ilc newsline

3 MARCH 2011

DIRECTOR'S CORNER

Preparing for SCRF industrialisation

by Barry Barish

Developing a realistic plan for cost-effective production of the large number of ILC superconducting cavities and cryomodules is perhaps our most challenging task in preparing for the *Technical Design Report*. A new round of visits to industry is aimed at informing that effort.

FEATURE

European detector experts join in the AIDA chorus

Scientists gather at CERN to launch the new AIDA project, a plan to ease collaboration among Europe's particle physics institutes

by Barbara Warmbein

European accelerator and detector sciences kick off the AIDA project, a four-year plan that will allow easier coordination and collaboration among the continent's particle physics institutes.

AROUND THE WORLD

Tumbling opens possibilities

Fermilab scientists develop a method of ultra-fine polishing for the interior walls of accelerating cavities.

by Leah Hesla

A Fermilab team places water and pebble-like materials in a niobium accelerating cavity and spins it around like a carnival ride. As they do, they hope to perfect the recipe for achieving not only a high gradient, but a mirror-like finish every time.

IMAGE OF THE WEEK

US labs featured at AAAS Exhibit Fair

Image: Reidar Hahn

Many ILC-affiliated laboratories were represented at the Exhibit Fair at the annual meeting of the American Association for the Advancement of Science held in Washington D.C. from 16 to 20 February

IN THE NEWS

From From BBC News
28 February 2011
LHC 'has two years to find Higgs'
"If we don't see it after this two year run it means that something is perhaps not the way that we think it is, either the Higgs search itself had to be amended in some way or some of its indirect evidence may be pointing us in the wrong direction," said Professor LeCompte.

From Time
28 February 2011
Dark Energy: Was Einstein Right After All?
James Braatz and Cheng-Yu Kuo have measured the distance to galaxy NGC 6264 to an accuracy of 450 million light-years from Earth, give or take 9%. That's crucial, because while it's simple to measure how fast a galaxy is moving, you also need to know exactly where it is.

From CERN Courier
23 February 2011
CERN launches AIDA project
The particle detectors developed in the AIDA project will be used in a planned upgrade to the LHC; at the proposed International Linear Collider, which will study the Standard Model of physics and beyond with higher precision; Super-B factories, which aim to understand the matter–antimatter asymmetry in the universe; and neutrino facilities.

From CERN Courier
23 February 2011
Women in science through the decade
To celebrate the 100th anniversary of the first International Women's Day, we look at the crucial role that women have played in nuclear and particle physics during the past century.

From CERN Courier
23 February 2011
ECFA extends its linear collider study for another three years
…the future relies on the successful start of the LHC and discoveries there. This implies that the international linear-collider community should be ready by 2012 to propose a viable project for a machine with two detectors.

CALENDAR

UPCOMING EVENTS

End Station Test Beam (ESTB) Workshop 2011

BLOGLINE

24 February 2011
Fermilab
The Future of Fermilab

SLAC
17 March 2011

2011 Linear Collider Workshop of the Americas (ALCPG11)
University of Oregon, Eugene, Oregon, USA
19- 23 March 2011

2011 Particle Accelerator Conference (PAC'11)
New York Marriott Marquis Hotel, New York, NY, USA
28 March- 01 April 2011

UPCOMING SCHOOLS

Joint US-CERN-Japan-Russia School on Particle Accelerators
Course on Synchrotron Radiation and Free Electron Lasers
Ettore Majorana Foundation and Center for Scientific Culture, Erice, Sicily, Italy
06- 15 April 2011

View complete calendar

PREPRINTS

ARXIV PREPRINTS

1102.5147
Testing Higgs portal dark matter via *Z* fusion at a linear collider

1102.4402
Top quark rare three-body decays in the littlest Higgs model with T-parity

FEATURE

European detector experts join in the AIDA chorus

Scientists gather at CERN to launch the new AIDA project, a plan to ease collaboration among Europe's particle physics institutes

Barbara Warmbein | 3 March 2011

European detector development infrastructures get organised under AIDA.

When a project has the musical name AIDA but is all about organising the future of detector technologies for particle physics, metaphors from the world of opera only go a certain way. It is therefore understandable, if a bit of a pity, that the 80 European institutes involved in the project decided to gather for their kick-off meeting (rather than the premiere) and refer to their host Laurent Serin as Scientific Coordinator rather than as conductor. They met at CERN in February and will be working on advanced European infrastructures for detectors at accelerators (thus the name AIDA) for the next four years with a budget of 26 million Euros, eight of which will be from the EU under the Seventh Framework programme.

The kick-off meeting marks the official beginning of the project that focuses on European infrastructures, networking activities and joint research projects for detector development – specifically for detector technologies for future particle accelerators like the linear collider, the upgrade of the LHC, Super-B factories or neutrino experiments. Conductor-coordinator Laurent Serin was happy about the 125 registrants at the meeting: “It is great to see people coming together, in some cases for the first time, ready and enthusiastic to collaborate and advance detector development,” he said.

If the detectors and their developers are the actors, the infrastructures are the stage set that puts them in context and breathes scientific life into them – test beams, beam telescopes, labs and all those other facilities that every lab and institute would like to have but cannot necessarily afford.

A special AIDA leitmotif is the promotion of transnational access, which means that researchers can apply for travel grants, free use of facilities and in some cases even a daily allowance to test their systems in the AIDA facilities. Test beams at CERN and DESY and irradiation facilities at CERN, in Belgium, Slovenia and Germany are on the menu.

Many talks during the kick-off meeting made it clear that AIDA is like an enhanced encore to the EUDET project that ended last year. Many successful projects continue during the four years of AIDA, including for example the development of a prototype for an ILC time projection chamber (TPC). The magnetic field needed to test the TPC and its readout modules under (almost) real-life conditions had been shipped from Japan to DESY under EUDET. Under AIDA it will travel back to Japan for an upgrade that will make its cooling system easier to handle: as a magnet designed for a balloon-borne experiment it featured a helium system that was self-sustained but also complicated and work-intensive. It will now be fitted into a cryomodule that will ensure safe, easy and efficient operation for the many future user groups, and after six months of modification and shipping around the world it is supposed to be back in the test beam at the beginning of 2012.

AIDA also tackles an area that fits snugly into one of the most important challenges for the linear collider – industrialisation of mass-produced components. Detector developers work together with industry to find the best existing technologies, create new ones and search for the best way to produce them. First steps were taken live during the kick-off meeting because an industrial event on silicon photomultipliers took place at CERN at the very same time.

ILC NewsLine will follow the AIDA project and its highlights and results in future issues. The curtain has only just been raised…

Read more about the project in *ILC NewsLine*:

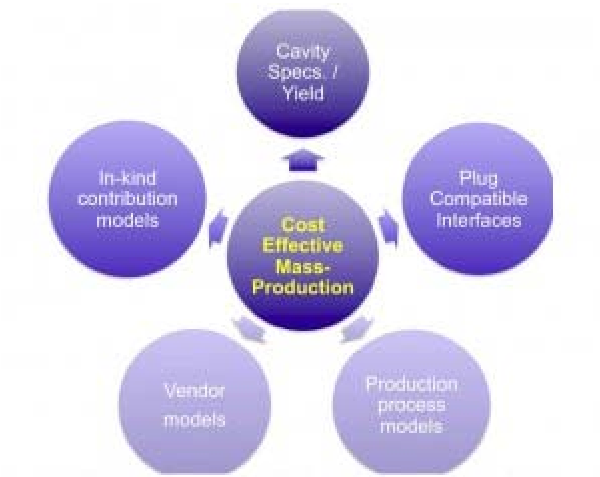
- EU projects get musical
- Returning victorious

AIDA | EUROPE | EUROPEAN UNION

DIRECTOR'S CORNER

Preparing for SCRF industrialisation

Barry Barish | 3 March 2011



The key elements involved in cost-effective SCRF production.

The Global Design Effort (GDE) was created by the International Committee for Future Accelerators with the specific mandate to develop a design for the ILC based on superconducting radiofrequency acceleration. One of the earliest goals of the GDE was to pursue an aggressive R&D programme to develop high-gradient cavities. We set an ambitious goal of 35 MV/m, and in 2010 we achieved the major milestone of producing 35-MV/m cavities with 50 percent yield. Now, our goal has shifted towards refining the process of reliably producing high-gradient cavities, as well as working toward developing a cost-effective industrial capability worldwide.

Last year, GDE Project Managers Marc Ross, Nick Walker and Akira Yamamoto visited industries around the world in order to familiarise potential vendors with the detailed technical issues that are involved in producing high-gradient superconducting cavities. Those visits were quite useful in aiding technology transfer to industry and informing us better about the capabilities and issues for industrial vendors.

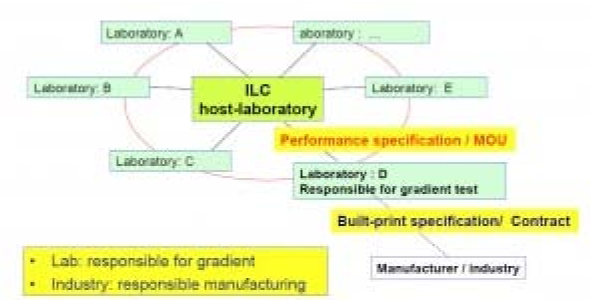
We have recently begun a second round of industrial visits that are aimed at facilitating the development of cost-effective mass production of cavities and cryomodules for the ILC. The primary cost driver for the ILC is production of roughly 2,000 operational high-gradient cryomodules. Making this process cost-effective is one of the most important objectives of the GDE as it prepares to produce the *Technical Design Report*. The scheme we develop will guide future R&D and be the basis of the costs included in the TDR.

The GDE project managers, led by Akira Yamamoto, have developed an informative report to accompany their industrial visits. In it they list several key themes that need to be developed in order to prepare for industrialisation and for making a reliable cost estimate:

- Cavity and cryomodule gradient specification and projected production yield (laboratory's responsibility)
- Flexible technical specification based on a 'plug-compatibility' concept with interface definition and specifications (as requirements for manufacturers)
- Production process and industrialisation models
- Models for international cooperation, including in-kind contributions from nations and/or laboratories

A central goal of our R&D programme has been focused on the first theme, and we have recently had good success at achieving high gradient. We will now work towards refining the processes involved in order to obtain, we hope, a yield approaching 90 percent during the next phase of the TDR preparations. In addition, we have also developed the plug-compatibility concept (see second point above) to enable each contributing institution to optimise their process for delivering subsystems. This concept is being tested in a real-life situation for the S1-Global tests at KEK. We are now increasing the efforts specified in the last two bullet points, which will be essential for worldwide production of the SCRF main linac cryomodules components. Lastly, we must strive to develop plans for production that will be very cost-effective.

The ILC Project Advisory Committee emphasised this last point in their technical review last autumn. They suggested that we look at developing a model for mass production similar to what was done for the LHC magnets. In that case, as much performance risk as possible was assumed by the laboratory; industry was relied upon to



A schematic view of production, such that industry assumes responsibility for manufacturing and the ILC laboratories assume responsibility for performance.

produce the components to specifications. Although this scheme requires far more from the laboratory in terms of integrating the components and taking responsibility for performance, it enables industry to do what it does best within minimum risk, and that is to build components to well-defined specifications. We believe this approach will considerably reduce costs from the present level where industry is assuming more performance responsibility. For that reason, we are extending the dialogue with industry to better understand how they would like to approach mass-producing SCRF cryomodules.

It may seem early to work on optimising the production process, but it will take a concerted effort and time to develop a reliable and cost-effective scheme for constructing the SCRF main linac. We believe the present scheme, which is to develop our plan in close collaboration with industry, will help us accomplish this goal. It will therefore also better enable us to be able to reliably estimate the cost of the main linac for the ILC *Technical Design Report*.

GDE PROJECT MANAGERS | INDUSTRIALISATION | SCRF | SRF INDUSTRIALISATION

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AROUND THE WORLD

Tumbling opens possibilities

Fermilab scientists develop a method of ultra-fine polishing for the interior walls of accelerating cavities.

Leah Hesla | 3 March 2011

Spatterings, pits, defects in weld beads – these are the thorns in the sides of many a newly minted accelerator cavity, marring their interior walls and getting in the way of healthy accelerating gradients.

Scientists at Fermilab are testing a new method of removing these blemishes from superconducting radiofrequency cavities. It's called centrifugal barrel polishing, and the team hopes it will yield a consistently reproducible mirror-like finish, and so consistent cavity performance.

"What we're doing is similar to the process of polishing gemstones," said Fermilab's SRF Materials Group Leader Lance Cooley. "We're making shiny jewels."

A mirror-like finish was achieved on a single-cell cavity after the tumbling process.

Of course, with niobium cavities, the purpose is not to turn the cavity's inner wall into shimmering eye candy. The fewer surface imperfections inside the cavity, the more easily a particle beam will accelerate from one end of the cavity to the other.

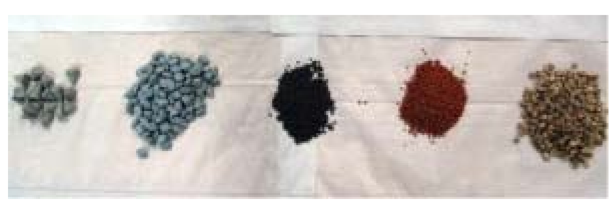
Charlie Cooper proposed the method – known more familiarly as tumbling – as a potential cavity-polishing method at Fermilab. He has been testing various fine-polishing procedures over the last year. Approaching cavity-polishing from a metallographic standpoint, he set out to develop a process that would be environmentally friendly, safe and repeatable.

His efforts extend past procedures tested by DESY's Waldemar Singer and KEK's Kenji Saito, who tested mechanical polishing that would remove 120 to 150 micrometres' thickness from the cavity wall. They laid the R&D foundation for mechanical bulk removal of metal, which shaves off cavities' deep pits and other defects.

Cooper's team added further fine-polishing steps that, so far, result in a finish smoother than those obtained after the final electropolishing steps of the ILC baseline procedure. The final tumbling step, which utilises a colloidal silica, is key to the mirror-like finishes currently obtainable. Early results show that tumbling can bring cavities to an average roughness on the scale of mere tens of nanometres (the average height of the various bumps and craters over a specified area of the metal). Very preliminary tests also show that tumbling can help cavities achieve gradients that would satisfy the ILC baseline requirements.

The active ingredients in tumbling are abrasive polishing materials, called medias. Themselves jewel-like in their myriad colors, their various densities and shapes are appropriated for different degrees of mechanical polishing.

The medias fill half the cavity's volume. The cavity is placed horizontally into the barrel of a tumbling machine, which can hold up to four nine-cell cavities. The barrels revolve around a central shaft 115 times every minute. Individual barrels simultaneously rotate at the same speed around their own axes, turning in the direction opposite the main shaft's rotation.



Medias are tumbled inside the niobium cavities. The grey cones (far left) are a plastic with aluminum silicate, used for bulk removal. The powder blue media (second from left) are

As the cavities spin, the medias inside them slide against the inside wall to remove material. The types of medias, their sizes and their force against the wall determine the removal rate.

ceramic abrasives, useful as a first-pass media. A hardwood cut into small cubes (far right) is also a useful abrasive.

"It's like sanding a piece of wood," Cooper said. "You're putting abrasive material inside the cavity, but you're doing it in a three-dimensional geometry."

So far Cooper's team has tumbled 1.3-gigahertz single-cell and nine-cell cavities as well as 3.9-GHz single-cell cavities. Their goal is to consistently polish the cavities to acceptable accelerating gradients.

In one test, they subjected a nine-cell cavity with a 200-micrometre pit to intermediate-level tumbling, scouring out the defect and so bringing the accelerating gradient from 19 megavolts per metre to 35 MV/m and a quality factor above 10^{10}.

Another result came from a virgin single-cell 1.3-GHz cavity. After an intermediate-level tumbling polish, the cavity achieved just more than 40 MV/m. Nearly up to that gradient value, the cavity maintained a quality factor just above 10^{10}.

The tumbling machine (left) can hold two nine-cell accelerating cavities, rotating them up to 115 turns per minute. The rinsing device (right) washes the media out. Cavities must be absolutely free of any extraneous material after tumbling.

Though the results come very early in the rigorous testing process, they are motivating. The team is working towards the goal of replacing the more elaborate, acid-intensive and costly electropolishing steps of the current ILC baseline. So far, a final, very mild electropolishing has been applied to tumbled cavities as a precaution, but they hope that this too could be simplified or removed.

They are currently cold-testing cavities to see the effects of the mirror-like finish on accelerating gradient and quality factor. The results will help to further tune the tumbling process.

Though tumble finishing is a common practice in industry – tumbling is used for refinishing auto parts, for example – those practices are typically meant to polish the outsides of things, not the insides. For that reason, among others, Cooper had to develop a different approach to tumbling rather than adopt industry wisdom.

"I obtained many different medias and tried many different recipes – I did a lot of cooking," Cooper said.

Scientists will apply tests of tumbling to cavities at different stages in the polishing process. In the future, they also hope to extend tests to various rinsing methods and to cavities of a shape or frequency different from the ILC-type cavities.

"I'm surprised that in a few months Charlie has taken some rocks and created a pretty nice system for polishing cavities," said Cooley.

CAVITY TESTING | CENTRIFUGAL BARREL POLISHING | FERMILAB | POLISHING | TUMBLING