
CERN

FCC Special Technologies Workpackage

Task 11: **Radiation Hardness Assurance**

Preparing FCC CDR
https://indico.cern.ch/event/687721/

FCC Special Technologies WP
Task 11 Radiation Hardness Assurance

- 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, evaluation of test facilities
  - TASK 3 Equipment needs for the accelerator, particle detectors and service systems; strategies for RHA taking into account maintenance, reliability and remote operation
  - TASK 4 State of the art and development efforts on radhard components for HL-LHC (assuring continuity: evaluation of HL-LHC VS FCC needs, identify common VSs specific developments).
  - TASK 5 New Technologies: developments linked to technologies: wireless communication, miniaturization, optical transmission, compactness, on-chip optical/electrical, packaging, new materials…

RHA Resources - Personnel

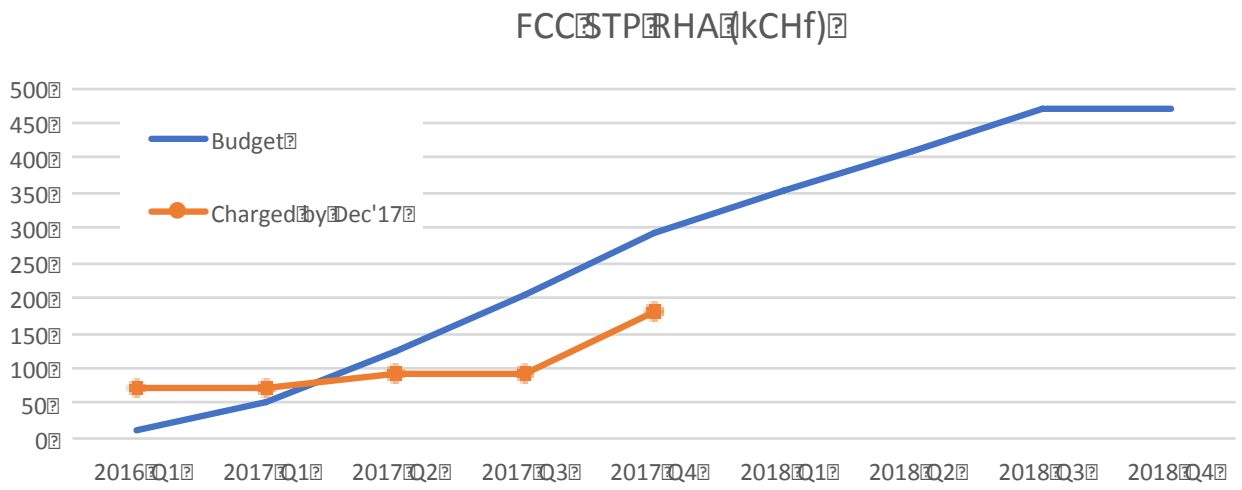
Funded by FCC

Category	Budget (PM)	Committed	Available
Fellow	30	24 A.Infantino EN-STI (1/2/16 – 31/1/19)	36 Approved!
Doctoral	60	36 G.Gorine EP-DT (from 1/11/15) 24 G.Borghello EP-ESE (from 1/8/16)	Ok 36 Approved!
PJAS	30	6 m (1/1/16 – 30/7/16)	

Differences wrt original plan:

- + 6m fellow
- +12m Doctoral
- - 24 PJAS

RHA Resources – Materials (B.C. 10811)



Number	Type	Short Description	Creator	Created	Budget Codes	Total	REAL TOTAL	
6515666	TID	(TID0779632) EPFL Cleanroom Jan-Aug 2016 Gorine	Alessandro Alberto MAPELLI	16.09.16		1878	1878.02	2016
6517325	DAI	FCC Dosimeter Holder PCB	Georgi GORINE	19.09.16	10811	1244	1244	
6524909	DAI	FCC Dosimeter Holder PCB - IDC_to_DB37	Georgi GORINE	25.09.16	10811	95	95	
6563578	TID	(TID0780530) EPFL Cleanroom September 2016 Gorine	Alessandro Alberto MAPELLI	27.10.16		801.79	801.79	
6607998	DAI	PM8 Manual Probe Station for 8" wafers	Georgi GORINE	02.12.16	10811	66377	66377	
6686393	DAI	FCC Dosimeter Holder PCB	Georgi GORINE	13.02.17	10811	1505	1505	Q1 17
6699973	MAG	(BAANQUAL6699973) Components for FCC-RADMON test at LHC	Georgi GORINE	22.02.17		237.64	237.64	
6749539	JOB	(J3039329) (33413/PEZZULLO) EDA-02623-V1-0 RADMON 2012	Marie-Elisabeth MAGNIN	03.04.17		477	477	Q2 17
6760751	DAI	Neutron Irradiation at JSI Triga Reactor	Georgi GORINE	11.04.17	10811	6385	6385	
6824999	DAI	RADTEST_CHIPS - 40 NM	Gert OLESEN	09.06.17	10811	12397	12397	
6906519	TID	(TID0785201) EPFL Cleanroom Sep-Dec 2016 Gorine	Alessandro Alberto MAPELLI	16.08.17		1627.9	1627.89	Q3 17
6962367	TID	(TID0786018) EPFL Cleanroom Jan-Aug 2017 Gorine	Alessandro Alberto MAPELLI	02.10.17		9461.8	9461.8	Q4 17
6979546	DAI	Keithley 4200A for IRRAD Probe Station	Georgi GORINE	12.10.17	10811,33331, 33332,34740	65025	32512.5	
6986894	DAI	RADTEST_CHIPS - GF 40 NM	Konstantinos KLOUKINAS	17.10.17	10811	20974	20974	
6986900	DAI	RADTEST_CHIPS - TSMC 40 NM	Konstantinos KLOUKINAS	17.10.17	10811	23265	23265	
7023411	TID	(TID0786980) EPFL Cleanroom Oct 2017 Gorine	Alessandro Alberto MAPELLI	14.11.17		1429.6	1429.6	

~250K available

In the Budget we foresaw 50K for FLUKA…, 60k for radiation tester…

FCC Week 2018

2 oral
1 poster

Special Technologies sessions

- ✓ Status overview of the radiation hardness assurance studies for FCC (Wed 31/05)
- ✓ FLUKA Monte Carlo modelling of the FCC arccell: radiation environment and energy deposition due to beam-gas interactions (Thu 01/06)
- ✓ Radiation Monitoring Technologies and Irradiation Test Facilities for FCC

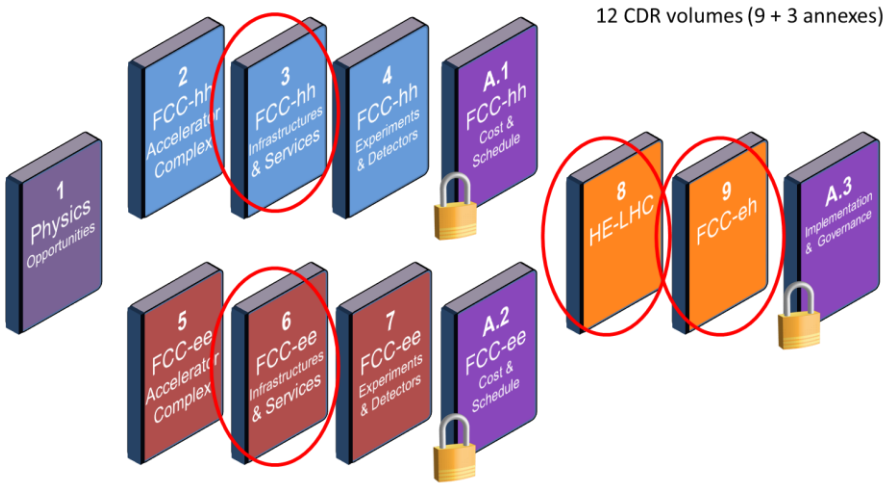
9-13 April 2018 Amsterdam
https://indico.cern.ch/event/656491/

Special Technologies sessions

- ✓ Overview of the radiation hardness assurance studies for FCC - Ruben ? (include facilities upgrade awareness?)
- ✓ Radiation environment assessment in the FCChh and FCCee machines – Angelo
- ✓ Overview of dose response in CMOS technology – Federico/Giulio?
- ✓ Radiation Dependent Resistors: Fluence Monitoring Technology for the Future Circular Collider– Georgi

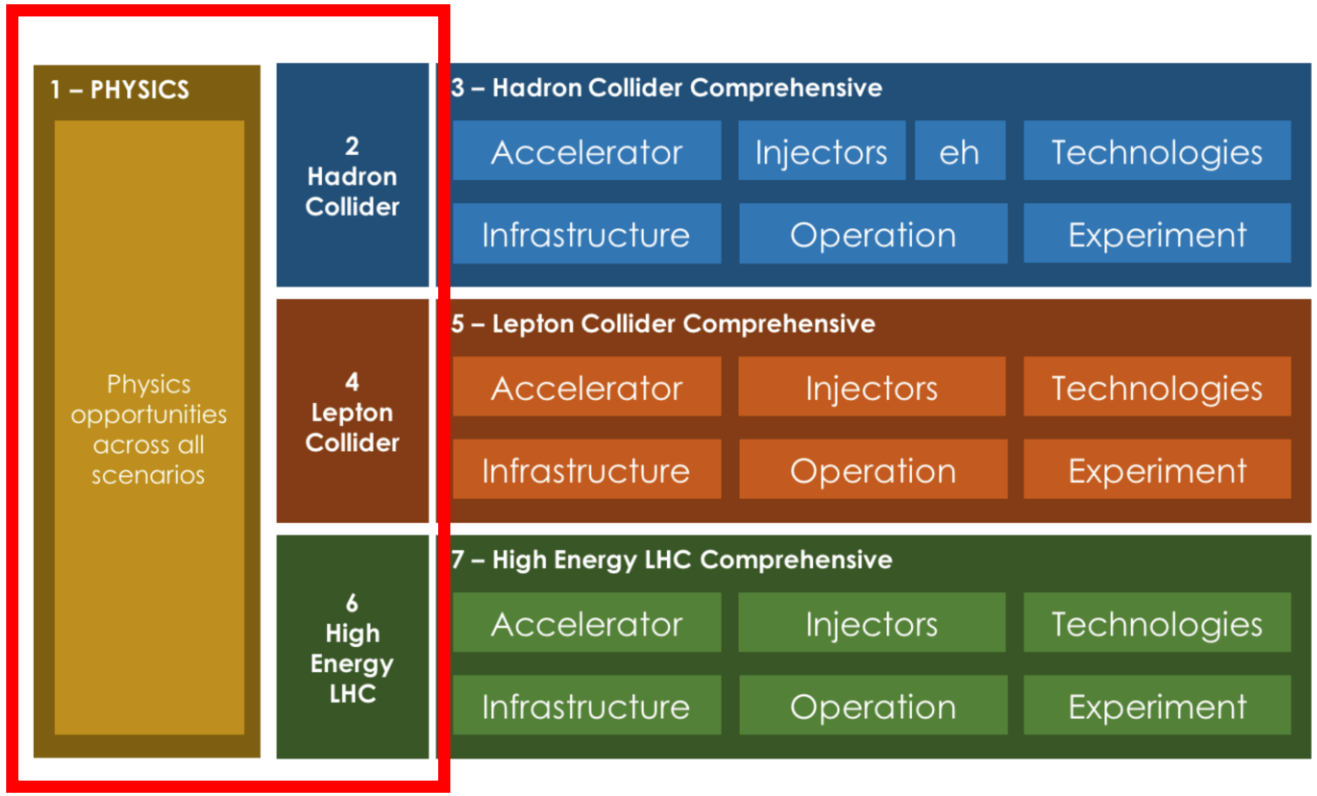
CDR

2016 Proposal



From M. Benedikt's presentation in FCC CGM #39 7.10.2016
https://indico.cern.ch/event/547867/

FINAL



The FCC study aims at producing seven scientific/technical volumes. The priority for November 2018 is **short/concise volumes for** physics, the hadron collider, the lepton collider and the high-energy LHC scenario.
Each of these volumes is supposed to have a core text corpus of not more than 150 pages (excluding front matters, appendices, indices and references).

CDR Timeline 2018

Main Effort period
Deliver content for 1, 2, 4, 6

Period for review of concise volumes 1, 2, 4, 6

Time to work on the long, living versions: vol.s 3, 5, 7

FINAL INPUT to concise volumes

- **January 31:** Draft contents of hh, ee, HE summary volumes ready
- **February:** Editing
- **March 1:** Distribution of summary volumes hh, ee, HE to International Advisory
- **April 9-13:** Contents consolidation during FCC Week
- **May 17/18:** Review by IAC
- **July 30:** Deadline for any input for final version
- **August/September**: Final editing, homogenization, references, glossary, index
- **October**: Print of limited number of paper copies
- **November 22/23**: Publication and presentation

CDR FCC-hh Existing outline

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CDR FCC-ee Existing outline

CDR – Our initial proposal (20-30 pages)

NOW to compress URGENTLY in 2 pages, for FCC-hh and FCc-ee

- **Field conditions and radiation levels at FCC -** 5 pages
  - Documentation of Fluka models, tunnel layout and corresponding radiation maps/levels, assessment of radiation levels on critical areas for electronics.
- **Qualification Protocols -** 5 pages
  - Definition of qualification requirements (safety factors, sample size, procedures) for components and systems, including particle detectors and FE electronics. Limitations of COTS-based designs.
  - Limitations of current irradiation facilities and testing infrastructure at CERN and available worldwide; proposal of upgrade programs for facilities at CERN.
- **Equipment needs and RHA strategies for the accelerator, particle detectors and service systems -** 5-7 pages
  - Catalog of technologies used at FCC and radiation levels they will be exposed to.
  - Strategies for RHA taking into account maintenance, equipment availability and reliability and remote operation.
- **Rad-hard technology trends -** 5-8 pages
  - Communication technologies: Ethernet-based, fiber optic-based and wireless solutions.
  - Miniaturization, compactness, Deep submicron CMOS technologies, On-chip optical/electrical.
  - MGy dosimetry.

CDR – New proposal
Valid for hh and ee machines

- **Field conditions and radiation levels at FCC -** 1 page by ANGELO
  - Documentation of Fluka models, **tunnel layout and corresponding radiation maps**/levels, assessment of radiation levels on critical areas for electronics.
  - Example of few **key technologies used at FCC and radiation levels** they will be exposed

- **Qualification Protocols and RHA strategies for the accelerator and service systems -** 1 page
  - Definition of **qualification requirements** (safety factors, sample size, procedures) for components and systems, including particle detectors and FE electronics. Limitations of COTS-based designs. – SALVATORE & RUBEN
  - **Strategies for RHA** taking into account maintenance, equipment availability and reliability and remote operation – SALVATORE & RUBEN
  - **Limitations of current irradiation facilities** and testing infrastructure at CERN and available worldwide; proposal of upgrade programs for facilities at CERN. – GEORGI and SALVATORE

- **Rad-hard technology trends -** 1 page
  - Communication technologies: Ethernet-based, fiber optic-based and wireless solutions - SALVATORE
  - Miniaturization, compactness, Deep submicron CMOS technologies – FEDERICO&GIULIO
  - MGy dosimetry - GEORGI

CDR – RHA input to Future R&D for accelerators

- Pick key aspects where R&D should be continued, and provide a short justifying sentence
  - Upgrade of irradiation facilities

File format

Figures and images should be provided in a scalable vector graphic format in

- Portable Document Format (**PDF**) file format or
- Encapsulated PostScript (**EPS**) file format.

If an image cannot be provided in vector format, please use **JPEG** for photos and **PNG bitmap** formats for drawings.

Please provide the source files with your graphic files and provide minimal information with which software the image was created.

Example:

File	Description
`collider_layout.pdf`	The collider layout in scalable vector graphic format
`collider_layout.png`	A bitmap graphic version of the collider layout
`collider_layout.ai`	The original graphic file of the collider layout, prepared using Adobe Illustrator

`collider_layout.txt`	A text file describing who created the graphic in which format and with which softare. The format of this information file is as follows:
	
	`AUTHOR: First name, last name`
	`CONTACT: your e-mail address`
	`CREATED: Year-Month-Day`
	`SOFTWARE: Name and version of the software used to produce the image`
	`DESCRIPTION: A brief description of the image`

Dimensions and Resolutions

Figures must **fit into a 16 cm x 24 cm**, ready for printing on A4 portrait layout (210 mm wide, 297 mm high). Images may be rotated by 90 degrees to fit landscape format, but no other text must appear on the page when using this layout. Images must be prepared for a printing resolution of at least **600 dots per inch (dpi) without resizing**. This means that a bitmap file must be about 4'000 pixels wide horizontally.

NOTE: If you put text in a bitmap, consider that at 600 dpi printing, a 10 pt high font should be ca. 80 pixels hight and a 12 pt high font should be 100 px high.

Fonts and font sizes

Use the **Helvetica or Arial sans serif font with 10 pt size in images.**
NOTE: Check spelling and punctuation before you deliver the image.

Colors

While screens use three color components to mix colours (red, green and blue, RGB model), printers use cyan, magent, yelllow and black (CMYK model). Consider this when designing your images and specify colours using the **CMYK model** or export them using CMYK colors. **Test-print** your images on paper **before you deliver** them.

Background must be transparent or white.

Foreground text should be black.