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Work Package Description

FUTURE CIRCULAR COLLIDER

SPECIAL TECHNOLOGIES WP2
CRYOGENIC CHALLENGES

Abstract

This document describes the FCC Special Technologies Work Package 2. The objective of this WP was to identify the challenges, the showstoppers and look towards opportunities for technology breakthroughs.

A feasibility study of the magnetic refrigeration allowing reaching temperature down to 1.6K with a continuous refrigeration capacity of 5 kW and a conceptual design of the proximity cryogenics for the superconducting magnets and the beam screen for FCC-hh are proposed.

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Approval List :

History of Changes

Rev. No.	*Date*	*Pages*	*Description of Changes*

Table of Contents *(not compulsory, can be removed)*

1 CRYOGENICS CHALLENGE

1.1 MAGNETIC REFRIGERATION FOR SC RF CAVITIES

Participant	CERN	CEA				
Person months	**0.5**	3				
Type	STAFF	STAFF				

Objectives

Feasibility study on magnetic refrigeration allowing reaching temperature down to 1.6 K with a continuous refrigeration capacity of 5 kW.

Description of Work, Tasks with associated milestones

Based on its recent development for space applications, CEA/DSM/INAC-SBT will carry a feasibility study on magnetic refrigeration allowing reaching temperature down to 1.6 K with a continuous refrigeration capacity of 5 kW.

Task 1: Deliver a study report on new architectures and technologies for innovative superfluid helium refrigeration at 1.6 K based on magnetic refrigeration.

Deliverables	**Month**
D1. Deliver a study report on new architectures and technologies	**M30**
CERN Resources (Manpower) [Person.Months (PM)]	
STAFF	**0.5**
FELL/PJAS	**0**
PhD	**0**
CERN Resources (Material) [kCHF]	
Travels	**10**

Arbitration decision

Task Completed. Report delivered
(see https://journals.aps.org/prab/abstract/10.1103/PhysRevAccelBeams.20.041001)

1.2 PROXIMITY CRYOGENICS FOR FCC-HH

Participant	CERN					
Person months	**42**					
Type	All types					

Objectives

Conceptual design of the proximity cryogenics for the:

a. Superconducting magnets (FCC-hh)
b. Beam Screen (FCC-hh)

Description of Work, Tasks with associated milestones

Large cryogenic systems must be conceptually designed for the cooling of a 100-km circumference superconducting hadron collider. This collider will be mainly constituted of superconducting bending dipole and focusing quadruple magnets which will produce magnetic fields in the 16-20 T range. The operating temperature of these superconducting magnets is not defined yet and an operating temperature of 4.5 K or 1.9 K must be considered. For each operating temperature, specific cooling and distribution schemes must be defined and optimized. In addition, the collider will be sectorized and the cryogenic power must be transported over distances of up to 7-10 km.
Another important parameter which strongly impacts the cryogenic system is the beam synchrotron radiation which will deposit a specific power of up to 44 W/m in the cryogenic system on dedicated beam screens operating at a temperature around 50 K. For the whole accelerator, the total synchrotron radiation power will reach about 5 MW. Helium or neon has to be considered as cooling fluid of these beam screens.

Task 1: Deliver the PhD thesis on the conceptual design the cooling schemes of the superconducting magnets operating at 4.5 or 1.9 K and of the beam screens, to compare the different cooling and distribution schemes in terms of energetic efficiency and of piping dimensions. **Delivery milestone: 30.09.2016.**

Deliverables	**Month**
D1. Deliver the PhD thesis on the conceptual design	**M36**
CERN Resources (Manpower) [Person.Months (PM)]	
STAFF	**3**
FELL/PJAS	**0**
PhD (Claudio Kotnig)	**36**
CERN Resources (Material) [kCHF]	
Travels	**10**
Material budget for PhD Student	**30**
Arbitration decision	
Top priority. Work in progress. PHD student at CERN (TE/CRG)	

2 MANPOWER & BUDGET

2.1 SUMMARY TABLE

		2016	2017	2018	2019
Manpower [FTE]					
	Engineer (ENG)	*.05*	*.05*	*.05*	
	Technician (TEC)				
	Fell/PJAS (FEL)				
	PhD	*1(1.2)*	*1(1.2)*	*0.5(1.2)*	
	FSU (FSU)				
Material Budget [kCHF]					
	Total				
	Fell/Pjas	*120*	*70*	*80*	
	CEA Grenoble Coll.				
	Material budget for PhD Student	*10*	*10*	*10*	
	AOB (travel..)	*20*	*20*	*20*	
	Used				
	Carry over				