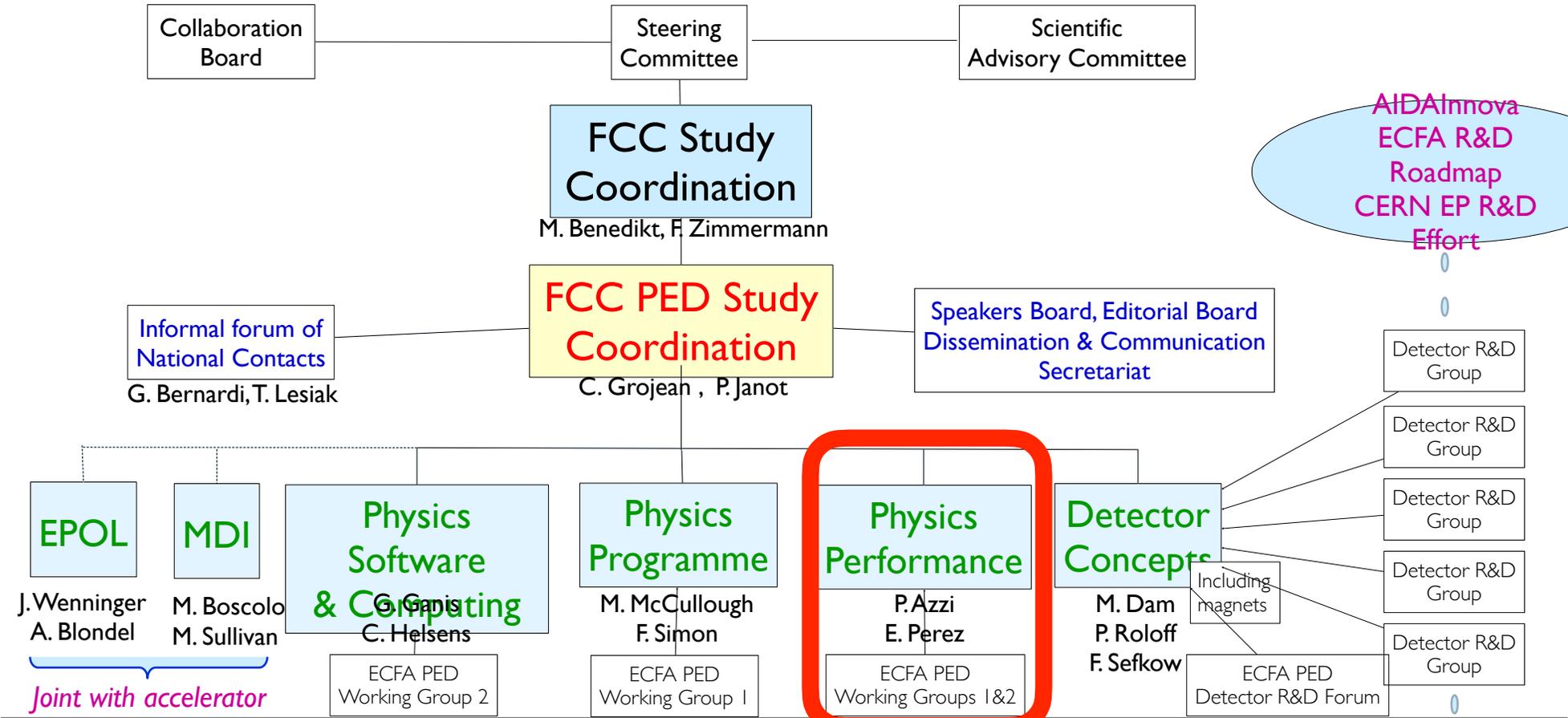# Plans for Physics Performance

FCC Physics Week - 11/02/2022

P. Azzi (INFN-PD/CERN), E. Perez(CERN)

P. Janot

Tailored PED pillar organisation & conveners

Collaboration Board — Steering Committee — Scientific Advisory Committee

FCC Study Coordination
M. Benedikt, F. Zimmermann

FCC PED Study Coordination
C. Grojean , P. Janot

Informal forum of National Contacts
G. Bernardi, T. Lesiak

Speakers Board, Editorial Board
Dissemination & Communication
Secretariat

AIDAInnova
ECFA R&D
Roadmap
CERN EP R&D
Effort

EPOL
J. Wenninger
A. Blondel

MDI
M. Boscolo
M. Sullivan

Joint with accelerator

Physics Software & Computing
G. Ganis
C. Helsens
ECFA PED Working Group 2

Physics Programme
M. McCullough
F. Simon
ECFA PED Working Group 1

Physics Performance
P. Azzi
E. Perez
ECFA PED Working Groups 1&2

Detector Concepts
M. Dam
P. Roloff
F. Sefkow
Including magnets
ECFA PED Detector R&D Forum

Detector R&D Group
Detector R&D Group
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Detector R&D Group
Detector R&D Group

WE ARE HERE

A. Blondel, C. Grojean, P. Janot

FCC Physics Workshop, Liverpool
11 Feb 2022

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Introduction

FCC

* Physics Performance (PPe) WP is the forum where the following aspects come together:

    * Studying in depth the most significant benchmark measurements

    * Developing the software tools for event reconstruction and analysis

    * Extracting the detector requirements

    * Exploring the performance of innovative ideas for detector design

* All these can only happen in tight coordination with the Physics Programme, the Software and the Detector Concepts WP areas and activities

    * Overlap also of technical topics between PPg and PPe, for instance generators and treatment of systematics.

Case Studies

>>>**"Case Studies":** reverse engineering of a chosen benchmark process. The elements contributing to the final results are "unpacked" to allow maximal optimisation on all aspects.

✤ Develop optimal reconstruction algorithms that fully exploit the statistics, detector information and new techniques

✤ Develop calibration strategies and analysis techniques to shrink the uncertainties as needed

✤ Study the effect of the detector simulation on the systematics

✤ Extract requirements to achieve desired performance on:

  ✤ Detectors [-> *Detector Concepts*]

  ✤ Simulation of machine conditions [->*MDI]*

  ✤ Event generation [-> *Physics Programme*]

The first ~year experience

✤ « case studies » have generated a very nice momentum

✤ Need to acknowledge that:

   ✤ 1) people have small fraction of their time for these analysis

   ✤ 2) software environment is new and in development

   ✤ 3) most totally new to e+e- physics

✤ Effort on collecting the information in a clear and useful way on Git:

   ✤ **https://hep-fcc.github.io/FCCeePhysicsPerformance/**

   ✤ **https://github.com/HEP-FCC/FCCeePhysicsPerformance**

   ✤ Practical Informations (meetings, datasets…)

   ✤ Instructions and examples on FCCAnalysis

   ✤ Directories by "topic" collecting material related to the "case studies" (available to the analysers)

Lesson learned

- Concerning analysis: increasing number of users of the FCCAnalysis model:
  - Work to improve the initial examples
  - Profit of the collaborative aspect of this approach
- Centralised MonteCarlo datasets very useful:
  - Validation helped by the analysts
  - Turnaround on bug fixes on best effort
- Fast Simulation with Delphes excellent solution to get started
  - Additional tools developed
  - Better tracking & vertexing
  - Easy to fix/modify in standalone. Recipe to re-run in FCCSW.
  - Need more work to expand also the EDM4HEP content
- FullSim becoming available:
  - First transition of analysis from Delphes to FullSim shown this week. Nearly transparent thanks to FCCAnalysis.
  - Usage of FullSim ramping up for the near future

Snapshot of ongoing activities in PPe

HIGGS

Mass and XS in HZ

Invisible Higgs

$H \to b\bar{b}, c\bar{c}, q\bar{q}, s\bar{s}$

couplings

Higgs self-coupling

FLAVOUR

$B_c \to \tau\nu$

$B_s \to D_s K$

$B^+ \to D^0 K^+$

$B_s \to K^*\tau\tau$

$B_s \to \phi\phi$

$B \to K^*\nu\nu$

EWK
Z Peak
$A_{FB}(bb, cc)$
W polarization

TOP
EWK couplings
FCNC

QCD
Alpha_s

BSM
LLP
Axions

Italic: not presented at this workshop

✤ Critical mass on Higgs physics not surprising

✤ Large interest on Flavour shows the critical role of Tera-Z and precision in detector requirements

✤ Increasing interest in BSM, now moving from theory models to experimental case studies

✤ Need to increase the experimental studies for the EWK precision

Snapshot of cross-analyses topics

❖ Several cross-analysis activities identified (excellent discussion during this workshop)

❖ Topics to be discussed in specific working meetings or in the general Physics Performance.

Jet reconstruction

Exploring most appropriate choices

MC Truth association

Vertexing

Studying displaced vertices

Particle ID

Implementing PID techniques in EDM4HEP

Isolation

Jet Flavour tagging

Comparing different approaches

Kinematical fits

…more can come up!

New structure

- Appointing Experimental Conveners for the Physics Groups, common between Physics Performance and Physics Programme
- The various sub-groups are invited to organise their own working meetings
  - Monthly Physics Programme/Performance meeting devoted to mature results or common topics

HIGGS	Michele Selvaggi (CERN), Jan Eyserman (MIT)
EWK	Christoph Paus(MIT), TBC
FLAVOR+TAU	Stephane Monteil(Clermont), Alberto Lusiani(Pisa)
BSM	R. Gonzalez Suarez(Uppsala), Giacomo Polesello(Pavia)
QCD	David D'Enterria(CERN), TBC
TOP	TBC, TBC

Short-term plans for the PPe

FCC

* Finalize the team of conveners

* Organize a "Physics Coordination" meeting with the conveners.

    * An opportunity to welcome to FCC colleagues that have mostly a pp experience

    * Profiting also of their feedback, produce a clear mandate for the PPe conveners.

* Facilitate the transition to new structure: help organise sub-group "working meetings"

    * Maybe have "kick-off" meetings for groups with smaller critical mass at the moment. With proposals for studies that could be started with the current tools.

* Revise the scope and content of the Physics Performance monthly meeting

    * Focus on more "mature" presentations or on "cross-topics" (which might need their own working meetings as well)

* New round of production of central samples.

    * Address known issues on the generator side

    * Fixing some features in Delphes

    * Add new content to EDM4HEP (in collaboration with SW and Key4Hep group)

Toward the June FCC Week

✤ Push first studies with FullSim:

  ✤ use the existing CLD workflow to debug and put together the missing pieces (e.g. the MC associations, etc.)

  ✤ Testing FullSim description of IDEA

✤ Flavour tagging algorithms:

  ✤ Comparison between different algos in FCCAnalysis

  ✤ Comparison between FullSim(CLD) and Delphes

✤ Publishing Internal Notes on more advanced analyses:

  ✤ With detector requirement information

  ✤ Start having in place also some internal review for material to become public (in conjunction with Phys. Programme)

Summary

- The start of the Physics Programme activities will nicely merge and complement ongoing work

  - Through the proposal of new benchmarks to extend the physics potential exploration using the tools developed within PPe

  - Common Experimental Conveners most efficient way to achieve the program

- The start of the Detector Concept Coordination area will help speed up the development of FullSimulation response to explore new design and technologies

  - A nice feedback from "case studies" result will inform and guide detector designs

  - Incorporating TestBeam data for more realistic checks of performance values in simulation

- Physics Performance is an excellent forum for experimentalists to explore the physics potential of the FCC-ee on a specific process using their favorite detector or algorithm.

  - We are mindful of the importance of being active on LHC (or other running experiments) and everything is in place to facilitate the participation and the feasibility of achieving interesting results