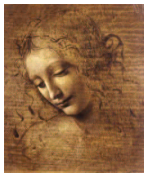
8 Utility Tools

8.1 Debug tool

Debug tool

Goal: Provide user friendly dump of the event

- Work on both reconstructed and MC data.
- Side by side print out of reconstructed and MC data.
- Informations can be selected by the user.
- Flat or Tree display.



Debug tool usage

Getting the tool

Get the definition `#include "DaVinciMCTools/IDebugTool.h"`

Declare your instance `IDebugTool *m_debug`

Get your instance `toolSvc()->retrieveTool("DebugTool", m_debug)`

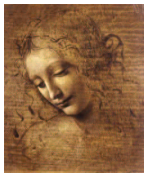
Using the tool

Event as trees `m_debug->printEventAsTree( mcparts [, assoc] )`

Particle decay as tree `m_debug->printTree( part [, depth] )`

Event as a flat list `m_debug->printEventAsList( parts [, assoc] )`

Ancestors `m_debug->printAncestor( mcpart )`



Debug tool output

<-------------------------------- MCParticle -------------------------------->

Name	E	M	P	Pt	phi	Vz
	GeV	GeV	GeV	GeV	mrad	cm
B0	29.828	5.279	29.358	7.666	-29.331	-1.780
+-->J/psi(1S)	29.119	3.097	28.954	7.707	4.943	-1.450
|+-->mu+	23.835	0.106	23.835	7.396	69.765	-1.450
|+-->mu-	5.284	0.106	5.283	0.580	-967.540	-1.450
| +-->nu_e	0.046	-0.000	0.046	0.041	58.550	1932.276
| +-->e-	0.039	0.001	0.039	0.038	-2650.137	1932.276
| +-->nu_e	0.021	-0.000	0.021	0.017	1996.055	1932.276
+-->KS0	0.710	0.498	0.506	0.267	-1736.262	-1.450
+-->pi+	0.280	0.140	0.243	0.167	2955.913	-0.167
|+-->mu+	0.110	0.106	0.030	0.019	-1545.998	234.307
||+-->nu_e	0.017	0.000	0.017	0.007	2418.076	234.307
||+-->e+	0.036	0.001	0.036	0.030	2629.653	234.307
||+-->nu_e	0.052	-0.000	0.052	0.037	-554.517	234.307
|+-->nu_e	0.030	0.000	0.030	0.019	1595.595	234.307
+-->pi-	0.429	0.140	0.406	0.317	-1182.472	-0.167

Debug tool side by side output

```
<------------- MCParticle ------------><--------- Particle --------->
                Name          P        Pt      Name          P        Pt
                             GeV       GeV                   GeV       GeV
B0                        29.358     7.666  No associated particle
+-->J/psi(1S)             28.954     7.707  No associated particle
|+-->mu+                  23.835     7.396  No associated particle
|+-->mu-                   5.283     0.580 mu-            5.272     0.578
| +-->nu_e                 0.046     0.041  No associated particle
| +-->e-                   0.039     0.038  No associated particle
| +-->nu_e                 0.021     0.017  No associated particle
+-->KS0                    0.506     0.267  No associated particle
 +-->pi+                   0.243     0.167  No associated particle
 |+-->mu+                  0.030     0.019  No associated particle
 ||+-->nu_e                0.017     0.007  No associated particle
 ||+-->e+                  0.036     0.030  No associated particle
 ||+-->nu_e                0.052     0.037  No associated particle
 |+-->nu_e                 0.030     0.019  No associated particle
 +-->pi-                   0.406     0.317  No associated particle
```

Debug tool List and Ancestors output

Flat list

<-------------------- Particle -------------------->			
	Name	Vz	Vz	Vz
		cm	cm	cm
pi+		0.645	0.537	64.9
pi-		0.385	-0.729	28.9
e-		-0.735	7.2	484
pi+		0.393	0.728	28.9
mu-		5.97	15.5	487
pi+		6.01	15.2	488
pi-		-0.293	0.899	15.4
e-		-3.85	-6.23	232
mu-		0.664	-0.854	7.93
gamma		-205	-295	1.26e+03

Ancestors

pi0 -> gamma -> e+

Debug tool configuration

In the *jobOption* file:

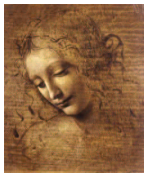
- User can select the informations to dump.
- Width of the columns can be adjusted.
- Numerical precision can also be tuned.
- Tree depth can be limited in general.

Available informations are:

`Name`	The particle name (plus the tree drawing)
`E`	The energy
`M`	The mass
`P`, `Pt`, `Px`, `Py`, `Pz`	The momentum
`Vx`, `Vy`, `Vz`	The position of the first measured point
`theta`, `phi`	The spherical angles
`eta`	The pseudo-rapidity

Debug tool example jobOption

```
// Defaults for DebugTool
MyToolOwner.DebugTool.PrintDepth = 999;
MyToolOwner.DebugTool.TreeWidth = 20;
MyToolOwner.DebugTool.FieldWidth = 10;
MyToolOwner.DebugTool.FieldPrecision = 3;
MyToolOwner.DebugTool.Informations = "Name E M P Pt phi Vz";
```



8.2 (MC)DecayFinder

(MC)DecayFinder

Goal: Find any inclusive or exclusive decay in an event

- **Work at the particle ID level.**
- **Work on both reconstructed and MC data.**
- **Find multiple instances of the decay.**
- **Use a simple description of the decay.**

(MC)DecayFinder usage

Getting the tool

Get the definition `#include "DaVinciMCTools/I(MC)DecayFinder.h"`

Declare your instance `I(MC)DecayFinder *m_finder`

Get your instance

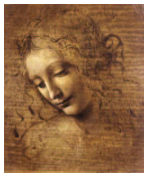
```
toolSvc()->retrieveTool("(MC)DecayFinder",
                        m_finder)
```

Using the tool

```
const (MC)Particle *result = NULL;
while( m_finder->findDecay( (mc)parts, result ) )
{
// The decay has been found
  m_debug->printTree( result );
}
```

Or to simply test for the presence of the decay

```
bool found = m_finder->hasDecay( (mc)parts )
```



(MC)DecayFinder configuration

Only two parameters exists:

`Decay` **The decay we are looking for. Must be set in the jobOption file.**

`ResonanceThreshold` **The lifetime under which a particle is considered a resonance. Default provided.**

(MC)DecayFinder decay grammar

A *decay* is a **mother** **or**

mother -> daughter$_1$ daughter$_2$ ...

Use => instead of -> if you want to skip the resonances.

A *mother* is either

- **a particle name or** `!`**name or** `?`
- `(`**name**`)`
- `[`**name**`]os`
- `[`**name$_1$, name$_2$**`]cc`
- `{`**mother$_1$, mother$_2$,...**`}`
- `pp`

A *daughter* is either

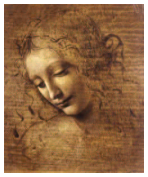
- **a particle name or** `!`**name or** `?`
- `(`**decay**`)`
- `[`**name$_1$, name$_2$**`]cc`
- `{`**mother$_1$, mother$_2$,...**`}`
- `{(`**decay$_1$**`), (`**decay$_2$**`),...}`
- `...`

(MC)DecayFinder grammar examples

`B0`	**any** B^0
`(B0)`	**any stable** B^0
`(pi+)`	**any stable** π^+
`J/psi(1S)`	**any stable** $J\Psi$
`pi0 -> gamma gamma`	**any** π^0 **decay to 2** γ
`[B0,B+]cc`	**any** B^0, $\bar{B}^0$, B^+ **or** B^-

```
pp => [K-]cc
B0 -> (J/psi(1S) -> mu+ mu- ) (KS0 -> pi- pi+)
B0 -> (J/psi(1S) -> mu+ mu- {gamma,}) (KS0 -> pi- pi+)
B0 => mu+ mu- gamma (KS0 -> pi+ pi-)
```

8.3 Gaudi utilities: a reminder



Printing

To print out informations use the *MessageService* and not `cout`. Because:

- **It works like `cout`.**
- **It adds a severity tag to your message.**
- **It tells the user from where the message is coming.**
- **It can be filtered based on severity.**

Printing How-To

- **Get the definition of this facility.**

```
#include "GaudiKernel/MsgStream.h"
```

- **Create a stream.**

```
MsgStream log(msgSvc(), name())
```

- **Print!**

```
log << MSG::DEBUG << "Hello World!" << endreq
```

Severity & Notes

The available severity levels are (in increasing order):

- `MSG::DEBUG`
- `MSG::INFO`
- `MSG::WARNING`
- `MSG::ERROR`
- `MSG::FATAL`

One *request* to the Message Service can be split. You just need to start it with a severity tag and end it with a `endreq`.

```
log << MSG::INFO << "Momentum along x: " << mypart->momentum().px()/GeV << endl;
double ptx = sqrt(pow(mypart->momentum().py(),2)+pow(mypart->momentum().pz(),2));
log << "Momentum in yz plane: " << ptx/GeV << endreq;
```

Ntuple

To use a Ntuple you have to

1. **Declare the variables of your ntuple.**
2. **Create the ntuple.**
3. **Register the ntuple.**
4. **Register your variables to your ntuple.**
5. **Fill the variables & commit.**
6. **Adjust the `NtupleSvc.Output` in your jobOption file.**

Note that step 2. could fail if the ntuple already exists.

Ntuple variables declaration

First get the definition of what kind of items can be put in the ntuple.

```
#include "GaudiKernel/NTupleItems.h"
```

Than declare your variables with the appropriate type.

```
NTuple::Item<long> m_nPart;
NTuple::Array<float> m_px, m_py, m_pz;
NTuple::Matrix<float> m_trackEnds_x, m_trackEnds_y, m_trackEnds_z;
```

`Array` **and** `Matrix` **can only be used with a column wise ntuple.**

Ntuple creation & booking

First check if your ntuple has already been registered.

```
NTuplePtr MyNtuple(ntupleSvc(), "MyFileKey/MyDirectory/MyID");
```

If not (*MyNtuple* == 0) then create and book your ntuple.

```
MyNtuple = ntupleSvc()->book ("MyFileKey/MyDirectory", MyID,
                              CLID_ColumnWiseTuple, "MyTitle");
```

Here it was created in *MyDirectory* as *MyID* in the file associated to *MyFileKey*.

Ntuple setup

Attach the variables to the ntuple.

```
status = nt->addItem ("NParts",  m_nPart, 0, 5000);
if( status.isSuccess() )
  status = nt->addIndexedItem ("px", m_nPart, m_px);
if( status.isSuccess() )
  status = nt->addIndexedItem ("vx", m_nPart, 2, m_trackEnds_x);
...
```

Or if it already exists, reattach the variables.

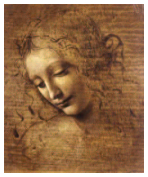
```
status = nt->item ("NParts",  m_nPart);
if( status.isSuccess() )  status = nt->item ("px", m_px);
if( status.isSuccess() )  status = nt->item ("vx", m_trackEnds_x);
...
```

Ntuple filling

Use the variables you associated to the ntuple as usual. When you are ready to write the row of the ntuple out, simply call the `write` method.

```
ntuple->write()
```

After that call, all the variables will be reset to zero.



Ntuple jobOption settings

Be sure to have the NTuple service loaded (it is by default in DaVinci).

```
ApplicationMgr.ExtSvc += { "NTupleSvc" };
```

Then to have your ntuple saved to disk you need to say what kind of persistence format you want.
For the traditional HBOOK format:

```
NTupleSvc.Output={"MyFileKey DATAFILE='MyFileName.hbook' TYP='HBOOK' OPT='NEW'"};
```

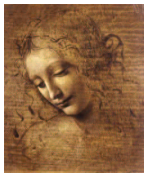
For the more recent ROOT format:

```
NTupleSvc.Output={"MyFileKey DATAFILE='MyOtherFileName.rt' TYP='ROOT' OPT='NEW'"};
```

Histogram

To use the histogram facility you have to

1. **Select the kind of persistence you want (Hbook or Root).**
2. **Adjust the jobOption file.**
3. **Create & register your histograms.**
4. **Fill them.**



Histogram persistence

Histogram persistence can be achieved with either Hbook or Root.
To change the default of Hbook to Root you must change the requirement file of DaVinci to

```
#use HbookCnv            v12r0
use RootHistCnv         v6r0
```

You also need to change the jobOption file to

```
\\#include "$STDOPTS/Hbook.opts"
\\HistogramPersistencySvc.OutputFile = "Histos.hbook";
#include "$STDOPTS/RootHist.opts"
HistogramPersistencySvc.OutputFile = "Histos.rt";
```

Histogram creation

Get the headers defining the histograms.

```
#include "GaudiKernel/IHistogramSvc.h"
#include "AIDA/IHistogram1D.h"
```

Declare the variable which will contain your histogram.

```
IHistogram1D *m_hB0Mass
```

Create and book your histogram.

```
m_hB0Mass = histoSvc()->book("MyDirectory", MyID, "MyTitle",
                             NBins, Min, Max);
if( 0 == m_hB0Mass) BUG();
```

Histogram filling

Histogram filling is straightforward.

```
m_hB0Mass->fill(candB0.mass()/GeV, 1.)
```

Always divide the value by the unit so you don't have to remember the default units.