9th ATF2 Project Meeting

Accelerator Design and Integration – New Baseline Proposal for ILC – 'Strawman Baseline 2009' (SB2009)

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Goal of the session:

- Present and discuss activities toward an updated ILC baseline, called ‘SB2009’.
- What changes are under consideration and how could the ATF2 program be adapted to study them?

- http://ilc.kek.jp/SB2009/

Goals of the new baseline (1):

- **Overall cost reduction - Any opportunities for cost reduction should be taken, in as much as they do not unacceptably impact performance or increase technical risk.**

- **Improved cost balancing - Cost margins created as part of the cost-reduction exercise, can be made available for other subsystems which incur increased (estimated) construction costs.**

  - **Cost containment of the total, rather than few ~10% cost reduction is the focus**

Goals of the new baseline (2):

- **Improved understanding of system functionality - Attempts at understanding of any performance impact force a careful analysis of systems' functionalities, strengths and vulnerabilities; this has a critical value on its own beyond cost-reduction.**

- **More complete and robust design - Revisiting many of the design and implementation details that were not completely covered during the RDR design phase. These efforts, when made appropriately, will improve the overall robustness of the ILC systems design.**

- **Re-optimised R&D plans - Improved understanding of the system functionalities and performance issues will help the Project Management in producing a re-optimised and more effective global R&D plan to pursue in TD Phase 2.**

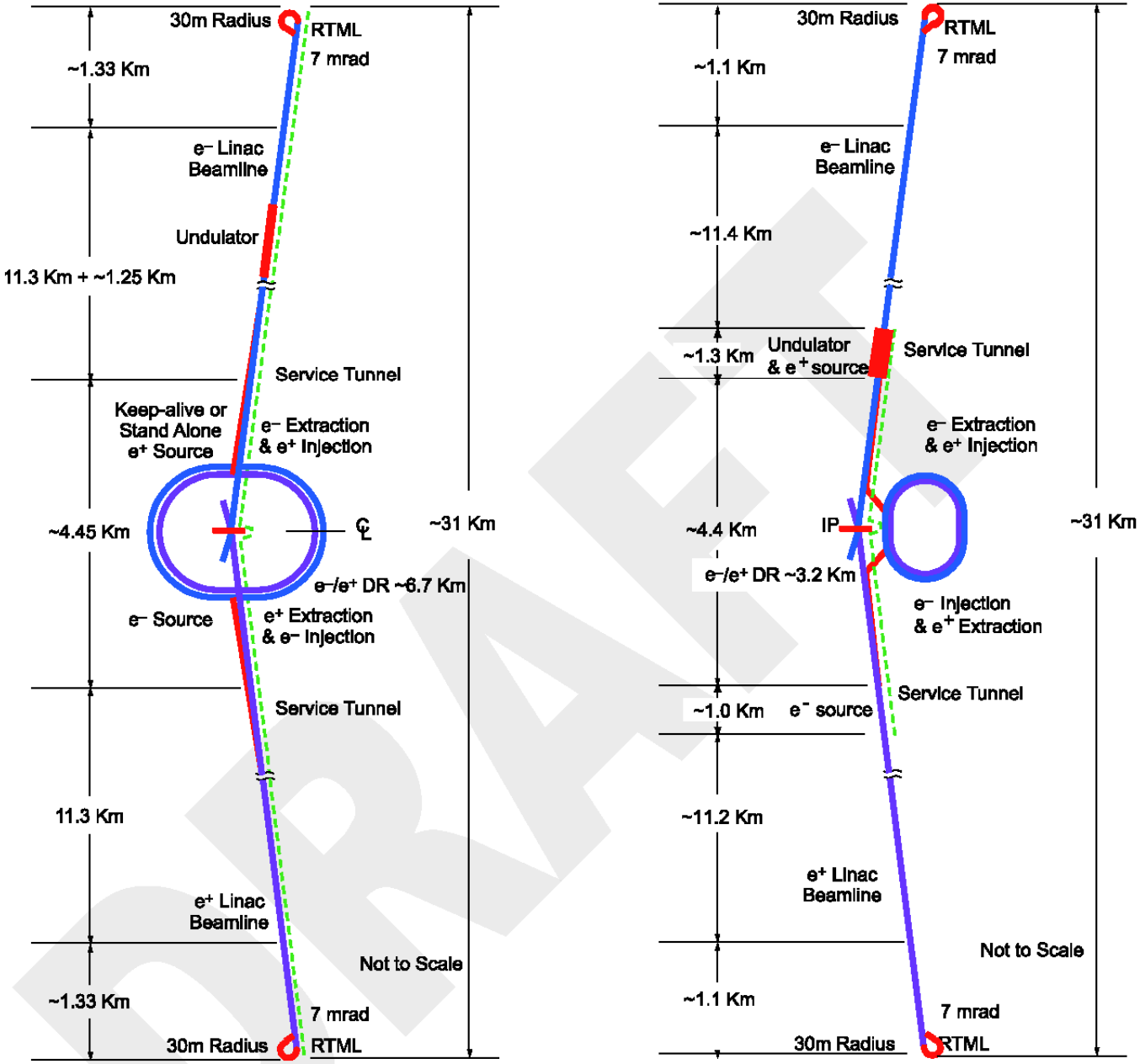


Figure 2.1: RDR layout (left) and the re-baseline layout in proposal (right). The numbers are approximate.

‘Work Assumptions’ (1)

- WA1. A Main Linac length consistent with an *average* accelerating gradient of 31.5 MV/m and maximum operational beam energy of 250 GeV, together with a High-Level RF distribution scheme which optimally supports a spread of individual cavity gradients.

- WA2. A single-tunnel solution for the Main Linacs and RTML, with two possible variants for the High-Level RF (HLRF):
- a) Klystron cluster scheme (KCS);
- b) Distributed RF Source scheme (DRFS).

- WA3. Undulator-based positron source located at the end of the electron Main Linac (250 GeV),
  - Quarter-wave transformer as capture device.

Working Assumptions (2)

- WA4. A lower beam-power parameter set with the number of bunches per pulse reduced by a factor of two (nb = 1312), as compared to the nominal RDR parameter set.

- WA5. Reduced circumference Damping Rings (~3.2 km) at 5 GeV with a 6 mm bunch length

- WA6. Single-stage bunch compressor with a compression ratio of 20.

- WA7. Integration of the positron and electron sources into a common “central region beam tunnel”, together with the BDS, resulting in an overall *simplification* of civil construction in the central region.

Single Tunnel Main Linac

- 1. The single tunnel configuration is a simpler underground construction, removing the ~26 km support tunnel.
- 2. Safety studies in each region (Asia /Japan, Americas/US and Europe / CERN) found that valid strategies could be realized for single-tunnel life safety egress
- 3. Recent studies on High Level show feasible new concepts that are much more suited to a single-tunnel solution than the RDR
- 4. Availability studies of the Main Linac on the proposed single-tunnel and new HLRF systems configurations show that an acceptable performance can be achieved with appropriate engineering of sub-system designs.

two proposed novel HLRF solutions (KCS, DRFS)

- provide options for specific sites where local constraints may favour one solution over the other.
- Allowing such flexibility in the designs (multiple configurations) goes beyond the “generic site” approach used in the RDR.

Central Region 'Integration'

- The Damping Rings have been moved vertically into the same plane as the BDS and shifted horizontally to avoid the Detector Hall
  - This removes the need for the long (~2 km) vertically sloped beam tunnels (so-called escalator), which can be replaced by much shorter horizontal transfer tunnels. The Damping Rings tunnel can now also share one shaft with the Detector Hall.

- Since the BDS magnets do not require a large amount of transverse tunnel space, it is feasible to house the electron source and the 5 GeV injector linac in the same tunnel as the positron BDS, thus removing the need for a separate beam tunnel.
  - Retain the support tunnel for Central region

Central Region (2)

- undulator-based positron source and associated 5 GeV booster linac can be more efficiently accommodated at the exit of the main electron linac
- An additional ~450 m beam path length is maintained in the positron system for bunch timing.
- Finally, an additional 500 MeV linac can be incorporated into the e+ source region
  - in conjunction with the e+ source photon target, facilitates low charge auxiliary source

Cost increments

- cost increments associated with the proposed modifications have been scaled directly from the RDR VALUE estimate
- No attempt was made to provide new updated unit cost estimates at this time,
  - except those components that are new to SB2009
  - (notably the HLRF system components).
  - increments here are direct comparisons to RDR estimate.
- To date, the total reduction of the modifications proposed in this document amount to ~13% of the RDR value estimate.

Central Area Scheme

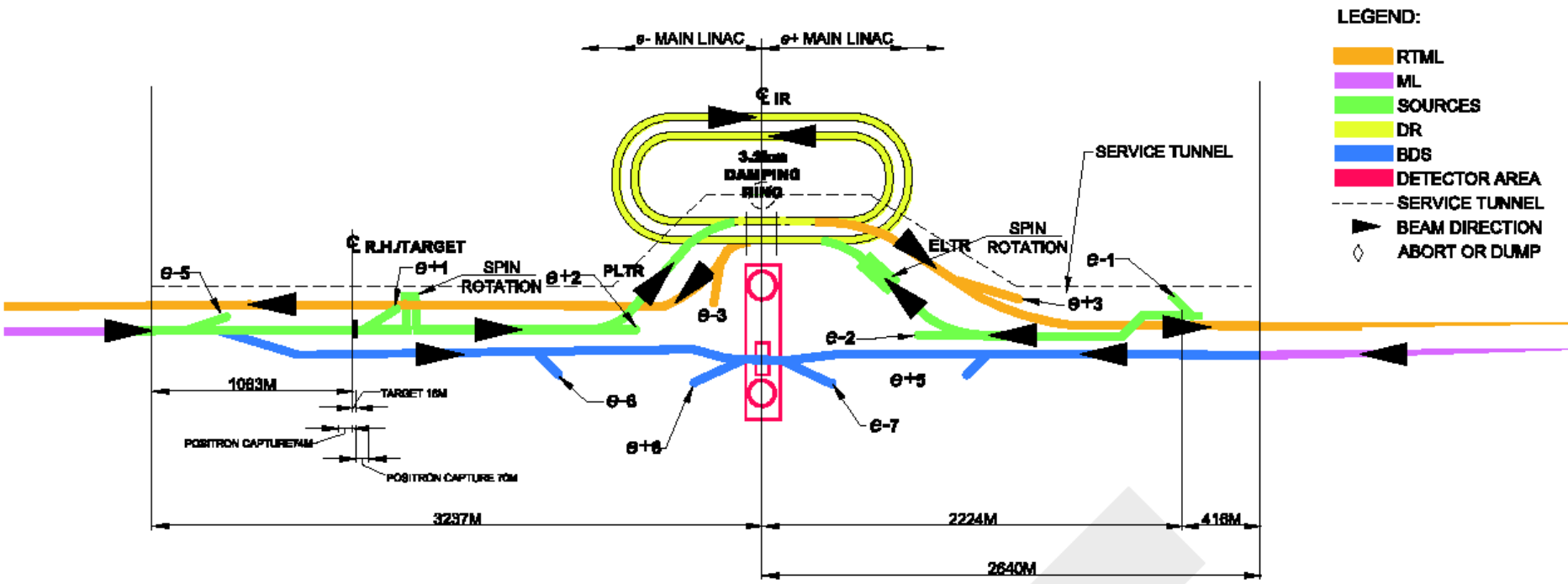
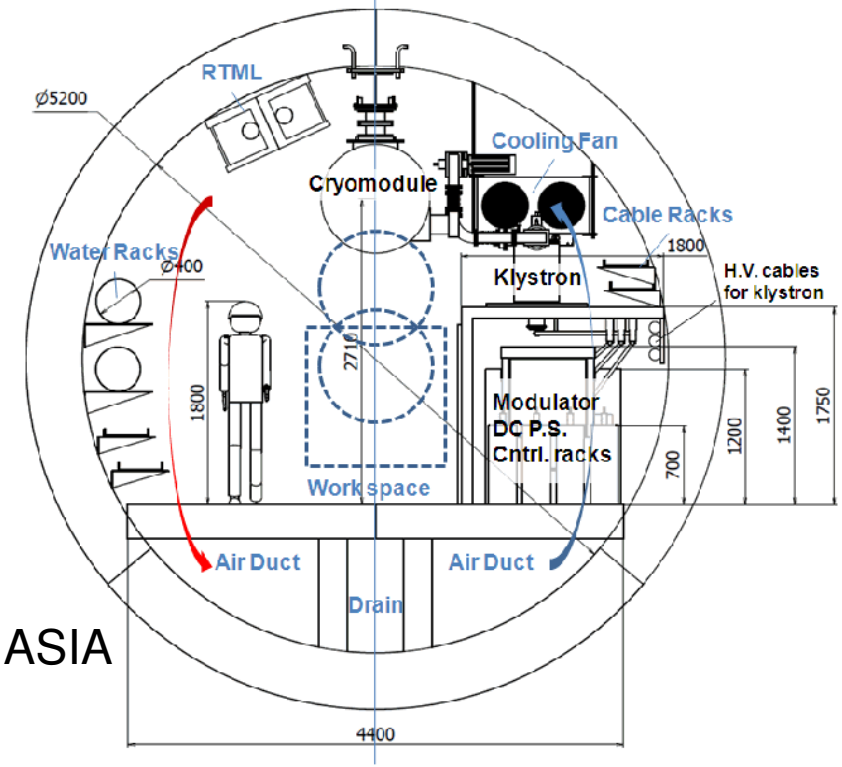
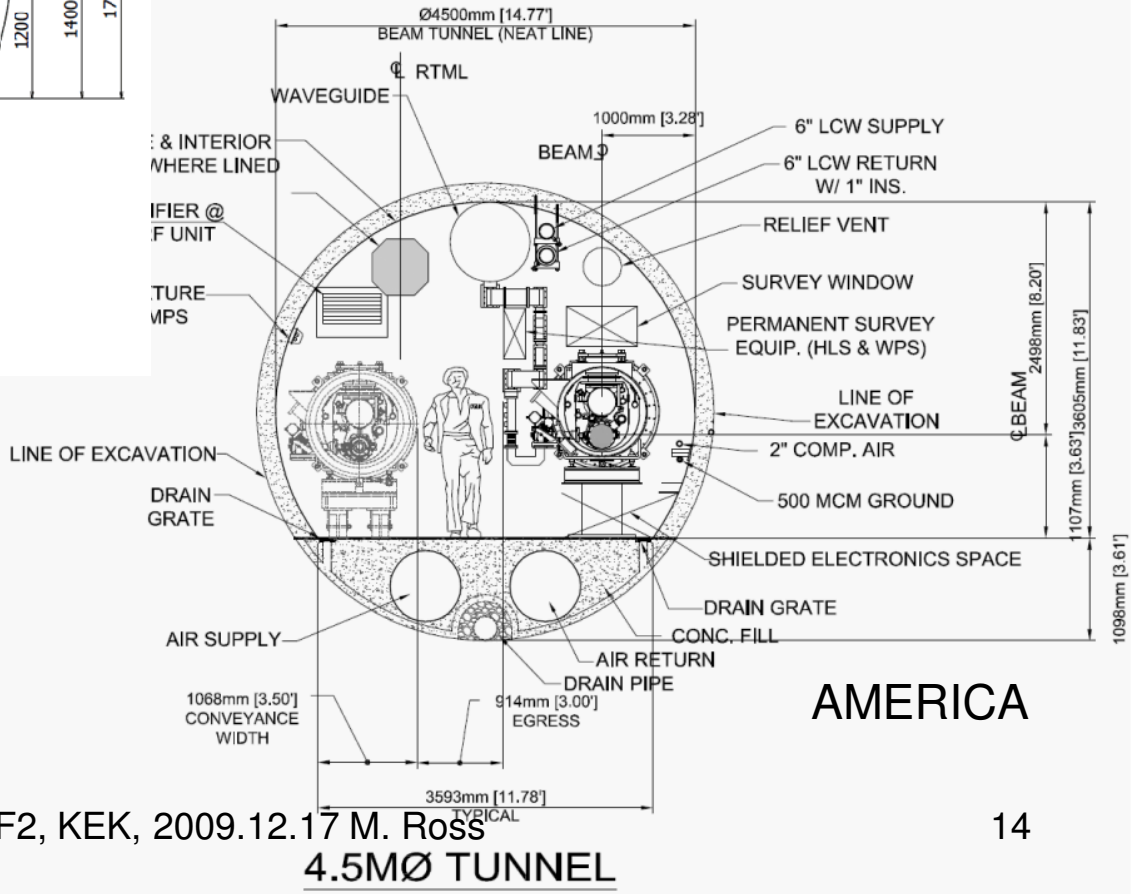


Figure 3.2: Topological diagram of the beamlines in the ILC central area.

Tunnel Cross section

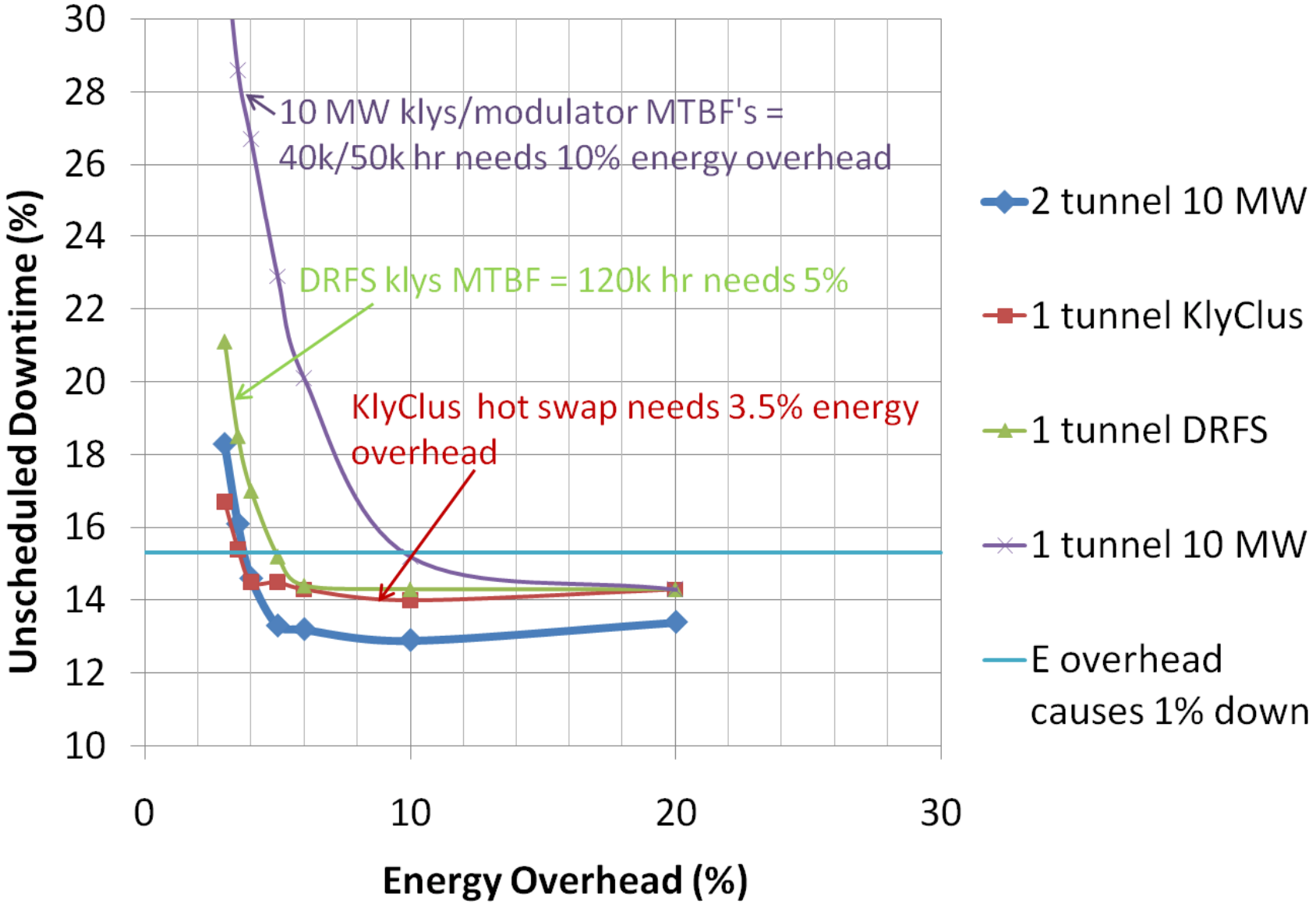


ASIA



AMERICA

Downtime – 'ILC Availability'



Summary: CFS Goals / Mission:

- Identify cost drivers, justify these and develop alternates
  - High delta-T water cooling and single/double tunnel
  - ‘value-engineering’
- Develop design and support TA Groups
  - Extensions of RDR and support of Integrated Design Initiative
  - Extend sample sites beyond ‘RDR 3’
- Build global collaborative resource network
  - CLIC, Dubna, XFEL specialists

Siting –

- Lack of definite site weakens ILC project
- ILC technical basis is conservative and very strong
  - (although much R & D remains)
- ILC technology can be *adapted* to various linac configurations
  - (TESLA and RDR are 2 such configurations)

CFS Group Conclusion:

- *Adaptation* should be studied and supported through Technical R & D

Director's Corner 23.07.2009

international linear collider

Director's Corner

23 July 2009

Other options for distributing HLRF for a single tunnel will be considered, including the XFEL two-kilometre linac design, which will provide the most accurate cost estimate.

A primary motivation in considering a single underground tunnel for the main linac and associated beamlines is the potential large cost savings realised by eliminating an entire 30-kilometre-long underground tunnel. However, removal of the second (service) tunnel requires us to revisit the original reasons we chose a double-tunnel solution for the RDR: concerns about availability and safety.

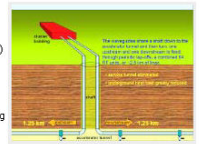
The double-tunnel configuration provided us with a conservative solution for the RDR, since access to klystrons, modulators, electronics and other hardware during beam operation improves availability, and escape routes from one tunnel provide straight-forward safety solutions. Nevertheless, the potential savings for a single-tunnel configuration [illegible] million dollars, including anticipated extra costs to achieve good availability and safety solutions. For this reason, we have always planned to come back to study the single-tunnel configurations. One of the primary goals of the present study is to quantify the potential savings and to present realistic concepts for single-tunnel configurations.

The ILC Reference Design uses a double-tunnel configuration with the klystron high-level RF system in an [illegible] service tunnel.

Safety is a difficult issue to [illegible] safety rules, since an acceptable safety scheme may differ for different sites. We are therefore carrying out studies to determine single-tunnel safety solutions for our full range of potential sites. If we adopt a single-tunnel baseline for the TDP-2, we must recognise that the final tunnel configuration will depend on the chosen site and the preference of the host country. The *Technical Design Report* (TDR) information, along with the RDR double tunnel study, will enable an informed analysis of costs and trade-offs, giving a realistic starting point for the host country.

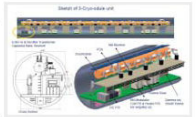
For single-tunnel configurations, two different novel concepts are being pursued for the high-level RF distribution and the choice between them may depend on the actual site characteristics. One approach is to employ a distributed RF system (DRFS). The other is to use a clustered klystron (HLRF) approach. In each case, the total cost is being determined, but we expect both will result in significant cost savings with respect to the double-tunnel RDR configuration.

In a little more detail, DRFS consists of about 8000 times 800-kW modulating anode klystrons (MAK), modulators and power supplies installed in the (single) tunnel. In a MAK, a secondary anode near the klystron gun is used, much like a grid in a conventional tube, to control the tube beam current. [illegible] specifications from the [illegible] around 35 of the [illegible] are located in a surface building and the RF power is combined [illegible] into the underground tunnel, where power is 'tapped off' to [illegible] approximately every two kilometres. The associated risks



RF klystron cluster configuration with serviceable klystron buildings on the surface

[illegible] underway at SLAC, to [illegible] waveguide components, as [illegible] energy control of a [illegible] need to be well understood,



Tunnel view of a distributed RF concept integrated into a single tunnel main linac

[illegible] order to show its feasibility [illegible] a problem for a single klystron driving two or four cavities. The main challenge will be in making the concept cost effective, as well as resolving whether a single 4.5-metre diameter tunnel layout is workable or the tunnel diameter must be enlarged.

Finally, I note that today I am giving a snapshot of work in progress. Other options for distributing HLRF for a single tunnel will be considered, including the XFEL two-kilometre linac design, which will provide the most accurate cost estimate. In the upcoming months, we will be studying both HLRF schemes, whether to include both in our TDP-1 baseline and, if so, to develop a realistic subsequent work plan for the Technical Design Phase.

-- *Barry Barish*

(potential cost savings could be ~ 100 MILCU)… For this reason, we have always planned to come back to study the single-tunnel configurations. One of the primary goals of the present study is to quantify the potential savings and to present realistic concepts for single-tunnel configurations.