Draft 27 November 2006

Amendment to the Addenda covering the contributions to the CTF3 Collaboration of the European Organization for Nuclear Research (CERN) and the Budker Institute of Nuclear Physics (BINP)

Joint Development of Superconducting Wiggler Magnets

Introduction

This document amends the Addenda to the Memorandum of Understanding between the Institutions and Funding Agencies of the CTF3 Collaboration ("the MoU") covering the contributions to the CTF3 Collaboration of the European Organization for Nuclear Research ("CERN") and the Budker Institute of Nuclear Physics ("BINP") (CERN and BINP jointly "the Parties"), by defining additional contributions by the Parties.

The BINP Addendum of 23 August 2005 stipulates that BINP shall consider providing superconducting wiggler magnets and other components for CTF3, as required in the future. This Amendment defines the terms of BINP's collaboration with CERN towards the provision of the magnets ("the collaboration"), in the context of the CTF3 Collaboration.

The aim of the collaboration is the development of a short prototype of a superconducting wiggler magnet ("the magnet") and the measurement of its performance. The BINP magnet team is among the leading experts in the world in this kind of technology. This has been demonstrated by many cutting edge wiggler devices designed and constructed by BINP and in use at numerous electron storage rings worldwide.

The projected parameters and performance of the magnet in terms of wiggler period, gap height, maximum magnetic field strength and field quality are beyond the present state of the art. A large part of the effort to develop the prototype will therefore be invested in the magnet design and the development of appropriate production methods, rather than in the final machining and measurement of the magnet.

Scope and value of the work

BINP's contribution

BINP shall be responsible for the development of the magnet, including its engineering, measurement, delivery DDU CERN-Prevessin and any other task, in accordance with the proposal (including milestone dates) laid down in Annex 1 to this Amendment and with any further specification as may be agreed in writing by the Parties. It is understood that in case of contradiction or ambiguity, the provisions of this Amendment shall prevail over Annex 1.

The value of BINP's contribution (excluding the value of materials and production work but including delivery DDU CERN-Prevessin) is estimated at 60.000 € and BINP shall be credited for this amount in the Addendum recording the value of its contribution to the CTF3 Collaboration. It is noted that although it is difficult to estimate the cost of a similar device in European industry, since no directly comparable device has ever been built and no design team with competence similar to the BINP team exist in European industry, it could roughly be estimated at 250.000,- €.

CERN's contribution

CERN shall be responsible for making available the financial resources to pay for the materials and production work, in a total amount of 60.000 €.

CERN shall be credited for this amount in the Addendum recording the value of its contribution to the CTF3 Collaboration.

The CERN contribution shall be paid to BINP through the CLIC budget code 69770 "CLIC new studies".

A first payment in an amount of 30.000 € shall be made when the design has been completed and the written design report has been accepted by CERN. It is expected that this milestone will be achieved six months after the date of this Amendment.

A second payment in the same amount shall be made after delivery DDU CERN Prevessin, and acceptance by CERN, of the magnet, including technical documentation and all measurement reports. It is expected that this milestone will be achieved expected 18 months after the date of this Amendment.

Other provisions governing this Amendment

This Amendment is subject to the provisions of the MoU. For the sake of avoidance of doubt, it is agreed that the rights to intellectual property resulting from the collaboration, including from BINP's contribution, are vested jointly in the Parties, who herewith each grant a free, irrevocable and non-exclusive licence to such intellectual property to the Members of the CTF3 Collaboration, in accordance with article 7 of the MoU.

ANNEX 1

SC WIGGLER PROTOTYPE FOR THE CLIC DAMPING RING
(TECHNICAL OFFER)

1. INTRODUCTION

To achieve high damping rate and low emittance in the CLIC damping ring, a number of damping wigglers will be installed in the long straight section of the damping ring. The emittance simulation including the IBS effect (M.Korostelev, 16/09/2005) has shown the normalized emittance EMBED Equation.3 nm at a betatron coupling of 0.65% for the following wiggler parameters: a peak field of 2.5 T and a period length of 50 mm. Such parameters may be reached only using the superconducting technology.

Below we propose a design of the SC wiggler prototype for the CLIC damping ring.

2. SCOPE OF WORK

The main parameters of the wiggler are as follows:

Conductor	NbTi
Conductor temperature	4.2 K
Period length	5 cm
Vertical pole gap	2 cm
Beam aperture	1.4 cm
Peak field	2.5 T
Prototype length	50 cm

The Offer covers engineering design, manufacture, assembly, testing (in the existing test cryostat) and delivery of the wiggler prototype for the CLIC damping ring.

Particularly, the work includes:

Approval of the wiggler technology. It is planned to install a lot of wigglers on the damping ring and the wiggler design has to be easy-to-produce, reliable and inexpensive.
Design and test of the quench protection system. This problem is important because 2.5 T field amplitude can be reached with high current density in the conductor.
Magnetic field measurement in the existing test cryostat. The test program includes the field map in the wiggler gap, measurement and correction of the first and second field integral, and measurement of the transverse field distribution.
It is planned to find the maximum pole gap for fixed field amplitude of 2.5 T.

3. WIGGLER DETAILS

To reduce the period length for rather high magnetic field and to avoid many interconnections between adjacent pole coils, we propose to wound each wiggler half with a single-piece conductor wire instead of manufacture of a number of individual coils (Fig.1).

Fig.1 Schematic view of the wiggler design.

Two symmetrical iron yokes (upper and lower) together with the fiberglass plastic spool support the single (for each half) coil without any interconnections between the poles. The conductor wire transition (foldover) from pole to pole is performed in a groove cut in the fiberglass spool. Fig.2 and Fig.3 show a preliminary design of the wiggler.

Fig.2 Preliminary general drawing of the wiggler.

Fig.3 Details of the conductor foldover (transition).

Two wiggler halves are spaced by stainless steel spacers in the wiggler gap.

Magnetic flux lines of the wiggler pole are shown in Fig.4 and the longitudinal on-axis field profile is depicted in Fig.5.

Fig.4 Wiggler pole flux lines.

Fig.5 Longitudinal distribution of the wiggler magnetic field.

4. COST AND SCHEDULE

The total cost of the SC wiggler prototype for the CLIC damping ring including the engineering design, manufacture, assembly, testing (in the existing test cryostat) and delivery is 60,000 Euro (sixty thousand euro).

Below is the timetable of designing, production, test and delivery:

Amendment	Week 0
Engineering design (including tooling)	Week 26
Wiggler manufacture	Week 52
Completion of tests	Week 70
Delivery	Week 78

The total term is 1.5 year.