

Collaboration With CERN Drives LINAC Innovation

OCT 03, 2014

The European Spallation Source and CERN begin their seventh year of formal collaboration with the installation of a high-power klystron modulator at a CERN testing facility.

LUND and MEYRIN — This past summer an important milestone was achieved in the collaboration between ESS and CERN, marking the technical advancement of both institutions. ESS developed and procured its first high-power modulator (pictured below), and together with CERN personnel, it was certified and installed at a CERN test facility.

'This [collaboration] gives us more options, and more back-up options for the future,' said ESS Project Leader and Head of Accelerator Division Mats Lindroos. 'It allows us to establish facts about present design work and prototyping.'



Assembled klystron modulator.

RF test stands

Modulators are high-voltage electrical pulse generators that supply power to radio frequency (RF)-amplifying klystrons. They are the power packs for an accelerator's energy beam. CERN will use the modulator, together with a new cryomodule they are producing in parallel, to conduct tests for the purpose of developing their potential future Superconducting Proton LINAC (SPL), a major long-term initiative at CERN. ESS will also use the RF test stand in the development of its accelerator.

With the modulator and klystron installed, the CERN test stand awaits the completed cryomodule and other components, with the first high-power RF tests scheduled for 2016.

'Evidently we would all very much like to have some power through a 704MHz klystron (and beyond) as part of the status," says CERN engineer David Nisbet, 'which I believe could happen in the next month or two.'

Additionally, ESS has launched a project to create a similar RF test stand to be located at Uppsala University, north of Stockholm. A supplier has been found for a modulator specified at twice the average power of the one at CERN. It is presently in the technical design stage, and scheduled for delivery at the end of 2015. This will be the next important step toward peak power at ESS.

While this project began in late 2010, the formal collaboration between ESS and CERN was initiated in October 2008. Colin Carlisle, former Director General of ESS, and Robert Aymar, former Director General of CERN, signed the agreement. CERN at the time was interested in accelerating its SPL R&D, while ESS was focused on gaining valuable experience for its personnel. This modest beginning established the framework for future collaborations, and some 20 successive addenda to the original agreement have led to joint development of technology prototypes, new models for procurement of components, and significant knowledge transfer between the organizations.

Addendum 10

Addendum 10 is the rubric under which the modulator and cryomodule are being developed. It was signed in December 2010 and has been managed jointly by Roland Garoby, then in charge of R&D for the anticipated SPL at CERN, and at ESS by Lindroos.

Specifically, the addendum calls for the design and construction of a four-elliptical-cavity cryomodule and its installation in the SM18 test place at CERN, a facility for testing superconducting magnets. For that purpose, the cavities, the cryomodule, and all associated hardware are designed and ordered by CERN and affiliates. CERN also invests in the upgrade of the RF and cryogenic infrastructure of SM18, and purchases a 704 MHz, 1.5 MW klystron. For its part, ESS provides extensive support for Fellows and works to develop and procure the klystron modulator from industry.

The underlying purpose of the addendum is twofold: to push forward the development of a new cryomodule for CERN's SPL, while at the same time to move toward a test environment that is up to spec for ESS's high-powered LINAC components. 'With 1.5 MW,' says Garoby, 'the CERN test stand will provide the highest RF power at 704 MHz, precious for testing prototype equipment required by ESS couplers, for example.'

Additionally, the modulator installed by ESS at CERN is the first step toward the development of what will ultimately be required to generate the 5 MW of power specified for the ESS accelerator.

'Most of these devices require unprecedented ratings or performances at a worldwide scale,' says Carlos Martins, the ESS power converters engineer in charge of developing and procuring the modulator. 'In particular, the demanding requirements for the modulator

have placed this component among the most challenging parts to be procured and developed.”

The modulator was enough of an outlier, in fact, that the chosen supplier did not have sufficient electrical power to certify the device. The Factory Acceptance Testing had to be done at CERN, where this past July Nisbet, who previously worked on powering the LHC accelerator, and fellow CERN engineer Sven Puetz took it upon themselves to test the modulator at full power. This confirmed the modulator’s successful development exactly three years after the Invitation to Tender was issued, and three and a half years after Addendum 10 was signed.

Procurement milestone and knowledge transfer

‘This project has marked an important milestone for the accelerator division as the first successful procurement process directed entirely by ESS,” says Martins, who was assisted at ESS by Christine Darve, Anders Sunesson, and RF Group Leader David McGinnis, as well as senior procurement officer Malcolm DeSilva. ‘ESS and CERN have gained further expertise in the procurement of such complex accelerator systems and have an early assessment of the existing industrial capabilities.”

Another important result of this agreement has been the movement of people between CERN and ESS. At least three key members of the ESS technical staff have come from CERN over the course of this collaboration, while ESS has financed the tenure of several Fellows at CERN. Martins was a section leader at CERN, and Lindroos himself is a CERN alumnus who was seconded by ESS several years ago. Garoby has recently made a transition to ESS, after 36 years at CERN, assuming the role of ESS Technical Director on October 1. Together they will continue the challenge of developing the ESS accelerator to its unique, high-power specifications.

‘This agreement was extremely important to get started,” says Lindroos, speaking of the umbrella agreement between the two institutions. ‘At the time, [Deputy Head of Accelerator Projects] Steve Peggs and I were the only technical people [at ESS]. It was very important for credibility, doing development, and forming a network. It was an important factor that enabled me to come to ESS, where I wanted to be.”



The modulator at CERN after completing the full power FAT. From L to R: David Nisbet, CERN section leader for Fast Pulsed Converters, Carlos Martins, ESS power converters engineer responsible for the modulator project, and Sven Puetz, CERN project Engineer.

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