Writing a Selection Algorithm

- ✘ Naming Convention: SelectBd2JPsiKshort, SelectJPsi2mumu
- ✘ Located under Phys/PhysSelections package
- ✘ Inherits from DVAlgorithm where all the retrieving of the basic tools is done
- ✘ use emacs: It will create an Algorithm framework.

Job Options File

✘ **Naming Convention: SelectBd2JPsi2MuMuKshort2PiPi.opts (specify all the final states)**

✘ **All the properties of the Selection Algorithm are declared.**

- ☞ **Configure the PhysDesktop tool**
- ☞ **Configure the AxParticleMaker tool**
- ☞ **Configure the Particle Filter Tool**
- ☞ **Configure each FilterCriterion**
- ☞ **Configure the User defined Properties (cuts, histogram flag, etc)**

Select*.h

Since a Selection Algorithm inherits from the DVAlgorithm, it should include:

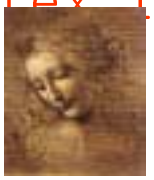
```
#include "DaVinciTools/DVAlgorithm.h"
```

and

```
class SelectJPsi2MuMu :  public DVAlgorithm { ...  }
```

The cuts will be properties of the algorithm, so they should be data members:

```
private:
double m_JPsiMassWin; ///< Mass window for the two Muons
double m_JPsiZWin; ///< Z vertex window for the two Muons
double m_chi2ConVtxCut; ///< chi2 of constrained vertex fit
```



Usually some histograms will be produced:

```
// Forward declarations
class IHistogram1D;
private:
bool m_produceHistogram; ///< flag for histo production
IHistogram1D* m_hSum4p;///< Histo of two muons mass
IHistogram1D* m_hChi2ConFit;///< Histo of the Chi2
```

some SdtHep information and counters:

```
long m_jpsiID; ///< SdtHep ID for JPsi
double m_jpsiMass; ///< SdtHep mass for JPsi
int m_nEvents; ///< N events processed
int m_JPsiCount; ///< Number of JPsi's
```

Select*.cpp

Files to be included:

```
// from Gaudi
#include "GaudiKernel/AlgFactory.h"
#include "GaudiKernel/SmartDataPtr.h"
#include "GaudiKernel/IDataProviderSvc.h"
#include "GaudiKernel/IParticlePropertySvc.h"
#include "GaudiKernel/ParticleProperty.h"
#include "GaudiKernel/IHistogramSvc.h"
#include "AIDA/IHistogram1D.h"
// from Event
#include "Event/EventHeader.h"
#include "Event/Vertex.h"
#include "Event/Particle.h"
```

```
// CLHEP
#include "CLHEP/Units/PhysicalConstants.h"
#include "CLHEP/Geometry/Point3D.h"
// local
#include "SelectJPsi2MuMu.h"
```

Constructor

Declare the Properties in the Constructor:

```
SelectJPsi2MuMu::SelectJPsi2MuMu( const std::string& name,
                                  ISvcLocator* pSvcLocator)
  :  DVAlgorithm ( name , pSvcLocator),
    m_nEvents(0),
    m_JPsiCount(0){
  declareProperty("HistogramFlag",m_produceHistogram = false);
  declareProperty("JPsiMassWindow", m_JPsiMassWin = 0.2*GeV);
  declareProperty("JPsiZWindow", m_JPsiZWin = 50.0 * cm);
  declareProperty("Chi2ConFit", m_chi2ConVtxCut = 20.0);
}
```

initialize()

The initialize() method is where the tools are retrieved, the Particle Property Service is requested and the histograms are booked.

Remark: When a StatusCode is returned it is because it has the possibility of FAILURE, so it has always to be tested. I put here one example of testing, but it will be omitted from then on.

```
StatusCode SelectJPsi2MuMu::initialize() {
  MsgStream log(msgSvc(), name());
  log « MSG::DEBUG « "==> Initialize" « endreq;
  StatusCode sc = StatusCode::SUCCESS;
```

```
// Load all necessary tools via the base class
sc = loadTools();
if( sc.isFailure() ) {
  log « MSG::ERROR « " Unable to load tools" « endreq;
  return StatusCode::FAILURE;
}
// Access the ParticlePropertySvc
IParticlePropertySvc* ppSvc = 0;
sc = service("ParticlePropertySvc", ppSvc);
ParticleProperty* partProp;
partProp = ppSvc->find( "J/psi(1S)" );
//Note that the particleID().pid() is the jetsetID() code
m_jpsiID = (*partProp).jetsetID();
m_jpsiMass = (*partProp).mass();
```

```
// If histograms are required initialize them
if( m_produceHistogram ) {
  m_hChi2ConFit = histoSvc()-> book("/stat/simple/5",
            "Chi2 of Constrained J/Psi vertex Fit",
            100, 0.0, 20.0);
  if( 0 == m_hChi2ConFit ) {
    log « MSG::ERROR « " Cannot register histogram 5"
        « endreq;
    return StatusCode::FAILURE;
  }
  m_hSum4p = histoSvc()->book("/stat/simple/6",
        "Mass of 2 Muons", 100, 3.05, 3.15);
}
return StatusCode::SUCCESS;   }
```

execute()

The execute() method is where event by event is processed.

```
StatusCode SelectJPsi2MuMu::execute() {
  MsgStream log( msgSvc(), name() );
  // Counter of events processed
  log « MSG::INFO « "»> Execute" « endreq;
  log « MSG::INFO « " processing event number " « ++m_nEvents
            « endreq;
  // Retrieve informations about event
  SmartDataPtr<EventHeader> evt(eventSvc(),
                                EventHeaderLocation::Default );
  if ( evt ) {
    log « MSG::INFO « " retrieved EVENT: " « evt->evtNum()
              « " RUN: " « evt->runNum() « endreq;
```

```
  }
  else {
    log « MSG::ERROR « " not able to retrieve event" « endreq;
    return StatusCode::FAILURE;
  }
  //Fill the PhysDesktop particle and vertex vectors.
  //Use the configuration set in the corresponding job options
  StatusCode scDesktop = desktop()->getInput();
  // Retrieve the particles and vertices from PhysDesktop
  const VertexVector& verts = desktop()->vertices();
  const ParticleVector& parts = desktop()->particles();
  log « MSG::DEBUG « " Particle Vector size " « parts.size()
« endreq;
  // Print out some Primary Vertex Information
```

```
// Save the z position of the first one
VertexVector::const_iterator ivert = 0;
int nPrim = 0;
double zPrim = 0.;
for(ivert = verts.begin();ivert != verts.end();ivert++){
   if( (*ivert)->type() == Vertex::Primary ){
      nprim++;
      log « MSG::DEBUG « " Primary Vertex coordinates = "
          « (*ivert)->position().x()
          « " , " « (*ivert)->position().y()
          « " , " « (*ivert)->position().z() « endreq;
      HepSymMatrix primVertexErr = (*ivert)->positionErr();
      log « MSG::DEBUG «"z error on prim vertex = "
          « sqrt(primVertexErr(3,3))/cm «" cm"« end
```

```
      // Take the first one
      if (nPrim == 1) zPrim = (*ivert)->position().z();
    }
  }
  // ParticleFilter according to job options
  ParticleVector vMuPlus, vMuMinus;
  StatusCode scFilPos = ParticleFilter()->
        filterPositive( parts, vMuPlus );
  StatusCode scFilNeg = ParticleFilter()->
        filterNegative( parts, vMuMinus );
  log « MSG::DEBUG« "vMuPlus size" « vMuPlus.size()«endreq;
  log « MSG::DEBUG« "vMuMinus size" « vMuMinus.size()«endreq;
```

```
// Do all mu+/mu- combinations
ParticleVector::iterator iMuPlus;
ParticleVector::iterator iMuMinus;
for( iMuMinus = vMuMinus.begin();
     iMuMinus != vMuMinus.end(); iMuMinus++ ) {
  for (iMuPlus = vMuPlus.begin(); iMuPlus != vMuPlus.end();
       iMuPlus++) {
    // Find invariant mass
    HepLorentzVector twoMuComb(0.0, 0.0, 0.0, 0.0);
    twoMuComb = (*iMuMinus)->momentum() +
                (*iMuPlus)->momentum();
    //Units are MeV/mm/nsec.  I want histos in GeV/cm
    if( m_produceHistogram )
      {m_hSum4p->fill( twoMuComb.m()/GeV, 1.);}
```

```
//Check that muon-antimuon invariant mass is close
 to the J/Psi mass
if (fabs(twoMuComb.m() - m_jpsiMass)< m_JPsiMassWin){
  //Perform Unconstrained vertex fit
  Vertex MuMuVertex;
  StatusCode scMuMuVertex =
    vertexFitter()->fitVertex(*(*iMuMinus),*(*iMuPlus),
                              MuMuVertex);
  log « MSG::DEBUG « "Unconstrained vertex position "
      « MuMuVertex.position().x()/cm « " "
      « MuMuVertex.position().y()/cm « " "
      « MuMuVertex.position().z()/cm « endreq;
  log « MSG::DEBUG « " Chisquare " « MuMuVertex.chi2()
      « endreq;
```

```
//Check that muon-antimuon vertex is within a
//reasonable window around z = 0
if ( fabs(MuMuVertex.position().z()) < m_JPsiZWin){
  // Cut on Chi2 of J/Psi unconstrained vertex fit
  if (MuMuVertex.chi2() < m_chi2UncVtxCut) {
    // Create Particle from Vertex (ParticleStuffer)
    Particle candJpsi;
    ParticleID jpsiPID( m_jpsiID );
    StatusCode scStuff =
      particleStuffer()->fillParticle( MuMuVertex,
            candJpsi, jpsiPID );
```

```
// Debug it, Access the daughters through the vertex
SmartRefVector<Particle>::const_iterator it;
for ( it = candJpsi.endVertex()->products().begin();
      it != candJpsi.endVertex()->products().end();
      it++ ){
   log « MSG::DEBUG « "Momentum of daughters "
       « (*it)->momentum().px() « " "
       « (*it)->momentum().py() « " "
       « (*it)->momentum().pz() « endreq;
}
```

```
//How to use the geometrical Displacement Tools.
double ip=0.;
Hep3Vector ipVector;
HepSymMatrix errMatrix;
double ipErr=0;
double dist=0.;
double distErr=0;
for(ivert = verts.begin();ivert != verts.end();ivert++){
  if ((*ivert)->type()==Vertex::Primary){
   // Calculate the IP vector(and its error) of the
   mu- wrt primary vertex (other signatures are provided)
   StatusCode scImp = geomDispCalculator()->
       calcImpactPar(*(*iMuMinus),*(*ivert),
         ip,ipErr,ipVector,errMatrix);
```

```
    log« MSG::DEBUG« " IP = "« ipVector.mag()« endreq;
    // Calculate the distance (and its error) of closest
     approach between two particles
    StatusCode scCda = geomDispCalculator()->
       calcCloseAppr(*(*iMuMinus),(*(*iMuPlus)),
          dist, distErr);
    log « MSG::DEBUG « " CDA = " « dist « endreq;
    // Calculate the magnitude of the distance (and its
    error) between the primary and secondary vertex
    StatusCode scDist = geomDispCalculator()->
     calcVertexDis(MuMuVertex,*(*ivert),dist,distErr);
    log « MSG::DEBUG « " DIST = " « dist « endreq;
  }
}
```

```
//Perform mass constrained vertex fit
Vertex jpsiVtx;
Particle jpsi;
StatusCode scLagFit =
     massVertexFitter()->fitWithMass("J/psi(1S)",
     *(*iMuMinus),*(*iMuPlus), jpsiVtx, jpsi);
//Fill the Chi2 histogram
if( m_produceHistogram ) {
  m_hChi2ConFit->fill(jpsiVtx.chi2(), 1.);
}
//Cut on Chi2 of J/Psi constrained vertex fit
if (jpsiVtx.chi2() < m_chi2ConVtxCut) {
  log « MSG::INFO « " Passed all cuts " « endreq;
  m_JPsiCount++;
```

```
      //saving THIS particle and its vertex to deskTop
      //The pointer to the particle is returned ->
      it is created
      Particle* pInDesktop= desktop()->createParticle(&jpsi);
      if( pInDesktop) {
        log « MSG::DEBUG « "J/Psi added to PhysDesktop "
      }
      else {
        log «MSG::DEBUG« "not able to save J/Psi in desktop"
            « endreq;        }
   //Close all the if's
   }//for(iMuMinus = vMuPlus.begin() ...
}//for( iMuPlus = vMuMinus.begin()...
```

```
// Now save desktop to TES in the location specified in
jobOptions
// Notice that this delete particles from desktop
 at the moment
// It can only be called once per Algorithm
scDesktop = desktop()->saveDesktop();
if (scDesktop) {
  log « MSG::INFO « " PhysDeskTop Saved to TES"«endreq;
}
else {
  log « MSG::ERROR « "not able to save desktop in TES"
    « endreq;
  return StatusCode::FAILURE;
}
```

```
  // End of execution for each event
  return StatusCode::SUCCESS;
}
```

finalize()

Print out some statistics

```
StatusCode SelectJPsi2MuMu::finalize() {
  MsgStream log(msgSvc(), name());
  log << MSG::DEBUG << "==> Finalize" << endreq;
  // Print out counters
  log << MSG::INFO << " Number of events processed = "
    << m_nEvents << endreq;
  log << MSG::INFO << " Number of selected JPsi = "
    << m_JPsiCount << endreq;
  // End of finalization step
  return StatusCode::SUCCESS;
}
```