CLICdp Software and Computing Status

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CERN-EP-LCD

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Section 1:

1. Software/Computing Infrastructure
   - Storage at CERN
   - Version Control at CERN
   - iLCSoft

User Storage at CERN

- AFS is being phased out at CERN
  - Workspace creation (`/afs/cern.ch/work/u/username/`) no longer possible
- New Storage solution: EOS
  - 1 TB storage for owners of CERN computing account, you have to log-in to `cernbox.cern.ch` before it is there
  - On lxplus/lxbatch/desktops `/eos/user/u/username` can be used for access
  - Not feasible to mount in outside institutes

Shared Storage

- `/afs/cern.ch/eng/clic/*` will be removed: `software, data, work, work2`
- Shared storage on EOS `/eos/experiment/clicdp/*`: `grid, data, phys`
  - `grid`: equal to `CERN-DST-EOS` iLCDirac Storage Element, allow direct **read** access for grid files: both central production and user output
  - `data`: test beam data
  - `phys`: Lumi spectra, background files, samples

Software Distribution

- Software distribution via */cvmfs/clicdp.cern.ch*
  - compilers, iLCSoft, iLCDirac, git, . . .
  - Mounted on lxplus, lxbatch, and grid sites around the world, desktops
  - Can be efficiently mounted (and maybe already is) at your institute work stations
    - ⋆ Usable for SL6, CC7 or binary compatible
  - gcc 6.2, llvm 3.9
  - Simply `source` the corresponding `setup` or `init_ilcsoft` script and go

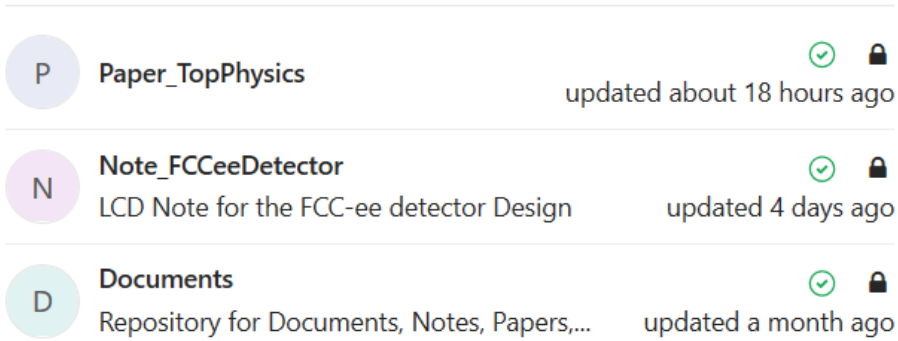
Version Control at CERN

- subversion (svn) is being phased out (based on AFS)
  - Subversion was used for CDRs, papers, etc.
  - Some repositories migrated from subversion to GitLab, preserving the history
- Replaced by Git(Lab)
- CLICdp repository: `https://gitlab.cern.ch/CLICdp/`
  - recently restructured into sub-groups, more fine-grain access control: Look into *subgroups* on given pages to find the actual repositories
  - Templates for notes, iLCDirac source world readable
  - Draft Notes, etc. only visible to collaboration
  - Requires a CERN computing account for anything beyond access to world visible repositories
- Tutorials:
  - `https://github.com/andresailer/tutorial`
  - `https://indico.cern.ch/event/562188/`

GitLab

GitLab offers

- Possibility for reviewing changes before merging
- Simple setup of continuous integration
  - Build your paper or software for every change, ensure things are working, distribute PDFs from GitLab

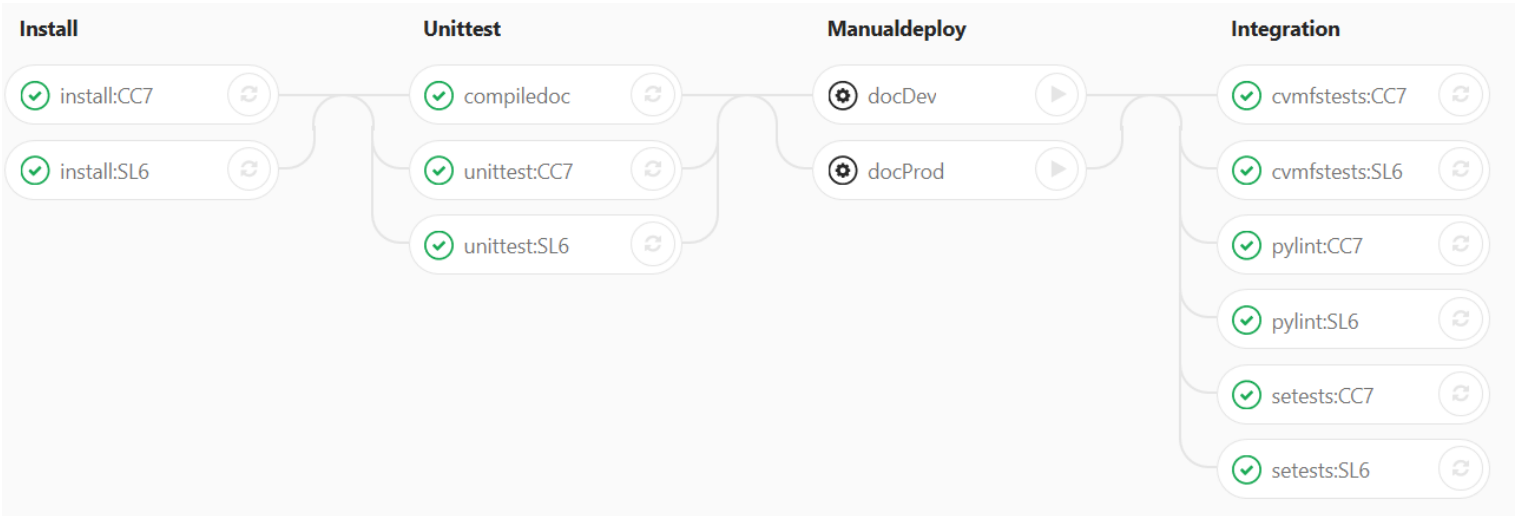


- The `container` used for building the papers can be modified via the CI system as well. `https://gitlab.cern.ch/CLICdp/Publications/Templates/custom_ci_worker`
- If you have anything in GitLab that compiles, you might as well add automation to it: theses, analysis code, ...
  - Talk to Marko and me

More Complicated CI Pipeline

Also chaining of jobs for CI is possible:

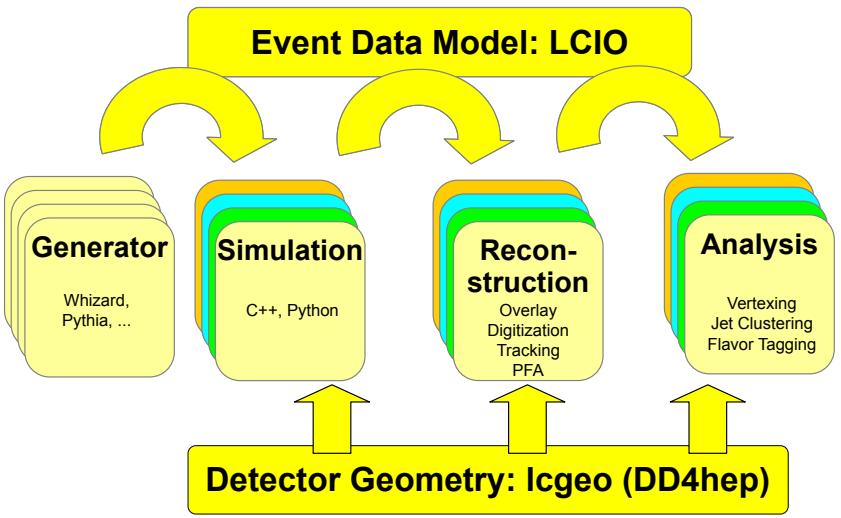
- Install/Compile Software → Run tests/Compile Docs → Deploy Documentation to Website (manual) → run more tests



iLCSoft Overview

Detector Simulation and Reconstruction chain

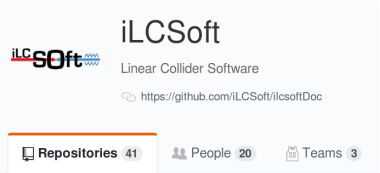
- `DD4hep` based geometry information in simulation, reconstruction, analysis (`DD4hep`, `lcgeo`)
- Event data model and persistency format LCIO to pass data from Simulation to reconstruction to analysis
- Reconstruction and Analysis framework: `Marlin`
  - Includes many, many packages: `Marlin, MarlinReco, Tracking, Overlay, LCFIVertex/Plus,...`
  - CLICdp steering files in the `CLICPerformance` package



LC Software Hands On Week

- 1 Week Software Working meeting of SiD, ILD, CLICdp software experts: `https://indico.cern.ch/event/606671/`
- Move iLCSoft to GitHub; address simulation, reconstruction, iLCDirac

iLCSoft on GitHub



`https://github.com/iLCSoft`

- Consensus among LC software to move iLCSoft to GitHub for
  - Ease of access control: no CERN or DESY account needs to be created
  - build in features: code review, Pull Request, issue tracker
  - Extensions: TravisCI, coverity
- All packages moved to GitHub
- All packages equipped with continuous integration and coverity checks

`ilcsoft.github.io`

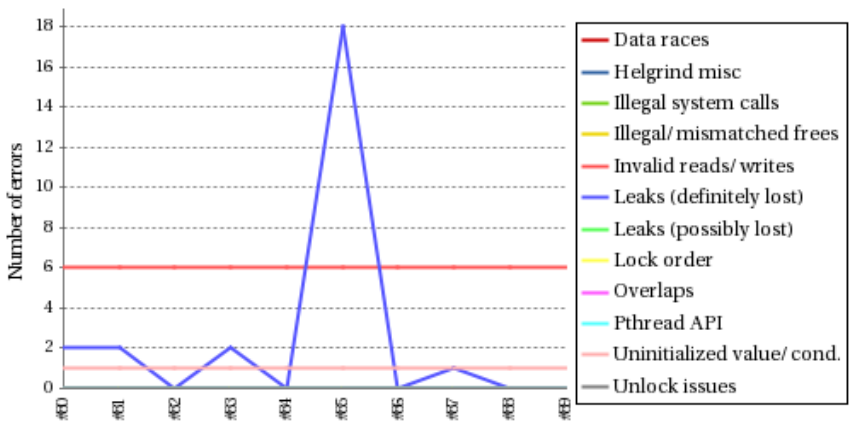
Nightly	Build GCC			Build LLVM
iLCSoft	build passing			build passing
AIDASoft	**Build Status**	**Issues**	**PRs**	**Coverity Scan**
DD4hep	build passing	issues 6	pull requests 1	coverity passed
aidaTT	build passing	issues 0	pull requests 0	coverity passed
iLCSoft	**Build Status**	**Issues**	**PRs**	**Coverity Scan**
CED	build passing	issues 1	pull requests 0	coverity passed
CEDViewer	build passing	issues 1	pull requests 1	coverity passed
CLICPerformance	build passing	issues 1	pull requests 1	coverity passed

Monitoring Code Quality

- Run two-hourly compilation of iLCSoft with `gcc` and `clang`
  - Nightly build deployed to CVMFS, used in CIs
- Individual nightlies to monitor number of compiler warnings
  - Once package without warnings easy to disallow new ones (`-Werror` in CI build)
  - Still large amount of *technical debt*
- Run reconstruction with `valgrind` to monitor memory leaks

All | **Overview** | +

S	W	Name ↓	Last Success	Last Failure	Last Duration	# Compiler Warnings
		aidaTT	37 min - #110	N/A	1 min 19 sec	13
		CED	17 hr - #110	N/A	23 sec	116
		CEDViewer	9 hr 25 min - #110	N/A	1 min 3 sec	192
		ClicPerformance	3 hr 23 min - #137	N/A	31 min	0
		Clupatra	6 hr 24 min - #109	N/A	1 min 12 sec	77
		ConformalTracking	13 hr - #108	N/A	52 sec	331
		DDKalTest	5 hr 3 min - #115	N/A	54 sec	59
		DDMarlinPandora	11 hr - #106	N/A	1 min 40 sec	0
		FCalClusterer	8 hr 23 min - #108	N/A	2 min 22 sec	13
		ForwardTracking	13 hr - #115	N/A	1 min 32 sec	230
		iLCUtil	14 hr - #106	N/A	3 min 16 sec	11
		KalDet	7 hr 15 min - #110	N/A	2 min 14 sec	293
		KalTest	4 hr 0 min - #107	N/A	1 min 50 sec	115
		KiTrack	5 hr 13 min - #109	N/A	1 min 10 sec	105
		KiTrackMarlin	17 hr - #109	N/A	1 min 24 sec	192
		LCFIPlus	7 hr 47 min - #111	N/A	2 min 35 sec	6
		LCFIVertex	14 hr - #110	N/A	4 min 39 sec	4
		lcgeo	22 hr - #117	N/A	7 min 25 sec	0
		LCIO	18 hr - #107	N/A	4 min 11 sec	10



Section 2:

2 Detector Simulation and Reconstruction Status

- DD4hep + Simulation Program
- Detector Model Updates
- Reconstruction Developments

Developments in DD4hep

- Large developments by Markus Frank (CERN/LHCb) for conditions and alignment support
- Restructuring of the `DD4hep` namespaces to be more sensible; some `DD4hep` sub packages re-factored
- Bugfix for MC history; added flag to identify hits from secondaries; fix a number of minor memory leaks; some bugfixes in the `cmake`; slimmed down some objects
- Including some contributions from users outside LC community

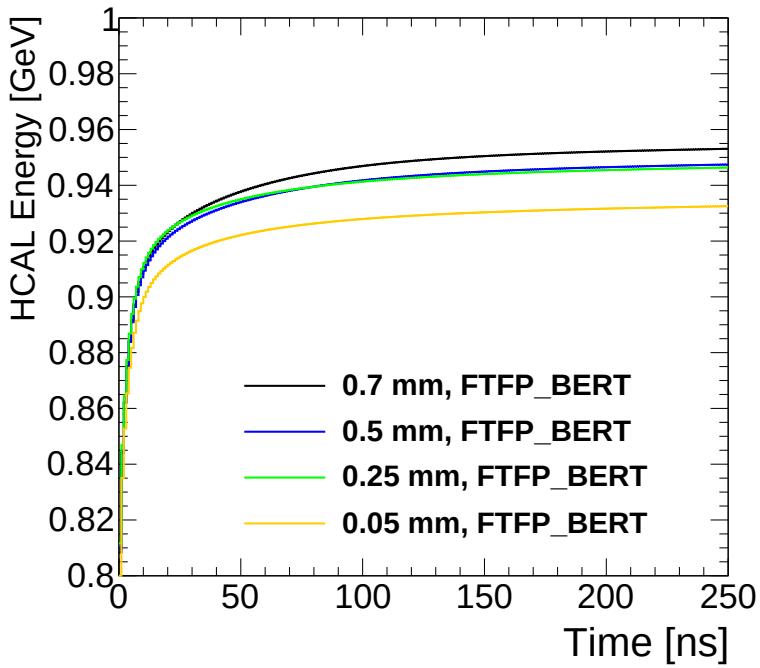
Detector Model Updates

- Had to make some minor modifications to the detector model: `CLIC_o3_v13`
  - Fix material name for G4_Polystyrene (required for Birks Law to work)
  - Fix overlaps in the BeamCal and Tracker
    - ★ Synergy with use of the detector model for FCC-ee
  - Correct segmentation in HCal endcap
  - Unify calorimeter encoding strings
- Steering file for Simulation in: `CLICPerformance/examples/clic_steer.py`
- To run: `ddsim --steeringFile clic_steer.py ...`

Calorimeter Energy Deposits

https://indico.cern.ch/event/625237/

Variation of range-cut



Range Cut	E	E(10ns)
0.7 mm	0.98 GeV	0.908 GeV
0.5 mm	0.974 GeV	0.907 GeV
0.25 mm	0.973 GeV	0.909 GeV
0.05 mm	0.959 GeV	0.898 GeV

- Larger energy suppression is observed for smaller range-cut values
- 2% effect on total recorded energy with 0.7 mm and 0.05 mm range-cuts
- $\sim$ 1% effect for energy recorded in 10 ns time window.

Range-cut	Sim. time [m]	Ratio [%]
0.7 mm	129	100
0.5 mm	135	105
0.25 mm	142	110
0.05 mm	152	118

Reconstruction Workflow

Reconstruction workflow

1. Overlay
2. Digitisation
3. Track Pattern recognition (TruthTracking, ConformalTracking)
4. Track Fit (Refit for better track parameter estimate)
5. Particle Flow Reconstruction (PandoraPFA)
6. Forward calorimeter reconstruction (LumiCal/BeamCal)
7. PFO selection

- Implemented in one unified steering file for the reconstruction that can be configured on the fly: avoid duplicating parameter settings in different files that will diverge as much as possible
  `CLICPerformance/examples/clicReconstruction.xml`
- `Marlin --Config.Tracking=Conformal --global.LCIOIn...`

Validation

- The reconstruction is running from overlay to flavour tagging, etc.
  - Centrally creating larger sized samples: $\texttt{Z} \rightarrow \texttt{uds}$, $\texttt{qqqq}$, $\texttt{t}\bar{\texttt{t}}$ in `iLCDirac`
  - with and without overlay of $\gamma\gamma \rightarrow$ hadron
  - Can add more samples if someone is interested
- Performances are being studied to identify issues that still need to be addressed, can, or should be improved
  - Improve pattern recognition for displaced tracks, tune parameter settings
  - Avoid memory overflow for events with too many hits in the vertex detector
  - Improve track parameter resolutions, parameter uncertainty
  - Improve particle ID efficiencies
  - Tune particle flow reconstruction
  - Add PFO Selector for lower energy

Details on current status of performance in the afternoon session

Track Fit

- When investigating bad resolution of the impact parameter (see Peter's presentation later today), identified initial trackstate used for final track fit as sub-optimal.
- Use the existing track fit as the initial track state for the refit of the hits identified in the pattern recognition
  - Used in all cases of pattern recognition
- The *pull* distributions of the track parameters become broader, but resolutions are better and without bias, so most likely the track parameter uncertainties are underestimated

Summary

Summary

- Computing Infrastructure at CERN is evolving
  - We can all benefit from CVMFS, GitLab, EOS
- Some bugfixes in the implementation of the Detector Model
- Validation of the reconstruction on-going: stay tuned