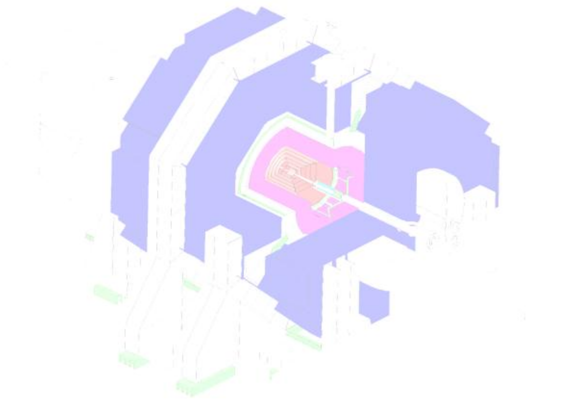
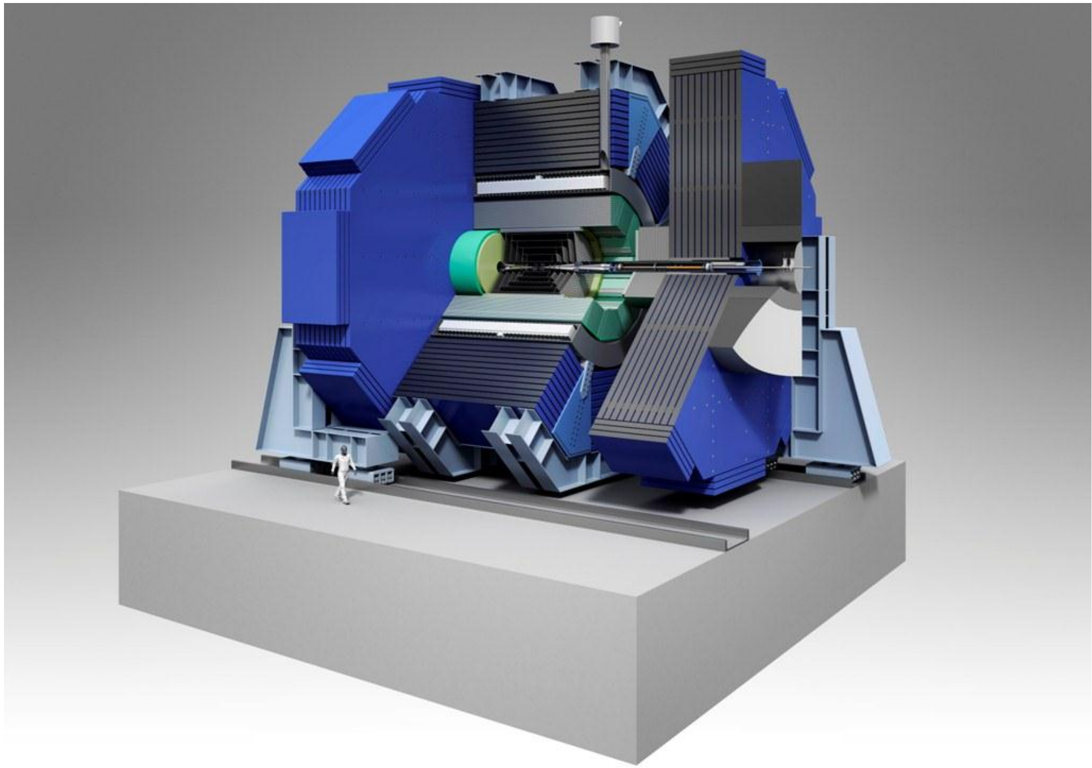


Towards a Physical SiD

Steps towards a project completing in the 2020’s

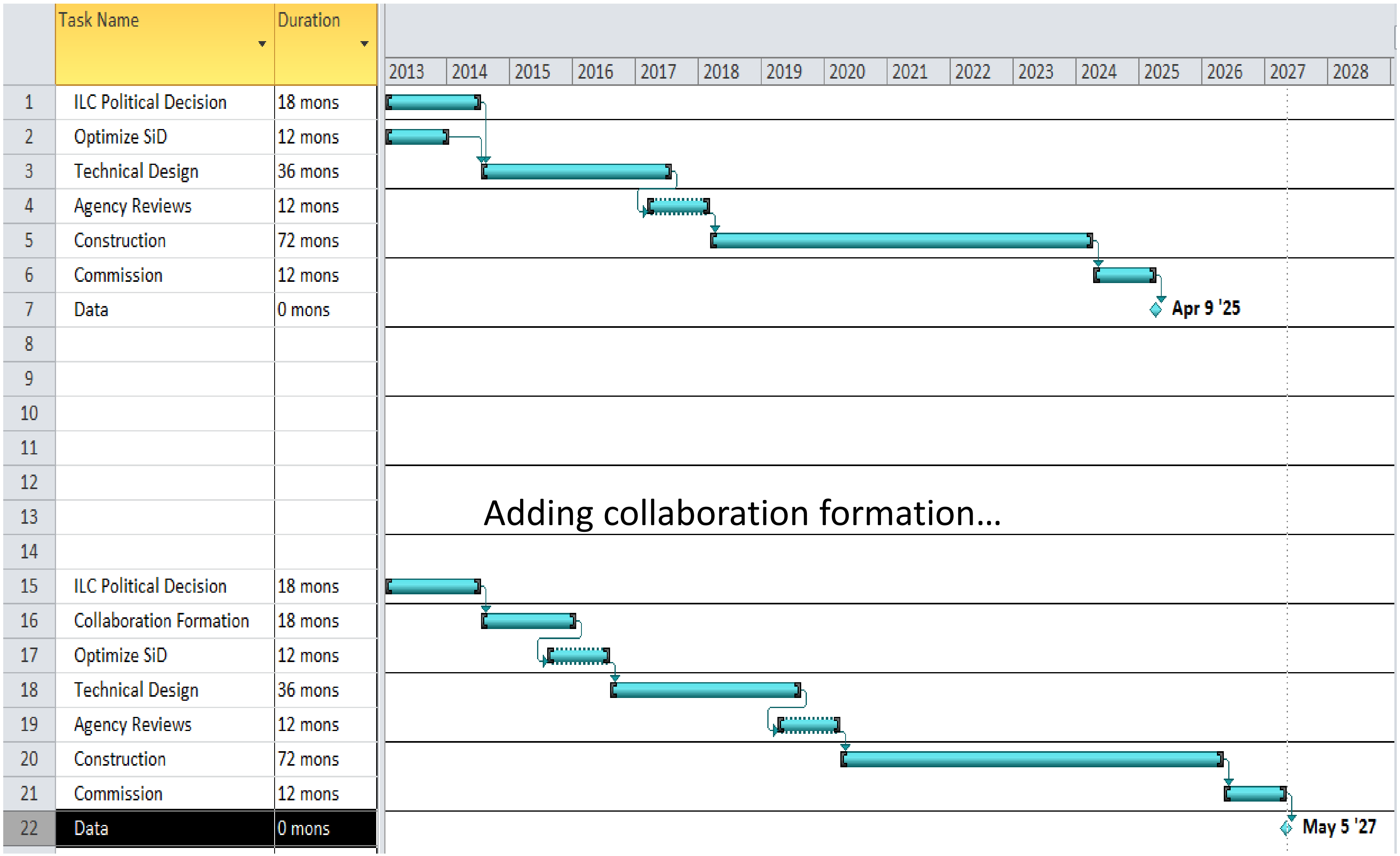


Steps toward SiD

- Some national body (ies) (Japan and collaborators?) commits to linear collider 2013
- Optimize SiD (Only crude optimization for LOI; ~0 for DBD!) Can we lower costs and preserve performance?
- Prepare serious TDR with technical prototypes and serious cost estimate. 3 years: 2016
- Requires a fully reviewed TDR. Assume the review process, with minor iterations, takes 1 year. 2017
- Procurement, fabrication, and assembly: 6 years 2023
- Begin Commissioning

- But SiD is still a concept, not a collaboration.
- We will need technically a collaboration of ~500 people.
- They will have to develop an understanding of all the issues, optimize SiD, and buy into a design.
- This will also take time.

Technically Limited Timeline



Adding collaboration formation…

Some overlap of major tasks possible…

From here to Commitment

- The DBD does not demonstrate significant technical progress since the LOI except for Benchmarking.
- At least the calorimeters need optimization: thicknesses, layer structure, and aspect ratio. ~1-2 physicist years.
- A Technical Design Report should include:
  - Clear baseline choices for all subsystems
  - Final subsystem dimensions & clearances
  - Reasonably complete mechanical designs including tooling
  - Prototypes and beamtests
  - Serious cost estimate
- We presently have < 0.5 Mechanical Engineers total in SiD. This would have to go to 2 FTE's to begin to make mechanical progress.
- In the intensive TDR stage, this should be ~10 FTE's + similar number of designers.
- The Electronic Engineering is in better shape.
- System Engineering (Interfaces) needs serious effort, particularly cryogenics interfaces . Japanese codes (e.g. radiation, B fields, seismic, transport, etc) need to be studied. Need to encourage US-Japan collaboration proposal.

Critical Issues for Mechanical Engineering

1. The SiD Solenoid:

- Iron structure and supercoil – have a pre-conceptual design. R&D is ~stalled on interesting aspects such as better superconductors and stabilizers.
- Japanese mountain sites require iron engineering & optimization study of segmentation for:
  - Transport
  - Assembly including handling fixtures
  - Integration of muon system on surface
- The integrated dipole seems difficult. ILC should confirm there is no beamline optics solution.
- The design can not progress beyond this until the inner radius and length of the solenoid is settled.
  - This requires optimization of the solenoid.
  - This is not an engineering choice, but a physics and cost issue.
- The Exoskeleton should be revisited. Is it needed?

Critical Issues for Mechanical Engineering

2. Machine – Detector Interface

- There is ~1.5 m radial difference between SiD and ILD. The SiD platform is 3.8 m thick. The platforms appear to add a year to the construction schedule. Revisit platforms??
- SiD L* = 3.5 m; ILD L* = 4.5 m. BNL design dimensions for the SiD QD0 are needed.
- Support and vibration issues need continued work.
- SiD needs seismic study.

Critical Issues for Mechanical Engineering

3. Mechanical Engineering is in short supply
   - Fermilab is reducing its commitment to SiD.
   - SLAC is down to <1 FTE
   - Annecy and Argonne are occasionally seen at the engineering meetings for some HCal effort.

Critical Issues for Mechanical Engineering

4. It is believed – within the engineering group – that while there are *plenty* of other difficult problems to work on, they do not have the impact or logjam effect of optimization.

- There is an enhanced effort on MDI issues at SLAC. We will try to focus them on Critical Issue 2 – Support of the detector, quads, and vibrations and costs.

Engineering – Detector Subsystems

- Beamline:
  - Adequate conceptual design.
  - Impedance issues that can generate wakefields and heating have been checked.
  - Synchrotron radiation issues seem ok.
  - Vacuum design seems ok.
- Vertex Detector:
  - Minimal conceptual design for modeling.
  - Little ongoing work on support structures, power and cooling, which may make the modeling of multiple scattering and dead regions somewhat optimistic.
- Tracker:
  - Adequate conceptual design for modeling.
  - Conceptual design for support mechanics.
  - Need to understand Lorentz force issues from pulsed power and cable design.
- EMCal:
  - Adequate conceptual design for modeling. (But may not be optimized; CLIC work suggests 20 layers adequate for PFA)
  - Mechanical prototyping of structure using relatively small tungsten sheets has stalled.
  - First trials indicate some problems bump bonding KPiX. (Work active for beamtest)
  - Need work on assembly strategy. Current estimate is extremely labor intensive. Robotics?

Engineering – Detector Subsystems

- HCal:
  - No settled conceptual design.
  - Active efforts in PFA work.
  - Critically need outer dimensions of barrel and endcap for solenoid and iron engineering.
  - Radial cracks between modules are apparently accepted, documentation may be weak.
  - The actual detector choice is secondary to the mechanical engineering issues as long as it fits in the allocated space.
  - Cost may well be an issue.
- Solenoid:
  - In principle CMS approach is ok.
  - Might be significant cost improvements with advanced conductor R&D.
- Muon System:
  - SiD has changed baseline to scintillator.
  - Conceptual design probably stalled waiting iron segmentation design.
  - Need conceptual design for SiPM readout.
- BeamCal:
  - Minor mechanical engineering issues.
  - Needs sensor development!

Critical Issues for Metrology

- The SiD push-pull concept relies on a design that minimizes stresses on (primarily) the tracker and vertex systems so that there is little relative motion, *and* a metrology system able to measure any motion to the required precision needed to avoid beam based re-calibration.
- The key technology is a Frequency Scanning Interferometer (FSI) able to make absolute measurements of about a meter to an accuracy of ~ 1 micrometer in air between a fiber optic launcher and a corner reflector. This work was not initially supported by DOE, but now may be. *Progress is too slow for a critical component of SiD.*
- In addition there are higher precision systems contemplated for locating the QD0's (Mona Lisa, etc). Since the FSI's should be able to locate the quads well enough for Beam Based Alignment to work, the case is not as strong as for the FSI's.

Critical Issues for Electronic Engineering

- None!
- Issues for Electrical Engineering (excluding sensors):
  - Continue evolution of KPiX, including consideration of time structure of warm machines.
  - Continue evolution of Beam Calorimeter readout chip.
  - Support prototype work, including readout planes for gas detectors.
  - Evaluate concepts for front end powering, e.g. DC-DC conversion.
- Defer:
  - Continued design of DAQ. Existing ATCA – RCE conceptual design is adequate, will profit by delay. This assumes uniform architectures of the front end systems (except for the vertex detector).
  - Note that SiD will not have a hardware trigger. (A warm machine may need consideration of a trigger)

Integration Issues

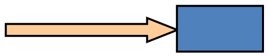
- MDI issues are real, but are believed workable.
- The Self Shielding concept has had another round of Fluka testing, and appears to be conservative. There are schemes for hinged Pacmen to work with both detectors.
- The vertex detector is being treated as a moderate integration issue. The beampipe conceptual design accommodates the SiD vertex detector design, and appropriate space within the tracker volume is allocated. Details can be worked out once a sensor strategy is selected. This could be quite late.

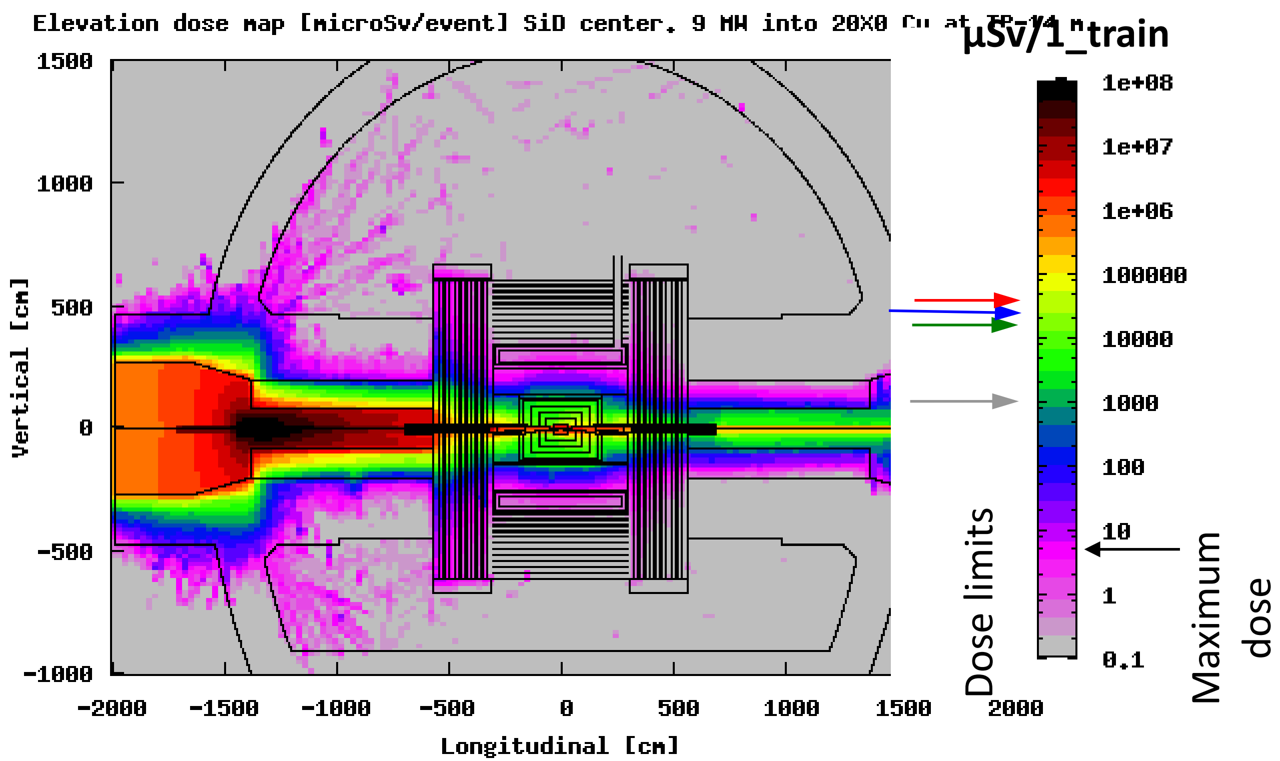
Detector Strategic Work

- Review and document:
  - Radiation shielding properties of SiD.
  - Magnetic field leakage
    - Identify any orientation issues for power transformers, motors, etc.
- Seismic – Japan has very significant seismic activity. Understand interplay of platform, detector, and beamline. Japanese codes?
- Detector Alignment procedures:
  - How will initial assembly alignment be done?
  - Conceptual design of FSI networks.
- Internal detector services
  - Space assignments for electronics, power conversion
  - Preliminary cable routing
- Develop better understanding of interfaces and Treaty points with ILC.

20 R.L. Cu target in IP-14 m. Large pacman.

9 MW





- The maximum **integrated dose** per event is ~8 µSv << 30 mSv
- The corresponding peak **dose rate** is ~140 mSv/h < 250 mSv/h

Integration Issues

- The tracker and EMCal baseline approach is to use KPiX chips with local connections to Primary Concentrators which will transition to optical signal transmission and handle low voltage power distribution.
- There is no genuinely accepted solution for the HCal sensor and readout scheme. This is a cost and DAQ – event building/filtering issue.
- The service penetration requirements for SiD have had a first look, and seem quite modest. Another study will be needed when the magnet end door concept settles down.

Cost

- There has been a heroic effort by ILC over the past few years to reduce costs, resulting nominally in “SB2009”.
- There has been no corresponding effort by SiD.
- Historically there was a strong effort to keep a cost cap, but that evaporated in the push for the LO I. There was an explicit effort to optimize the detector using Mark Thompson’s parameterization of PFA performance vs R_{trkr}, B, and Hcal λ against the SiD parametric cost model. However, there was no cost cap. This was crude! There has been no subsequent optimization.
- In ILC costing, the answer is:

	LOI	DBD
– M&S Base	$238M	$309M
– M&S Contingency	$88M	$116M
– Engineering Labor	206 MY	187 MY
– Technical Labor	613 MY	553 MY
– Administrative Labor	25 MY	30 MY

Costs – Is this Reasonable?

- In US accounting, assuming we start construction in 2017; 3.5% inflation; and DOE National Laboratory labor rates, this corresponds to $877M.
- Is this reasonable and rational going forward – particularly in view of the cost consciousness of ILC?
- Will there be (more) pressure to move to a single detector?
- If so, are we better off being a bit more modest?
- We need a mechanism to make some rational decisions…
- Will this be a LCO issue?

Costs – Are they right?

- To a reasonable extent, there are two semi-disjoint exercises in generating the SiD cost estimate:
  - Calculating quantities of a material or service – e.g. how many tonnes of iron.
  - Estimating unit costs – e.g. how much does a tonne of machined, painted, QC'ed, delivered iron cost.
- The quantity calculations have been done largely by one person. They need to be checked. Each review has found errors. There is no rational reason to believe all have been found!
- The unit costs have been studied and agreed upon between SiD and ILD. This does not make them correct!! The sensitivities to unit costs for the major items are indicated in the following by showing the effect of doubling the assumed unit cost:

Unit Cost Sensitivity

Item	Nominal Unit Cost	ΔSiD Base M&S Cost (M$)
Magnet Iron (finished and delivered)	$6/Kg	48
Tungsten (powder alloy) plate	$180/Kg	14
Si Detector	$6/cm^2	79
Hcal Detector (sensor)	$12000/m^2	42

There may be little basis to adjusting these numbers to be "correct" – but there seems to real value in both detectors using the same values

Conclusions

- There are "technical" and "philosophical" issues that must be resolved before significant forward progress on SiD:
  - Detector (but particularly calorimeter) optimization
  - HCal sensor & readout decisions
  - What do we do (if anything) about the SiD cost?