

FCC Physics Workshop

Monday, February 7, 2022 - Friday, February 11, 2022



Book of Abstracts

Contents

Welcome to the 5th FCC Physics Workshop	1
Welcome and CERN vision	1
The FCC feasibility study	1
PED study introduction and goals of meeting	1
ECFA and the FCC	1
The R&D on High Field Magnets	1
Recap of the FCC-ee physics potential and open questions	1
Recap of the FCC-hh physics potential and open questions	2
Recap of the FCC-eh physics potential and open questions	2
FCC in America and the Snowmass process	2
Naturalness	2
Higgs couplings and naturalness	2
Higgs Physics at CEPC	2
Higgs mass and ZH cross-section from $Z(\mu\mu)H$ events	2
Higgs to invisible	3
Hbb, Hcc, Hgg	3
Higgs self-coupling	3
HH in the $b\bar{b}\tau\tau$ channel @ FCC-hh	3
Detecting Heavy Higgs Bosons from Natural SUSY at a 100 TeV Hadron Collider	3
Di-Higgs with missing transverse momentum at FCC-hh	3
Unveiling the Higgs at FCC-hh with new diboson precision measurements	3
ECM calibration and Polarization status and plans	4
Electroweak precision measurements status	4

MDI status and plans	4
Mandate for the Software and Computing Team	4
Physics performance plans	4
Physics Programme plans	4
Detector concepts plans	5
Closing remarks	5
High-dimensional Anomaly Detection with Radiative Return in e^+e^- Collisions	5
Discovery stories	5
Long-Lived Particles	5
Light BSM scalars at e^+e^- machines	5
Tera-Zooming in on light (composite) axion-like particles	5
BSM & top Physics with FCC-eh	6
Systematics in HEP	6
FCC-eh accelerator / IR and common hh detector	6
IP generated radiation monitor for center-of-mass energy measurements	6
Low angle luminosity monitoring	6
MDI design integration	6
The quadrupole QD0 for the SuperB interaction region	6
Status of beam backgrounds in Belle II at SuperKEKB	7
Status of the software	7
Lesson learned when migrating the IDEA drift chamber software to EDM4hep	7
Lesson learned when migrating the IDEA DR calo software to DD4hep and to EDM4hep	7
FCC software step-by-step	7
Noble Liquid Calorimetry for a Future FCC-ee Experiment	7
Superconducting Detector Magnets for FCC-ee	8
The preshower and the muon detection system of the IDEA detector for FCC-ee	8
Test Beam Results and R&D Programme for a Highly Granular Fibre-Sampling Dual-Readout Calorimeter	8
CALICE overview	8
Semi-Digital Hadronic Calorimeter	8

Combining Dual-Readout Crystals and Fibers in a Hybrid Calorimeter for IDEA	8
DMAPS for large area FCC trackers	8
Large area curved silicon modules for future trackers	9
A Triplet Track Trigger for FCC-hh & its impact on measuring the Higgs self-coupling	9
Event Generators & Parton Showers	9
Jet energy spectrum and substructure in $e+e-$ collisions at 91.2 GeV	9
Hadronization corrections in event shapes	9
Alpha_s extractions from jets	9
A Robust Measure of Event Isotropy at Colliders	10
Path to precision	10
Three-loop elliptic integrals for the Standard Model rho parameter	10
Electroweak pseudo-observables and Z-boson form factors at two-loop accuracy	10
Partonic structure of electron	10
Tools for higher loops	10
KKMCEE status and planning	10
Higgs and Electroweak ep Physics at FCC-eh	11
$ee \rightarrow H$	11
Particle ID with Dual Readout calorimeter	11
A beam test for the cluster counting technique	11
Monochromatization	11
quark/gluon discrimination	11
Flavour Tagging with ParticleNet	11
Strange Jet Tagging at FCCee using CNNs	12
$H \rightarrow ss$	12
Tau physics	12
Z-boson LFV	12
Probing B-Anomalies via Dimuon Tails at a Future Collider	12
Discovering true tauonium in two-photon fusion processes at FCC-ee	12
$B \rightarrow K^* \tau \tau$	12
$B_s \rightarrow \Phi\Phi$	13

Ks reconstruction and B+ to D K+	13
B to K* nu nu	13
Parton structure, forward physics and eA and FCC-eh	13
Overview of FCCSW and Key4HEP	13
Status of CLD Software	13
Status of IDEA software	14
Status of the FCC-ee LAr calorimeter software	14
Path to FCC-ee 0.01% Theoretical Luminosity Precision	14
Majorana vs Dirac Heavy Neutral Leptons	14
Flavour at FCC	14
Thanks	14

Welcome and overview / 1

Welcome to the 5th FCC Physics Workshop

Corresponding Author: c.p.welsch@liverpool.ac.uk

Welcome and overview / 2

Welcome and CERN vision

Corresponding Author: joachim.mnich@cern.ch

Welcome and overview / 3

The FCC feasibility study

Corresponding Author: michael.benedikt@cern.ch

Welcome and overview / 4

PED study introduction and goals of meeting

Corresponding Author: patrick.janot@cern.ch

Welcome and overview / 5

ECFA and the FCC

Corresponding Author: karl.jakobs@uni-freiburg.de

Welcome and overview / 91

The R&D on High Field Magnets

Corresponding Author: soprestemon@lbl.gov

Welcome and overview / 92

Recap of the FCC-ee physics potential and open questions

Corresponding Author: christophe.grojean@cern.ch

Welcome and overview / 93

Recap of the FCC-hh physics potential and open questions

Corresponding Author: monica.d'onofrio@cern.ch

Welcome and overview / 94

Recap of the FCC-eh physics potential and open questions

Corresponding Author: daniel.britzger@cern.ch

Higgs Physics / 95

FCC in America and the Snowmass process

Corresponding Author: sarah.eno@cern.ch

Higgs Physics / 96

Naturalness

Corresponding Author: mic.geller@gmail.com

Higgs Physics / 97

Higgs couplings and naturalness

Corresponding Author: ennio.salvioni@cern.ch

Higgs Physics / 98

Higgs Physics at CEPC

Corresponding Authors: li.gang@mail.ihep.ac.cn, ligang@ihep.ac.cn

Higgs Physics / 99

Higgs mass and ZH cross-section from Z(mumu)H events

Corresponding Authors: ang.l@cern.ch, jan.eysermans@cern.ch

Higgs Physics / 100

Higgs to invisible

Corresponding Authors: nikolaos.rompotis@cern.ch, andrew.mehta@cern.ch

Higgs Physics / 101

Hbb, Hcc, Hgg

Corresponding Author: giovanni.marchiori@cern.ch

Higgs Physics / 102

Higgs self-coupling

Corresponding Author: roberto.salerno@cern.ch

Higgs Physics / 103

HH in the bbtatau channel @ FCC-hh

Corresponding Author: matthew.james.sullivan@cern.ch

Di-higgs studies in the bb-tautau channel, and BSM Higgs searches at the FCC-hh,

Higgs Physics / 104

Detecting Heavy Higgs Bosons from Natural SUSY at a 100 TeV Hadron Collider

Corresponding Author: baer@nhn.ou.edu

Higgs Physics / 105

Di-Higgs with missing transverse momentum at FCC-hh

Corresponding Author: birgit.sylvia.stapf@cern.ch

Higgs Physics / 106

Unveiling the Higgs at FCC-hh with new diboson precision measurements

Corresponding Author: alejo.rossia@manchester.ac.uk

Next steps / 107

ECM calibration and Polarization status and plans

Corresponding Authors: jacqueline.keintzel@cern.ch, alain.blondel@cern.ch

Next steps / 108

Electroweak precision measurements status

Corresponding Author: juan.alcaraz@cern.ch

Next steps / 109

MDI status and plans

Corresponding Author: manuela.boscolo@cern.ch

Next steps / 110

Mandate for the Software and Computing Team

Corresponding Author: david.lange@cern.ch

Next steps / 111

Physics performance plans

Corresponding Authors: patrizia.azzi@cern.ch, emmanuel.perez@cern.ch

Next steps / 112

Physics Programme plans

Corresponding Authors: frank.simon@cern.ch, matthew.mccullough@cern.ch

Next steps / 113

Detector concepts plans

Corresponding Author: dam@nbi.dk

Next steps / 114

Closing remarks

Corresponding Author: guy.wilkinson@cern.ch

FCC Physics / 116

High-dimensional Anomaly Detection with Radiative Return in e^+e^- Collisions

Corresponding Author: julia.gonski@cern.ch

FCC Physics / 117

Discovery stories

Corresponding Author: tevong.you@cern.ch

FCC Physics / 118

Long-Lived Particles

Corresponding Author: juliette.alimena@cern.ch

FCC Physics / 119

Light BSM scalars at e^+e^- machines

Corresponding Author: tania.robens@cern.ch

FCC Physics / 120

Tera-Zooming in on light (composite) axion-like particles

Corresponding Author: g.cacciapaglia@ipnl.in2p3.fr

FCC Physics / 121

BSM & top Physics with FCC-eh

Corresponding Author: oliver.fischer@liverpool.ac.uk

FCC Physics / 122

Systematics in HEP

Corresponding Author: louis.lyons@cern.ch

Machine Detector Interface / 123

FCC-eh accelerator / IR and common hh detector

Corresponding Author: k.andre@cern.ch

Machine Detector Interface / 124

IP generated radiation monitor for center-of-mass energy measurements

Corresponding Author: andrea.ciarma@cern.ch

Machine Detector Interface / 125

Low angle luminosity monitoring

Corresponding Author: helmut.burkhardt@cern.ch

Machine Detector Interface / 126

MDI design integration

Corresponding Author: luigi.pellegrino@cern.ch

Machine Detector Interface / 127

The quadrupole QD0 for the SuperB interaction region

Corresponding Author: stefania.farinon@ge.infn.it

Machine Detector Interface / 128

Status of beam backgrounds in Belle II at SuperKEKB

Corresponding Author: natochii@hawaii.edu

Software / 129

Status of the software

Corresponding Author: gerardo.ganis@cern.ch

Software / 130

Lesson learned when migrating the IDEA drift chamber software to EDM4hep

Corresponding Author: lia.lavezzi@cern.ch

Software / 131

Lesson learned when migrating the IDEA DR calo software to DD4hep and to EDM4hep

Corresponding Authors: sanghyun.ko@cern.ch, roberto.ferrari@cern.ch, iacopo.vivarelli@cern.ch

Software / 132

FCC software step-by-step

Corresponding Author: valentin.volkl@cern.ch

Detector Concepts / 133

Noble Liquid Calorimetry for a Future FCC-ee Experiment

Corresponding Author: brieuc.francois@cern.ch

Detector Concepts / 134

Superconducting Detector Magnets for FCC-ee

Corresponding Author: nikkie.deelen@cern.ch

Detector Concepts / 135

The preshower and the muon detection system of the IDEA detector for FCC-ee

Corresponding Authors: gmezzadr@fe.infn.it, giulio.mezzadri@cern.ch

Detector Concepts / 136

Test Beam Results and R&D Programme for a Highly Granular Fibre-Sampling Dual-Readout Calorimeter

Corresponding Author: gabriella.gaudio@cern.ch

Detector Concepts / 137

CALICE overview

Corresponding Author: vincent.boudry@in2p3.fr

Detector Concepts / 138

Semi-Digital Hadronic Calorimeter

Corresponding Author: imad.baptiste.laktineh@cern.ch

Detector Concepts / 139

Combining Dual-Readout Crystals and Fibers in a Hybrid Calorimeter for IDEA

Corresponding Author: marco.toliman.lucchini@cern.ch

Detector Concepts / 140

DMAPS for large area FCC trackers

Corresponding Author: attilio.andreazza@cern.ch

Detector Concepts / 141

Large area curved silicon modules for future trackers

Corresponding Author: a.j.bevan@qmul.ac.uk

Detector Concepts / 142

A Triplet Track Trigger for FCC-hh & its impact on measuring the Higgs self-coupling

Corresponding Author: tamasi.kar@cern.ch

FCC Physics / 143

Event Generators & Parton Showers

Corresponding Authors: simon.plaetzer@desy.de, simon.platzer@cern.ch

FCC Physics / 144

Jet energy spectrum and substructure in $e+e^-$ collisions at 91.2 GeV

Corresponding Author: yen-jie.lee@cern.ch

FCC Physics / 145

Hadronization corrections in event shapes

Corresponding Authors: s.ferrarioravasio@campus.unimib.it, silvia.ferrarioravasio@gmail.com

146

Alpha_s extractions from jets

FCC Physics / 147

A Robust Measure of Event Isotropy at Colliders

Corresponding Author: cjc359@cornell.edu

FCC Physics / 148

Path to precision

Corresponding Author: afreitas@pitt.edu

FCC Physics / 149

Three-loop elliptic integrals for the Standard Model rho parameter

Corresponding Author: samuel.abreu@cern.ch

FCC Physics / 150

Electroweak pseudo-observables and Z-boson form factors at two-loop accuracy

Corresponding Author: johann.usovitsch@cern.ch

FCC Physics / 151

Partonic structure of electron

Corresponding Authors: stefano.frixione@cern.ch, frixs@cern.ch

FCC Physics / 152

Tools for higher loops

Corresponding Author: janusz.gluza@cern.ch

FCC Physics / 153

KKMCee status and planning

Corresponding Author: stanislaw.jadach@cern.ch

Higgs Physics / 154

Higgs and Electroweak ep Physics at FCC-eh

Corresponding Author: christian.schwanenberger@cern.ch

Higgs Physics / 155

ee -> H

Corresponding Author: david.d'enterria@cern.ch

Higgs Physics / 156

Particle ID with Dual Readout calorimeter

Corresponding Authors: lucatorresiemail@gmail.com, luca.torresi@roma1.infn.it

Higgs Physics / 157

A beam test for the cluster counting technique

Corresponding Author: francesco.grancagnolo@cern.ch

Higgs Physics / 158

Monochromatization

Corresponding Author: frank.zimmermann@cern.ch

Higgs Physics / 159

quark/gluon discrimination

Corresponding Author: gregory.soyez@cern.ch

Higgs Physics / 160

Flavour Tagging with ParticleNet

Corresponding Authors: michele.selvaggi@cern.ch, loukas.gouskos@cern.ch

Higgs Physics / 161

Strange Jet Tagging at FCCee using CNNs

Corresponding Authors: eduardo.ploerer@cern.ch, eduardo.ploerer@vub.be

Higgs Physics / 162

H \rightarrow ss

Corresponding Author: valentina.maria.cairo@cern.ch

Flavour at FCC / 164

Tau physics

Corresponding Author: alberto.lusiani@cern.ch

Flavour at FCC / 165

Z-boson LFV

Corresponding Author: xabier.marcano@uam.es

Flavour at FCC / 166

Probing B-Anomalies via Dimuon Tails at a Future Collider

Corresponding Author: sebastian.jaeger@cern.ch

Flavour at FCC / 167

Discovering true tauonium in two-photon fusion processes at FCC-ee

Corresponding Authors: erdisshaw@gmail.com, david.d'enterra@cern.ch

Flavour at FCC / 168

B to K^* tau tau

Corresponding Author: tristan.miralles@etu.uca.fr

Flavour at FCC / 169

Bs to PhiPhi

Corresponding Author: roy.aleksan@cea.fr

Flavour at FCC / 170

Ks reconstruction and B^+ to $D K^+$

Corresponding Author: emmanuel.perez@cern.ch

Flavour at FCC / 171

B to K^* nu nu

Corresponding Author: matthew.william.kenzie@cern.ch

FCC Physics / 172

Parton structure, forward physics and eA and FCC-eh

Corresponding Author: kpiotrz@gmail.com

Joint Software, Physics Performance and Detector session / 173

Overview of FCCSW and Key4HEP

Corresponding Author: clement.helsens@cern.ch

Joint Software, Physics Performance and Detector session / 174

Status of CLD Software

Corresponding Author: andre.philippe.sailer@cern.ch

Joint Software, Physics Performance and Detector session / 175

Status of IDEA software

Corresponding Author: walaa.elmetenawee@cern.ch

Joint Software, Physics Performance and Detector session / 176

Status of the FCC-ee LAr calorimeter software

Corresponding Author: brieuc.francois@cern.ch

FCC Physics / 177

Path to FCC-ee 0.01% Theoretical Luminosity Precision

Corresponding Authors: bfl_ward@baylor.edu, bennie.ward@cern.ch

Path to FCC-ee 0.01% Theoretical Luminosity Precision with an Eye toward Synergies with Other FCC Precision Theory Requirements and toward Recent Developments

FCC Physics Neutrinos and Flavour / 178

Majorana vs Dirac Heavy Neutral Leptons

Corresponding Author: richard.physics@gmail.com

FCC Physics Neutrinos and Flavour / 179

Flavour at FCC

Corresponding Author: jernej.kamenik@ijs.si

Next steps / 180

Thanks

Corresponding Author: alain.blondel@cern.ch