

SAS methods for stacking RGS spectra



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ABSTRACT:

As part of continuing efforts to maximise the usefulness to observers of the SAS in general, and its RGS components in particular, SAS v8 saw the introduction of spectra calculated as a function of wavelength as an alternative to the usual instrumental dispersion angle. This makes it possible to align two or more RGS spectra, not necessarily of the same target, in a common wavelength reference frame, independent of source geometry, with the rigorous preservation of counting statistics. As a result, it is easy to stack RGS spectra using the latest version of the task rgscombine in SAS v9. In this poster, we present a study of the methods implemented in rgscombine and discuss the advantages of their application to some relevant astronomical examples.

Origin:

SAS originally calculates RGS spectra on a grid defined in dispersion angle units β

- Corresponding wavelength grid changes depending on the source geometry.
- Difficult to combine spectra rigorously for quantitative analysis.

Redefinition of the RGS spectrum grid

- Fixed wavelength grid for all spectra.
- Bad columns and chip gaps are calculated in instrumental coordinates.
- Open significant new possibilities for both science and calibration.
- Proposal: to redefine RGS spectrum grid in fixed wavelength terms...

REPROJECTION

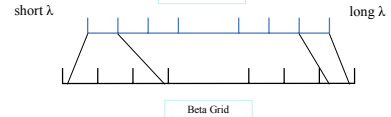
Method:

Lambda reprojection

Default values:

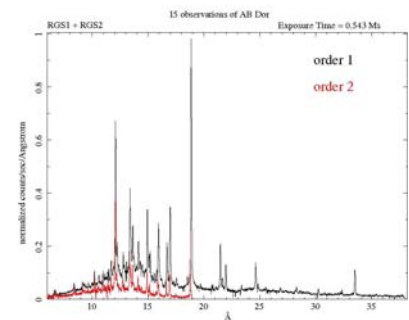
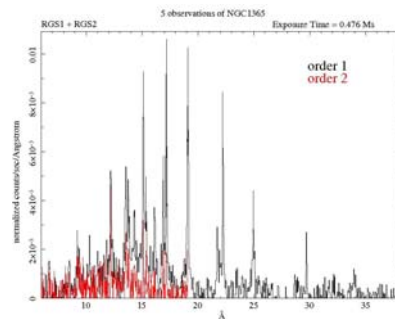
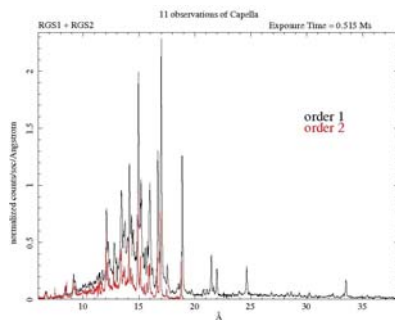
- rgsangles
 - lambdabinref = 4.005 Å
 - lambdabinwidth = 0.010 Å
 - nlambdabins = 3600
- rgsrmsfn
 - New method that reprojects the response matrix calculated in beta space into lambda space.
- rgsproc
 - New parameter: spectrumbinning = lambda
 - The new reprojection calculates the OGIP quantities; AREASCAL, BACKSCAL, quality and errors on the corresponding lambda grid.
 - AREASCAL = chipExposure / maxExposure
 - BACKSCAL = channelAccumExposure / chipExposure
 - quality -> Good if any coverage available

$$\cos \beta = \cos(\alpha + \varphi) + (m \cdot \lambda) / d$$



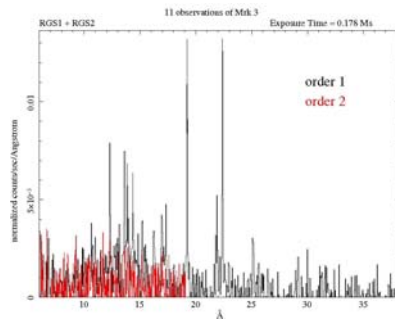
rgscombine

- Stacks all spectra calculated with the parameter spectrumbinning=lambda
- Accumulate counts in lambda bins.
- Accumulate BACKSCAL and AREASCAL for all spectra, taking into account bad channels.
- Accumulate Effective Area weighted with the exposure time for each observation



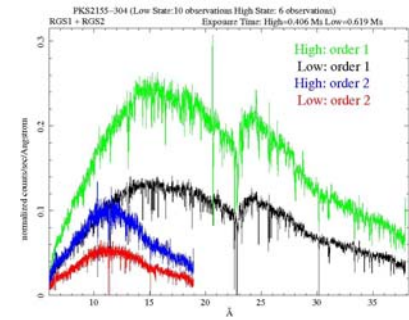
Results:

- The combined spectra of five different objects (AB Dor, Capella, PKS2155-304, Mrk 3 and NGC1365) are shown in this poster.
- This five objects sample give us more than 2Msec of RGS exposure time.
- A sample of 96 observations of Seyfert 2 galaxies have been stacked, giving a total of more than 2.2 Msec.
- Robust statistics.
- RGS operates reliable over more than three orders of magnitude in flux.



Conclusions:

- No limit for the length of RGS observations!
- Wavelength scale is becoming the default in SAS 10.0

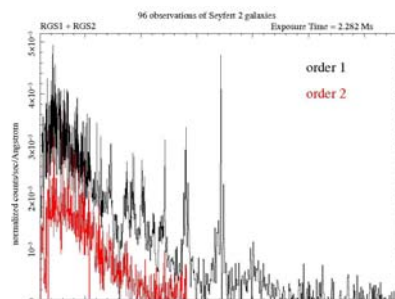


Sanity Checks:

To check the consistency of the new lambda binning and rgscombine, we have split an RGS exposure in two parts and merged them again using rgscombine obtaining identical results.

To check the output of rgscombine, we have run rgsfluxer using as input parameter:

- all the individual spectra.
 - single spectrum obtaining with rgscombine.
- The average flux obtained with this two different input parameters differs in aprox. 1%



Future work...

- Rest frame wavelength scale.
- Heliocentric corrections.
- Archive common lambda scale for all RGS spectra.
- Inform data analysis developments in future missions.

Give us your ideas (and requirements)