
Subject: Covariance Matrices in RhoCandidates
Posted by [SHenssler](#) on Tue, 25 Mar 2014 13:51:53 GMT
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Hello together,

I am currently evaluating 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 calculate 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 advance

Simon Henssler

Subject: Re: Covariance Matrices in RhoCandidates
Posted by [Ralf Kliemt](#) on Tue, 25 Mar 2014 15:24:36 GMT
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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
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Hello Ralf,

i used the macro in tutorials/rho/tut_ana_task.C
i will check the covariances as you said, then i'll post the results again.

Cheers
Simon

Subject: Re: Covariance Matrices in RhoCandidates
Posted by [SHenssler](#) on Tue, 25 Mar 2014 16:22:18 GMT
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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
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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
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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.

Greetings
Simon

Subject: Re: Covariance Matrices in RhoCandidates
Posted by [Ralf Kliemt](#) on Wed, 26 Mar 2014 07:01:21 GMT
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Hi Simon,

Well, Only final state particles 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 constructions with `if(0=myPidcand) ...`

Cheers
Ralf

Subject: Re: Covariance Matrices in RhoCandidates
Posted by [SHenssler](#) on Wed, 26 Mar 2014 08:26:14 GMT
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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
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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();
```

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

Cheers
Ralf

Subject: Re: Covariance Matrices in RhoCandidates
Posted by [SHenssler](#) on Thu, 03 Apr 2014 10:14:17 GMT
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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
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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
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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
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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
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Sorry but I have not well understood, please excuse my ignorance.
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
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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 be guaranteed that the Chi Square value is positive.
It is a mathematical property that every Covariance Matrix Must have.

Cheers
Simon

Subject: Re: Covariance Matrices in RhoCandidates
Posted by [StefanoSpataro](#) on Wed, 16 Apr 2014 20:02:16 GMT
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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
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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
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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
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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
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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
