Raw-data display and visual reconstruction validation in ALICE

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- □ Architecture of the ALICE Event Visualization
- □ Features & Status
- □ Raw-data visualization
- □ Visual validation of the reconstruction chain
- □ Conclusion

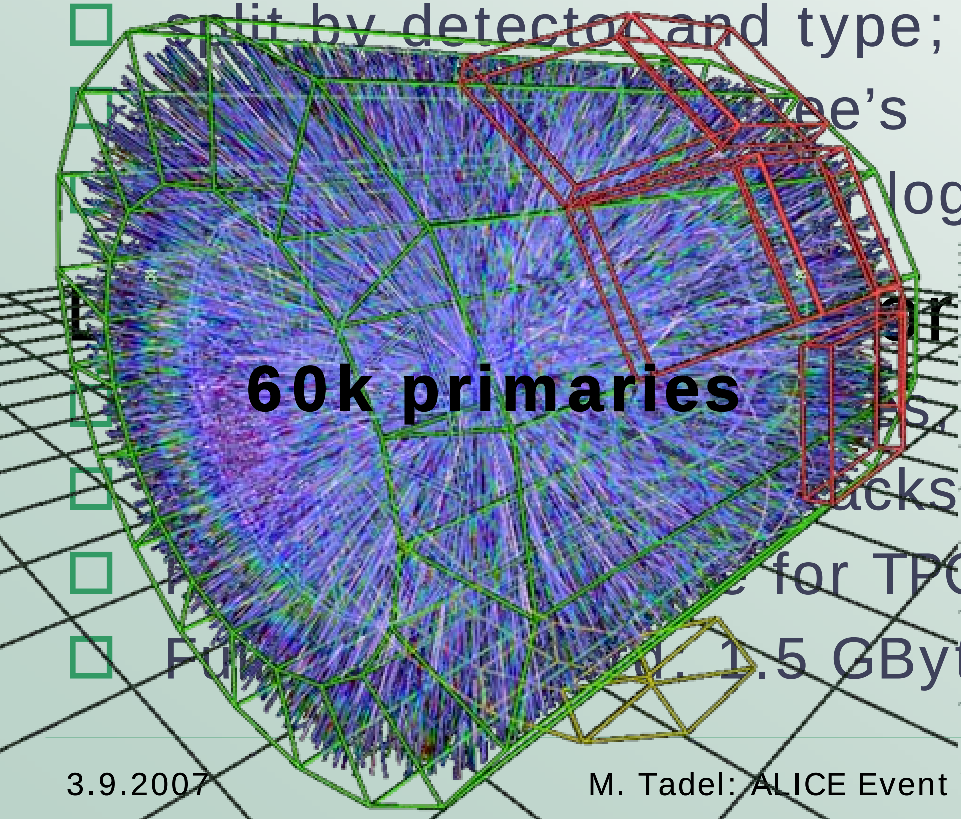
ALICE computing environment

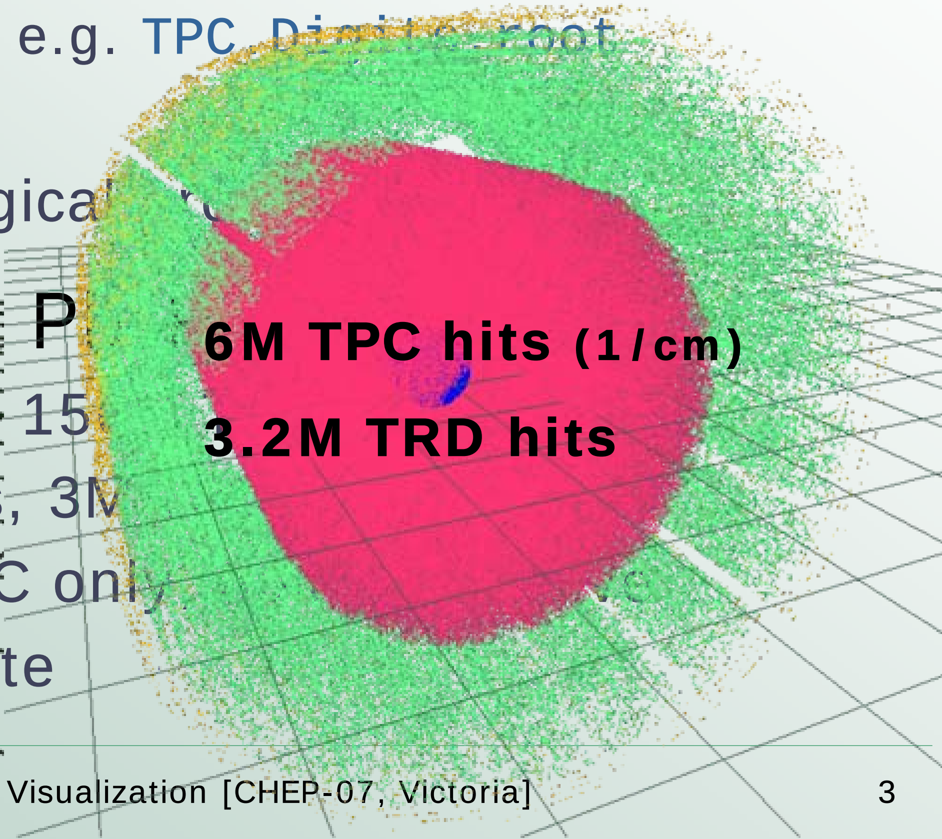
ALICE + ROOT → AliROOT ♥

- Only external dependencies are transport engines
- Runs on almost every os/arch (but windows)

Event data is stored in a set of ROOT files:

- split by detector and type; e.g. TPC.Digits.root
- ee's
- logica
- L ar P
- s, 15
- acks, 3M
- e for TPC only
- Fu d: 1.5 GByte





Event Visualization Environment I.

Requirements – what to display:

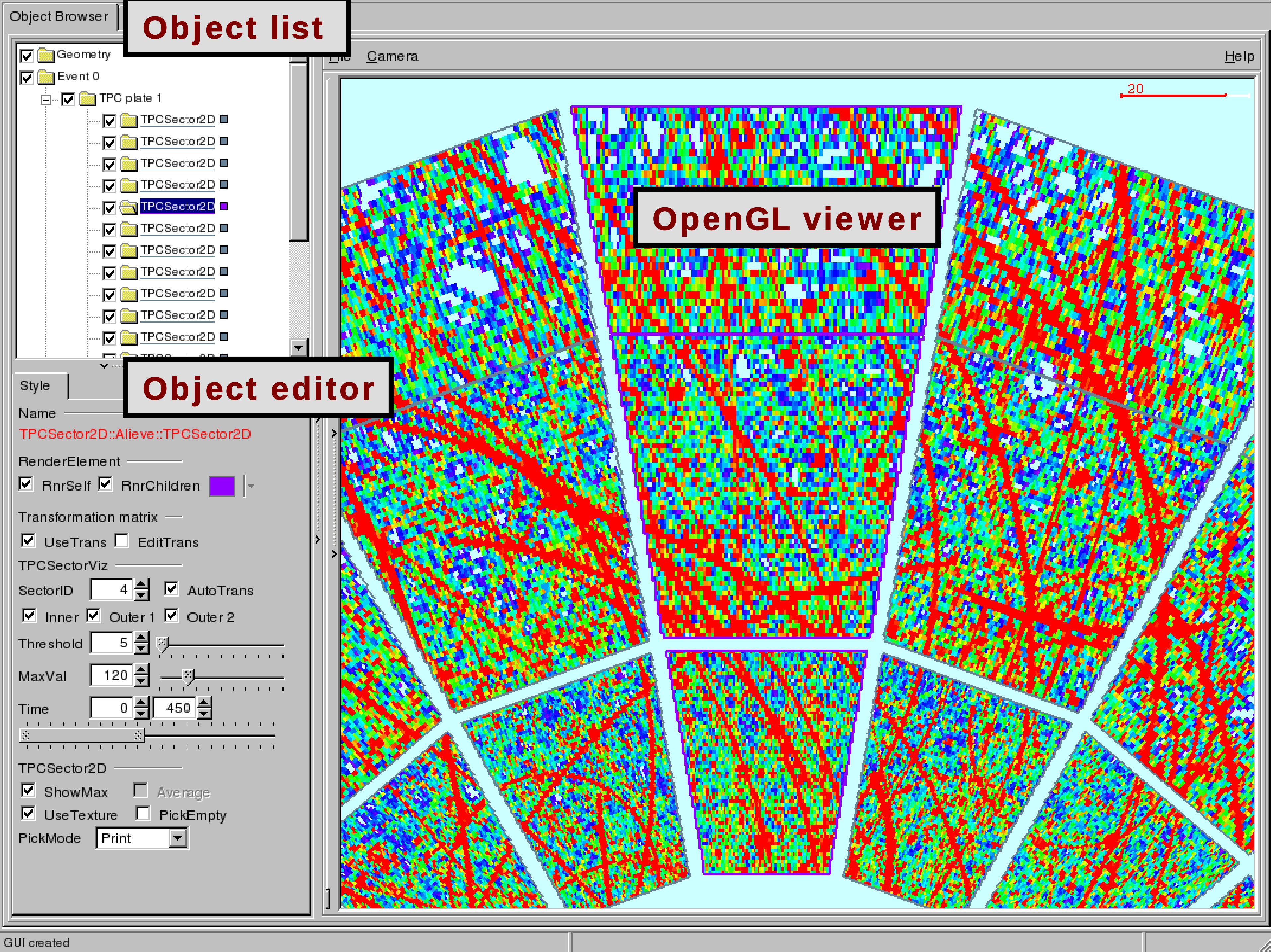
1. Geometry, simulation & reconstruction data
2. Raw-data
3. Top-level trigger events and monitoring data
4. On-line detector monitoring data

Allow progressive introduction of functionality:

simple things must be simple, complicated possible.

Implementation – how to do it:

1. EVE – extendible framework, not a monolithic application
2. Build on top of ROOT: GUI, OpenGL for 3D graphics
3. Use same philosophy: modular, loosely coupled class toolbox
4. Provide new elements as needed:
   - i. Put basic / low-level development back into ROOT
   - ii. Build composite / top-level elements from those



Object list

OpenGL viewer

Object editor

☑ Geometry
☑ Event 0
☑ TPC plate 1
☑ TPCSector2D
☑ TPCSector2D
☑ TPCSector2D
☑ TPCSector2D
☑ TPCSector2D
☑ TPCSector2D
☑ TPCSector2D
☑ TPCSector2D
☑ TPCSector2D
☑ TPCSector2D
☑ TPCSector2D

Name

TPCSector2D::Alieve::TPCSector2D

RenderElement

☑ RnrSelf ☑ RnrChildren

Transformation matrix

☑ UseTrans □ EditTrans

TPCSectorViz

SectorID 4 ☑ AutoTrans

☑ Inner ☑ Outer 1 ☑ Outer 2

Threshold 5

MaxVal 120

Time 0 450

TPCSector2D

☑ ShowMax □ Average

☑ UseTexture □ PickEmpty

PickMode Print

Event Visualization Environment II.

Two main modules:

1. Reve/ ROOT only, **is becoming a ROOT module**
   1. Application core
   2. Framework base-classes for GUI and VIZ
   3. Basic visualization classes (points, tracks, raw-base, …)

      All with GUI editors and GL renderers!
2. Alieve/ AliROOT
   1. Event loading / navigation
   2. Classes for detector-module representation (raw-data)
   3. CINT scripts that perform data extraction

Application core:

1. Management of browsers and viewers
2. Registration of visualization objects (global / event)
3. Execution environment for CINT scripts
4. Event management & navigation

Standard visualization classes

Geometry:

a) Direct usage via TGeoPainter: requires geometry

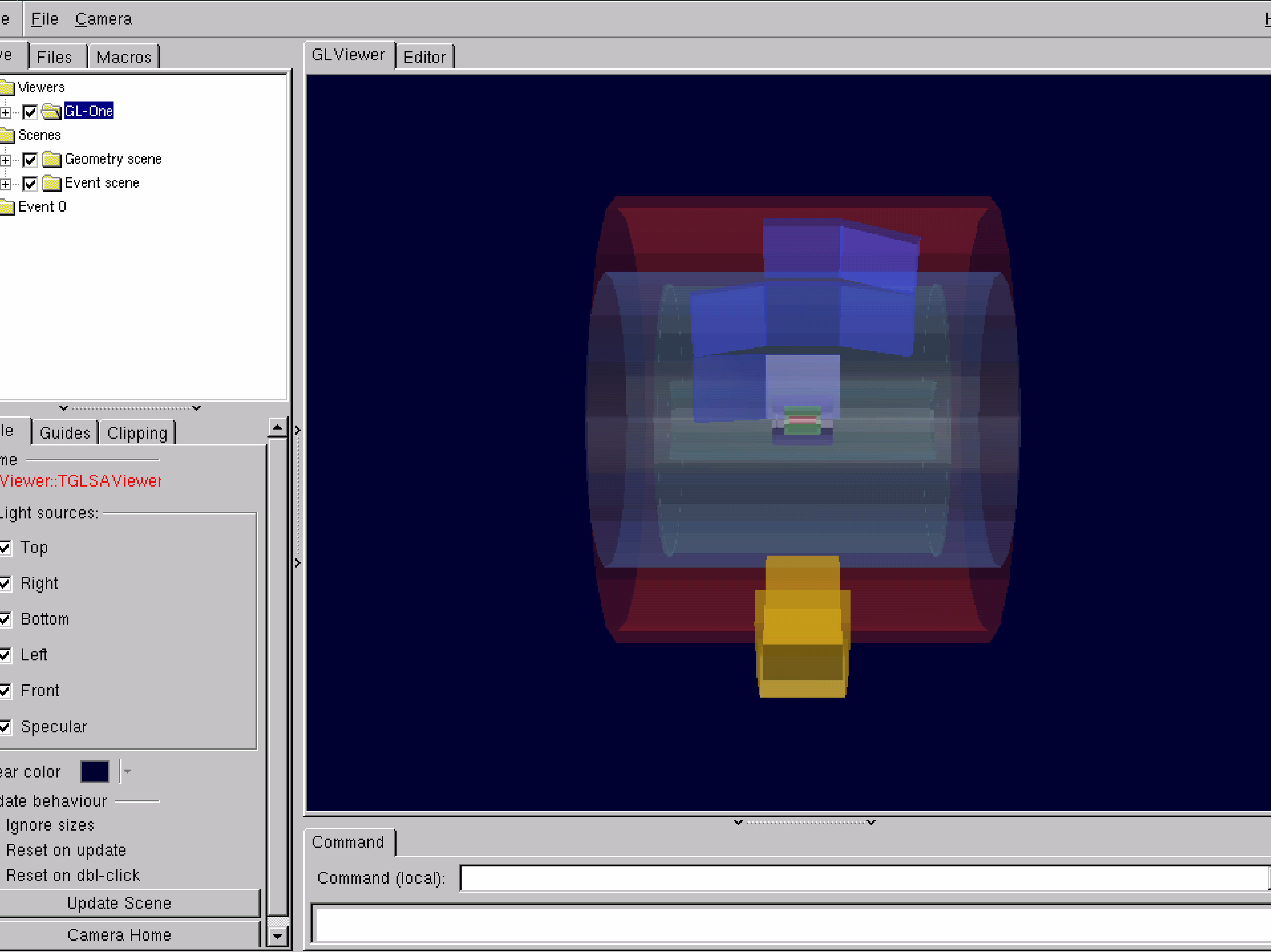
b) Extracted shape-data: standalone, fully configurable

Hits, clusters:

- PointSet: per-point TRef (optionally owned by the object)
  Special TSelector provided for filling - use Tree machinery
- PointSetArray: an array of point-sets - interactive histogram
  Select on external criteria provided during filling

Trajectories, particles, tracks:

- Track: supports extrapolation in (const) magnetic field
  Can specify position/momentum at:
  1. arbitrary reference points (enter/leave certain volume)
  2. daughter creation points / momentum
  3. decay points
- TrackList – an array of tracks
  Interactive selection on standard track parameters: pT, chi2, ...



Viewers
☑ GL-One
Scenes
☑ Geometry scene
☑ Event scene
Event 0

me
Viewer::TGLSAViewer

Light sources:
☑ Top
☑ Right
☑ Bottom
☑ Left
☑ Front
☑ Specular

ear color

date behaviour
Ignore sizes
Reset on update
Reset on dbl-click

Command (local):

Raw-data visualization classes

Digits, raw-data:

- □ QuadSet – set of rectangles, lines or hexagons

  Supports per quad TRef → secondary-selection

  Used for silicon detectors, TRD, TOF, PMD, ...

- □ BoxSet – set of boxes (calorimeters)
- □ TriangleSet – arbitrary triangle mesh or soup

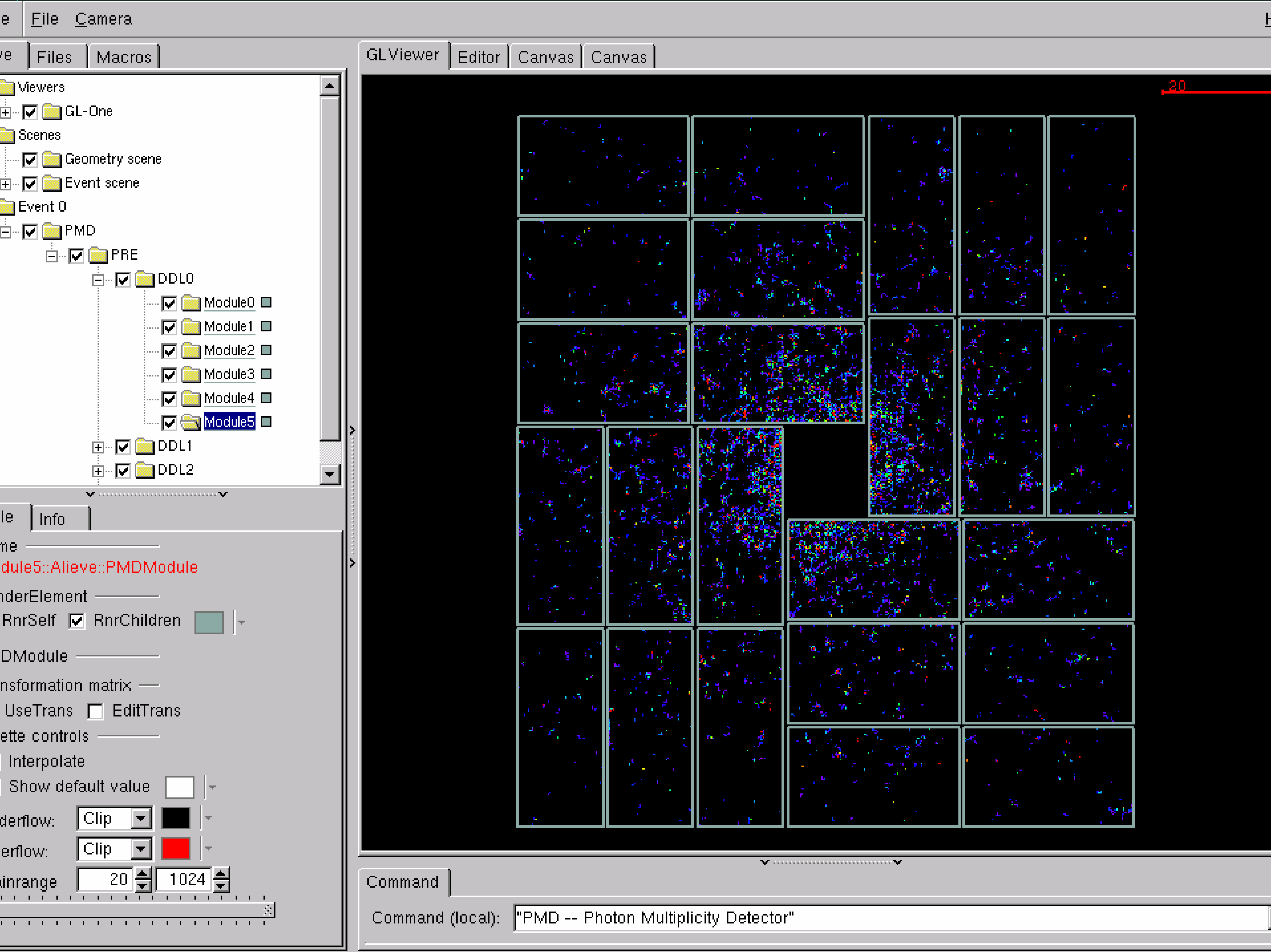
All optimized for small memory usage and fast rendering!

Support classes:

Instances shared among several modules

- □ RGBAPalette: map signal to colors + thresholds
- □ FrameBox: provide a uniform frame

Ref-counting (auto-deletion) & back-refs (update)



RnrSelf ☑ RnrChildren

DModule

nsformation matrix

UseTrans □ EditTrans

ette controls

Interpolate

Show default value

derflow: Clip

erflow: Clip

inrange 20 1024

Command (local): "PMD -- Photon Multiplicity Detector"

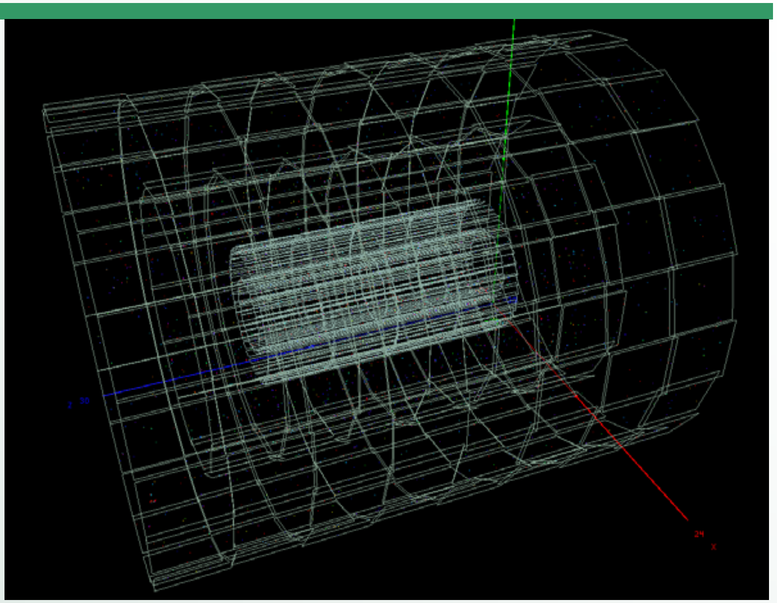
Intermediate-level raw-data inspection

Two common problems:

I. detectors hide each other

II. individual digit is too small

3D view nonsensical …



I. Planar layout w/ pager

View as many modules as possible

Arrange them in pages

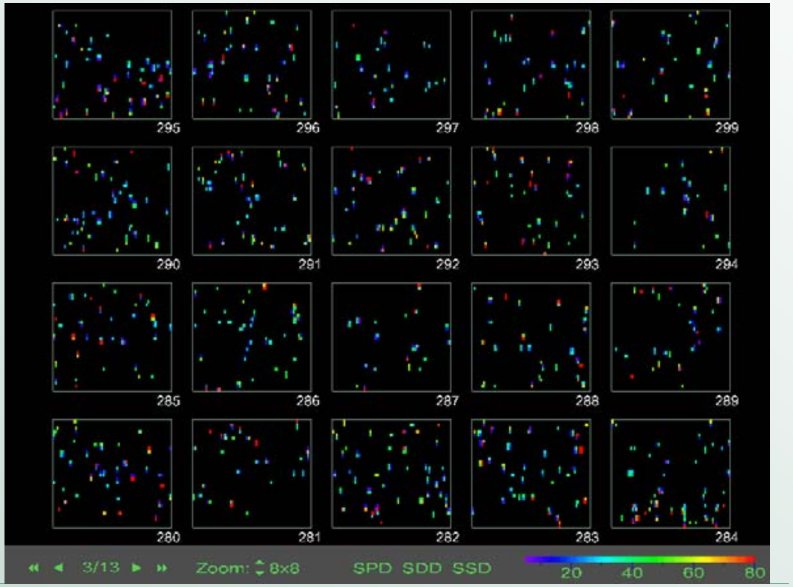
Provide selection (by type, phi, eta, …)

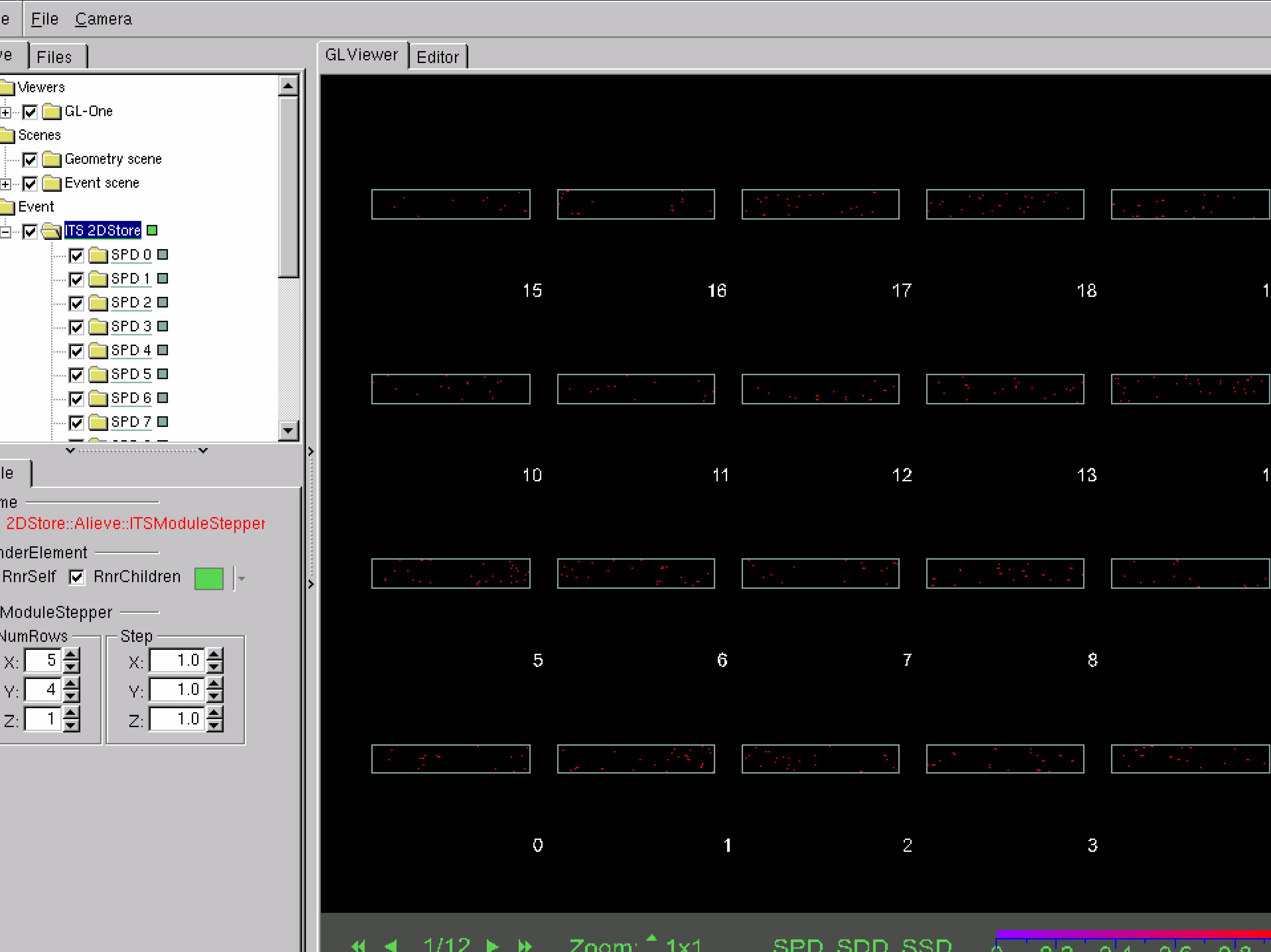
II. Digit scaling

Accumulate nearby digits.

Show statistical quantities for group:

- □ average, RMS
- □ occupancy
- □ min / max values





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2DStore::Alieve::ITSModuleStepper

nderElement

RnrSelf ☑ RnrChildren

ModuleStepper

NumRows

X: 5

Y: 4

Z: 1

Step

X: 1.0

Y: 1.0

Z: 1.0

TPC raw-data visualization

75% of data-volume (60MBytes for Pb-Pb)

SectorViz (base-class)

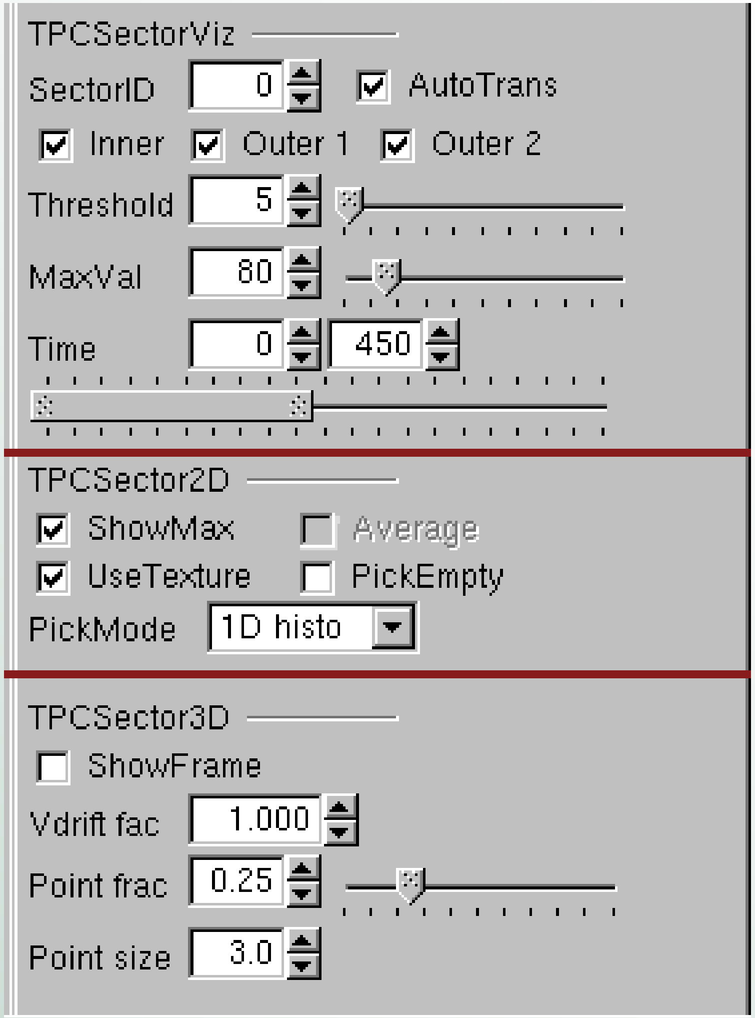
- sector id, part selection
- threshold and saturation
- time-range

Sector2D (projected to plane)

- data collect mode
- interaction mode

Sector3D (complete view)

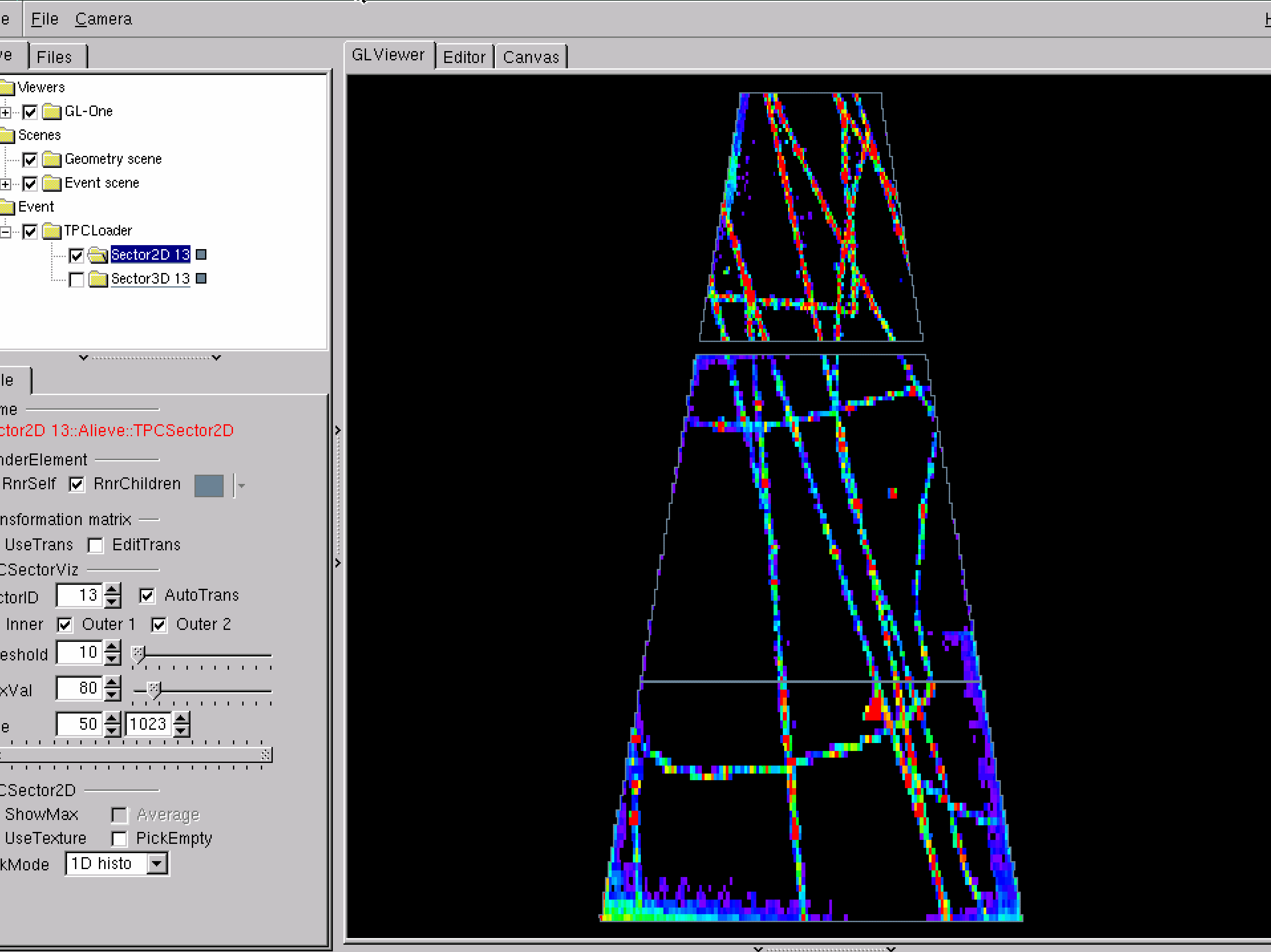
- drift velocity tweak
- fraction of boxes / points



TPCSectorViz
SectorID 0 ☑ AutoTrans
☑ Inner ☑ Outer 1 ☑ Outer 2
Threshold 5
MaxVal 80
Time 0 450

TPCSector2D
☑ ShowMax □ Average
☑ UseTexture □ PickEmpty
PickMode 1D histo

TPCSector3D
□ ShowFrame
Vdrift fac 1.000
Point frac 0.25
Point size 3.0



- Viewers
  - ☑ GL-One
- Scenes
  - ☑ Geometry scene
  - ☑ Event scene
- Event
  - ☑ TPCLoader
    - ☑ Sector2D 13
    - □ Sector3D 13

me

ctor2D 13::Alieve::TPCSector2D

nderElement

RnrSelf ☑ RnrChildren

nsformation matrix

UseTrans □ EditTrans

CSectorViz

ctorID 13 ☑ AutoTrans

Inner ☑ Outer 1 ☑ Outer 2

eshold 10

xVal 80

e 50 1023

CSector2D

ShowMax □ Average

UseTexture □ PickEmpty

kMode 1D histo

Visual reconstruction validation

Detailed view of reconstruction

Primary vertex, tracks, clusters

Backward navigation to simulation data

Counting of primary tracks on initial data-sample:

cross-check pT and eta distributions against std reconstruction

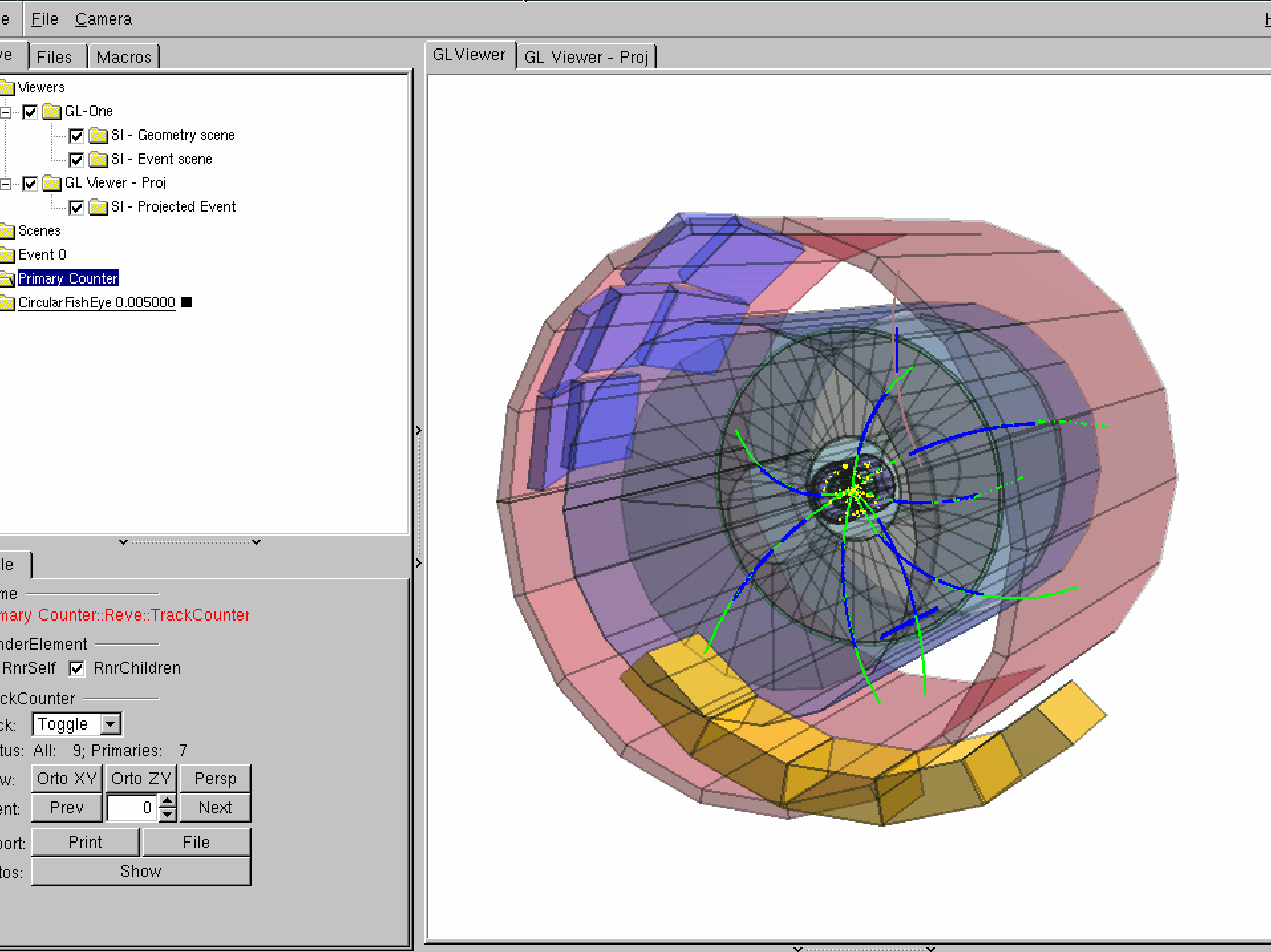
Projections à la H. Drevermann (no V-plot ☺)

Supported data-types:

1. geometry preferably simplified
2. PointSet clusters, hits
3. Track kine, reco; compound objects – kinks, V0s

Non-linear transformations – fisheye view of vertex region

Allows better inspection of cluster-track associations



mary Counter::Reve::TrackCounter

tus: All: 9; Primaries: 7

ent: 0

Conclusion

1. General application core + base-classes

   Solve general problems in Reve / Root ...

   and specific ones in Alieve / AliRoot.

2. Via CINT scripts users gain full flexibility
   1. edit them for specific selections, packing of output
   2. extend them to include user's private data
   3. combine them together

   Allows fast development of specific display programs

3. Often data can be visualized directly from ROOT
   1. trees, scripts, geometry and other data can be packed together in a single ROOT file containing several events
   2. independent of experiment software

      laptops, unsupported platforms; use by universities, outreach
   3. experiment-independent part is becoming a ROOT module!

      will be included in the next production release in December