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No.

TEST REQUEST

Title: LC- Longitudinal profile diagnostics

Date: 16 March 2006

Spokesman: George Doucas
Address: Dept. of Physics, Univ. of Oxford, UK
Telephone:
Email: g.doucas@physics.oxford.ac.uk

Purpose of Test:
see attached pages

Description of Test Apparatus:
see attached pages

Beam Requirements

Momentum: 28GeV (see attached pages)

Particles:

Rep Rate:

$\Delta p/p$:

Space Requirements (include sketch): see attached pages

Special Power Requirements: none

Duration of Test and Shift Utilization:

Desired Calendar dates: as early as possible in 2007

- -

Note: The following signatures indicate notification but do not imply final approval, which will require schedule and safety reviews.

Test Beam Coordinator____Date: __________________
Radiation Physicist____Date:__________________
Chairman, SOC____Date:__________________
Area Manager____Date: __________________
Accelerator Dept. Physicist_____________________________________Date: __________________

- -

<u>Program Coordinator</u>
Action: Approve/Disapprove/Defer Signature___________________________Date:___________
Remarks:

Test beam request

Title: LC- Longitudinal profile diagnostics
Spokesman: George Doucas

Date 16 March 2006
Tel: +44 1865 273313
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Introduction

Calculation of the 'beam-beam' effects in the context of the International Linear Collider, (ILC) will require knowledge of the bunch profile, both in the transverse and in the longitudinal dimensions. We are developing a technique for the determination of the longitudinal (time) profile. This is based on the wavelength distribution of the coherent radiation produced through the interaction of the bunch with a periodic structure (Smith-Purcell radiation). In principle, any radiative process could be used for this purpose, but SP radiation offers some distinct advantages: the radiated power is ample, the process does not interfere with the beam, and the experimental set-up can be made to be simple, compact and robust.

Purpose of tests

The feasibility of the process has been demonstrated at low energies (γ=10) and 14ps long bunches [1]. The results of recent runs at higher energy (γ=89) and 5ps bunches are about to be submitted for publication [2]. We wish to extend our measurements into the GeV regime and even shorter bunch lengths in order to get as close as possible to ILC bunch parameters. The beam parameters at ESA seem to be particularly well-suited to this objective. Recent results from the FELIX facility in The Netherlands have been very encouraging and have suggested some changes to the electronics and the data acquisition system. We propose to test these changes at ESA. We are also making changes to the grating support mechanism in order to improve discrimination against background radiation in the beam pipe. These changes will also be tested at ESA. We see this test as a first in a series of 2-3 runs that will establish the validity of the technique and will provide the basic specification of a prototype device.

Description of apparatus

The device consists of a small vacuum chamber and an array of 11 room temperature pyroelectric detectors that are mounted on the chamber, on the ambient atmosphere side. The chamber will contain four gratings and a mechanism for changing and positioning them by means of a remotely operated motor. The infrared radiation emerges from inside the chamber through a crystalline quartz window, 210x50x6mm. Immediately after the chamber is a vacuum 'cross' with a viewing window and a retractable scintillating screen for the initial positioning of the beam. The total insertion length of the device in the beam line is about 500mm and its transverse dimension is also about 500mm. It terminates, on both sides, in *non-rotating* FC33 flanges.

The electronics and DAQ hardware will be in a single box approximately 220 x 150 x 75mm. It will connect to the detectors on the beam line apparatus by a single fat cable (14 small coaxial cores in an overall braid shield), of length up to 2m (though preferably a bit shorter). It needs to be surrounded with lead bricks, about 150mm

thick. It will have an RS232 serial connection to a laptop PC, and DC power from a low voltage supply, both located in the user area. Connection can be by a single multi-core cable, though a small number of coaxial cables (3 or 4) can be used instead. Cable length up to 50m is no problem, and longer is possible.

Beam requirements

We would like to approximate as closely as possible, the ILC bunch parameters. We assume the following:

1. Momentum: 28GeV, but not critical
2. Bunch length: approx. 1ps
3. Electrons in bunch: 10^{10}
4. Bunch train structure: single bunch, at a frequency of 10Hz
5. Transverse beam size at the centre of our chamber: <2mm

If any of the bunch parameters are going to be significantly different from the above values, we would like to know well in advance.

Requests to SLAC

1. TV camera and support, plus appropriate cabling to the monitor in user area.
2. Lead bricks. An approximate number can be calculated when we know the size of the bricks available at SLAC.
3. Support table for the chamber and lead bricks. The main contribution to the load on the table is going to be the weight of the lead.
4. 5 cables, connecting the chamber to the user area.
5. Triggering signal about 50μs before the beam.
6. 230V power for grating motor (*this is provisional and may not be required*).

Space requirements

The basic space requirement is the insertion length of the chamber in the beam line. The exact location is not critical. We assume that the electronics box will be on the floor, near the chamber and inside its lead brick castle. Some bricks will be placed on the support table, between the beam line and the detectors (see figure).

Collaborators

1. University of Oxford, UK (Wade Allison, Victoria Blackmore, Colin Perry, George Doucas, Brian Ottewell, Michael Johnston)--- all aspects of the experiment.
2. Rutherford Appleton Laboratory, UK (Peter Huggard)--- filter design and testing.
3. University of Essex, UK (Maurice Kimmitt)--- far-infrared detectors.
4. Dartmouth College, (James H. Brownell)--- theory and analysis.
5. SLAC

Duration of tests

4 days. One day for setting-up and 3 days for data taking. *Please note that this experiment requires frequent access to the beam line because we will be changing the far-infrared filters.*

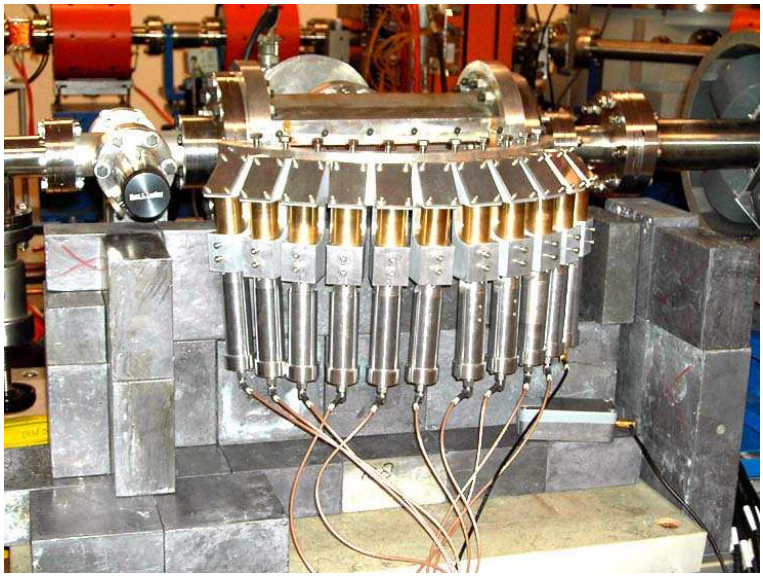
Desired dates

As early as possible in 2007.

References

1. G. Doucas, M. F. Kimmitt, A. Doria, G. P. Gallerano, E. Giovenale, G. Messina, H. L. Andrews, and J. H. Brownell, Phys. Rev. Special Topics-Accelerators & Beams **5**, 072802 (2002).
2. W. Allison et al., 'Longitudinal electron bunch profile diagnostics at 45-50MeV using coherent Smith-Purcell radiation', unpublished, in preparation.

Pictures/Drawing



As installed at FELIX (above) and showing basic dimensions (below)