



WP 4: Crab Cavity Ed Ciapala, Erk Jensen BE-RF, CERN

HL-LHC Meeting, CERN, 20 Oct 2010





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		201	LO	2011	2012	2013	
8	LHC operation				Splice Conso	lid.	
8							
8	EuCARD						
8	DS HL-LHC					PDR	
8	Compact Crab Cavity						
8	Validation						
8	Cavity RF Design						
	Design of Couplers						
	Thermal/Mechnical A	Analysis					
	Order Nb & Long-lea	6 m [DS (= nolin				
Fabrication Drawing & tooling DS (preliminary)							
	Fabrication (Cu & Nb	Model	s)				
	Surface Treatment						
8	VIF lesting						
8	Milestone		Com	pact Cavity 1	Fechnology v	validation	





	201	10	2011	2012	2013	2014	2015
LHC operation			Splice Consolid.				C
EuCARD							
DS HL-LHC					PDR	Т	DR
Compact Crab Cavity							
Validation							
Milestone		Com	pact Cavity	Technology v	alidation		
Technical Design							
Conceptual Cryostat							
He-Tank & Tuner Des	sign						
Cryostat Structural A	nalysis						
Fabrication Drawings	& Tool	ing					
Material Orders	se se	ιесι	ed for I	JS (preii	minary)		
Fabrication & Assem	bly						
Test Facility Preparat	ion						
Pre-Series Module Te	sting						
Milestone	Dee	cision	on implem	entation: Loc	al scheme w	ith Compact	cc





	201	LO	2011	2012	2013	2014	2015
LHC operation			Splice Consolid.				Co
EuCARD							
DS HL-LHC					PDR	Т	DR
Project Document							
Elliptical Crab Cavity							
Technical Design							
LOM HOM & SOM couplers							
Helium tanks	Sele	ecte	d for DS	(prelimir	nary)		
cryostat							
Pre-series construction							
cavity with accessories							
cryostat							
clean room assembly							
power tests (SM18)							
beam test SPS							
Milestone	Deci	sion (on implemer	ntation: Glob	al scheme w	ith Elliptical	CC



- WP2 (Accelerator Physics):
 - Impedance and growth rate estimates for specific HOMs to specify exact damping needs and feedback measures,
 - Effect of non-zero dispersion and stable working points,
 - Crab consistent optics,
 - Local doglegs & feedback to control beam transverse position @ CC.
- WP3 (Magnets) Task 3:
 - Dog-leg dipoles for Elliptical Crab Cavities.
- WP5 (Collimation & Beam losses):
 - Tracking simulations for loss maps for fast failure modes,
 - Beam-beam simulations to investigate instabilities, noise issues and DA.

WP4: Possible Tasks (2nd draft)

Tas	k 4.1: Coordination and Communication	
•	Coordination and scheduling of the WP tasks	
•	Monitoring the work, informing the project management and	CERN, LARP, ULANC
	participants within the JRA	
•	WP budget follow-up	
Tas	k 4.2: Support studies	
•	Tunnel preparation SPS and LHC	
•	Local IR layout and spatial integration	
•	Effect of phase noise , LLRF system conceptual design	CERN, KEK, LARP
•	RF power system specification	
•	Operational aspects (how to commission/make invisible)	
•	Interlocks and fast Feedback	
Tas	k 4.3: Compact Crab Cavity design	
•	Complete cavity and cryomodule specifications	
•	Design optimisation for novel schemes	
•	Conceptual design of SOM, HOM and LOM couplers	
•	Conceptual design of helium tank and cryostat	LILANC LARP CERN
•	Multipacting simulations on cavity & couplers	
•	FEM simulations: mechanical & thermal aspects	
•	Initial down-selection of the CC options	
•	Completion of a full technical design on the initial down-selected	
	options, with mechanical drawings and specification.	
•	Design of tooling, dies and cavity fabrication equipment	

WP4: Possible Tasks (2nd draft)



Task 4.4: Elliptical Crab Cavity Technical design	
Coupler development and testing	
Tuner design and mock up on copper models	
Study of mechanical effects: resonances, microphonics.	CERN, CEA, CNRS,
Cavity performance with couplers and horizontal cryostat	KEK
Performance difference between 2 K & 4 K	
Cryostat and He Tank Design	
Complete the full technical design	
Task 4.5: Compact Crab Cavity Prototyping and Test	
Procurement /fabrication of tooling, dies and equipment.	
Construction of models to refine manufacturing techniques and tooling.	
Fabrication of prototype niobium cavity	
• Cleaning and electro-polishing on the bare niobium cavity. (i.e. no couplers,	CERN, CEA, CNRS,
antennas or other accessories), including cavity surface inspection.	ULANC, STFC, LARP
• Development and procurement of all test equipment and instrumentation.	
• Low power tests and measurements on the bare cavity in a test cryostat to	
test for compliance with design gradient and cavity performance specs.	
Make the final CC design down-selection	

WP4: Crab Cavity



First estimate on man-power:



... will have to be revised!

Work package WP4		Start dat	M1						
Work Package title	Crab Cavity Design								
Activity type	RTD								
Participant id	CERN	ULANC	CEA	CNRS	STFC	BNL	FNA L	JLAB	
Person-months per beneficiary:	153	91.8	25.2	60	28.8	30.6	43.8	76.2	
Participant id	LBNL	SLAC	KEK						
Person-months per beneficiary:	10.8	78.6	82.2						

Show Excel: "Crab Cavities for LHC spending profile DS_Oct20.xlsx".



Deliverables and Milestones



... will have to be revised! Here a first draft (too many! Too strict!)

Deliverables	Description/title	Nature	Delivery
of tasks			month
1	Valid proposal on handling machine protection issues		6
	Valid proposal on ensuring an acceptable minimum of		
2	perturbation to normal LHC operation		18
	Specification documents on conceptual design of High		
3	Power and Low Level RF systems.		24
4	Integration drawings for SPS and LHC CC installations		
	Results on expected performance of the different CC cavity		
5	options to allow initial down-selection		28
6	Conceptual design of SOM, HOM and LOM couplers		28
7	Conceptual design of He tank and cryostat for CCs		
	Technical design of a complete elliptical cavity in its		
8	cryostat with ancillaries		36
9	Initial down-selected bare cavities built and tested with RF		48

Mile-	Description/title	Nature	Delivery	Comment
stone			month	
1	Machine protection concerns satisfied		6	
2	Operating scenario during LHC		12	
2	ramping specified		12	
	Initial CC cavity designs down-			
3	selection, leaving at least two CC		28	
	options for prototyping			
4	Completion of technical design of		26	
4	elliptical cavity in its cryostat			
Б	Final CC design(s) down-selected for		19	
5	series production		40	





- Lancaster and STFC planned activities:
- I. Finalise cavity and coupler designs,
- 2. Test a Prototype Nb Cavity without couplers,
- 3. Prototype couplers in copper,
- 4. Design a Cryostat and tuner,
- 5. LLRF modelling (sketchy).

ULANC+STFC initial planning



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	Task Name	2011 2012 2013 2014 2015 2014 2015 2014 2015 2014 2014 2014 2014 2014 2014 2014 2014	▲
1	EUCARD activities		
2	🗆 Compact EM cavity design		
3	Multipactor for Cavity		
4	Preliminary LOM couplers		
5	Preliminary HOM coupler		
6	Preliminary Input Coupler		
7	Multipactor with Coupler		
8	🗆 Mechanical Design		
9	Microphonics		
10	Thermal simulations		
11	Make Dies		
12	Construct Copper Prototype		
13	Mechanical Design LOM Coupler		
14	Construct Copper LOM coupler		
· 15 도			
16 16	LLRF preliminary work		
B 17	LLRF system design		
18	HL-LHC EU Bid		•
19	Cavity Prototype		▼
20	Niobium Prototype		
21	VIC test		
22	Full design of Input coupler		
23	Build prototype comper couplers		
25	Test couplers on conner model		
26	Final Write up		、
27			•
28	LLRF prototype (HL-LHC bid)		
29	Cryomodule Development		
30	Cryostat Design		
31	Tuner Design		
	-		
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Info from JM De Conto:

"We have made a demand, via the French "Grand Emprunt", for the development of Elliptical Crab Cavities. This demand is relative to:

- equipement (RF instrumentation, clean rooms etc) for about 250 k€,
- running costs, maintenance (~6 k € /year over 10 years)
- people: lab installation (1 FTEy) and cavity development (0.5 FTE over 10 years, like high level engineer or post doc),
 in addition to the LPSC people. The demand is shared between two applications: "EQUIPEX" (Equipements d'Excellence) and LABEX (Laboratoire d'Excellence)."

This is complementary to the Design Study in which we will put the accent on the design of the Elliptical Crab Cavity and the Cryostat as well as the prototypes and their tests.





• US Partners:

- existing LARP: BNL, FNAL, LBNL, SLAC
- JLAB

• LBNL (John Byrd writes):

"I wanted to express our strong interest to be involved in the LLRF for this program. Our group has a lot to offer to this program. We are presently designing the LLRF controls for the crab cavity program at the Advanced Photon Source. This is a so-called "local" crabbing scheme with the goal of producing picosecond x-ray pulses. We are very interested in helping the LHC. We will be requesting funding from US-LARP to get involved in this effort."

• JLAB (Jean Delayen) have sent their





Sorry – I haven't progressed here ...