Work Package 7: 30 GHz structure development

Introduction

Both main-linac accelerating structures and drive-linac decelerating structures, the latter referred to as 'PETS', have demanding high-gradient, high-power and wakefield performance requirements. The nominal performances, 560 MW power production and 150 MV/m accelerating gradient, have been identified as key feasibility issues for CLIC and demonstrations of such performances are among the most important objectives of CTF3.

The main constraints on structure performance come from rf breakdown, pulsed surface heating and beam dynamics – effects that make the performance goals challenging. Progress towards achieving the design performances is being made through a combination of rf design innovations and through technological developments, especially through the use of new materials.

Development of both accelerating and PETS structures has been a long standing priority of the CLIC study, which has acquired a considerable expertise in the design of the structures. The adoption of new materials such as refractory metals on high electric field surfaces and copper alloys such as CuZr on surfaces subject to high magnetic fields, however presents numerous new technological issues which require specialized knowledge well beyond the capabilities of the current CLIC study. Collaborators are required to make these new technological developments, integrate them into full structure design and participate in demonstrating full power production and accelerating gradient.

Work package 7.1, Accelerating structure development

The accelerating structure development program during the past few years has established the computation tools necessary to simultaneously consider all of the major relevant physical effects of peak surface electric fields, pulsed surface heating, short range wakefields and higher order mode damping. The overall design of the structure and integration with main linac beam simulations is now underway. Certain subjects, such as optimization of the power coupler, of the higher-order damping waveguide terminations and thermal/mechanical computations are available for collaboration. Experimental investigations into rf breakdown and pulsed surface heating which could lead to an improved implementation into the structure design process of physical limits would also be extremely important. Development of computational tools for rf breakdown is an extremely ambitions, but potentially extremely profitable, area open for collaboration.

Time schedule : ongoing 2004-2009
Resources : CERN MTP

Work package 7.2, Transfer structure development

Many aspects of the PETS structure design mirror those of the accelerating structures, and the comments made for work package 7.1 apply here as well. An added complexity of the PETS structure is that it is over-moded. More effort is need in the development of experimental techniques for the measurement of over-moded structures.

Another aspect of the PETS structure development program is the fabrication of 14 structures for the two-beam linac in CLEX, work package 6. Participation in the design, fabrication and testing of these structures is requested.

Time schedule : ongoing, proof-of-principle prototype for 2007, TBL PETS for 2008
Resources : 2.5 MCHF and 7 man. years

Work package 7.3, Structure technology development

Three of the most important new developments in the structure design program are,

- the use of refractory metals in high electric field regions,
- the use of copper alloys such as CuZr in high magnetic field regions,

- assembly of structures in quadrants rather than disks which requires ultra-high precision, multi-axis, three-dimensional milling.

Finding, adapting and integrating technologies for our 30 GHz high-gradient rf application represents a substantial, and well coordinated, engineering and technical effort for which we require one or more partners. All of the issues, such as forming, joining, surface and vacuum preparation, which are well known for pure copper (which is usually used for normal-conducting rf structures) must be adapted to the new materials.

Some specialized experiments have been started in order to speed progress on breakdown and pulsed surface heating by complimenting rf tests, which are expensive, infrequent and often limited in time. They are

- a dc spark test,
- a laser induced pulsed surface heating test,
- an ultra-sonic fatigue test.

These tests will allow a pre-selection of candidate materials, development of preparation techniques and insight into the physics of the effects under study. Collaborators are requested, and these activities are particularly relevant to experts outside accelerator physics such as solid state, materials and plasma physicists and engineers.

Time schedule : ongoing 2004-2006
Resources : 0.5 MCHF and 12 man.years