

The Event Reconstruction Chain

Reconstruction

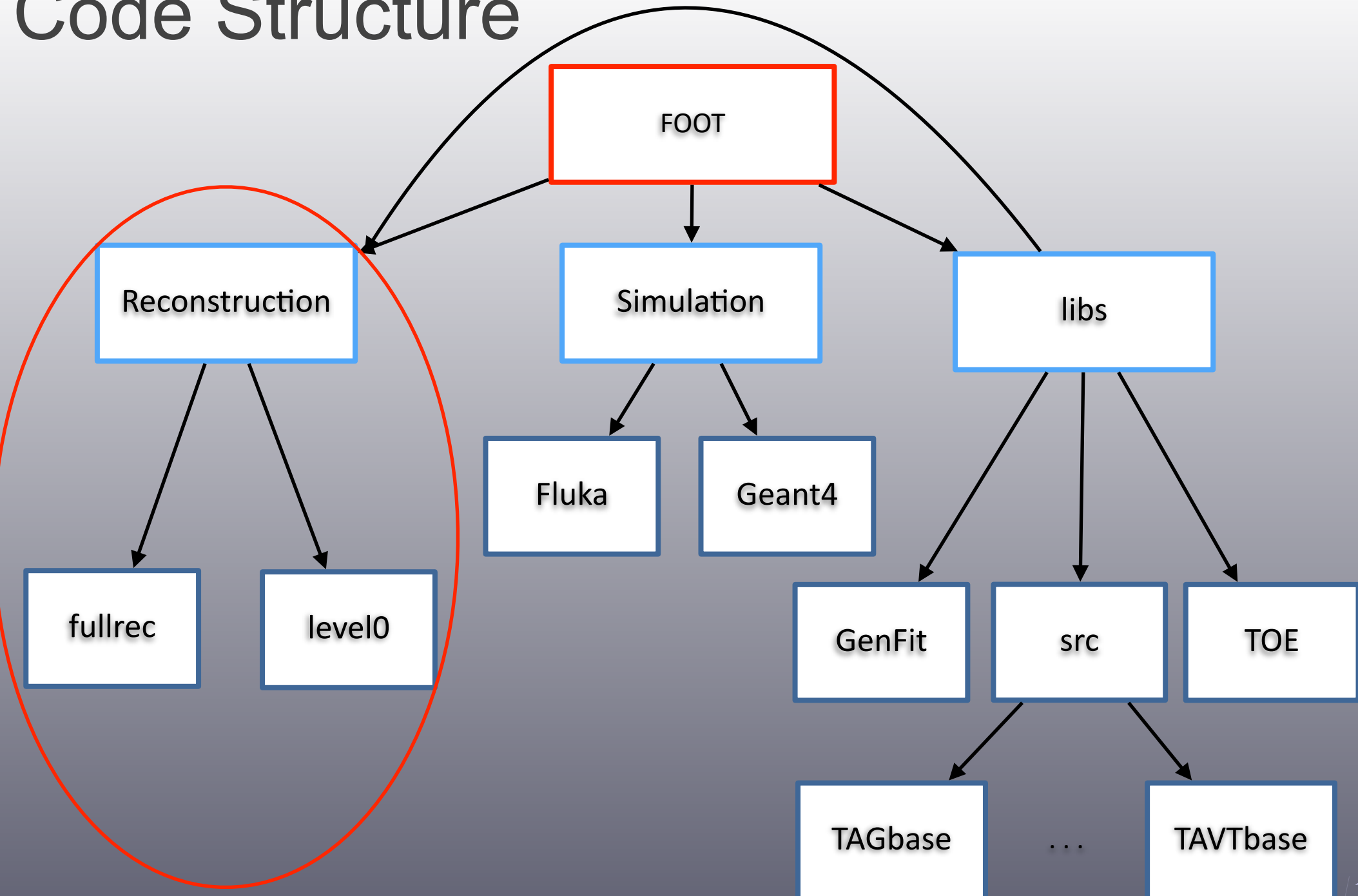
Campaign manager

Foot Global Parameters

Executables

Event Display

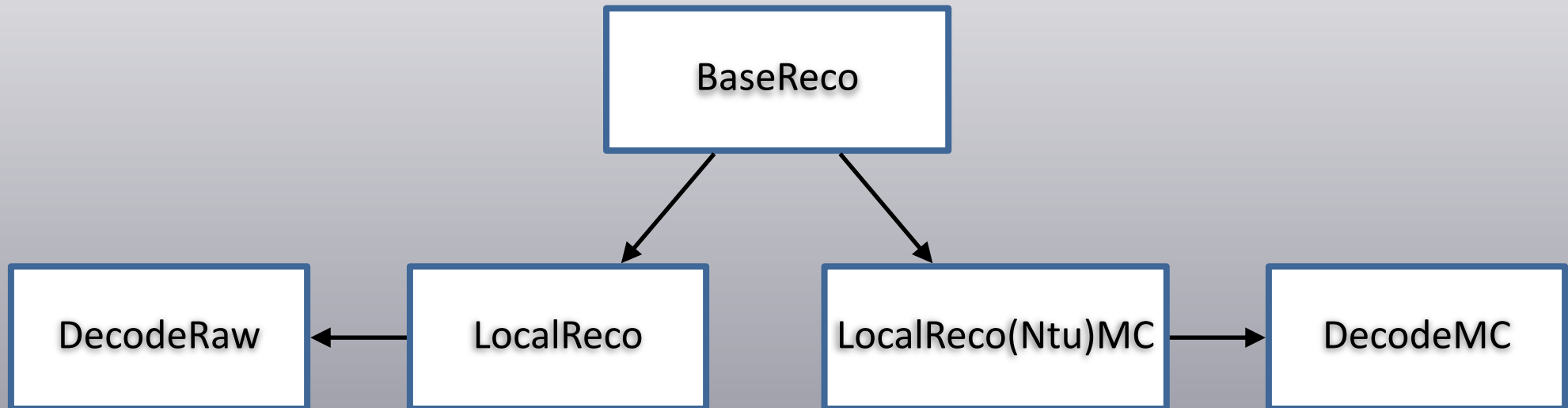
Code Structure



Reconstruction

Local reconstruction

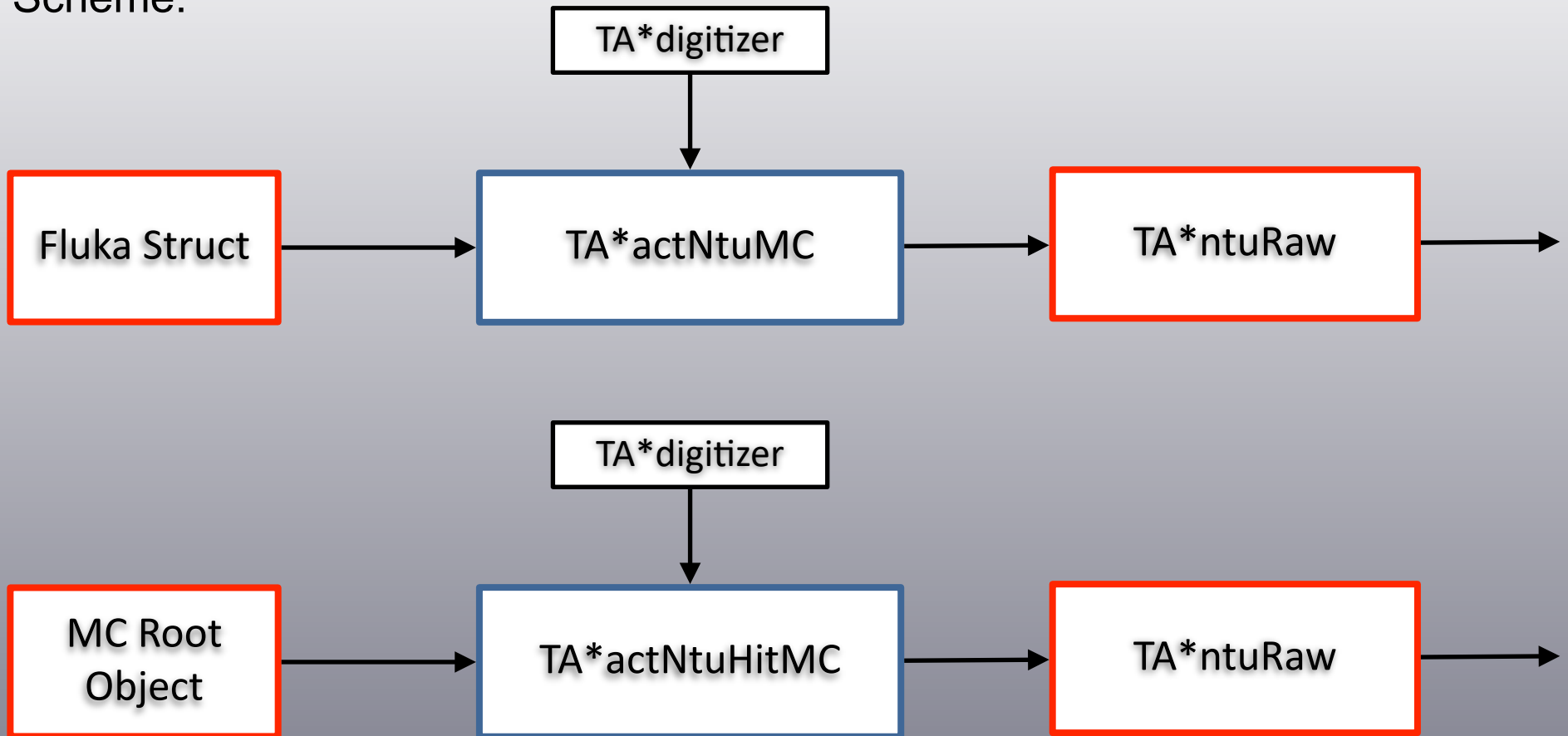
✦ Scheme:



- Actions common to MC and real data (clusters, points, tracks and vertexes)
- Dedicated classes for actions MC and real data
- DecodeMC(Raw) are available as compiled executable

Raw MC reconstruction

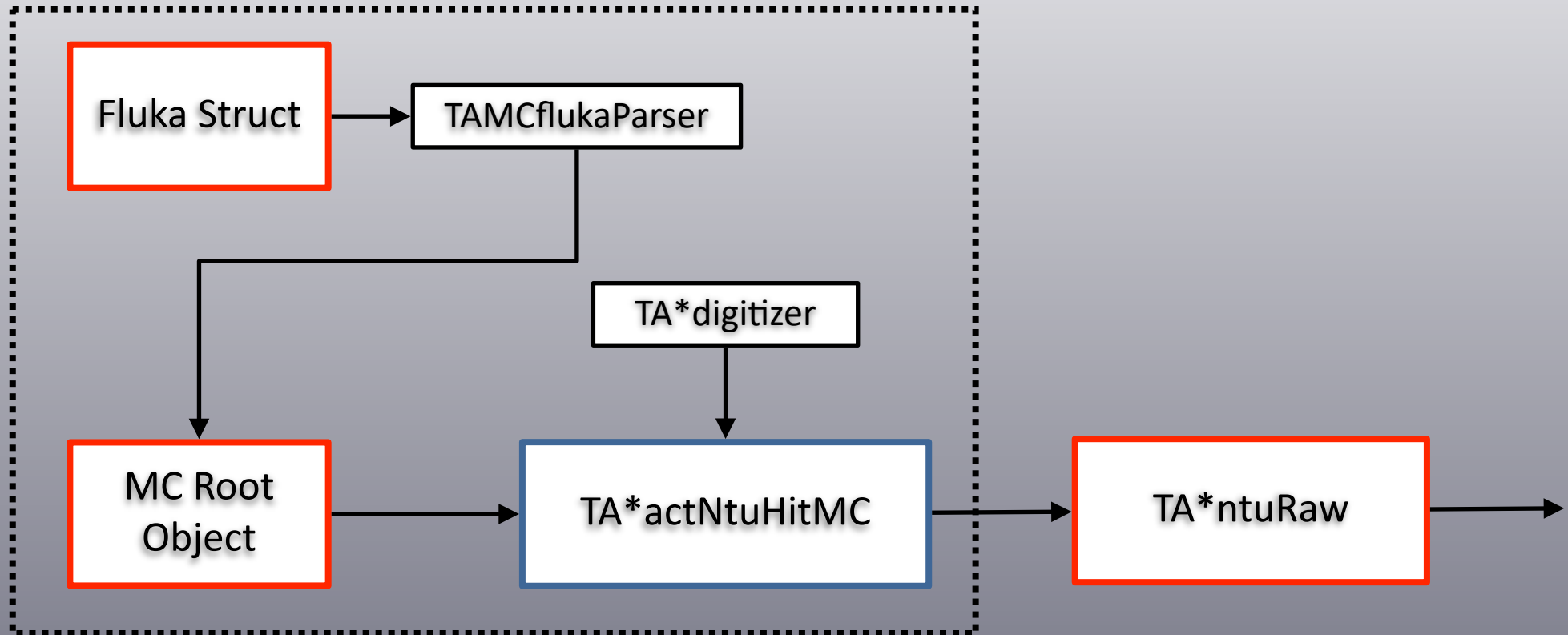
• Scheme:



- Read back either Fluka structure or Ntupled root object
- TA*actNtu(Hit)MC actions and TA*ntuRaw containers dedicated for each detector

Raw MC reconstruction

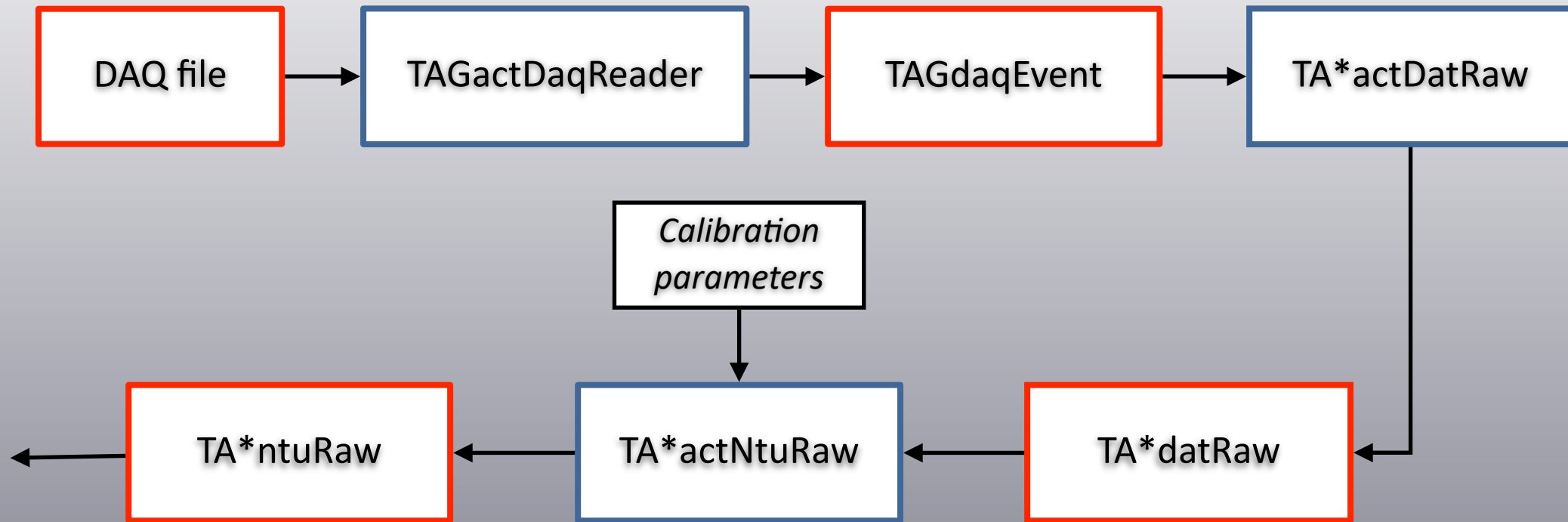
✦ New Scheme:



- TA*actNtuHitMC actions read back either Fluka structure or Ntupled root object

Raw data reconstruction

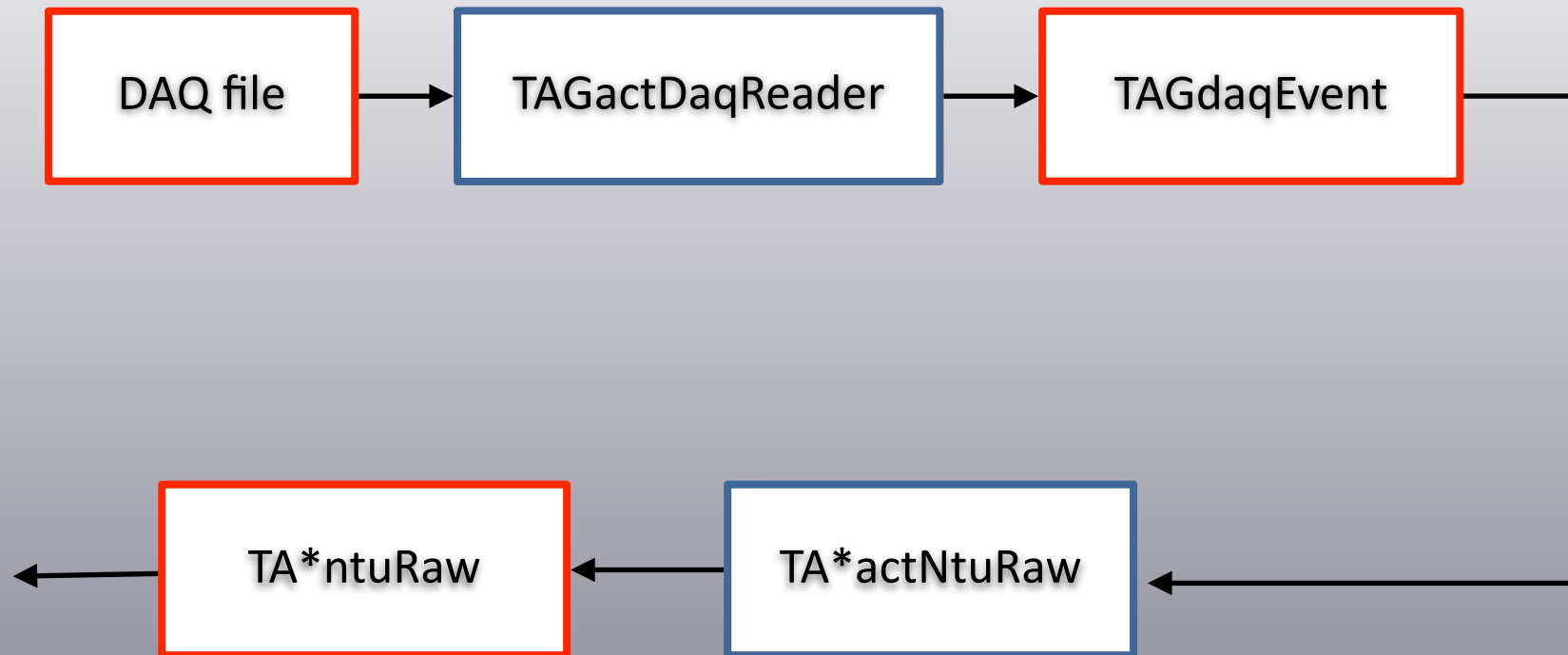
• Scheme with calibration:



- TAGactDaqReader: interface with DAQ in TAGdaq folder
- To pack/unpack DAQ event provided by DAQ and put in TAGdaqApi
- TA*actDatRaw actions and TA*datRaw containers dedicated for each detector

Raw data reconstruction

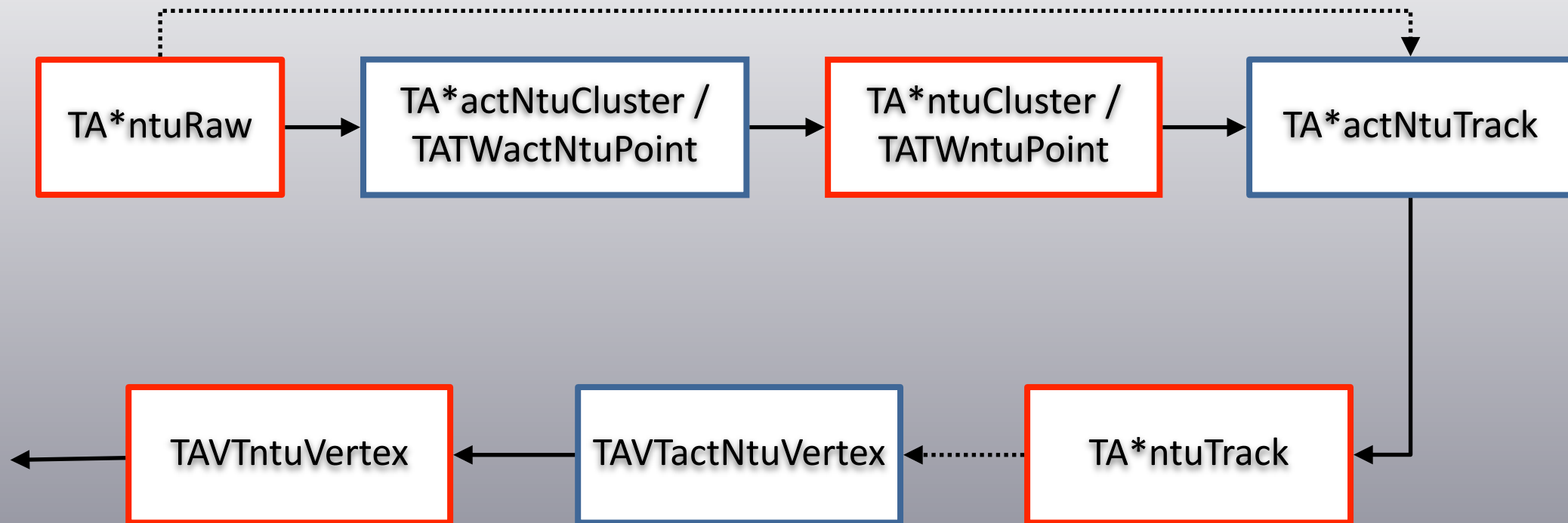
✦ Scheme w/o calibration:



- TAGactDaqReader: interface with DAQ in TAGdaq folder
- To pack/unpack DAQ event provided by DAQ and put in TAGdaqApi
- TA*actDatRaw actions and TA*datRaw containers dedicated for each detector

Reconstruction

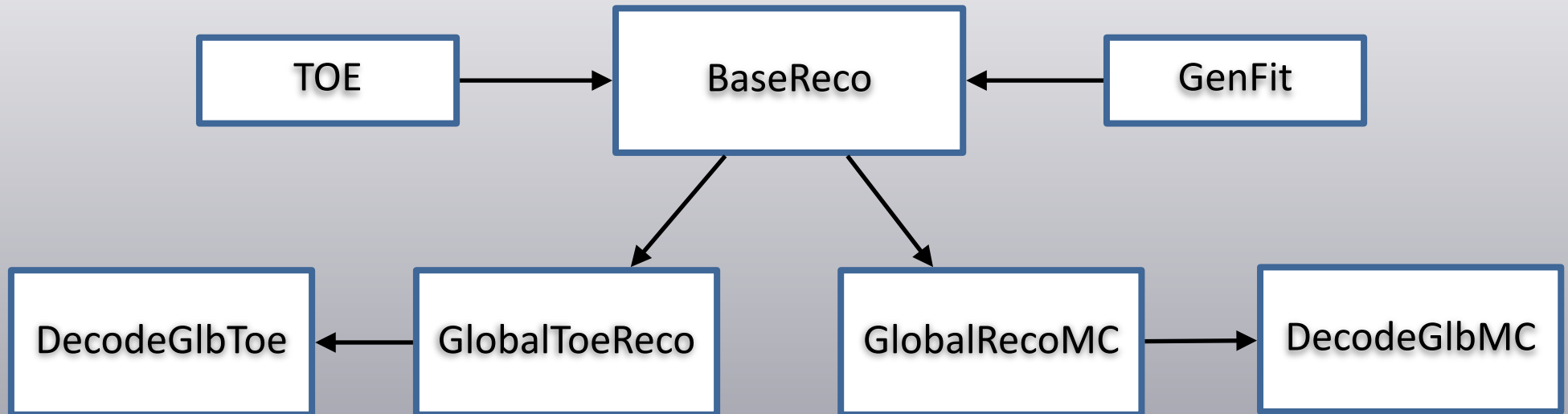
• Scheme:



- Hits: STC - BM - VTX - ITR - MSD - TW - CAL
 - Clusters/Points: VTX - ITR - MSD - CAL / TW
 - Tracks: BM - VTX - (ITR)
 - Vertex: VTX
- ➔ All positions are given in the detector's framework !

Global reconstruction

✦ Scheme:



- Since the L0 reconstruction actions are common, glb reconstruction inherits from base
- GlobalToeReco: global reconstruction with TOE libraries
- GlobalRecoMC: global reconstruction with GenFit libraries from MC data
- Global reconstruction either from raw data or level0 reconstruction tree
- DecodeGlb: run global reconstruction with GenFit (trial to put back GenFit reconstruction into framework, in progress)

Campaign Manager

Campaign manager (i)

Master file: ./cammaps/FOOT.map

```
// List of Campaigns
```

```
CamNumber: 0  
CamName: "STD"  
CamDataMC: 1  
CamDate: ""  
CamSum: "Test using standard input files"
```

```
CamNumber: 1  
CamName: "12C_200"  
CamDataMC: 1  
CamDate: ""  
CamSum: "Simulation data for 12C on 12C (5mm target) @ 200MeV/u"
```

```
CamNumber: 2  
CamName: "160_200"  
CamDataMC: 1  
CamDate: ""  
CamSum: "Simulation data for 160 on 12C (run 6) or C2H4 (run 1-5) for 5mm target thickness @ 200MeV/u"
```

```
CamNumber: 3  
CamName: "GSI"  
CamDataMC: 0  
CamDate: "5-8 April 2019"  
CamSum: "Test experiment with ST+BM+VTX+TW..."
```

```
CamNumber: 4  
CamName: "HE_MC"  
CamDataMC: 1  
CamDate: "5-8 January 2020"  
CamSum: "MC data for HE reaction produced by FLUKA"
```

```
CamNumber: 5  
CamName: "H_MC"  
CamDataMC: 1  
CamDate: ""  
CamSum: "Simulation data for 1H on C2H4 for 5mm target thickness @ 200MeV/u (run 1) and @ 700MeV/u (run 2)"
```

- Campaign name with associated id
- MC data flag
- Date of data taking or production
- Summary of the campaign

➔ e.g.: load campaign file in ./cammaps/GSI.cam when option: `-exp GSI`

Campaign manager (ii)

Real data structure: ./cammaps/GSI.cam

```
// Campaign file
CamName: "GSI"
RunNumber: 2187-2261
NumberDevices: 6

DetectorName: "FOOT"
NumberFiles: 1
"./geomaps/GSI/FOOT.geo": 2210; 2239

DetectorName: "ST"
NumberFiles: 4
"./geomaps/GSI/TASTdetector.geo": -1
"./config/GSI/TASTdetector.cfg": -1
"./config/GSI/WDChannelMap.map": -1
"./calib/GSI/WDTimeCalibration/tcalib.dat": 2187;
2190; 2191; 2192; 2193; 2200; 2202; 2203; 2204;
2205; 2206; 2208; 2209; 2210; 2211; 2212; 2213;
2214; 2216; 2217; 2218; 2219; 2220; 2221; 2222;
2223; 2224; 2225; 2226; 2227; 2228; 2229; 2230;
2231; 2232; 2233; 2234; 2235; 2236; 2237; 2238;
2239; 2240; 2241; 2242; 2243; 2244; 2245; 2246;
2247; 2248; 2249; 2250; 2251; 2252; 2253; 2254;
2255; 2256; 2257; 2258; 2259; 2260; 2261; 2262;
2263; 2264; 2270; 2271; 2272;

DetectorName: "BM"
NumberFiles: 4
"./geomaps/GSI/TABMdetector.geo": -1
"./config/GSI/TABMdetector.cfg": -1
"./config/GSI/TABMdetector.map": -1
"./calib/GSI/TABM_T0_Calibration.cal": 2210; 2239

DetectorName: "TG"
NumberFiles: 1
"./geomaps/GSI/TAGdetector.geo": 2187; 2210
```

```
DetectorName: "VT"
NumberFiles: 3
"./geomaps/GSI/TAVTdetector.map": -1
"./config/GSI/TAVTdetector.geo": -1
"./config/GSI/TAVTdetector.map": -1

DetectorName: "TW"
NumberFiles: 7
"./geomaps/GSI/TATWdetector.geo": -1
"./config/GSI/TATW_BBparameters.cfg": 2187; 2210
"./config/GSI/TATWChannelMapXML.map": -1
"./config/GSI/TATWbarsMapStatus.map": -1
"./calib/GSI/TATW_Energy_Calibration.cal": -1
"./calib/GSI/TATW_Tof_Calibration.cal": -1
"./calib/GSI/TATWEnergyTuning.cal": -1
```

- Campaign name with associated run
- Detector name with associated file number and name
- Name following with the corresponding run number validity (-1 no dependence)

Campaign manager (iii)

✦ Run dependency: (as example)

```
// Campaign file
CamName: "GSI"
RunNumber: 2187-2261
NumberDevices: 6

. . .

DetectorName: "BM"
NumberFiles: 4
"./geomaps/GSI/TABMdetector.geo": -1
"./config/GSI/TABMdetector.cfg": -1
"./config/GSI/TABMdetector.map": -1
"./calib/GSI/TABM_T0_Calibration.cal": 2210; 2239
. . .
```

- Config file `./config/GSI/TABM_T0_Calibration_2210.cal` for BM is valid for runs 2210-2238
- Config file `./config/GSI/TABM_T0_Calibration_2239.cal` for BM is valid for runs 2239-2261

Campaign manager (iv)

MC Structure: ./cammapp/12C_200.cam

```
// Campaign file
CamName: "12C_200"
RunNumber: 1
NumberDevices: 10

DetectorName: "FOOT"
NumberFiles: 1
"./geomaps/12C_200/FOOT.geo": -1

DetectorName: "DI"
NumberFiles: 1
"./geomaps/12C_200/TADIdetector.geo": -1

DetectorName: "ST"
NumberFiles: 2
"./geomaps/12C_200/TASTdetector.geo": -1
"./config/12C_200/TASTdetector.cfg": -1

DetectorName: "BM"
NumberFiles: 2
"./geomaps/12C_200/TABMdetector.geo": -1
"./config/12C_200/TABMdetector.cfg": -1

DetectorName: "TG"
NumberFiles: 1
"./geomaps/12C_200/TAGdetector.geo": -1
```

```
DetectorName: "VT"
NumberFiles: 2
"./geomaps/12C_200/TAVTdetector.geo": -1
"./config/12C_200/TAVTdetector.cfg": -1

DetectorName: "IT"
NumberFiles: 2
"./geomaps/12C_200/TAITdetector.geo": -1
"./config/12C_200/TAITdetector.cfg": -1

DetectorName: "MSD"
NumberFiles: 1
"./geomaps/12C_200/TAMSDdetector.geo": -1

DetectorName: "TW"
NumberFiles: 5
"./geomaps/12C_200/TATWdetector.geo": -1
"./config/12C_200/TATW_BBparameters.cfg": -1
"./config/12C_200/TATWbarsMapStatus.map": -1
"./calib/12C_200/TATW_Energy_Calibration.cal": -1
"./calib/12C_200/TATW_Tof_Calibration.cal": -1

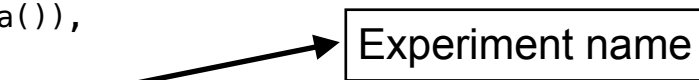
DetectorName: "CA"
NumberFiles: 1
"./geomaps/12C_200/TACAdetector.geo": -1
```

➔ Campaign manager will return the name of the parameter files with the right name with respect to campaign and run number for a given detector.

Campaign manager (v)

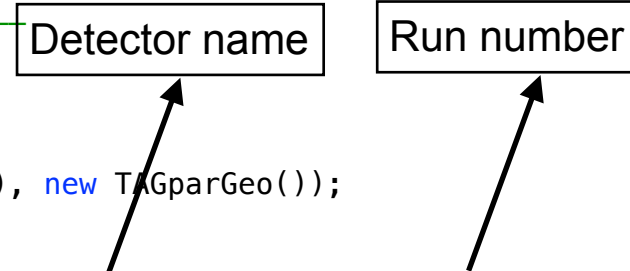
✚ Example of implementation:

```
BaseReco::BaseReco(TString expName, Int_t runNumber, TString fileNameIn, TString fileNameout)
: TNamed(fileNameIn.Data(), fileNameout.Data()),
. . .
// load campaign file
fCampaignManager = new TAGcampaignManager(expName);
fCampaignManager->FromFile();
. . .
}
```



```
// _____
void BaseReco::ReadParFiles()
{
. . .
if (GlobalPar::GetPar()->IncludeTG()) {
    fpParGeoG = new TAGparaDsc(TAGparGeo::GetDefParaName(), new TAGparGeo());
    TAGparGeo* parGeo = (TAGparGeo*)fpParGeoG->Object();

    TString parFileName = fCampaignManager->GetCurGeoFile(TAGparGeo::GetBaseName(), fRunNumber);
    parGeo->FromFile(parFileName.Data());
}
. . .
}
```



➔ Campaign manager from detector name and the run number will compose the name of the different cfg, map, cal, geo files.

Global Parameters

Foot Global Parameters (i)

File: FootGlobal.par (i)

```
IncludeKalman:  n
IncludeTOE:    n
EnableLocalReco: n
```

Global Reconstruction Options

```
Kalman Mode:      ON
Tracking Systems Considered: VT IT MSD
Reverse Tracking: false
```

```
##### Options for reconstruction #####
```

```
EnableTree:      y
EnableHisto:    y
EnableTracking: y

EnableSaveHits:  n
EnableRootObject: n
EnableTofZmc:    n
EnableTofCalBar: n
```

Reconstruction Options

Enable Glb Reco from level0 trees

```
EnableTree:      enable tree filling
EnableHisto:    enable control histograms
EnableTracking: enable tracking actions
EnableSaveHits : enable saving hits in tree
EnableRootObject: enable reading from root object
EnableTofZmc:   use Z from MC and not the one reconstructed with TW
EnableTofCalBar: enable TW calibration per bar
```

Foot Global Parameters (i)

File: FootGlobal.par (ii)

```
##### END - Options for reconstruction
```

IncludeDI:	n
IncludeST:	y
IncludeBM:	y
IncludeTG:	y
IncludeVT:	y
IncludeIT:	n
IncludeMSD:	n
IncludeTW:	y
IncludeCA:	n

Detector to switch on/off

- Enable reconstruction of the different detectors
- Other options are depreciated or only use for global Genfit reconstruction

Foot Global Parameters (iii)

Debug Level

```
· · ·  
Debug: 0  
ClassDebugLevel: TAVTparGeo 1  
· · ·  
ClassDebugLevel: TAVTactBaseNtuMC 2  
· · ·
```

Examples: TAVTbaseParGeo/TAVTactBaseNtuMC

```
Bool_t TAVTbaseParGeo::FromFile(const TString& name)  
{  
· · ·  
  ReadItem(fSensorsN);  
  if(FootDebugLevel(1))  
    cout << endl << "Sensors number " << fSensorsN << endl;  
· · ·  
}
```

```
void TAVTactBaseNtuMC::ComputeNoiseLevel()  
{  
· · ·  
  FootDebug(1, "ComputeNoiseLevel()", Form("Number of noise pixels %d\n", fNoisyPixelsN));  
· · ·  
}
```

➔ Add class name and debug level for each class

Foot Global Parameters (iv)

✦ TAGrunInfo (i):

```
struct GlobalParameter_t : public TObject {  
    . . .  
    Bool_t EnableLocalReco;  
    Bool_t EnableTree;  
    Bool_t EnableHisto;  
    Bool_t EnableSaveHits;  
    Bool_t EnableTracking;  
    Bool_t EnableRootObject;  
    Bool_t EnableTofZmc;  
    Bool_t EnableTofCalBar;  
    Bool_t IncludeKalman;  
    Bool_t IncludeTOE;  
    Bool_t IncludeDI;  
    Bool_t IncludeST;  
    Bool_t IncludeBM;  
    Bool_t IncludeTG;  
    Bool_t IncludeVT;  
    Bool_t IncludeIT;  
    Bool_t IncludeMSD;  
    Bool_t IncludeTW;  
    Bool_t IncludeCA;  
    ClassDef(GlobalParameter_t,1)  
};  
  
class TAGrunInfo : public TAGobject {  
private:  
    TString          fsCam;          // campaign name  
    Short_t         fiRun;          // run number  
    GlobalParameter_t fGlobalParameter; // global parameters  
    . . .  
};
```

➡ Add all reconstruction parameters in run info

Foot Global Parameters (v)

✦ TAGrunInfo : printout (ii)

```
KEY: TAGrunInfo runinfo;1
root [3] runinfo->Print()
Run info:          cam: 12C_200/  run:    1
Global info:
  EnableLocalReco: 0
  EnableTree: 1
  EnableHisto: 1
  EnableTracking: 1
  EnableSaveHits: 0
  EnableRootObject: 0
  EnableTofZmc: 0
  EnableTofCalBar: 0

  IncludeKalman: 0
  IncludeTOE: 1

  IncludeDI: 1
  IncludeST: 1
  IncludeBM: 1
  IncludeTG: 1
  IncludeVT: 1
  IncludeIT: 1
  IncludeMSD: 1
  IncludeTW: 1
  IncludeCA: 0
```

➔ Run info saved at each stage, MC, local and global reconstruction


Executables

Local Reconstruction

• Command line:

```
. . .  
EnableTree:      y  
EnableHisto:     y  
EnableTracking:  y  
  
EnableSaveHits:  n  
EnableRootObject: n  
EnableTofZmc:   n  
EnableTofCalBar: n  
. . .
```

Set global parameters



➔ from MC hits:

```
DecodeMC -in 12C_C_200_1.root -out 12C_C_200_L0Out.root -nev 10000  
-exp 12C_200 -run 1
```

➔ from raw hits:

```
DecodeRaw -in data/data_built.2211.physics_foot.daq.VTX.1.dat  
-out 12C_C_200_L0Out.root -nev 10000 -exp GSI -run 2211
```


Global TOE Reconstruction (i)

✚ Command line:

```
. . .  
IncludeKalman:  n  
IncludeTOE:    y  
EnableLocalReco: n  
. . .
```

Will be put off anyhow by executable

Will be put on anyhow by executable

➔ from MC hits: `DecodeGlbToe -in 12C_C_200_1.root`
`-out 12C_C_200_1_GlbOut.root -nev 10000 -exp 12C_200 -run 1 -mc`

```
. . .  
IncludeKalman:  n  
IncludeTOE:    y  
EnableLocalReco: y  
. . .
```

➔ from L0 reco: `DecodeGlbToe -in 12C_C_200_L0Out.root`
`-out 12C_C_200_1_GlbOut.root -nev 10000 -exp 12C_200 -run 1 -mc`

Global TOE Reconstruction (ii)

✦ Command line:

```
. . .  
IncludeKalman:  y  
IncludeTOE:    n  
EnableLocalReco: n  
. . .
```

Will be put on anyhow by executable

Will be put off anyhow by executable

➡ from raw hits: `DecodeGlbToe -in data/data_built.2211.physics_foot.daq.VTX.1.dat
-out 12C_C_200_1_GlbOut.root -nev 10000 -exp GSI -run 2211`

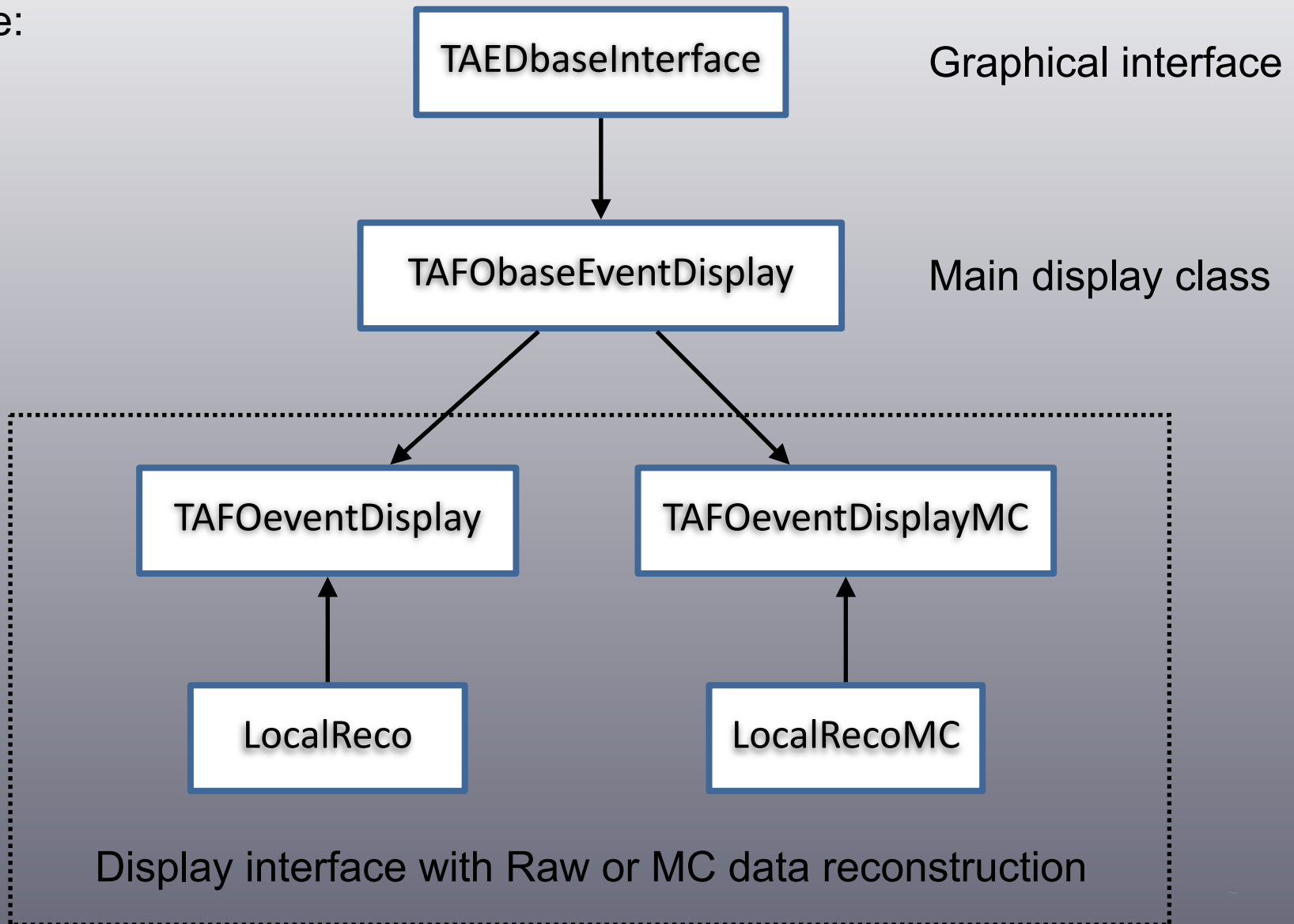
Change input file, remove -mc flag

➡ Still not fully tested cos don't have reliable raw data

Event Display

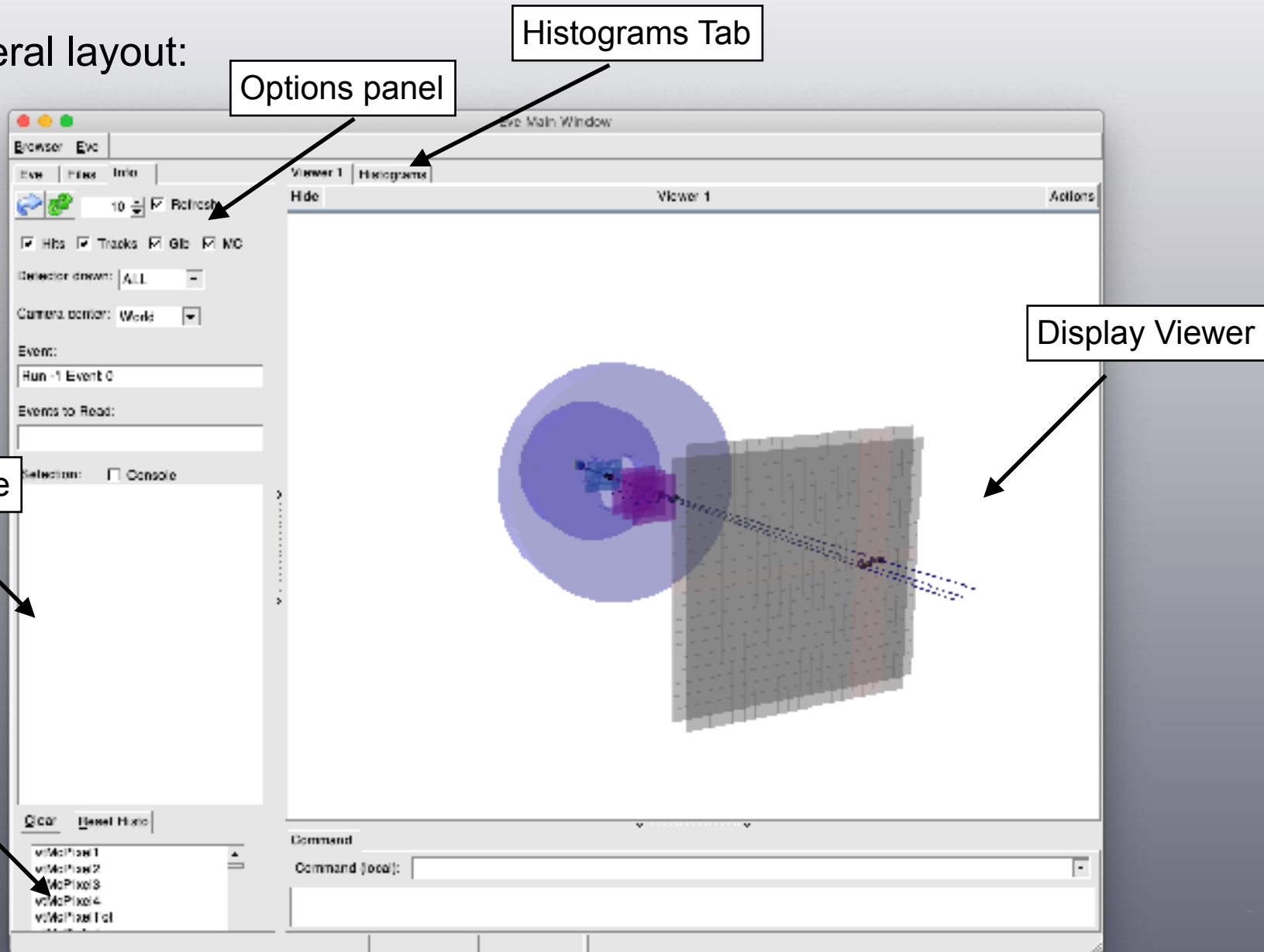
Event Display

✦ Scheme:



Event Display (i)

General layout:



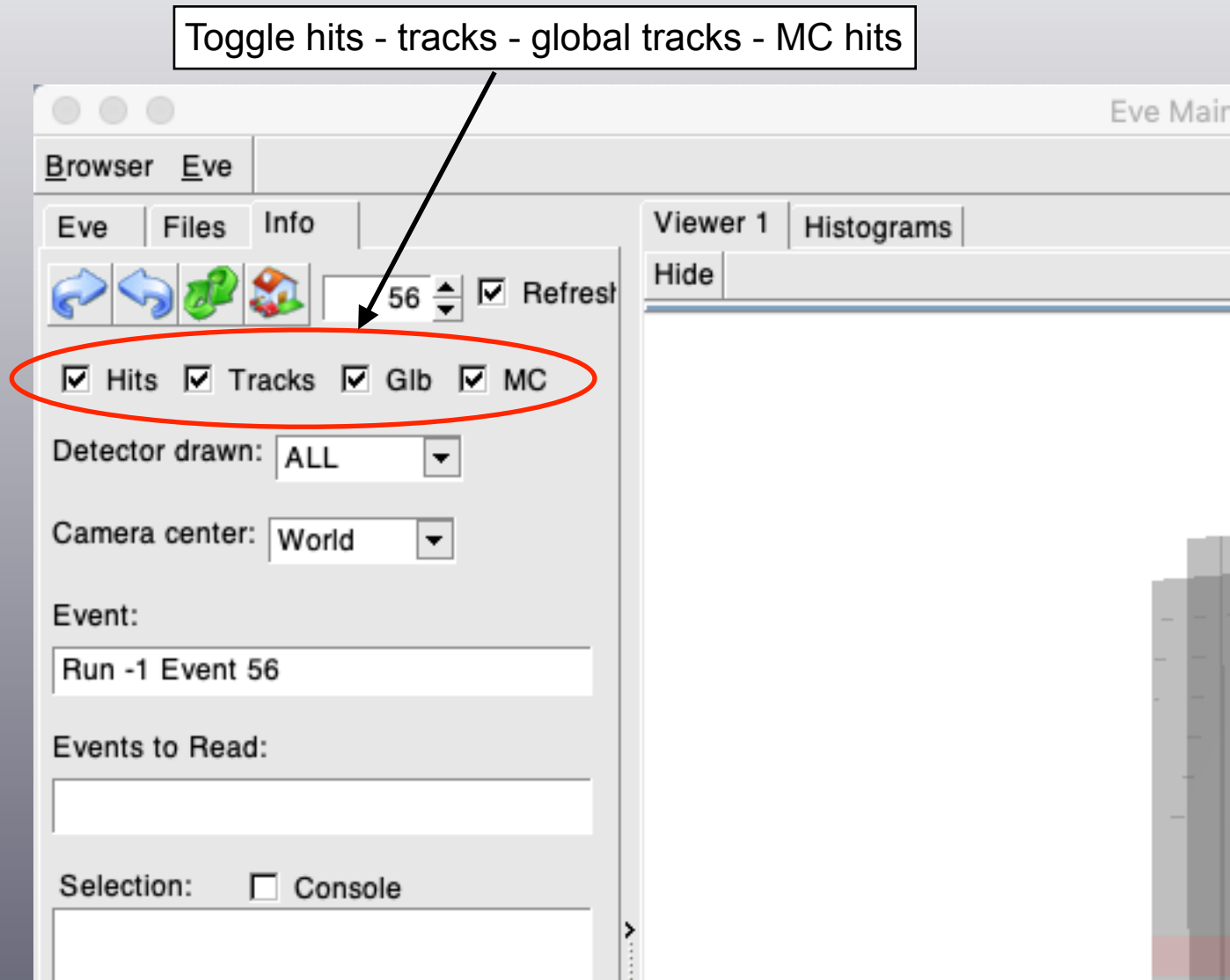
Event Display (ii)

Navigation

The screenshot shows the 'Eve Main' window with a navigation toolbar. The toolbar contains four icons: a blue right-pointing arrow, a blue left-pointing arrow, a green circular arrow, and a red house icon. These icons are circled in red. Labels with arrows point to each icon: 'forward' points to the right arrow, 'backward (only MC)' points to the left arrow, 'go to event' points to the house icon, and 'loop over events' points to the circular arrow. Below the toolbar, there is a '56' spinner, a 'Refresh' checkbox, and several other controls like 'Hits', 'Tracks', 'Detector drawn: ALL', and 'Camera center: World'. The 'Event:' field contains 'Run -1 Event 56'.

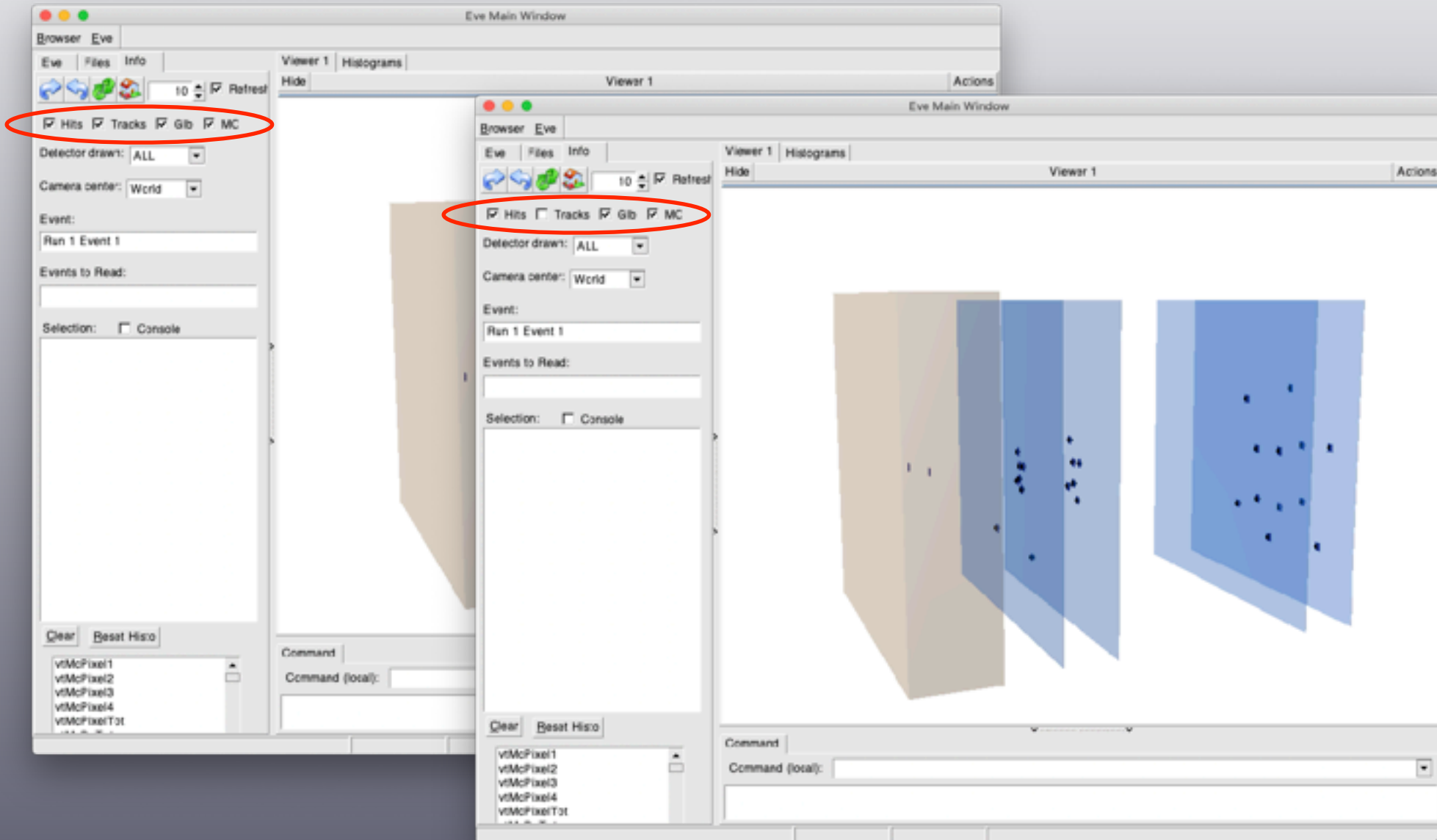
Event Display (iii)

• Drawing (i)



Event Display (iv)

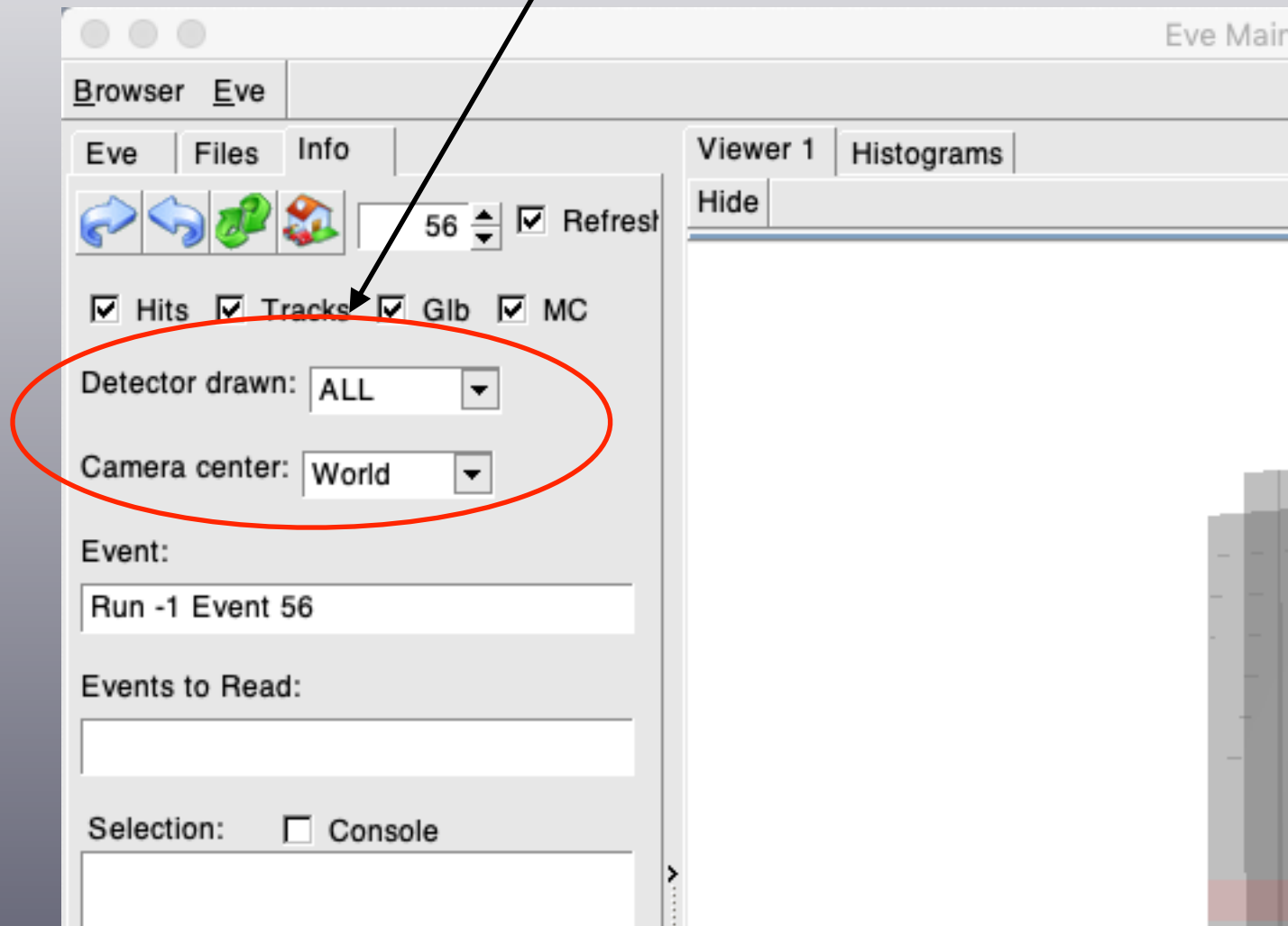
• Drawing (ii)



Event Display (v)

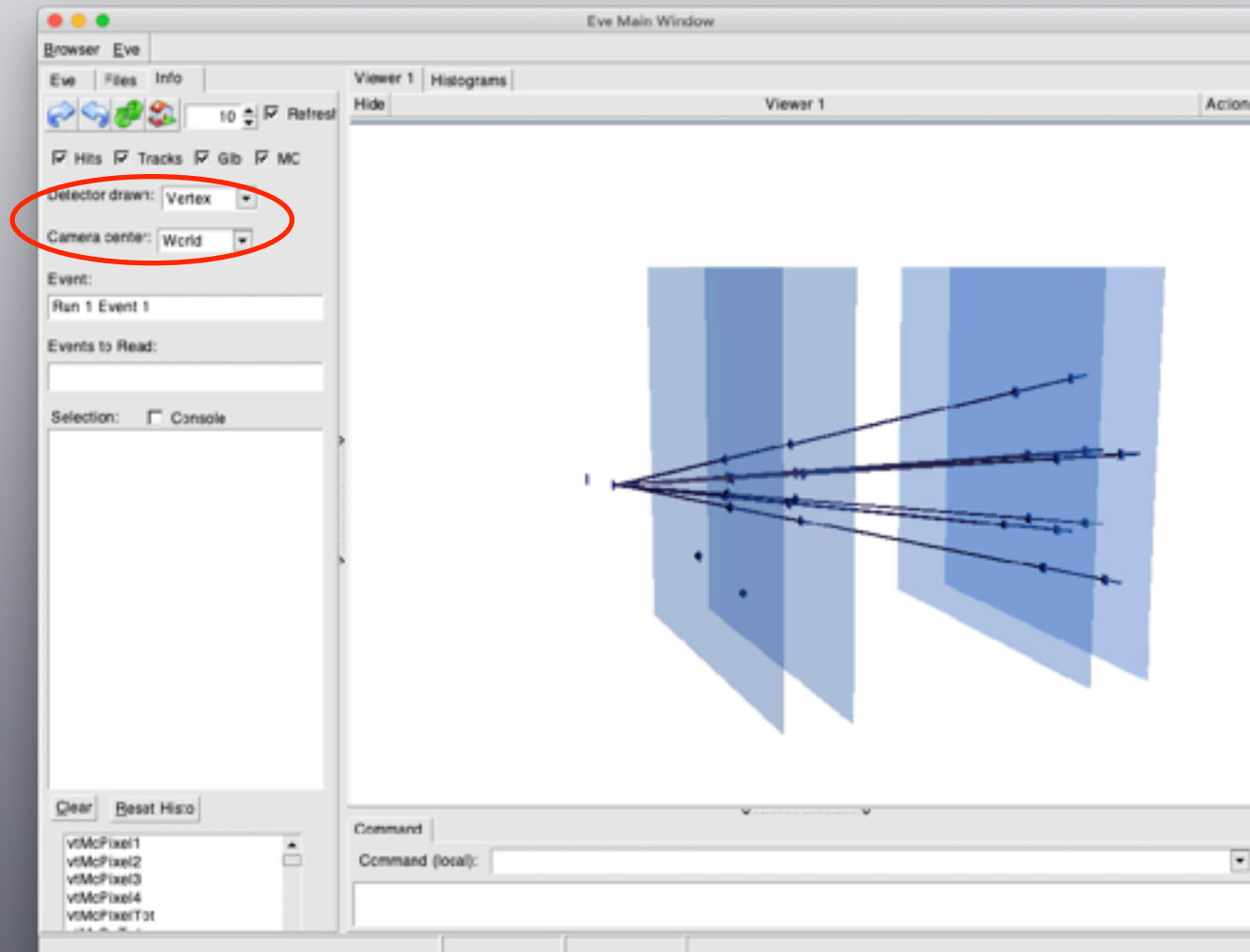
• Drawing (iii)

Menu: toggle selected detector to draw / center of camera



Event Display (vi)

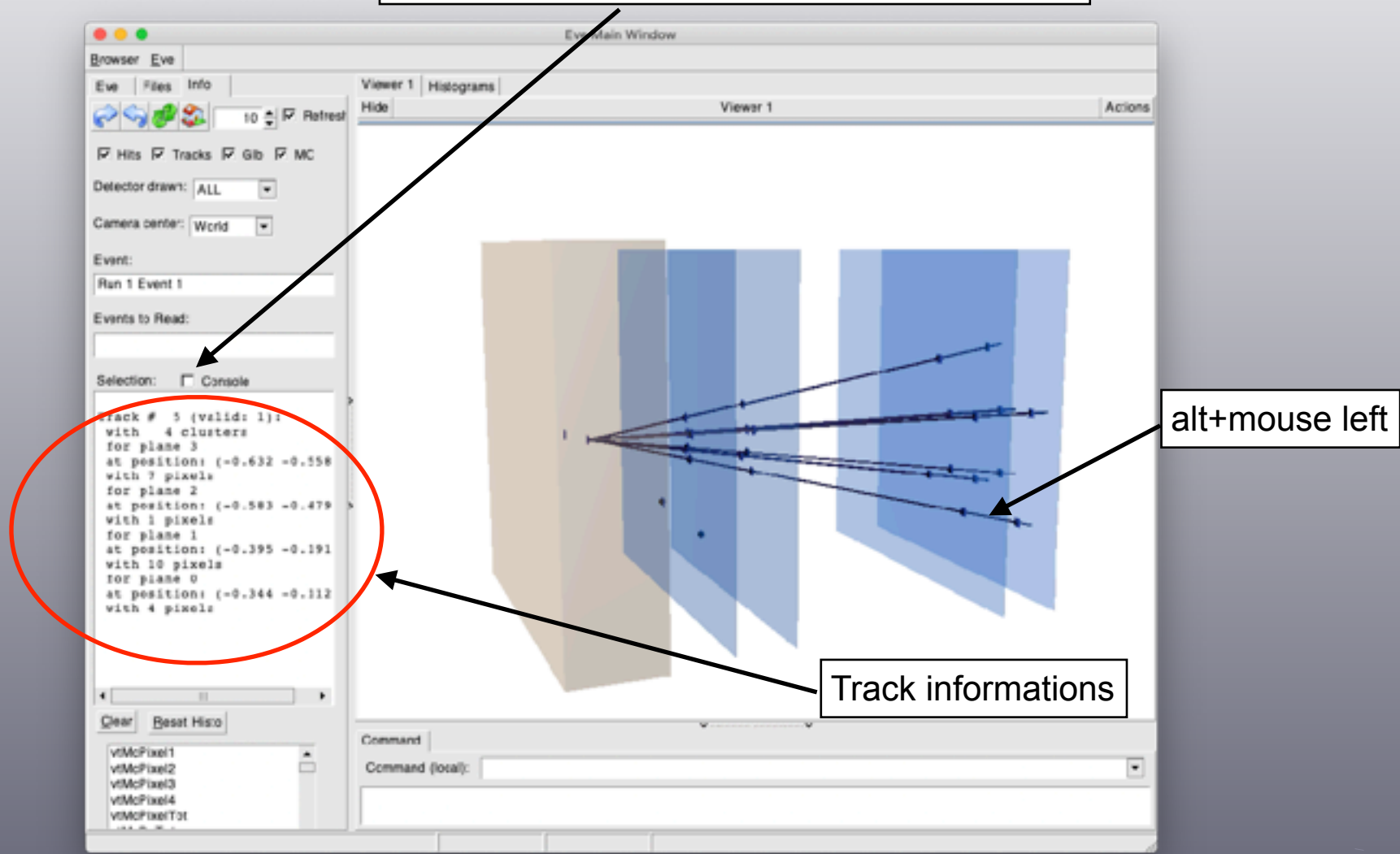
• Drawing (iv)



Event Display (vii)

- Frame info

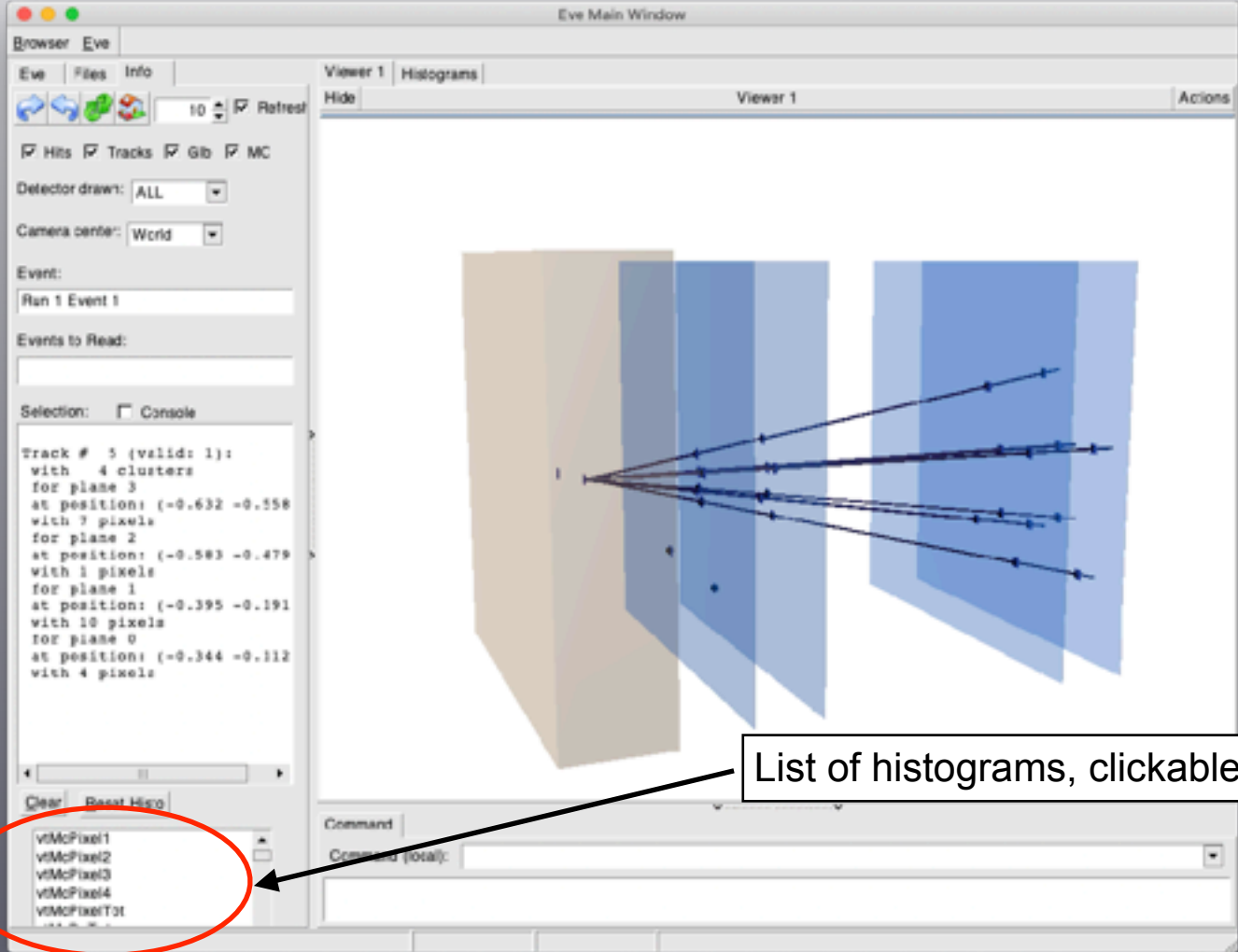
if activated, info also printed on your terminal



- All hit, cluster and tracks are clickable

Event Display (viii)

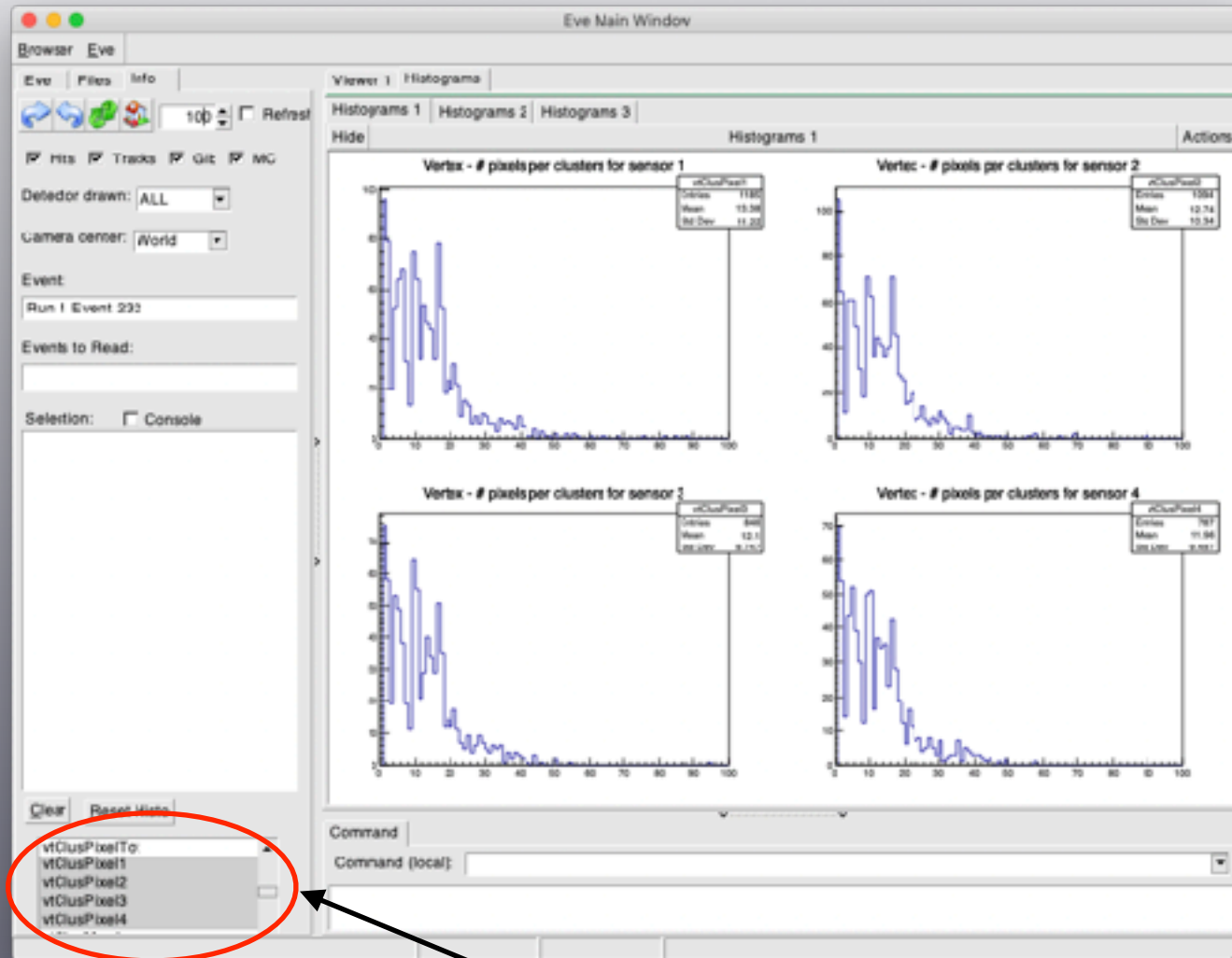
• Histograms (i)



The screenshot shows the 'Eve Main Window' interface. On the left, there is a control panel with tabs for 'Eve', 'Files', and 'Info'. Below these are navigation icons, a 'Refresh' button, and checkboxes for 'Hits', 'Tracks', 'Glb', and 'MC'. A 'Detector draw:' dropdown is set to 'ALL', and 'Camera center:' is set to 'World'. The 'Event:' field shows 'Run 1 Event 1'. Below that, there is a 'Selection:' section with a 'Console' checkbox. A text area displays track information for 'Track # 5 (valid: 1):', listing clusters for planes 3, 2, 1, and 0 with their respective positions and pixel counts. At the bottom left, a list of histograms is shown, with 'vMcPixel1' through 'vMcPixelTot' circled in red. An arrow points from a text box labeled 'List of histograms, clickable' to this list. The main window area shows a 3D visualization of detector planes and tracks. The bottom right contains a 'Command' field and a 'Command (total):' dropdown.

Event Display (ix)

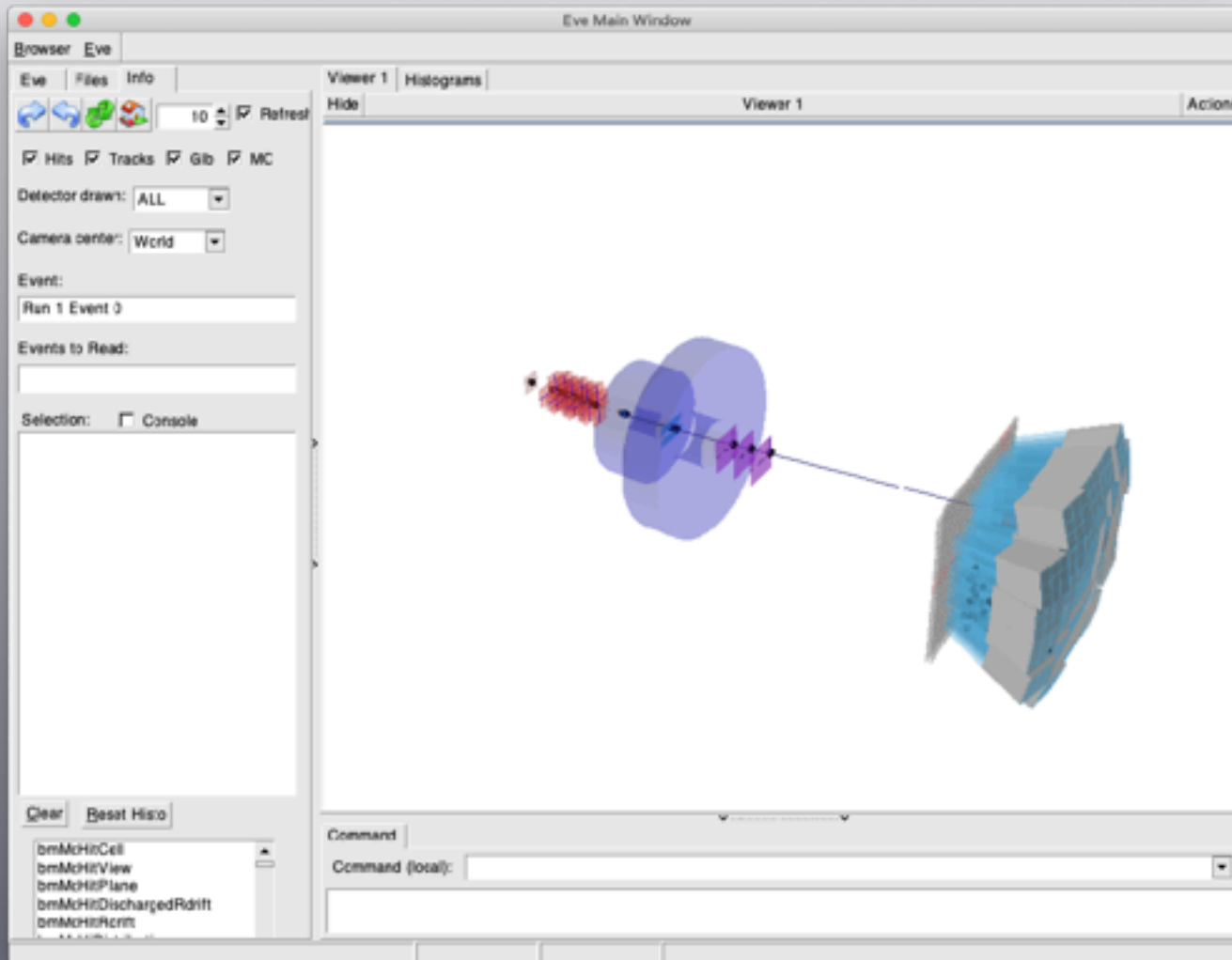
• Histograms (ii)



Selected histograms

Event Display (x)

✦ Global tracks



- Global track reconstructed with TOE package

End