

FROM RESEARCH TO INDUSTRY



# WP 2: ARC DESIGN AND LATTICE INTEGRATION

## WP 3: EIR



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EuroCirCol Coordination Committee meeting

9 October 2017

Antoine CHANCE

On behalf of WP2 and WP3 team

CEA, CERN, CNRS, EPFL, TUDa, KEK

CURRENT WORK, NEXT STEPS, SHOWSTOPPERS,  
COORDINATION NEEDS

WP2

WP3

10:15-10:35	Status of the lattice integration	CHANCE, Antoine
10:35-10:55	Status of the dynamic aperture studies	DALENA, Barbara
10:55-11:15	Status of the correction schemes in the arcs	BOUTIN, David
11:15-11:35	Extraction from / Injection into FCC-hh	RENNER, Elisabeth
11:35-11:55	Impedance and single-beam instabilities	BOINE-FRANKENHEIM, Oliver
11:55-12:15	Electron cloud studies	METHER, Lotta
14:00-14:20	Betatron collimation section	BRUCE, Roderik
14:20-14:40	Energy collimation studies	ALEXAHIN, Yuri
14:40-15:00	Collimation losses	MOLSON, James
15:00-15:20	Dispersion suppressor protection	KRAINER, Alexander
15:40-16:00	EIR optics updates	MARTIN, Roman
16:00-16:20	New triplet and EIR optics	VAN RIESEN-HAUPT, Leon
16:20-16:40	Dynamic aperture and nonlinear corrections studies	CRUZ ALANIZ, Emilia
16:40-17:00	Energy deposition studies for new triplet	ABELLEIRA, Jose
17:00-17:20	Energy deposition studies for the baseline EIR	INFANTINO, Angelo
17:20-17:40	Low luminosity IRs	HOFER, Michael

WP3	08:25-08:45	Beam-beam studies	BARRANCO GARCIA, Javier
	08:45-09:05	Beam-Beam Effects, octupoles and Landau damping	TAMBASCO, Claudia
	09:05-09:25	Updates on cross-talk and machine induced backgrounds	RAFIQUE, Haroon
	09:45-10:05	Updates on SR in IR	COLLAMATI, Francesco
WP2	10:05-10:25	Update on Landau damping	KORNILOV, Vladimir
	10:25-10:45	Transverse feedback	HOFLE, Wolfgang
	10:45-11:05	Impedance database	ARSENYEV, Sergey
	11:05-11:25	Warm beam pipe impedance	RIEMANN, Bernard

14 WP2 talks + 10 WP3 tals: total of 24 talks

- New version of the **lattice has been released for  $L^*=40$  m.**
- First and second order optics details can have still a significant impact on DA: **a change of the phase advances between the IP has a significant impact.**
- **Landau Damping octupoles give big reduction of DA 'if no feedback).**
- Preliminary results with new dipole field quality **table v2 gives DA below the target of  $12 \sigma$  at 3.3 TeV injection energy.**
  - **We need to discuss with magnet people if better dipole can be designed.**
- A **global correction scheme** of the residual orbit, the linear coupling and the ring tunes for the arc section of FCC-hh **has been updated**
- The reference tolerances on quadrupole alignment and on dipole b1 give **reasonable orbit correctors strengths**, a quadrupole misalignment of 0.5 mm can be excluded
- The residual orbit and angle are **compatible with the aperture considered** for the synchrotron radiation evacuation
- **More than 10 unit systematic b2 is challenging.**
- **Correction of  $a_{2U} = 1.1$  unit seems to be feasible** with 16 skew correctors per long arc but **residual beta-beating need dedicated correction.**
- We have to refine the coupling correction scheme.

- New  $L^*=40$  m with splitted quadrupoles
- Detailed studies with 2 versions for the inner triplet
- **Alternative with flat beam optics.**
- **Energy deposition, background studies are ok.**
- **DA with triplet errors are ok. Big sensitivity to phase advances.** (gain of  $10\sigma$ )
- Beam-beam studies: studies ongoing with new optics.
  - **Needs for a mask unification** and test cases to check the next releases.
  - Promising results with octupoles with negative polarity
  - Beta-beating is under investigation and correction scheme may need to be explored.
  - Alternative with electron lens for compensation is promising but needs more studies.
- Low-luminosity+injection section design exists and is integrated.

- Betatron cleaning at top energy
  - **Cleaning efficiency** and energy deposition in cold magnets under control
  - **Energy deposition on collimators and warm magnets**: some open points but good hope to solve them in next iterations
  - **Aperture at injection is not sufficient**— several ideas being investigated, good hope to find a solution
- Momentum collimation: Studies ongoing.
  - **Alternative energy collimation section from FNAL.**
    - Larger normalized dispersion at primary collimator.
    - First estimations of the survival of protons with the new optics were done: no survival for energy  $> 1.6 \cdot 10^{-3}$ .
- Dispersion suppressor:
  - **Updated design increases the safety margin significantly.**
  - Energy deposition studies after the Betatron cleaning insertion show that a **factor 8 on top of the deposited energy can be handled.**
  - **An additional collimator was placed** after the quadrupole in cell 8 **to lower the load on the next bending dipole** significantly.
  - Currently, the **energy collimation dispersion suppressor collimators do not collect all targeted particles**: two should have them at a cell downstream.
- **Care required with energy loss into the EIR**

- Injector options and injection optics are completed
- Extraction straight and dump line optics are completed
- Beam failures:
  - Studies now starting in **collaboration between collimation and dump teams**
  - Extraction design **driven by failure case of asynchronous dump**, due to impact on extraction protection and dump.
  - **We have now a baseline design to handle erratics extraction kicker module and 2 alternatives.**

- Impedances studies:
  - Screen and coatings (HTS and laser): HTS for impedance, Laser for SEY
  - Warm parts (**contribution near cold part, major contributions: IRA and IRG**)
  - Collimators: Important at top energy
  - **Impedance LHC-like library** (Database webpage: <https://impedance.web.cern.ch/impedance/fcchh/impedances.html>)
- Impedance budgets from instability thresholds, feedback speed, tolerable head loads.
  - Screen/Collimators: Coupled bunch damped by Octupoles ( $k > 0$ ) + **Feedback**
  - TMCI (might be an issue with laser coating and collimators)
  - Landau damping: **Octupole scheme under discussion, seems to be reasonable.** We use feedback..
- Transverse **feedback: must-do-have (25 ns: LHC-based baseline proposal, 5 ns: more kickers to cover higher frequency).**
- Which parts of the beam screen need to be coated to avoid electron cloud depends strongly on the assumptions of the SEY behavior
  - **In all cases, the 12.5 ns beam sets the most stringent constraints**
- Constraints on photoelectrons/photons depend on the photoelectron yield
  - **The dipoles with 12.5 ns beam, and quadrupoles with 5 ns beam set the strongest constraints**
  - **Loop with new beam screen design**

- To finalize lattice files and to **generate alternative optics**.
- We need to **decide which scheme is the baseline** and which alternatives should be generated (which energy collimation section, which EIR, ...)
- To refine tuning procedures: **we have to fix some phase advances**:. DA is very dependent on this.
- **To continue DA studies** (new dipole table, quadrupole errors, higher order multipole correctionn, beam-beam, ...)
- To **converge on magnet families** (corrector lengthes, multipole lengthes,...)
- To follow up **collimation studies** and to go on collaboration between dump and collimation teams: activation, radiation damage, design of shielding /absorbers, further optimization of optics, advanced collimation concepts (electron lens, crystals... ), beam failures (erratics extraction kickers and asynchronous dump)
- To **refine impedance library** (longitudinal, Pumping holes, interconnects, kickers, larger aperture in the IRs, ...)
- To continue investigations on **Landau damping** (higher modes stability study , octupoles, use of feedback systems, electron lenses, RF quadrupole)
- To follow up **electron cloud studies** and to refine models (drifts and chamber shape)
- To follow up **feedback studies** (impact of feedback noise, suppression of emittance growth by ground motion and crab cavity noise, to go on studies on GHz-feedback)
- **To follow up the good work!**

