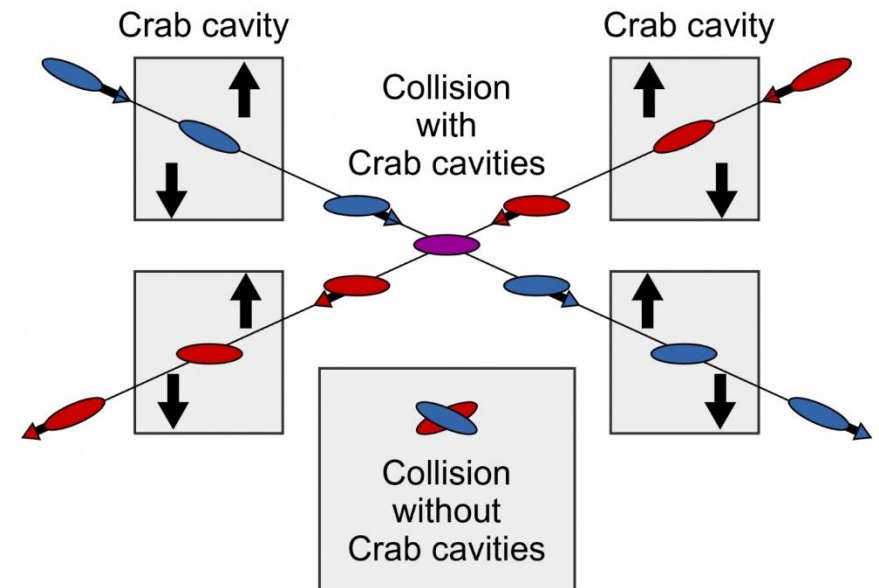


WG2 SRF: WP3 Crab Cavities

Design Review Workshop #3

Peter McIntosh
UKRI-STFC Daresbury Laboratory

21st October 2022



Agenda for Today (GMT)

13:30	Introduction and Remit for the Workshop	Peter McIntosh (STFC)	5 min
13:35	Specification Review	Peter McIntosh (STFC)	15 min
Cavity Design Updates			
13:50	Elliptical/Racetrack	Graeme Burt (Lancaster University)	15 + 5 min
14:10	RF Dipole (RFD)	Suba De Silva/Jean Delayen (ODU/JLab)	15 + 5 min
14:30	Double Quarter Wave (DQW)	Silvia Verdu Andres (CERN)	15 + 5 min
14:50	Wide Open Waveguide (WOW)	Binping Xiao (BNL)	15 + 5 min
15:10	Quasi-waveguide Multicell Resonator (QMIR)	Andrei Lunin (FNAL)	15 + 5 min
15:30	Next Stage CC Preparations	Peter McIntosh (STFC)/K Yamamoto (KEK)/A Yamamoto (KEK)	30 min
16:00	Meeting close		

Preparations for 3rd Design Review

- Assess and compare CC EM designs, not likely finally optimised:
 - Cavity,
 - HOMs,
 - Couplers,
 - Multipacting,
 - Tuning.
- Clarifying then next steps to ‘head towards’ a down-selection process:
 - All EM design aspects complete, including pressure stability and fabrication assessment.
 - Down-select 2 optimum CC designs for future prototype development (external review).
- Final CC down-selection, post-prototype validation at ~18-months later.

As proposed at 1st Design Review – Dec 21

Workshop Remit

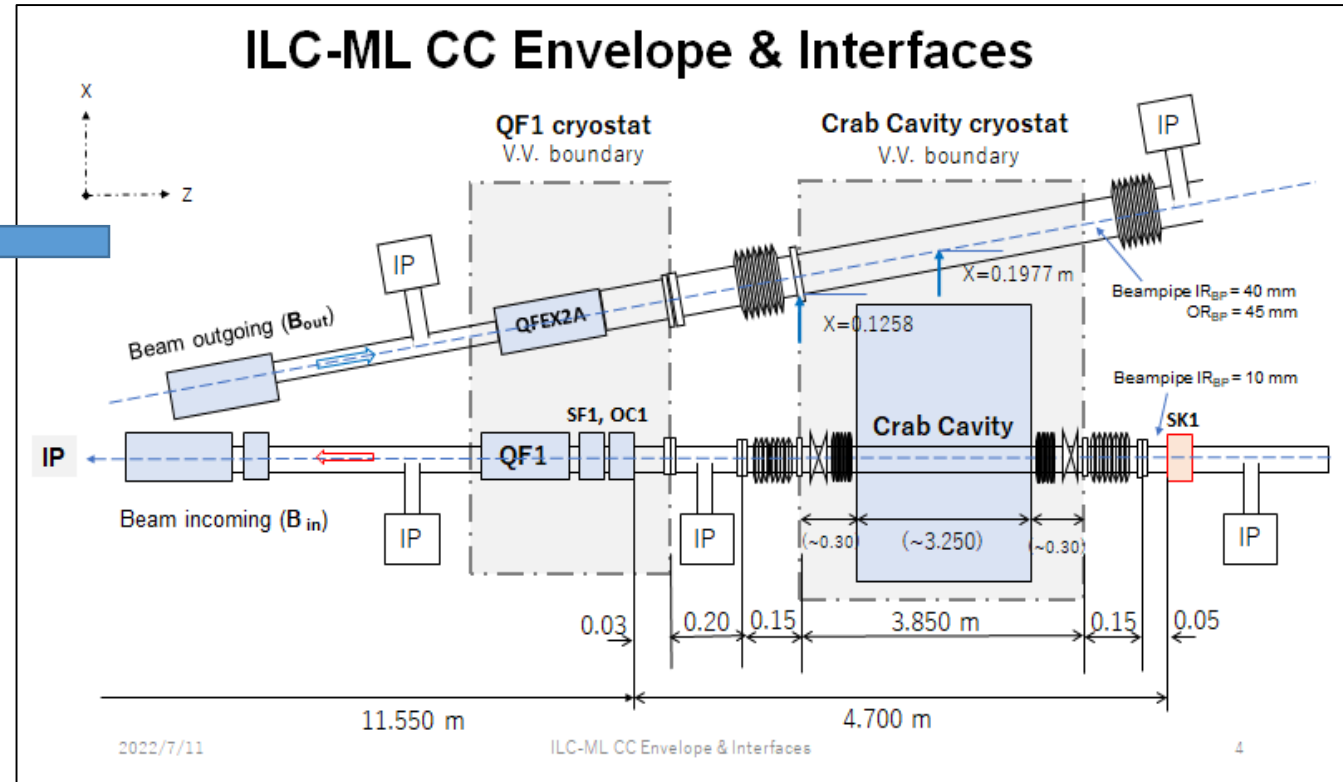
- For WP3 teams to identify progress made with CC designs.
- Identify outstanding issues which may exist regarding specifications as defined (v14).
- **Start populating the cavity parameter list for each of the respective cavity designs.**

CC Design Updates

- Elliptical/Racetrack
 - RF Dipole (RFD)
 - Double Quarter Wave (DQW)
 - Wide Open Waveguide (WOW)
 - Quasi-waveguide Multicell Resonator (QMIR)
- G Burt (Lancaster U)
- S De Silva/J Delayen (ODU/Jlab)
- S Verdu Andres (CERN)
- B Xiao (BNL)
- A Lunin (FNAL)

Specifications Update (v14)

Parameter	Post-TDR Specification	10Hz Upgrade ^{1,2}	1 TeV CoM Spec ²			
Beam Energy (GeV) e-	125		500			
Crossing Angle (mrad)	14					
Installation site (m from IP)	14					
RF Repetition Rate (Hz)	5	10	4			
Number of bunches	1312	2625	2450			
Bunch Train Length (ms)	727	961	897			
Bunch Spacing (ns)	554	366				
Beam current (mA)	5.8	8.75	7.6			
Operating Temp (K)	2					
Cryomodule installation length (m)	3.8 (incorporating gate valves) ←					
Horizontal beam-pipe separation (m)	0.1967 (centre) ±0.0266 (each end of installation length)					
Cavity Frequency (GHz)	3.9	2.6	1.3	3.9	2.6	1.3
Total Kick Voltage (MV)	0.615	0.923	1.845	2.5	3.7	7.4
Max Ep (MV/m)	45			45		
Max Bp (mT)	80			80		
Amplitude regulation/cavity (% rms)	3.5 (for 2% luminosity drop)					
Relative RF Phase Jitter (deg rms)	0.069					
Timing Jitter (fs rms)	49 (for 2% luminosity drop)					
Max Detuning (kHz)	240	170	100 - 180	240	170	100 - 180
Longitudinal impedance threshold (Ohm)	Cavity wakefield dependent					
Trasverse impedance threshold (MOhm/m) (X,Y)	48.8, 61.7					
Cavity field rotation tolerance/cavity (mrad rms)	5.2 (for 2% luminosity drop)					
Beam tilt tolerance (H and V) (mrad rms and urad rms)	0.35, 7.4 (for 2% luminosity drop)					
Minimum CC beam-pipe aperture size (mm)	>25 (same as FD magnets)					
Minimum Extraction beam-pipe aperture size (mm)	20					
Beam size at CC location (X, Y,Z) (mm,um,um)	0.97, 66, 300					
Beta function at CC location (X, Y) (m,m)	23200, 15400					
CC System operation	assume CW-mode operation					



Akira Yamamoto – 19/7

Cavity Parameters

Parameter	Elliptical/Racetrack	RFD	DQW	WOW	QMIR	Units	Nomenclature
Operating frequency	3.9	1.3	1.3	1.3	2.6	GHz	
SOM						GHz	
1 st Longitudinal HOM						GHz	
1 st Transverse HOM						GHz	
E_p/E_t^*							E_t - clarify eqtn (JD)
B_p/E_t^*						mT/(MV/m)	
B_p/E_p						mT/(MV/m)	
G						Ω	
R/Q						Ω	
$R_t R_s$						Ω^2	Assumptions for Rs
V_t per cavity						MV	
E_p						MV/m	
B_p						mT	
Total V_t						MV	
Total No. of cavities							
Active Cavity Length						mm	
Flange-flange Cavity Length							
Number of cells							
Cavity Diameter						mm	
Minimum Aperture						mm	
FPC Q_L							List assumptions used
Bandwidth						kHz	
Cavity Input Power						kW	
Horizontal Kick Factor k_x						V/pC	
Vertical Kick Factor k_y						V/pC/m	
Stored Energy W						J	Assume E_t 1 MV/m
HOM impedance (Longitudinal)						M Ω	
HOM impedance (Transverse)						M Ω /m	
First 3 multipole parameters							

Break Here



Next Stage CC Preparations

For a future down-selection process:

- Agree the criteria to develop for each of the CC designs:
 - Cavity
 - Couplers (input and HOM)
 - Pressure stability and tuning
 - Multipacting
 - Fabrication
 - Anything else?
- What's left to complete for each of the design options currently?
- What are the expected timescales to complete – try and agree/set today?
- What alignment is needed with ILC IDT processes - timescales?
- Context for a proposed down-selection review:
 - Terms of reference to be developed/agreed.
 - Specialist membership – who defines/invites?
 - IDT output anticipated?

MANY THANKS

Questions?