



4th FCC / DRD France Workshop, Strasbourg (Nov.22-24/2023)

Status of the Key4hep Ecosystem

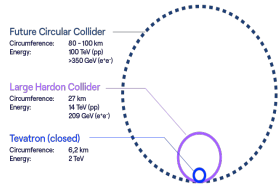
[J.M. Carceller, 2nd ECFA Workshop 2023](#)

[A. Tolosa-Delgado, 2nd ECFA Workshop 2023](#)

[B. François, 2nd ECFA Workshop 2023](#)

Ambitious physics studies

Physics Landscape @ FCCee



Detector requirement @ FCCee

Higgs
factory
 m_H, σ, Γ_H
self-coupling
 $H \rightarrow bb, cc, ss, gg$
 $H \rightarrow inv$
 $ee \rightarrow H$
 $H \rightarrow bs, \dots$

Top
 $m_{top}, \Gamma_{top}, ttZ, FCNCs$

Flavor
“boosted” B/D/ τ factory
CKM matrix
CP measurements
Charged LFV
Lepton Universality
 τ properties (lifetime, BRs..)
 $B_c \rightarrow \tau \nu$
 $B_s \rightarrow D_s K$
 $B_s \rightarrow K^* \tau \tau$
 $B \rightarrow K^* \nu \nu$
 $B_s \rightarrow \phi \nu \nu \dots$

QCD – EWK
most precise SM test
 $m_Z, \Gamma_Z, \Gamma_{inv}$
 $\sin^2\theta_W, R_Z^\ell, R_b, R_c$
 $A_{FB}^{b,c}, \tau$ pol.
 α_S
 m_W, Γ_W

BSM
feebly interacting particles
Heavy Neutral Leptons (HNL)
Dark Photons Z_D
Axion Like Particles (ALPs)
Exotic Higgs decays

Higgs
factory
track momentum
resolution (low X_0)
IP/vertex resolution for
flavor tagging
PID capabilities for flavor
tagging
Hadron energy resolution
(stochastic and noise)
and PF

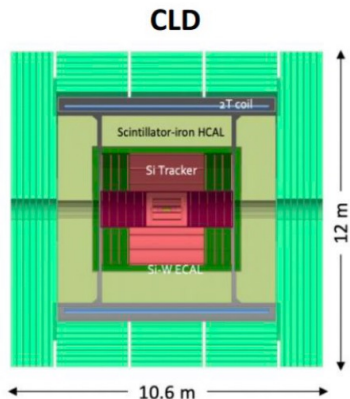
Flavor
“boosted” B/D/ τ factory
track momentum
resolution (low X_0)
IP/vertex resolution
PID capabilities
Photon resolution, π_0
reconstruction

QCD – EWK
most precise SM test
acceptance/alignment
knowledge to 10 μm
magnetic field uniformity
lumiCal coverage down
to 60 mrad

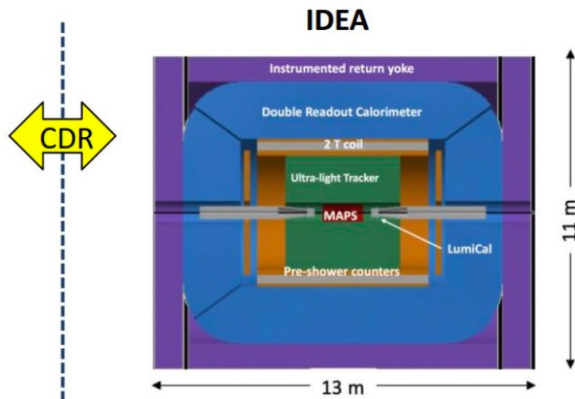
BSM
feebly interacting particles
Large decay volume
High radial segmentation
- tracker
- calorimetry
- muon
impact parameter
resolution for large
displacement
triggerless

[M. Selvaggi, FCC Week 2023](#)

Detector concepts

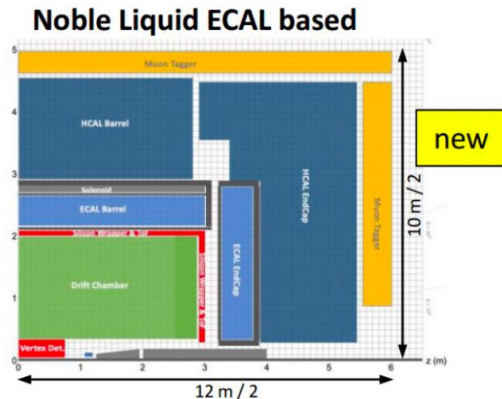


- Well established design
 - ILC -> CLIC detector -> CLD
- Full Si vtx + tracker;
- CALICE-like calorimetry;
- Large coil, muon system
- Engineering still needed for operation with continuous beam (no power pulsing)
 - Cooling of Si-sensors & calorimeters
- Possible detector optimizations
 - σ_p/p , σ_E/E
 - PID ($\mathcal{O}(10\text{ ps})$ timing and/or RICH)?



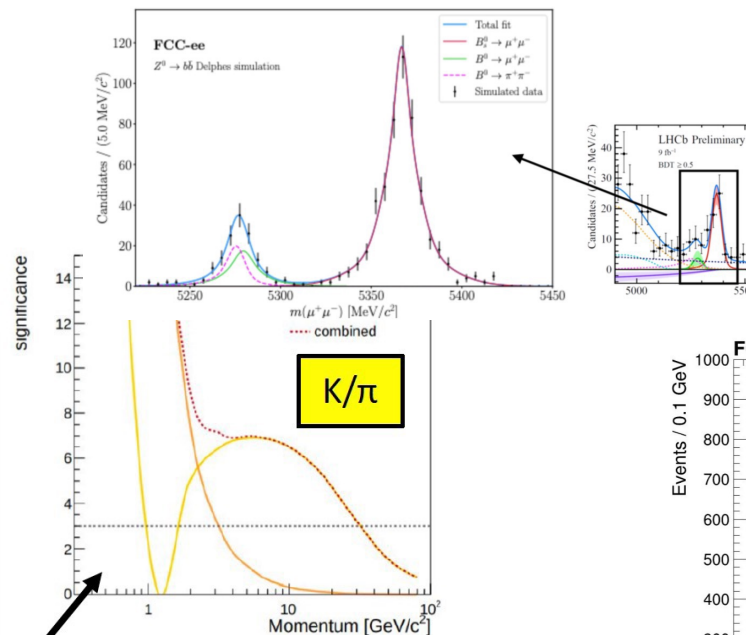
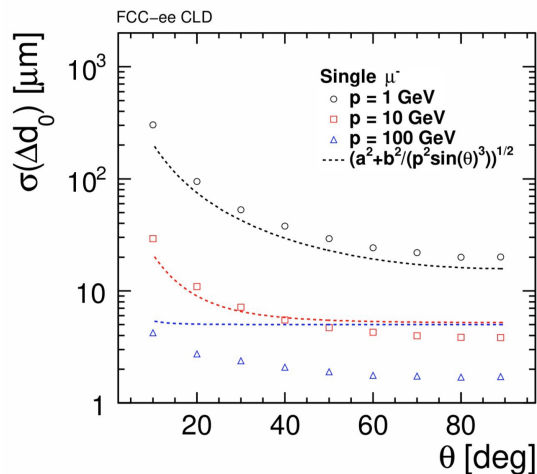
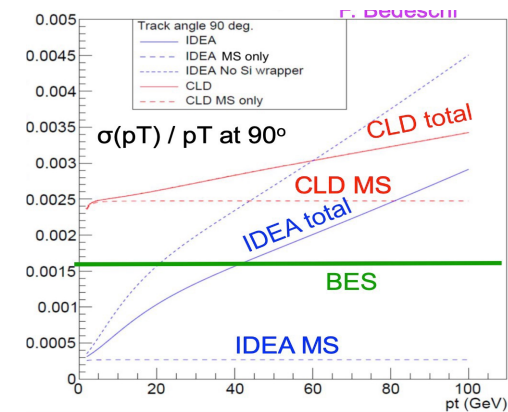
- A bit less established design
 - But still ~15y history
- Si vtx detector; ultra light drift chamber w powerful PID; compact, light coil;
- Monolithic dual readout calorimeter;
 - Possibly augmented by crystal ECAL
- Muon system
- Very active community
 - Prototype designs, test beam campaigns, ...

FCC-ee CDR

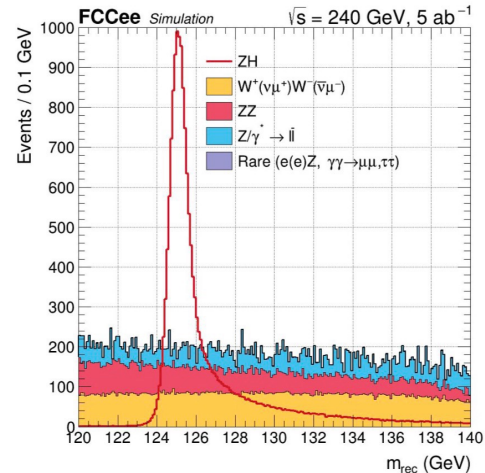
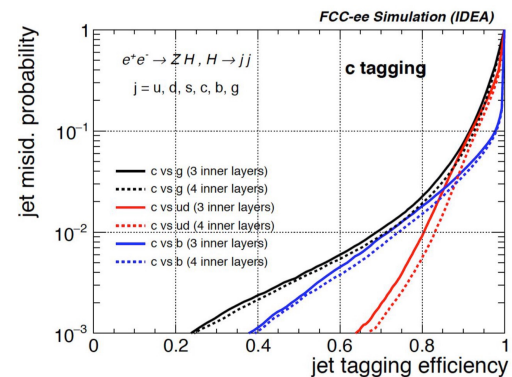


- A design in its infancy
- Si vtx det., ultra light drift chamber (or Si)
- High granularity Noble Liquid ECAL as core
 - Pb/W+LAR (or denser W+LKr)
- CALICE-like or TileCal-like HCAL;
- Coil inside same cryostat as LAR, outside ECAL
- Muon system.
- Very active Noble Liquid R&D team
 - Readout electrodes, feed-throughs, electronics, light cryostat, ...
 - Software & performance studies

Exploring new physics...



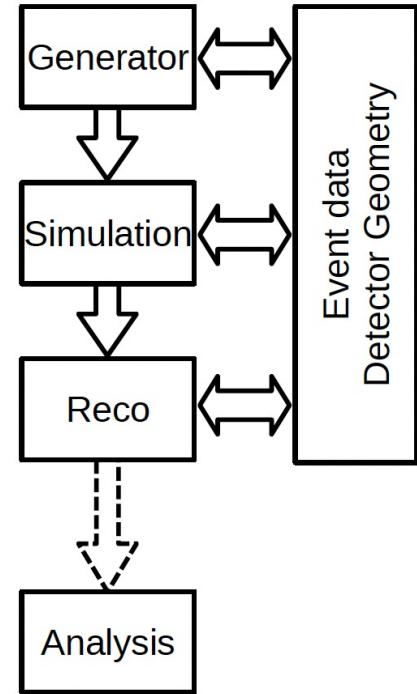
3-sigma separation for tracks with $p < 30$ GeV



The key4HEP Software Ecosystem

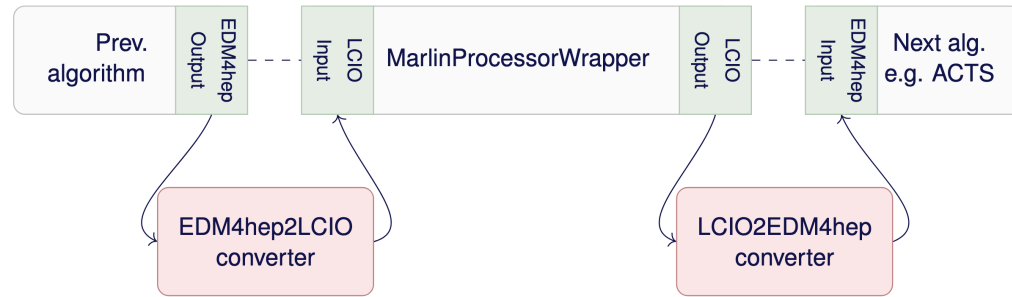
[A. Tolosa-Delgado, 2nd ECFA Workshop 2023](#)

- [Key4hep](#) software stack aimed to be a common tool for e+e- colliders:
 - CLIC, FCC, ILC, C³, CEPC.
- Data format is [EDM4hep](#)
- Detector Geometry built by DD4hep (Based on Geant4)
 - Central repository for geometry: [k4geo](#) (ALLEGRO, CLD, IDEA)
- Actions are a [Gaudi](#) service/tool/alg
 - Several repositories for reconstruction
- A dedicated framework for analysis

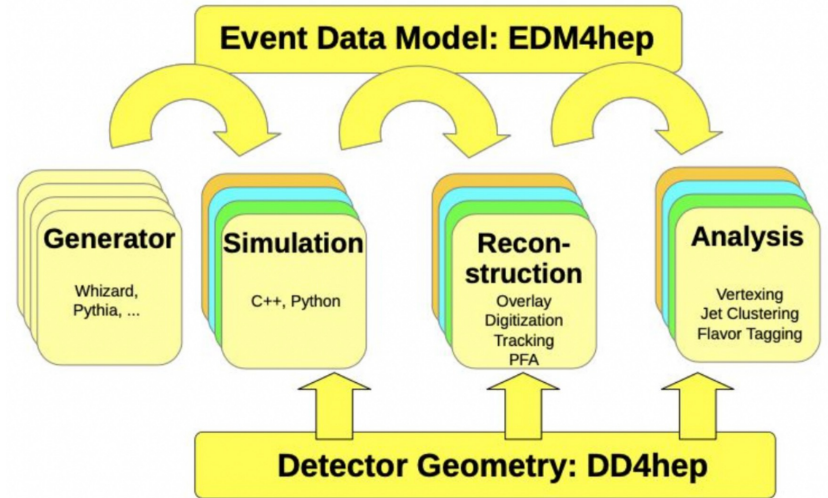
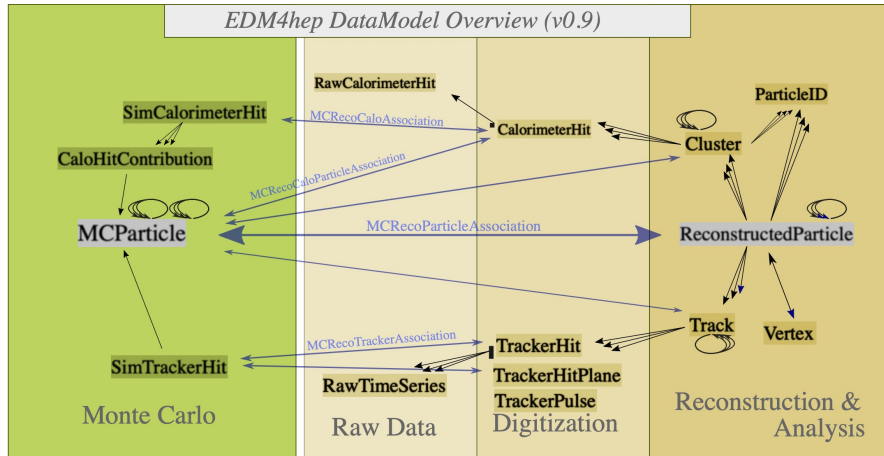


Inheritance from the ILCSoftware

- ILC community has a very advanced simulation toolkit and it has strongly influenced the central key4HEP components (*DD4hep* and *edm4hep*).
- Availability of MarlinWrapper and data format (LCIO ↔ EDM4hep) conversion were extremely valuable for the launching of key4hep.



EDM4hep Data Model



New functionalities

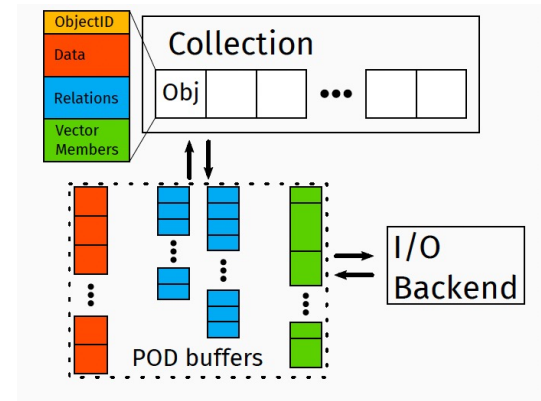
(definitely not an exhaustive overview)

Podio : a need for a versatile EDM

[T. Madlener et al., vCHEP 2021](#)

[AIDAsoft/podio](#)

- Original HEP c++ EDMs are heavily Object Oriented
 - Deep inheritance structures
 - Thread-safety can be hard
 - Objects scattered in memory
- Data access can be slow with these approaches
- Use podio to generate thread-safe code starting from a high level description of the desired EDM
 - Users are isolated from implementation details
 - Target different I/O backends for persistence
 - Provide an easy-to-use interface to the users
- Users should not need to worry about resource management
- Python is used as first choice programming language

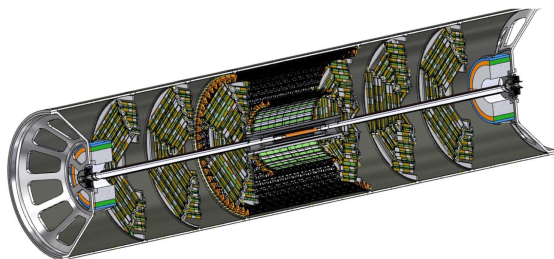


I/O Podio (flattening)

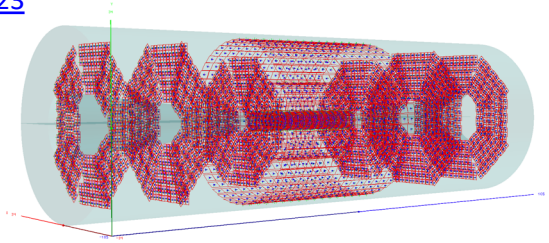
Geometry import from Computer Aided Design

• IDEA:

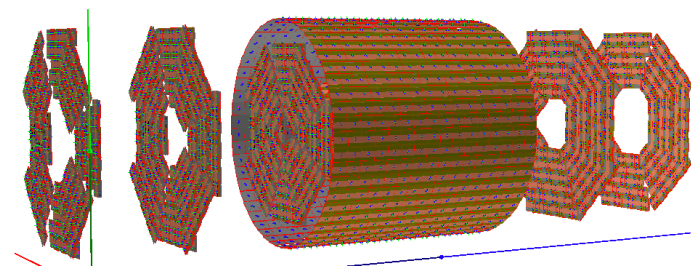
- Sensitive surfaces in IDEA vertex implementation in DD4hep
- Vertex detector geometry based on Arcadia sensors imported from CAD



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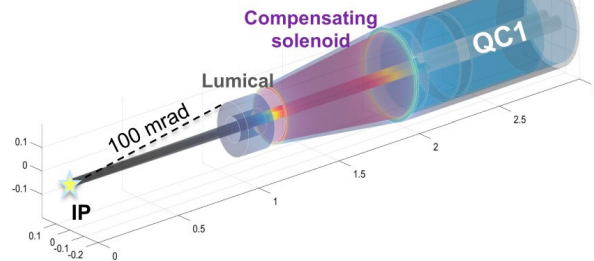


[F. Palla, 2nd ECFA Workshop 2023](#)



3D view

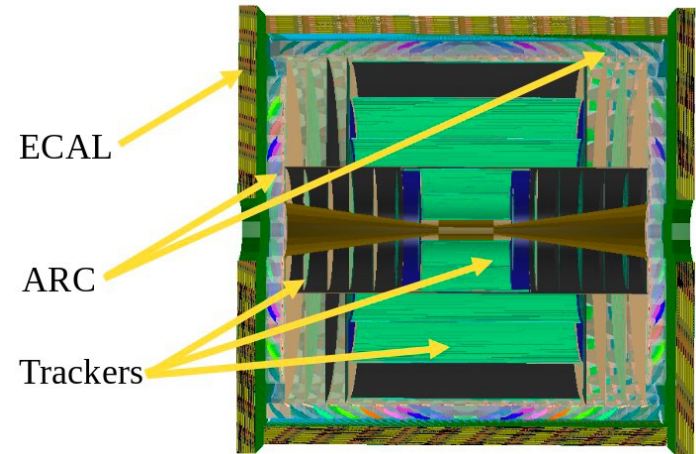
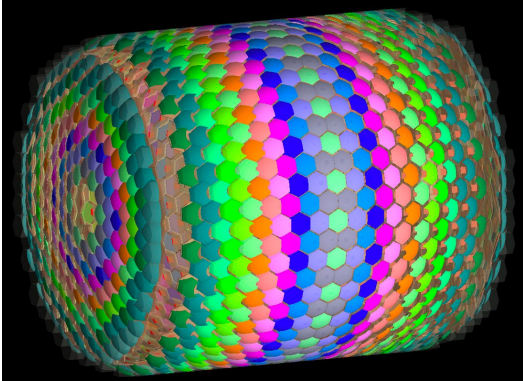
screening solenoid



[A. Tolosa-Delgado, 2nd ECFA Workshop 2023](#)

ARC Implementation in CLD

- New option of CLD to accommodate ARC (Array RICH Cells) subdetector Cerenkov-based detector
- RICH detectors are suitable for particle identification at high momentum
- Work in geometry optimization, digitization and reconstruction algorithms is ongoing



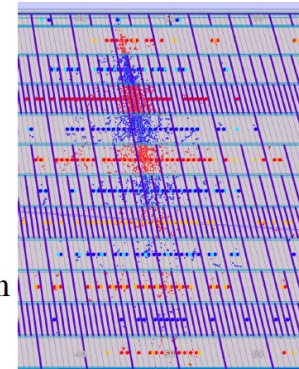
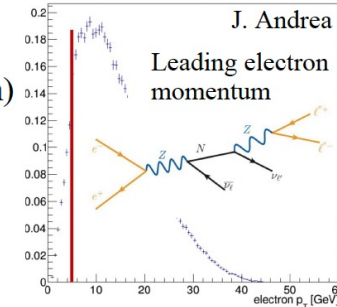
[A. Tolosa-Delgado, 2nd ECFA Workshop 2023](#)

Highlights from FCC-ee

B. François, 2nd ECFA Workshop 2023



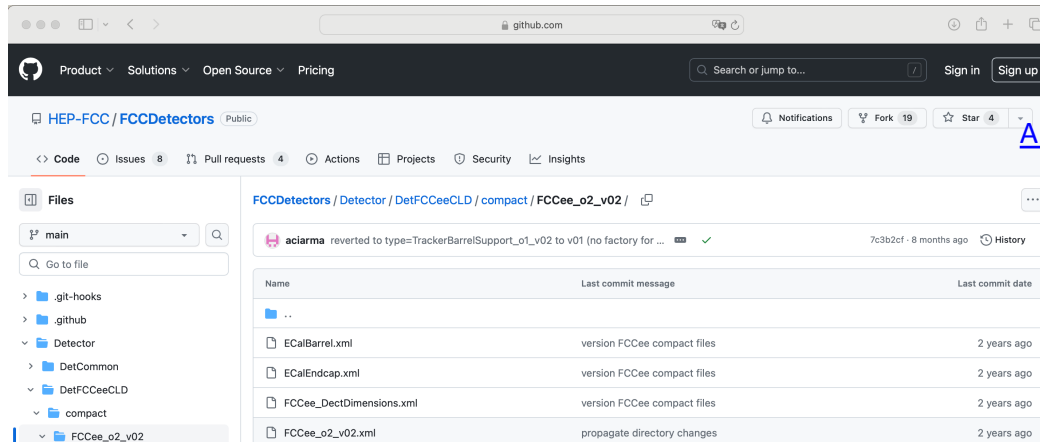
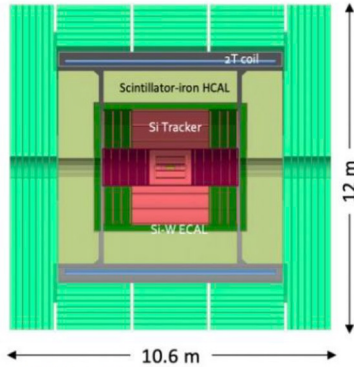
- 4 IP (baseline), 3 detector concepts (so far) under development/optimization
 - Detailed **beampipe**: **CAD drawing imported in DD4hep**, PR opened
 - Luminosity measurement studies starting
 - **CLD**: **fully available** in Key4hep (DD4hep, ddsim, ILCSoft reconstruction)
 - **First Full Sim physics analysis (HNL) starting!**
 - **IDEA**: many components were developed in standalone Geant4
 - Whole detector **being implemented in DD4hep/Key4hep**
 - Most sub-detectors are at the digitization/reconstruction step
 - **ALLEGRO**: new concept based on IDEA with different calorimeters
 - Started right away with Key4hep in mind
 - **ECAL and HCAL available**, will adapt the other IDEA sub-detectors
- Efficient **calorimeter granularity optimization** strategy
 - Time consuming Geant4 simulation with 'atomic' granularity
 - Multiple readout granularities defined at digitization step, from one simulation
 - Now possible to have different cell size per longitudinal layer
- Detector geometries ported in **k4geo** (already hosting ILC and CLIC detectors)



G. Marchiori

A common repository for detector description

CLD

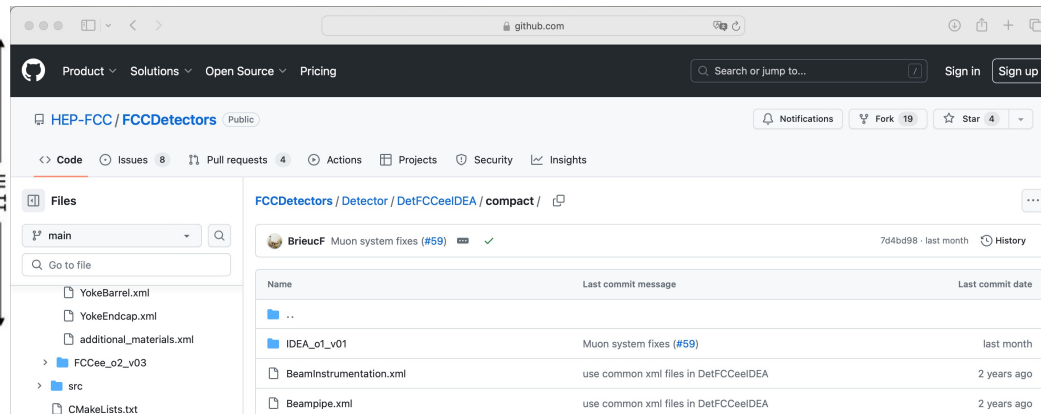
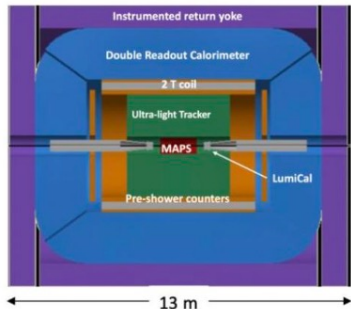


[A. T-Delgado, 2nd ECFA Workshop 2023](#)

[A. Sailer, 2nd ECFA Workshop, 2023](#)

[CLD Detector Description](#)

IDEA



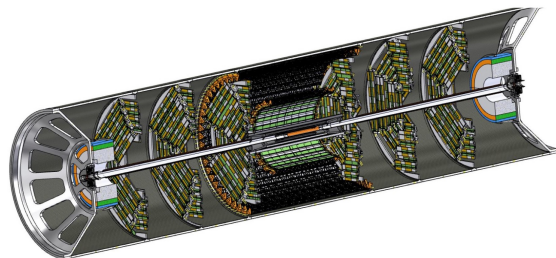
[A. Ilg, FCC Week 2023](#)

[F. M. Procacci, 2nd ECFA Workshop](#)

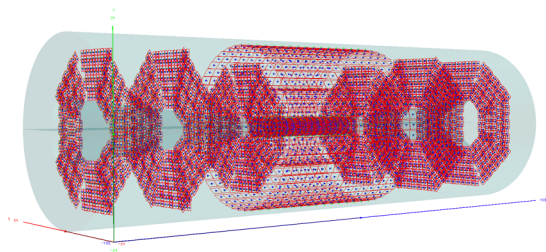
[IDEA Detector Description](#)

A case study: implementation of IDEA Vertex Detector with Key4HEP

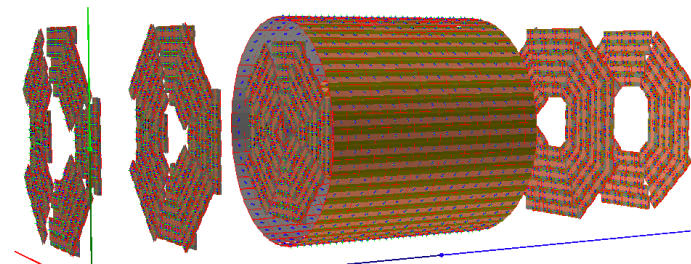
Sensitive surfaces in IDEA vertex implementation in DD4hep
Vertex detector geometry based on Arcadia sensors imported from CAD



[A. Ilg, FCC Week 2023](#)



[F. Palla, 2nd ECFA Workshop 2023](#)



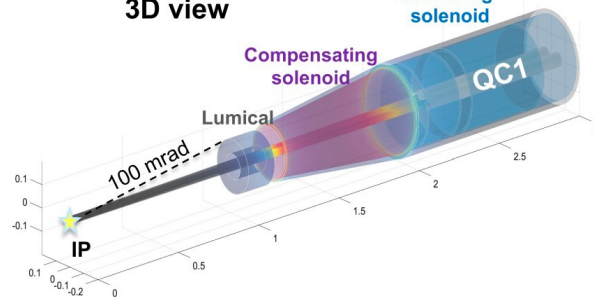
3D view

screening solenoid

Compensating solenoid

Lumical

QC1



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Run simulation on detector compact file (xml), using FCC steering file to generate EDM4hep output:

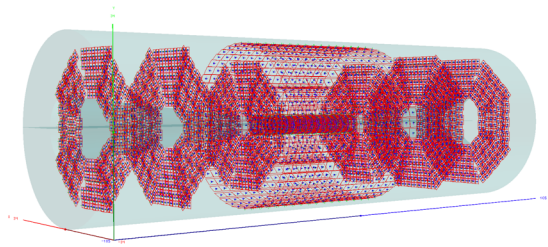
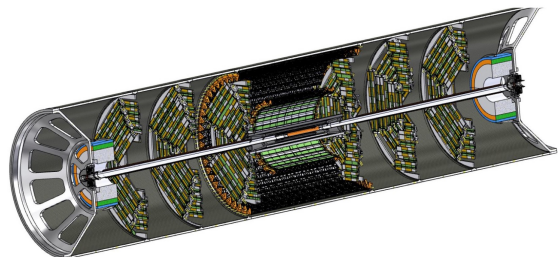
```
ddsim --compactFile k4geo/FCCee/compact/FCCee_IDEA_o01_v01.xml  
--enableGun --gun.thetaMin 9.999 --gun.thetaMax 10.001  
--gun.distribution uniform --gun.energy 10*GeV --gun.particle mu-  
--steeringFile fcc_steer.py --numberOfEvents 1000  
--outputFile ddsim_edm4hep.root
```

Run linear collider reconstruction ([iLCSof](#)/[CLICPerformance](#)) using [k4MarlinWrapper](#):

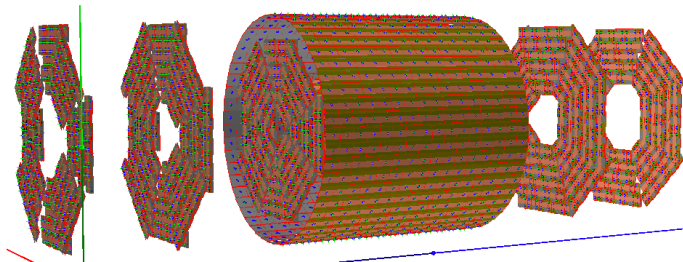
```
k4run fccRec_e4h_input.py --EventDataSvc.input  
ddsim_edm4hep.root -n 1000
```

A case study: implementation of IDEA Vertex Detector with Key4HEP

Sensitive surfaces in IDEA vertex implementation in DD4hep
Vertex detector geometry based on Arcadia sensors imported from CAD



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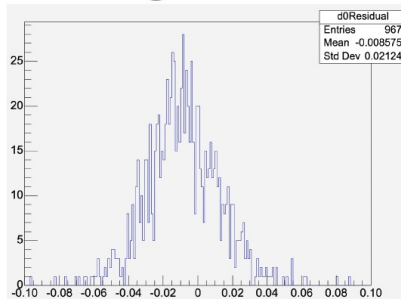
Run simulation on detector compact file (xml), using FCC steering file to generate EDM4hep output:

```
ddsim --compactFile k4geo/FCCee/compact/FCCee_IDEA_o01_v01.xml  
--enableGun --gun.thetaMin 9.999 --gun.thetaMax 10.001  
--gun.distribution uniform --gun.energy 10*GeV --gun.particle mu-  
--steeringFile fcc_steer.py --numberOfEvents 1000  
--outputFile ddsim_edm4hep.root
```

Run linear collider reconstruction ([iLCSOft/CLICPerformance](#)) using [k4MarlinWrapper](#):

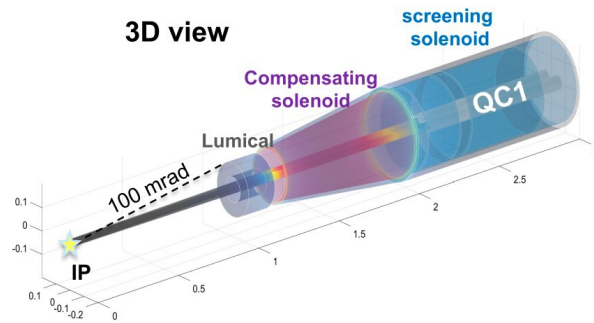
```
k4run fccRec_e4h_input.py --EventDataSvc.input  
ddsim_edm4hep.root -n 1000
```

...inserting IDEA vertex



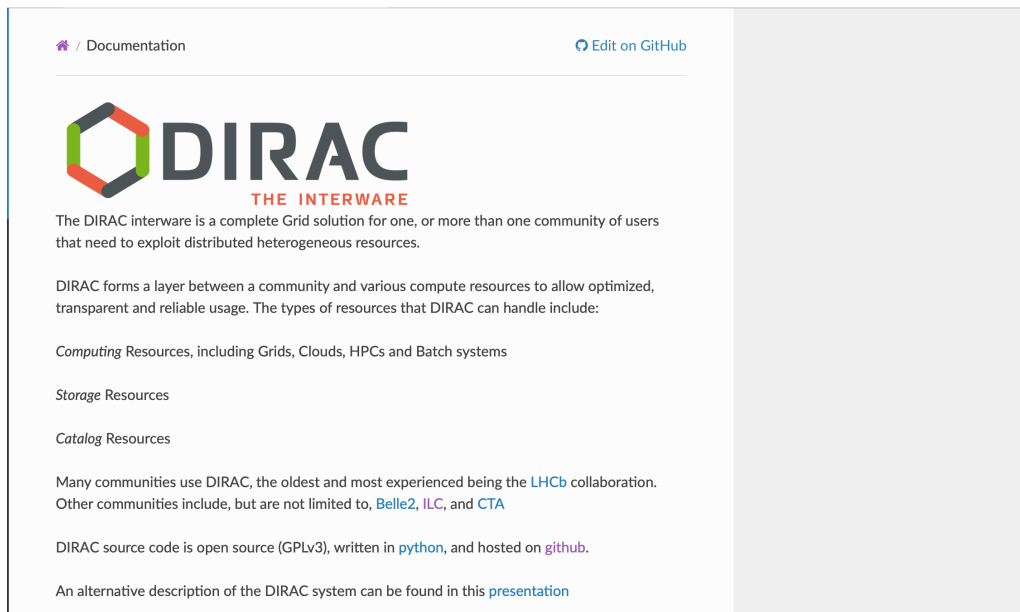
D_0 resolution in mm.

3D view



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Need for massive production



The screenshot shows the top portion of a web page for DIRAC documentation. At the top left, there is a home icon followed by the text "/ Documentation". At the top right, there is a link that says "Edit on GitHub". Below this is the DIRAC logo, which consists of a stylized hexagon with green and red sides and the text "DIRAC" in large black letters, with "THE INTERWARE" in smaller red letters underneath. The main content area contains several paragraphs of text describing the DIRAC interware, its purpose, and the types of resources it handles. The text is left-aligned and includes several hyperlinks.

🏠 / Documentation [Edit on GitHub](#)

DIRAC

THE INTERWARE

The DIRAC interware is a complete Grid solution for one, or more than one community of users that need to exploit distributed heterogeneous resources.

DIRAC forms a layer between a community and various compute resources to allow optimized, transparent and reliable usage. The types of resources that DIRAC can handle include:

- Computing Resources*, including Grids, Clouds, HPCs and Batch systems
- Storage Resources*
- Catalog Resources*

Many communities use DIRAC, the oldest and most experienced being the [LHCb](#) collaboration. Other communities include, but are not limited to, [Belle2](#), [ILC](#), and [CTA](#)

DIRAC source code is open source (GPLv3), written in [python](#), and hosted on [github](#).

An alternative description of the DIRAC system can be found in this [presentation](#)

Mastering the workflow for Dirac

Generation :
MadGraph, Pythia
(data
format:hepMC)

Simulation:
ddsim

Reconstruction and
Analysis

Translate into Dirac ...

```
DDSIM-Multiple.py
DDSIM-Multiple
DDSIM-Multiple No Selection
1 From DIRAC.Core.Base.Imports
2 Script.setCommandLine()
3
4 from L1DIRAC.Interfaces.API.DiracLIC import DiracLIC
5 from L1DIRAC.Interfaces.API.NewInterface.UserJob import UserJob
6 from L1DIRAC.Interfaces.API.NewInterface.Applications import DDSim
7
8 NEventsPerJob=3000
9 for i in range(1, 88):
10
11     job = UserJob()
12     job.setCPUTime(3000)
13     job.setName("DDSIM_tttbar_M_ %s")
14     dfile = DiracLIC()
15
16     job.setInputSandBox(["DDSIM-Multiple.py", "fcc_steer.py"])
17
18 # Note: if you run on debug mode, and log file may be too big, which could not be written out.
19 job.setOutputSandBox(["*_log_*", "_*.xml", "*_*.py"])
20 # job.setOutputFile("LOG_2009.py")
21 job.setOutputFile("LOG_0309.ch")
22 InputFileName = "dirac-lic-logs/DDSIM/InputData/tttbar_10000Events_v05.hmc"
23 # job.setInputData([InputFileName])
24 job.setOutputData(["%s-%s"] % i)
25 InputData = []
26
27 ddsim = DDSim()
28
29 # Note: you have to use the above tool "dirac-lic-show-softname" to find out the right/available tag name for your study.
30 ddsim.setVersion("keyhep_2008B")
31 ddsim.setVersion("keyhep_01p11")
32
33 # ddsim.setDetectorModel("FCO_v02.tar.gz")
34 ddsim.setDetectorModel("FCO_000")
35 ddsim.setInputFile("LFN:/dirac-lic-logs/DDSIM/InputData/tttbar_10000Events_v05.hmc")
36
37 ddsim.setSteeringFile("fcc_steer.py")
38 ddsim.setNuberOfEvents(NEventsPerJob)
39
40 Nkappa=1000000
41 ddsim.setStartFromNkappaEvents()
42 OutputFileName = "ttbar_*str(i)*_nightly.sicla"
43 ddsim.setOutputFile(OutputFileName)
44
45
46 InputData.append(OutputFileName)
47 res = job.append(ddsims)
48
49 if not res['OK']:
50     print "res['Not ok appending ddsim to job']"
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DDSIM

```
Gaudi-Multiple.py
Gaudi-Multiple
Gaudi-Multiple No Selection
1 From DIRAC.Core.Base.Imports
2 Script.setCommandLine()
3
4 from L1DIRAC.Interfaces.API.DiracLIC import DiracLIC
5 from L1DIRAC.Interfaces.API.NewInterface.UserJob import UserJob
6 from L1DIRAC.Interfaces.API.NewInterface.Applications import DDSim
7
8 # ddsim = DiracLIC()
9
10 for i in range(1, 88):
11
12     job = UserJob()
13     job.setCPUTime(3000)
14 # job.setInputData(["hep_*_arguments=hello"])
15
16 job.setName("Gaudi_MK_M_ %s")
17 dfile = DiracLIC()
18
19 job.setInputSandBox(["Gaudi-Multiple.py", "fccwe_sicla_input.py", "fCCwe_01_02_03.tar.gz", "PandoraSettings.tar.gz",
20 "CalibrationPandoraSettings.tar.gz"])
21
22 job.setOutputFile("res", arguments="+xvz PandoraSettings(fCCwe_01_02_03)")
23 job.setOutputFile("res", arguments="+xvz CalibrationPandoraSettings(fCCwe_01_02_03)")
24 job.setOutputFile("res", arguments="+xvz fCCwe_01_02_03.tar.gz")
25
26 # Note: if you run on debug mode, and log file may be too big, which could not be written out.
27 job.setOutputSandBox(["*_log_*", "_*.xml", "*_*.py"])
28 job.setOutputFile("LOG_2009.py")
29 job.setOutputFile("LOG_0309.ch")
30 InputFileName = "dirac-lic-logs/DDSIM/InputData/tttbar_*str(i)*_nightly.sicla"
31 job.setInputData([InputFileName])
32 job.setOutputData(["%s-%s"] % i)
33 InputData = []
34
35 GaudiApp = []
36 from L1DIRAC.Interfaces.API.NewInterface.Applications import GaudiApp
37 ga = GaudiApp()
38
39 # Note: you have to use the above tool "dirac-lic-show-softname" to find out the right/available tag name for your study.
40 # ga.setVersion("keyhep_2008B")
41 ga.setVersion("keyhep_01p11")
42
43 ga.setExecutableName("Gaudi")
44 ga.setSteeringFile("fccwe_sicla_input.py")
45
46 # ga.setDetectorModel("FCO_v02")
47 # InputFileName should be with an ".slicla" extension
48 # InputFileName = "dirac-lic-logs/DDSIM/InputData/tttbar_*str(i)*_nightly.sicla"
49
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Gaudi

Dirac web portal for jobs monitoring

Jobid	Status	Mir	Application	Site	Job	LastUpdate(UTC)	LastSignOff(UTC)	Submit
65021590	Done	Exec	Job Finishe...	LCG.CERN...	DDSI	2023-11-22 19:03:40	2023-11-22 19:03:41	2023-1
65021592	Done	Exec	Job Finishe...	LCG.CERN...	Gauc	2023-11-22 18:06:49	2023-11-22 18:06:49	2023-1
65021591	Done	Exec	Job Finishe...	LCG.CERN...	Gauc	2023-11-22 17:58:11	2023-11-22 17:58:11	2023-1
65021590	Done	Exec	Job Finishe...	LCG.CERN...	Gauc	2023-11-22 18:16:48	2023-11-22 18:16:48	2023-1
65021588	Done	Exec	Job Finishe...	LCG.CERN...	Gauc	2023-11-22 17:47:26	2023-11-22 17:47:26	2023-1
65021587	Done	Exec	Job Finishe...	LCG.CERN...	Gauc	2023-11-22 17:33:33	2023-11-22 17:33:34	2023-1
65021586	Done	Exec	Job Finishe...	LCG.CERN...	Gauc	2023-11-22 18:09:06	2023-11-22 18:09:06	2023-1
65021585	Done	Exec	Job Finishe...	LCG.CERN...	Gauc	2023-11-22 17:58:06	2023-11-22 17:58:06	2023-1
65021582	Done	Exec	Job Finishe...	LCG.CERN...	Gauc	2023-11-22 18:16:56	2023-11-22 18:16:56	2023-1
65021581	Done	Exec	Job Finishe...	LCG.CERN...	Gauc	2023-11-22 18:04:00	2023-11-22 18:04:00	2023-1
65021579	Done	Exec	Job Finishe...	LCG.CERN...	Gauc	2023-11-22 17:41:08	2023-11-22 17:41:08	2023-1
65021578	Done	Exec	Job Finishe...	LCG.CERN...	Gauc	2023-11-22 18:27:47	2023-11-22 18:27:47	2023-1
65021577	Done	Exec	Job Finishe...	LCG.CERN...	Gauc	2023-11-22 19:14:01	2023-11-22 19:14:01	2023-1
65021576	Done	Exec	Job Finishe...	LCG.CERN...	Gauc	2023-11-22 18:10:16	2023-11-22 18:10:17	2023-1
65021575	Done	Exec	Job Finishe...	LCG.CERN...	Gauc	2023-11-22 17:45:44	2023-11-22 17:45:44	2023-1
65021574	Done	Exec	Job Finishe...	LCG.CERN...	Gauc	2023-11-22 17:45:35	2023-11-22 17:45:35	2023-1
65021573	Done	Exec	Job Finishe...	LCG.CERN...	Gauc	2023-11-22 17:34:08	2023-11-22 17:34:08	2023-1
65021572	Done	Exec	Job Finishe...	LCG.CERN...	Gauc	2023-11-22 17:32:10	2023-11-22 17:32:11	2023-1

Dirac script manages Data so that it is directly written to a Storage Element



```
-FWXFWX-x 1 zbitar ilc_user 2754289498 2023-11-22 18:08:33 ttbar_rec_8_nightly_edm4hep.root
-FWXFWX-x 1 zbitar ilc_user 2743137725 2023-11-22 17:29:39 ttbar_rec_10_nightly_edm4hep.root
-FWXFWX-x 1 zbitar ilc_user 2743421644 2023-11-22 18:14:17 ttbar_rec_11_nightly_edm4hep.root
-FWXFWX-x 1 zbitar ilc_user 2749268481 2023-11-22 17:24:29 ttbar_rec_13_nightly_edm4hep.root
-FWXFWX-x 1 zbitar ilc_user 2721079858 2023-11-22 18:13:11 ttbar_rec_14_nightly_edm4hep.root
-FWXFWX-x 1 zbitar ilc_user 2761447728 2023-11-22 17:39:08 ttbar_rec_15_nightly_edm4hep.root
-FWXFWX-x 1 zbitar ilc_user 2767963858 2023-11-22 18:18:28 ttbar_rec_16_nightly_edm4hep.root
-FWXFWX-x 1 zbitar ilc_user 2728744831 2023-11-22 17:37:53 ttbar_rec_17_nightly_edm4hep.root
-FWXFWX-x 1 zbitar ilc_user 2719530272 2023-11-22 18:07:53 ttbar_rec_18_nightly_edm4hep.root
-FWXFWX-x 1 zbitar ilc_user 2728135713 2023-11-22 18:16:19 ttbar_rec_19_nightly_edm4hep.root
-FWXFWX-x 1 zbitar ilc_user 2729354237 2023-11-22 17:58:05 ttbar_rec_1_nightly_edm4hep.root
-FWXFWX-x 1 zbitar ilc_user 2747528849 2023-11-22 18:18:18 ttbar_rec_20_nightly_edm4hep.root
-FWXFWX-x 1 zbitar ilc_user 2741287396 2023-11-22 17:42:26 ttbar_rec_22_nightly_edm4hep.root
-FWXFWX-x 1 zbitar ilc_user 2780810817 2023-11-22 17:42:26 ttbar_rec_23_nightly_edm4hep.root
-FWXFWX-x 1 zbitar ilc_user 2768655802 2023-11-22 18:36:49 ttbar_rec_24_nightly_edm4hep.root
-FWXFWX-x 1 zbitar ilc_user 2746833877 2023-11-22 18:03:56 ttbar_rec_25_nightly_edm4hep.root
-FWXFWX-x 1 zbitar ilc_user 2767613818 2023-11-22 18:32:14 ttbar_rec_26_nightly_edm4hep.root
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-FWXFWX-x 1 zbitar ilc_user 2734887898 2023-11-22 17:31:42 ttbar_rec_28_nightly_edm4hep.root
-FWXFWX-x 1 zbitar ilc_user 2766072680 2023-11-22 17:31:51 ttbar_rec_29_nightly_edm4hep.root
-FWXFWX-x 1 zbitar ilc_user 2759499464 2023-11-22 17:46:01 ttbar_rec_2_nightly_edm4hep.root
-FWXFWX-x 1 zbitar ilc_user 2753113818 2023-11-22 17:33:49 ttbar_rec_30_nightly_edm4hep.root
-FWXFWX-x 1 zbitar ilc_user 2761016163 2023-11-22 17:45:13 ttbar_rec_31_nightly_edm4hep.root
-FWXFWX-x 1 zbitar ilc_user 2734488886 2023-11-22 17:45:25 ttbar_rec_32_nightly_edm4hep.root
-FWXFWX-x 1 zbitar ilc_user 2739909731 2023-11-22 18:09:49 ttbar_rec_33_nightly_edm4hep.root
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-FWXFWX-x 1 zbitar ilc_user 2765347113 2023-11-22 17:33:17 ttbar_rec_44_nightly_edm4hep.root
-FWXFWX-x 1 zbitar ilc_user 2764196695 2023-11-22 17:58:28 ttbar_rec_3_nightly_edm4hep.root
-FWXFWX-x 1 zbitar ilc_user 2753431228 2023-11-22 18:24:16 ttbar_rec_40_nightly_edm4hep.root
-FWXFWX-x 1 zbitar ilc_user 2748628447 2023-11-22 17:57:43 ttbar_rec_42_nightly_edm4hep.root
-FWXFWX-x 2 zbitar ilc_user 2738331865 2023-11-22 18:05:43 ttbar_rec_43_nightly_edm4hep.root
-FWXFWX-x 1 zbitar ilc_user 2768347113 2023-11-22 17:33:17 ttbar_rec_44_nightly_edm4hep.root
-FWXFWX-x 1 zbitar ilc_user 2763598074 2023-11-22 17:47:07 ttbar_rec_45_nightly_edm4hep.root
-FWXFWX-x 1 zbitar ilc_user 2772021283 2023-11-22 18:16:31 ttbar_rec_47_nightly_edm4hep.root
-FWXFWX-x 1 zbitar ilc_user 2727440758 2023-11-22 17:57:48 ttbar_rec_48_nightly_edm4hep.root
-FWXFWX-x 1 zbitar ilc_user 2744622886 2023-11-22 18:06:29 ttbar_rec_49_nightly_edm4hep.root
-FWXFWX-x 2 zbitar ilc_user 2749740511 2023-11-22 18:03:37 ttbar_rec_4_nightly_edm4hep.root
-FWXFWX-x 1 zbitar ilc_user 2724369285 2023-11-22 17:58:10 ttbar_rec_5_nightly_edm4hep.root
-FWXFWX-x 1 zbitar ilc_user 2783125180 2023-11-22 17:31:50 ttbar_rec_7_nightly_edm4hep.root
-FWXFWX-x 1 zbitar ilc_user 2746227712 2023-11-22 18:18:10 ttbar_rec_8_nightly_edm4hep.root
FC:/ilc/user/z/zbitar/k4run/output2[]
```

Conclusion

- Many ongoing developments and improvements in the Key4hep Ecosystem: detector description (CAD, RICH), data format, and calculation.
- Full simulation studies on the impact of the geometry on tracking and vertexing are on going for interesting physics cases (see [J. Andrea](#) and G. Sadowski talks).
- Massive production is available also on DIRAC (need a grid certificate, could be ilc or fcc user).
- Regular meeting and dynamic community :
[FCC-PED-SoftwareAndComputing-Full-Simulation](#)

Thank you