The Status of the International Linear Collider

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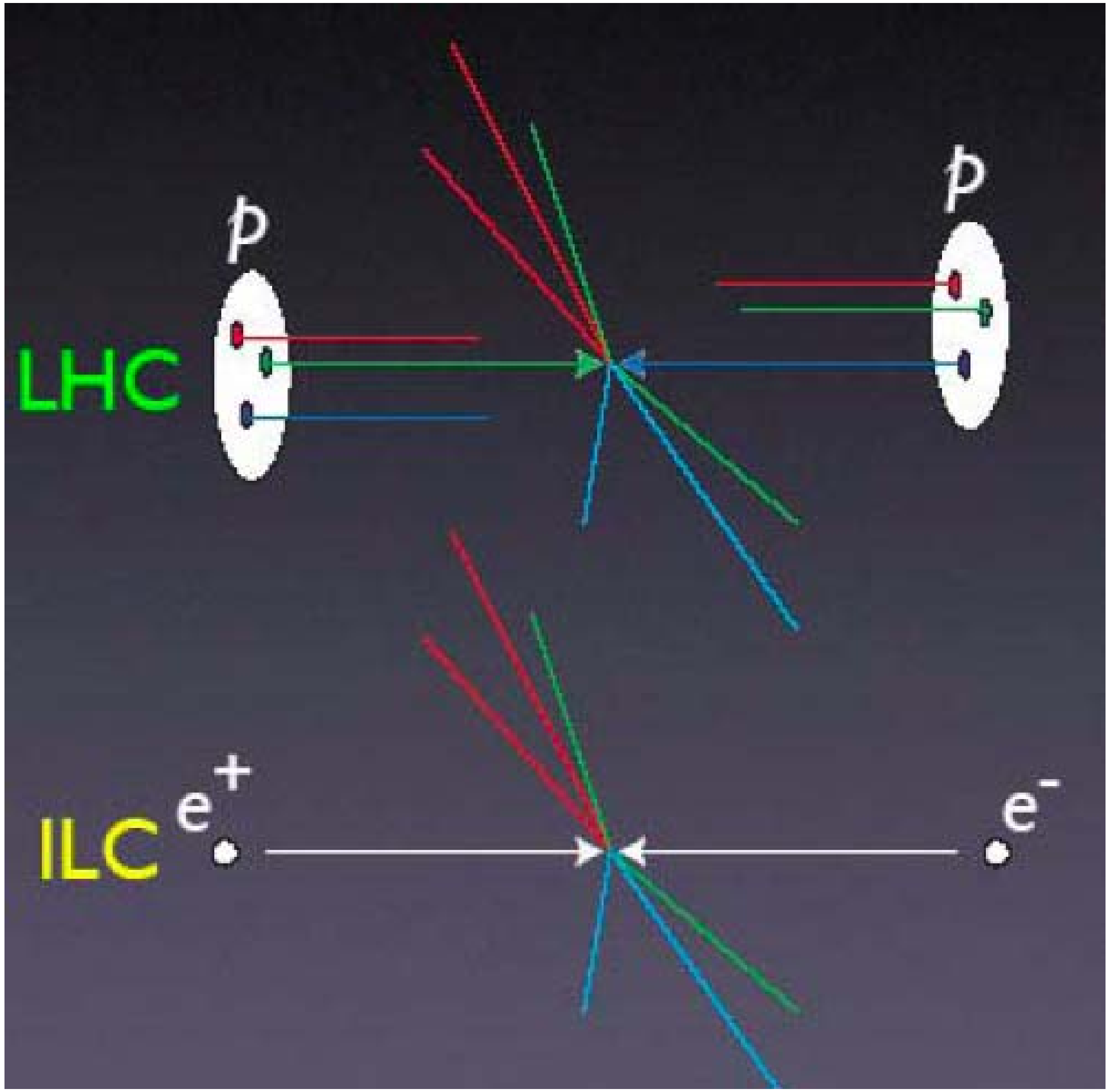
XIIIth Lomonosov Conference
Moscow

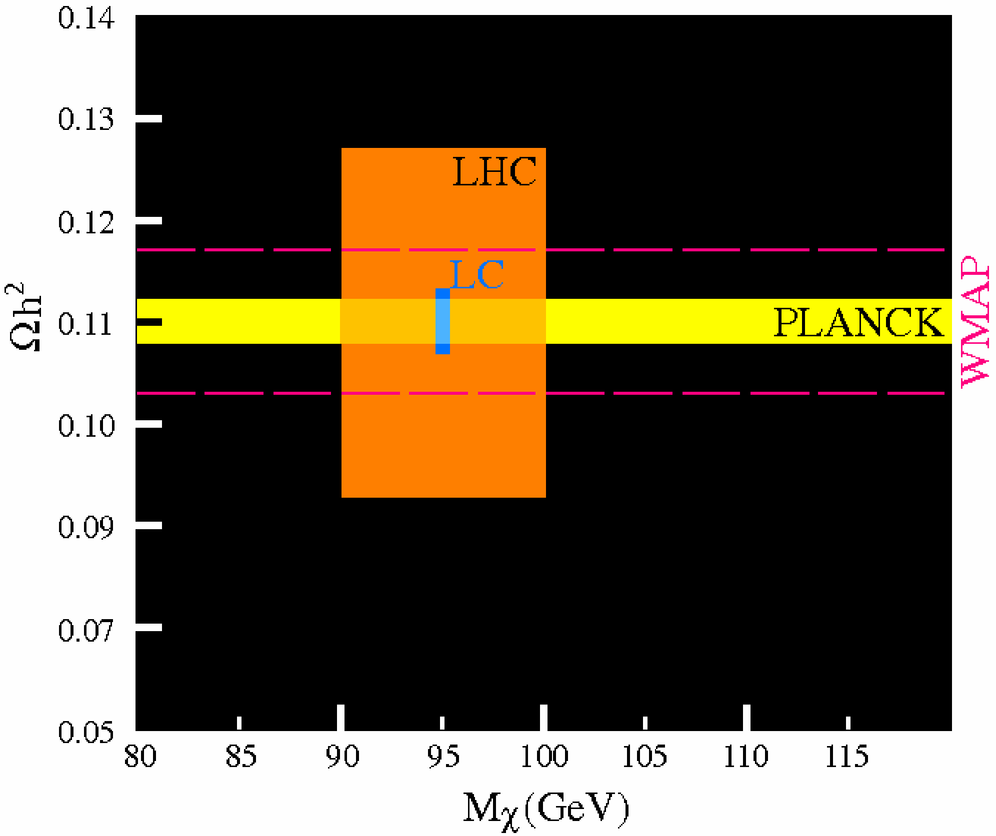
Why e^+e^-?

- **Simple particles**
- **Well defined:**
  energy
  angular momentum
- **E can be scanned precisely**
- **Particles produced democratically**
- **Final states generally fully reconstructable**



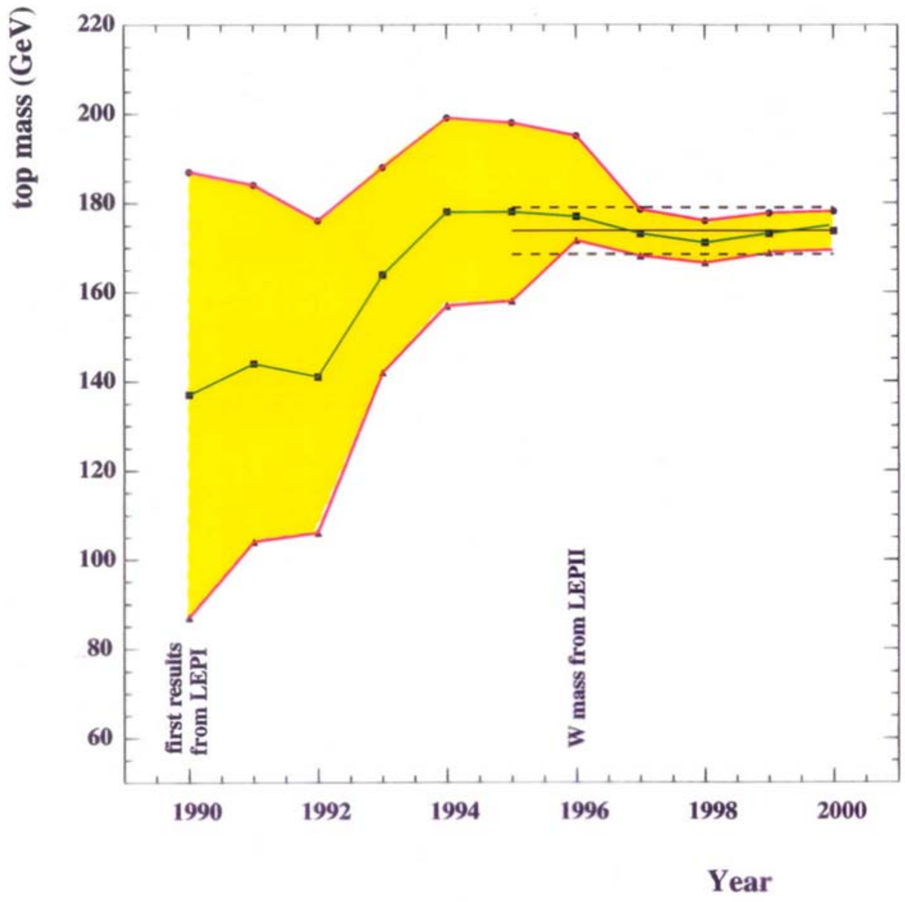
Why/what is ILC?

- Why do we want to build a high-energy e^+e^- collider?
- Physics case rests on three legs:known phenomena that ILC will definitely study- top quark;
- the Higgs: for which there is very strong indirect evidence and if LHC doesn't find it then ILC will be essential to understand why;
- new particles for which there is very strong theoretical prejudice



Why/what is ILC?

- Furthermore the high precision of e^+e^- means that it is sensitive to phenomena far above its CM energy because of quantum corrections – as LEP proved.



ILC Parameters

- E_{cm} adjustable from 200 – 500 GeV
- Luminosity $\int L dt = 500\ fb^{-1}$ in 4 years

  (corresponds to $2*10^{34}\ cm^{-2}\ s^{-1}$)
- Ability to scan between 200 and 500 GeV
- Energy stability and precision below 0.1%
- Electron polarization of at least 80%

- **The machine must be upgradeable to 1 TeV**

ILC Reference Design Report

~700 Contributors from 84 Institutes

QuickTime™ and a
TIFF (LZW) decompressor
are needed to see this picture.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3:00pm, May 4, 2007

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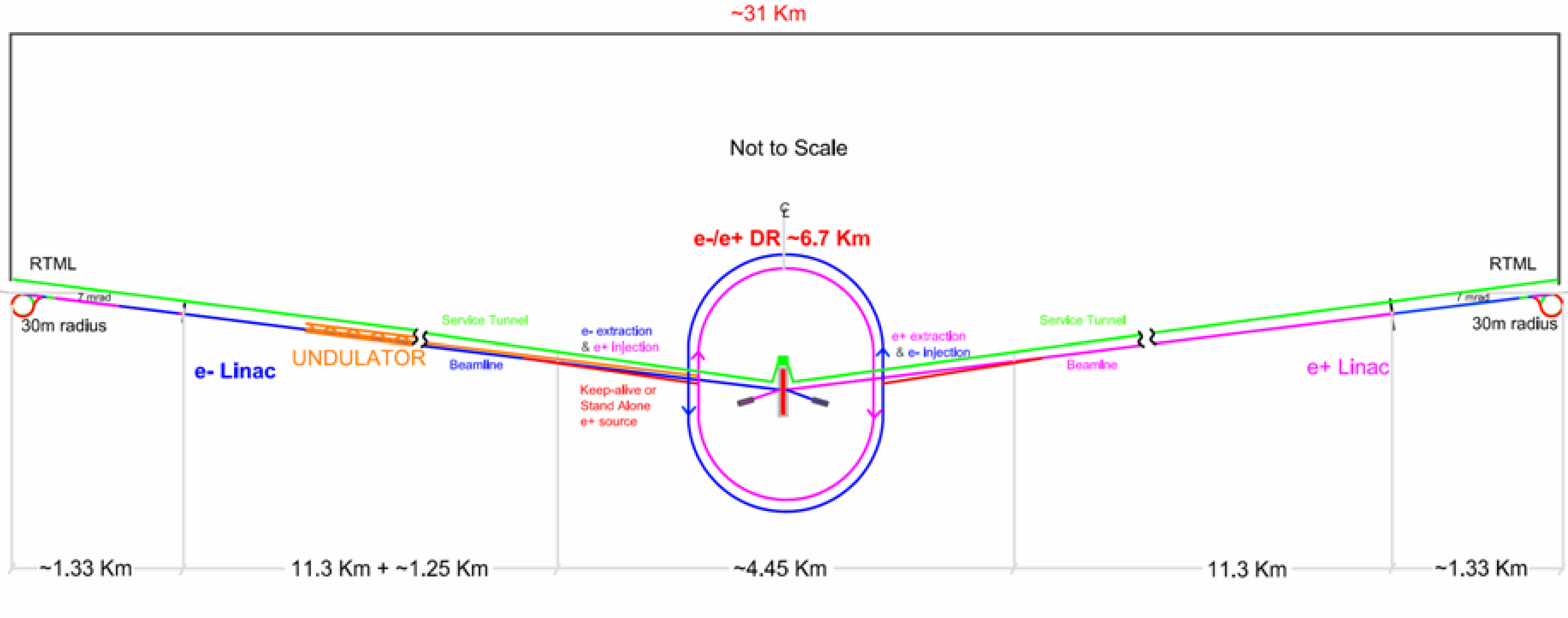
ii ILC-Reference Design Report

The RDR is not a full engineering design - it is conceptual; some aspects require R&D. Forms reliable basis for detailed engineering design & costing.

Overall Layout

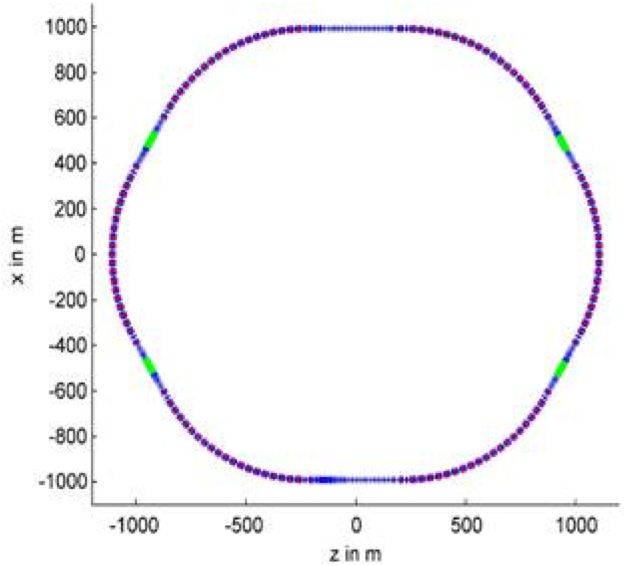
1st Stage: 500 GeV; central DR et al. campus; 2 “push-pull” detectors in 14 mrad IR.



Schematic Layout of the 500 GeV Machine

DR Issues

- Injection/extraction kickers
- Instabilities
  - **Electron-cloud, Fast Ion, …**
- Dynamic aperture
- Tuning for low emittance

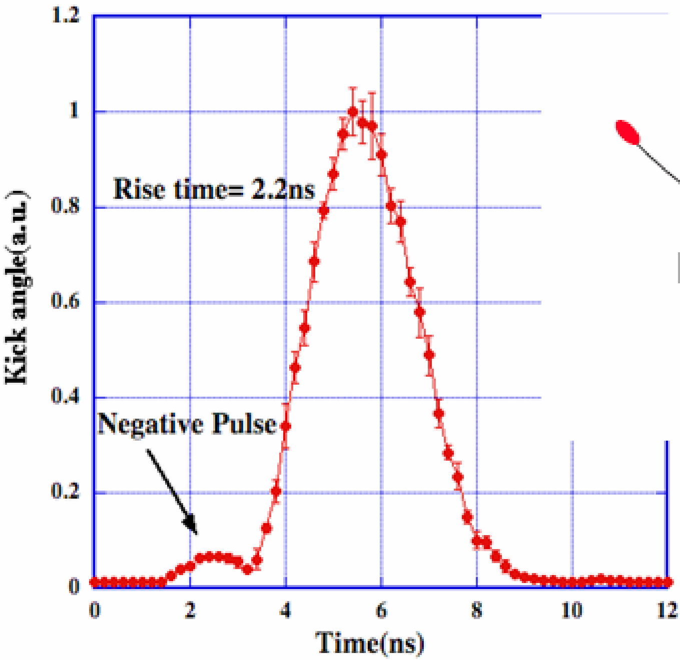


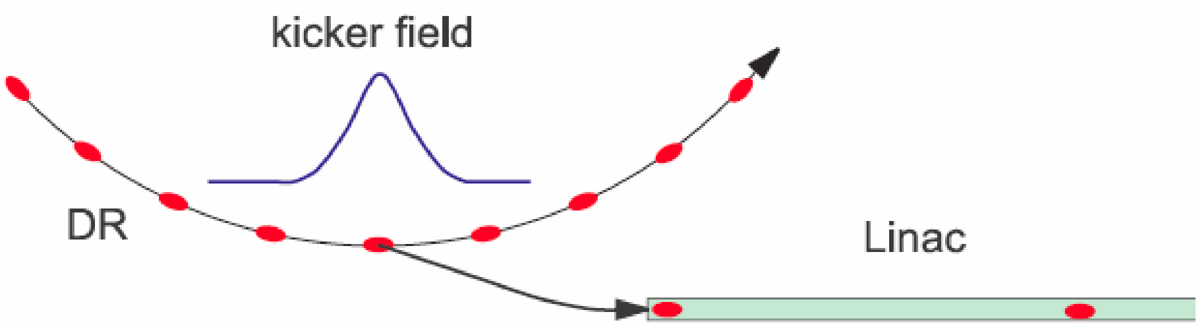
Task Force been established for DR R&D

- Defining work packages
- Available machines
  - KEK-ATF
  - KEKB, CESR, HERA

Kicker System

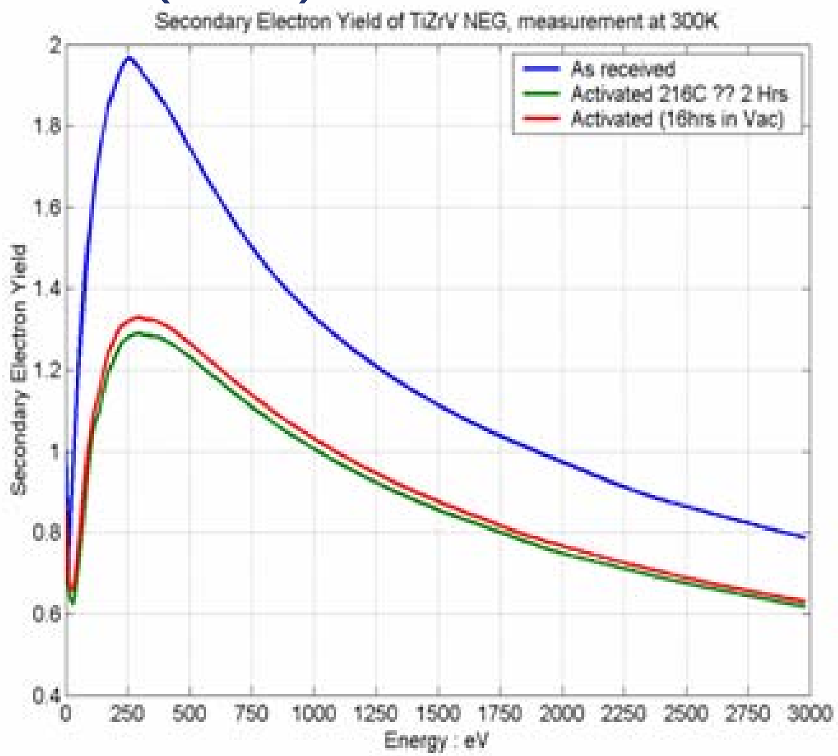
- Number of bunches 3000 (6000 desirable)
- 300ns interval in linac ⇒ total length ~1ms → 300km
- Store compactly in DR
  (circumference 20km → bunch interval ~20ns, 6km → ~6ns)
- Bunch by bunch extraction at 300ns interval (injection, too)





Electron Cloud

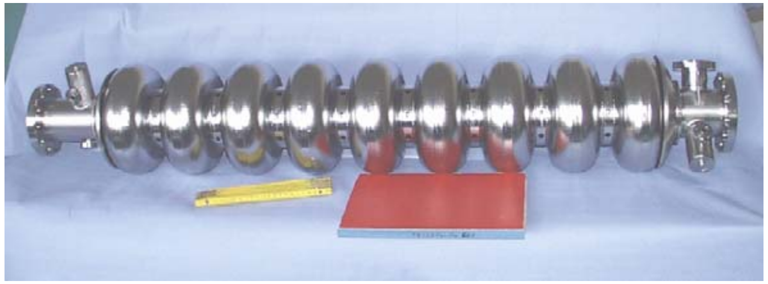
- Secondary electrons attracted by positron beam causes an instability
- Max. of Secondary Electron Yield (SEY) should be < 1.1
- Possible cures
  - **Coating with NEG**
  - **Solenoids in free field region**
  - **Grooves on chamber wall**
  - **Clearing electrode**



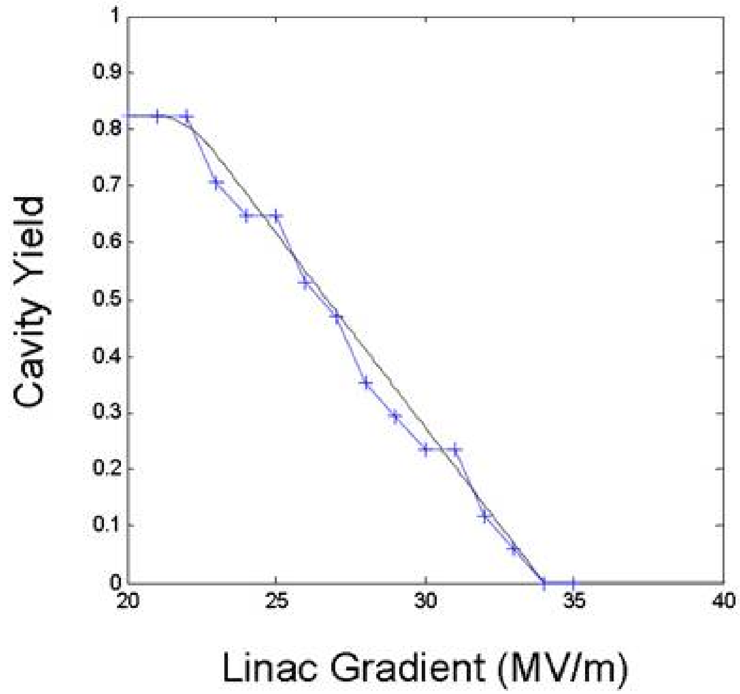
- Confident enough to baseline single e+ DR

Cavities

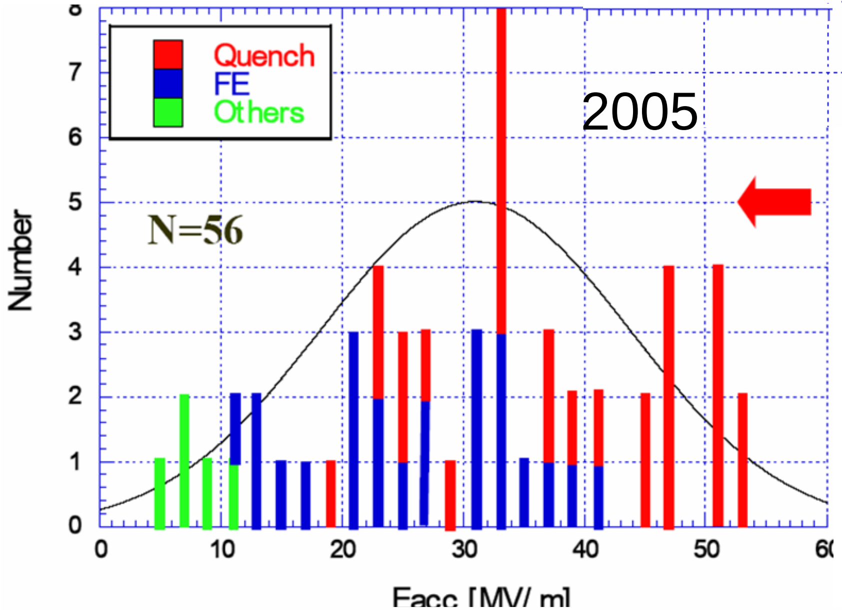
- Baseline: TESLA-type 1.3 GHz
  - **Identical to XFEL cavities**
    - Only beamtubes shortened
- Accelerating gradient
  - **Vertical test**
    - >35 MV/m, Q>0.8×10^{10}
  - **Average gradient in cryomodule**
    - 31.5 MV/m, Q>1×10^{10}

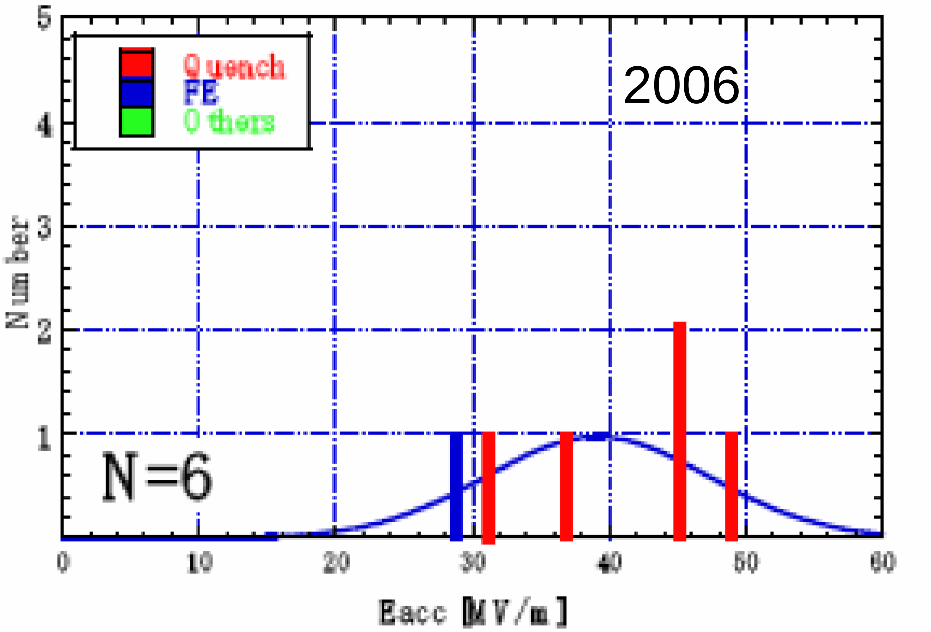


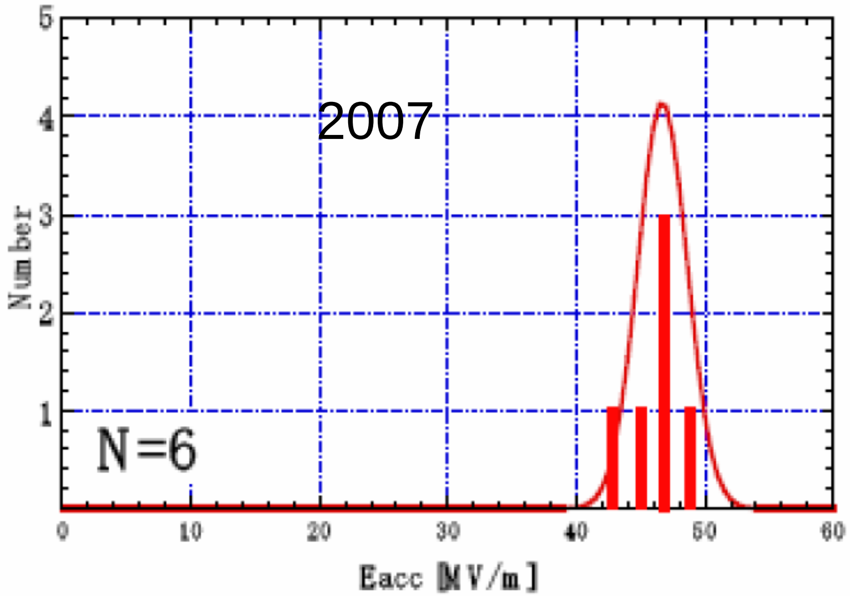
- With the presently available technology
  - **average gradient lower than 31.5 MV/m**
  - **spread of gradient large**
  - **if no improvement, uniform distribution in 22<G<34 MV/m, average 28 MV/m: => Cost increase ~7 %**



Current status







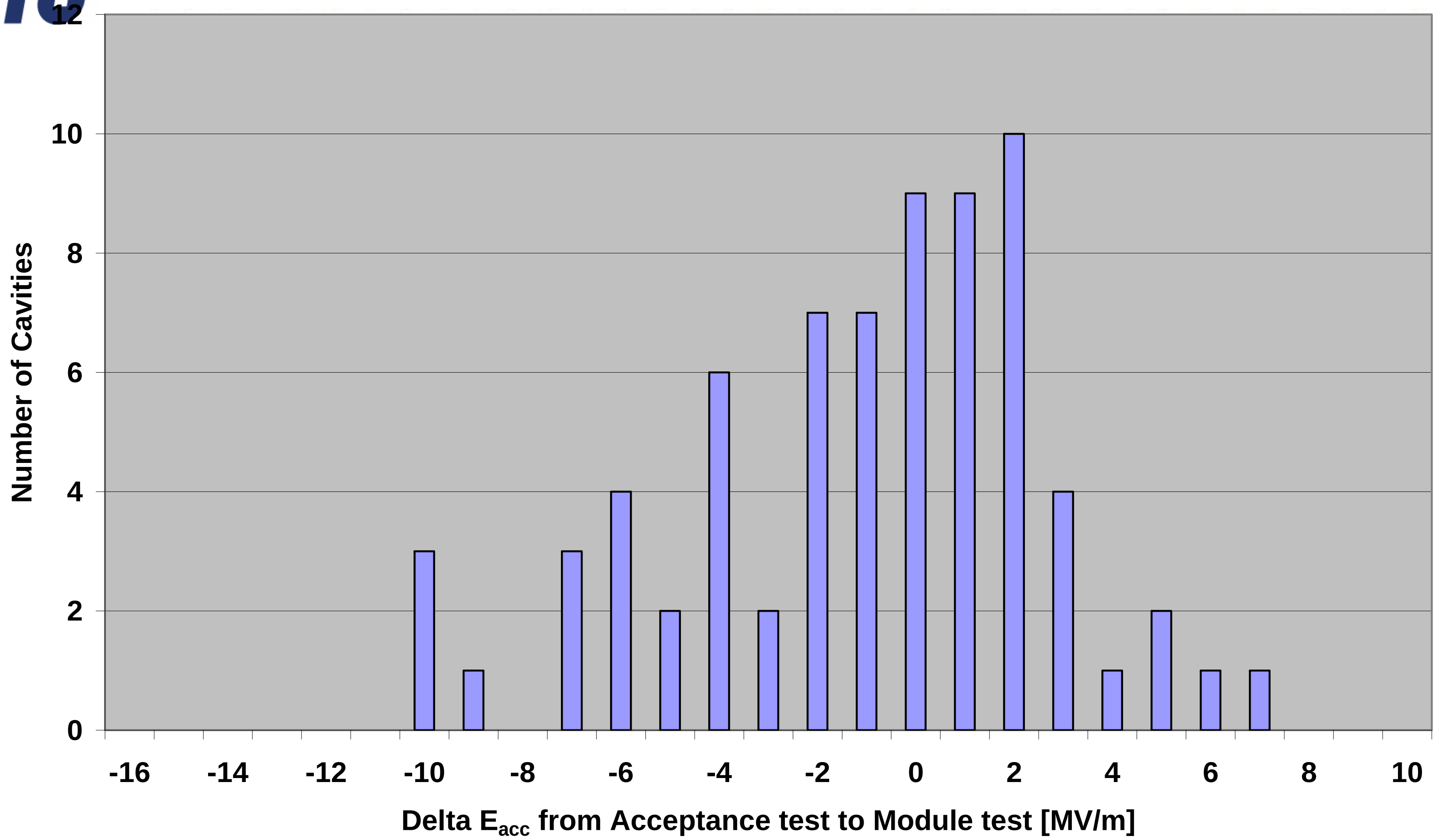
KEK single cell results:
2005 – just learning
2006 – standard recipe
2007 – add final 3 µm fresh acid EP

Note: multi-cells harder than singles

Module Test – Goal

- Intermediate goal
  - **Achieve 31.5 MV/m average operational accelerating gradient in a single cryomodule as a proof-of-principle. In case of cavities performing below the average, this could be achieved by tweaking the RF distribution accordingly.**
  - **Auxiliary systems like fast tuners should all work.**
- Final goal
  - **Achieve > 31.5 MeV/m operational gradient in 3 cryomodules.**
  - **The cavities accepted in the low power test should achieve 35 MV/m at $Q_0 = 10^{10}$ with a yield as described above (80% after first test, 95% after re-preparation).**
  - **It does not need to be the final cryomodule design**

S1 RF Performance: Compare Acceptance Test with Module Operational Accelerating Gradient

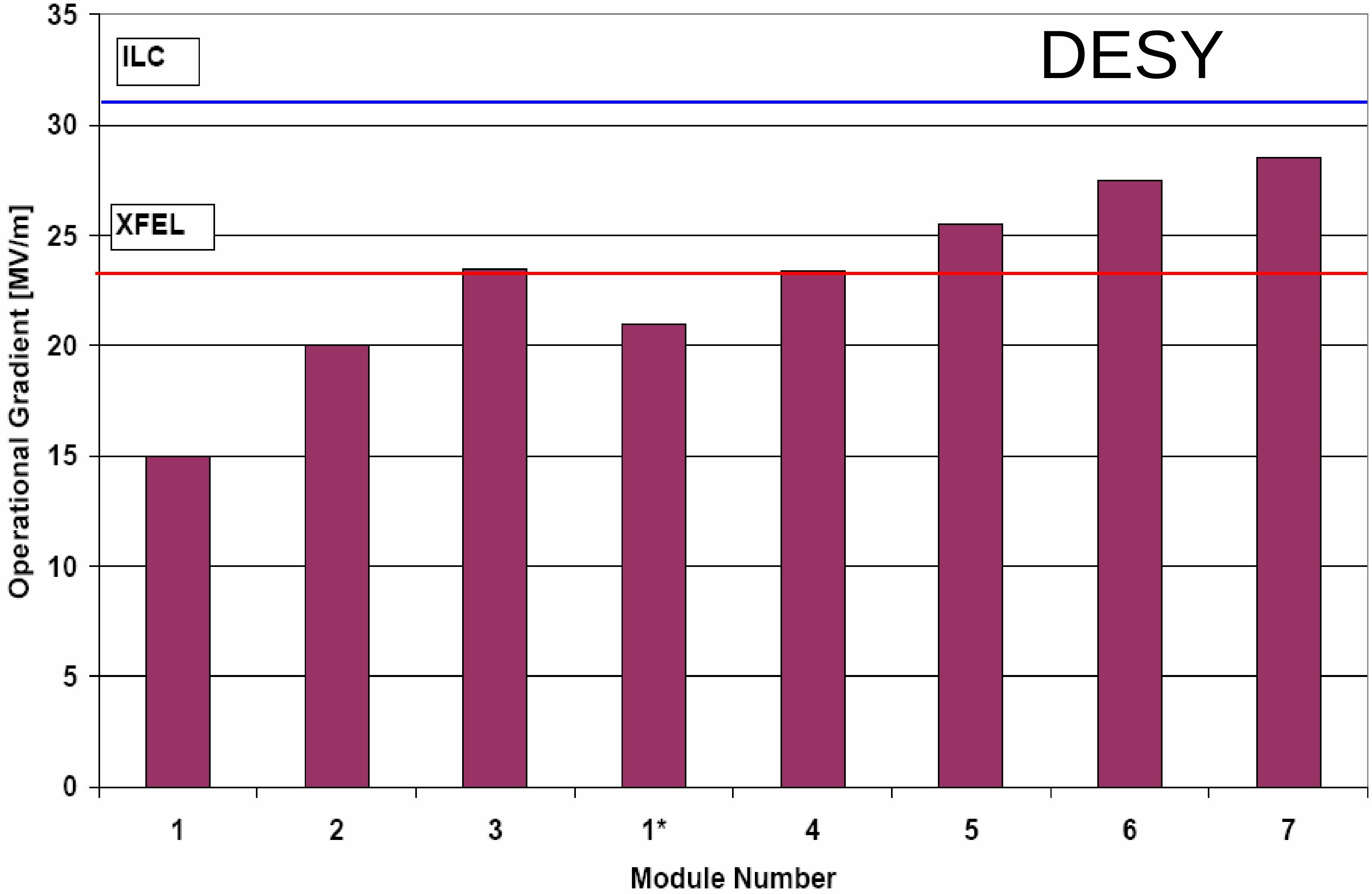


- This is the main motivation for S1
- Improvement on assembly procedures needed
  - **Addressed in studies with industry also**

XFEL synergy: Module Test @ DESY

- High gradient modules have been assembled
  - **For installation in FLASH**
- Test in dedicated test stand possible e.g.
  - **Cavity performance**
  - **Thermal cycles**
  - **Heat loads**
  - **Coupler conditioning**
  - **Fast tuner performance**
  - **(LLRF tests)**
- Part of the ongoing preparation work for XFEL

Module Test


DESY
ILC
XFEL
Operational Gradient [MV/m]
35
30
25
20
15
10
5
0
1
2
3
1*
4
5
6
7
Module Number

ILC COST

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)

Σ Value = 6.62 B ILC Units

The reference design was "frozen" on 1-12-06 for RDR production, including costs.

Important to realise this is a snapshot; design will continue to evolve, due to R&D, accelerator studies & value engineering.

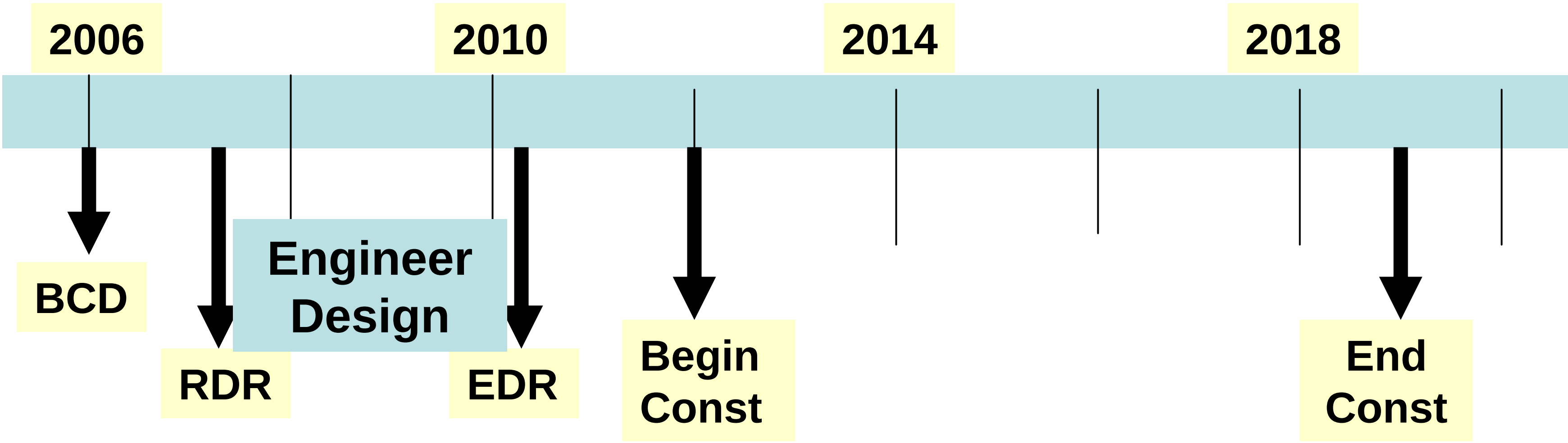
The value costs have already been reviewed many times; all reviews have been very positive and generally consider there is scope for further cost reductions.

The future programme

"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,"

- **It's the GDE's job to go as fast as possible to put Dr Orbach on the spot - "technically driven timeline"**
  - **Construction proposal in 2010**
  - **Construction start in 2012**
  - **Construction complete in 2019**
- **What do we need to do to achieve <u>our</u> timeline?**

Technically driven timeline

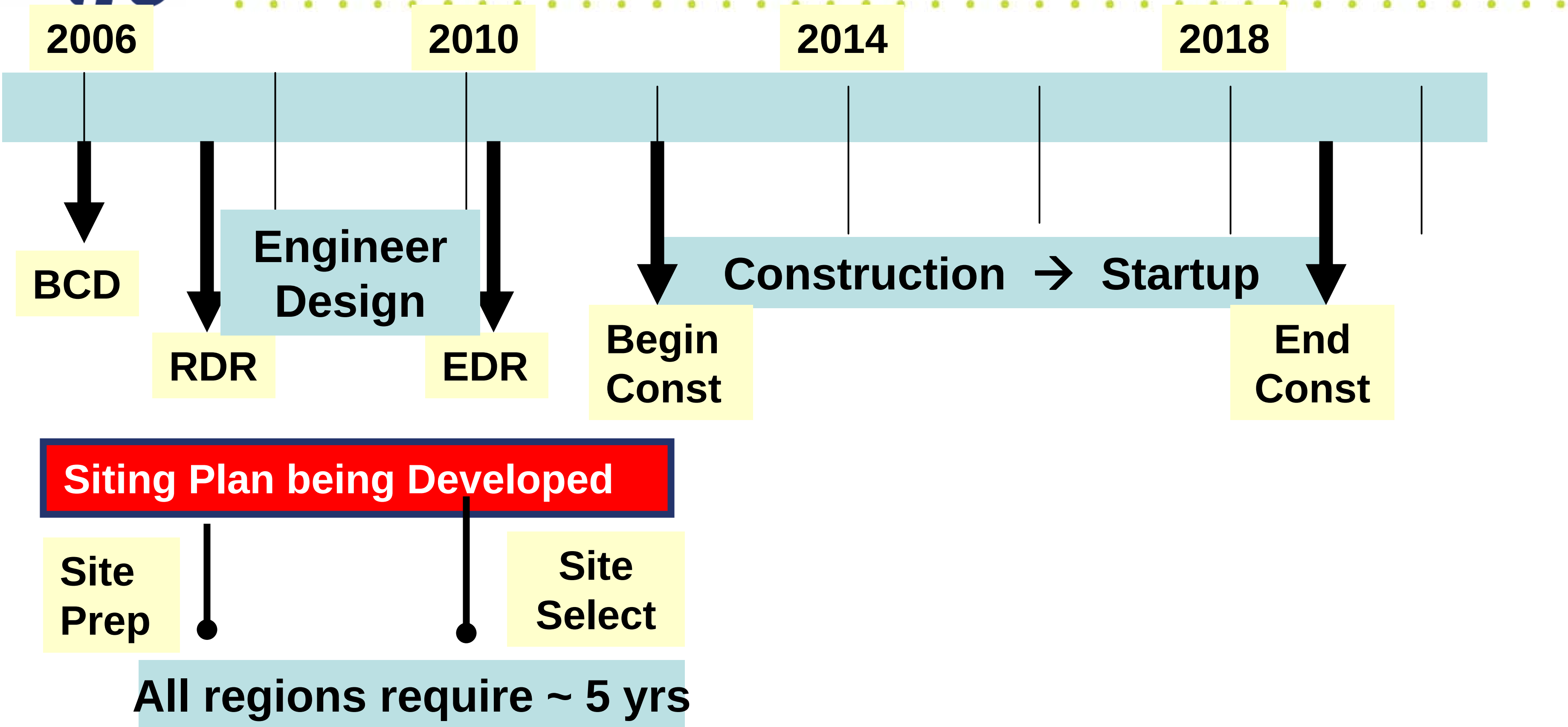


Engineering Design Phase

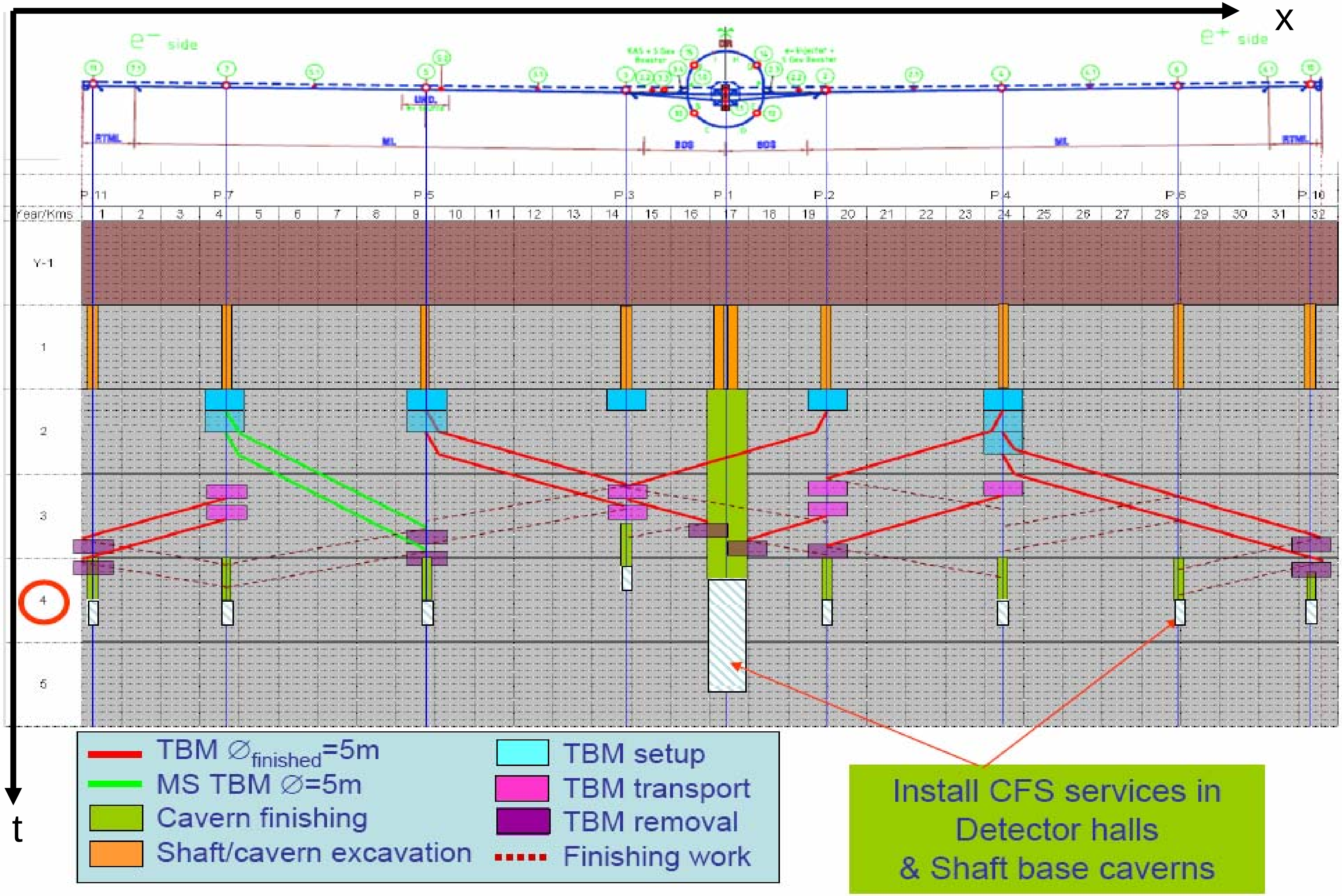
- **ILC Engineering Design**
  - We have a solid design concept in the reference design, but it is immature and needs engineering designs, value engineering, supporting R&D and industrialization.
- **GDE will be reorganized around a Project Management Office to reach this goal**
  - M. Ross, N. Walker 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

– 2010 was foreseen as the time at which LHC results, CLIC progress etc would be reviewed and decision on ILC construction made. GDE committed to be ready at that time!

Technically driven timeline

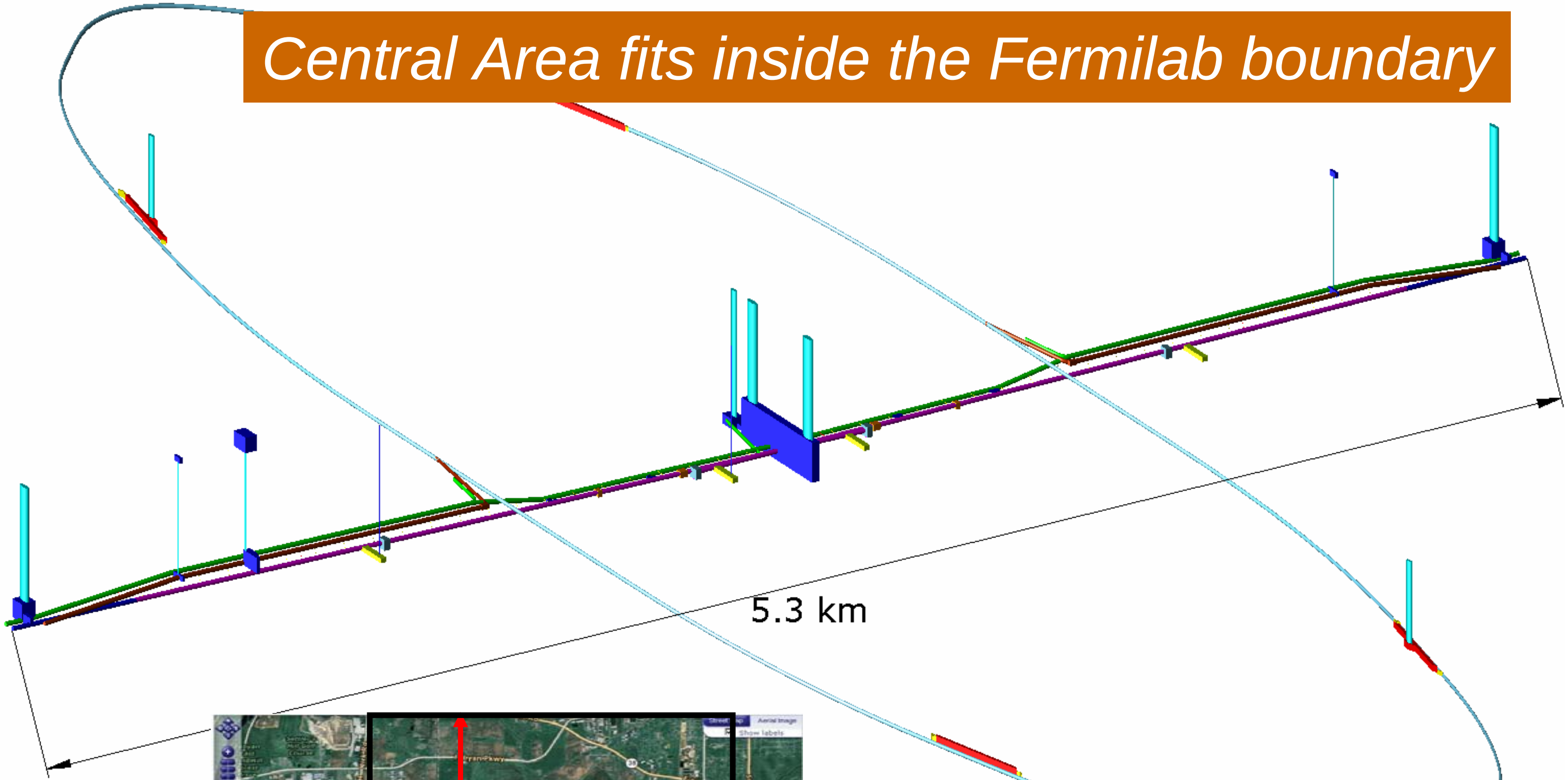


Civil Construction Timeline

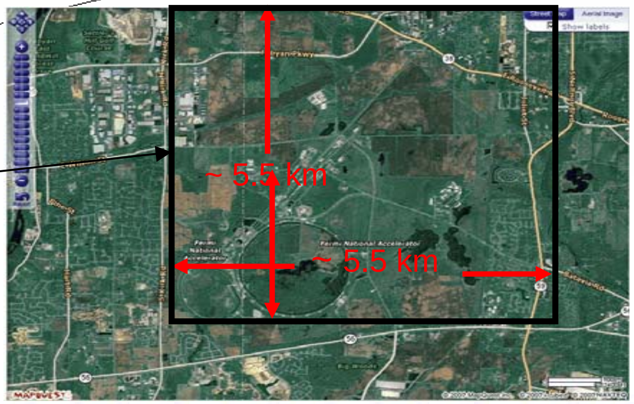


Fermilab site

Central Area fits inside the Fermilab boundary

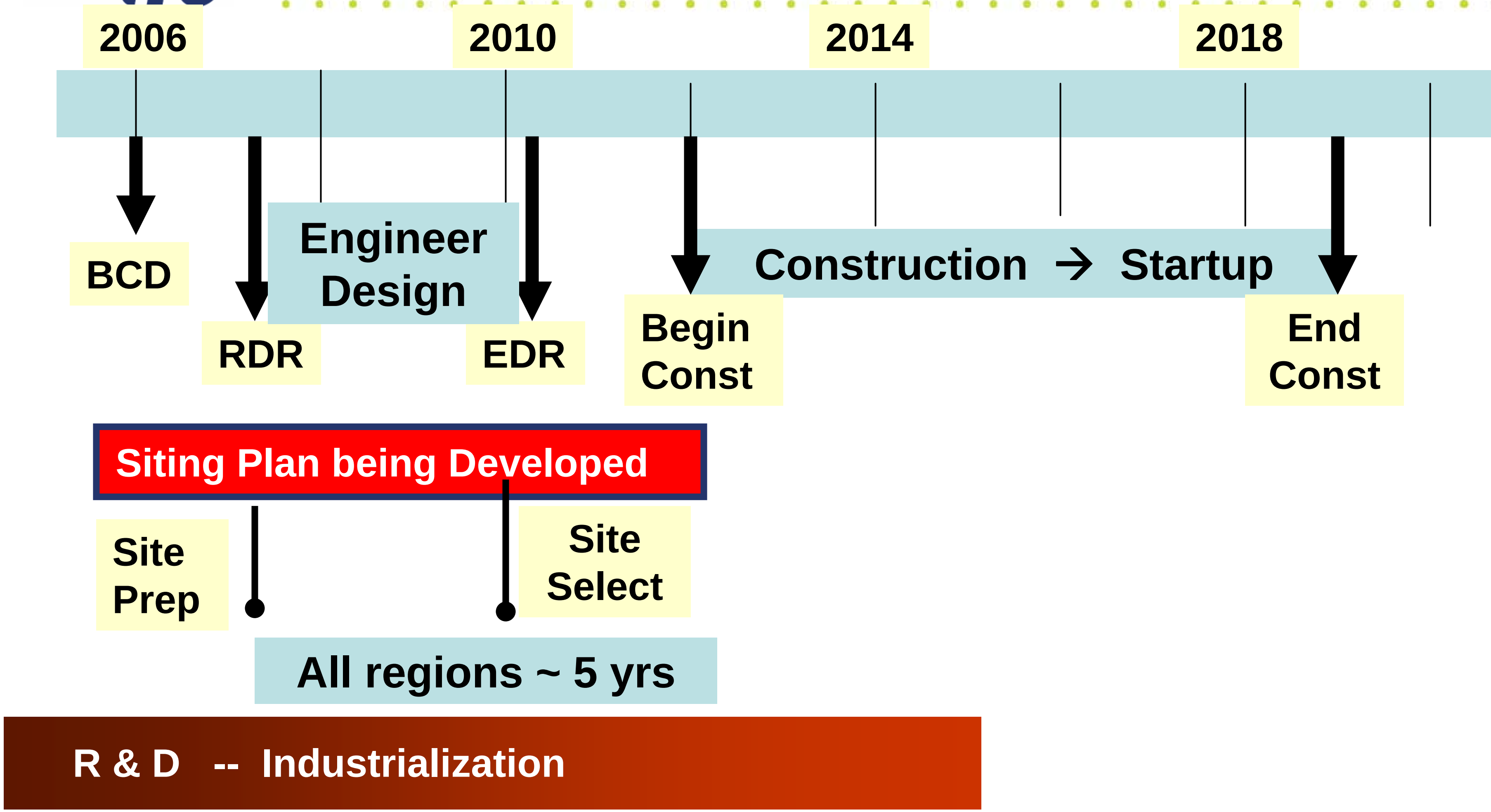


~ Boundary of Fermilab



Site Characterization of the Central Area can be done already

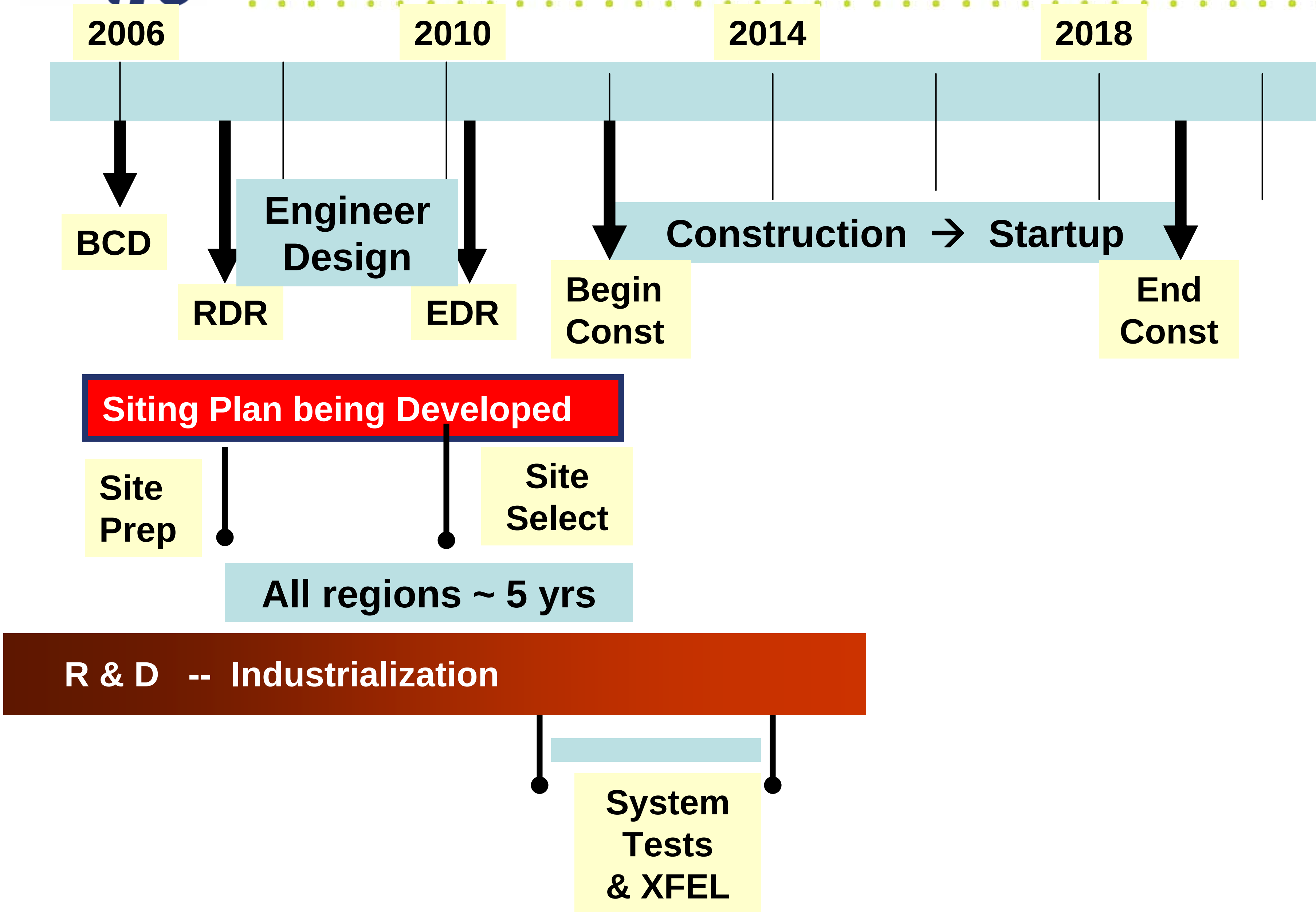
Technically driven timeline



R&D Task Forces

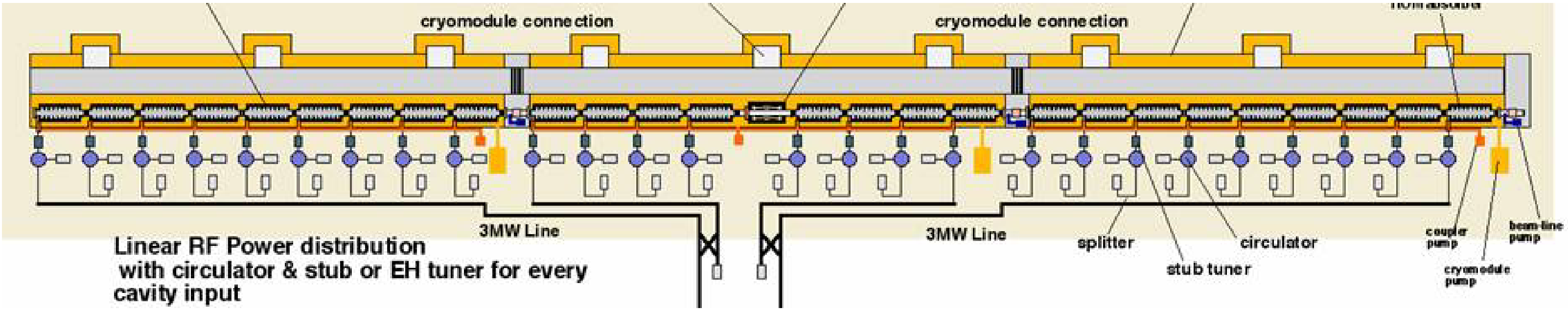
- **The Task Forces were put together successively over a period of five months:**
  - **S0/S1 - Cavities, Cryomodule**
  - **S2 - Cryomodule String Tests**
  - **S3 - Damping Rings**
  - **S4 - Beam Delivery System**
  - **S5 - Positron Source**
  - **S6 - Controls, not yet active**
  - **S7 - RF**
- **The industrialisation in Europe dominated by the preparatory work for XFEL.**

Technically driven timeline



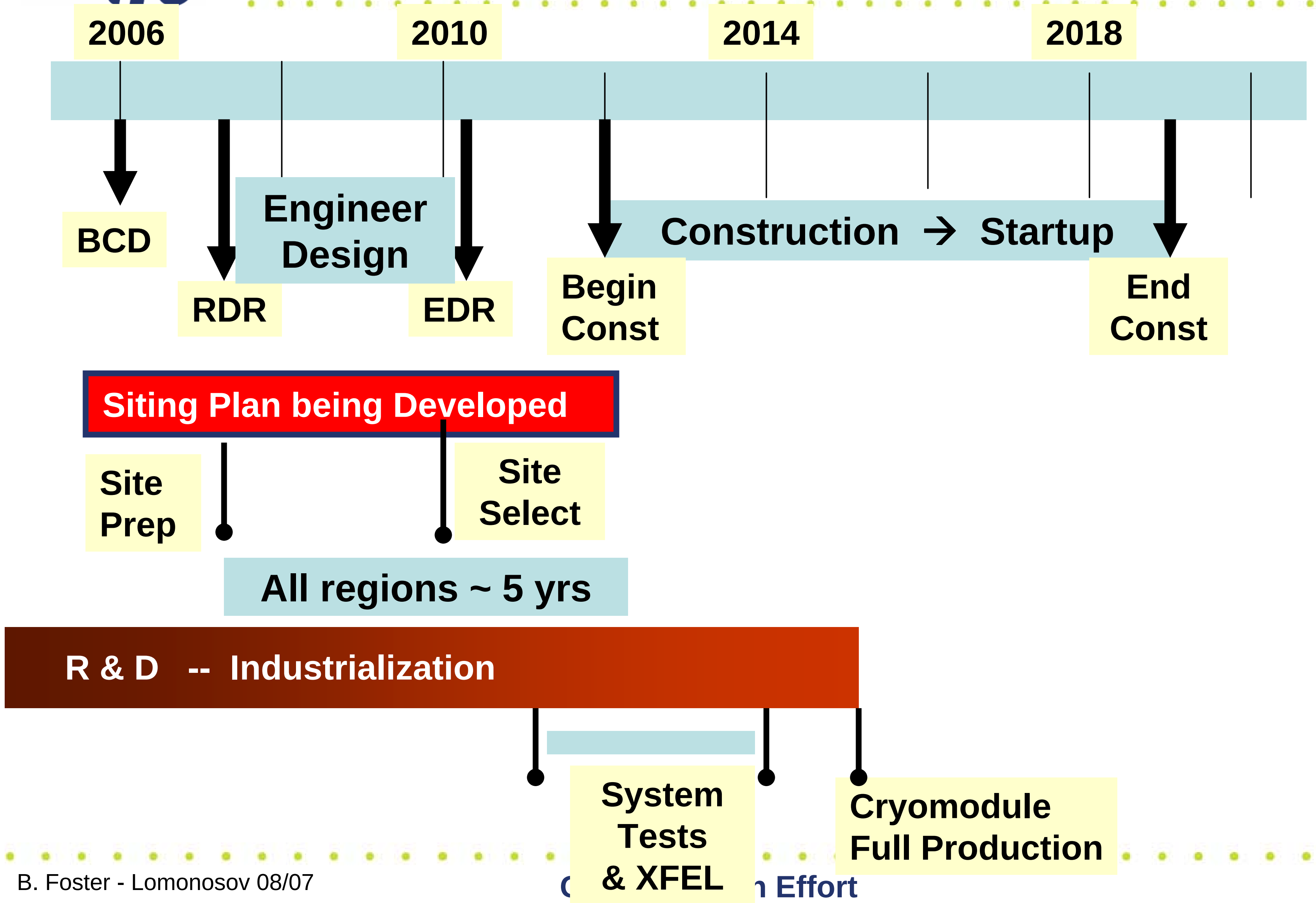
String test - goal

- Build 1 RF unit (3 cryomodules + 1 Klystron) fully to check:



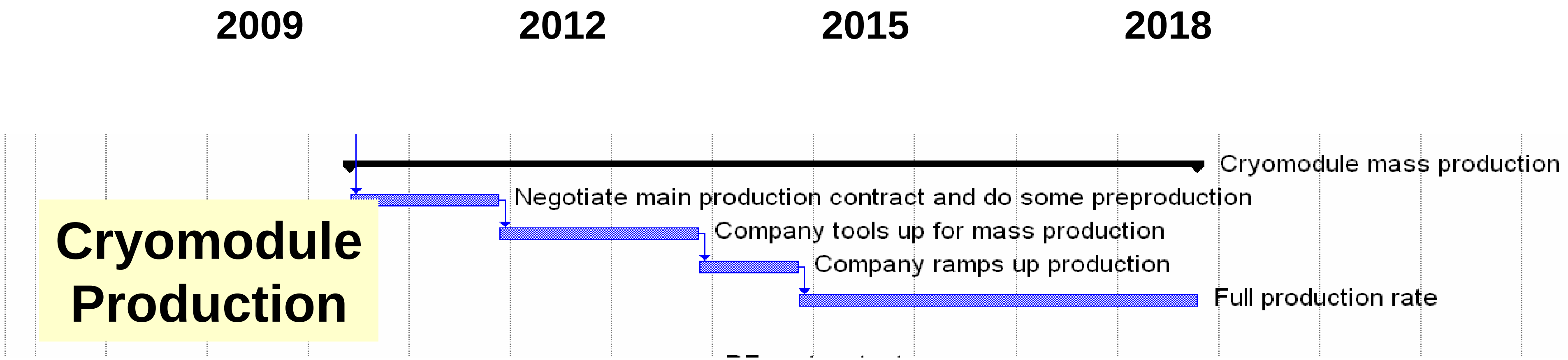
  - **What gradient spread can be handled by LLRF system. This test should be done with and without beam loading, etc.**
- Partial check of:
  - **Reliability**
  - **Dark current**
  - **for degradation or other weaknesses**
- The ILC cryomodule is different enough compared to TTF that a new system test is prudent.

Technically driven timeline

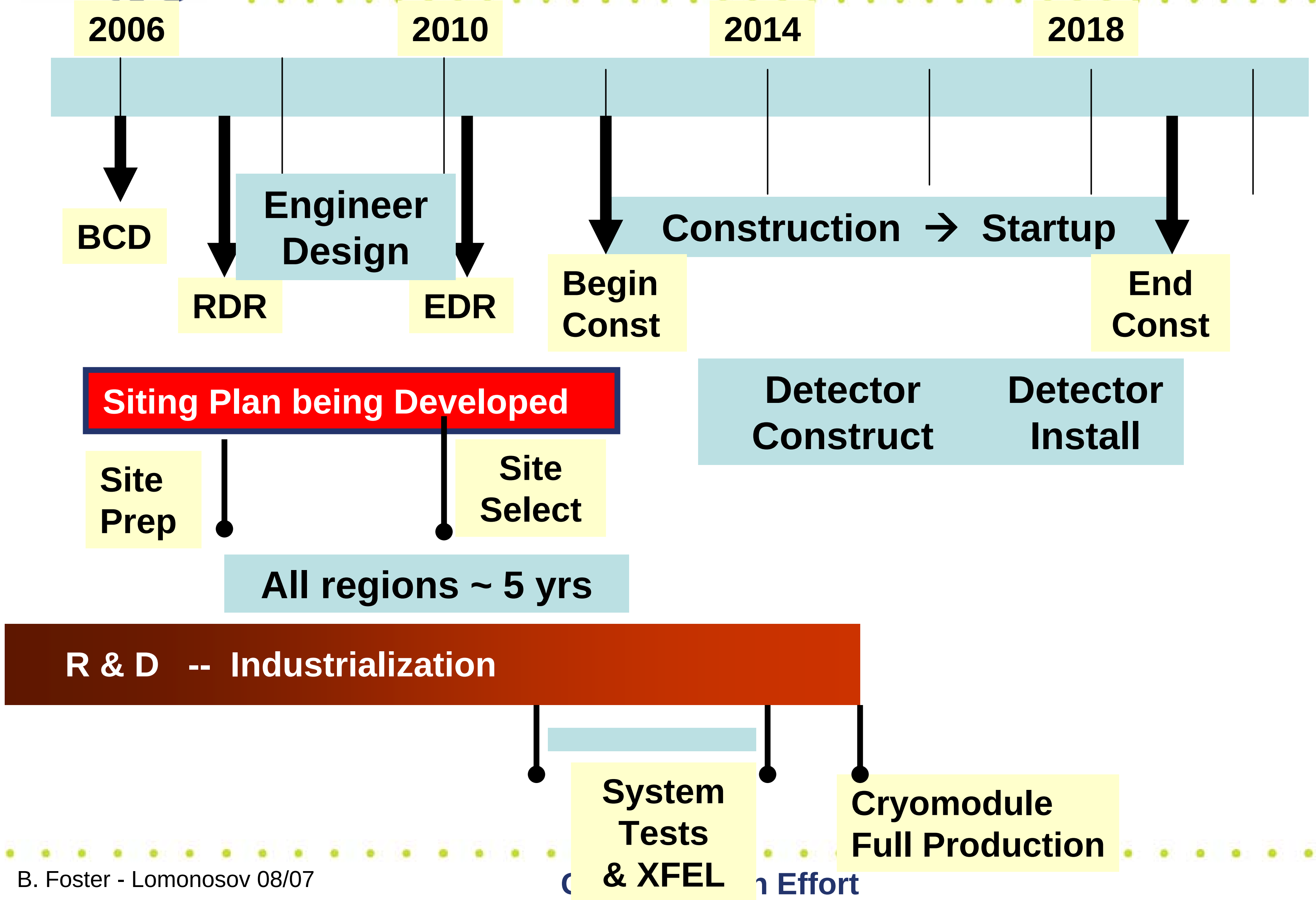


Schedule in Graphical Form

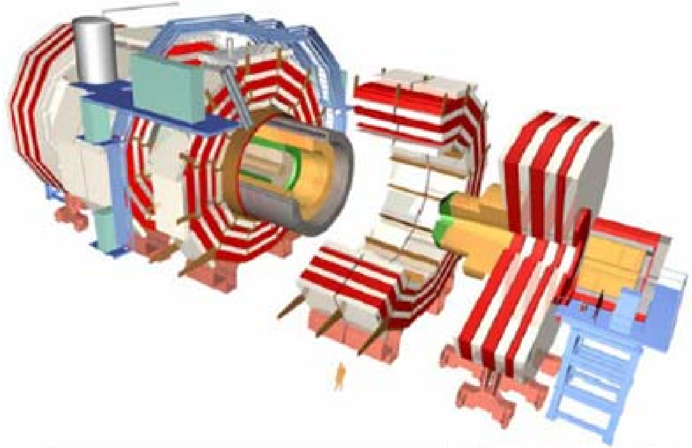
Country

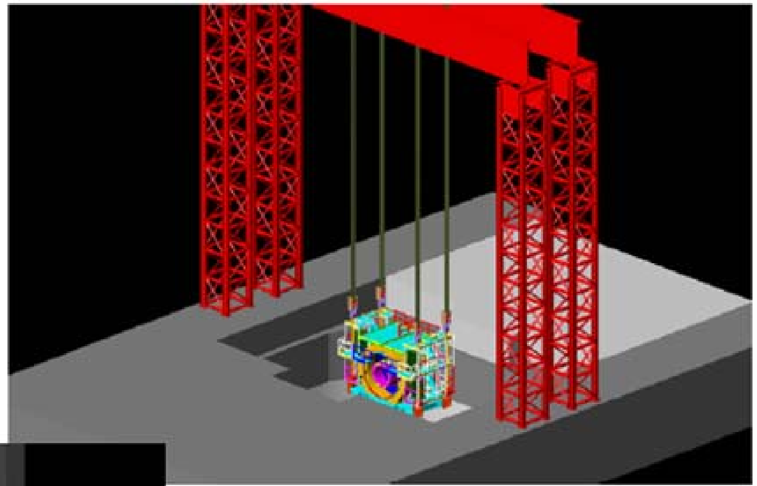


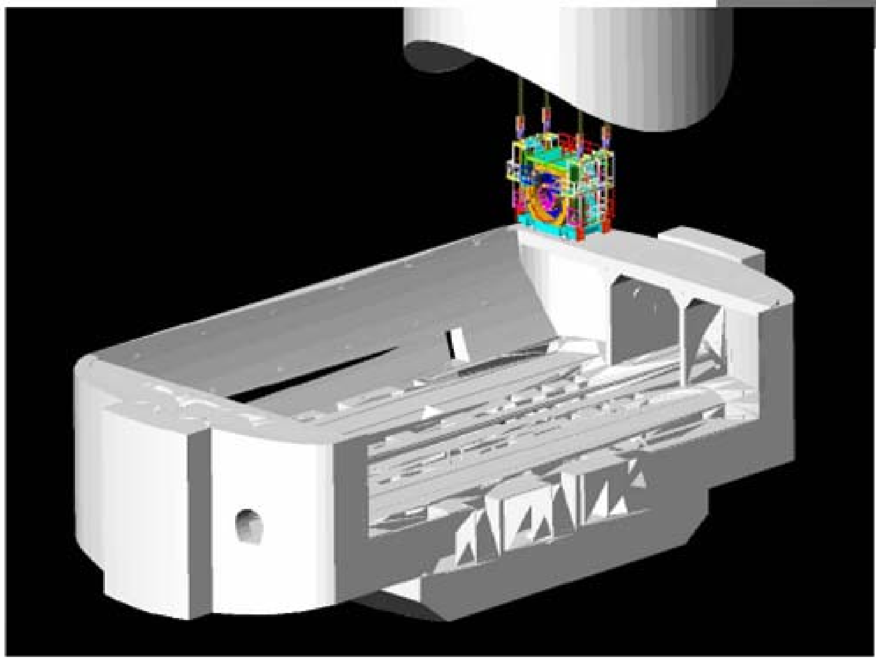
Technically driven timeline



Assemble detectors on surface



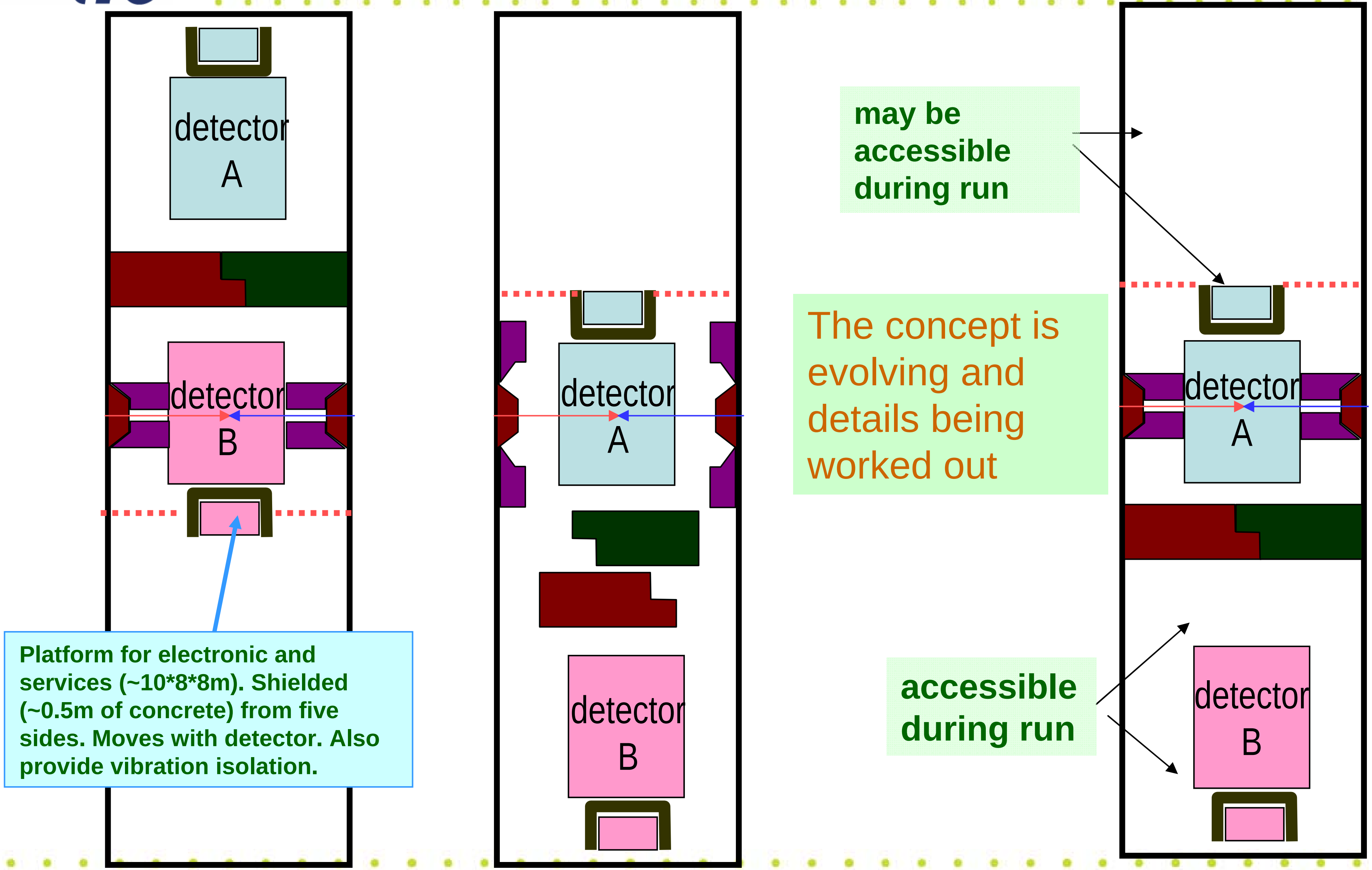




CMS assembly approach:

- **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**

IR Hall for push-pull



European situation

- FP7 calls:
  - **“Preparatory phase” is intended for projects on the ESFRI Road map; scheme is meant to take mature projects over the final threshold to construction. ILC is eligible since it is on the European particle physics roadmap, which was assimilated into the ESFRI roadmap. The EU Commission ruled that only 2 projects were sufficiently advanced to be eligible for PP funding: the LHC upgrade, and ILC. Call last May; result received this month.**
  - **Excellent reviews and award of 5 Meuro cf 7 Meuro requested - MUCH better than pro rata per project.**

European situation

- Goals:
  - **“Political”: prepare sites within Europe (including Russia) and explore with governments mechanisms for site proposal and selection; develop models for governance of an ILC laboratory - FALC Chair is a member of collaboration; develop outreach materials and strategies in many EU languages.**
  - **“Technical”: make 30 cavities integrated into ILC R&D programme; close interaction and synergy with XFEL facilities to build and test high-performance cavities and modules and to develop EU industrial capacity to produce substantial fraction of the ILC SC modules.**

Summary and Outlook

- RDR Draft & costing published in February 2007
- Final RDR now published and presented to ILCSC this month
  - represents enormous effort over last 18 months.
- Many R&D and engineering design issues still remain.
  – **The next document will contain much more technical detail: Engineering Design Report due 2010.**
- Our job in the GDE is two-fold:

  - produce the EDR, a blueprint for ILC construction containing and hopefully reducing cost so that governments have to act.
  - mount political and scientific campaign to convince them and the general public that the ILC is a good investment.
- We all had better do a good job -
  the future health of world HEP depends on it.