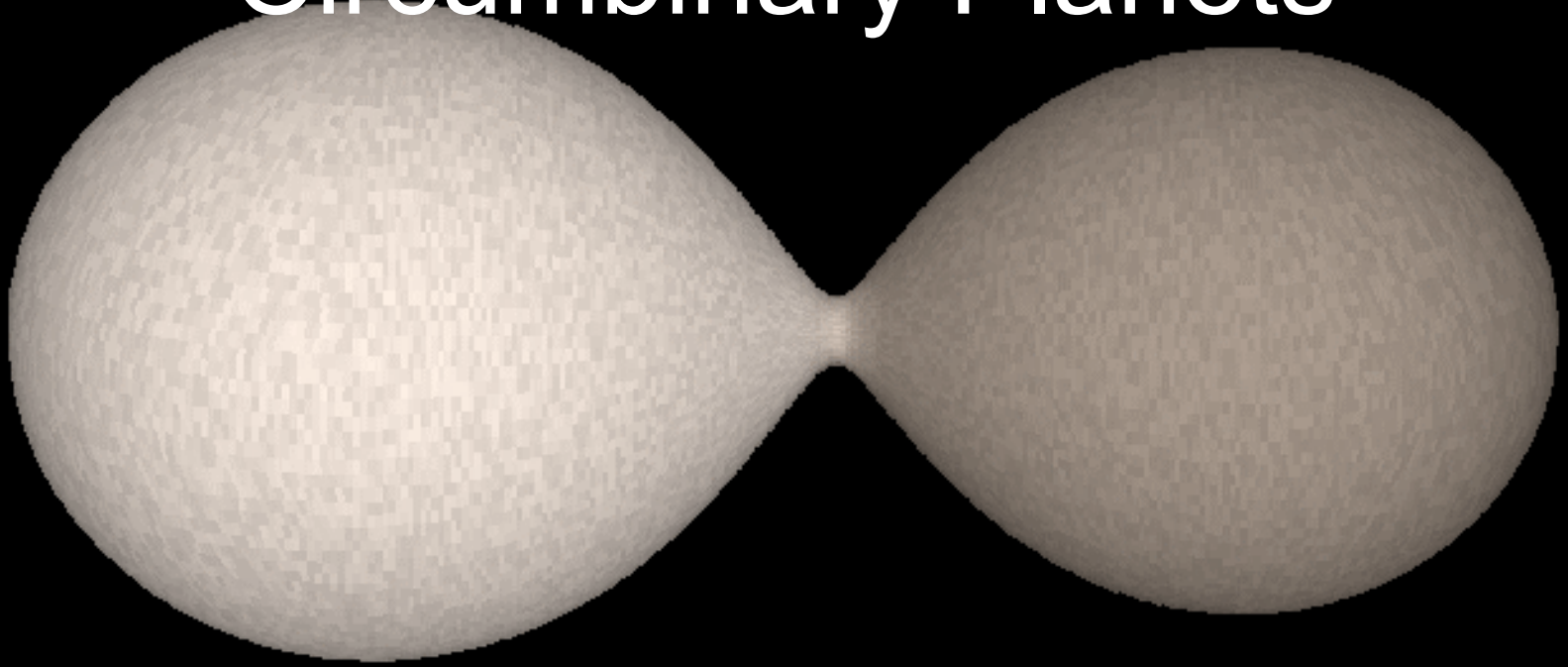
CB-BLS: Identifying Transiting Circumbinary Planets



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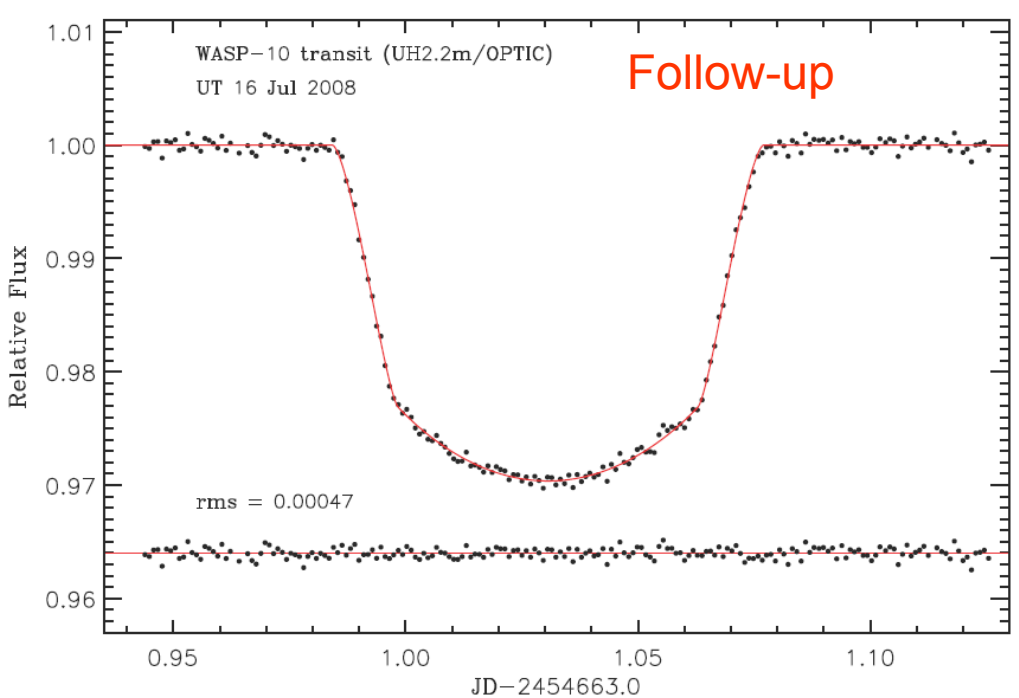
MNRAS 387, 1597 + updates

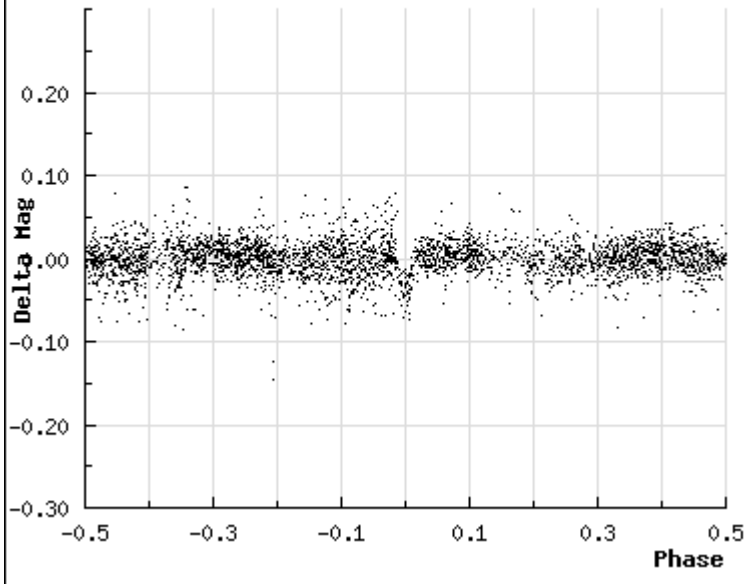
Background

- ~330 extra-solar planets are known.
- Detected in variety of techniques:
  - RV, transits, microlensing, imaging, timing, …
- The basic transit light curve is simple:



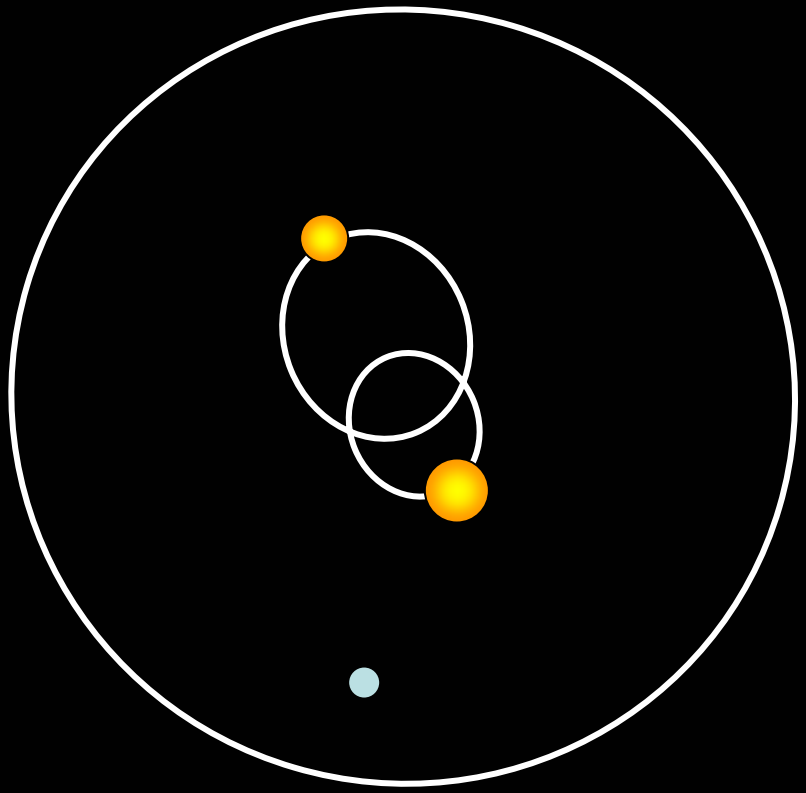
Follow-up

Discovery



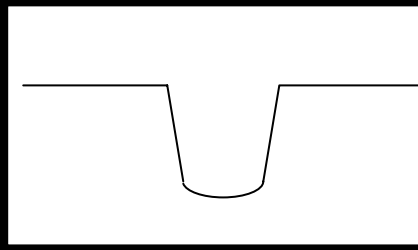
Identifying Transiting Circumbinary Planets

- The Challenges
- Solution: “CB-BLS”
- Updates
- Conclusions

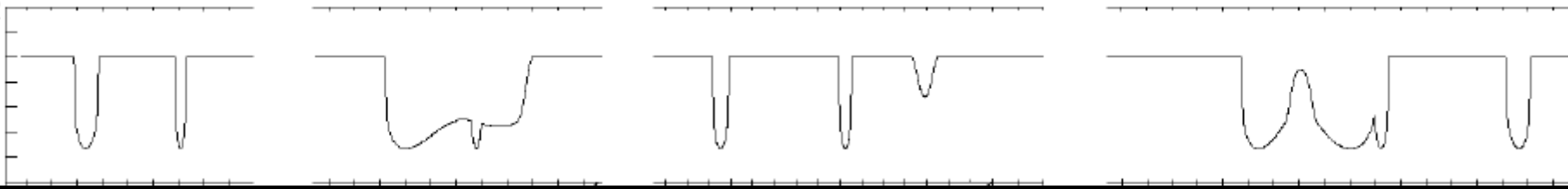


The Challenges (1)

- **Goal: detecting transiting exoplanets around eclipsing binaries (EBs).**
- Transiting planets around single stars have precise depth, duration, time



- Transiting circumbinary (CB) planets are expected to have special photometric and temporal characteristics



Source: Deeg *et al.* (1998)

The Challenges (2)

Nothing is constant:

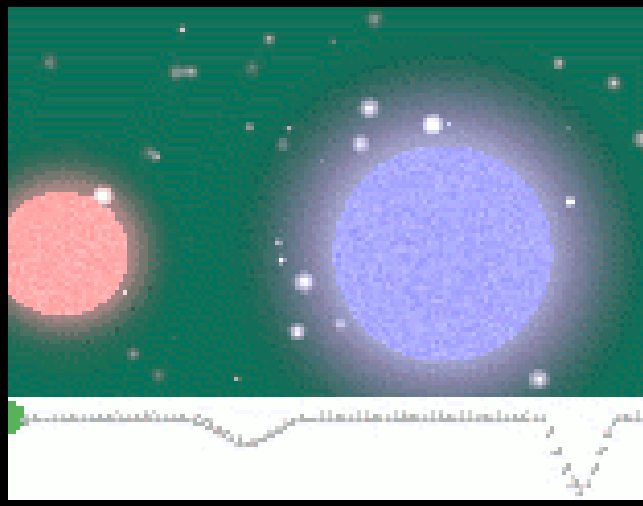
- Photometric: Signal not constant in depth
  - Signal = blocked / total instantaneous flux, but:

Different surface brightness of components

Depends on the binary orbital phase (ellipsoidal variation, eclipses).

- Temporal:
  - The transits are not periodic
  - Transit durations are highly non-uniform

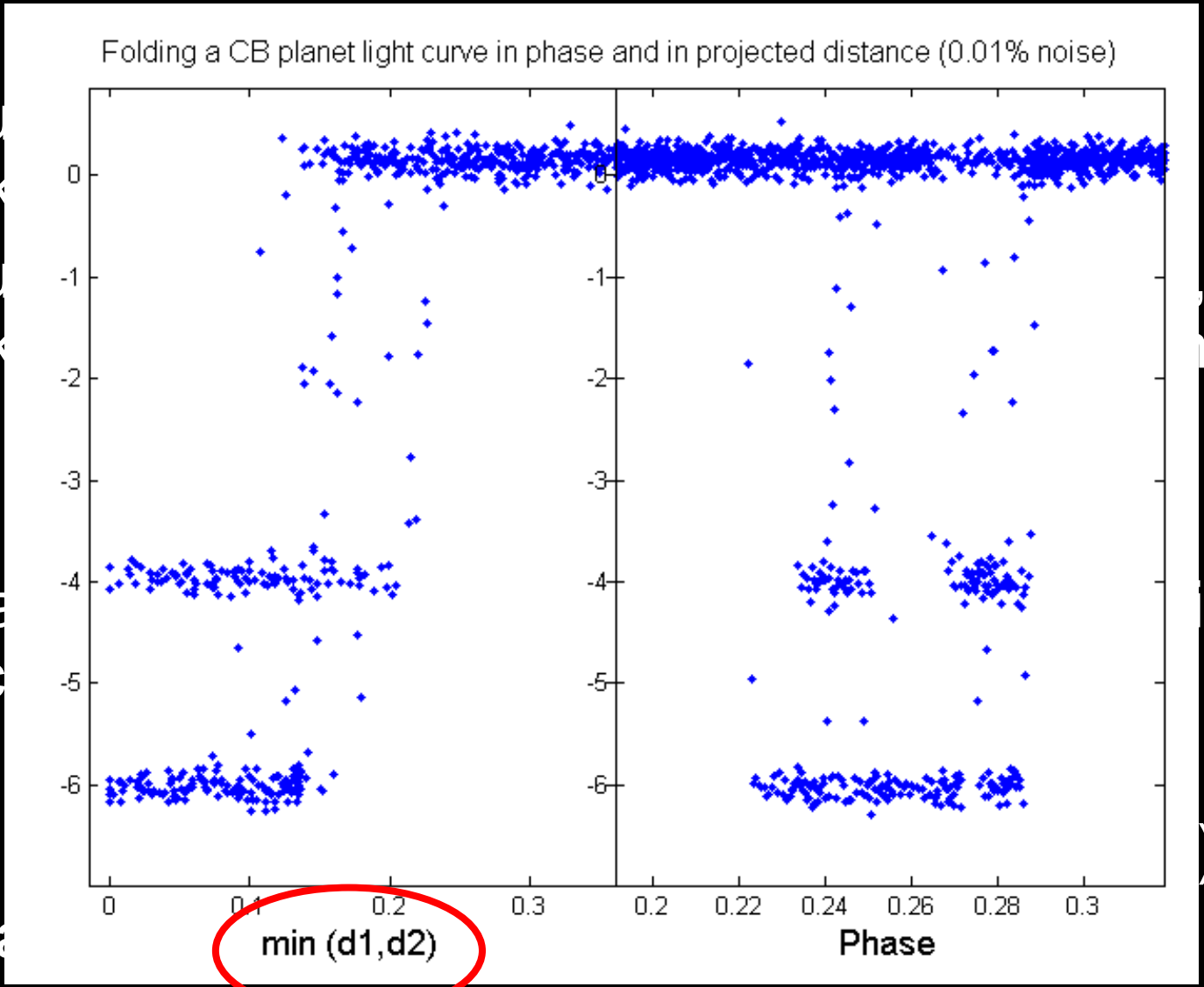
The **CB-BLS** Solution - Overview



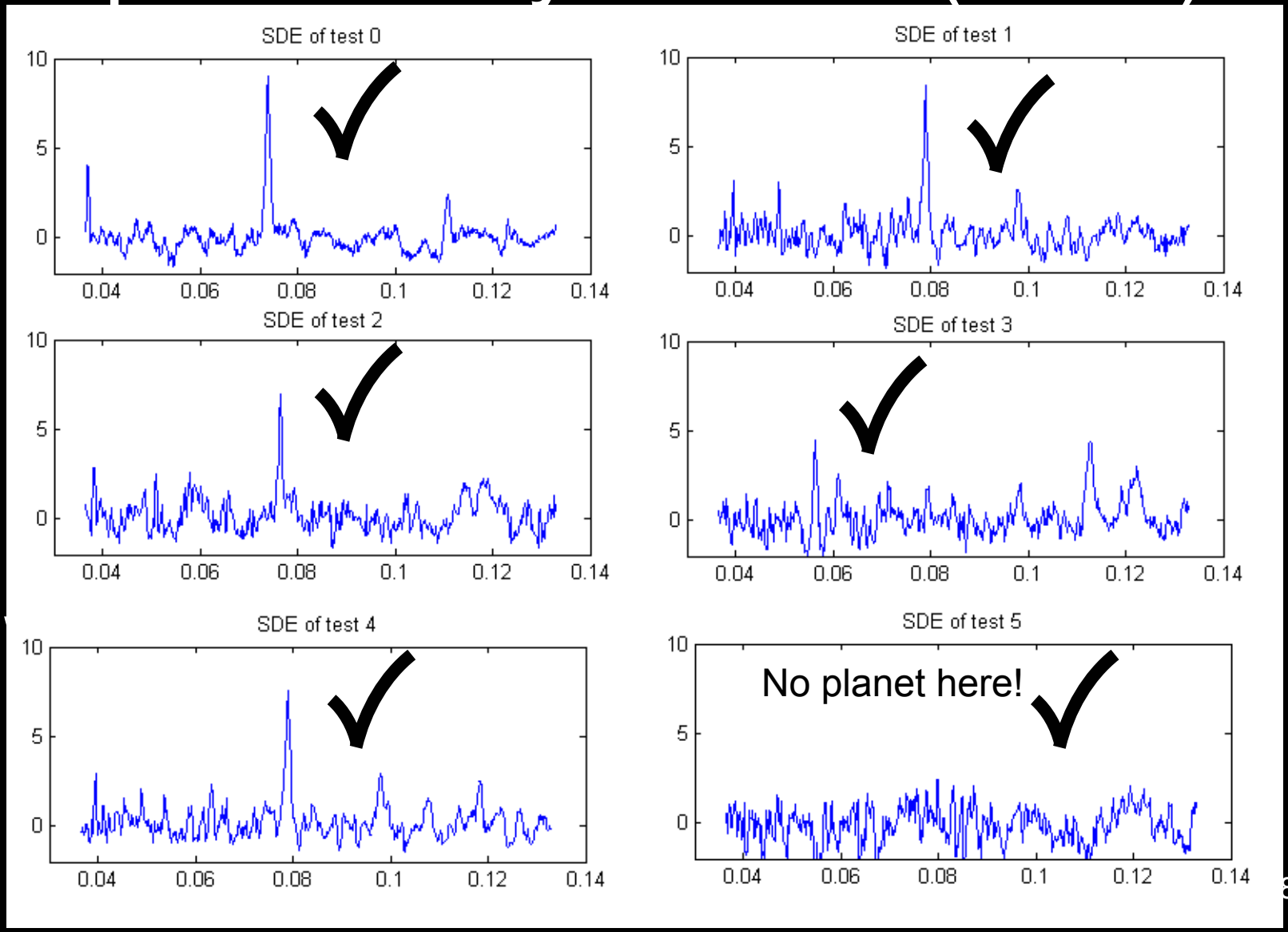
- Solve EB (P_B, T_0, e, ω, i_B, $R_{1,2}$, J)
- Photometric characteristics
  - Regularize the depths:
    - normalize LC,EB model to max (model flux)=1
    - multiply LC residuals (and errors) by the EB model
  - Define a CB-BLS statistic that allows for different surface brightness / use J
- Temporal characteristics → Geometric
  - Transits are NOT a function of time, but of geometry: the alignment of celestial bodies

Solution - Geometric

- Assu … $+m_2$)
  → sk …
- Assu … φ_0)
  → sk … ned
- At ea … it is
  exac …
- Visua …



Updates Beyond Ofir (2008)



Conclusions – **CB-BLS**: A New Tool

- CB-BLS is general, sensitive, quick
- CB-BLS allows to harness existing datasets to the detection of transiting CB planets
- CB-BLS efficient even when noise > signal (~100% recovery for 1_{Jup} around 2 x ~Sun @ 1% noise)

- Remaining difficulty: EB modeling errors
  - Will add red noise to the residuals
  - But: Different time scale, periodic, and false-alarms can be identified

Thank You.

Questions?