

ILD software & simulation

Daniel Jeans, KEK/IPNS

ILD strategy meeting on software
2022 / 6 / 28



素粒子原子核研究所
Institute of Particle and Nuclear Studies

ILD software group

Convener Frank Gaede [deputy D.J.]

Coordinators

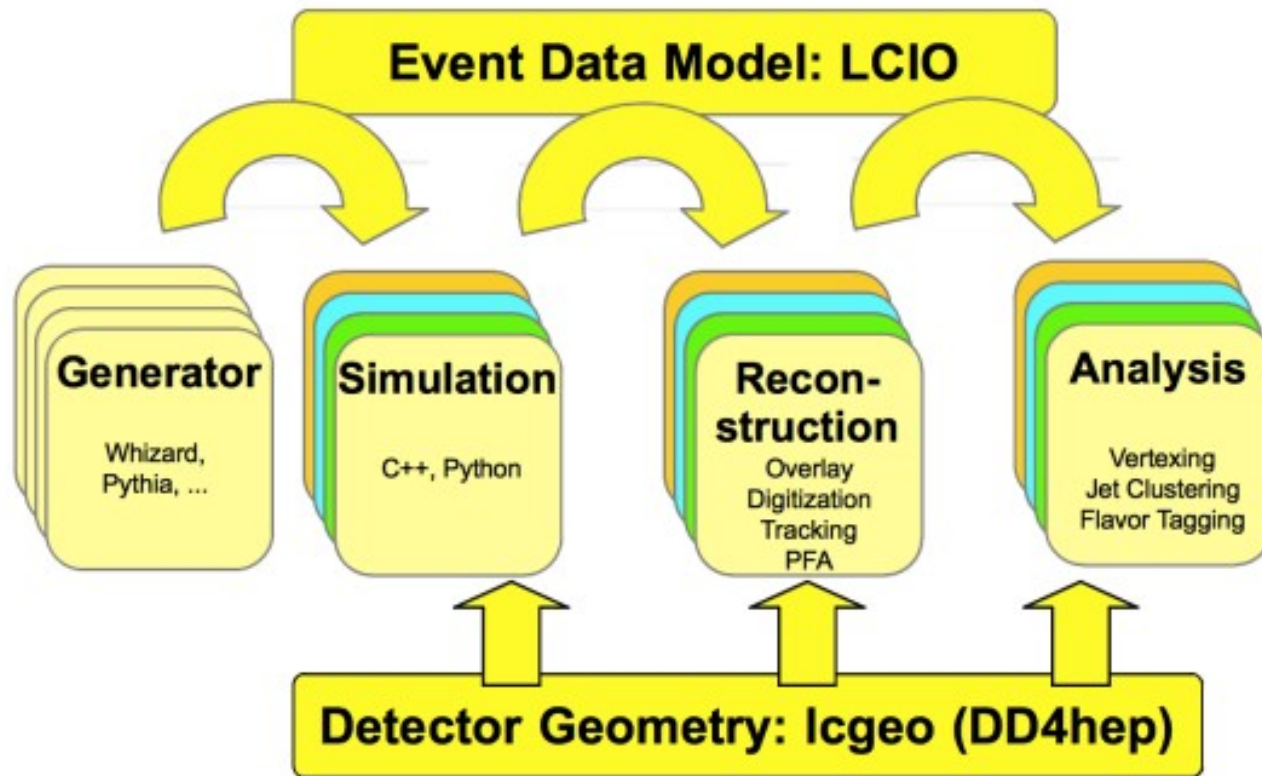
Generator Mikael Berggren, Junping Tian

Simulation Daniel Jeans, Manqi Ruan

Reconstruction Thomas Madlener, Adrian Irles

MC production Hiroaki Ono, Ryo Yonamine

+ key contributions from several ILD members

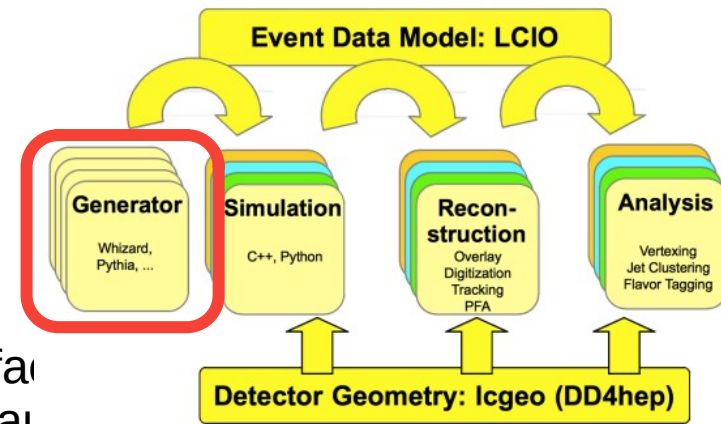




generator

power users / contributors / debuggers
of WHIZARD event generator

- ILC beamstrahlung spectra, pythia interface
- excellent and valuable relationship with all



generation of entire SM:

DBD, IDR	whizard 1.9.6
mc-2020	whizard 2.8.5

possible future directions:

- WHIZARD 3 [NLO QCD, UFO for BSM, NLO E-W, ...]
- PYTHIA6 → 8
- other generators [general purpose, specialised, ...]

fast detector simulation

SGV

[Mikael Berggren]

recent tutorial <https://agenda.linearcollider.org/event/9394/>

perfect for many detector optimisation studies

→ fast optimisation of tracker layout ; also good description of PFA performance

Delphes ILC detector card, tuned largely on ILD full-simulation

[F. Zarnecki]

recent tutorial <https://agenda.linearcollider.org/event/9264/>

fast entry point to ILC/ILD analysis

full detector simulation

~8 years ago started migration to DD4hep :
common tool for geometry & material description;
interface to Geant4

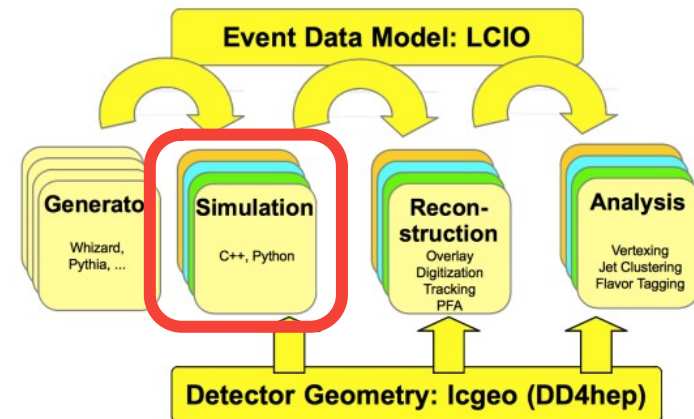
for IDR: Larger and Smaller ILD models ILD_[]/s]5_v02

“hybrid” calorimeter description → simultaneous simulation of
silicon / scintillator ECAL
RPC / scintillator HCAL

mc-2020: uses larger model

possible future studies:

alternative models: e.g. with silicon-only tracker a la CLICdp [started]
layout of VXD barrel–endcap transition
more “intrusive” MDI (eg for circular colliders)



Digitisation & reconstruction

stable & performant

Realistic subdetector digitisation

→ verified/developed by hardware experts
recently add simplistic TOF in ECAL layers

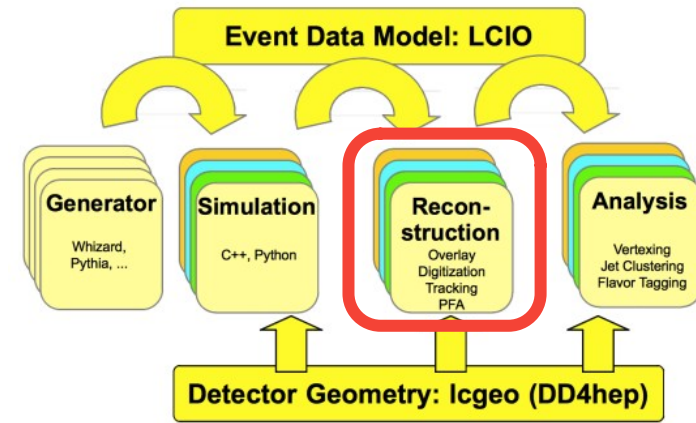
Efficient track finding & fitting

Particle Flow: PandoraPFA

→ **stable** = little recent development ; no “internal” expert

possible future studies

all-silicon tracking → apply existing Conformal Tracking algorithm from CLIC
more realistic digitisation of timing information
PFA development → ARBOR ; machine-learning
improve photon treatment, pi0 finding



High-level reconstruction tools

Particle ID

dE/dx in TPC

timing in ECAL layers

isolated lepton finding

Calorimeter cluster shapes

LCFIplus

→ Jet Clustering & Flavor tagging

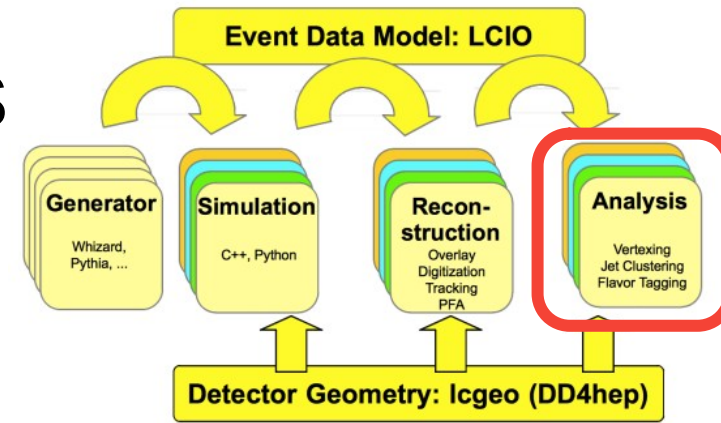
→ expertise remains in ILD (but limited person-power)

MarlinKinFit

→ recent work on jet-by-jet uncertainties

possible future studies

kinked tracks, V0s...



data formats

generator output

SIM → output of simulation

REC → full output of reconstruction (digitisation, tracking, Particle Flow)

DST → stripped down version of REC (e.g. no individual hits) to control file size

and relatively new, not yet produced centrally:

[S. Kawada]

mini-DST → after High-Level Reconstruction
(eg isolated lepton&photon ID, jet clustering, flavour tagging, ...)

MC production



based on ilcdircac tools (maintained by A. Sailer et al @ CERN)

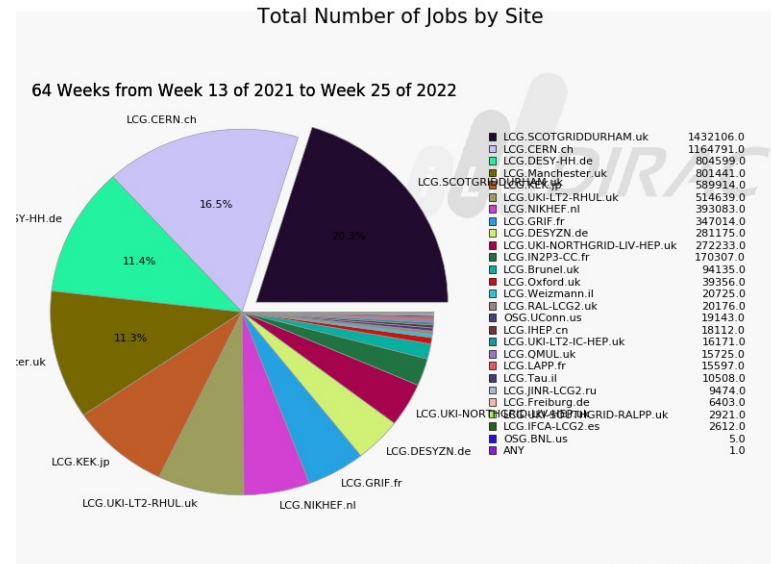
efficient operation: H. Ono + A. Miyamoto → R. Yonamine

enormous 250 GeV production now nearing completion after ~2 years work

- full SM
- several times 2 ab^{-1} statistics
- serve ILD physics analyses for coming years

DST stored @ DESY and KEK
~10% of REC data stored

c.f. large 500 GeV sample produced for IDR studies



- limited new “non-standard” samples:
HH @ 550GeV, qq @ 500 GeV with latest reco software, ...

spreading the word

many ILD contributions to tutorials

Snowmass

<http://ilcsnowmass.org/>

- [MC/Simulation Framework Tutorial: ILC](#) [General overview and introduction; held on Aug 28, 2020] J. List, J. Strube, C. Potter
- [MC/Simulation Framework Tutorial: Whizard for e+e-](#) [MC event generation; Sept 28, 2020] J. Reuter
- [MC/Simulation Framework Tutorial: ILC Analysis Walkthrough](#) [Fast ILC detector simulation, example analysis; Oct 14, 2020] C. Potter, D. Jeans

IDT-WG3

<https://agenda.linearcollider.org/category/273/>

May 2022

 May 18 Jenny List, "tutorial: MarlinKinFit" J. List

October 2021

 Oct 13 tutorial: SGV - fast simulation M. Berggren

August 2021

 Aug 18 tutorial: Jet flavor identification with LCFIPlus
T. Suehara

July 2021

 Jul 21 tutorial: Introduction to iLCSoft T. Madlener

June 2021

 Jun 23 tutorial: DELPHES + miniDST J. List, F. Zarnecki¹¹

ilcsoft is a very successful software suite:

ILD, SiD, CLICdp, CEPC, ...

→ continue to support current tools and analyses



limited person-power inside ILC/ILD,

some new people from other future collider projects

→ new generation of common SW framework & tools

→ as seamless as possible for ilcsoft users

e.g. Marlin processor wrappers, lcio converters, ...

→ more details in next talks

summary

ILD has benefited from a performant and stable software environment

- contributions from software experts, subdetector experts, (power) users
- enabled many physics and detector optimisation studies

Many opportunities still exist for developments & improvements

- impact of detector design changes
- new capabilities: timing, cerenkov, ...
- improved reconstruction: machine learning, ...

Trend is towards common tools with other future detector studies

- cooperation to pool expertise and effort