

FCC Special Technologies WP

- The objective of this WP is to identify the challenges, the showstoppers and look towards opportunities for technology breakthroughs.
- Indeed, this last argument will complement perfectly the Physic Cases to get an approval for the next step of the FCC Study.

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FCC Special Technologies WP

Task 11 Radiation Hardness Assurance

(Oct'15 – Dec'18)

- RHA consists of all activities undertaken to ensure that the electronics and materials developed for FCC perform to their design specifications after exposure to the FCC radiation environment.
- RHA deals with environment definition, part selection, part testing, radiation tolerant design, and FCC subsystems requirements.
 - TASK 1 Field conditions and radiation levels at FCC
 - TASK 2 FCC Qualification Protocols
 - TASK 3 Equipment needs for the accelerator, particle detectors and service systems
 - TASK 4 State of the art and development efforts on radhard components for HL-LHC
 - TASK 5 New Technologies: Radiation monitoring systems, Luminosity monitors , Radiation-hard sensors and readout for environmental monitoring (P, T, H) for detector and accelerator equipment, Interconnection technologies reliability, High density assemblies on PCB, New materials for electronics...

FCC Special Technologies WP

Task 11 Radiation Hardness Assurance



BACKGROUND WORK

- **Task 1:** Field conditions and radiation levels at FCC
- **Task 2:** Qualification Protocols: Define FCC qualification requirements (safety factors, sample size, procedures) for components and systems, including particle detectors and FE electronics. Evaluation of current irradiation facilities and testing infrastructure at CERN and available worldwide; proposal of upgrade programs for facilities at CERN, if needed.
- **Task 3:** Equipment needs for the accelerator, particle detectors and service systems. Identification of technologies used at FCC and radiation levels they will be exposed to: propose strategies for RHA taking into account maintenance, reliability and remote operation. Catalogue of critical equipment (technology, supplier, function, etc.) and possible common developments.
- **Task 4:** State of the art and development efforts on rad hard components for HL-LHC.
Intensive work is ongoing in terms of radiation hardening of electronics, components, materials and detectors in the framework of R2E, RD50, RD51, RD53, presently with a main focus on HL-LHC. Cost optimization for electronic systems will most likely have to consider the use of components of the shelf (COTS), thus a respective early technology analysis will be key throughout the development process. Assuring the continuity of these research projects will guide us towards the FCC and assure that expertise in radiation testing/hardening is kept, testing facilities are kept operational and state-of-the-art as well as forefront development electronics is tested and radiation hardened at any point in time. Evaluate HL-LHC VS FCC needs, identify common versus specific developments.

EXPERIMENTAL WORK

- **Task 5:** Technologies: define needed developments linked to technologies: wireless communication, miniaturization, optical transmission, compactness, on-chip optical/electrical, packaging, new materials...
 - Example: i) establish a program to develop miniaturized prototypes, ii) develop prototypes, iii) test prototypes at irradiation facilities to define threshold for miniaturization with respect to radiation hardness
- **Specific system development and qualification:** Radiation monitoring systems (for detector and accelerator areas), Luminosity monitors, Radiation-hard sensors and readout for environmental monitoring (P, T, H) for detector and accelerator equipment, Interconnection technologies reliability, High density assemblies on PCB, New materials for electronics



Goal of today's meeting

Available information	Action	Who
Information about available resources		
Update about ongoing work	Produce a status report for FCC mgt	Mar & Markus
Review of deliverables	Set up priorities, Identify deliverables' owners, review teams Set up regular task meetings	All

Resources

Category	Budget (PM)	Committed @ June16	Remaining months
FELLOW	30	24 A.Infantino (from 1/2/16)	0
PJAS	30	6 m (1/1/16 – 30/7/16)	23
PhD	60	36 G.Gorine EP-DT (from 1/11/15) 24 G.Borghello EP-ESE (from 1/8/16)	0

Category	Budget (kCHF)
FLUKA/TCAD/Spice model development	50
Evaluation of irradiation and testing infrastructure requirements	210
Development of a radiation tester	60
Development of radiation sensor	100
R&D on materials radiation damage	50
	470

Project Status @ Nov 2015



- **Task 1: Field conditions and radiation levels at FCC**

- Resources: Selected Fellow candidate got delayed, **started only as from February 1st** (hosted by EN)
- Progress: work started earlier using resources of the R2E project

- **Task 2: Qualification Protocols and Facilities**

- Resources: **FCC Doctoral student started 1.11.15** (G.Gorine, EP-DT)
 - Evaluation of existing irradiation facilities and adapting them for the FCC qualification program
 - Development of integrated radiation sensor for high energy hadron and mixed rad environment for TID/DD/SEE measurements at FCC

- **Task-3: Equipment needs**

- Resources: PJAS being agreed
 - Communication links and common building blocks -> linked to BE/CO (strategy requirements discussed)
 - Interesting component identified (NDA with company signed)
 - University collaboration established
 - **Ready for PJAS hiring procedure as from autumn 2016**

- **Tasks 4/5: FCC Technologies and HL-LHC efforts**

- Agreement with EP-ESE for **FCC Doctoral Student in 2016 Committee (starting as PJAS asap)**
 - Compilation of available results on rad tolerant state-of-the art electronics
 - Prediction of the radiation response of 65nm technology in a real accelerator environment
 - Tests of 28nm transistors, FINFETs, miniaturization trends

- **Other:**

- Link to WP3 (3.4) -> Pieter van Trappen (iterated through RadWG and first tests to be prepared)

+ Update by Ruben at FCC week in Rome, April 2016
http://indico.cern.ch/event/438866/contributions/1085072/attachments/1257853/1857660/2016-04_Radiation_Hardness_of_Electronics_in_the_FCC.pdf

Work ahead/Deliverables



The FCC study will produce a conceptual design report to be delivered in time for the next update of the European Strategy for Particle Physics, foreseen by 2018.

FCC Task 11	Deliverables	Month	By end of
TASK 1 Field conditions and radiation levels at FCC	D1-1. Evaluation of FLUKA models' needs (environment and effects)	M6	Mar'16
	D1-2. FLUKA tuning for FCC (operational/layout options/requirements)	M12	Sep'16
	D1-3. Agreement on FCC target radiation field/levels	M14	Nov'16
TASK 2 FCC Qualification Protocols	D2-1. Define overall FCC qualification requirements as input to RHA	M12	Sep'16
	D2-2. Evaluation of current irradiation facilities and testing infrastructure	M20	May'17
TASK 3 Equipment needs for the accelerator, detectors, service systems	D3-1. Identification of technologies used at FCC with their expected radiation levels	M14	Nov'16
	D3-2. Catalogue of critical equipment (technology, supplier, function, etc.)	M18	Mar'17
TASK 4 State of the art and development efforts on radhard components for HL-LHC	D4.1 Evaluate HL-LHC VS FCC needs of rad hard components	M20	May'17
TASK 5 New Technologies	D5.1 Prototype status and definition of developments linked to technologies	M20	May'17
	D5.2 Radiation tester_of advanced components/systems	M36	Sep'18
	D5.3 Radiation sensor	M40	Jan'19