GLAST tracking software

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Tracking simulations

Software workshop, September 7th, 2000

Introduction:

- The tracker software in GLAST
  - the detector
  - the physics
  - the evolution of the GLAST code
  - the general requirements

Simulation Part:

- Status
- some ideas for the future

Reconstruction:

- Introduction:
  - code evolution and versions
  - physics of the reconstruction
- status
  - code structure
  - performance
- future planes
  - data structure
  - package configuration
- conclusions

Tracking simulations

GLAST tracker/converter

GLAST tracker tower

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GLAST tracker:

- A modular design - 4x4 towers
- each towers 18 active planes (trays)
- microstrips silicon detectors (200 micros)

  with digital readout

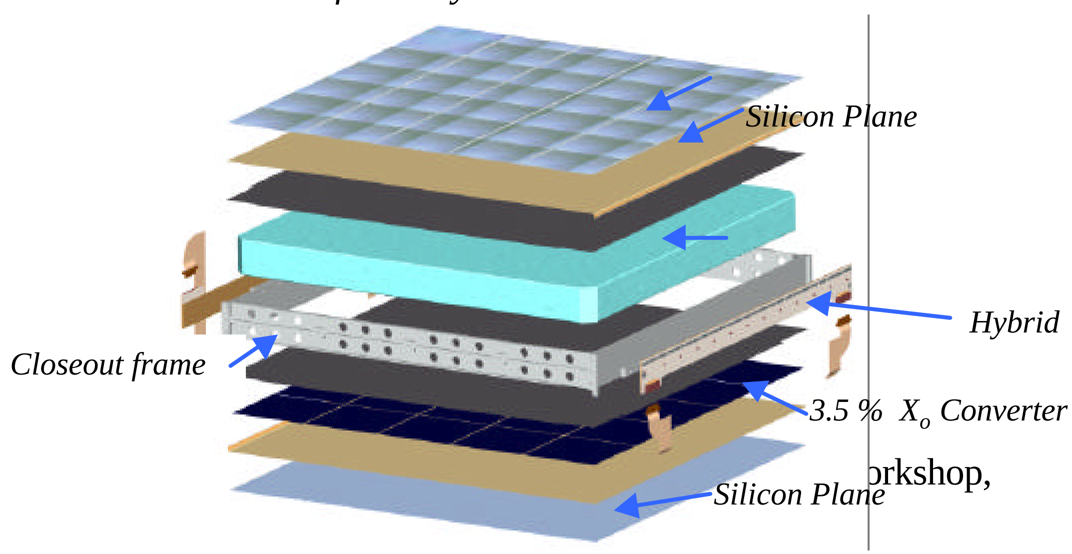
  per silicon plane: ToT and a list of strips
- Each tray separated 3.2 cm

  XY projections - separated by 0.24 cm

  Pb converters (2.5%-25%) just above the Si.

  1.5% XO of support material per tray

Elements of the tray:



rkshop,

Tracking simulations

Tracking physics on GLAST

GLASTgamma converter

* GLAST is a tracker/converter

"large" amount of material 1.5 Xo (TBR)

* 20MeV-200 GeV Range of energy

the MS effect varies from dominant to irrelevant

* Tracking electrons.

In addition with MS we have bremss

meaning of "chiSq", "energy", "fit parameters".

* Gamma conversion

Extra material

Energy of the tracks unknown: how to get the direction of the gamma.

* Should deal with cosmic and electrons

* Should provide a trigger (3 in a row, L3T)

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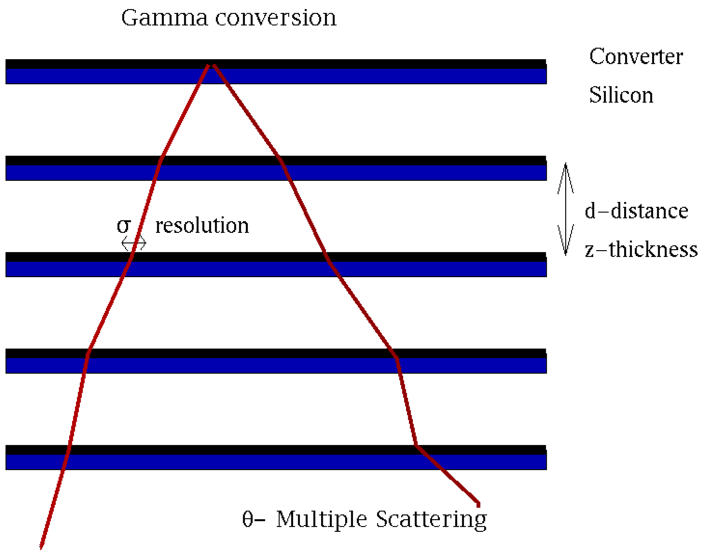


Design concepts:

small converter material outside the Pb

physics compromise:

to gain in PSF - small converter material

to gain in Aeff - large converter material

small pitch - vertex determination

better PSF

GLAST software workshop, SLAC, Sept 2000

Tracking simulations

GLAST software evolution

GLAST software evolution:

* until 1998 **B. Atwood** and T. Burnett

authors of GLASTsim.

initial studies.

B. Atwood responsible of the reconstruction

responsible of the detector performace

He was one of the persons who most had contributed to GLAST.

* 1998-1999 software group (T. Burnet).

Small group of people

AO response

J.A Hernando: responsible of trk recon

detector response.

* 2000 - software group (R. Dubois)

Arquitecture decitions:

CMT - packeage reorganization

GAUDI - data/Algorithms

persistency: first attempts ROOT

GEANT4 migration

test beam:

ROOT (root trees): SLAC, GSFC

tb_sim: (IRF2ROOT) a version of GLASTsim only for the simulation (UW)

tb_recon: (UCSC) a reconstruction program

centella framework

ROOT input/ouput (trees).

J.A. Hernando (tkr recon).

Tracking simulations

Tracker software: general requirements

Simulation:

* It should accuracy represent the tracker detector

It should contain the relevant passive/active materials

* It should produce the detector response of the pass of charged particles

* It should provide the detector response .

Simulation - Interaction with MC:

*It should provide the MonteCarlo information of how and who generated the detector response

Simulation - Interaction with trigger:

* It should help the definition of the different triggers

Reconstruction:

* It should reconstruct the tracks produced in the event

It should reconstruct the gamma

* It should provide the tracks reconstruction information

It should reconstruct the physical hits

It should provide the physical hits

Reconstruction - Interaction with CAL/ADC

* It should provide a combined determination of energy

Tracking simulations

Simulation: status

Status:

* It should accuracy represent the tracker detector

GISMO: W. Atwood, T. Burnett

parameters defined in the xml file

* It should produce the detector response of the pass of charged particles

average value of occupancy and threshold

* It should provide the detector response.

GLASTsim internal “persistency”: IRF files

Simulation - Interaction with MC:

*It should provide the MonteCarlo information of how and who generated the detector response

only noise or real hit

Simulation - Interaction with trigger:

* It should help the definition of the different triggers

Known Problems

change of the tracker detectors:

unique size of the detector

Pb constructor by reference to SI

not definition of some tracker elements (face sheets, electronics).

IRF decodification Not real persistency output of the simulation.

No valid checks of the performance of the pattern recognition, reconstruction by lack of MC information.

Tracking simulations

Simulation: conclusion

Tracker simulation:

* the tracker simulation is an acceptable level

but should be revisit

* a clear and well define list of geometry parameters

should be defined in an input file

* a "calibration" input for the electronic patameters should be revisit.

* the MC information associated with the tracker should be expanded.

* a persistency output should be added

In the new arquitecture:

* the transient classes to contain the tracker response should be defined

    * pure tracker information.

    * association with the MC

* the simulation: geometry and passage of the particle will migrate to GEANT4.

* A persistency data output should be defined.

Tracking simulations

Simulation: some ideas

Persistency:

* the parameters in the xml should be revisit:

coordination with R. Johnson.

they should corresponde 1-1 with the mechanical design

they should contain the flexibility of defining

the different elements of the tray

dices/ladders/planes/ tray

layers in tray/ electronics

should we include threshold/occupancy by chip?

*The simulation should provide a useful persistency data: (I.e ROOT tree)

do we need IRF as intermediate step?

TB: IRF2ROOT program

Transient Data:

* Definition of a container class of the tracker response:

TB: SiLayerList

SiLayers info: ID, ToT, list of strips

* Definition of the tracker response-MC connection

Data.

Tracking simulations

Reconstruction: evolution and versions

Tracker reconstruction evolution:

* until 1998 **B. Atwood** and T. Burnett

  LSQ fit

  pattern recognition based in a best track

  definition of the main physics algorithms

* 1998-1999 software group (T. Burnet).

  Tracker reconstruction based on:

  Kalman Filter

  Pair Fit (2D-3D) Pattern recognition: based in a gamma vertex

  AO response

* 2000 software group (R. Dubois).

  Tb_recon

  centella framework & ROOT tree

  definition of transient classes

  first reorganization in algorithms

  converters to ROOT tree

  New structure (work in progress):

  definition of data and algorithms

  reorganization in packeages

Tracking simulations

Reconstruction: summary status

Tracker reconstruction status:

* It is in a good shape to produce results (gamma and tracks reconstruction) for:

AO

TB

recent GLAST design studies GTOCC

* The physics algorithms works: they should be preserved, better understood and optimized.

Kalman Filter

Pair Fit

Energy determination

Topological selection “pair fit”

Selection criteria (quality && veto)

Gamma construction

* Studies with MC needed:

track purity

performance of the pattern (selection of best track)

Status with respect the new structure

***** the present reconstruction is unfortunately OO

the tracks are pattern objects and tracking objects

the tracks contain the construction/fitting algorithms

* There is no a clear user interface. How the user can retrieve tracker recon data?

Not needed: the data was passed to the an ASCII ntuple

GFdata is a user interface

GFsegment it was an intermediate level Pattern/Kalman

The new structure

***** need to preserve/improve the algorithms

* separate classes into: data algorithms conditions

* separate classes into packages

* define interfaces between packages and users

* documentation with doxygen

Tracking simulations

Reconstruction: Packages

Packages:

TkrRecon:

It contains the transient data

It defines the interface with the user

TkrPattern

It contains algorithms to select and construct TkrPattern data

A TkrPattern data is a collection of SiClusters

TkrKalman

It contains the algorithms to fit (filter/smooth) a Kalman Track

TkrNavigator

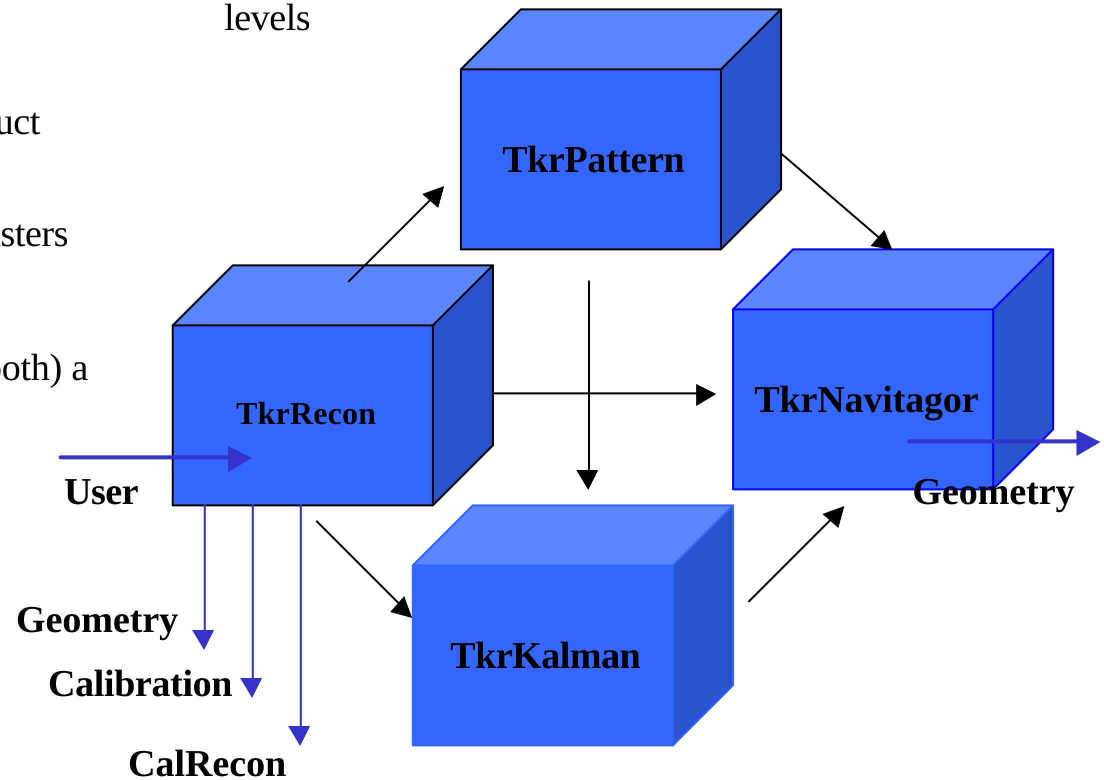
It contains the algorithms to navigate a TkrParticle though the detector.

Requirements:

they adopt data/algorithm/condition separations

they should minimize the relation with other packages

the relations with other packages are via intermediate levels



Tracking simulations

Reconstruction: data,algorithms, conditions

GAUDI/Centella Philosophy: devide classes into *data*, algorithms (+ conditions)

Data:
make();
clear();

Algorithm:
run();
initialize();
execute();
finalize();

Condition:
bool apply();

Data:

I.e containers

devided:

elements

server/List

Base class:

clear();

Algorithms:

I.e constructors

Base class:

run();

Set methods

setData();

setCondition();

Complex algorithms

multiAlgorithm

conditional Algorithms

Conditions:

Filters returns true/false Base class:

bool apply();

Set methods

setData();

setCondition();

Complex Conditions

multi Conditions (AND, OR)

Tracking simulations

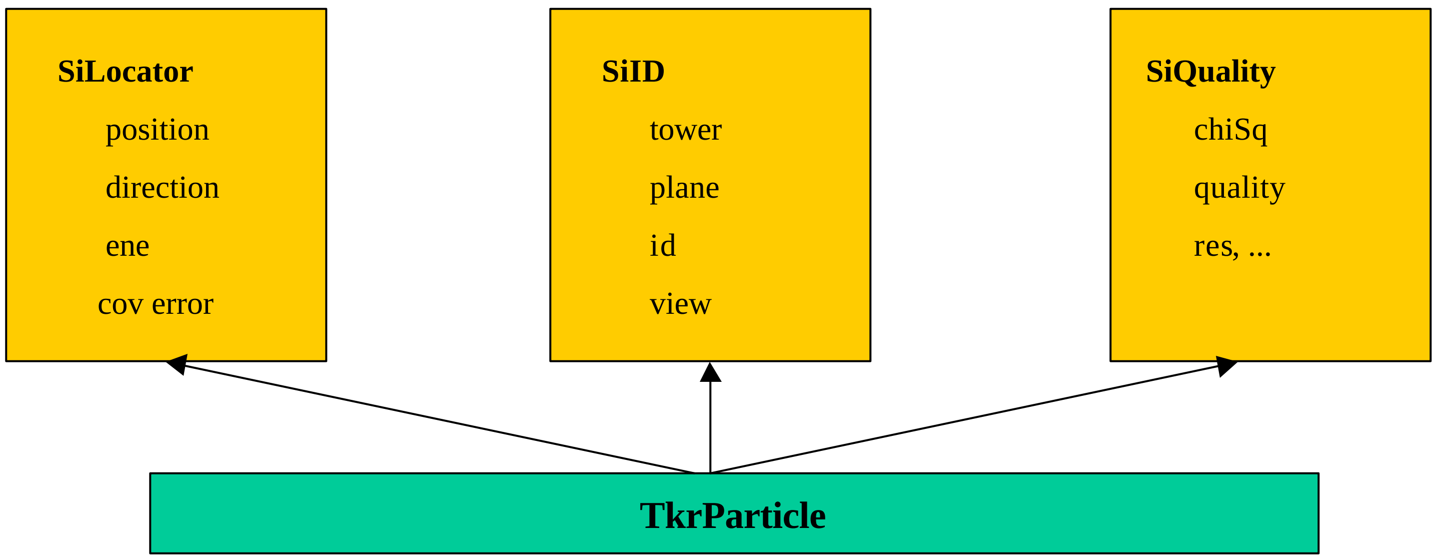
Reconstruction: interface

Interface : TkrParticle (from GFdata**)**

Most of the Tkr classes should be converter into a TkrParticle: SiTrack, SiGamma, KalTrack, etc..

The connection between the different Tkr recon packages should be done using a TkrParticle

Do we need a TkrParticleComposite?



Package Parameters:

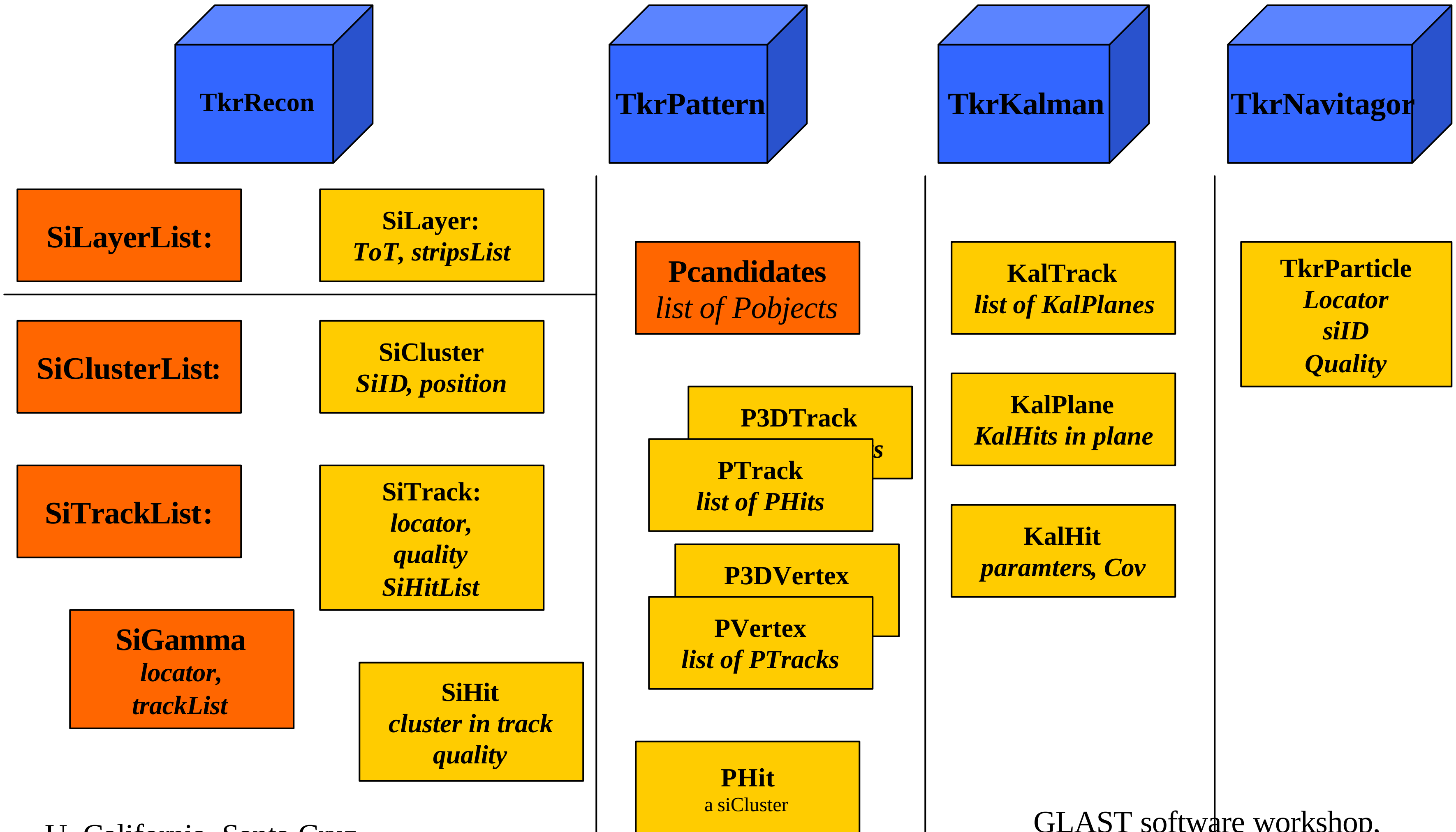
Every package has a class with static parameters

should be accessible by the user (xml file)

Tracking simulations

Reconstruction: transient data

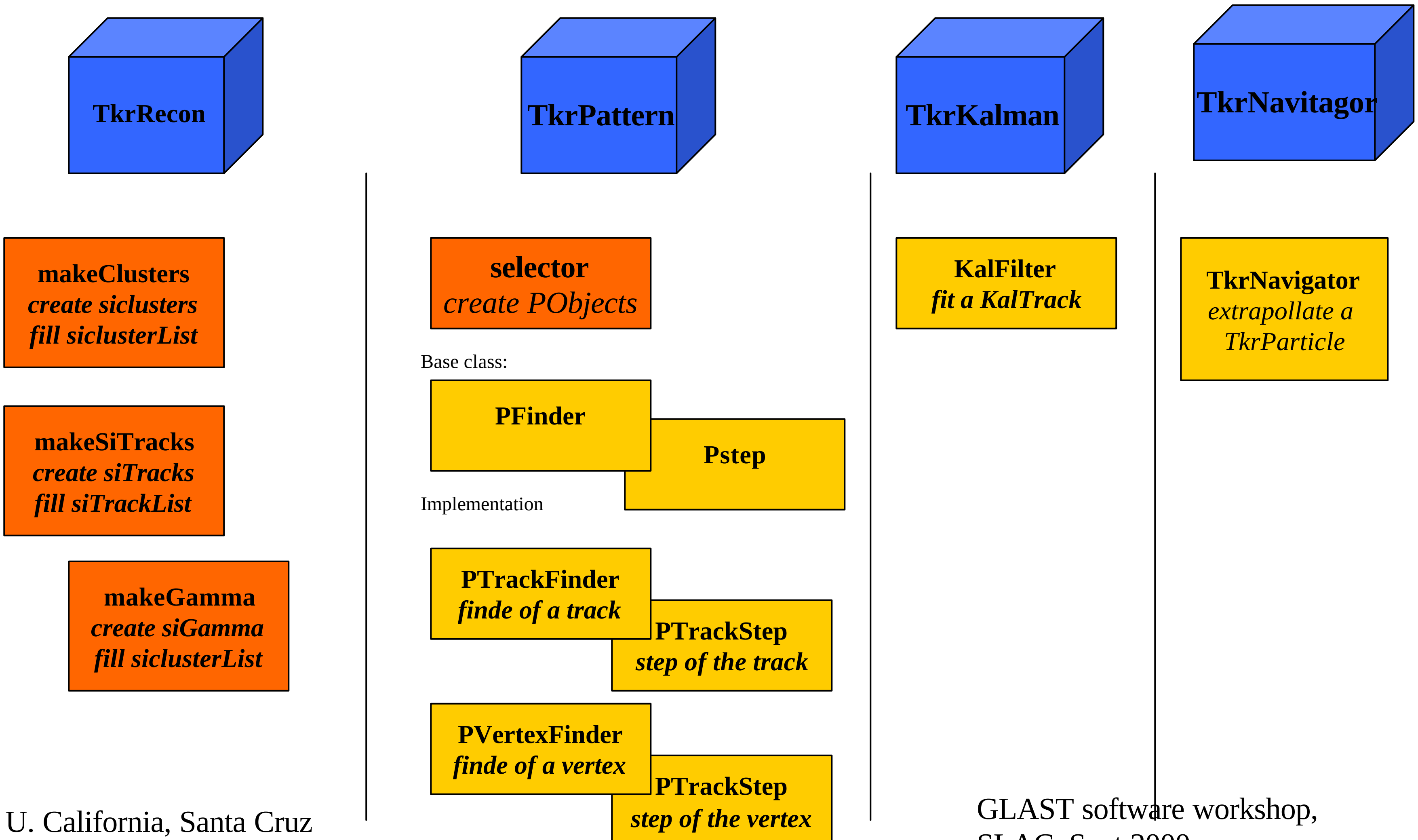
Transient Data:



Tracking simulations

<u>Reconstruction: algorithms</u>

Algorithms



Reconstruction: algorithms

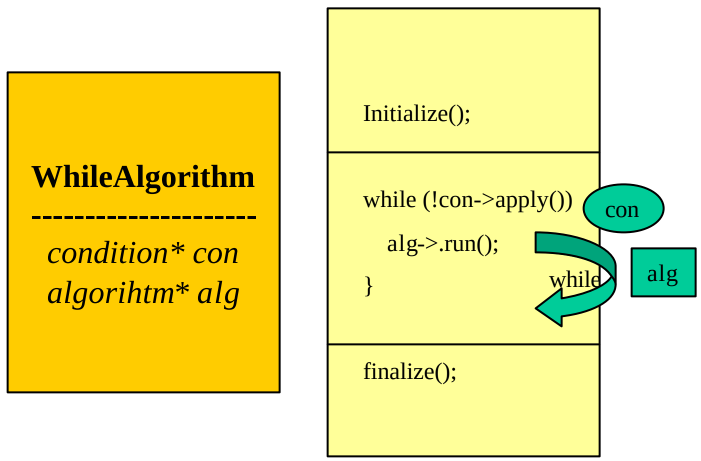
Algorithms in the Pattern Recognition

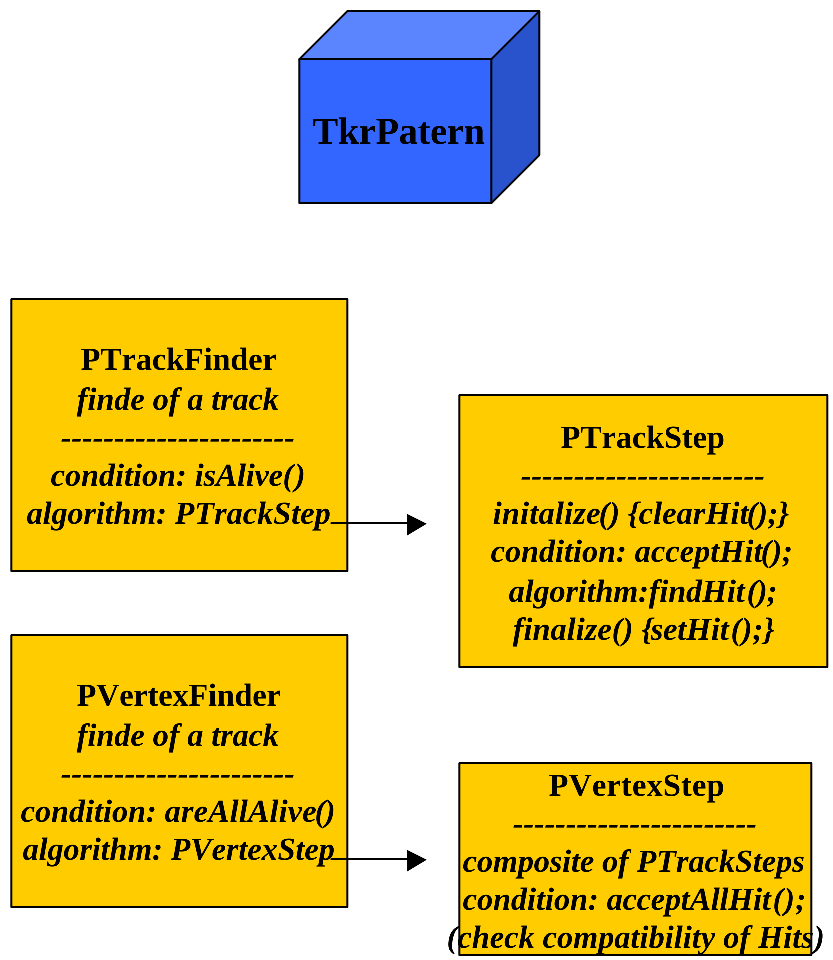
While Algorithm:

execute() method

runs an algorithm while a condition is true

We can create Composites of WhileAlgorihtms

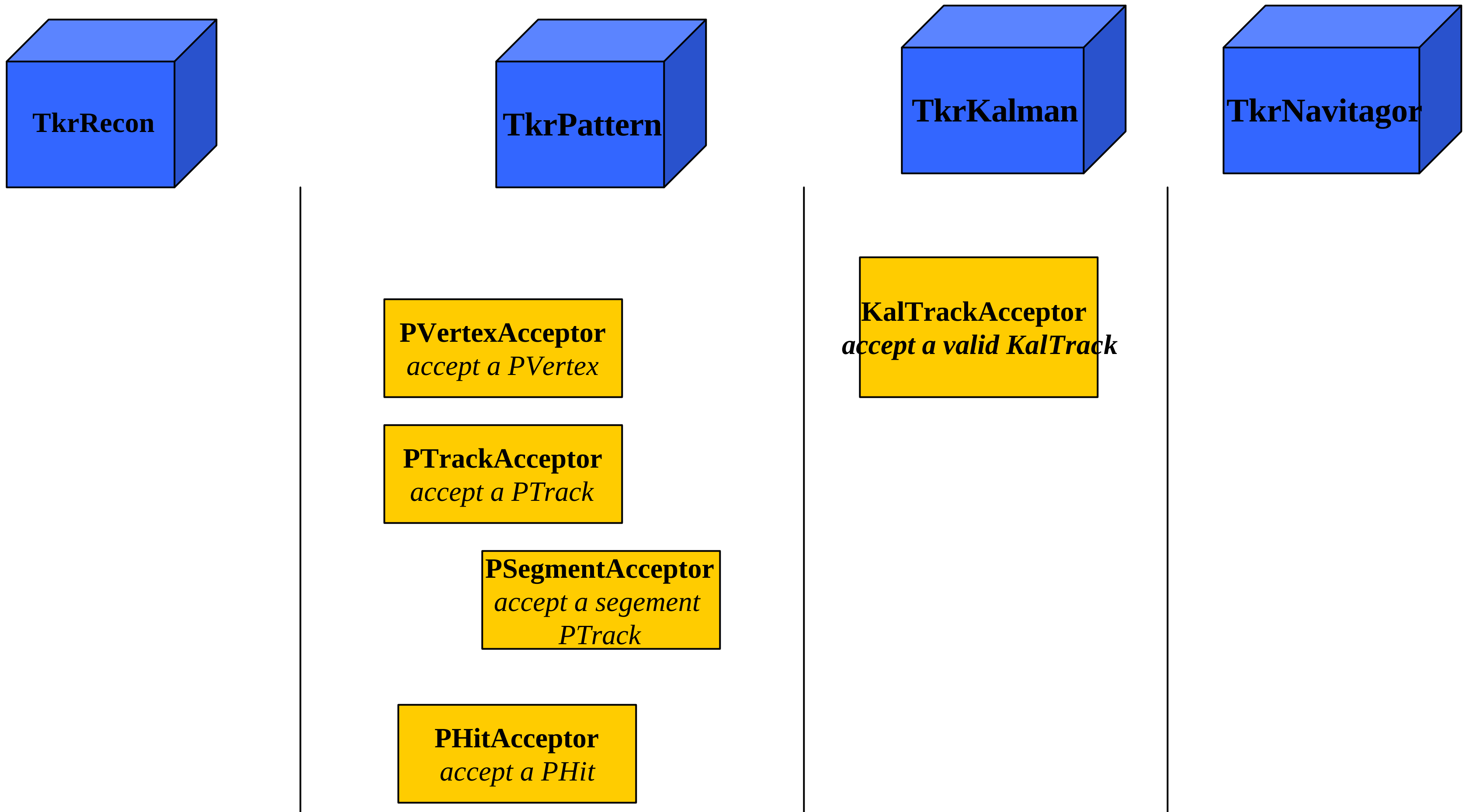




Tracking simulations

Reconstruction: conditions

Algorithms



Tracking simulations

Reconstruction: summary of plans

Work in progress:

user requirement document:

what the user can do with the Tkr recon?

How the user retrieve data from Tkr recon?

Reorganization in packeages:

Kalman Filter - Pattern Recognition

TkrRecon - TkrNavigator

60% work done

Waiting to commit to CVS.

Coordination with SLAC

Definition of data and algorithms:

tb_recon:

first attempt data reorganization: SiClusters

Future Planes:

user requirements document

tracker reconstruction documentation

adaptation of the code to the new structure

tracker recon group: UCSC, USC, SLAC

goal: next release (jan 01).

Reconstruction:conclusions

Conclusions:

* we need to understand the present reconstruction in terms of the general GLAST software evolution.

* the tracker reconstruction *works in an acceptable level and has produced good results* for:

AO, tb_recon, and GTOCC.

* the tracker reconstruction *contains a collection of correct algorithms* for the GLAST tracking problem

Kalman Filter   Pair Fit (“V” pattern recognition)

* the tracker reconstruction contains a minor collection of physics algorithms that should be understood, and explored.

Best track, addition of tracks, energy determination

* the tracker reconstruction *should be reorganize to fit into the new structure*. Work in progress.