Study Organisation

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FCC Preparatory Collaboration Board Meeting

September 9th, 2014

Outline

- Collaboration
- Memorandum of Understanding
- Study Organisation
- Work Breakdown
- Current Status and Resources

Frame for FCC Study

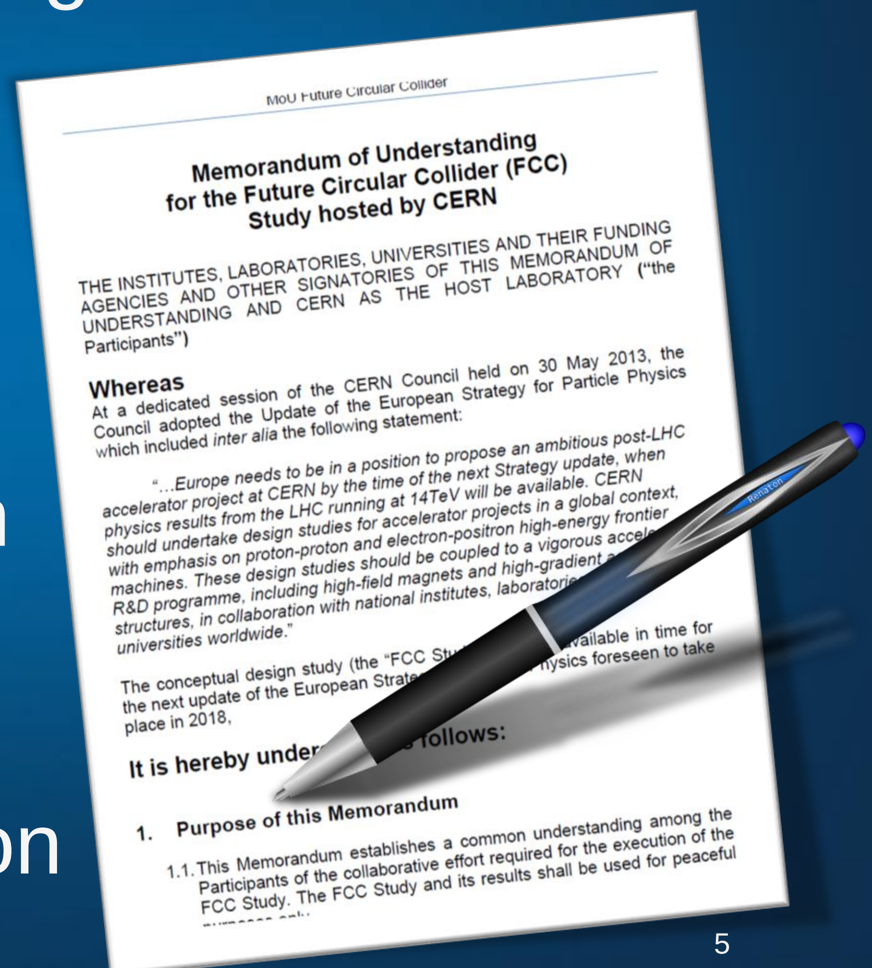
- Initiated by CERN as response to update of European Strategy for Particle Physics
- Produce **conceptual designs** for next large-scale particle physics research infrastructure **by 2018**
- As a **collaborative effort across national boundaries** & continental regions
- **CERN** acts as enabler for an international collaboration, **hosting the study**

CERN as Host Laboratory

- Establish organisational framework
- Set up a functioning international Collaboration
- Identify required research and development actions
- Monitor compliance by the Members of the Collaborations with their obligations and planning
- Collect, review and verify consistency of parameters, reports and deliverables
- Transmit information relevant to the study to any other Parties concerned
- Administer the contributions of the Members of the Collaboration and of external Funding Authorities

Collaboration

- A number of parties who agree to carry out the conceptual design work
- Memorandum of Understanding (**MoU**) defines Collaboration
- A public organisation joins the Collaboration by signing the MoU
- Collaboration is open to continuous extension



MoU

- Establishes a common understanding about the goals of the study
- Creates a situation of trust among equal participants to permit achieving the goals
- Work contribution of a participant is carried out on a “best-effort” basis
- CERN also is a participant

Scope of Work – WBS

- Work Breakdown Structure lists all work to be carried out to achieve the study goals
- Serves the participants of the Collaboration to commit to well-defined and manageable portions of work
- Permits the Coordinator to come to a topically complementary and geographically well-balanced network of contributions

MoU Addendum

- Each participant agrees with the Collaboration to take over some particular work unit

- Work unit contents and deliverables are defined in a specific Addendum for each participant indicating:
  - Resources contributed by the participant
  - ant Resources required from the host (CERN)

Addendum (Work Definition)

ADDENDUM {*IDENTIFIER*}

{Name of Participant} ("Participant")
This Addendum defines a contribution by one or more Participants under Article 6 of the Memorandum of Understanding for the FCC Study {MoU Identifier and date}
SCOPE OF WORK
{General description of scope of work}
PROJECT CONTACTS The following contacts may, on behalf of the Participant and of CERN as the Host Organization, update the contents of this Addendum by issuing a revised Addendum that will cancel and replace all previous versions.

Participant Project Contact:	{FIRST NAME} {LAST NAME} {e-mail} {phone}
CERN Project Contact:	{FIRST NAME} {LAST NAME} {e-mail} {phone}

Work areas covered by the participant competences brought into the collaboration

Contact persons participant, coordinator

DETAILED WORK DESCRIPTION

***Note**: The following table is repeated for each individual Work Unit constituting the Scope of Work (i.e. each deliverable, identifier, title, description and planned delivery date). The identifier should have the form {3-letter institute letter code}-{work unit code}-{deliverable code}.*

WORK UNIT	
{Identifier}	**{Title of work unit}**
Reference:	{Associated FCC Work Breakdown Structure items}
Objectives:	{Description of objectives}
Participant Work Unit Contact:	{First Name, Last Name, e-mail, phone}
CERN Work Unit Contact:	{First Name, Last Name, e-mail, phone}

Match to WBS

Definition of work

WORK UNIT DELIVERABLE	
{Identifier}/{Type}[1]	**{Name of deliverable}**
Participant's deliverable:	{Detailed description of deliverable for which Participant is responsible, which can either be a document, a service or a product in terms of hardware or software}
Required delivery date:	{Date and time by which deliverable should be provided to CERN for acceptance}

Definition of what is delivered as result

Addendum (Resources)

RESOURCES

The following table lists all resources (personnel, equipment, material, infrastructure, travel, subsistence and services) required for the Participant's deliverable and CERN's support (if any), as defined above, and as required to accomplish the defined Scope of Work:

	Resources	From Date	To Date
Participant:			
Personnel	{Number and expertise of personnel assigned to a Work Unit from indicated date until indicated date}		
Equipment, material and infrastructure	{Equipment, material and infrastructure supplied from date to date}		
Travel, subsistence and services	{Travel, subsistence and services supplied from date to date}		
CERN:			
Personnel	{Number and expertise of personnel assigned to a Work Unit from indicated date until indicated date}		
Equipment, material and infrastructure	{Equipment, material and infrastructure supplied from date to date}		
Travel, subsistence and services	{Travel, subsistence and services supplied from date to date}		

Contributed
- Personnel
- Material
- Services

Contributions required from CERN to complete work

Update of Addendum

- One addendum per participant
- One primary contact per participant
  - Separate contacts defined on participant and coordinator side for all work units
- Addendum can be updated
  - Participation scope and topics evolve
  - Participant consists of multiple logical units
  - Study scope evolves
  - Resources evolve
- Procedure applied for accelerators, infrastr. technology, experiments and detectors

Progress Monitoring

- Primarily via study organisational structure and coordination group(s)
- In addition participants provide a status update twice per year (by simple e-mail)
- For each defined deliverable:
  - Very brief status overview (5 lines)
  - Remaining work to be done (5 lines)
  - Showstoppers encountered (if any, 3 lines)
  - Foreseen, updated completion date (1 lines)

FCC Study – Main Areas

- FCC Study
  - Hadron Collider Physics and Experiments
  - Lepton Collider Physics and Experiments
  - e-p Physics and Experiments, Accelerators
  - Hadron Injectors
  - Hadron Collider
  - Lepton Injectors
  - Lepton Collider
  - Accelerator R & D and Technologies
  - Infrastructures and Operation
  - Costing Planning

Study Coordination Group

- **Study Coordination** — M. Benedikt, F. Zimmermann
  - **Hadron Collider Physics and Experiments** — F. Gianotti, A. Ball, M. Mangano
  - **Lepton Collider Physics and Experiments** — A. Blondel, J. Ellis, P. Janot
  - **e-p Physics, Experiments, IP Integration** — M. Klein, O. Bruning
  - **Hadron Injectors** — B. Goddard
  - **Hadron Collider** — D. Schulte, M. Syphers, J.M. Jimenez
  - **Lepton Injectors** — Y. Papaphilippou (tbc)
  - **Lepton Collider** — J. Wenninger, U. Wienands, J.M. Jimenez
  - **Accelerator R & D and Technologies** — M. Benedikt, F. Zimmermann
  - **Infrastructures and Operation** — P. Lebrun, P. Collier
  - **Costing Planning** — F. Sonnemann, P. Lebrun

Study Organisation

Study Coordination Group

- Hadron Collider Physics and Experiments
- Lepton Collider Physics and Experiments
- e-p Physics, Experiments, Accelerators
- Hadron Injectors
- Hadron Collider
- Lepton Injectors
- Lepton Collider
- Accelerator R & D and Technologies
- Infrastructures and Operation
- Costing Planning

Physics Coordination

Accelerator Coordination

Infrastructure Coordination

Meeting structure (i)

Work/meeting structures established based on INDICO:

- **FCC Study: https://indico.cern.ch/category/5153/**

- **FCC-hh Hadron Collider Physics and Experiments VIDYO meetings**
  - **https://indico.cern.ch/category/5258/**
  - **Contacts: michelangelo.mangano@cern.ch, fabiola.gianotti@cern.ch, austin.ball@cern.ch**

- **FCC-ee Lepton Collider Physics and Experiments VIDYO meetings**
  - **https://indico.cern.ch/category/5259/**
  - **Contacts: alain.blondel@cern.ch, patrick.janot@cern.ch, john.ellis@cern.ch**

Meeting structure (ii)

- FCC-hh Hadron Collider VIDYO meetings
  - https://indico.cern.ch/category/5263/
  - Contacts: daniel.schulte@cern.ch

- FCC-hadron injector meetings
  - https://indico.cern.ch/category/5262/
  - Contacts: brennan.goddard@cern.ch

- FCC-ee Lepton Collider VIDYO meetings
  - https://indico.cern.ch/category/5264/
  - Contacts: jorg.wenninger@cern.ch,

- FCC infrastructure meetings
  - https://indico.cern.ch/category/5253/
  - Contacts: philippe.lebrun@cern.ch, peter.sollander@cern.ch

Work Breakdown Structure

- **Physics and Experiments**
  - Hadron Collider Physics
  - Hadron Collider Experiments
  - Lepton Collider Physics
  - Lepton Collider Experiments
  - Lepton-Hadron Collider Physics
  - Lepton-Hadron Collider Experiment
- **Accelerators**
  - Hadron Injectors
  - Hadron Collider
  - Lepton Injectors
  - Lepton Collider
  - Lepton-Hadron Collider
  - Technology R&D
- **Infrastructures and Operation**
  - Civil Engineering
  - Technical Infrastructures
  - Operation and Energy Efficiency
  - Integration
  - Computing and Data Services
  - Safety, RP and Environment
- **Implementation and Planning**
  - Project Risk Assessment
  - Implementation Scenarios
  - Cost Models
- **Study and Quality Management**
  - Study Administration
  - Communications
  - Conceptual Design Report

WBS – H2020 EU DS proposal

- **Physics and Experiments**
  - Hadron Collider Physics
  - Hadron Collider Experiments
  - Lepton Collider Physics
  - Lepton Collider Experiments
  - Lepton-Hadron Collider Physics
  - Lepton-Hadron Collider Experiment
- **Accelerators**
  - Hadron Injectors
  - Hadron Collider
  - Lepton Injectors
  - Lepton Collider
  - Lepton-Hadron Collider
  - Technology R&D
- **Infrastructures and Operation**
  - Civil Engineering
  - Technical Infrastructures
  - Operation and Energy Efficiency
  - Integration
  - Computing and Data Services
  - Safety, RP and Environment
- **Implementation and Planning**
  - Project Risk Assessment
  - Implementation Scenarios
  - Cost Models
- **Study and Quality Management**
  - Study Administration
  - Communications
  - Conceptual Design Report

FCC-hh Hadron Collider

1.2.2	**Functional machine design**	**preliminary - institutes to be confirmed**
1.2.2.1	**Single beam collective effects**	KEK, CEA, TUD
1.2.2.11	**Beam-beam collective effects and dynamic aperture**	KEK, EPFL, FZJ
1.2.2.2	**Collimation and absorber concepts**	IN2P3-LAL, IN2P3-IPNO, DESY
1.2.2.3	Injection and extraction concepts and designs	
1.2.2.4	Ion beam operation design considerations	
1.2.2.5	**Interaction region and final focus design**	JAI
1.2.2.6	**Lattice design and integration and single particle dynamics**	IN2P3-IPNO, DESY, CEA
1.2.2.7	**Machine detector interface**	CI, IN2P3-LAL, DESY, INFN-LNF
1.2.2.8	Machine protection, magnet protection, QPS, BLM concepts	
1.2.2.9	Radiation maps and effects	
1.2.2.10	HE-LHC performance needs and conceptual design	
1.2.2.12	RF and feedback conceptual design	
1.2.3	**Technical systems**	
1.2.3.1	Technologies that require R&D	
1.2.3.2	Beam diagnostics requirements and conceptual design	
1.2.3.3	Beam transfer elements requirements and conceptual design	
1.2.3.4	Collimation systems and absorber requirements and conceptual design	
1.2.3.5	Control system requirements	
1.2.3.6	Dump and stopper requirements and conceptual design	
1.2.3.7	Element support, survey and alignment requirements and concepts	
1.2.3.8	**Machine detector interface system needs and conceptual design**	CI, INFN
1.2.3.9	Machine protection system requirements and conceptual design	
1.2.3.10	Normal magnet requirements and element conceptual design	
1.2.3.11	Power converter requirements and conceptual design	
1.2.3.12	Quench protection and stored energy management requirements and concepts	INFN, TUT
1.2.3.13	**RF requirements and conceptual design**	CI
1.2.3.14	Superconducting magnet and cryostat requirements and conceptual design	
1.2.3.15	Proximity cryogenics for superconducting magnets and RF	
1.2.3.16	**Vacuum system requirements and conceptual design**	CI, INFN-LNF, STFC
1.2.3.17	Shielding	
1.2.3.18	**Cryogenic beam vacuum system**	ALBA, CIEMAT, STFC, INFN, KIT

Hadron Collider Physics

2.1.1	**Exploration of EW Symmetry Breaking**	**preliminary - institutes to be confirmed**
2.1.1.1	High-mass WW scattering, high mass HH production	
2.1.1.2	Rare Higgs production/decays and precision studies of Higgs properties	
2.1.1.3	Additional BSM Higgs bosons: discovery reach and precision physics programme	
2.1.1.4	New handles on the study of non-SM EWSB dynamics	
2.1.2	**Exploration of BSM phenomena**	
2.1.2.1	Discovery reach for various scenarios	
2.1.2.2	Theoretical implications of discovery/non-discovery of BSM scenarios	
2.1.3	**Continued exploration of SM particles**	
2.1.3.1	Physics of the top quark	
2.1.3.2	Physics of the bottom quark	
2.1.3.3	Physics of the tau lepton	
2.1.3.4	W/Z physics	
2.1.3.5	QCD dynamics	
2.1.4	**Opportunities other than pp physics**	
2.1.4.1	Heavy Ion Collisions	
2.1.4.2	Fixed target experiments	
2.1.4.3	Smaller-size experiments for dedicated purposes	
2.1.5	**Theoretical tools for the study of 100 TeV collisions**	
2.1.5.1	Parton Distribution Function	
2.1.5.2	MC generators	
2.1.5.3	N^nLO calculations	

Hadron Collider Experiments

2.2.1	**Detector performance**	**preliminary - institutes to be confirmed**
2.2.1.1	Rapidity coverage for tracking, leptons, jets	
2.2.1.2	Forward tracking and b-tag vs pile-up density	
2.2.1.3	Electromagnetic calorimeter: dynamic range, forward granularity	
2.2.1.4	Forward jet tagging	
2.2.1.5	Muon resolution in the O(10 TeV) region	
2.2.1.6	Optimisation of the bunch spacing (trigger and readout vs pile-up)	
2.2.2	**Technical systems**	
2.2.2.1	Technologies that require R&D	
2.2.2.2	Detector technologies	
2.2.2.3	Radiation effects	
2.2.2.4	Shielding	
2.2.2.5	ECAL	
2.2.2.6	HCAL	
2.2.2.7	Magnet system	
2.2.2.8	Muon detection	
2.2.2.9	Inner detector	
2.2.2.10	Tracking	
2.2.2.11	Trigger system	
2.2.2.12	Data acquisition, detector controls and detector safety	

FCC-ee Lepton Collider

1.4.2	**Functional machine design**	**preliminary - institutes to be confirmed**
1.4.2.1	**Beam-beam effects**	BINP, KEK, CI
1.4.2.11	**Impedance and single-beam collective effects**	KEK
1.4.2.2	Collimation and absorber concepts	
1.4.2.3	Injection and extraction concepts and designs	
1.4.2.4	**Interaction region and final focus design**	BINP, CI, INFN-LNF
1.4.2.5	Booster ring conceptual design and integration	
1.4.2.6	Lattice design and single particle dynamics	
1.4.2.7	**Polarization and energy calibration**	BINP, Uni Geneva
1.4.2.8	**Machine detector interface**	INFN-LNF
1.4.2.9	Machine protection concepts	
1.4.2.10	Radiation effects	
1.4.3	**Technical systems**	
1.4.3.1	Technologies that require R&D	
1.4.3.2	Beam diagnostics requirements and conceptual design	
1.4.3.3	Beam transfer elements requirements and conceptual design	
1.4.3.4	Collimation systems and absorber requirements and conceptual design	
1.4.3.5	Control system requirements	
1.4.3.6	Dump and stopper requirements and conceptual design	
1.4.3.7	Element support, survey and alignment requirements and concepts	
1.4.3.8	Machine detector integration	
1.4.3.9	Machine protection system requirements and conceptual design	
1.4.3.10	Normal magnet requirements and element conceptual design	
1.4.3.11	Power converter requirements and conceptual design	
1.4.3.12	Quench protection and stored energy management requirements and concepts	
1.4.3.13	RF system requirements and conceptual design	
1.4.3.14	Superconducting magnet and cryostat requirements and conceptual design	
1.4.3.15	Proximity cryogenics for RF and magnets	
1.4.3.16	**Vacuum system requirements and conceptual design**	KEK
1.4.3.17	Shielding	

FCC-ee Physics, Experiments

2.3.1	**Model building and new physics**	**preliminary - institutes to be confirmed**
	To be completed	
2.3.2	**Precision EW calculations**	
	To be completed	
2.3.3	**Flavour (b,c, τ , ν) physics and rare decays**	
	To be completed	
2.3.4	**QCD and $\gamma\gamma$ physics**	
	To be completed	
2.3.5	**Combination and complementarity**	
	To be completed	

2.4.1	**EW physics at Z pole**	
2.4.2	**WW, ZZ, Zγ physics**	
2.4.3	**H(126) properties**	
2.4.4	**Top quark physics**	
2.4.5	**Flavour (b,c, τ , ν) physics and rare decays**	
2.4.6	**QCD and $\gamma\gamma$ physics**	
2.4.7	**Experimental signatures of new physics**	
2.4.8	**Experimental environment**	
2.4.9	**Detector designs**	
2.4.10	**On-line software**	
2.4.11	**Off-line software**	

Technology R&D

1.6.1	**16 T Superconducting Magnet Program**	**preliminary - institutes to be confirmed**
1.6.1.1	**Accelerator magnet design study for hadron collider**	CIEMAT, UT, KEK, TUT, CEA, INFN
1.6.1.2	**Nb3Sn material R&D**	UT, KEK, UNIGE
1.6.1.3	16 T short model construction	
1.6.1.4	16 T support technologies	
1.6.1.5	Magnet/collider integration studies	
1.6.2	**20 T Superconducting Magnet Program**	
1.6.2.1	5 T HTS insert	
1.6.2.2	HTS Material R&D	
1.6.2.3	20 T magnet design	
1.6.5	**Injector/Booster Magnet Program**	KEK
1.6.5.1	Superferric HTS magnet	
1.6.5.2	Superferric HTS short model	
1.6.5.3	Performance of ramped SC magnets	
1.6.3	**100 MW RF Program**	KEK
1.6.3.1	**Cavity design**	CI
1.6.3.2	Optimisation of cryogenic power consumption	
1.6.3.3	Multi-beam klystron demonstrator	
1.6.3.4	Klystron working point for optimum efficiency	
1.6.3.5	Cryo-module and ancillary systems design	
1.6.4	**Specific Technologies Program**	
1.6.4.1	More efficient, compact and higher capacity helium cryo-plants	
1.6.4.2	Non conventional cryogen mixtures for efficient refrigeration below 100 K	
…	…	

Organisation Physics/Phenomenology

- Status of physics/phenomenology studies
  - First exploration of physics opportunities for ee and eh already documented
  - For hh (incl. heavy ions and injectors) studies ongoing, first report by end 2015
  - Common (ee/eh/hh) software platform under development
- Coordination of physics/phenomenology studies:
  - Physics subgroups run by conveners. They outline priorities, define tasks, but also collect input from the broad pheno/theory community.
  - Most work arising from independent efforts of single theory groups. New original ideas are developing. This should not be coordinated from the top: conveners to engage authors and give coherence to all material emerging from the literature
  - Exploration of synergies and complementarities of ee/eh/hh jointly steered .
- **Participation in physics/phenomenology studies**
  - **Fully open: inform the group leaders of intent to contribute.**
  - **No requirement of formal MoU to join physics studies**
  - **MoU possible, if it helps the proponent group to obtain support from funding agency. Subject to agreement by Study group coordinators.**

MoU Status 8. September 2014

- ALBA/CELLS, Spain
- BINP, Russia
- CBPF, Brazil
- CIEMAT, Spain
- Cockcroft Institute, UK
- CSIC/IFIC, Spain
- DESY, Germany
- EPFL, Switzerland
- Hellenic Open U, Greece
- JAI/Oxford, UK
- KEK, Japan
- King's College London, UK
- MEPhI, Russia
- Sapienza/Roma, Italy
- TU Darmstadt, Germany
- TU Tampere, Finland
- U. Geneva, Switzerland
- U. Iowa, USA
- U. C. Santa Barbara, USA
- U Silesia, Poland

- 20 signed, 15 further basically agreed, pending signatures

Resource Status

- CERN
  - ➢ Medium-Term Plan 2015-2019 (June ‘14)
  - – ~ 30 FTEs: ~ 1800 person months
  - – ~ 30 fellows and doct. Students ~ 1800 person months
  - – Material budget for fellows, PhD and technology R&D (focus on 16 T dipole program and SRF): 50 MCHF
- Collaboration
  - – Commitment of 1085 person months for EuroCirCol H2020 DS proposal
  - – Other commitments (Addenda) presently: ~ 200 PM
  - – Further commitments TBD

Study Time Line

Explore options, now – spring 2015:

- Investigate **different options** in all technical areas, **taking a broad view**
- Deliverables: description/comparison of options with relative merits/cost, **understand relative impact of options on overall study/project**
- FCC workshop to converge to common baseline with small number of options
- **1st Yearly FCC Workshop 23 – 27 March 2015, Washington DC**
- Followed by review ~2 months later, begin June 2015

Summary

- Work has started
- International collaboration is forming
- H2020 EuroCirCol proposal submitted
- Work Breakdown Structure:
  http://cern.ch/fcc/Documents/Organisation/WBS.pdf
- Looking forward to our FCC Collaboration!