S2 Task Force Status (String test definition)

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- Reasons for a system test
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Overview

- Task force set up by the Global R&D board
  - **What are the reasons and goals of a system test? Start with TRC R2 list.**
  - **Determine how many RF units are needed as a system test before ILC construction**
  - **Do they need to be in a string?**
  - **Is beam needed?**
- We were just getting started in July at the Vancouver meeting
- Nearly finished now. Expect final report by early January.

Members

- Hasan Padamsee (Co-Chair)
- Tom Himel (Co-Chair)
- Bob Kephart
- Chris Adolphsen
- Hitoshi Hayano
- Nobu Toge
- Hans Weise
- Consultants: Sergei Nagaitsev, Nikolai Solyak, Lutz Lilje, Marc Ross, Daniel Schulte

Process

- The task force's work has been open.
- A few non–members have attended some meetings
- Wiki page available off the linearcollider.org website via the Global R&D board wiki or at: http://www.linearcollider.org/wiki/doku.php?id=rdb:rdb_external:rdb_s2_home

Process

- Followed 2 paths:
  1. **What do we want to test in a system test? How big a system is needed for each test? Is beam required? Has it been done or can it be done at TTF?**
  2. **What is the scale of the industrial effort and how will this provide a smooth transition to the start of main linac construction? Do the modules produced in this effort need a system test or does it produce so many RF units that we may as well use them in a system test?**
- Then compared results and made an overall plan

Process: 1. Reasons for test

- Review TRC R2 goals and revise them
- See what tests/ test facilities are presently planned FLASH (TTF-II), SMTF (ILCTA@FNAL), XFEL and STF
- Determine total amount of equipment planned or existing

The LIST

- Made a list of things that needed testing.
- Started with TRC R2 list.
- Spreadsheet with full list of 31 items is on our wiki page.
- Some items only need testing because of changes made or planned since TTF.
- Not all items MUST be tested. There is a cost/risk trade-off to be considered.

The LIST: Items too big to be practical

- Checking that DFS steering really controls the emittance growth would take well over 10 RF units with best RF gun as beam source.
- A full check of cryogen flows and controls requires a 2.5 km string (partial test can be simulated with much less)
- Checking that cavity misalignments don’t cause emittance growth

The LIST: Statistical effects where more is better and enough is too many

- Checking reliability is as good as required could require full ILC.
  - **Some aspects best tested in standalone stress tests (tuner motors, feedthroughs…)**
- Dark current
  - **Depends on statistics of number and location of emitters.**
  - **Can calibrate and check simulations of radiation/heat load due to captured dark current.**
- Long term testing of cryomodules to evaluate degradation or other weaknesses before large scale series production begins
  - **e.g. HOM failures in SNS caused by end wall heating due to field emissions. TTF has seen no degradation.**
- **We cannot for-sure find all potential problems, but can reduce the phase space**

The LIST: Items that can be fully tested

- Check what gradient spread can be handled by LLRF system. This test should be done with and without beam loading.
- Check for heating due to high freq HOMs
- Check amplitude and phase stability
- Check static and dynamic heat loads
- **Note that all of the above can be done with 1 RF unit**

The LIST: Most important reasons for a system test

- Do a system integration test with near final components and full gradient to demonstrate it works.
- Check for alignment problems caused by forces from the cryomodule interconnect.
- Check for beam deflections and cryo-load from HOMs (both trapped and propagating).

Industrialization needs

- Looked at how previous high tech projects have been industrialized
- Made sample cavity/cryomodule industrialization plans
- Counted how many cryomodules we may have as a function of time.
- Industrially produced cryomodules will clearly have to be tested either individually or in a system test.
- With present plans to industrially produce cryomodules in all 3 regions, test facilities will be needed.
- At least one test facility will need ILC like beam.

Industrialization timing

- Looked at industrialization of SSC, RHIC, LHC magnets and LEP cavities
- Some items we looked at were industrialized well before project approval. SC wire and Niobium sources for cavities are examples of this.
- Some items we looked at were prototyped in the labs and transferred to industry after project approval. LEP cavities and all the magnets are examples of this.
- It is yet to be decided how ILC cryomodules will be industrialized. Suspect S2 will be reconvened to make these plans. We have not considered the size of facilities needed to test the production cryomodules.

Decision Making Method

S2 DRAFT conclusions

- The TTF facility at DESY has provided a valuable system test of many elements of the ILC technology. More tests can and should be performed there. The XFEL will also provide valuable experience.
- However, several important changes to the TTF design are being planned for the ILC. These include a higher gradient, relocation of the quad, shortening of the cavity end-group, and a new tuner design. Also under discussion are different modulators, klystrons, cavity shapes, and other things.
- **The minimum size system test needed to confirm the performance of such a new design is a single RF unit (3 cryomodules) with ILC like beam. As many tests are statistical in nature, a larger test or multiple tests would be better.**

S2 DRAFT conclusions

- All three regions have expressed a desire for command of basic ILC SCRF technology and are preparing to manufacture cryomodules locally. Local test facilities at the scale of 1 RF unit are under construction in Asia and the Americas. In addition to TTF and XFEL, Europe has submitted an expression of interest for an ILC RF unit test facility at CERN.
- **As construction of the project starts, a larger second phase system test will be needed to check the final manufactured components. One of the possible scenarios is to build a test linac with contributions of a total of several RF units from the three regional teams of the final consolidated ILC linac system design. It is S2's intention to make recommendations on the suitable scale of this effort by the time of its final report.**

Rough Schedule

Phase	Completion date	Description
0	2005	TTF/FLASH, not final cavity design, type 3 cryomodule, not full gradient, has beam
1	2008	1 cryomodule, not final cavity design, type 3 cryomodule (and/or) STF type cryomodule, not full gradient, no beam
1.1	2010	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	2011	1 RF unit (replacing cryomodules of phase 1.1), final cavity design, full gradient, type 4 cryomodules, with beam
1.3	2012	1 RF unit (replacing cryomodules of phase 1.1), final cavity design, full gradient, type DFM cryomodules, with beam
1.4	2012	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
4	2018	First 2.5 km of ILC

Final steps

- Draft report sections are due Nov 30, 2006.
- Expect final report in early January
- After completion of the S2 report. Studies of industrialization aspects will need to be started in earnest. Test facilities associated with industrialization will also need to be defined. The RDB has already discussed extending the S2 task force to examine these issues.
- No good deed goes unpunished.