Estimating errors by bootstrapping.
Application to stellar diameters with PIONIER

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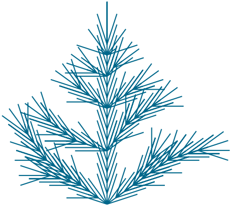

Non-Gaussian correlated errors

Origins of the correlation

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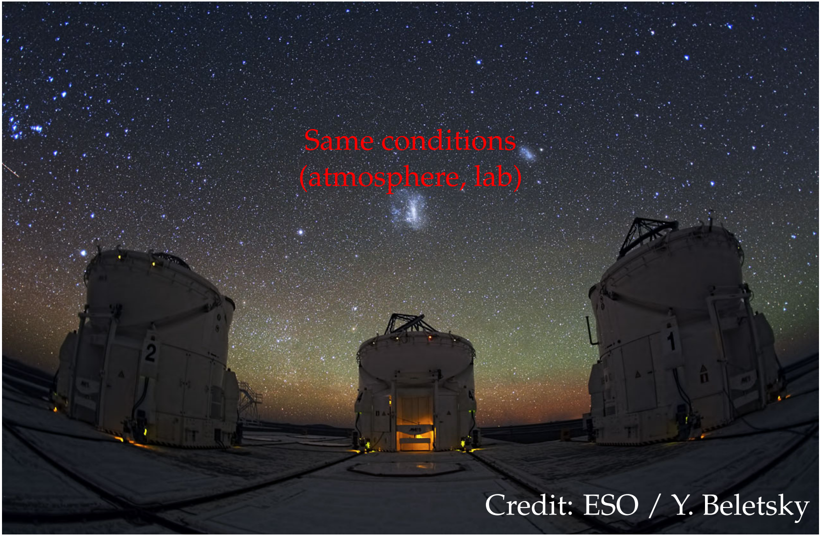

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Origins of the correlation

Non-Gaussian correlated errors

Departure from the Gaussian distribution

Is visibility is the sum of many random variables?

Non-Gaussian correlated errors

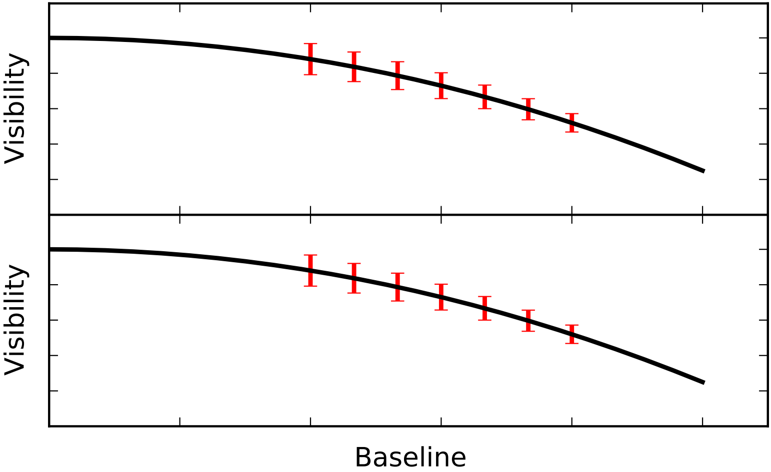
Departure from the Gaussian distribution

Is visibility is the sum of many random variables?

$$\underbrace{V_{\text{calibrated}}}_{\text{Quotient distribution?}} = \frac{\overbrace{V_{\text{uncalibrated}}}^{\text{Gaussian?}}}{\underbrace{V_{\text{uncalibrated}}}_{\text{Gaussian?}}} \quad (1)$$

Non-Gaussian correlated errors

Impact on model fitting



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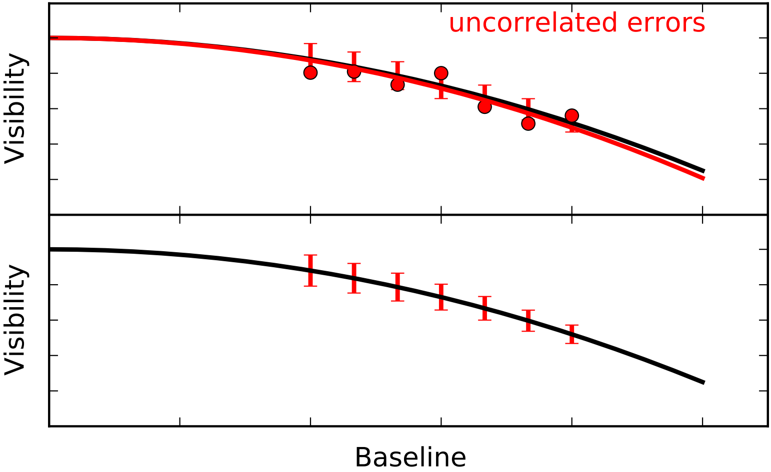

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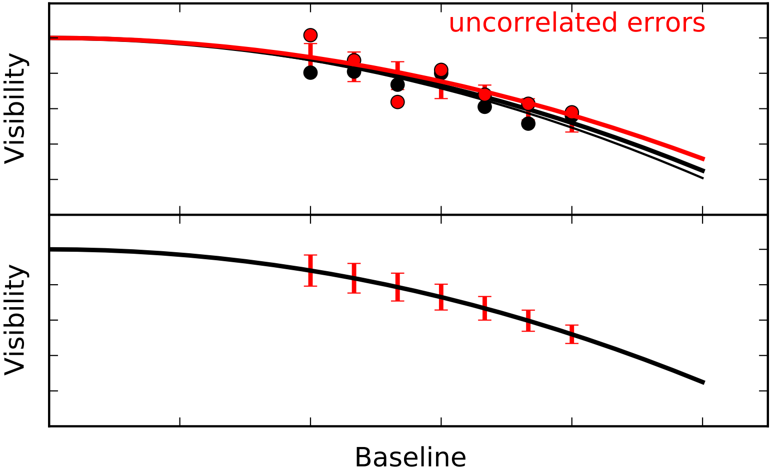
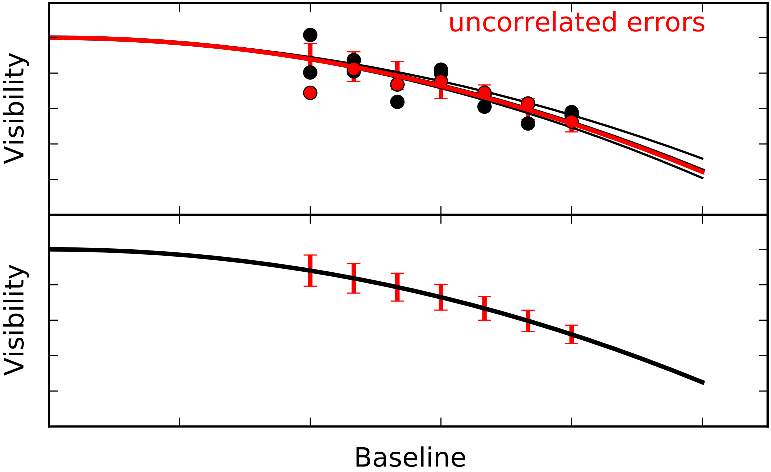


NON-GAUSSIAN CORRELATED ERRORS

IMPACT ON MODEL FITTING



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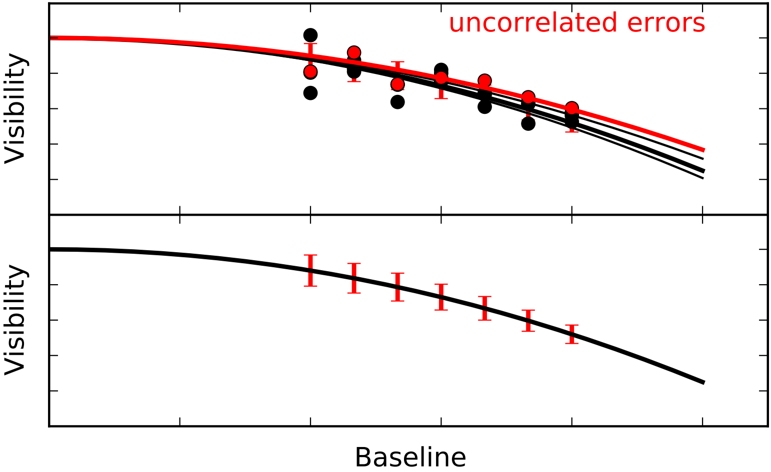

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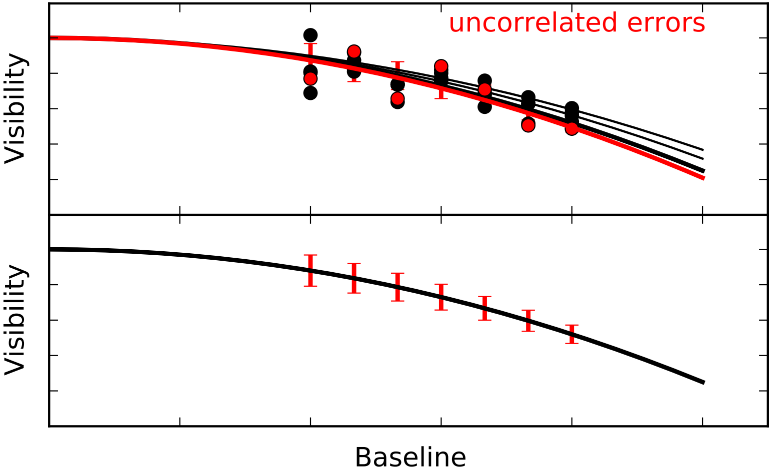

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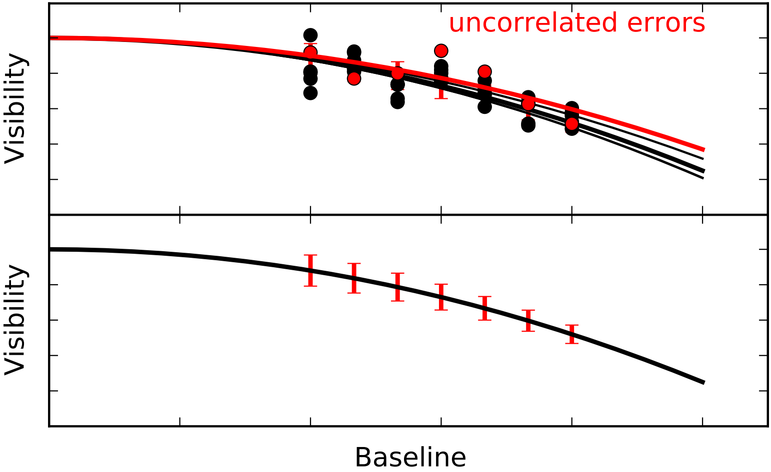

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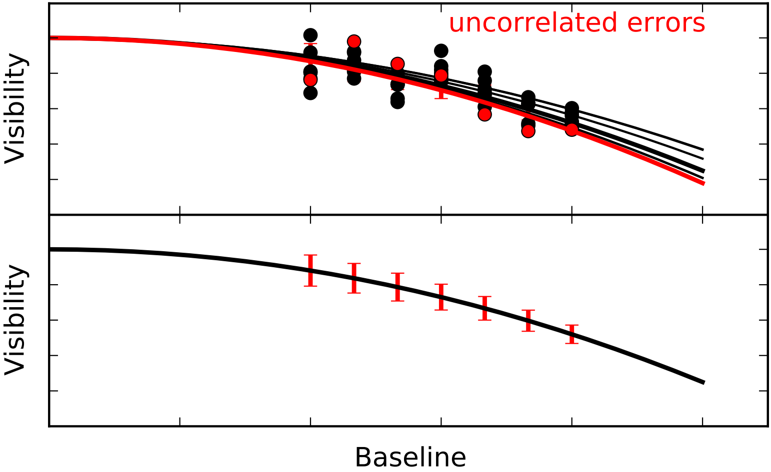

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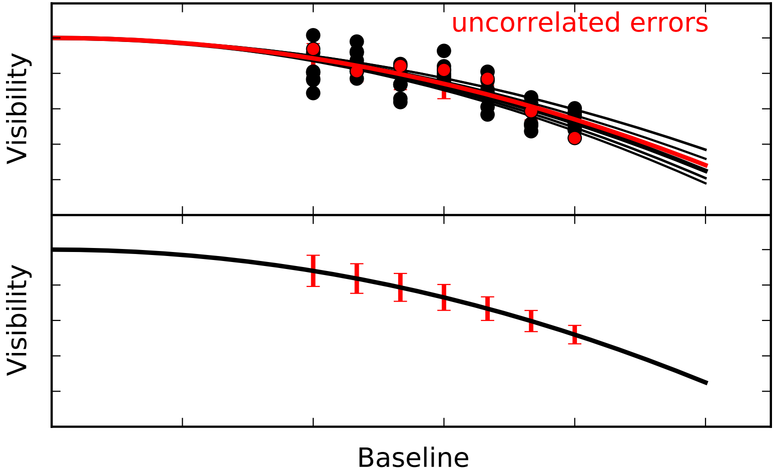

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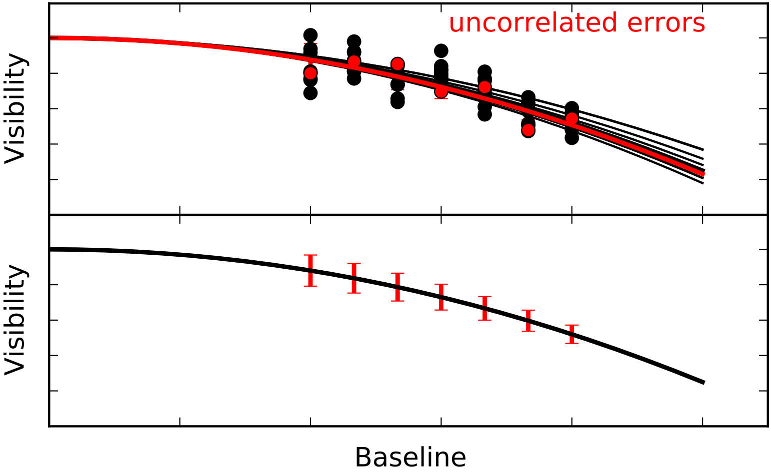

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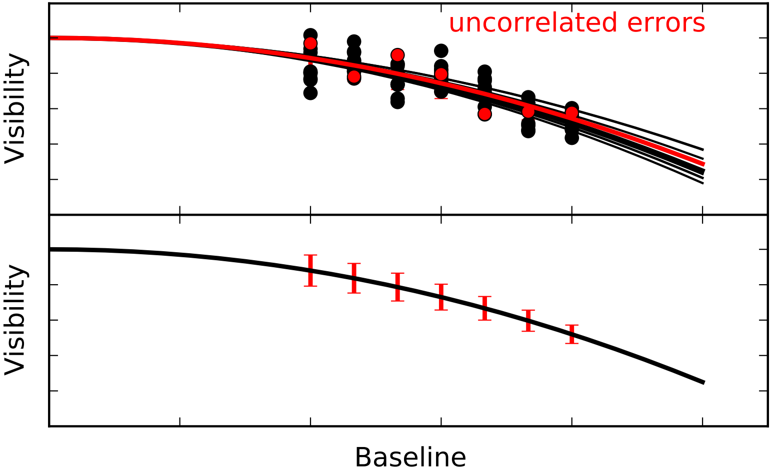

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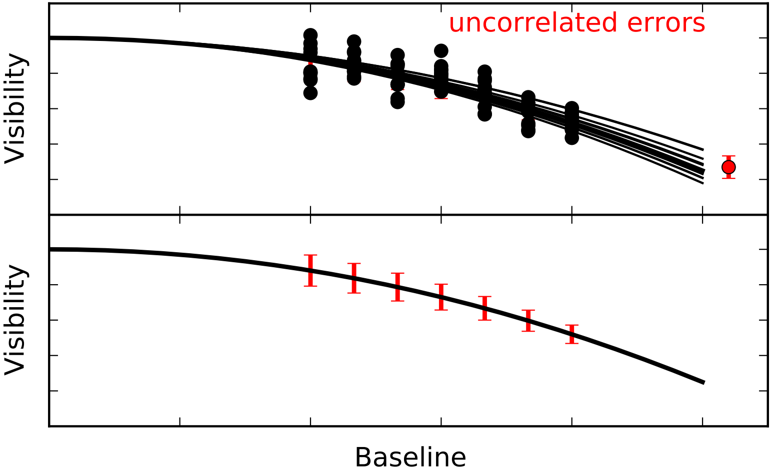

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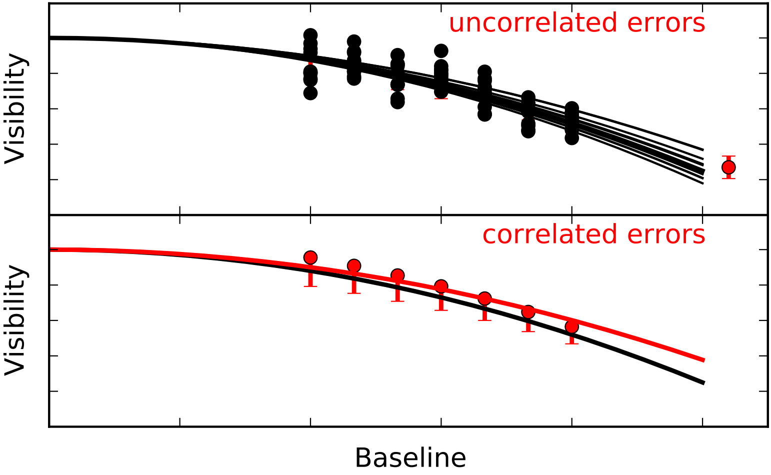

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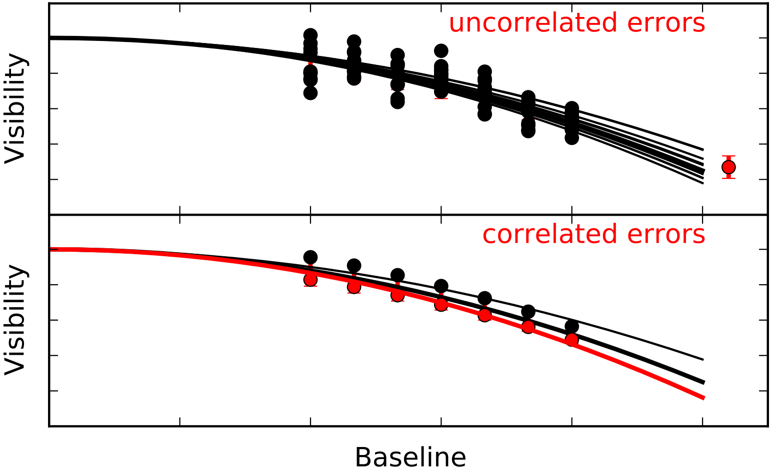

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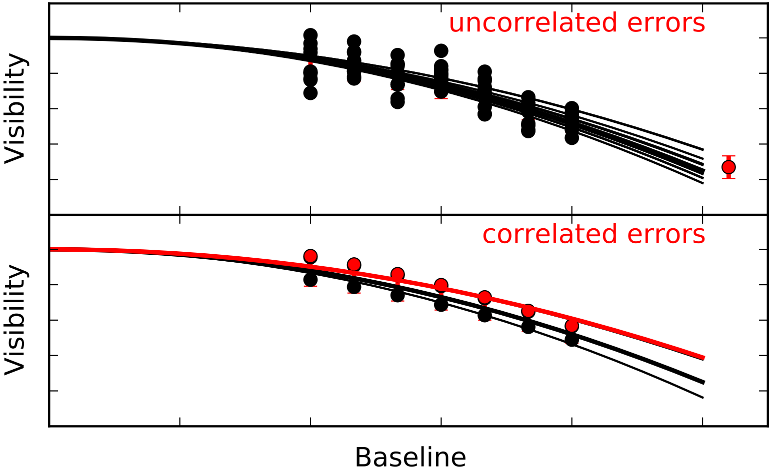

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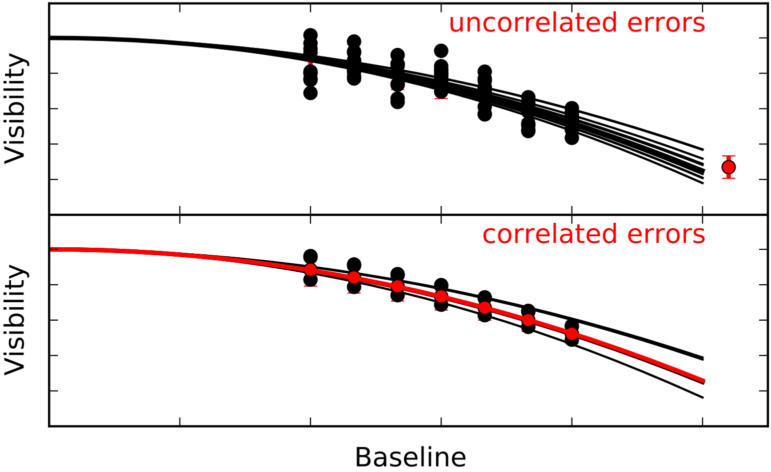

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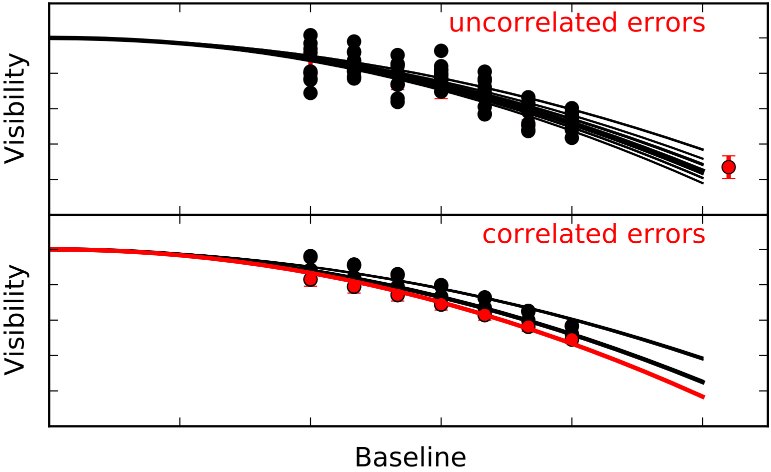

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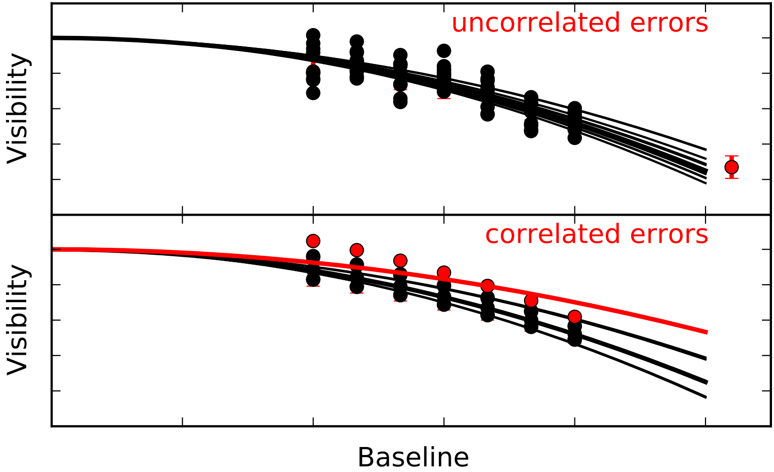

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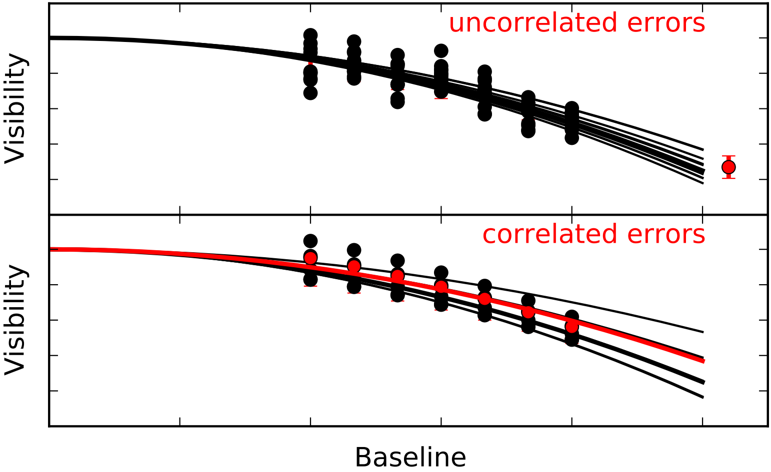

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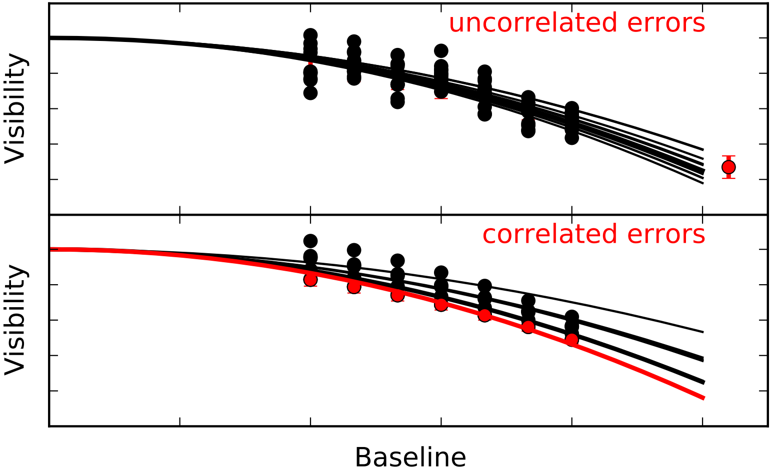

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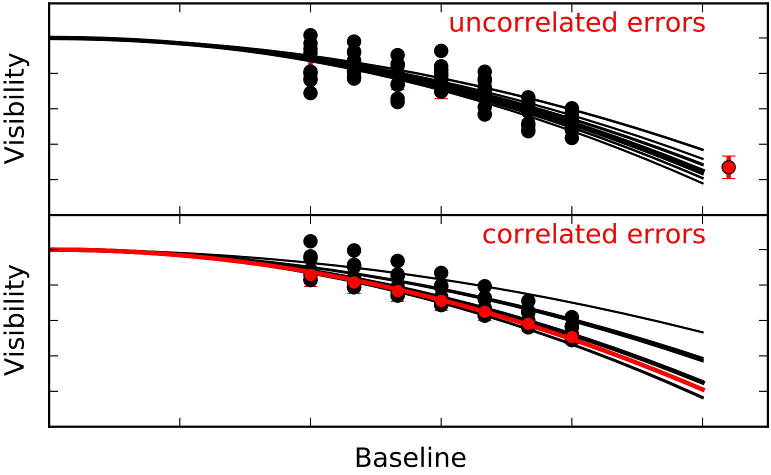
IMPACT ON MODEL FITTING



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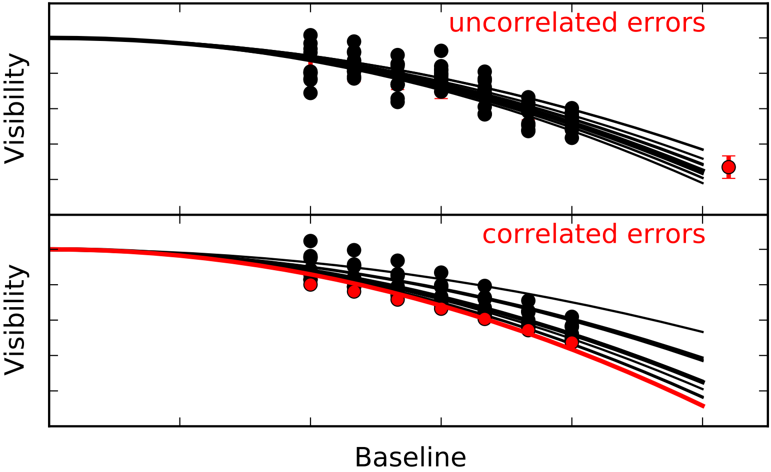

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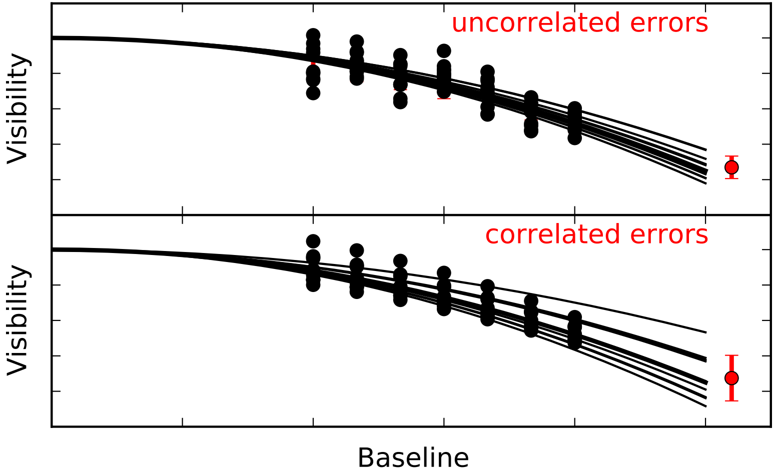


Non-Gaussian correlated errors

A pain to deal with?

- Data processing softwares ignores these errors.
- No OIFITS standard for non-Gaussian distributions.
- No OIFITS standard for correlated errors.

Not a new issue though: Perrin 2003 (A&A 400, 1173–1181)

The bootstrap method

How it works

For a whole run:

- Randomize the calibrators' diameters.
  Assume Gaussian distribution around catalog value.
- Randomize the calibrator observations.
  Picked at random with repeats.
- For each observation, randomize the interferograms.
  Picked at random with repeats.
- Perform the data processing.
  Standard PIONIER DRS.
- Perform a least-squares model fit to calibrated data.

Repeat a few hundred times.
$\rightarrow$ probability distribution of model parameters.

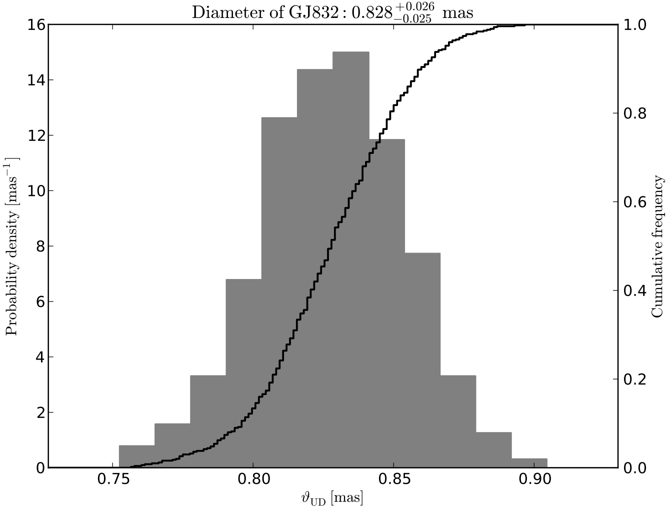
The bootstrap method

An extension to the PIONIER processing software

- An extension to PIONIER DRS has been developed.
- In practice, bootstraps are computed in parallel.
- A a single standard OIFITS holds the whole information.
  $\rightarrow$ No problem to specify correlation / PDF.
  (Bootstraps are coded as additional spectral channels.)

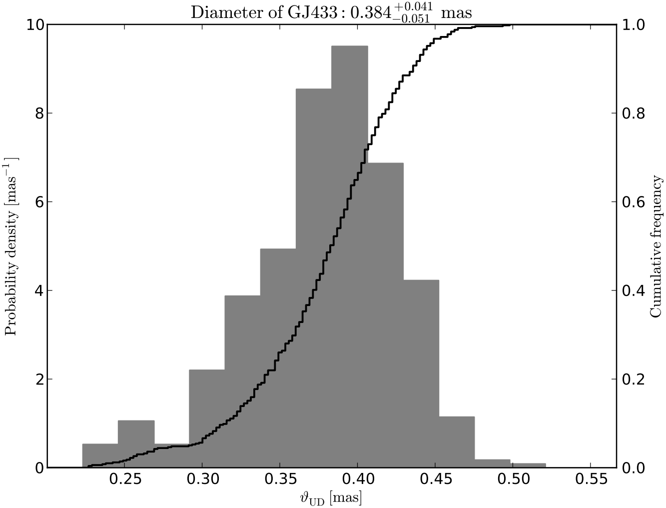
The bootstrap method

Cool dwarfs diameters (GJ 832)



The bootstrap method

Cool dwarfs diameters (GJ 433)



FUTURE WORK.

Stop trashing most of the visibility & phase information:
$\rightarrow$ Bootstrap = good estimate of the probability distribution!

- Bayesian inference of model parameters?
- Satistical hypothesis testing?