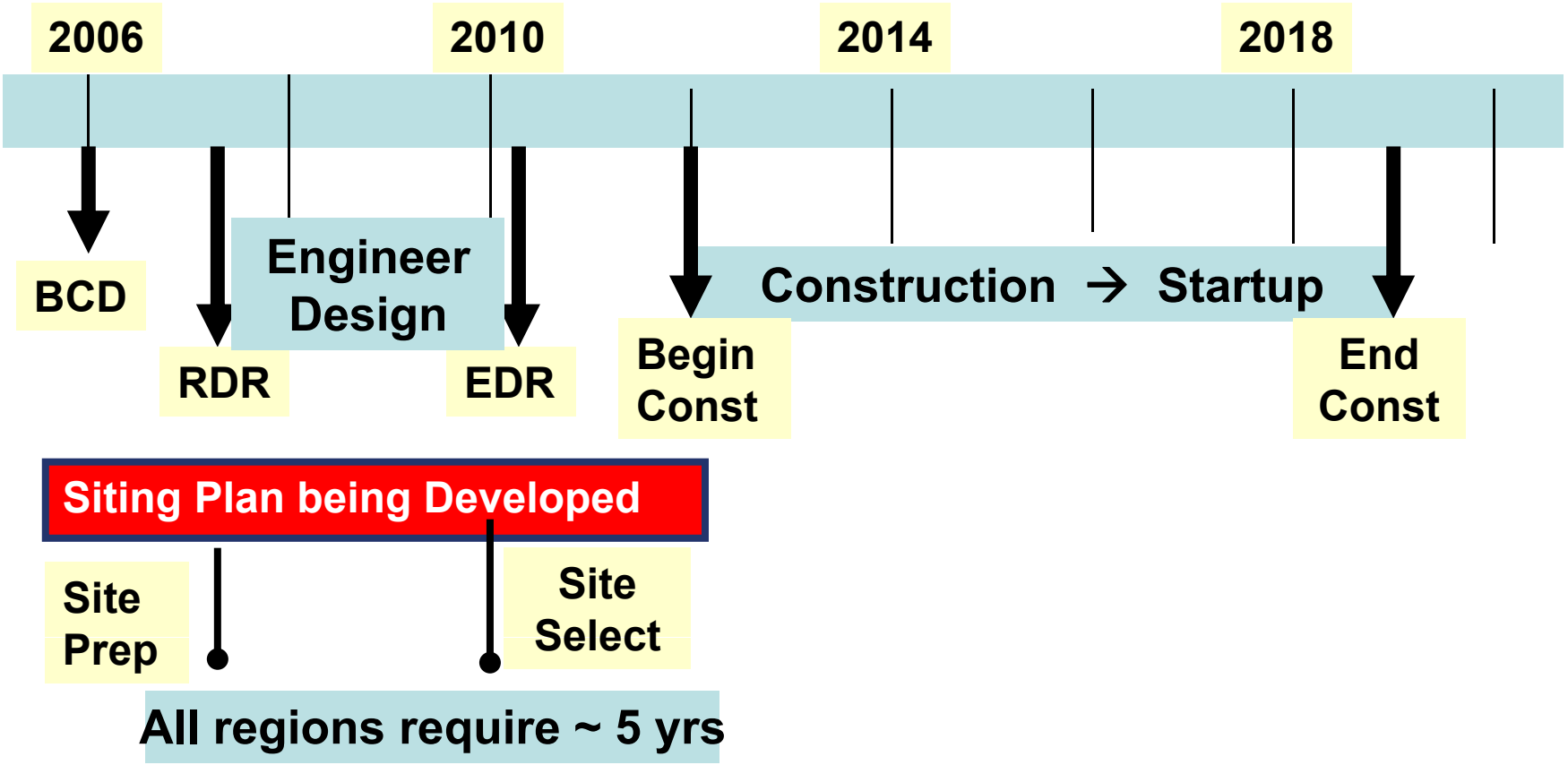




CMS assembly approach:

- **Assembled on the surface in parallel with underground work**
- **Allows pre-commissioning before lowering**
- **Lowering using dedicated heavy lifting equipment**
- **Potential for big time saving**
- **Reduces size of required underground hall**

Technically Driven Timeline

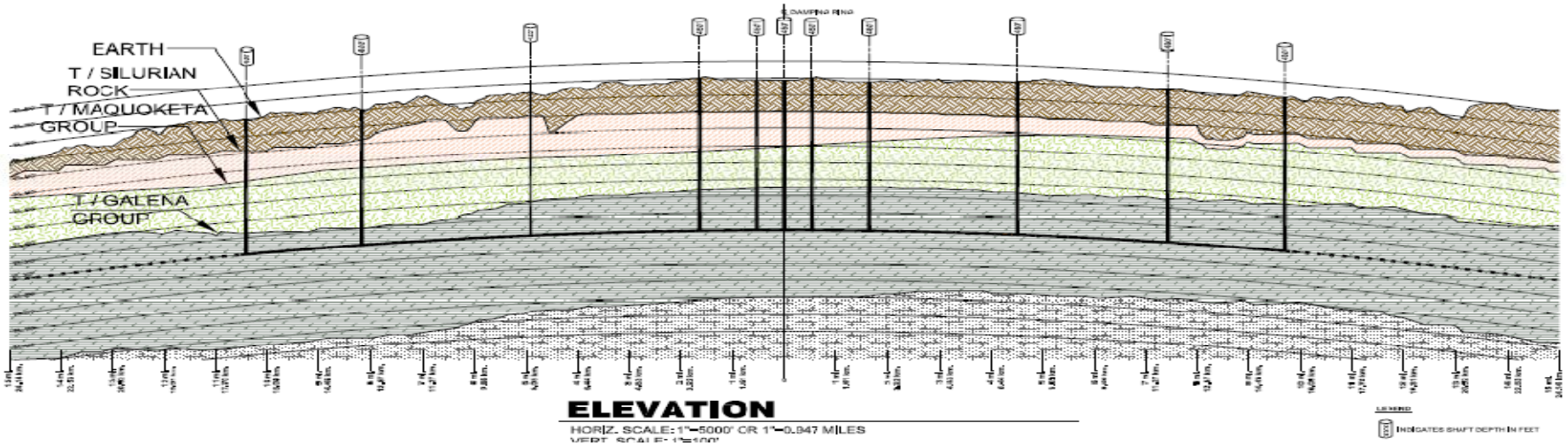


Americas Fermilab Sample Site

***Situation : i**n solid rock, close to existing institute, close to the city of Chicago and international airport, close to railway and highway networks.*

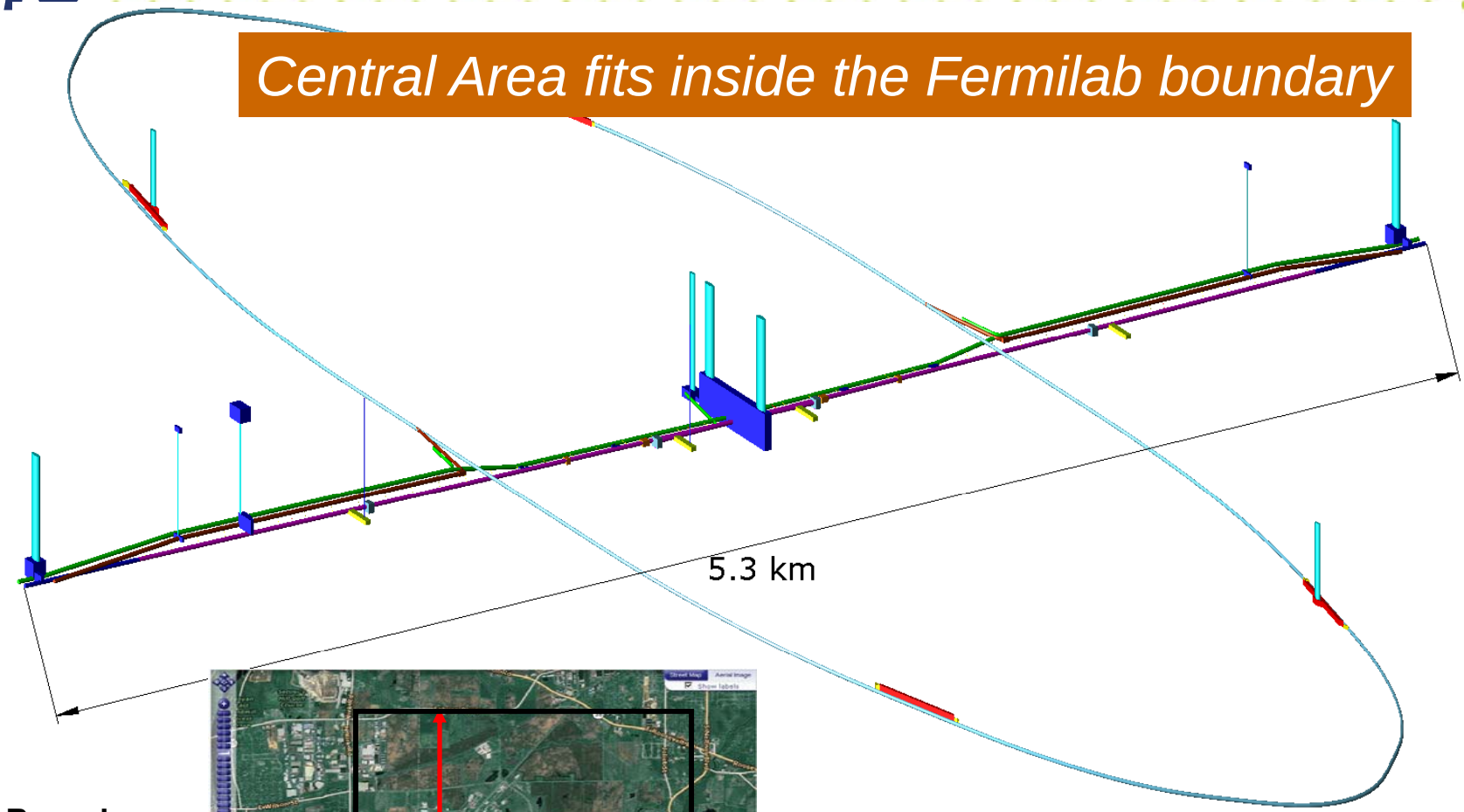
***Geology :** Glacially derived deposits overlaying Bedrock. The concerned rock layers are from top to bottom the Silurian dolomite, Maquoketa dolomitic shale, and the Galena-Platteville dolomites.*

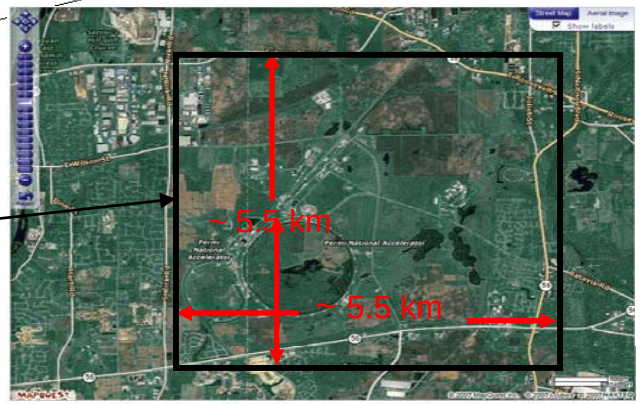
***Depth of main tunnels :** Average ~ 135 m*



Preconstruction Plan for Fermilab

Central Area fits inside the Fermilab boundary



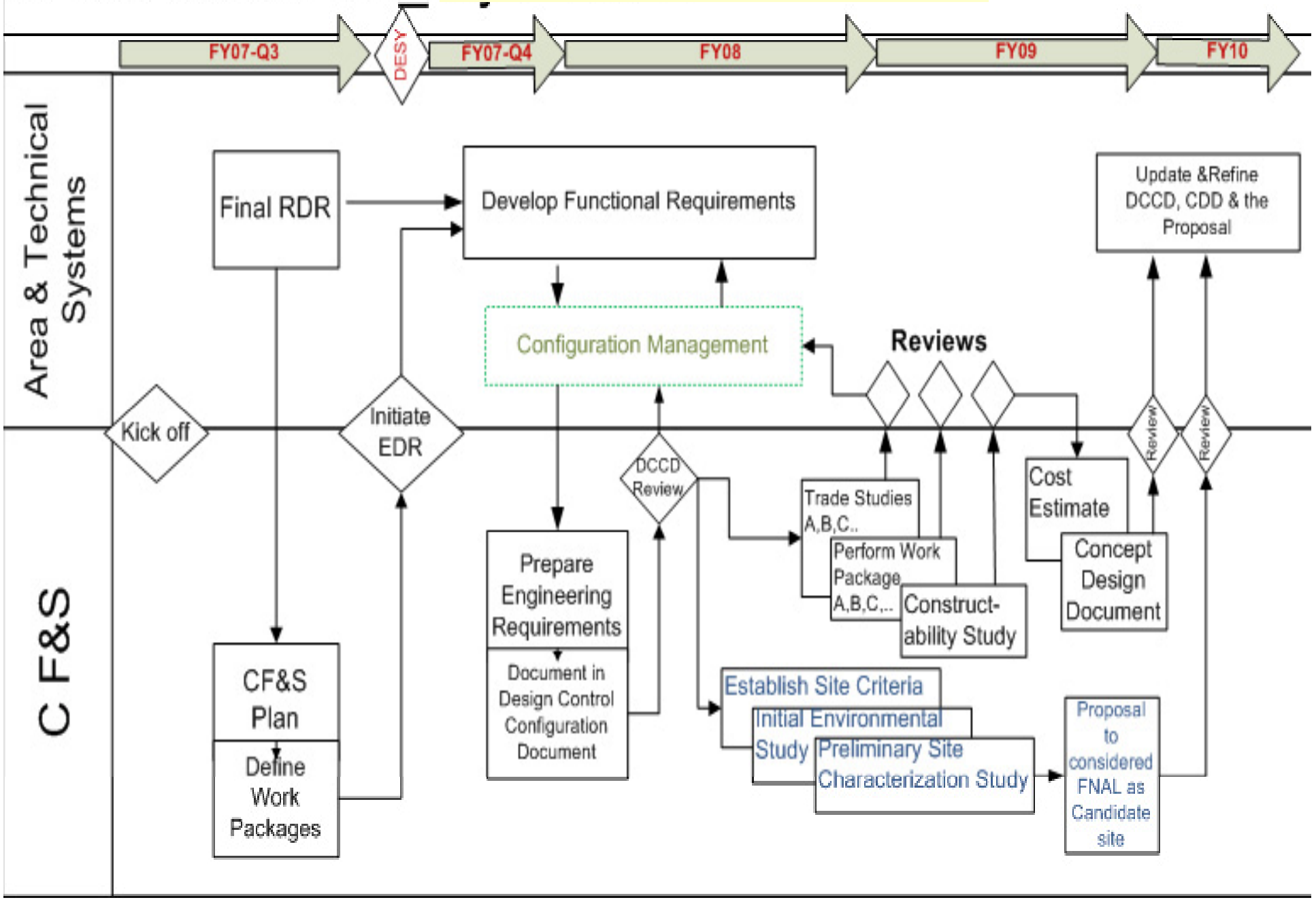


~ Boundary of Fermilab

Site Characterization of the Central Area can be done

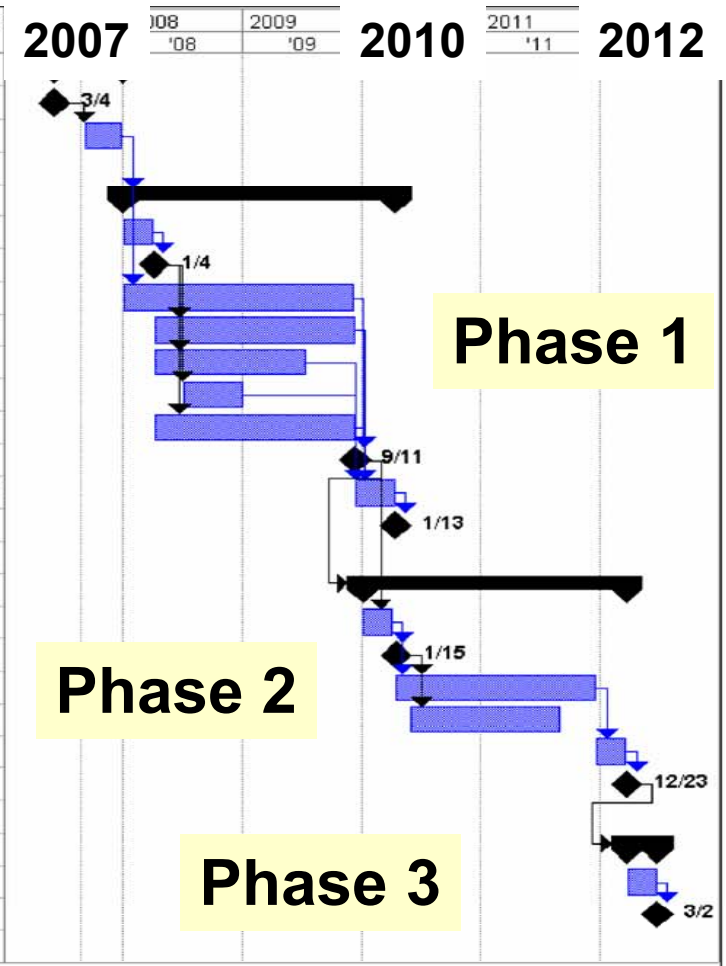
CF&S Work Plan

Americas Site Plan



Preparing for 2012 Construction Start

ID	Task Name	Duration	Start	Finish	Predec
1	**EDR_ Preparation**	**150 days**	**March 4**	**September 28**	
2	Notice to Proceed with EDR	0 days	March 4	March 4	
3	Define Scope and Work Packages	85 days	June 4	September 28	2
4					
5	**Concept Level Design Phase**	**598 days**	**October 1**	**January 13**	**3**
6	Define Requirements & SOW	3 mons	October 1	December 31	
7	Select Firms & Labs for Major Tasks	0 days	January 4	January 4	6
8	Generic Design_ In-house	23 mons	October 1	September 7	3
9	Site Specific Design of Central Area	20 mons	January 7	September 11	7
10	Geotechnical Investigations of Central Area	15 mons	January 7	April 10	7
11	Vibration Characterization of Central Area	6 mons	April 1	October 1	7
12	Environmental Assessments of Central Area	20 mons	January 7	September 11	7
13	Submit Draft of EDR	0 days	September 11	September 11	8,9
14	Prepare Proposal for American Site	4 mons	September 14	January 13	10,12,11
15	Submit Proposal for American Candidate Site	0 days	January 13	January 13	14
16					
17	**Preliminary Design Phase**	**580 days**	**October 5**	**December 23**	**13**
18	Down Select 3 Firms	3 mons	October 5	January 4	13
19	Decision to Use Fermilab as American Site	0 days	January 15	January 15	18
20	Prepare Preliminary Design (By 3 Firms)	20 mons	January 15	September 22	19,18
21	Geotechnical Investigations	15 mons	March 1	June 3	19
22	Review and Evaluate the Reports	3 mons	September 23	December 23	20
23	Make Recommendation	0 days	December 23	December 23	22
24					
25	**Final Design/Build Phase**	**66 days?**	**December 26**	**March 26**	**23**
26	Negotiations	3 mons	December 26	March 26	
27	Notice to Proceed	0 days	March 26	March 26	26
28					

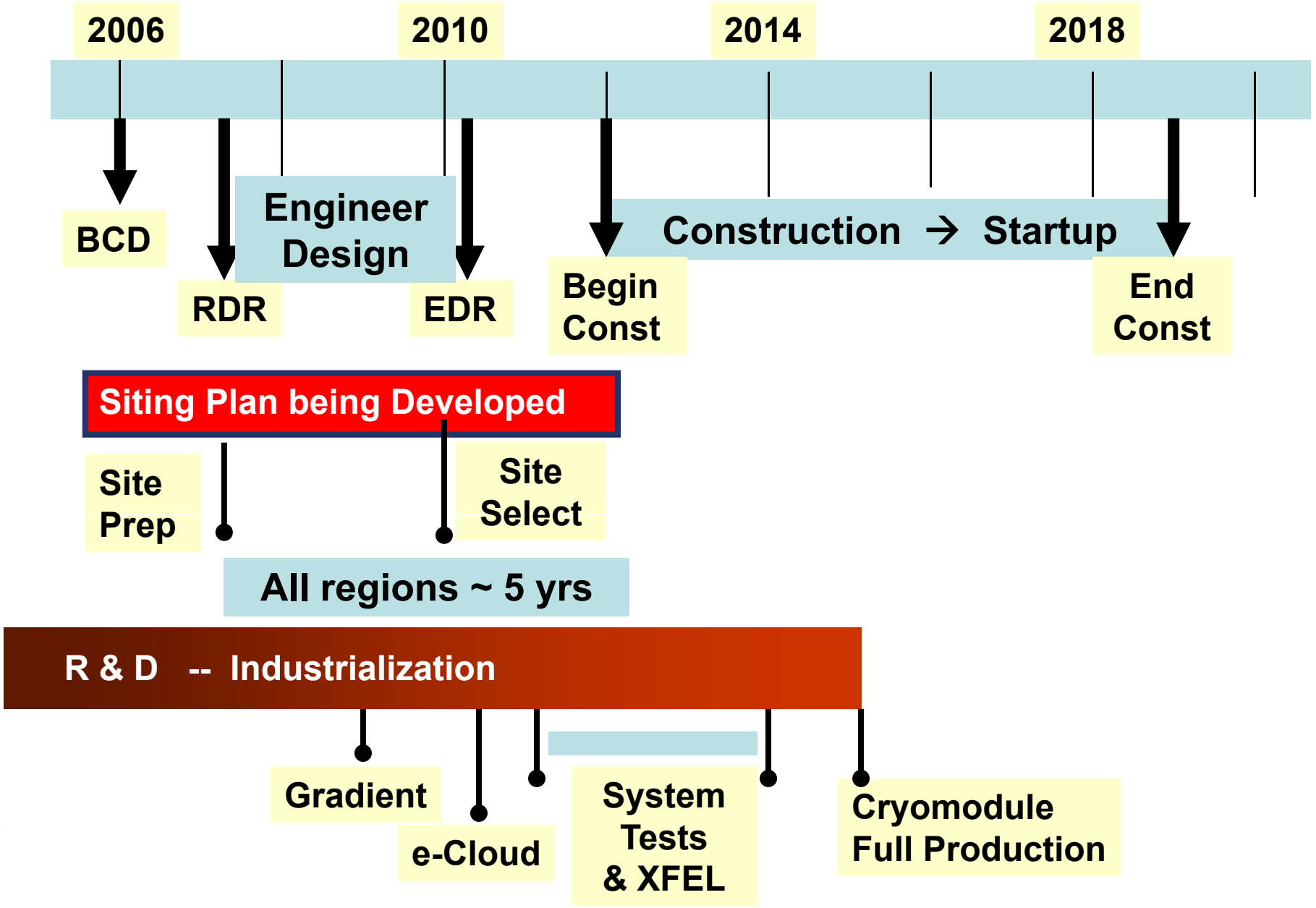


DRAFT

Project: CF&S-American Plan-Tentative
Date: May 22

Task
Split
Progress
Milestone
Summary
Project Summary
External Tasks
External Milestone
Deadline

Technically Driven Timeline



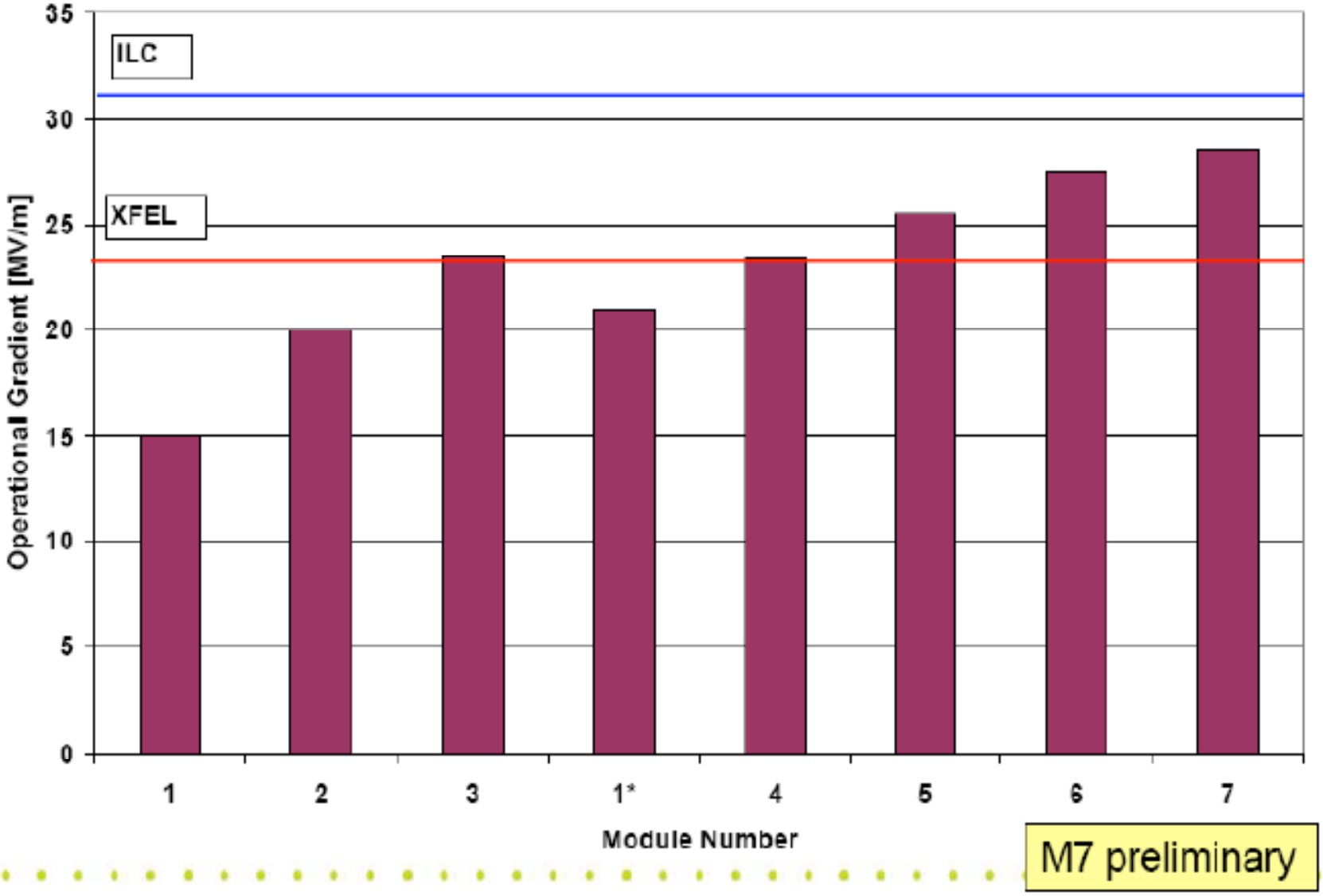
The Task Forces

- **The Task Forces were put together successively over a period of five months:**

  S0/S1-Cavities, Cryomodule
  S2 -Cryomodule String Tests
  S3 -Damping Rings
  S4 -Beam Delivery System
  S5-Positron Source
  S6-Controls, not yet active
  S7-RF

- **Working in close collaboration with the Engineering and Risk Assessment team.**

Module Operational Gradients



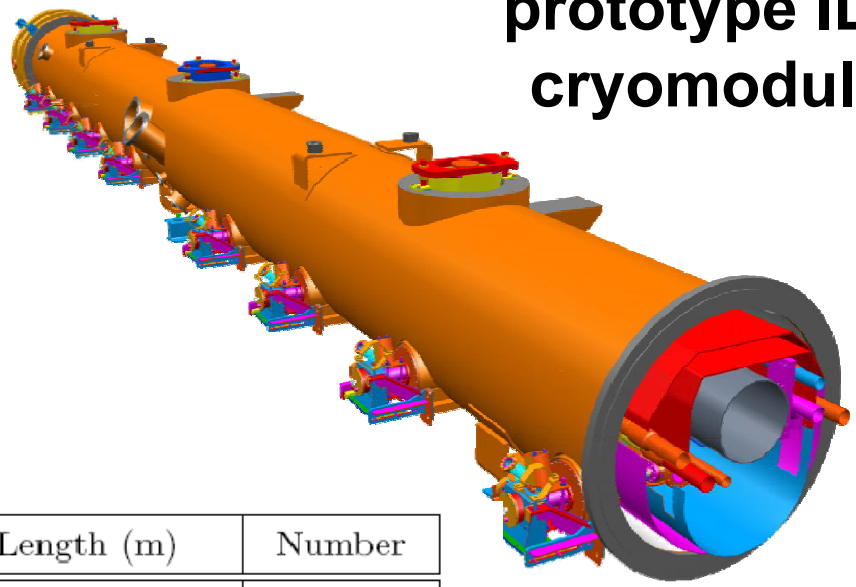
Rough S2 Schedule

Phase	Completion date	Description
0	2005	TTF/FLASH, not final cavity design, type 3 cryomodule, not full gradient, has beam
0.5	2008	Extra tests at TTF/FLASH with same type cryomodules as phase 0
1	2008	1 cryomodule, not final cavity design, type 3 cryomodule (and/or) STF type cryomodule, not full gradient, no beam
1.1	2009	1 RF unit, not all final cavity design, not all type 4 cryomodules, not full gradient, beam not needed for tests, but should be built so it and the LLRF are debugged for the next step
1.2	2010	1 RF unit (replacing cryomodules of phase 1.1), final cavity design, full gradient, type 4 cryomodules, with beam
1.3	2011	1 RF unit (replacing cryomodules of phase 1.1), final cavity design, full gradient, type DFM cryomodules, with beam
1.4	2011	Tunnel mockup above ground. 1 RF unit perhaps built with parts taken from earlier tests. Includes RTML and e+ transport, no beam
2	2013	N RF units at one site (of the final ILC?) as a system test of final designs from multiple manufacturers, no beam
3	2013	XFEL

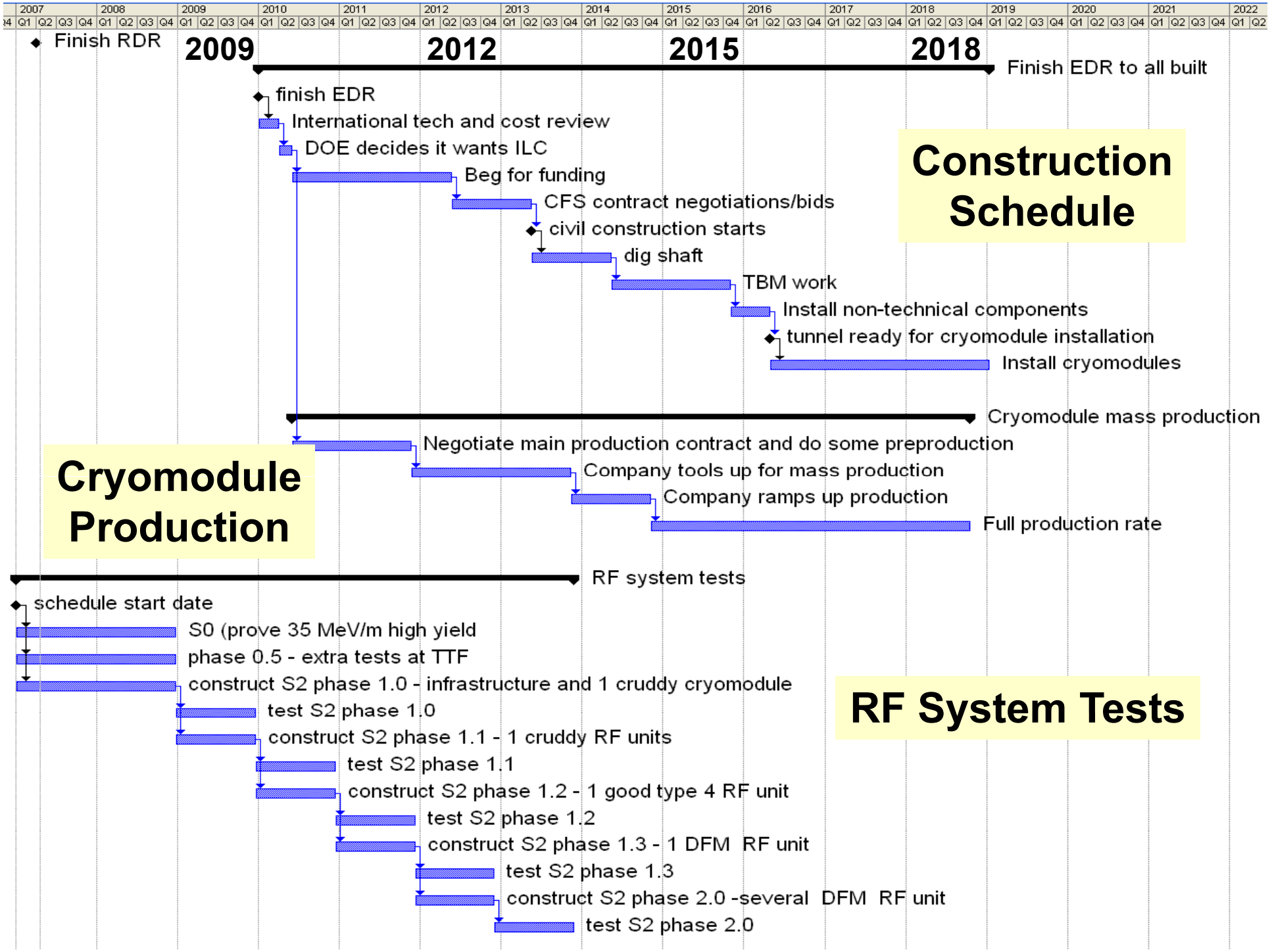
Cavities & Cryomodules

Producing Cavities

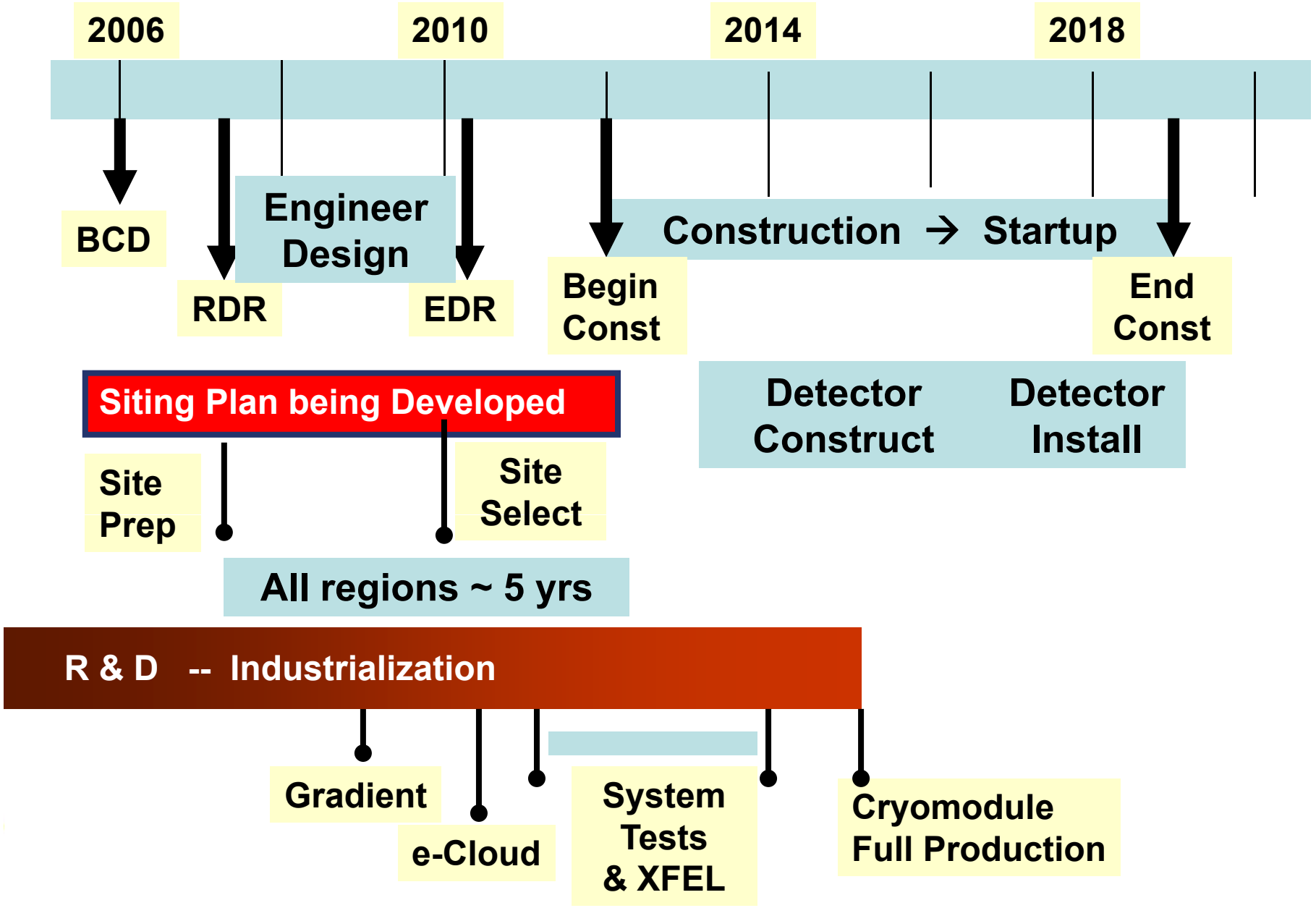
4th generation prototype ILC cryomodule



Subdivision	Length (m)	Number
Cavities (9 cells + ends)	1.326	14,560
Cryomodule (9 cavities or 8 cavities + quad)	12.652	1,680
RF unit (3 cryomodules)	37.956	560
Cryo-string of 4 RF units (3 RF units)	154.3 (116.4)	71 (6)
Cryogenic unit with 10 to 16 strings	1,546 to 2,472	10
Electron (positron) linac	10,917 (10,770)	1 (1)

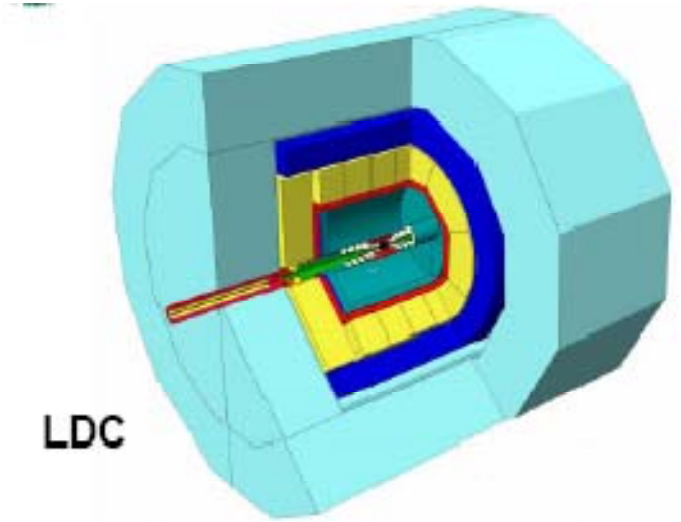

2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022
Finish RDR
2009
2012
2015
2018
Finish EDR to all built
finish EDR
International tech and cost review
DOE decides it wants ILC
Beg for funding
CFS contract negotiations/bids
civil construction starts
dig shaft
TBM work
Install non-technical components
tunnel ready for cryomodule installation
Install cryomodules
Construction Schedule
Cryomodule mass production
Negotiate main production contract and do some preproduction
Company tools up for mass production
Company ramps up production
Full production rate
Cryomodule Production
RF system tests
schedule start date
S0 (prove 35 MeV/m high yield
phase 0.5 - extra tests at TTF
construct S2 phase 1.0 - infrastructure and 1 cruddy cryomodule
test S2 phase 1.0
construct S2 phase 1.1 - 1 cruddy RF units
test S2 phase 1.1
construct S2 phase 1.2 - 1 good type 4 RF unit
test S2 phase 1.2
construct S2 phase 1.3 - 1 DFM RF unit
test S2 phase 1.3
construct S2 phase 2.0 -several DFM RF unit
test S2 phase 2.0
RF System Tests

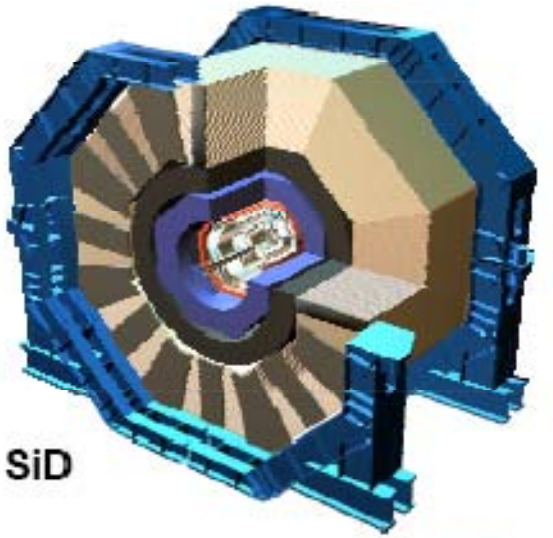
Technically Driven Timeline

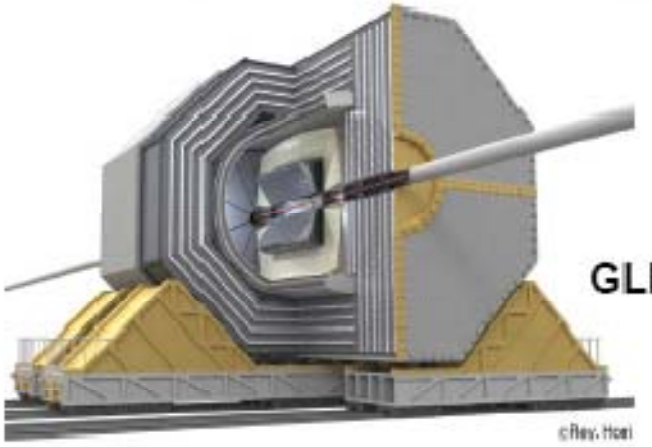


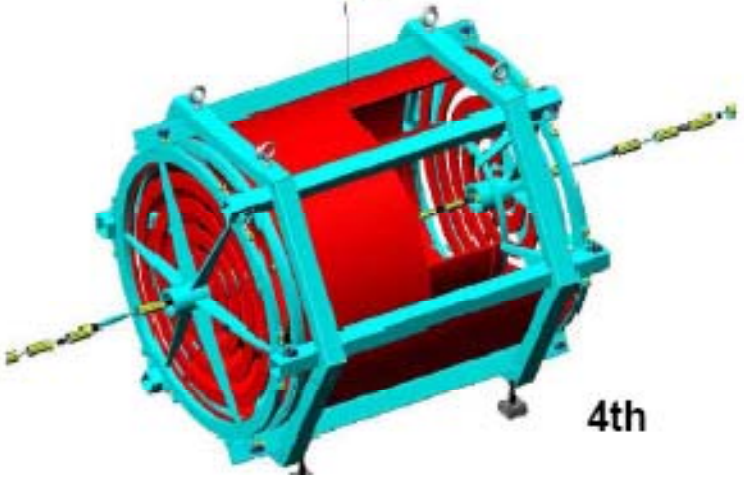
Detector Concepts

Road map to two detectors & EDR

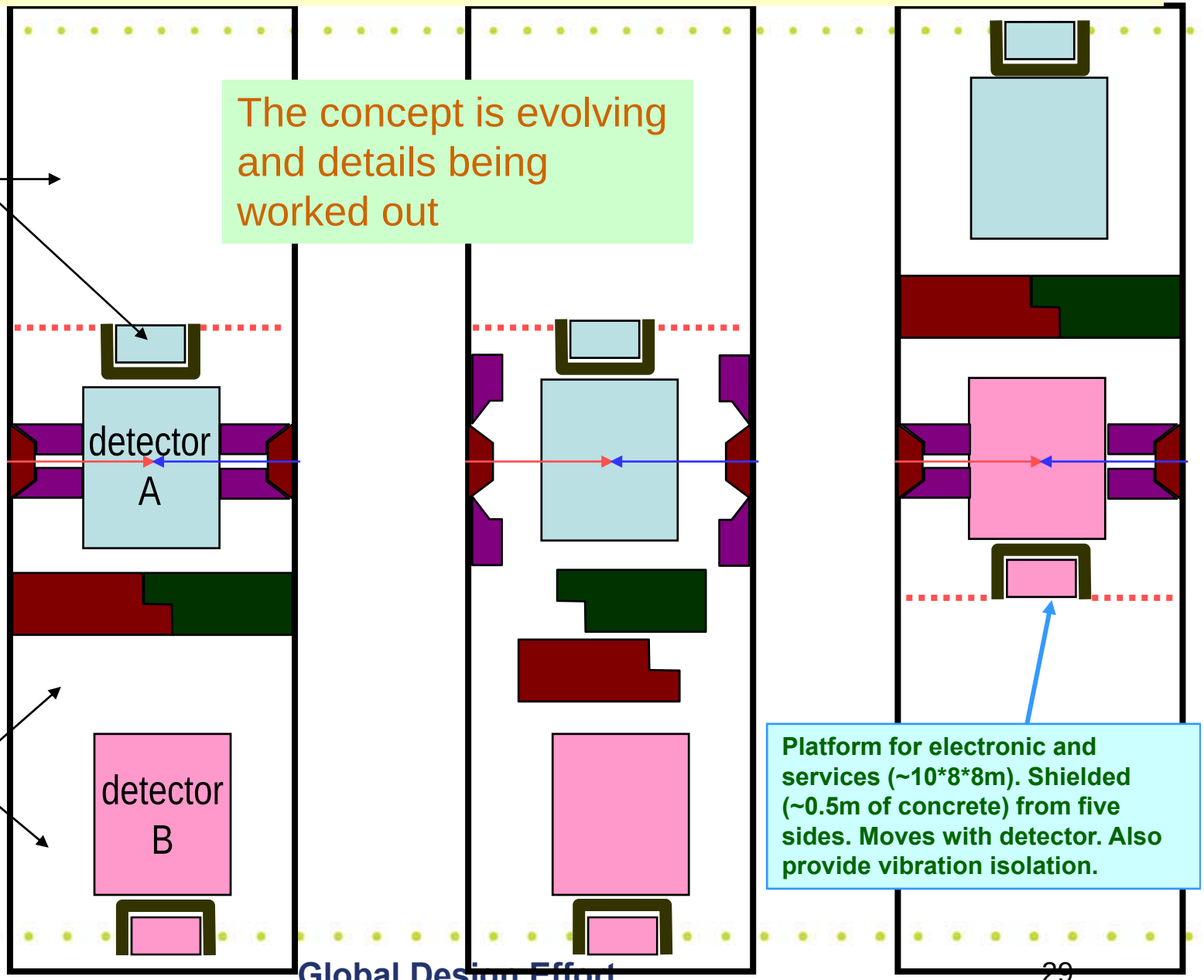




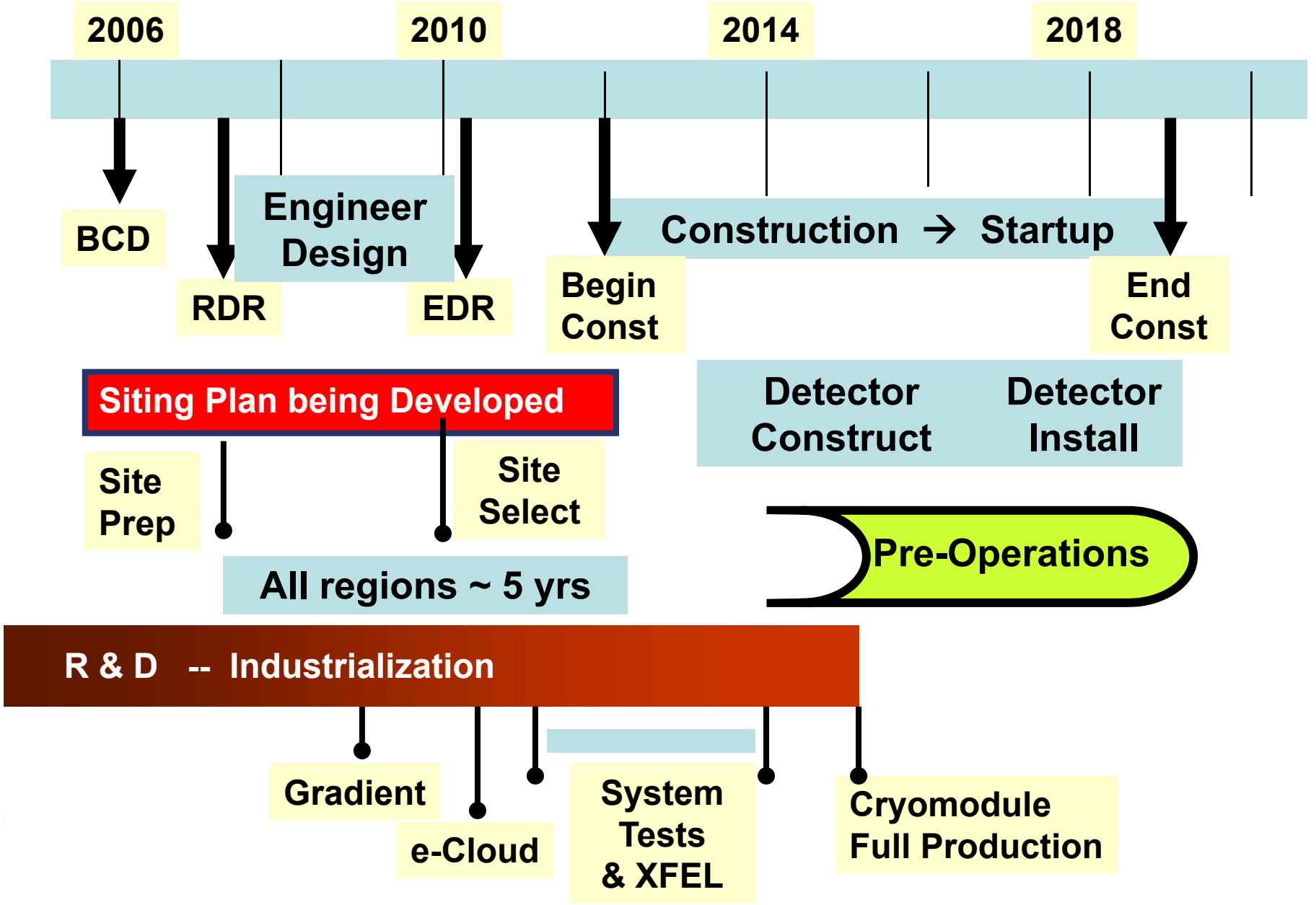




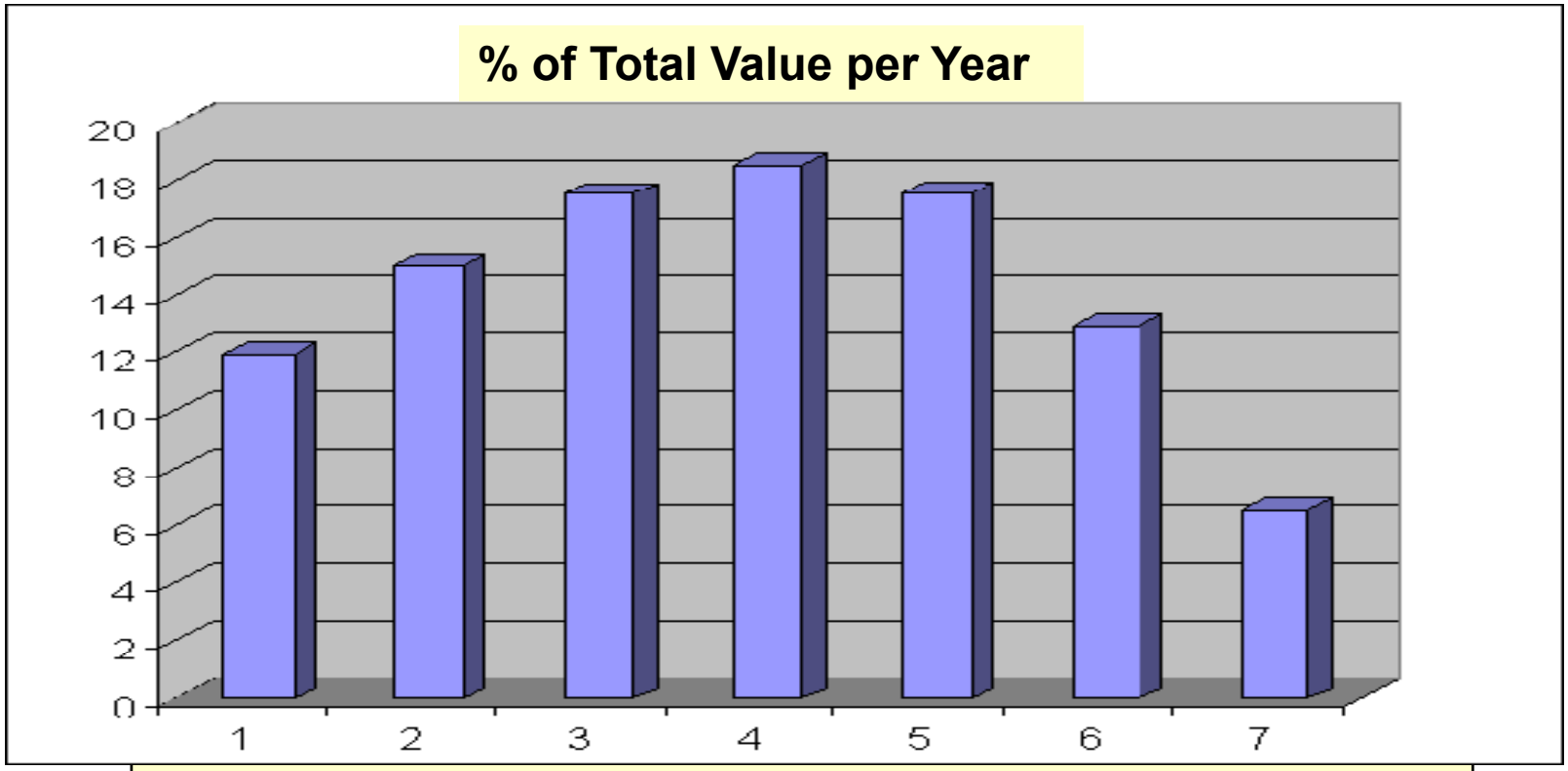
Concept of IR hall with two detectors



Technically Driven Timeline



Value Funding Profile



We are not using integrated cost/schedule tools yet; but it appears feasible to develop a realistic funding profile

Achieving our ILC Timeline

"The other issues"

- **We need to begin a campaign to prepare the way for submitting a winning proposal in about 2010.**
  - **Science Motivation is very strong, but we need LHC results for validation (~2010)**
  - **Must convince broader HEP and science communities on the ILC**
  - **Must engage the global governments to take ownership and develop international governance**
  - **Must develop a siting strategy**
- **JOIN US!! The ILC is our future. It's up to us make it happen and on our timescale.**