Subject: Covariance Matrices in RhoCandidates Posted by SHenssler on Tue, 25 Mar 2014 13:51:53 GMT View Forum Message <> Reply to Message

Hello together,

I am currently evaulating alternative procedures for kinematic fitting and while doing some debugging i noticed, that the Covariance-Matrices i get are not positive-semi-definite. I used the Rho-Macro for the kinematic fits and simply called my own routine after the vertex-fit was done (instead of calling the PndKinFitter).

My program also implements RhoFitterBase and after calling:

fDaughters.clear(); FindAndAddFinalStateDaughters(fHeadOfTree);

i take the P4-vectors and their covariances for each final state particle. When i calcualte the eigenvectors for the covariances there are always some who are negative, which means the covariance matrices are not positive-semi-definite (i calculated the eigenvectors by hand for one example to make sure it is not a numeric problem and i get the same results).

Does anybody know something about this?

Thanks in andvance

Simon Henssler

Subject: Re: Covariance Matrices in RhoCandidates Posted by Ralf Kliemt on Tue, 25 Mar 2014 15:24:36 GMT View Forum Message <> Reply to Message

Hello Simon,

Thanks for that finding.

Which macro do you use? I assume it is macro/run/ana\_complete.C. Please check those covariances before fitting. For one, the four-momenta of the RhoCandidates and if the issue is already present there, then try the reco candidate (PndPidCandidate/FairRecoCandidate).

Cheers Ralf

Subject: Re: Covariance Matrices in RhoCandidates Posted by SHenssler on Tue, 25 Mar 2014 15:43:18 GMT View Forum Message <> Reply to Message

Hello Ralf,

Cheers Simon

Subject: Re: Covariance Matrices in RhoCandidates Posted by SHenssler on Tue, 25 Mar 2014 16:22:18 GMT View Forum Message <> Reply to Message

Hello again,

i checked the P4-Covariances of the RhoCandidates before doing any fitting and there are still some eigenvalues < 0, though it seem to be less than before. I don't really understand what you mean by checking the RecoCandidates, because the FairRecoCandidate is virtual.

Greetings Simon

Subject: Re: Covariance Matrices in RhoCandidates Posted by Ralf Kliemt on Tue, 25 Mar 2014 16:39:01 GMT View Forum Message <> Reply to Message

Hi Simon,

That should be fine: PndPidCandidate\* myPidcand = (PndPidCandidate\*) myRhocand->GetRecoCandidate(); Then proceed from there. PndPidCandidate inherits from FairRecoCandidate.

Cheers Ralf

Subject: Re: Covariance Matrices in RhoCandidates Posted by SHenssler on Tue, 25 Mar 2014 21:13:59 GMT View Forum Message <> Reply to Message

Hello Ralf,

i'm not really sure if this simply doesn't work, or if i'm doing something wrong... if i do: PndPidCandidate \*myPidcand = (PndPidCandidate\*) (jpsi[j]->GetRecoCandidate());

this works fine, but trying to access any member-functions, for example: myPidCandidate->P4Cov().Print(); then i get a segmentation violation.

Subject: Re: Covariance Matrices in RhoCandidates Posted by Ralf Kliemt on Wed, 26 Mar 2014 07:01:21 GMT View Forum Message <> Reply to Message

## Hi Simon,

Well, Only final state paticles have a RecoCand (which is basically the track information plus PID related properties from various detectors). A J/Psi is always a combined candidate and thus has no RecoCand. I think firstly you should look at the final state particles anyways. To avoid segfaults, catch such pointer cunstructions with if(0=myPidcand) ...

Cheers Ralf

Subject: Re: Covariance Matrices in RhoCandidates Posted by SHenssler on Wed, 26 Mar 2014 08:26:14 GMT View Forum Message <> Reply to Message

## Hello Ralf,

i was just confused, because everything worked fine when i used the RhoCandidates directly... sorry i'm not really familiar with all the Panda physics and the computing framework,

anyway the calculated eigenvectors from the RhoCandidates and the PndPidCandidates are exactly the same and there are still some < 0. I used the TMatrixDEigen to calculate them, though i think with the values in a range of  $10^{-15}$  there should not occur any numeric issues.

Cheers Simon

Subject: Re: Covariance Matrices in RhoCandidates Posted by Ralf Kliemt on Fri, 28 Mar 2014 12:35:51 GMT View Forum Message <> Reply to Message

Hi Simon,

The next to check would be the tracks themselves:

Get a track array (mind loading the reco file): TClonesArray\* tca = ( TClonesArray\* ) fRootManager->GetObject ("SttMvdGemGenTrack");

Then get the track and proceed from there: PndPidCandidate\* pidCand = (PndPidCandidate\*)cand->GetRecoCandidate(); Cheers Ralf

Subject: Re: Covariance Matrices in RhoCandidates Posted by SHenssler on Thu, 03 Apr 2014 10:14:17 GMT View Forum Message <> Reply to Message

Hello Ralf,

I don't quite understand how to proceed with the tracks. Do they have covariances? If they do, then how do I get them?

Thanks Simon

Subject: Re: Covariance Matrices in RhoCandidates Posted by Ralf Kliemt on Fri, 04 Apr 2014 14:09:30 GMT View Forum Message <> Reply to Message

Hello Simon,

You could go with the track parameters defined at the "first" hit of the measured trajectory:

```
PndPidCandidate* pidCand = (PndPidCandidate*)cand->GetRecoCandidate();
PndTrack* track = ( PndTrack* ) tca->At ( pidCand->GetTrackIndex() );
```

FairTrackParP\* firstpar = track->GetParamFirst();

Then access the things via: GetX(), GetDX(), GetPx(), GetDPx() (and the other coordinates similar).

Header of FairTrackPar: here.

For the non-diagonal elements, i.e. the covariance matrix:

Double\_t fistparCov[6][6]; firstpar->GetMARSCov(firstparCov); //cov is being filled here

If you want to access the prefit do this:

PndTrackCand\* mytcand = track->GetTrackCandPtr();

Cheers Ralf Subject: Re: Covariance Matrices in RhoCandidates Posted by StefanoSpataro on Fri, 04 Apr 2014 14:17:46 GMT View Forum Message <> Reply to Message

However also the candidate stores covariance matrices:

const Float\_t\* GetErrorP7() const{return fErrP7;} const Float\_t\* GetCov() const{return fCov;} TMatrixD& Cov7() const; TMatrixD& P4Cov() const ;

Subject: Re: Covariance Matrices in RhoCandidates Posted by Ralf Kliemt on Fri, 04 Apr 2014 14:21:31 GMT View Forum Message <> Reply to Message

Hi Stefano,

Those covariances are after the propagation to the IP. With the firstPar you get the actual values from the track fit. That is my point here.

Cheers Ralf

Subject: Re: Covariance Matrices in RhoCandidates Posted by StefanoSpataro on Wed, 16 Apr 2014 16:01:00 GMT View Forum Message <> Reply to Message

Sorry but I have not well understood, please excuse my ignoramce. I suppose there can be negative values inside the covariance matrix, apart from the diagonal elements which must be positive. Now, how the eigenvectors enter and play a role? Are negative eigenvectors really problematic?

Subject: Re: Covariance Matrices in RhoCandidates Posted by SHenssler on Wed, 16 Apr 2014 17:37:27 GMT View Forum Message <> Reply to Message

Hello Stefano,

positive semi definite does not mean that there cannot be negative values.

The Definition says, that any vector y multiplied in the way: y^t \* C \* y,

where C is the Covariance Matrix, must result in a value greater or equal to zero.

In a way that is the proof, that the Chi-Square value ( y^t \* C^-1 \* y ) is always positive.

Or rather, if C is not positive semi definite, then it cannot ne guaranteed that the Chi Square value is positive.

It is a mathematical property that every Covarince Matrix Must have.

Subject: Re: Covariance Matrices in RhoCandidates Posted by StefanoSpataro on Wed, 16 Apr 2014 20:02:16 GMT View Forum Message <> Reply to Message

Can you plot which kind of value you obtain and with which kind of particle?

Subject: Re: Covariance Matrices in RhoCandidates Posted by SHenssler on Thu, 17 Apr 2014 08:08:36 GMT View Forum Message <> Reply to Message

You can Test if a Matrix ist positive semi definite by calculating the eigenvectors: if they are all positive, then the Matrix ist positive semi definite That's what i mentioned before

Subject: Re: Covariance Matrices in RhoCandidates Posted by StefanoSpataro on Thu, 17 Apr 2014 08:13:11 GMT View Forum Message <> Reply to Message

I repeat my question in more clear terms: can you please tell what have you simulated, better if you upload the sim macro and the code you used to verify this negative values, so that one can reproduce your results?

Subject: Re: Covariance Matrices in RhoCandidates Posted by SHenssler on Thu, 17 Apr 2014 11:10:11 GMT View Forum Message <> Reply to Message

Just as i mentioned at the start of this topic: I used the rho macro in /tutorials/rho and then followed the steps Ralf proposed. To verify the negative values i used the TMatrixDEigen Analysis from Root.

Subject: Re: Covariance Matrices in RhoCandidates Posted by StefanoSpataro on Thu, 17 Apr 2014 11:43:35 GMT View Forum Message <> Reply to Message

Plese write exactly the code you used.

Subject: Re: Covariance Matrices in RhoCandidates Posted by SHenssler on Thu, 17 Apr 2014 11:58:44 GMT Hello Stefano,

I am on vacation right now and do not have access, so this will have to wait until next week. Or you could ask Elisabetta, i think she verified the negative values.

Greetings Simon