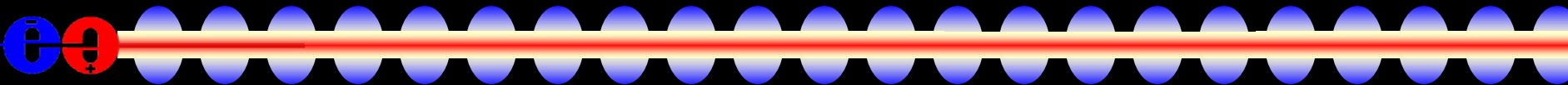


Software Status

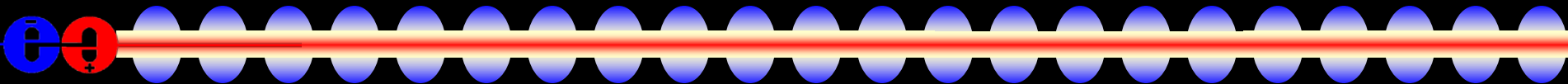
Norman Graf
(SLAC)

SiD Meeting, ALCW15, KEK
04/23/15

Introduction

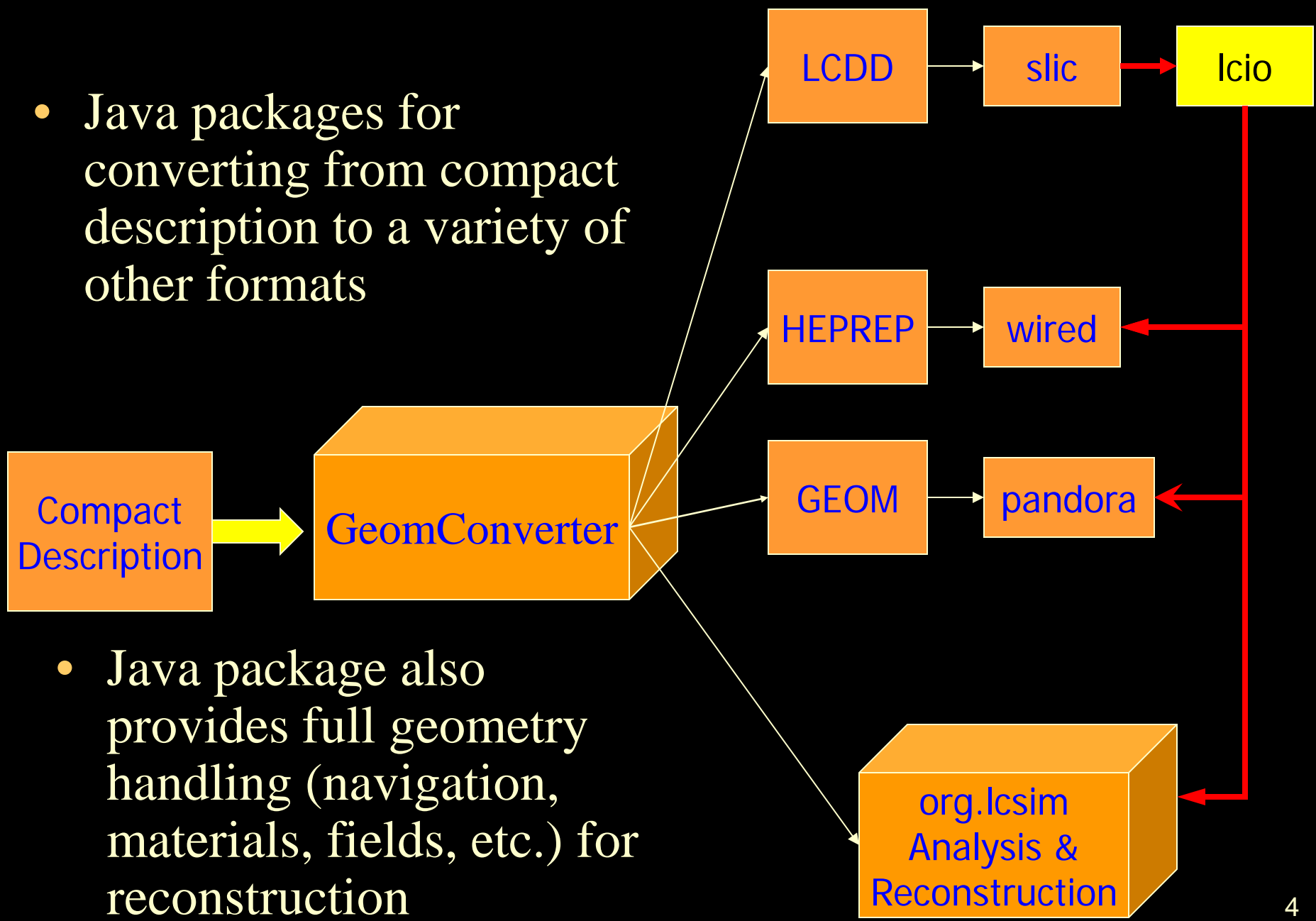
- 
- No major changes since ALCWS14, LCWS14.
 - Continue to improve/refactor existing core software
 - slic (Geant4-based simulation program, C++)
 - org.lcsim (Java-based reconstruction, Java)
 - Supporting individual analysis groups
 - Ecal testbeam
 - Fcal optimization
 - Detector occupancy studies
 - Pixel tracker resolutions
 - Maintaining existing functionality as best we can ²

Geometry description

- 
- added doc including doxygen tags to all functions & classes
 - reorganized sources into separate directories
 - extracted sensitive detector ProcessHits() code into separate HitProcessor classes
 - removed optical_calorimeter and other sensitive detector classes which were replaced by HitProcessors
 - added examples to lcdd/examples (still in progress)
 - added classes CellReadout, CellReadout2D, and CellReadout2DSegmentation as prototypes of possible refactoring for Segmentation-based classes
 - <http://www.lcsim.org/software/lcdd/doc/html/>
 - <http://www.lcsim.org/software/lcdd/doc/html/annotated.html>
 - LCDD article accepted for publication in NIM A.

“GeomConverter”

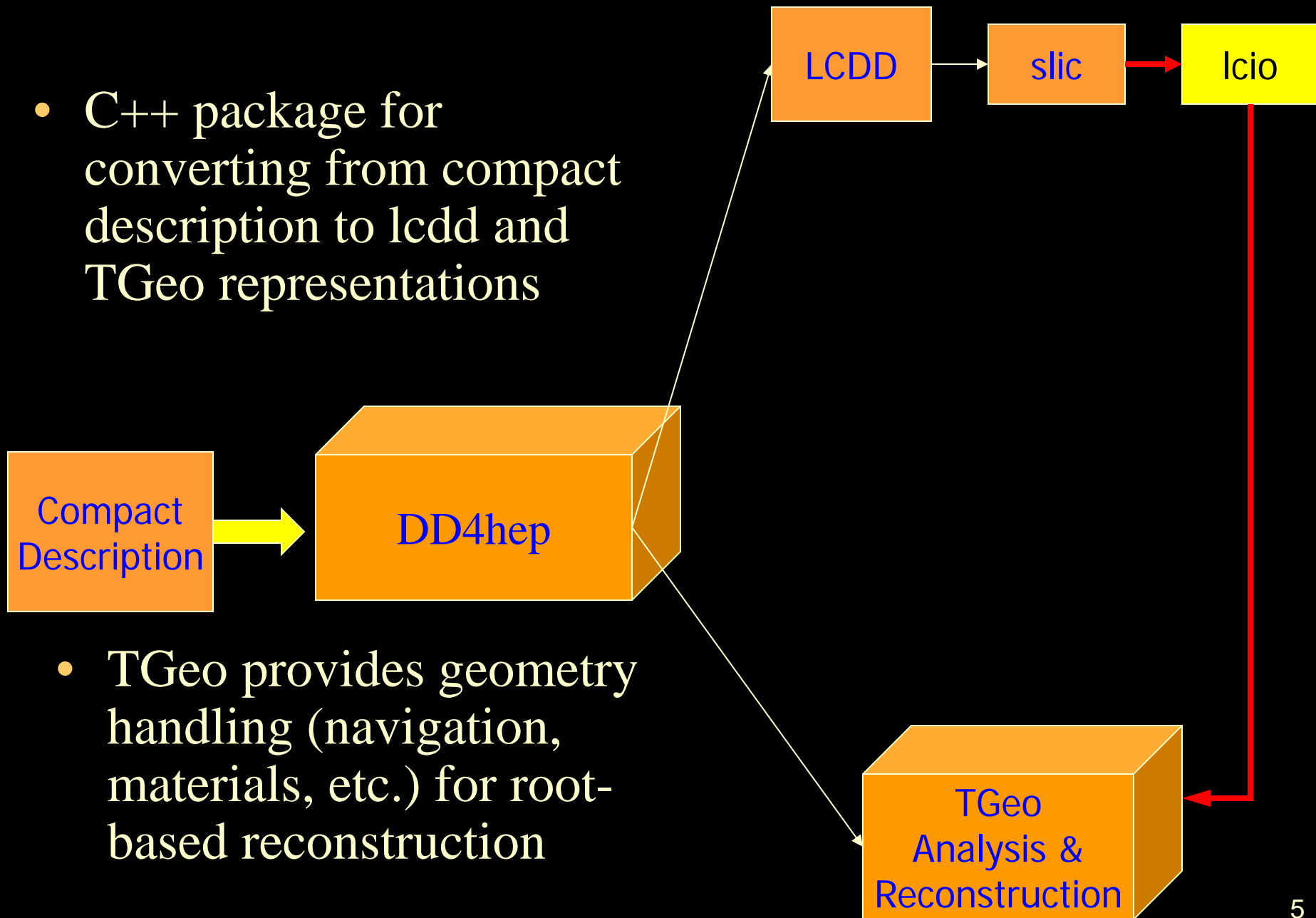
- Java packages for converting from compact description to a variety of other formats



- Java package also provides full geometry handling (navigation, materials, fields, etc.) for reconstruction

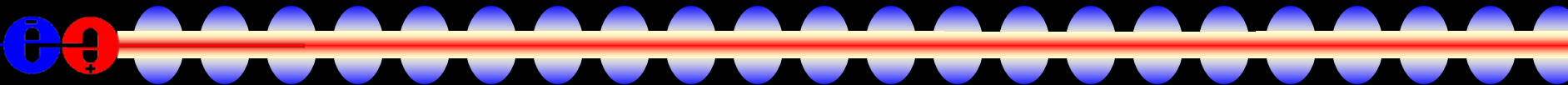
DD4hep

- C++ package for converting from compact description to lcdd and TGeo representations

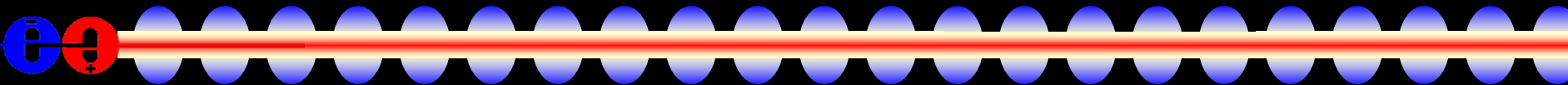


- TGeo provides geometry handling (navigation, materials, etc.) for root-based reconstruction

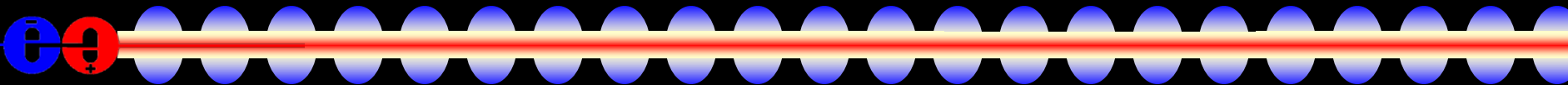
DD4hep and org.lcsim

- 
- Reconstruction using the DD4hep software is envisioned to use the TGeo geometry navigation system. Only supports a root (C++) environment.
 - Would have to make sure that:
 - the geometry navigation system used in the org.lcsim reconstruction packages continues to provide necessary functionality
 - the segmentation utilities continue to provide correct indexing and position information.

DD4hep and slic

- 
- Had expected that with the end of support for Mokka that the LC community would adopt slic as its full-detector simulation program.
 - DD4hep would write out LCDD as input to slic and provide TGeo support for root-based reconstruction. org.lcsim would continue to use compact.xml, but benefit from any common geometry development.
 - AIDA effort is being devoted to writing a new, from-scratch, Geant4-based simulation toolkit.
 - End-users can code their own subdetector geometries, build their own executables. Will they maintain interoperability? ₇

Magnetic Fields

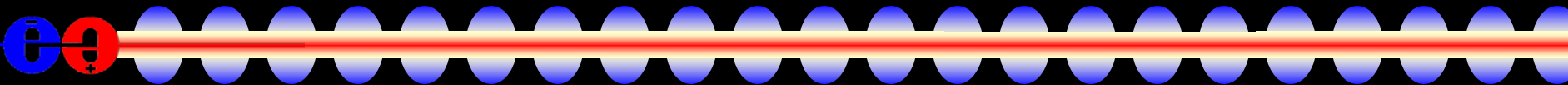
- 
- Most studies to-date for LC have used a very simplified constant magnetic field along the z axis.
 - Currently have support for:
 - 3D field map on regular Cartesian Grid using linear interpolation
 - Polynomial fit to 1D field (currently used for anti-DID)
 - Symmetric solenoidal field (B_z , B_r)
 - Work ongoing to extend to Bspline and Bezier fits
 - Performance now sufficient for use in full-scale simulations.

3D Magnetic Field Map Definition

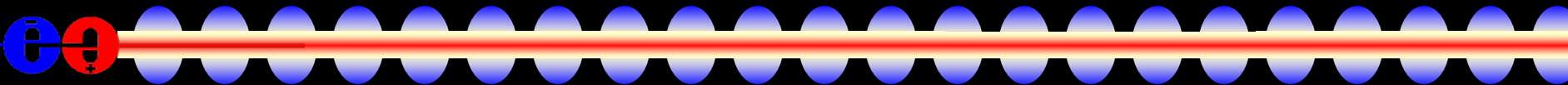
- ❖ Input (B_x, B_y, B_z) @ (x,y,z) on a regular Cartesian Grid
- ❖ Use linear interpolation to determine field at an arbitrary point within a box represented by surrounding grid points.
- ❖ Both memory and compute intensive, but simple and straightforward.
 - ❖ Would prefer to have polynomial fit to the field.
- ❖ Classes written for use in slic (C++) and lcsim (Java).
- ❖ org.lcsim code available to incorporate into lcdd and lcsim.
- ❖ Field map is defined in magnet coordinates.
 - ❖ Able to translate field in compact description
- ❖ Compact.xml usage:

```
<field
  type="FieldMap3D"
  name="HPSDipoleFieldMap3D"
  filename="HPS_b18d36_unfolded.dat"
  offsetX="1.0*cm"
  offsetY="2.0*cm"
  offsetZ="3.0*cm"
/>
```

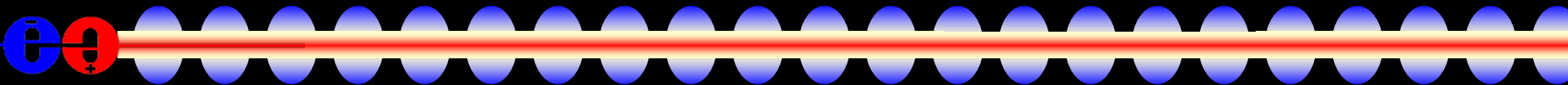
Geant4 10 Improvements

- 
- Would like to investigate the parallel geometry options in Geant4 to simulate more complex geometries
 - e.g. solenoid cryo chimney
 - Speedups navigating tessellated volumes
 - Change default physics list to FTFP_BERT.
 - What other new features from Geant4 10 would we like to benefit from?
 - Geant4 10.2 will require C++11/14 compiler

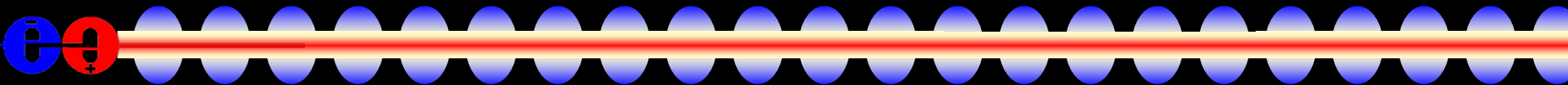
Reconstruction

- 
- Full reconstruction chain (e.g. DBD) involves a number of steps:
 - org.lcsim: track-finding and fitting
 - slicPandora: calorimeter clustering and track-cluster association, PFO creation
 - LCFIPlus: vertex finding, flavor-tagging
 - Improvements to the org.lcsim tracking ongoing, but at a low level, driven by need, limited by manpower
 - Maintaining interfaces to PandoraPFA and LCFIPlus will require continuing effort.

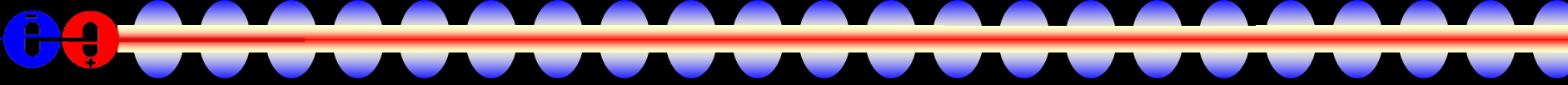
Track Reconstruction

- 
- Begins with signal digitization. Nick's PixSim package is very flexible and performant, but will need to be adapted to simulate the proposed "strixel" tracker readout.
 - Using 1.5D hits in the outer tracker will allow us to use different pattern recognition algorithms for track finding. Need effort to implement.
 - Use of pixels in forward tracking will also improve performance, but effort needed.
 - Need to refit using Kalman filter.

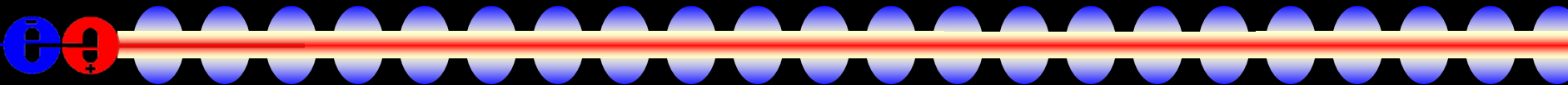
trf improvements

- 
- Improvements made to correctly handle inhomogeneous fields
 - 3D field map on regular Cartesian Grid now fully supported
 - Would like to collaborate with others to improve the interpolation scheme (both in trf and in slic)
 - Improved handling of material effects (e.g. dE/dx and energy loss for electrons in particular)
 - Small misalignments handled as perturbations on ideal surfaces
 - Propagation to arbitrary planar surfaces in constant fields supported (not yet released).

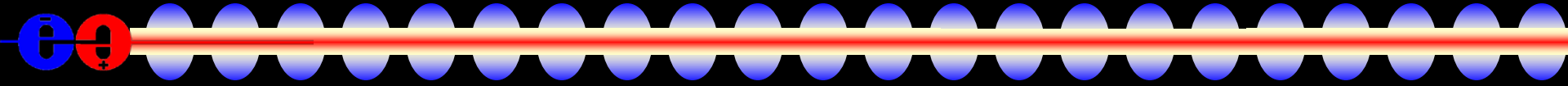
org.lcsim : Tracking

- 
- Primarily working on improvements required by HPS experiment to handle:
 - non-ideal geometries and tracker alignment
 - realistic field maps
 - more refined material effects
 - e.g. low energy electrons
 - track fitting and extrapolations in misaligned geometries and inhomogeneous fields.
 - Improvements will benefit SiD work when needed.

org.lcsim: Tracking

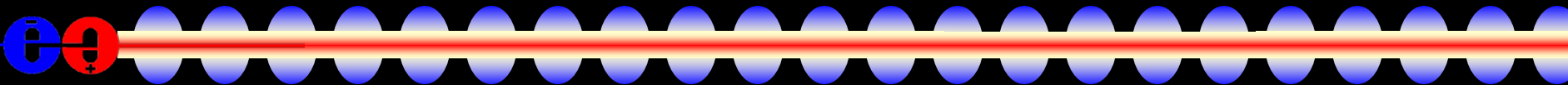
- 
- Work ongoing within the context of HPS support to provide binding to GBL package.
 - GBL provides tight coupling to millepede II alignment package.
 - Modifications being made to compact.xml description of tracker elements to more naturally target survey and alignment parameters.
 - Interested in learning from others' experience
 - e.g. EUDET telescope

org.lcsim : Calorimetry



- Modifications and improvements to support the SiD Ecal testbeam:
 - Use of hexagonal cells in both simulation and reconstruction
 - position to Cell ID
 - cell ID to position
 - cell ID provides List<CellID> neighbors
 - edge cells correctly handled
 - Robust clustering algorithms
 - Robust handling of dead & noisy channels
 - all the usual real-life problems encountered in testbeams

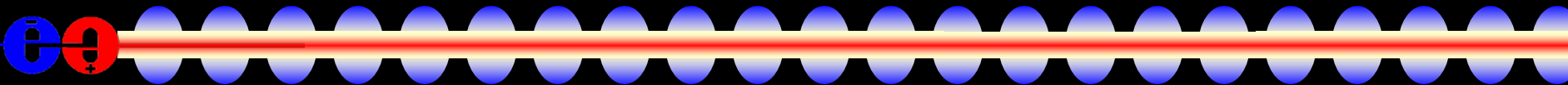
org.lcsim : Conditions

- 
- Again, driven more by HPS and SiD Ecal testbeam, but will eventually benefit use at other testbeams and LC.
 - More robust conditions database handling

Computing

- Not currently engaged in any large-scale physics or detector simulations studies a la LOI, DBD, so computing needs are modest.
- Smaller-scale production manageable on individual clusters.
- Grid production available via ILCDirac
 - Dedicated GSE and GCE primarily provided by European institutions under LCG.
 - OSG support noticeably lacking.
- See Jan's talk for plans for the future.

Future Plans

- 
- Maintain existing simulation/reconstruction functionality (but just barely).
 - Continue to work towards increased software commonality.
 - But AIDA appears to be heading in a different direction with new Geant4-based simulation toolkit.
 - Need to identify OSG support for large-scale production if we have future LOI/DBD-type studies. PNNL close
 - Need to find new institutional support for both software and computing effort.