

## GammaLib - Action #1305

### Understand why diffuse emission fitting takes so many iterations

07/29/2014 04:31 PM - Knödlseeder Jürgen

<b>Status:</b>	Closed	<b>Start date:</b>	07/29/2014
<b>Priority:</b>	Normal	<b>Due date:</b>	
<b>Assigned To:</b>	Knödlseeder Jürgen	<b>% Done:</b>	100%
<b>Category:</b>		<b>Estimated time:</b>	0.00 hour
<b>Target version:</b>	00-09-00		
<b>Description</b>			
Follow up of issue #1299. Not clear why diffuse models need several tens of iterations.			
<b>Related issues:</b>			
Related to GammaLib - Bug # 1299: Fitting problems with radial disk model		<b>Closed</b>	<b>07/25/2014</b>

#### History

##### #1 - 07/29/2014 09:55 PM - Knödlseeder Jürgen

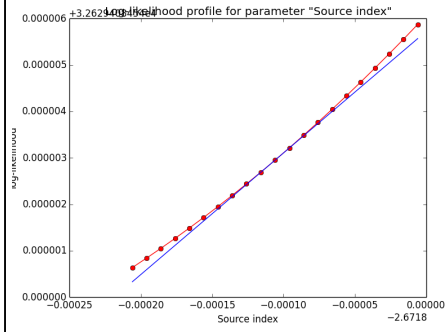
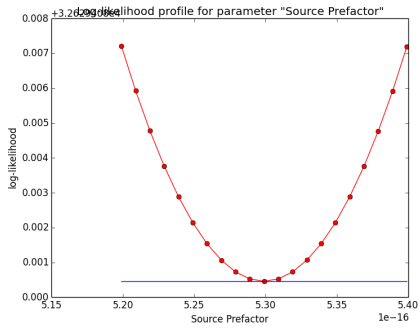
- File *diffuse\_unbinned\_scale5\_SrcPrefactor.png* added
- File *diffuse\_unbinned\_scale5\_SrcIndex.png* added
- File *diffuse\_unbinned\_scale5\_Sigma.png* added
- File *diffuse\_unbinned\_scale5\_BkgPrefactor.png* added
- File *diffuse\_unbinned\_scale5\_BkgIndex.png* added
- Status changed from New to In Progress
- Assigned To set to Knödlseeder Jürgen

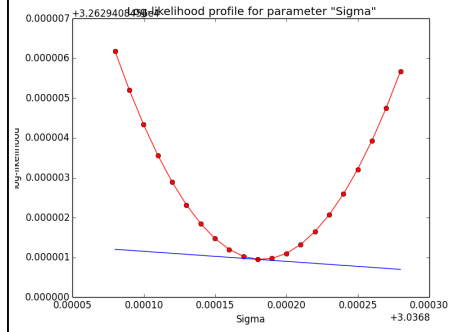
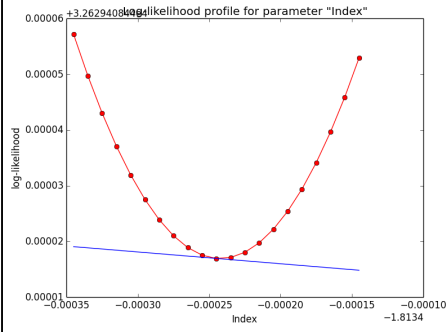
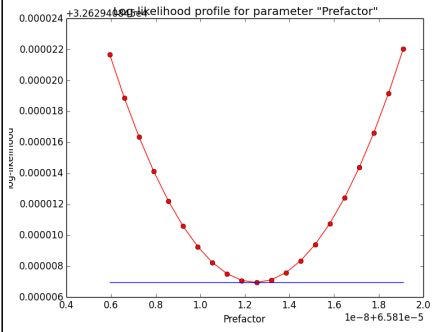
Here the output of the optimizer when fitting the diffuse model in an unbinned analysis:

```
>Iteration 0: -logL=32632.073, Lambda=1.0e-03
>Iteration 1: -logL=32632.024, Lambda=1.0e-03, delta=0.049, max(|grad|)=-70.118144 [Index:7]
Iteration 2: -logL=32632.024, Lambda=1.0e-04, delta=-0.519, max(|grad|)=-30.237027 [Index:2] (stalled)
Iteration 3: -logL=32632.024, Lambda=1.0e-03, delta=-0.389, max(|grad|)=-29.206366 [Index:2] (stalled)
>Iteration 4: -logL=32631.434, Lambda=1.0e-02, delta=0.590, max(|grad|)=-21.309557 [Index:2]
Iteration 5: -logL=32631.434, Lambda=1.0e-03, delta=-0.893, max(|grad|)=-54.630362 [Index:7] (stalled)
Iteration 6: -logL=32631.434, Lambda=1.0e-02, delta=-0.570, max(|grad|)=-41.063943 [Index:7] (stalled)
>Iteration 7: -logL=32629.450, Lambda=1.0e-01, delta=1.984, max(|grad|)=4.124423 [Sigma:5]
>Iteration 8: -logL=32629.412, Lambda=1.0e-02, delta=0.038, max(|grad|)=1.424688 [Index:7]
Iteration 9: -logL=32629.412, Lambda=1.0e-03, delta=-0.004, max(|grad|)=-1.126451 [Index:7] (stalled)
Iteration 10: -logL=32629.412, Lambda=1.0e-02, delta=-0.002, max(|grad|)=-0.771307 [Index:7] (stalled)
>Iteration 11: -logL=32629.409, Lambda=1.0e-01, delta=0.003, max(|grad|)=0.751852 [Index:7]
>Iteration 12: -logL=32629.409, Lambda=1.0e-02, delta=0.000, max(|grad|)=-0.163063 [Index:2]
Iteration 13: -logL=32629.409, Lambda=1.0e-03, delta=-0.000, max(|grad|)=-0.334147 [Index:7] (stalled)
Iteration 14: -logL=32629.409, Lambda=1.0e-02, delta=-0.000, max(|grad|)=-0.227450 [Index:7] (stalled)
>Iteration 15: -logL=32629.409, Lambda=1.0e-01, delta=0.000, max(|grad|)=0.237633 [Index:7]
>Iteration 16: -logL=32629.409, Lambda=1.0e-02, delta=0.000, max(|grad|)=-0.064887 [Index:2]
Iteration 17: -logL=32629.409, Lambda=1.0e-03, delta=-0.000, max(|grad|)=-0.130886 [Index:7] (stalled)
Iteration 18: -logL=32629.409, Lambda=1.0e-02, delta=-0.000, max(|grad|)=-0.088992 [Index:7] (stalled)
>Iteration 19: -logL=32629.408, Lambda=1.0e-01, delta=0.000, max(|grad|)=0.096239 [Index:7]
>Iteration 20: -logL=32629.408, Lambda=1.0e-02, delta=0.000, max(|grad|)=-0.026185 [Index:2]
```

It looks like that the spectral indices have the largest gradients. Below the corresponding log-likelihood profiles. Top row are the source parameters (Prefactor and Index), bottom row are the background parameters (Prefactor, Index, Sigma). While the background parameters have smooth log-likelihood profiles and seems to be well fit, the source Index log-likelihood profile indicates that a minima has not been reached.

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**#2 - 07/29/2014 10:03 PM - Knödlseider Jürgen**

- File diffuse\_unbinned\_scale5\_SrcPrefactor.png added

**#3 - 07/29/2014 10:03 PM - Knödlseider Jürgen**

- File deleted (diffuse\_unbinned\_scale5\_SrcPrefactor.png)

**#4 - 07/29/2014 10:38 PM - Knödlseider Jürgen**

- % Done changed from 0 to 10

I played around with the various integration precision in the lrf and Npred computation without any notable change in the number of iterations required for the fit or in the log-likelihood profile of the spectral index.

**#5 - 07/29/2014 11:00 PM - Knödlseider Jürgen**

- File diffuse\_unbinned\_scale5\_Index\_opt6.png added

- File diffuse\_unbinned\_scale5\_Index\_opt8.png added

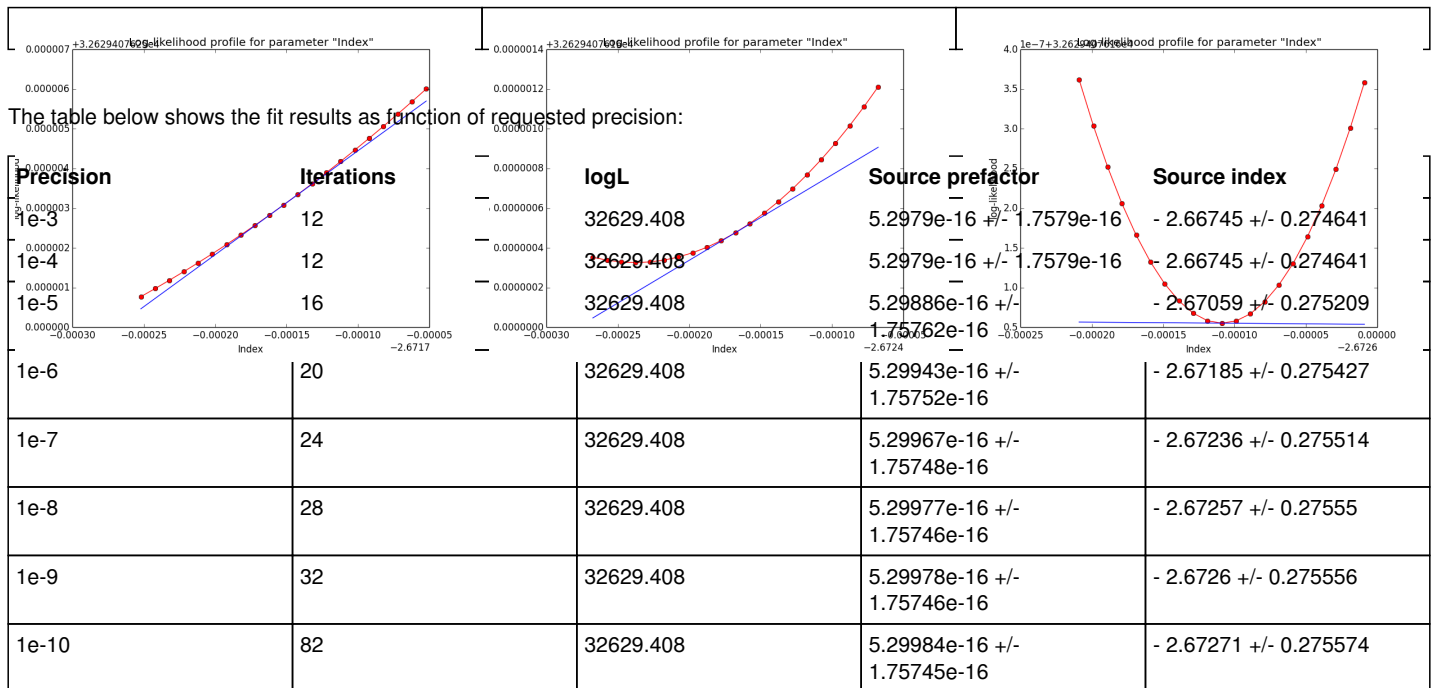
- File diffuse\_unbinned\_scale5\_Index\_opt10.png added

- Status changed from In Progress to Feedback

- Target version set to 00-09-00

- % Done changed from 10 to 100

Maybe this is just a question of fit precision. Increasing the requirement on the optimizer precision increases the number of iterations but leads to a better minimum in the spectral index, as indicated in the plots below that show the log-likelihood profile for a precision of 1e-6 (left), 1e-8 (centre) and 1e-10 (right).



So the results do not depend sensitively on the precision, but the gradients do. Note that the default GOptimizeLM precision is 1.0-6, which is also the value used in ctfite.

The question remains why the fit needs so many iterations? Possibly do to the diffuse nature of the source, which leads to a pretty strong correlation of source and background model. The biggest gradients are observed in the index of the background and the source model, and the fit alters between improvements and stalls. Maybe this could be changed if the full Hessian would be used in the fitting, but with the present scheme it looks like we have to live with this.

**#6 - 11/11/2014 11:27 PM - Knödseder Jürgen**

- Status changed from *Feedback* to *Closed*

- Remaining (hours) set to 0.0

**Files**

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diffuse_unbinned_scale5_SrcIndex.png	50.2 KB	07/29/2014	Knödseder Jürgen
diffuse_unbinned_scale5_Sigma.png	49.3 KB	07/29/2014	Knödseder Jürgen
diffuse_unbinned_scale5_BkgPrefactor.png	52.4 KB	07/29/2014	Knödseder Jürgen
diffuse_unbinned_scale5_BkgIndex.png	44.6 KB	07/29/2014	Knödseder Jürgen
diffuse_unbinned_scale5_SrcPrefactor.png	46.2 KB	07/29/2014	Knödseder Jürgen
diffuse_unbinned_scale5_Index_opt6.png	48.4 KB	07/29/2014	Knödseder Jürgen
diffuse_unbinned_scale5_Index_opt8.png	47.4 KB	07/29/2014	Knödseder Jürgen
diffuse_unbinned_scale5_Index_opt10.png	40 KB	07/29/2014	Knödseder Jürgen