# ALCPG Software Tools

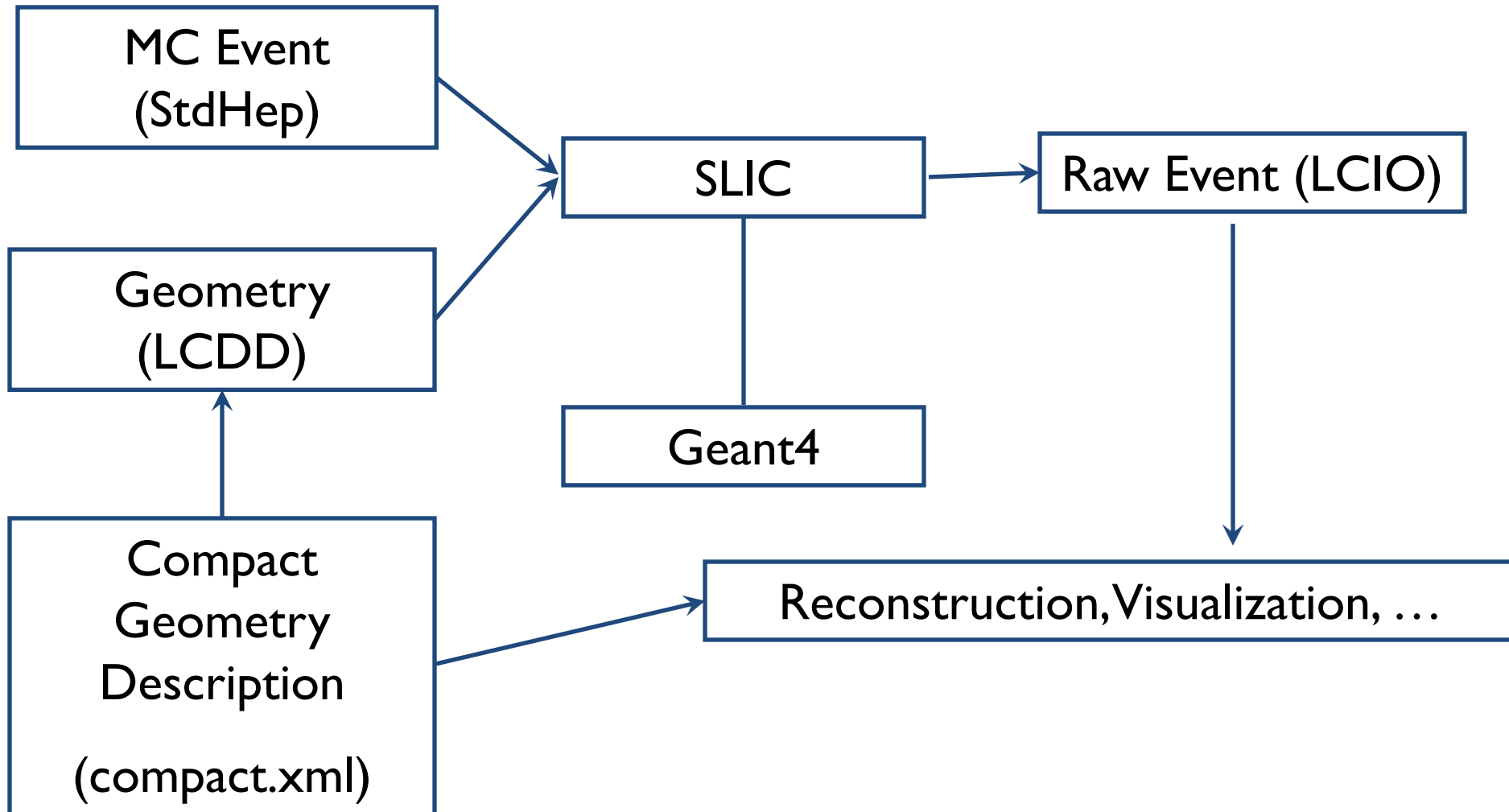**Jeremy McCormick, SLAC**
**LCWS 2012, UT Arlington**
**October 23, 2012**

# Framework

**APPLICATIONS**   **DATA**

Generation — Pythia, WHIZARD, etc. → StdHep

Simulation — LCDD → SLIC → LCIO Events

Reconstruction — Pandora XML → Tracking | PFA → LCIO PFOs

Analysis — Compact → Flavor-tagging, Jet-finding, etc. → LCIO, AIDA

Tuple Analysis & Visualization → JAS3/Wired → Publication
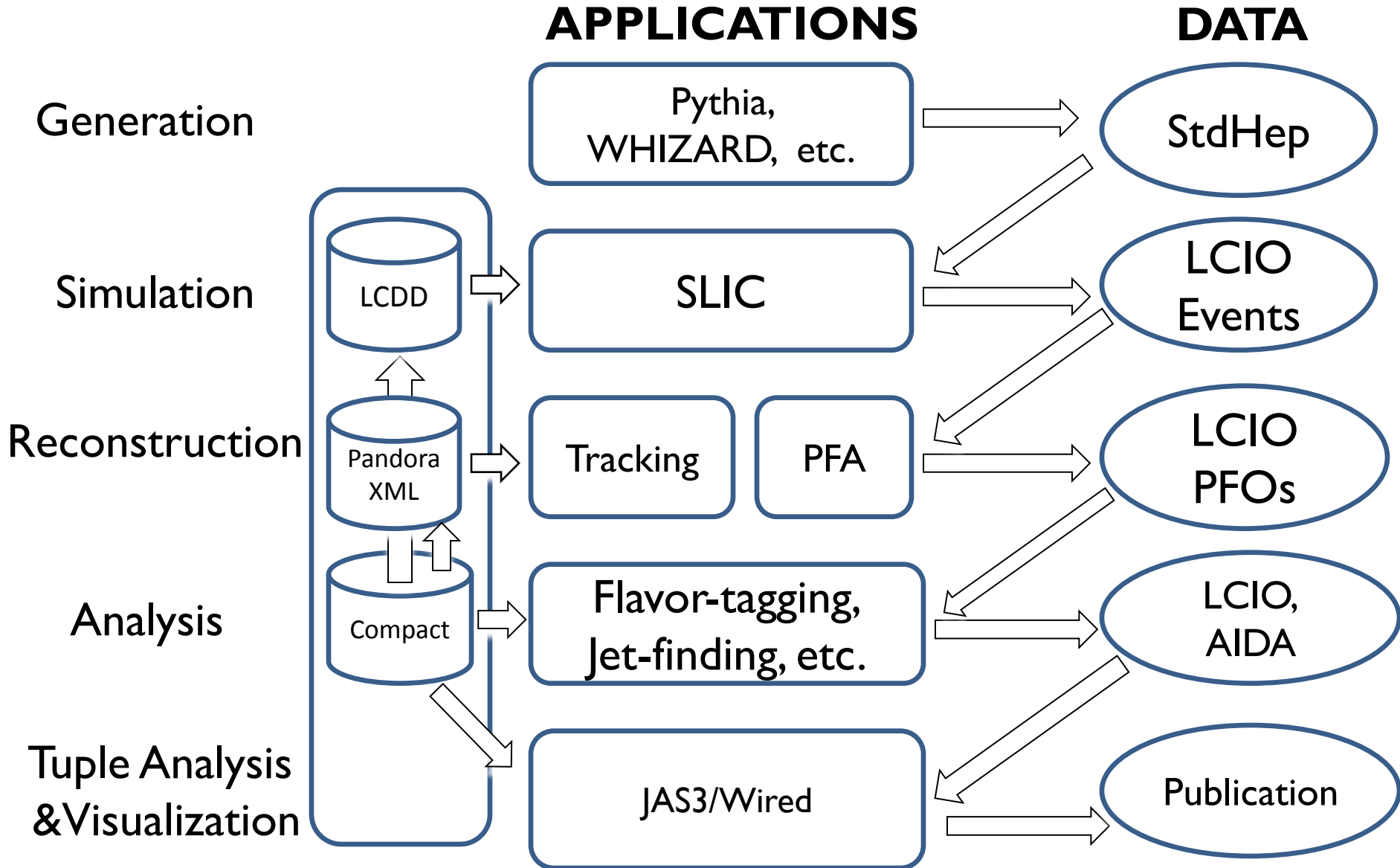
# LC Detector Full Simulation

```
MC Event
(StdHep)
```

```
Geometry
(LCDD)
```

```
Compact
Geometry
Description

(compact.xml)
```

```
SLIC
```

```
Geant4
```

```
Raw Event (LCIO)
```

```
Reconstruction, Visualization, …
```

# SLIC

- Simulator for the LInear Collider
- Full detector simulation
  - 4 PI detectors
  - test beams
  - other custom detector setups
- Integration
  - Geant4
  - GDML / LCDD
  - HEP PDT
  - LCIO
  - StdHep
- Minimal runtime dependencies
  - No database
  - No user code for geometry description

# Recent Features Added to SLIC

- Full 3D magnetic field map support
  - Grid => (x, y, z, Bx, By, Bz)
- Option to store step information for all energy depositions in CalorimeterHits.
  - Turn on via macro option.
  - Useful for detailed analysis of detector reponse
- Z smearing of generated event vertices
  - Gaussian smearing
- Geant4 version was updated to 9.5.1
- LCIO version updated to 2.0

# SimDist

- Since compiling SLIC from scratch is complicated, a build kit is provided.

- Based on well-worn and understood GNU tools
  - Autoconf, Make, GCC, etc.

- Works on many flavors of Linux, OSX
  - Windows support is deprecated.

- Options for different run modes
  - visualization
  - debugging
  - batch

- Binaries distributed on lcsim.org

# Geant4

- "Geometry and Tracking"
- Standard HEP toolkit for detector simulation
- Features
  - extensive and flexible physics process library
  - visualization
  - detailed and flexible geometry description
  - macro commands
- Advertised as a "toolkit" so need to put the pieces together to build your own app

# LCIO

- Linear Collider IO
- Implementations in C++, Java, Python, FORTRAN
- Supported throughout ALCPG tool chain
- Physics object interfaces
  - hits/digits, tracks, particles, etc.
- Allows data interchange between apps/frameworks
  - This has been very successful!  (SiD LOI, DBD)
  - Can even read your LCIO files into ROOT.  (built-in support)
- See other talk(s) at this workshop for more details

# GDML & LCDD

- XML geometry description
  - avoid completely user-defined geometry in code
- GDML
  - constants and definitions
  - materials
  - shapes
  - volumes
  - hierarchical geometry structure
- LCDD
  - sensitive detectors
  - identifiers
  - magnetic fields
  - visualization
  - physics limits
  - regions

# GeomConverter

- LCDD is too low-level for most users to hand code.
- Compact description provided for writing a high-level description of the geometry.
  - detector names, number of layers, layer thicknesses/materials, readout identifiers, B-fields
- Java program converts from compact to different formats.
  - LCDD
  - HepRep
  - Runtime Geometry (Java objects)
  - XML for Pandora
  - HTML
    - http://www.lcsim.org/detectors/sidloi3.html
  - SVG (experimental)
- Focus on data formats as different applications have different required levels of detail
- Data interchange

# LCSim

- Fully featured application framework for HEP analysis and reconstruction
- Written in Java
  - No more seg faults or mysterious memory leaks!
- Tracking
  - digitization
  - finding and fitting
- PFA
  - clustering
  - track/cluster association
- Analysis
  - jet finding, cluster finding, vertexing
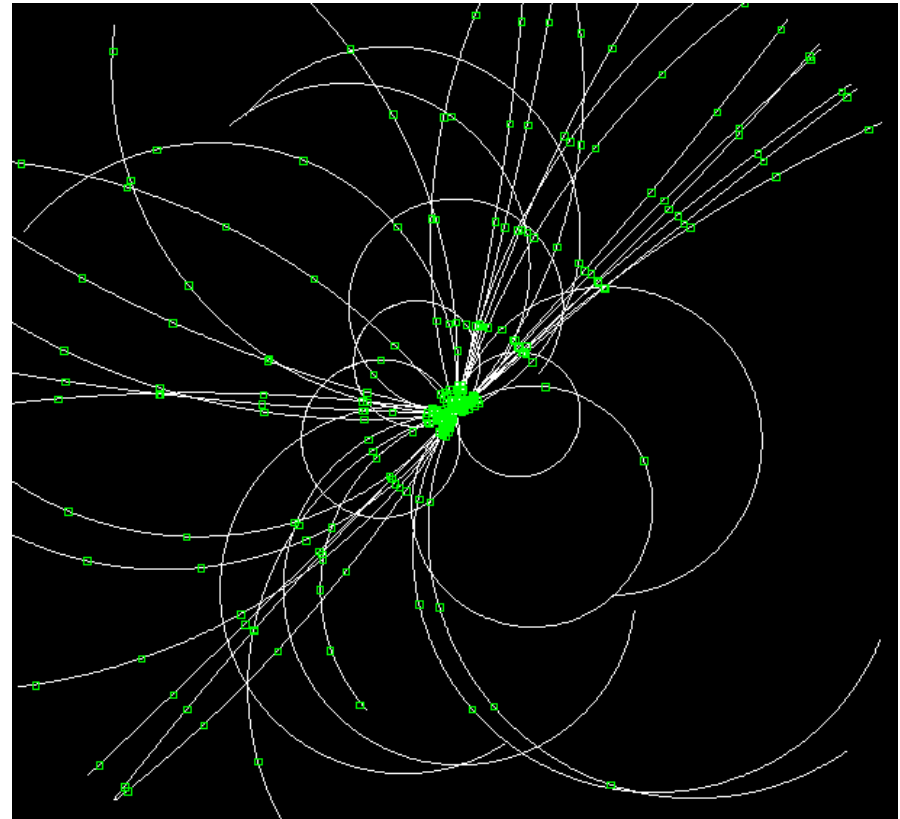
# slicPandora

- Interface from SLIC to PandoraPFA
  - But not actually limited to SLIC input; could accept any LCIO file with hits + tracks.
- LCIO compatible
  - read hits, tracks
  - write reconstructed particles
- XML geometry description generated by GeomConverter
- Used extensively for SiD LOI

# AIDA

- Abstract Interfaces for Data Analysis
- Analysis classes
  - 1, 2, & 3D Histograms + Clouds
  - 1 & 2D Profiles
  - DataPointSet
  - Tuples
- Java implementation
  - Other impl. exist in Python & C++
- compressed XML file format
- Readable in JAS

# JAS & Wired

- Java Analysis Studio
- Workbench
  - Wired event display
  - LCSim Event Browser
  - view/edit AIDA files
  - Load analysis drivers
  - Simple code editing
- Plugin architecture
  - extensible by writing loadable code modules

# Analysis Session

# Who uses LCSim Framework?

- SiD
  - LOI
  - DBD (ongoing)
- CLiC
  - CDR
  - CERN-based SiD studies
- Muon Collider
  - work ongoing
- HPS
  - Heavy Photon Search experiment at JLAB
- Dual Readout Calorimetry
  - FNAL

# Summary

- ALCPG software framework is mature, robust and well-tested.

- Supports standard ILC IO formats and applications

- Used for multiple rounds of iterative detector studies by different physics groups

- If you would like to use the framework, please contact us.  New comers welcome.

# Links

- Wiki - http://confluence.slac.stanford.edu/display/ilc/Home
- lcsim.org - http://www.lcsim.org
- ILC Forum - http://forum.linearcollider.org
- LCIO - http://lcio.desy.de
- SLIC - http://www.lcsim.org/software/slic
- LCDD - http://www.lcsim.org/software/lcdd
- JAS3 - http://jas.freehep.org/jas3
- AIDA - http://aida.freehep.org
- WIRED - http://wired.freehep.org