FCC SRF R&D program CDR plan and status

xx

Introduction

9 work packages :

- RF scenarios and parameter layout
- Cavity design and beam - cavity interaction
- Cavity material & performance
- CERN-LNL-STFC Collaboration agreement on cavity material & fabrication
- Cavity fabrication
- Cryomodule challenges
- High efficiency power sources
- Fundamental power couplers
- Low impedance deflecting cavities

"Ampere-class" machine

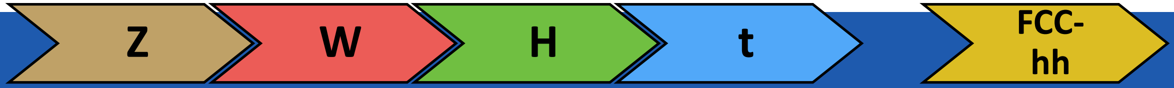
		V_tot (GV)	n_bunch	I_beam (mA)	σ (mm)	E_turnloss (GeV)
	FCC-hh	0.032		500		
FCC-ee	Z	0.4 / 0.2	30180 / 91500	1450	0.9/1.6	0.03
FCC-ee	W	0.8	5260	152	2	0.33
FCC-ee	H	3	780	30	2	1.67
FCC-ee	t	10	81	6.6	2.1	7.55

"high gradient" machine

short bunches

Scope :

- Define "ideal" RF system for each machine
- Propose optimum compromise vs operation and installation timeline



Low impedance deflecting cavities

1. Introduction
2. Development of low impedance devices is crucial for FCC_hh
    a. Design and simulation ✓
    b. Fabrication is ongoing ✓
    c. Nb coating system is under development ✓

- Status and Deliverables:
    - Publications?
    - CDR report
    - Device built and test report

Fundamental power couplers

1. Introduction
   a. Initiative for a coordinated worldwide effort on FPC
2. FCC specific requirements
   a. Road towards high(er) CW power (1MW?) ✓
   b. Need for “adaptable” couplers (i.e. “fixed”, but adaptable to different Qext without breaking cavity vacuum) ✓
   c. Large series production: ≈ several hundreds for FCC_ee high energy and booster ✓

- Status and Deliverables:
  - Description of challenges, perspectives and limits (CDR report)
  - R&D roadmap

High efficiency power sources

1. Introduction
   a. Big machine - > efficiency plot (Erk, Rome 2016)
   b. Each % - > xx MW -> XX MCHF
2. Revolution against the “textbooks”:
   a. HEIKA-phase1 ✓
   b. HEIKA-phase2 ✓
3. Very high efficient FCC klystron demonstrator:
   a. Parameters and design ✓
   b. Mechanical design and fabrication (Thales) ✓

- External collaborators/contributors:
  - ULAN (collaboration agreement)
  - HEIKA
  - THALES
- Status and Deliverables:
  - Description of challenges, perspectives and limits (CDR report)
  - Roadmap towards demonstrator fabrication

Cryomodule challenges

1. Introduction
    a. FCC CM design will be based of existing 2 or 4.5K design (ESS, LEP, LHC, XFEL)
2. Specific topics of interest
    a. Multi-purpose cryomodules ✓
    b. CM cost model ✓

- External collaborators/contributors:
    - Preliminary discussions with JLAB and CEA Saclay
    - Interesting developments at JLAB and possibly BNL and KEK
- Status and Deliverables:
    - Description of FCC specific requirements (CDR report)

Innovative cavity fabrication techniques

1. Introduction
    a. FCC_ee installation and operation timeline pushes for rapid and cost effective cavity fabrication techniques
        i. Ex: W -> H machines, hundred of cavities to be built assembled tested and installed
2. Technology developments
    a. High velocity hydroforming:
        i. Determine forming limits of high-velocity Electro-Hydraulic Forming (EHF) for Cu structures as substrate for superconducting coating (and for bulk superconducting Nb) ✓
    b. Spinning:
        i. Efforts towards seamless cavity fabrication (LNL) ✓

- External collaborators/contributors:
    - LNL
    - STFC
    - BMAX
- Status and Deliverables:
    - LNL 400, 800MHz cavities (on hold)
    - LNL 6GHz cavities + characterisation at STFC (ongoing?)
    - Bmax ?
    - CDR report

Cavity material & performance

1. Introduction
   a. Technology choices and limits
      i. Sarah's Paper (ref..) ✓
2. R&D and perspectives
   a. Bulk Nb:
      i. Performance and limits (reference to ESS, XFEL, …) ✓
      ii. N_doping: (FNAL collaboration) ✓
   b. Nb/Cu:
      i. CERN developments ongoing (Uni Geneva,..) ✓
      ii. *CERN-LNL-STFC collaboration* ✓
      iii. *ECR: JLAB* ✓
   c. A15:
      i. Nb3Sn on Nb (FNAL) ✓
      ii. Nb3Sn on Cu (CERN) ✓
      iii. V3Si (CERN) ✓

- External collaborators/contributors:
  - LNL
  - STFC
  - Uni Geneva
  - FNAL
  - JLAB
- Deliverables: insert list of publications

RF scenarios and parameter layout

Skeleton:

1. Introduction
2. Model description ✓
3. Machine layout (optimization for each machine):
   a. Limiting factors ✓
   b. Design choices and alternatives ✓
4. Staging scenarios:
   a. Timeline: installation and operation ✓
   b. Optimized scenario and options ✓
5. Cost and study model ✓
6. Sensitivity study ✓

- Deliverables:
  - FCC note in preparation (full model)
  - FCC note in preparation (scenarios and layout)

- Example:
  - Here insert an example

Cavity design and beam - cavity interaction (1)

1. Introduction
2. Cavity challenges:
   a. High energy: aim at acceleration efficiency
      i. Number of cells ✓
      ii. Material, frequency, temperature ✓
   b. High intensity:
      i. optimize cell shape with regard to HOMs ✓
      ii. HOM damping schemes ✓
3. Beam dynamic challenges:
   a. Single bunch instabilities (*Juan's analysis, report in preparation)* ✓
   b. Multi-bunch instabilities:
      i. Extension of the simulation tool for Gaussian bunch and synchrotron damping (BLOND) – *done by Juan* ✓
      ii. Study of coupled bunch instabilities for all machine using the improved code – *to be done, Ivan)* ✓
4. HOM heating for all machine – *in progress, Ivan* ✓
5. Impedance budget limits (narrow and broad band)
   a. Resonant build-up - *in progress/done, Juan/Ivan* ✓
6. Analysis of the need for a RF harmonic system – *to be done?* ✓
7. LLRF:
   a. FCC_hh: 25ns - >LHC, 5ns option -> transverse emittance preservation (FCC STP) ✓
   b. FCC_ee: scenario for high intensity operation (see Ph. Baudrenghien, FCC week 2016) ✓

- External collaborators/contributors:
  - Rostock University (FCC_ee high energy)
  - Frankfurt University (FCC_hh HOM damping)

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