FCC-ee MDI workshop & review
16-27 January 2017

– Introduction

- general FCC study time line
- FCC-ee design review Oct ‘16
- scope of this MDI workshop

Michael Benedikt and Frank Zimmermann,
thanks to Manuela Boscolo, Katsunobu Oide, Jorg Wenninger

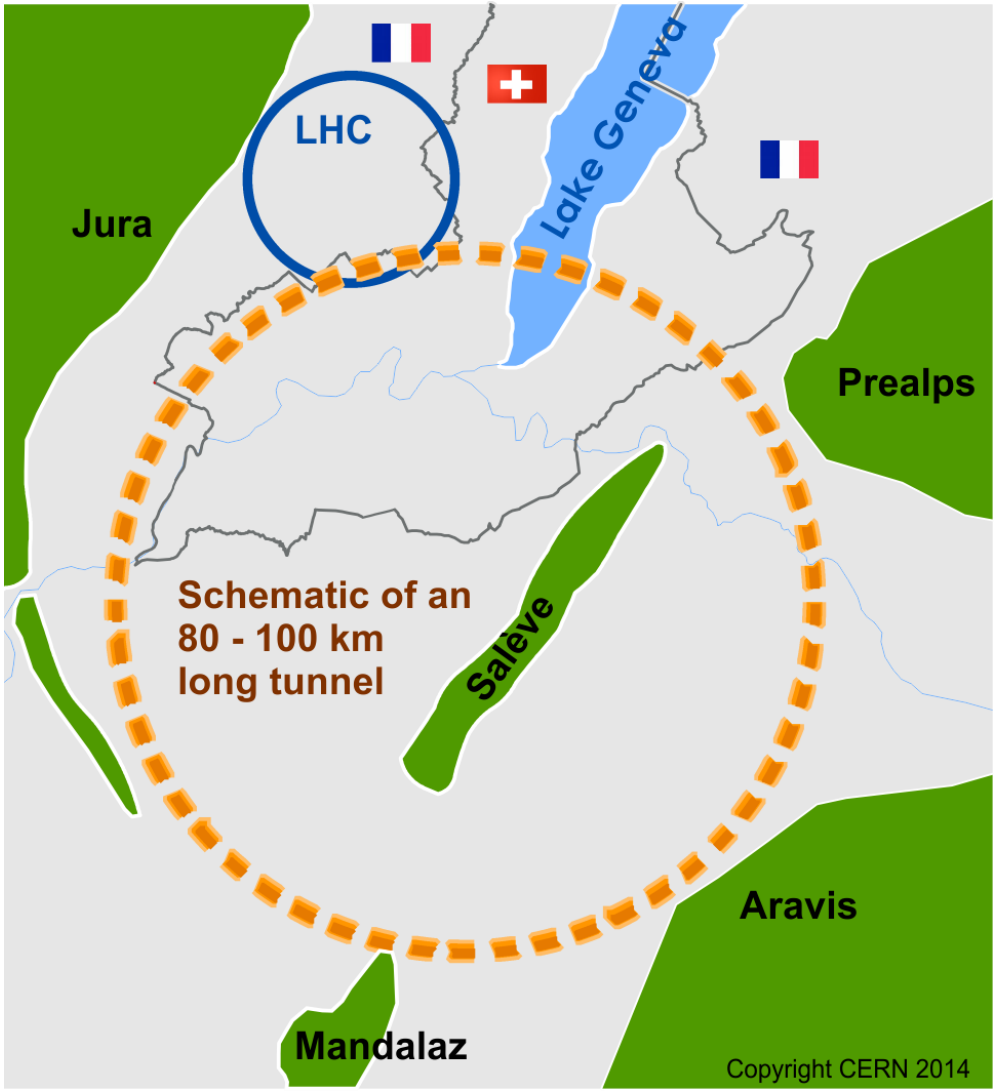
Future Circular Collider Study

International FCC collaboration (CERN as host lab) to study:

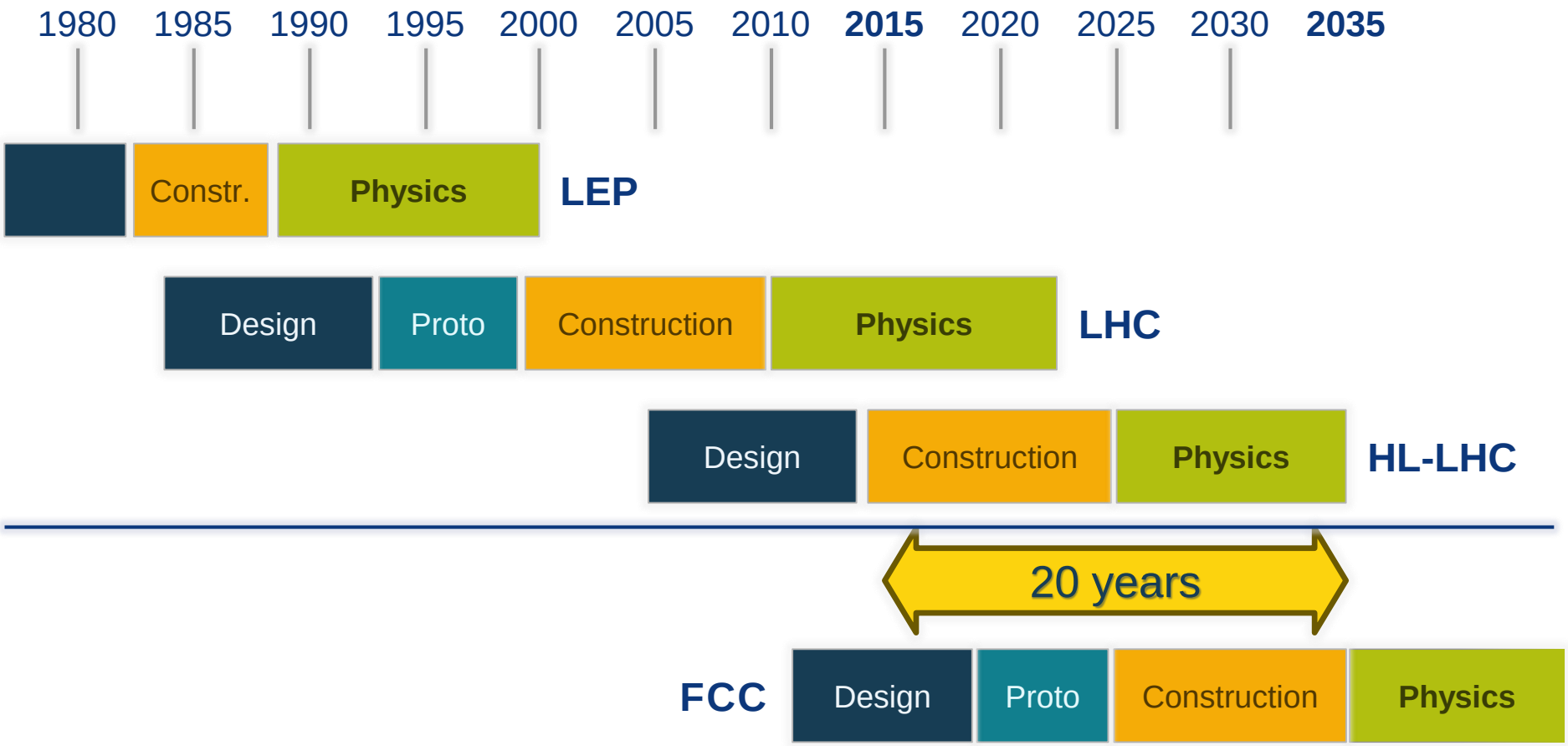
- ***pp* and *AA* collider (*FCC-hh*)**
  → main emphasis, defining infrastructure requirements

  ~16 T ⇒ 100 TeV *pp* in 100 km

- **80-100 km tunnel infrastructure** in Geneva area, site specific
- ***e*⁺*e*⁻ collider (*FCC-ee*),** as possible first step
- ***p/A-e* (*FCC-he*) option,** integration one IP, FCC-hh & ERL
- **HE-LHC** with *FCC-hh* technology

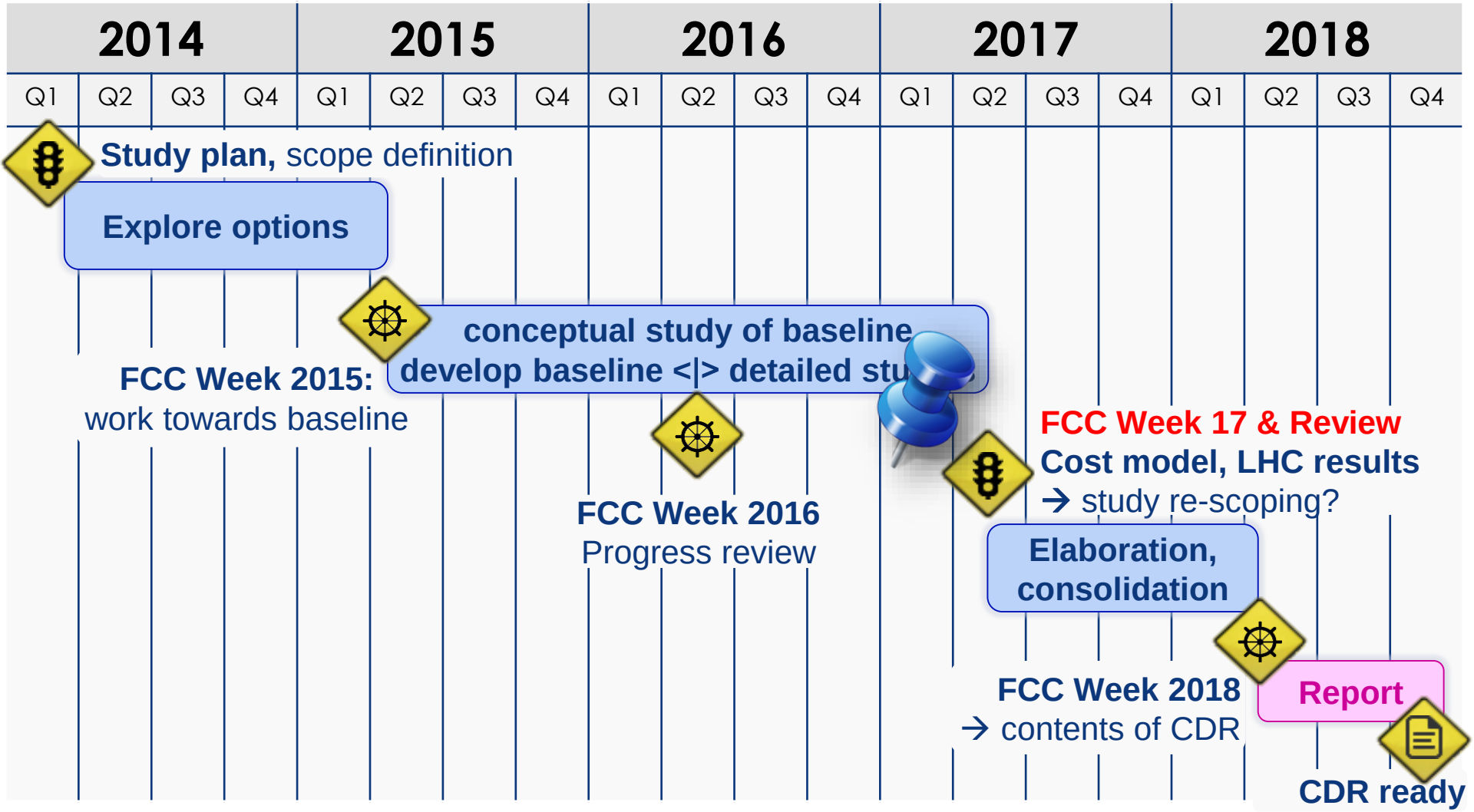


CERN circular collider time line



Must advance fast now to be ready for the period 2035 – 2040
Goal of phase 1: CDR by end 2018 for next update of European Strategy

CDR Study Time Line



FCC-ee design review, 13.-14.10.‘16

time	length	title	speaker(s)
08:30-08:45	15 min.	Introduction and charge	Frank Zimmermann
08:45-09:045	60 min.	Design overview, separated vs combined function arcs	Katsunobu Oide
09:45-10:00	15 min.	Arc magnet designs	(Attilio Milanese) pres. by Katsunobu Oide
10:00-10:30	30 min.	*Coffee break*	
10:30-11:00	30 min.	Alternative IR optics and possible monochromatization	Anton Bogomyagkov
11:00-11:30	30 min.	Emittance tuning	Sandra Aumon
11:30-12:00	30 min.	Tolerance and misalignment studies	Sergey Sinyatkin
12:00-13:30	90 min.	*Lunch break*	
13:30-14:00	30 min.	FCC-ee beam-beam effects, including instabilities and mitigations on the Z pole	Dmitry Shatilov
14:00-14:30	30 min.	FCC-ee beam-beam strong-strong simulations for all working and mitigations	Kazuhito Ohmi
14:30-15:00	30 min.	MDI incl. l* preferences	Manuela Boscolo
15:00-15:30	30 min.	*Coffee break*	
15:30-16:00	30 min.	IR quadrupole design choice	Eugene Levichev
16:00-17:00	60 min.	Collective effects overview incl. e-cloud	Eleonora Belli
17:00-18:00	60 min.	Closed session	

October review committee

Yunhai Cai, SLAC (Chair)

Catia Milardi, INFN Frascati

Pantaleo Raimondi, ESRF

Elena Shaposhnikova, CERN

Rogelio Tomas, CERN

October'16 review - tasks

1) **Select a baseline IR optics**
2) Comment on the choice between separate function and combined function arcs
3) **Comment on near-IR layout, incl. /* in oncoming and outgoing side**
4) **Comment on final quadrupole design**
5) Comment on tolerances and vertical emittance tuning
6) Have no important items be missed in the impedance and instability survey ?

…

Oct' review conclusions - general

Since the last review, a much more detailed study has been made including the radiation from the final focus quadrupole and introducing masks for mitigation.

A few possible improvements such as combined function dipoles, and asymmetric IR were also studied and presented in the review.

Many advances were made in the standard design study: in particular in studies of tolerances, machine tuning, impedance and collective instabilities.

The committee is pleased to see all these advances in the design, especially in the design of the interaction region.

A few issues emerged from the study done in the past year, among them coherent beam-beam instability and trapped modes near the interaction point. Some attempts were made for mitigation, but it is not clear if they present a cost-effective approach.

The committee recommends to have a comprehensive study of heating problem inside the detector and then make a proper decision how to pursuit the design.

Given the maturity of the design (KO) lattice, the committee recommends to officially declare it as a baseline so that the efforts can be more focused for a comprehensive study at a level of conceptual design.

The committee recommends also upgrading MAD-X to make it usable for the FCC-ee study, in particular, including proper implementation of synchrotron radiation (also for TWISS) and implementing tilt solenoid.

Oct'-rev. conclusions – IR optics

Select an IR optics:

Given the material shown in the review, **we recommend to select the presented lattice (KO) as a baseline to proceed for further study. Here are our motivations:**

A) It complies with100 keV maximum critical photon energy from the synchrotron radiation near the interaction point while alternative does not;

B) It has adequate dynamic and momentum apertures accommodating the large energy loss due to the beamstrahlung in the high-energy collision;

C) It has a layout that is compatible to the proton-proton collider aside from a tolerable deviation: 9.4 meter in the interaction region.

Along with this recommendation, **we suggest further study:**

D) Use the baseline for engineering design and cost estimate;

E) Complete tolerance study for baseline with reasonable specification of alignment & magnetic errors along with realistic & robust correction scheme;

F) Track dynamic and momentum apertures w errors after correction;

G) Generate a set of beam parameters that are consistent and can be used to study collective instabilities; define impedance budget and bunch patterns;

H) Make sure an adequate polarization at the beam energy < 81 GeV can be achieved with the errors after the correction

Oct'-rev. conclusions – IR Layout

Comment on near-IR layout, incl. L* in oncoming and outgoing side

We recommend keeping L*=2.2m symmetric IR as the baseline.

However at the moment, **we do not have enough elements to assess if there is a technological solution that is consistent with the lattice**.

We recommend to make changes after a comprehensive study of heating problem near the IP.
All the implications of choice of the detector side (luminosity monitor, stay clear, synchrotron radiation) have to be carefully analyzed and quantified.

Oct'-rev. conclusions – final quad

Comment on final quadrupole design

In general, there is a very good **R&D for this item** [which] **should be continued with closer interaction with the previous item.**

We suggest involving the experts in SC Nb3Sn quadrupole technology in the R&D program for a possibility of substantial increase of gradient.

a concrete outcome from Oct' review

Before freezing the IR baseline, the committee strongly suggested **revisiting several important and entangled MDI issues, such as the various beam-pipe dimensions, choice of l*, final magnet parameters, space and location of luminosity monitors, etc.**

Following discussions in the closed session we decided to address these MDI issues all together in the form of a **mini-workshop** assembling all (most?) system experts for 2 weeks at CERN.

Among the main questions to be addressed are:

- Minimum dimensions for chamber layout and masking
- Trapped mode analysis
- Definitive chamber layout
- IR quad design, l* choice, incoming/outgoing layout
- Integration, luminosity monitor
- Overall detector layout and magnetic integration

FCC-ee mini-workshop / review

CERN, 16-27 January 2017 (chair & main organizer M. Boscolo)

http://indico.cern.ch/event/596695

Overview

This mini-workshop for the Machine Detector Interface design of the FCC-ee collider aims at **revisiting/validating several open issues with worldwide experts**.
The main topics have to be discussed **before freezing the baseline MDI layout**, such as the various beam-pipe dimensions, choice of l*, final magnet parameters, space and location of luminosity monitors.
After this mini-workshop has made, or confirmed, the basic choices for the layout, a fully coherent study of all related systems and hardware will be performed in time for the CDR report. Further optimization work beyond the baseline should then take place either at an appropriate level in parallel to the baseline development, or in a second full iteration later on.
Overlapping in time with the FCC-ee MDI mini-workshop, the 1st FCC Physics Workshop will take place, in the week 16-20 January. Its agenda is available at the following link: https://indico.cern.ch/event/550509

Participants

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D. El Khechen (CNRS/LAL)

K. Elsener (CERN)

R. Kersevan (CERN)

E. Levichev (BINP)

A. Novokhatski (SLAC)

K. Oide (KEK)

M. Sullivan (SLAC)

H. Ten Kate (CERN)

P. Vobly (BINP)

F. Zimmermann (CERN)