ILC Status

Management activities

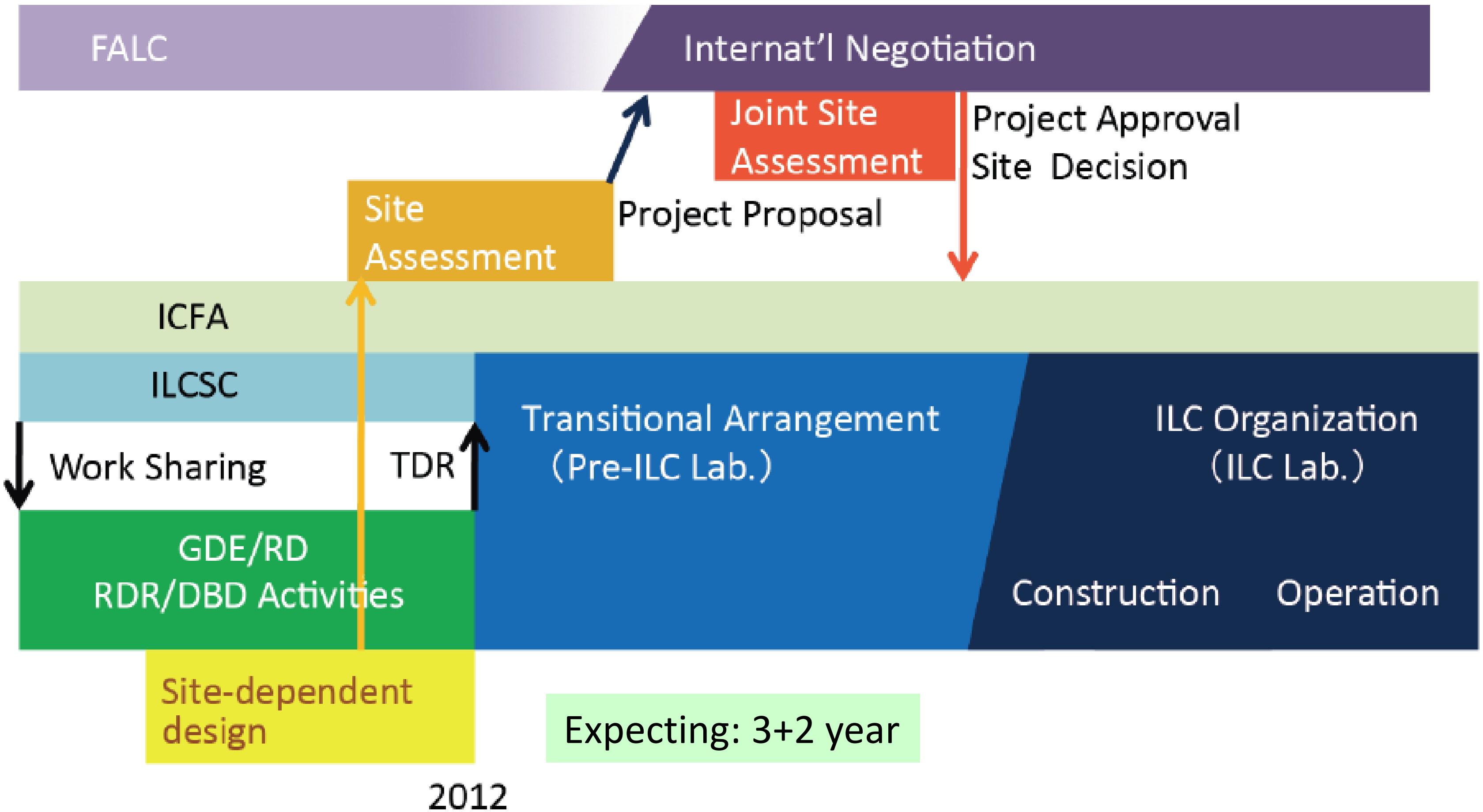
An Energy Phased Project

Schedule comments

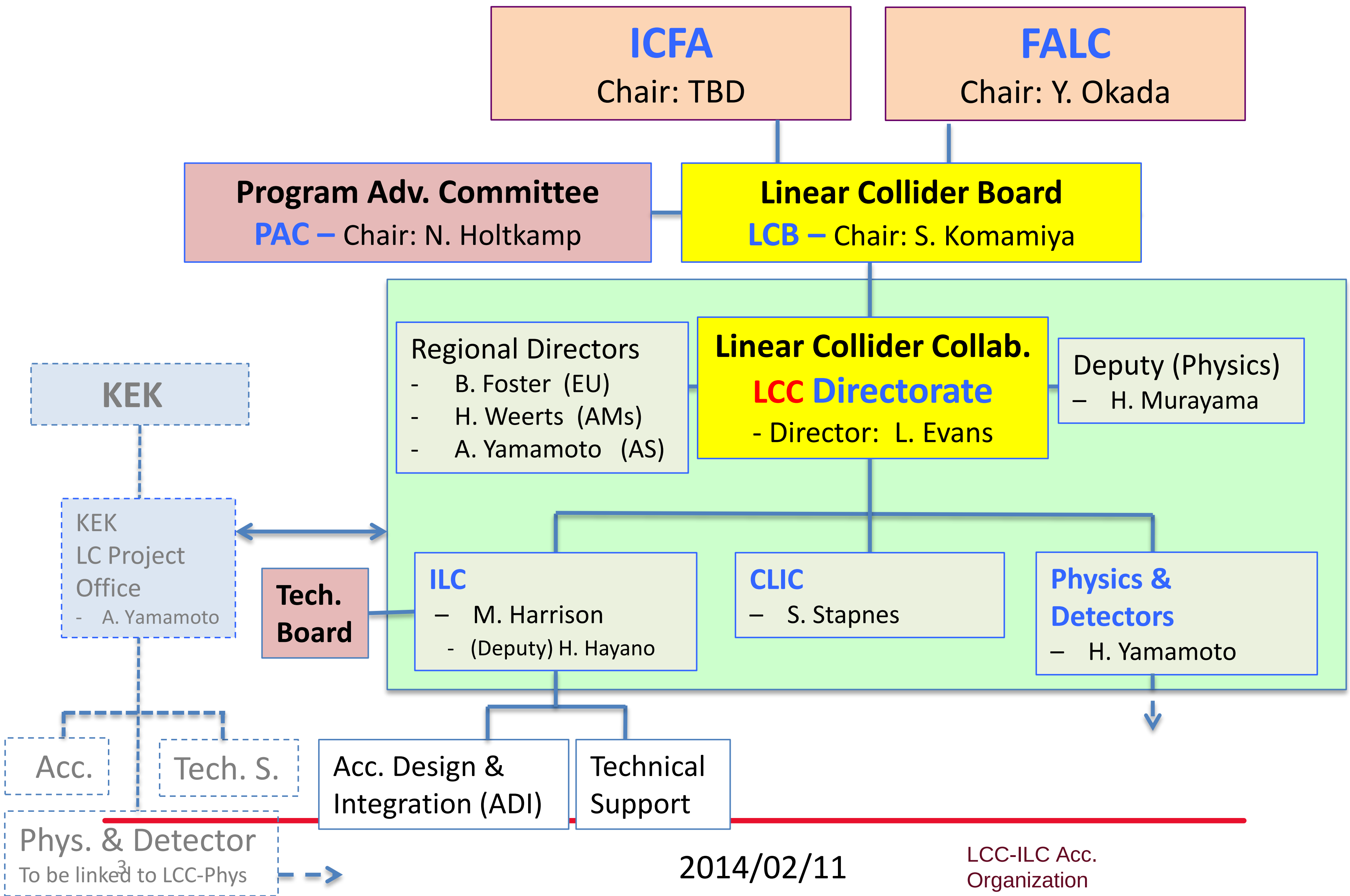
SRF

LCB DESY March 2014
Mike Harrison

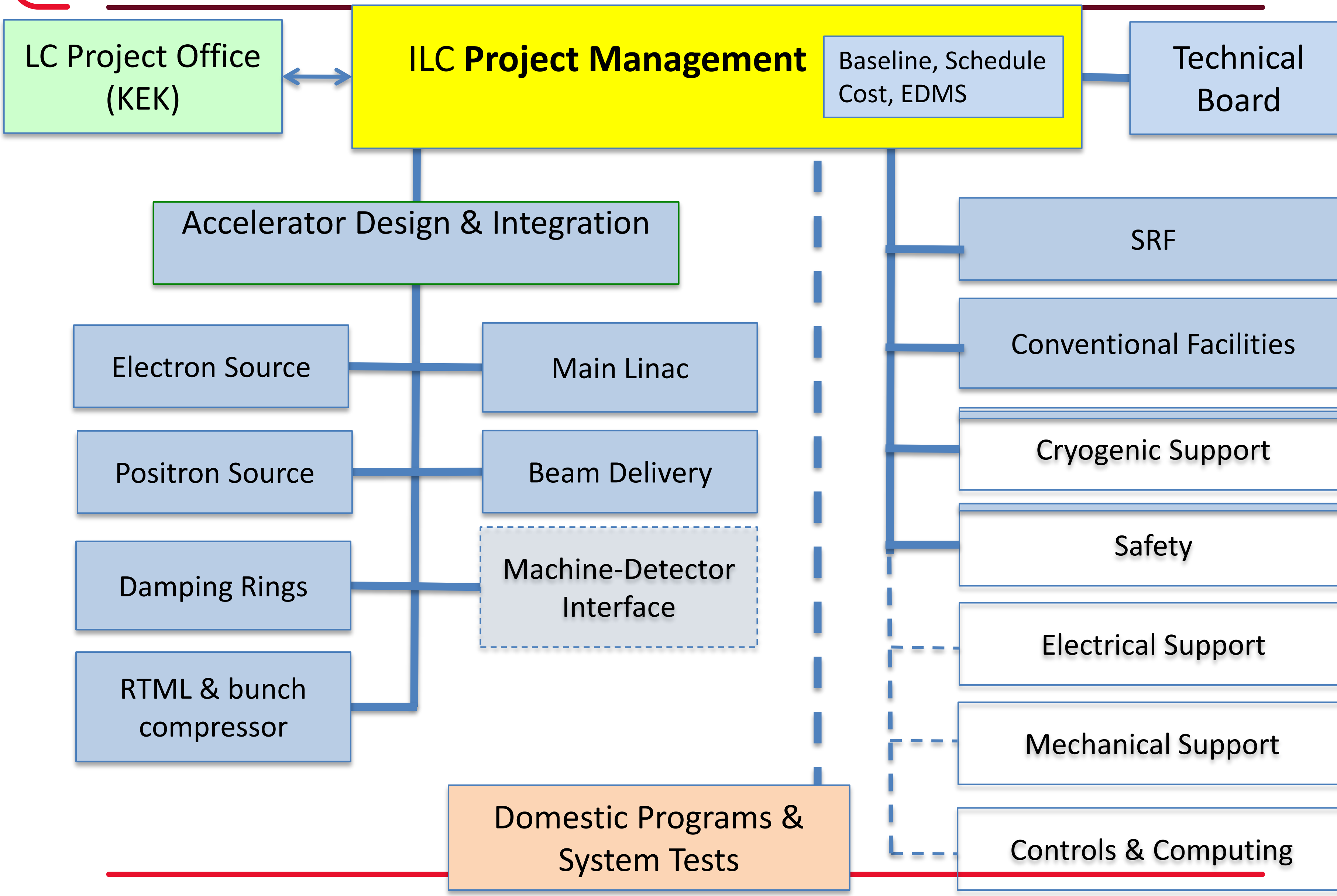
ILC Time Line: Progress and Prospect



ILC in the Linear Collider Collaboration

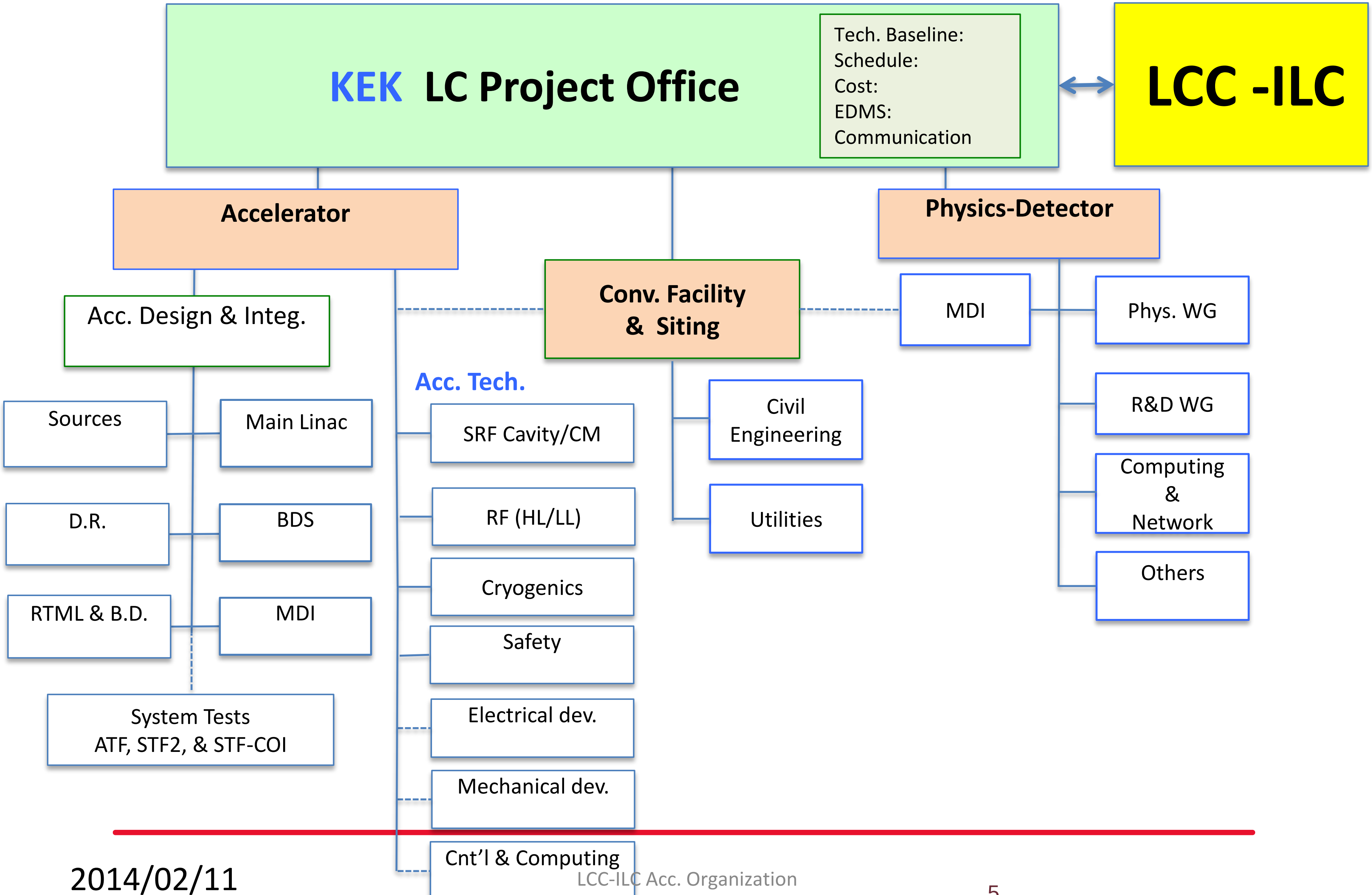


Pre-ILC Accelerator Organization in LCC



KEK-ILC Preparation Organization, proposed

(A. Yamamoto, Nov., 18, updated Dec. 15, 2013)



“Management” Activities – no others yet

- Cost
  - updating the cost files
  - Run the new files when ready (i.e. we can manipulate costs)
  - No plan for any cost update – is the TDR estimate enough ? Some parts were not too good but only a small fraction of the total.
- Site specific design
  - CFS data into EDMS
- Maintain Baseline design
  - Configuration control
  - Do we update the TDR as a living document ?
- Schedule
  - Develop and maintain. Phased approach.
- Project Implementation Planning
  - LCB takes charge of governance, LCC the other PIP elements

Energy Phasing - Which ILC ?

JAHEP statement Oct 2012

In March 2012, the Japan Association of High Energy Physicists (JAHEP) accepted the recommendations of the Subcommittee on Future Projects of High Energy Physics[1] and adopted them as JAHEP's basic strategy for future projects. In July 2012, a new particle consistent with a Higgs Boson was discovered at LHC, while in December 2012 the Technical Design Report of the International Linear Collider (ILC) will be completed by a worldwide collaboration.

On the basis of these developments and following the subcommittee's recommendation on ILC, JAHEP proposes that ILC be constructed in Japan as a global project with the agreement of and participation by the international community in the following scenario:

(1) Physics studies shall start with a precision study of the "Higgs Boson", and then evolve into studies of the top quark, "dark matter" particles, and Higgs self-couplings, by upgrading the accelerator. A more specific scenario is as follows:

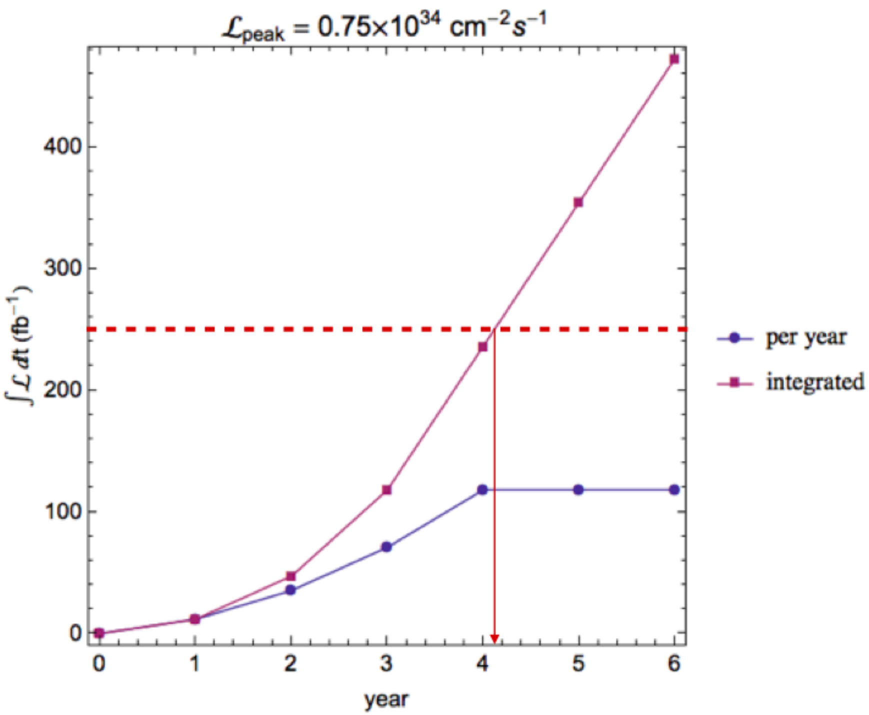
(A) A Higgs factory with a center-of-mass energy of approximately 250 GeV shall be constructed as a first phase.

(B) The machine shall be upgraded in stages up to a center-of-mass energy of ~500 GeV, which is the baseline energy of the overall project.

(C) Technical extendability to a 1 TeV region shall be secured.

Energy Phasing – Concept (LCC)

A multiple staged energy implementation, while technically feasible, will require several stop-start cycles with associated complications: thus the LCC Directorate has interpreted the JAHEP statement to mean a project with a first stage of 250 GeV.
A pause in installation would then ensue to allow for a period of commissioning (~1 year) and physics operation of approximately 4 years after which time a single shutdown of ~1 year would be used to complete the project to 500 GeV.

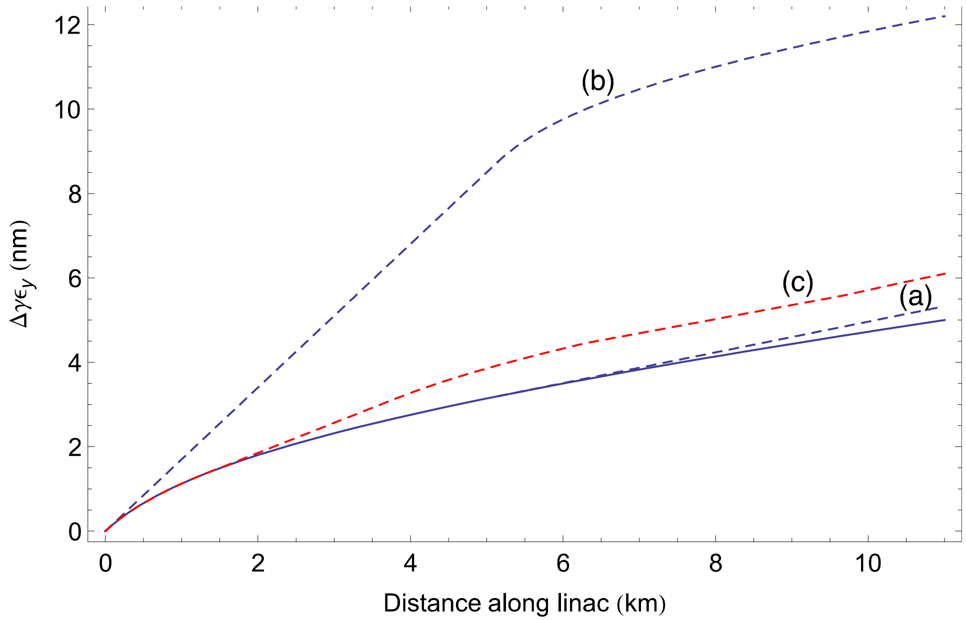


8 months running @ 75% efficiency
~1.6×10^{7} s/year

This is consistent with the TDR physics goal of 250 fb^{-1} of integrated luminosity at 250 GeV using the nominal TDR peak luminosity of 7.5×10^{33} cm^{-2}s^{-1} and assuming a yearly luminosity progression of 10%, 30% and 60% of peak as outlined by the Heuer parameter panel in 2006.

Energy Phasing - Linac Layout

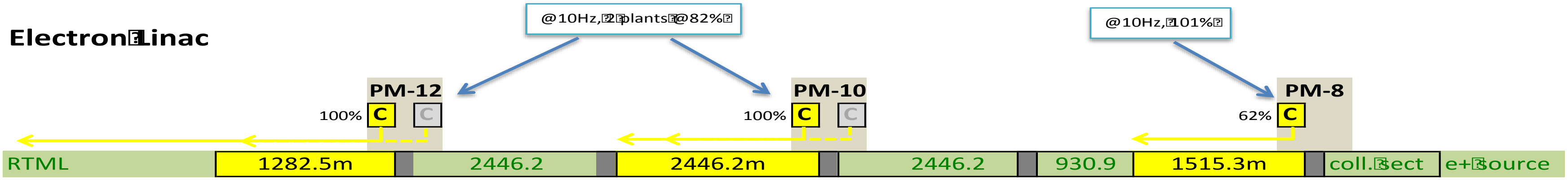
Approximate vertical emittance growth along the linac: (a) 15-125 GeV linac installed directly after bunch compressor with a 125 GeV transport line; (b) 5-125 GeV linac installed downstream of 15 GeV long transport line; (c) hybrid solution with three sections of linac with beam transport lines at 43 GeV, 96 GeV and 203 GeV. The solid line is the approximate TDR emittance growth for the full 250 GeV linac, which is used to estimate the other three curves.



Energy Phasing - Hybrid Tunnel Layout

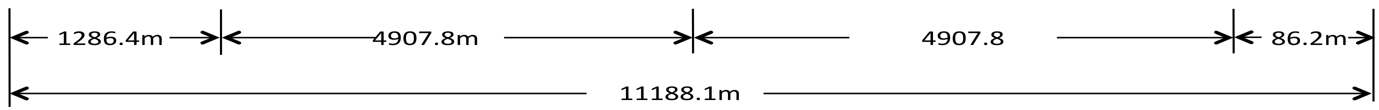
LINEAR COLLIDER COLLABORATION

Electron Linac

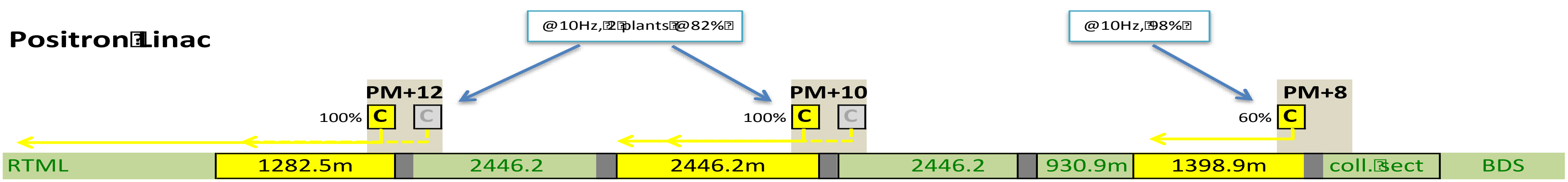


	tot.					
Long strings	0	0	0	0	0	0
Short strings	45	11	0	21	0	13
Cold boxes	42	10	0	20	0	12
ML units	135	33	0	63	0	39
Cryomodules	405	99	0	189	0	117
RF stations	90	22	0	42	0	26

Beam Energy	15	42.9	42.9	96.3	96.3	129.3 GeV

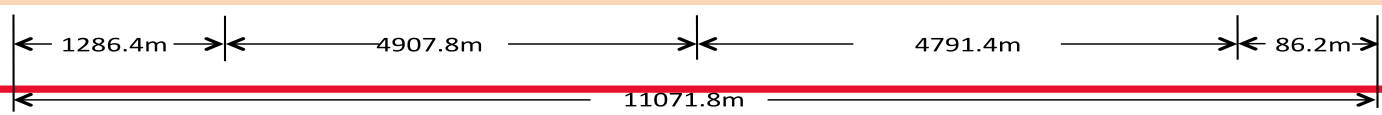


Positron Linac



	tot.					
Long strings	0	0	0	0	0	0
Short strings	44	11	0	21	0	12
Cold boxes	41	10	0	20	0	11
ML units	132	33	0	63	0	36
Cryomodules	396	99	0	189	0	108
RF stations	88	22	0	42	0	24

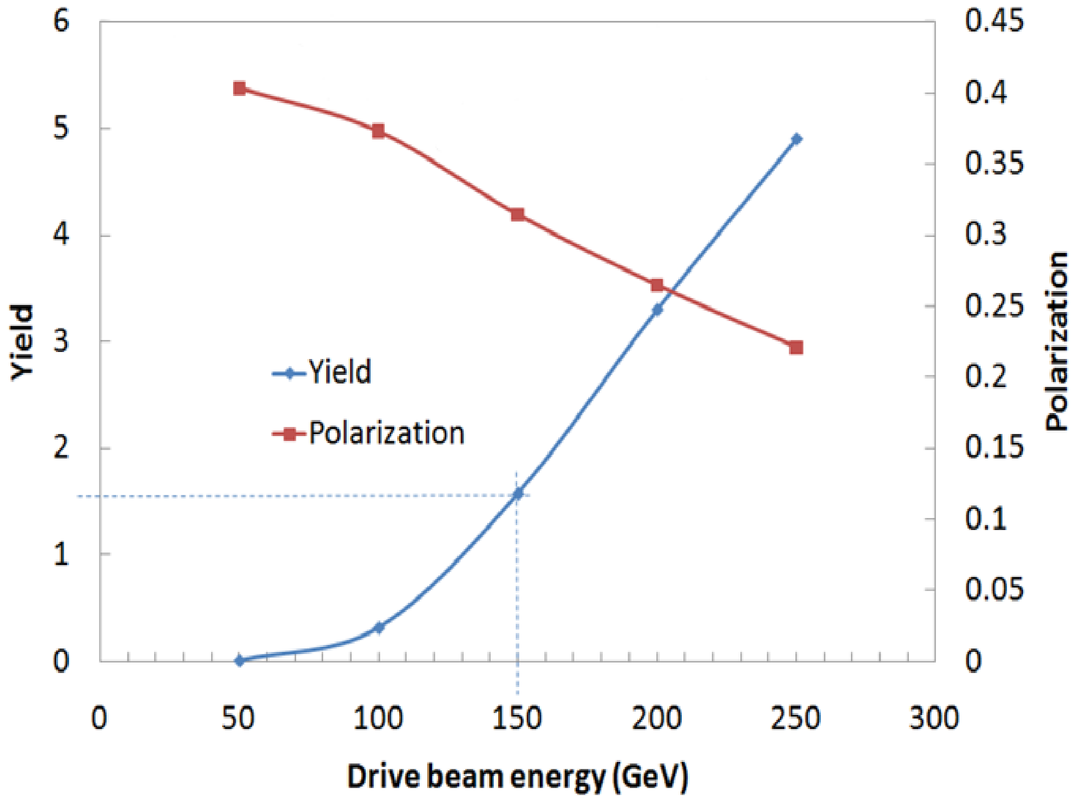
Beam Energy	15	42.9	42.9	96.3	96.3	126.8 GeV



Energy Phasing - Positrons

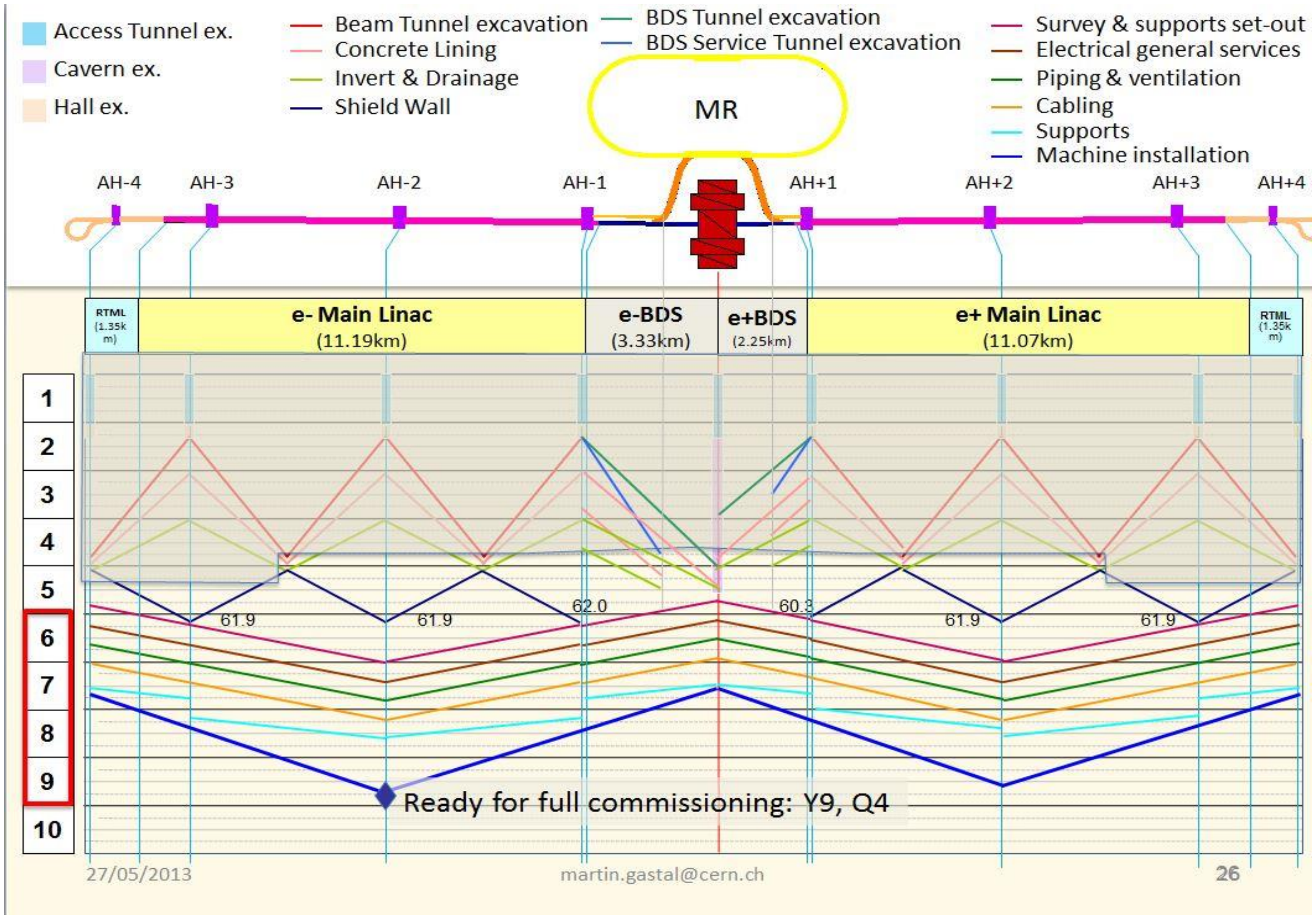
Positron yield and polarisation as a function of the primary electron beam energy.

Longer Undulators (230m) or 10Hz operation



Energy Phasing - Installation Schedule

Save a maximum of 9 months compared to the 500 GeV baseline



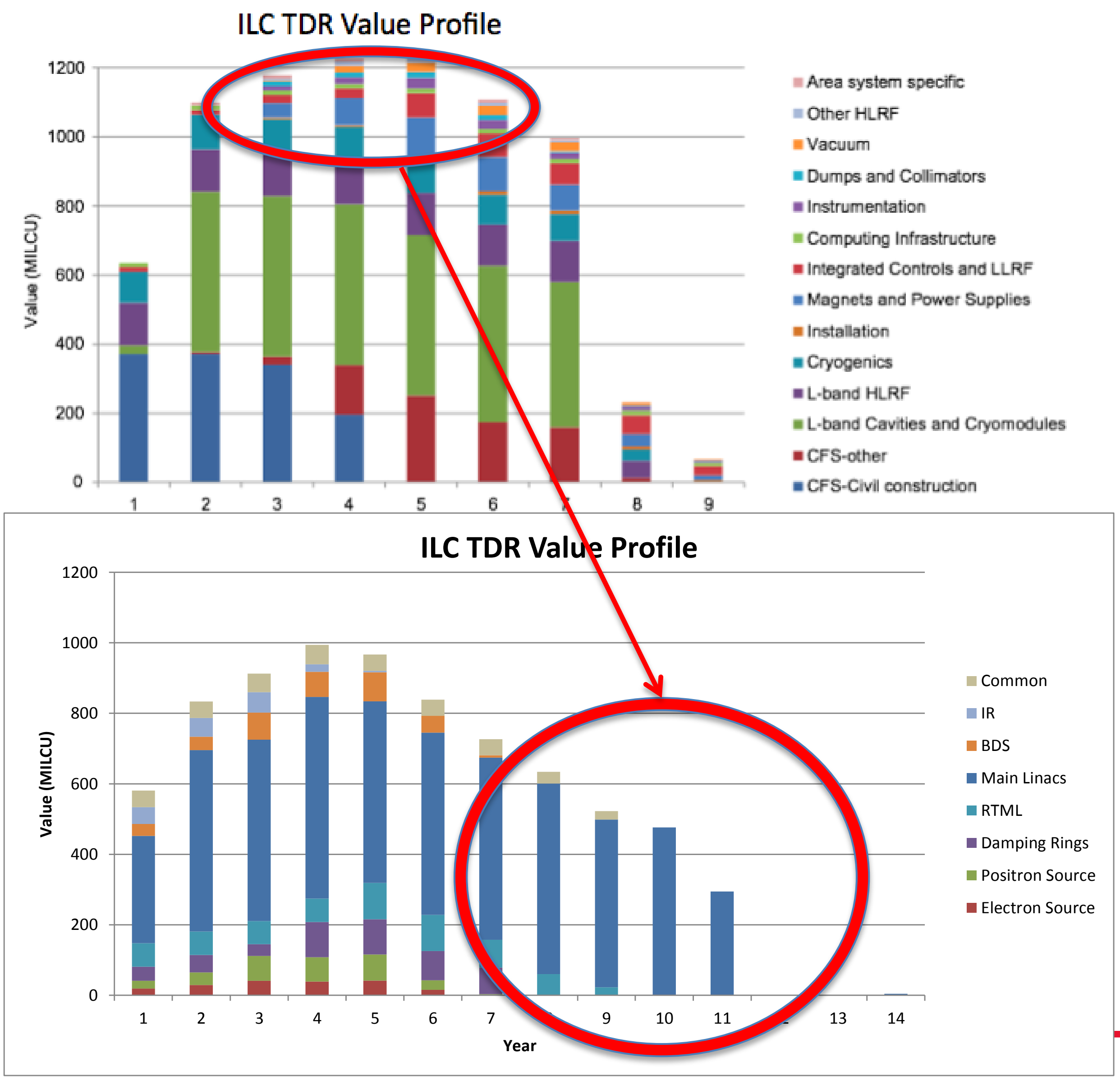
Energy Phasing - Cryomodule Production

The TDR cryomodule production rate called for ~2 units per day over a 3.5 year production cycle. This does not include a 2-year production ramp-up time. Since halting and restarting a complex production line will be highly inefficient, the most obvious production model would reduce the required rate to ~1 cryomodule/day but continue the production line without stopping at the same lower rate for an additional 3.5 years. This would result in the final cryomodules available 2 years before operation in the tunnel, the same time period as in the TDR baseline

RF power systems can be approached in a similar fashion

Could delay some aspects of the cryogenic systems

Energy Phasing - Cost & Funding



To first order the cost is unchanged (transfer lines ~1% of total)

Funding Peak reduced by ~$200M/yr

Profile develops Multiyear tale

Energy Phasing - Summary

A phased energy implementation results in a minimal change to the construction project costs and shortens the first-phase construction schedule slightly, allowing physics at 250 GeV centre of mass to begin up to 1 year earlier.

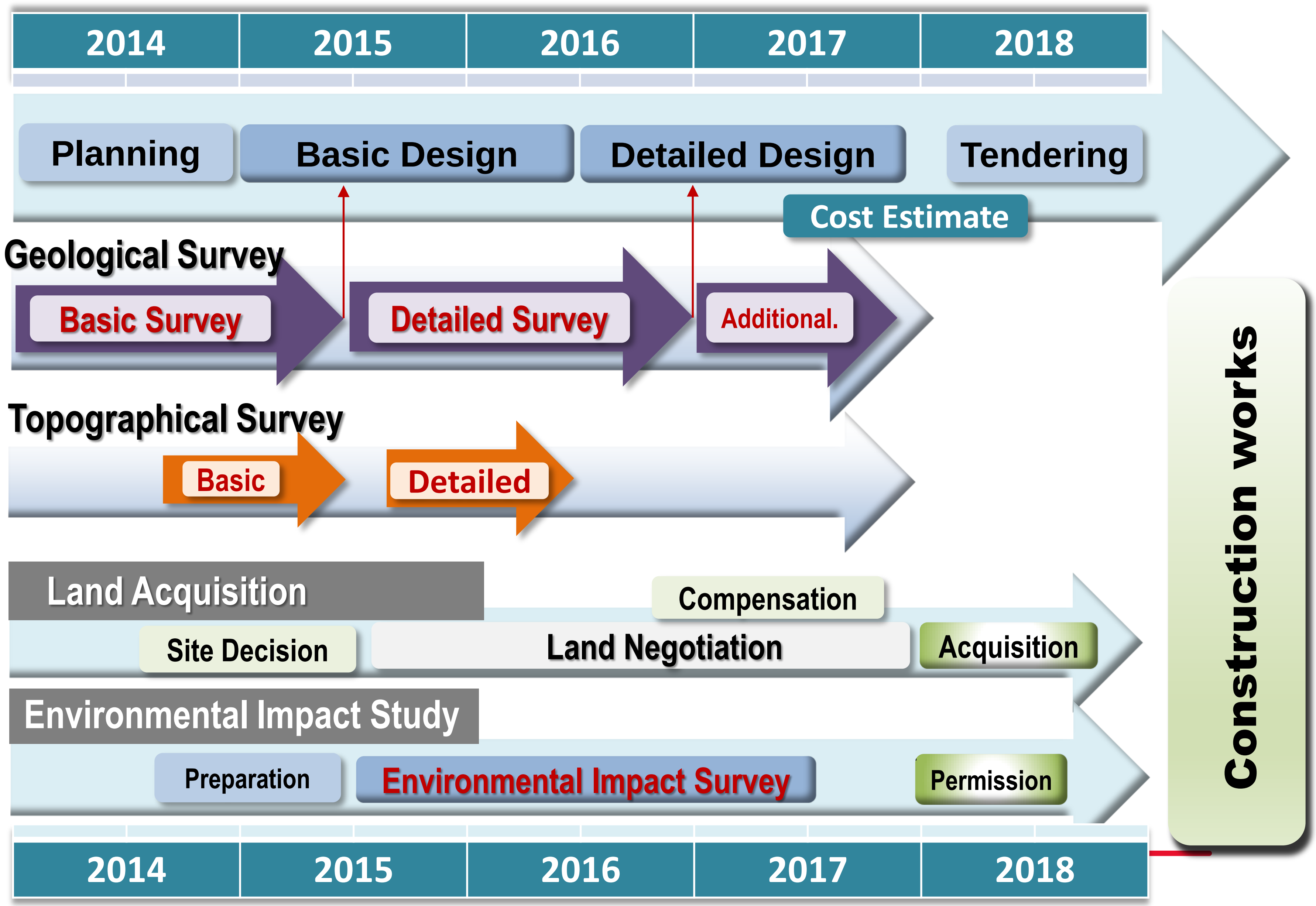
The complete tunnel construction and injector systems are necessary in the first stage to achieve this state of affairs.

Beam dynamics considerations argue for an initial accelerating stage and a hybrid scheme involving three linac sections is somewhat more favourable for luminosity upgrade schemes at 250 GeV CoM energies.

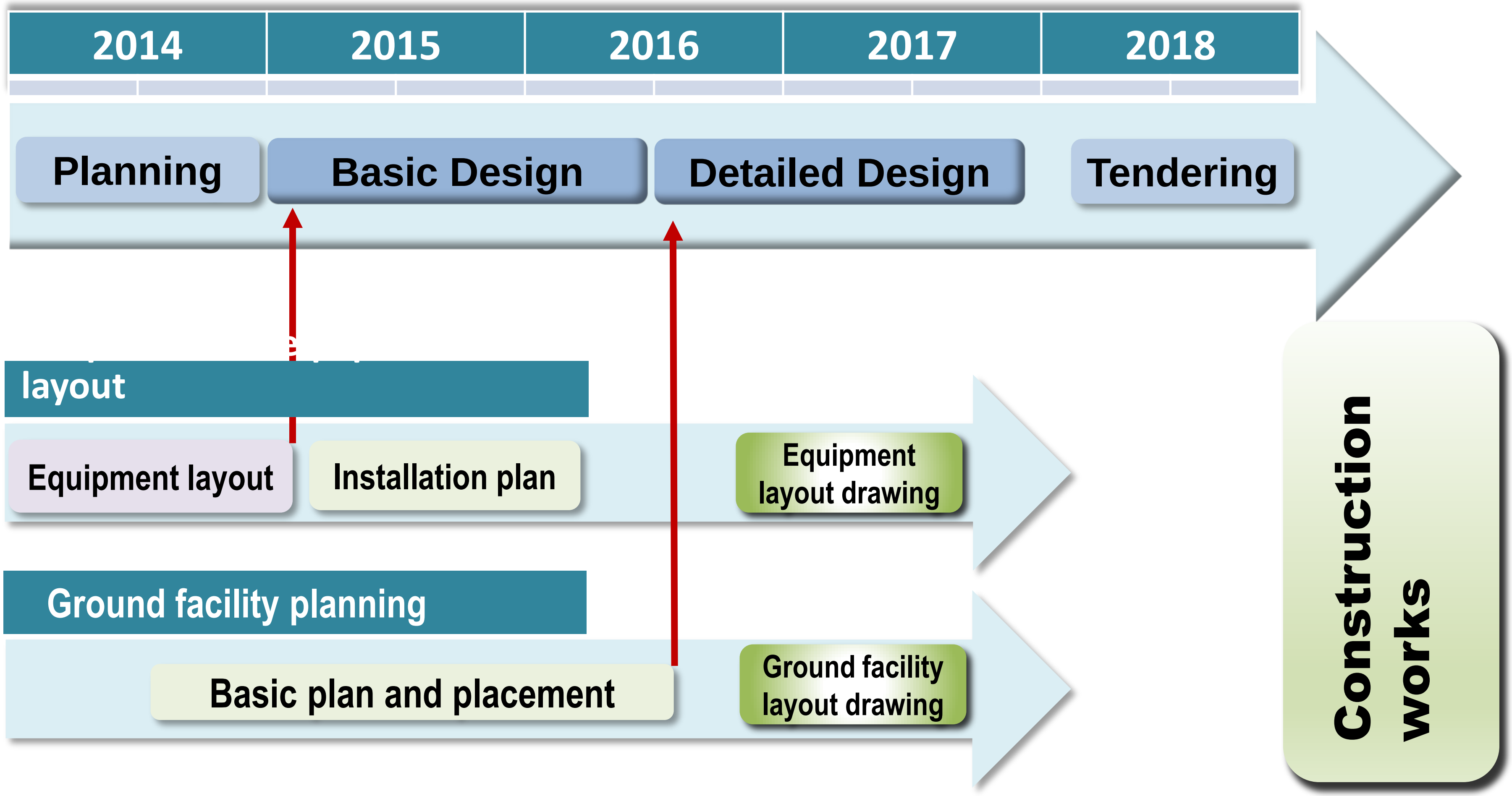
We estimate that one-year of commissioning and 4 years of operation at 250 GeV is necessary for 250 fb-1 of integrated luminosity. A subsequent shutdown of one year will be needed to attain 500 GeV.

The most significant change involves the cryomodule/HLRF production rate and the corresponding project funding profile.

Schedule – Pre-project CFS work



Schedule – Machine Input to CFS Design



Schedule - Site Specific Design

- We appear to have a mechanism (the Japan CFS group) to at least start this process. We seem to have a decent idea what needs to be done assuming no major machine design rework is needed.

- 5 years and $125M (?) before digging starts

- Schedule is a challenge given where we are
  - Will any resources be available JFY14 ?

- IP location and Linac footprint by the May workshop

SRF: Cavity & Component R&D

(1) Production
- TESLA cavity : XFEL Gradient Yield, cost-effective fabrication
- large-grain material
- LL cavity shape
- Hydro-forming fabrication
- Laser Beam Welding fabrication

(2) Surface treatment
- EP : Vertical-EP, Bi-polar EP, EP with He-Jacket
- CBP with no chemical processing
- N_2 treatment, thermal cycling for High-Q

(3) Cavity Testing
- multi-cavity package test facility

(4) New technology
- Thin-film coating for more high gradient

(5) Tuner : cost-effective design

(6) Coupler : copper plating technology, cost-effective design

(7) Magnetic shield : cost-effective design

(8) HOM pickup feed-through : for non-heating in vertical test(CW)

(9) High-pressure-vessel code : import/export

SRF: Cryomodule R&D

(1) Production

Gradient Degradation : assembly procedure in clean-room,
contaminations from couplers (coupler rinse process?)
from vacuum seal, bolts & nuts, beam-pipe bellows
cost-effective design: 5K shield removal
thermal (heat load) design check
Earth-quake resistant design

(2) Alignment

Procedure of cavity chain connection in clean room
Procedure after GRP hanging
Procedure after cold-mass insertion into vacuum vessel
WPM, Laser base alignment detection, vibration detection
beam induced HOM-base alignment detection

(3) Magnets

split core, conduction cooled magnet prototyping

(4) BPM

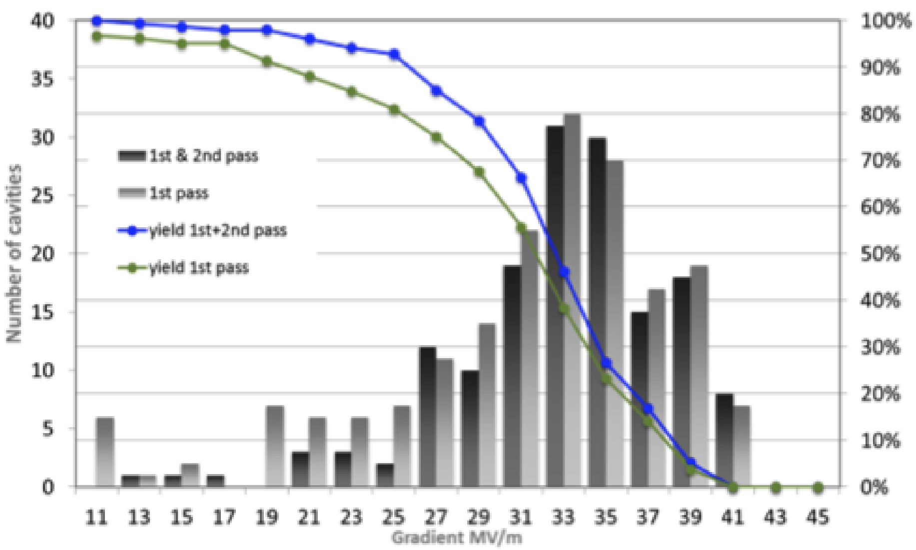
re-entrant BPM R&D

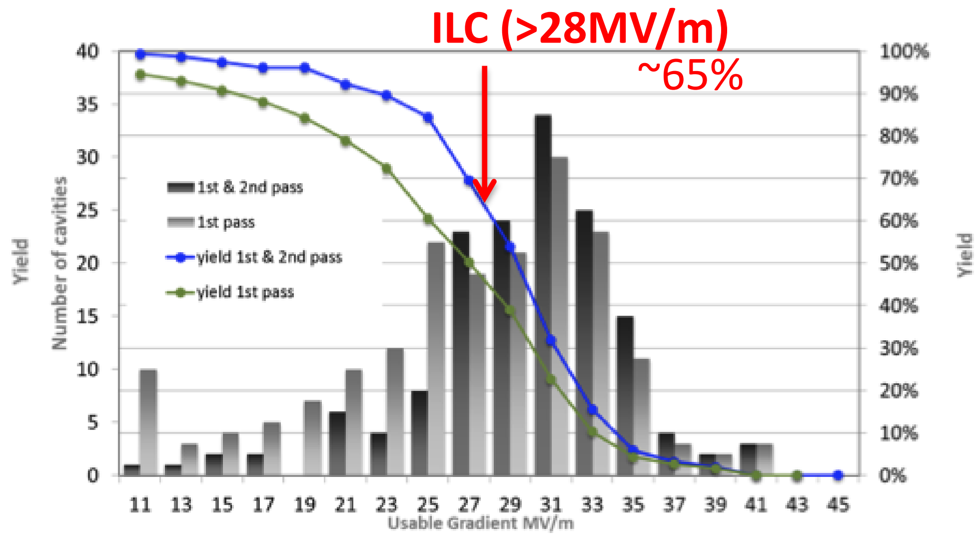
(5) Waveguide

cost-effective WG design, cryomodule interface design

Yield of gradients: After re-treatment (2. pass)

- Yield of usable and maximum gradient of 154 cavities (2.pass) **=> 84%** (cavities that passed in 1. pass + results of cavities after re-treatment)
- **Average** gradients **increased + spread reduced** (standard deviation)





Average **maximum** gradient:

(32.6 ± 5.1) MV/m

EZ: (30.7 ± 4.6) MV/m

RI: (35.2 ± 4.4) MV/m

Average **usable** gradient:

(29.3 ± 5.0) MV/m

EZ: (28.0 ± 4.7) MV/m

RI: (31.0 ± 5.0) MV/m

Preliminary data; results are not published

Summary

- Almost any energy staging scenario is feasible with some cost and schedule implications. Multiple installation stop-starts is inefficient, cryomodule production stop-starts are very disruptive.

- LCB needs to take the lead in officially updating machine parameters.

- CFS pre-project schedule will drive the accelerator design work and the overall project schedule at this point.

- Some level of pre-project funding is needed for CFS work in Japan.