Long Term Analysis for the BAM device

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Overview

- What is BAM
- Analysis in the time domain
- Analysis in the frequency domain
- Example

BAM device

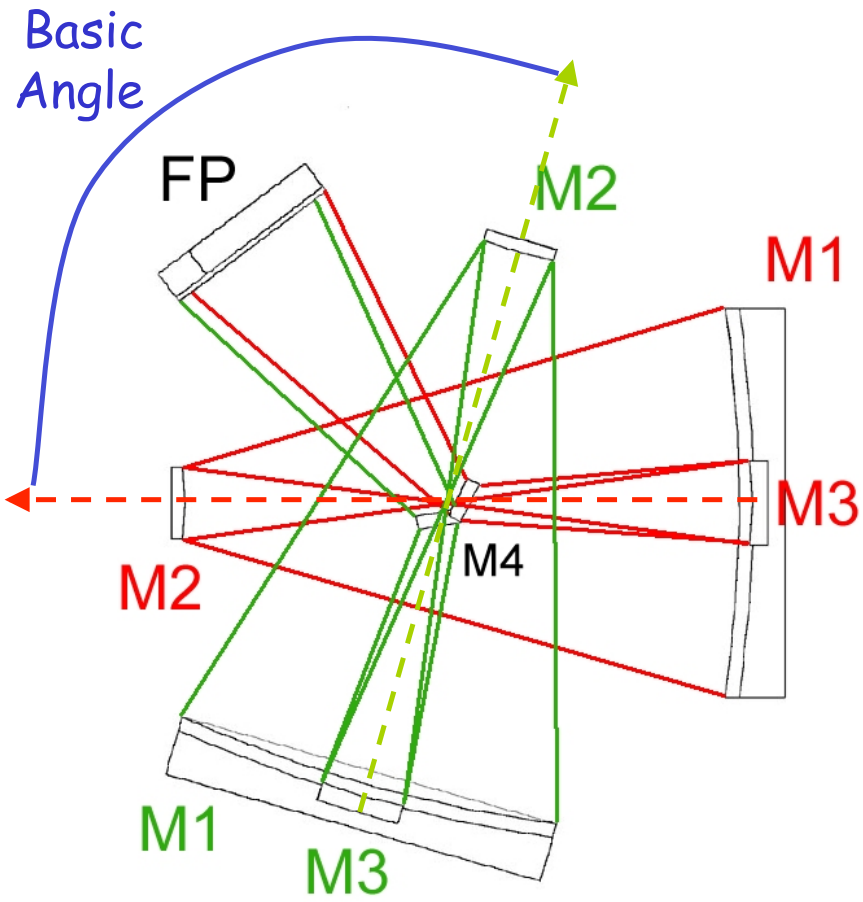
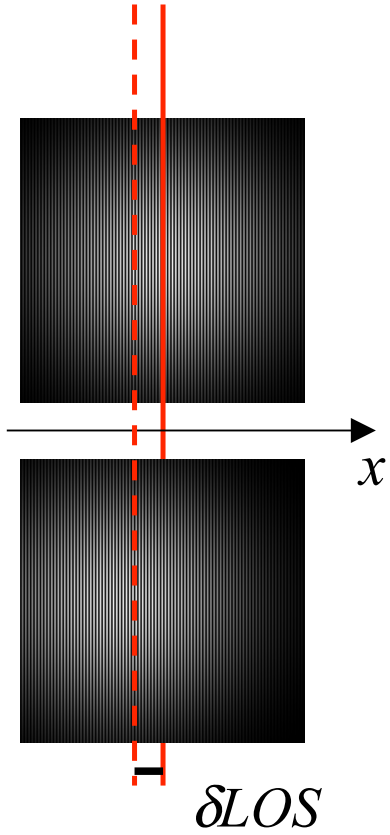


Image credit: www.rssd.esa.int



$$\delta BA = \delta LOS_2 - \delta LOS_1$$

BAM model and its parameters

Analytical description of each BAM CCD signal:

$$f(i,j) = A \cdot e^{\frac{x_i^2 + y_j^2}{2\sigma^2}} \cdot \left\{1 + V \cos\left[\frac{2\pi B}{\lambda f} x_i + \varphi\right]\right\} + B$$

where:

- [illegible] - shape amplitude
- V- fringe visibility
- [illegible] - fringe phase
- B - background
- A – intensity

Estimated by module **CAL** (calibration)

Needed by module RDP

$$\begin{cases} x_i = R(i - i_0) + \delta LOS \\ y_j = R(j - j_0) \end{cases}$$

Estimated by module **RDP** (Raw Data Processing)

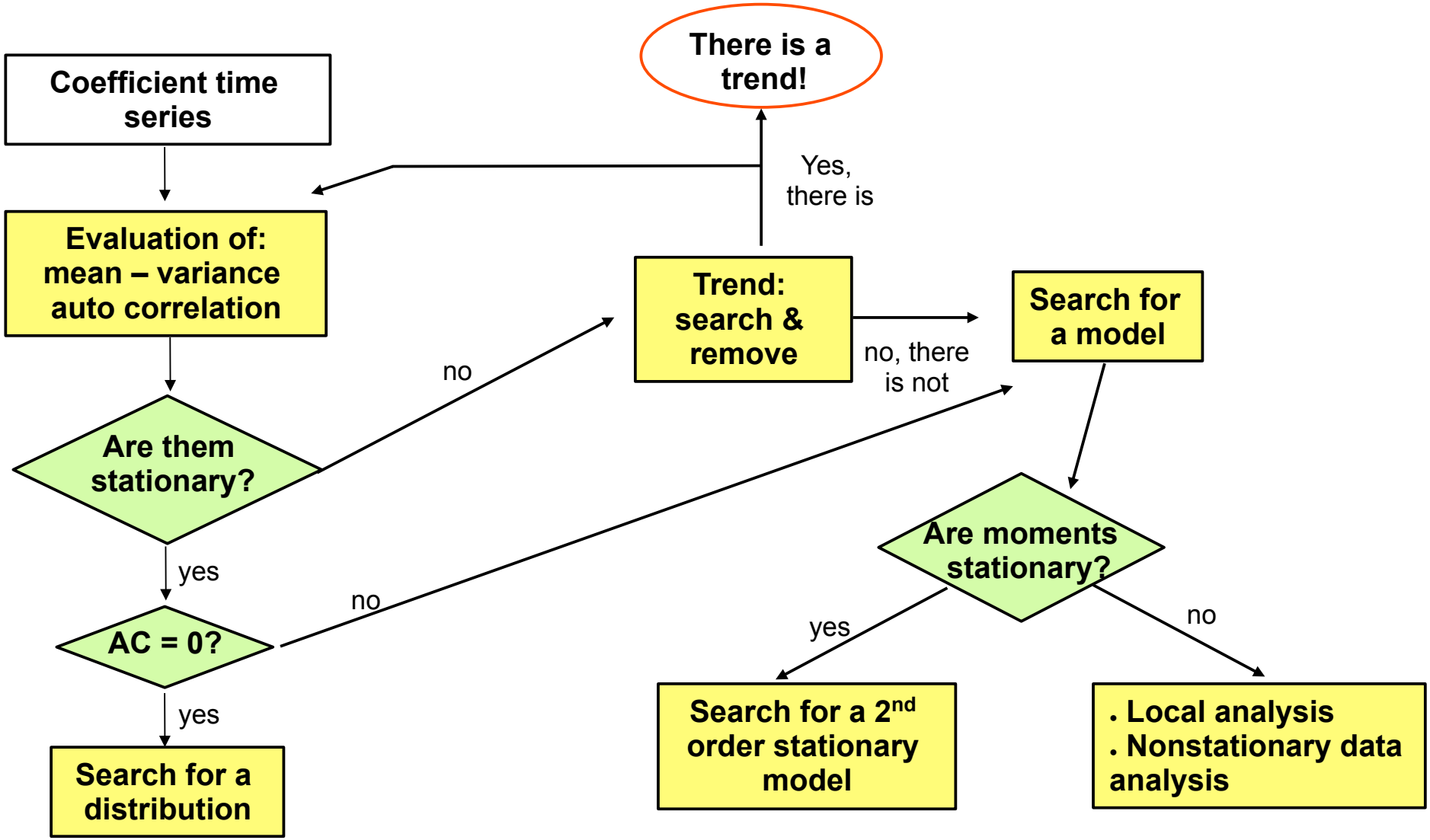
→ [illegible]BA = [illegible]LOS_2 - [illegible]LOS_1

At telemetry rate (3/4 CCD images / minute) = parameters time series

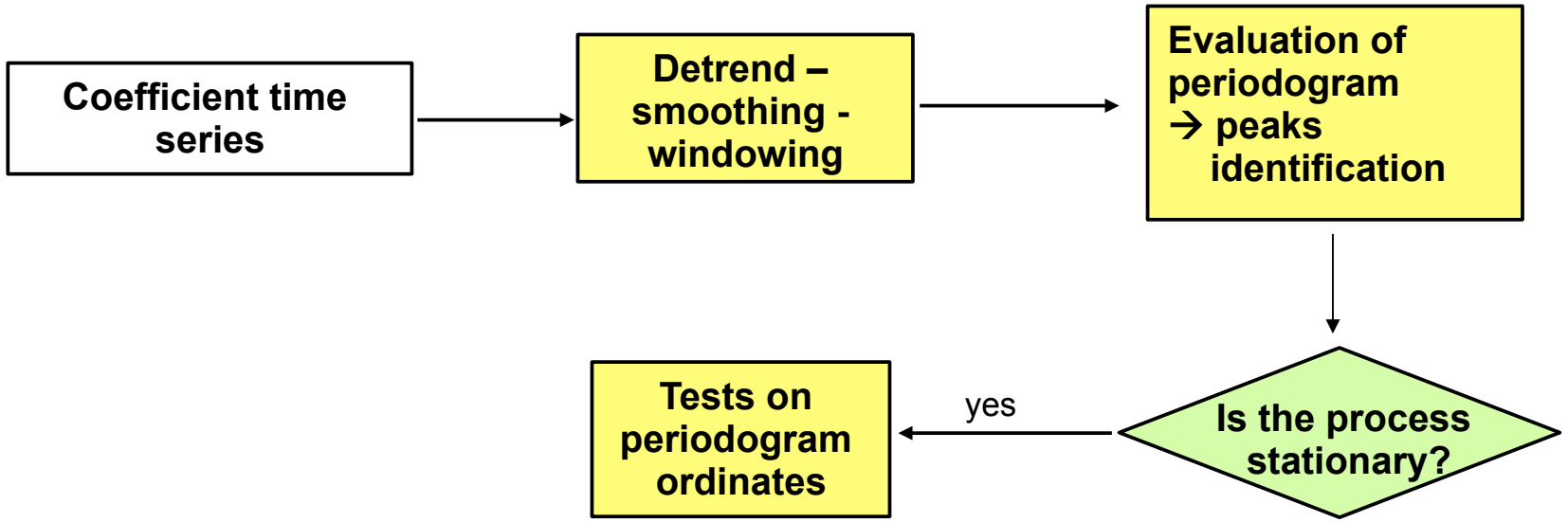
BAM LTA: Long Term Analysis

- **The Basic Angle variation will be determined independently by AGIS and FL, on timescale greater than 1 day**
- **To be comparable, BAM module needs analysis at daily timescale → needs for Long Term Analysis to verify consistency between different measurements**
- **Moreover, a survey on series of CCD images can provide information about variability on large timescale of instrumental parameters.**

Time series analysis: temporal domain



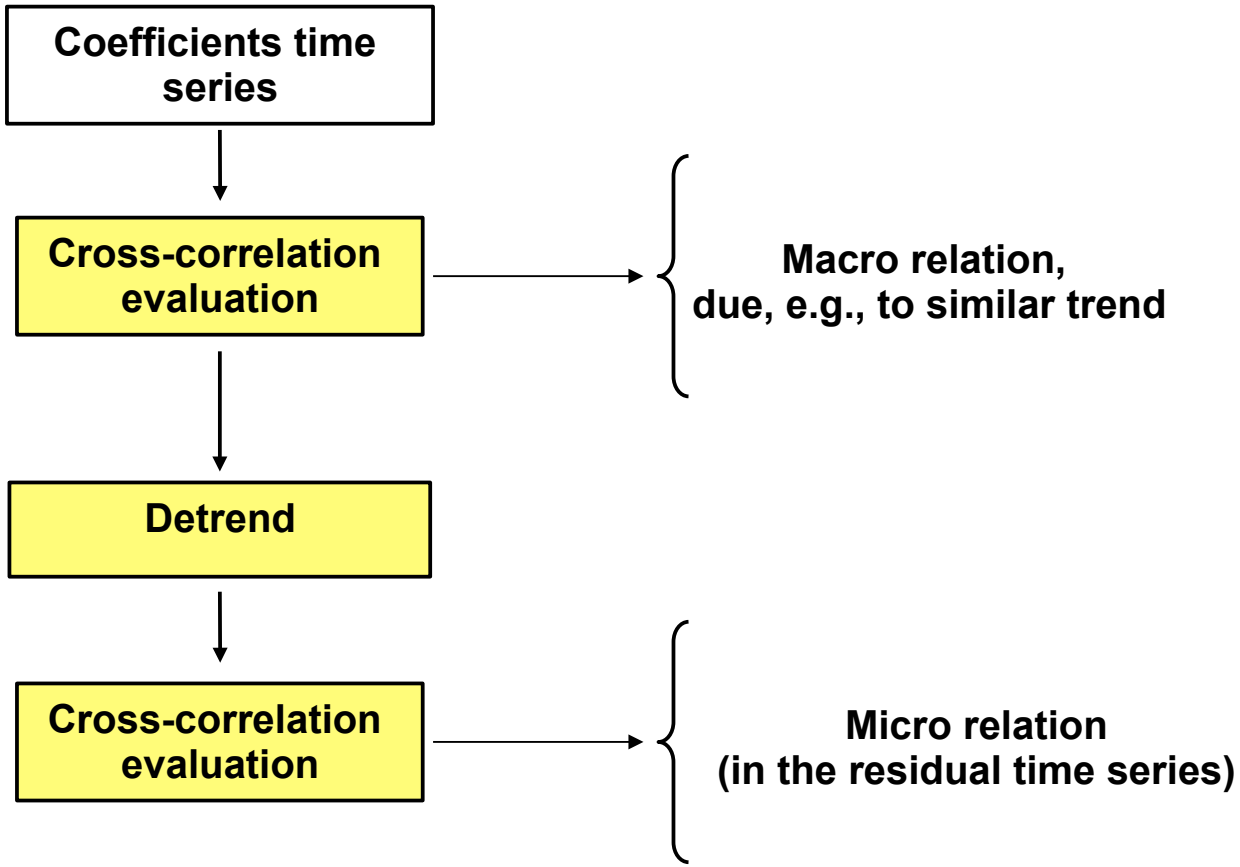
Time series analysis: frequency domain



Should confirm results of time analysis
Should evidence the presence of hidden periodicities

Time series analysis: cross-correlation

Search for cross-correlation between time series of different parameters, i.e.: are there some relations between changes in different parameters?



What we could expect?

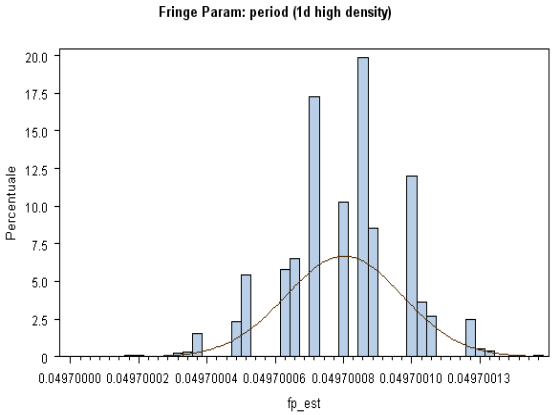
- Estimators features (bias, variance/covariance) adding with those of parameters distributions.
- Calibration module: parameters are (now) estimated over each image, so *indipendently*. However, we can expect at least periodicities linked to repeated transits.
- For raw data processing, we can expect some correlation due to the use of calibrated parameters, estimated over moving sets of images.
- BA is a differential quantity, so, under stability conditions, trends should cancel out.

Examples from simulated data

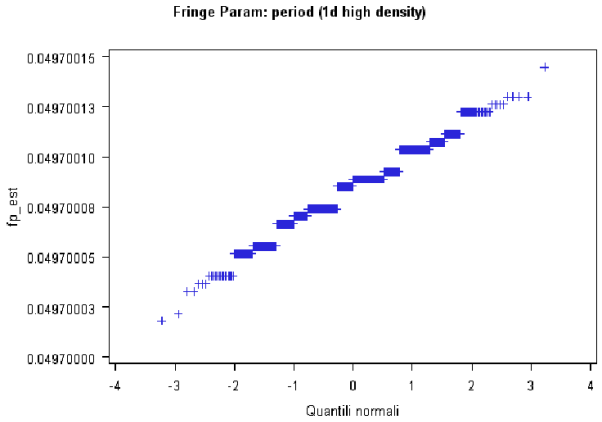
Test case 1: 1000 images with photon noise

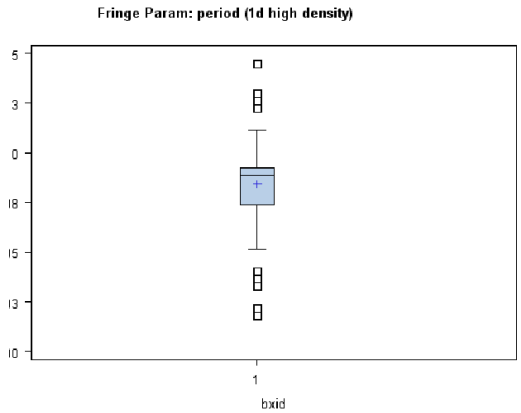
nominal model parameters

Evaluation of fringe period (FFT)

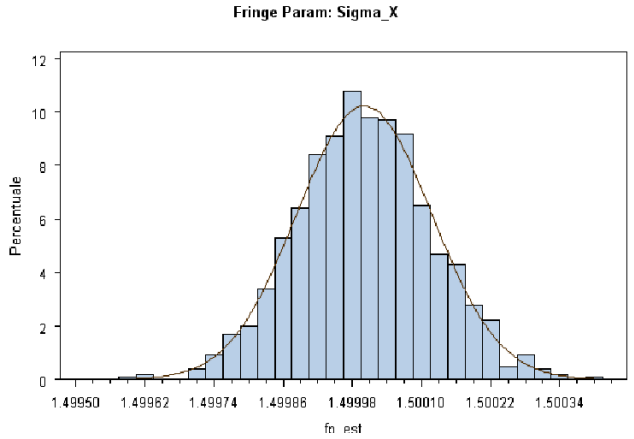


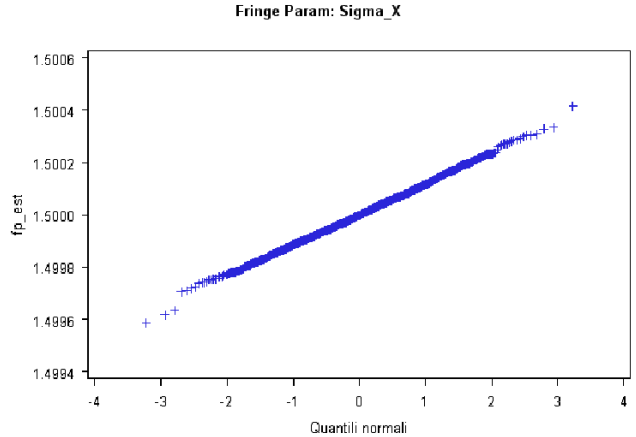
Test of Levene (H_0=HOV):
p-value = 0.0379





Evaluation of [W] (ML)



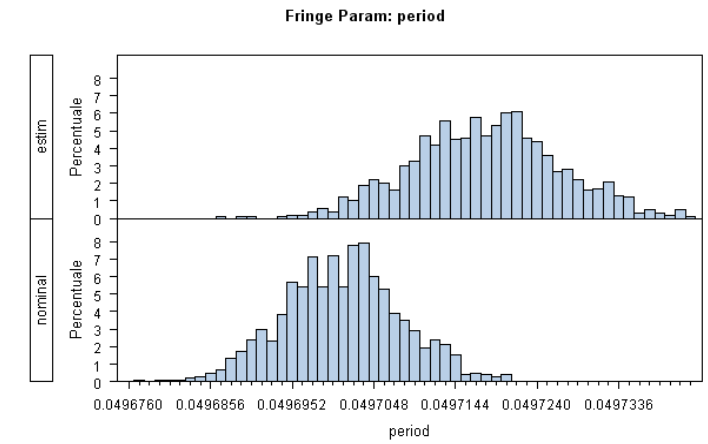


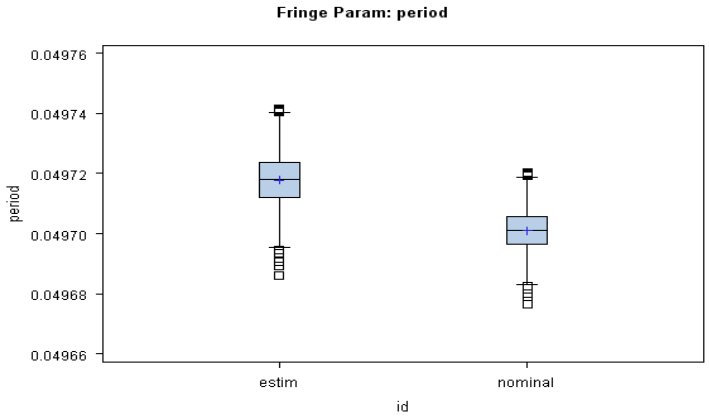
Examples from simulated data

Test case 2: 1000 images with photon noise

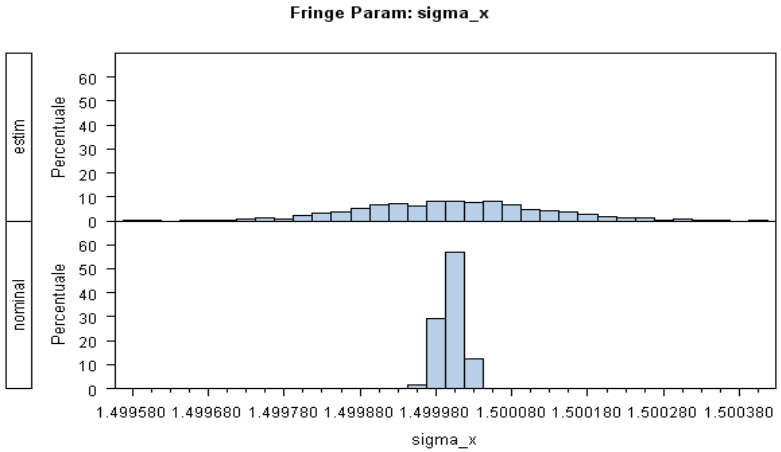
model parameters normally distributed

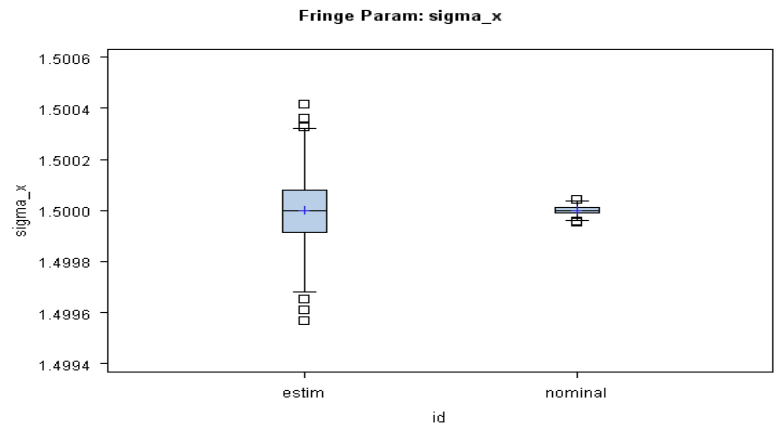
Evaluation of fringe period (FFT)





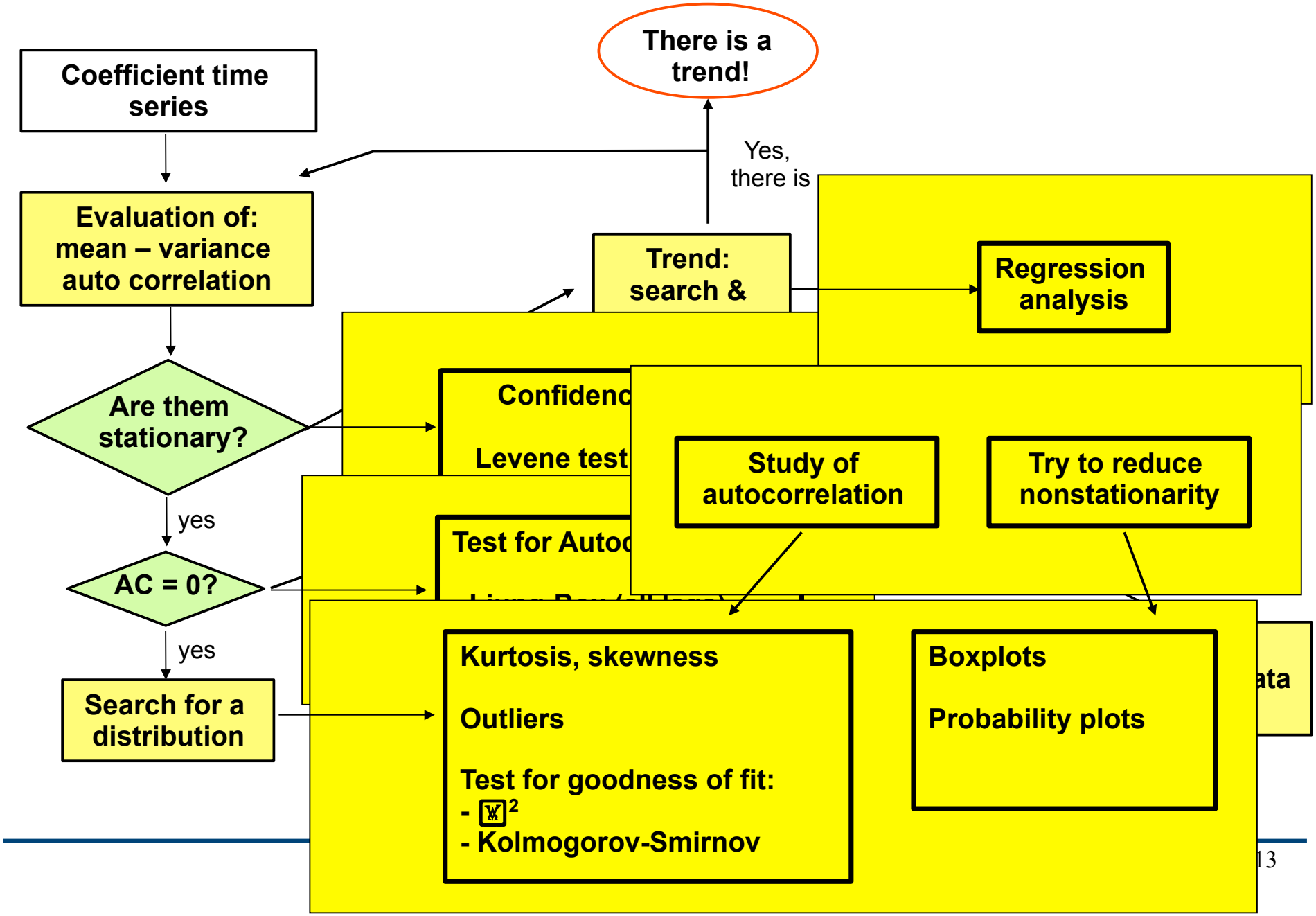
Evaluation of χ^2 (ML)



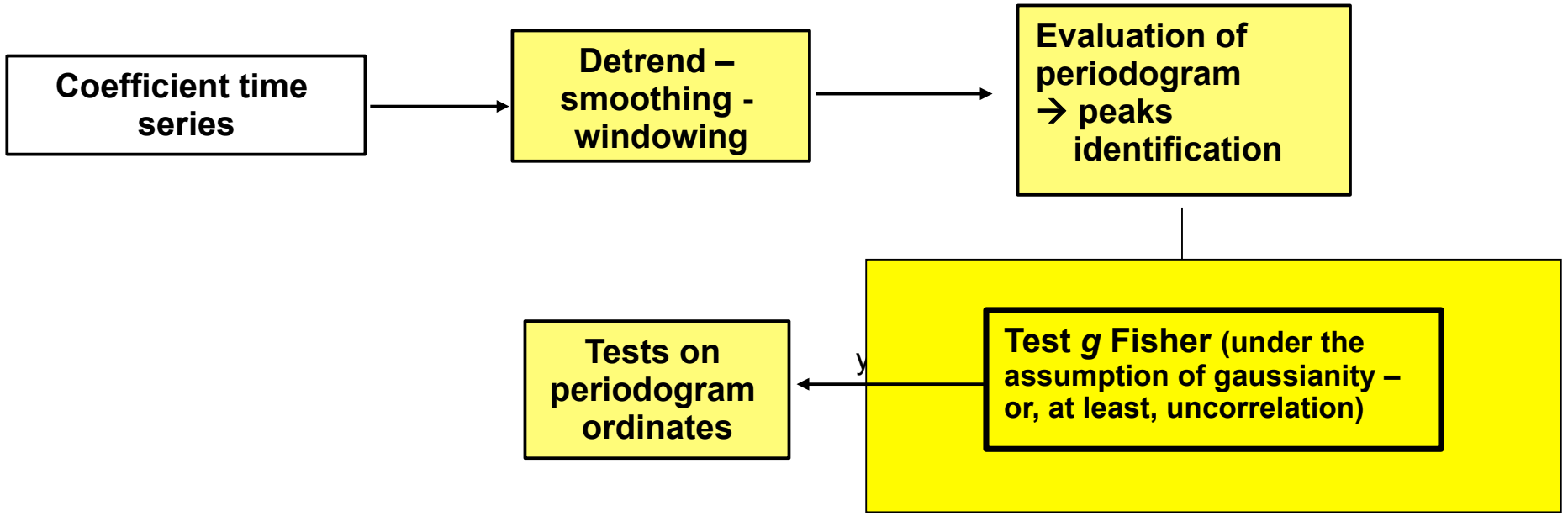


Spare slides

Time series analysis: temporal domain



Time series analysis: frequency domain



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