

Challenge N: Crossmatching

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XDACS



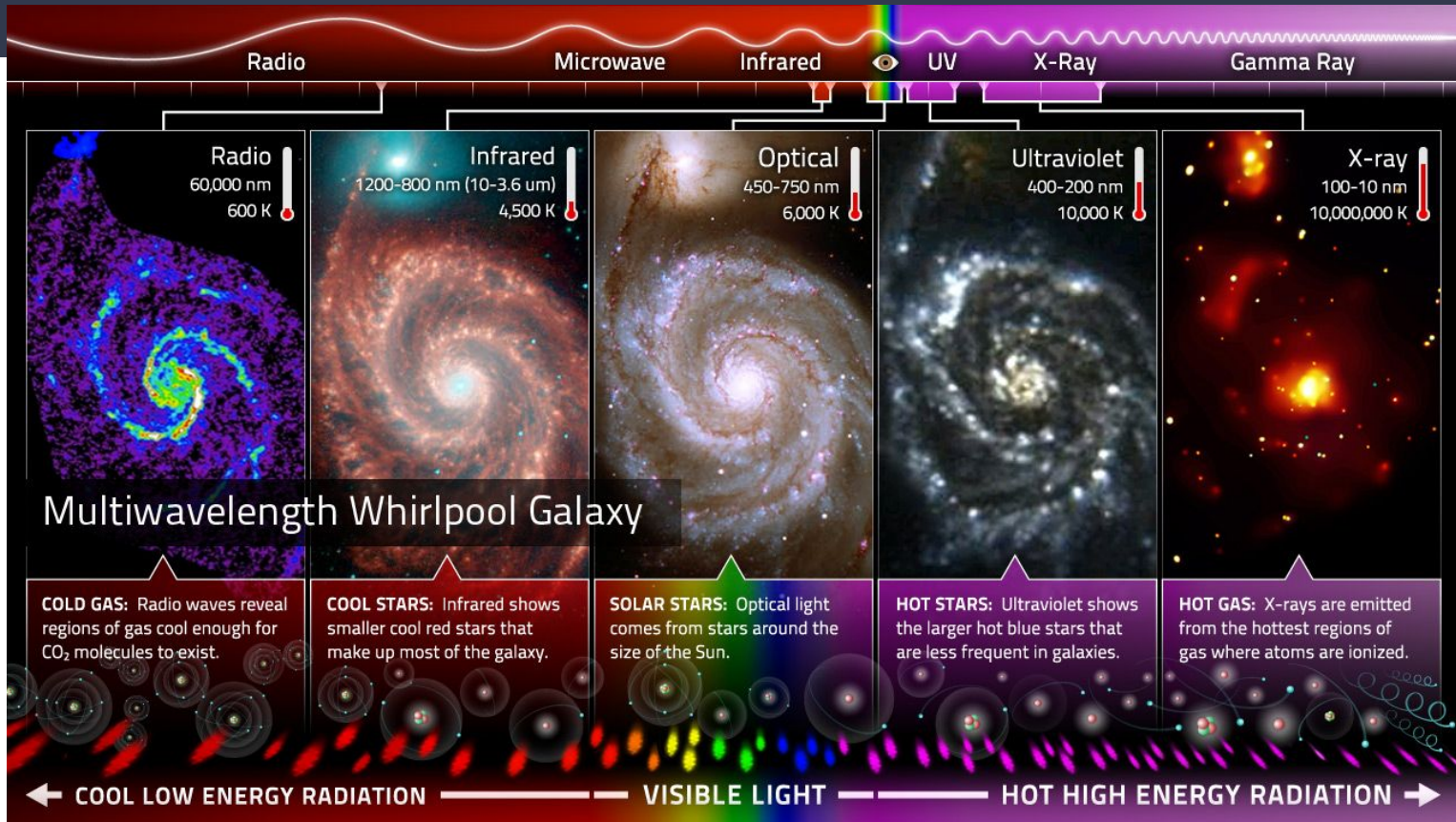
Curtin University



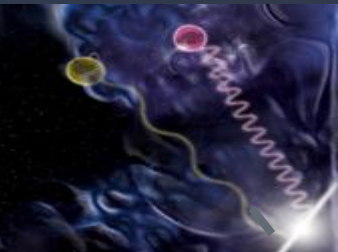
International
Centre for
Radio
Astronomy
Research



Our view into the universe



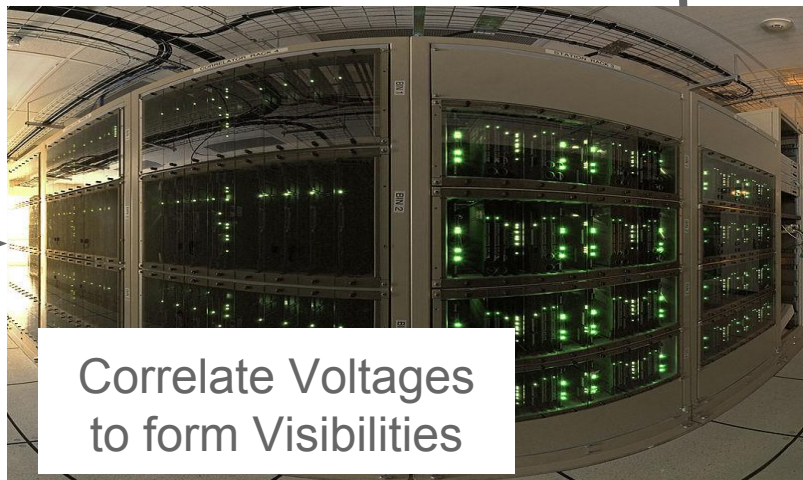
Radio Imaging: A supercomputer for a lense



Interesting
Event



Record
Voltages

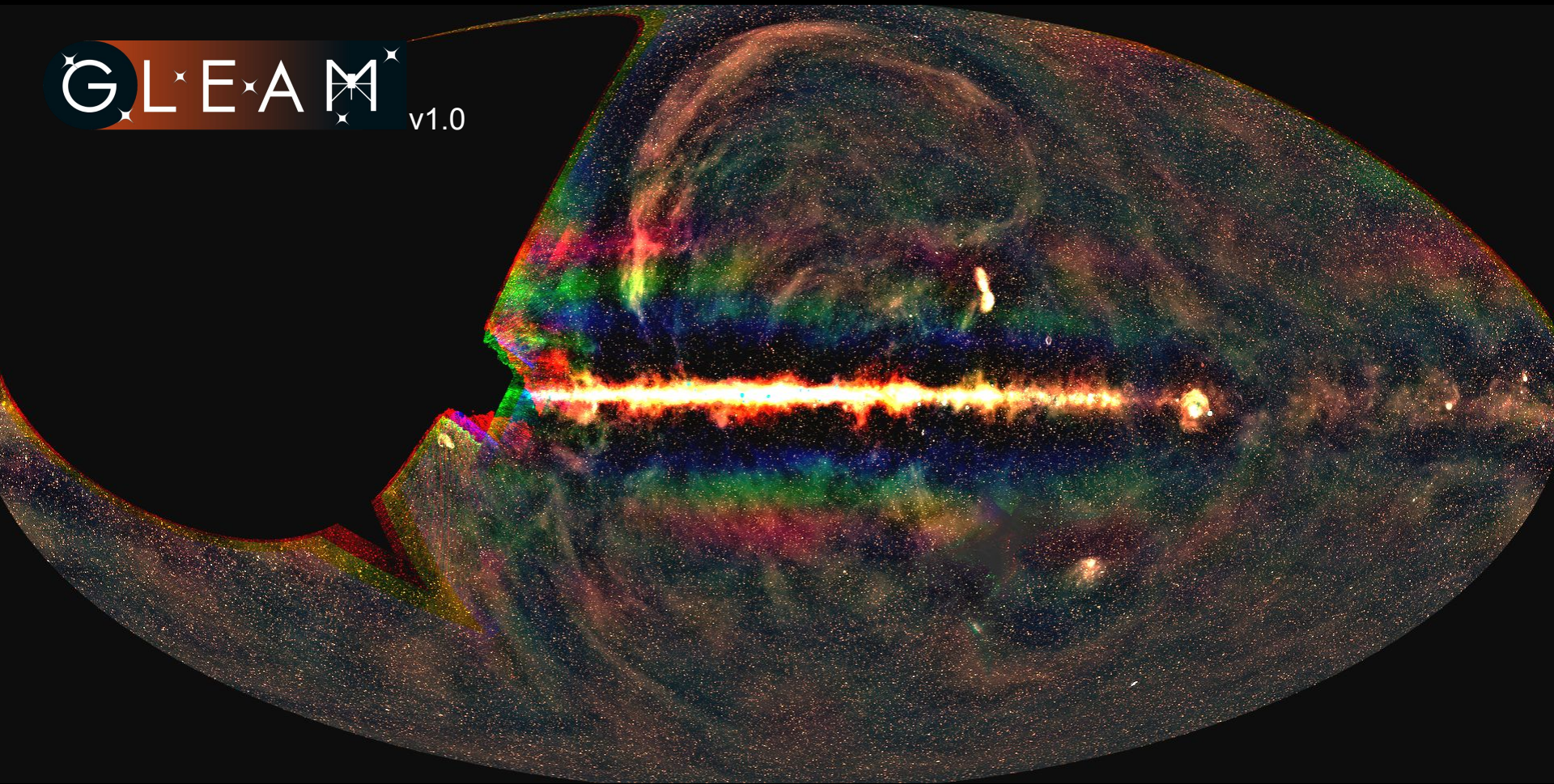


Correlate Voltages
to form Visibilities

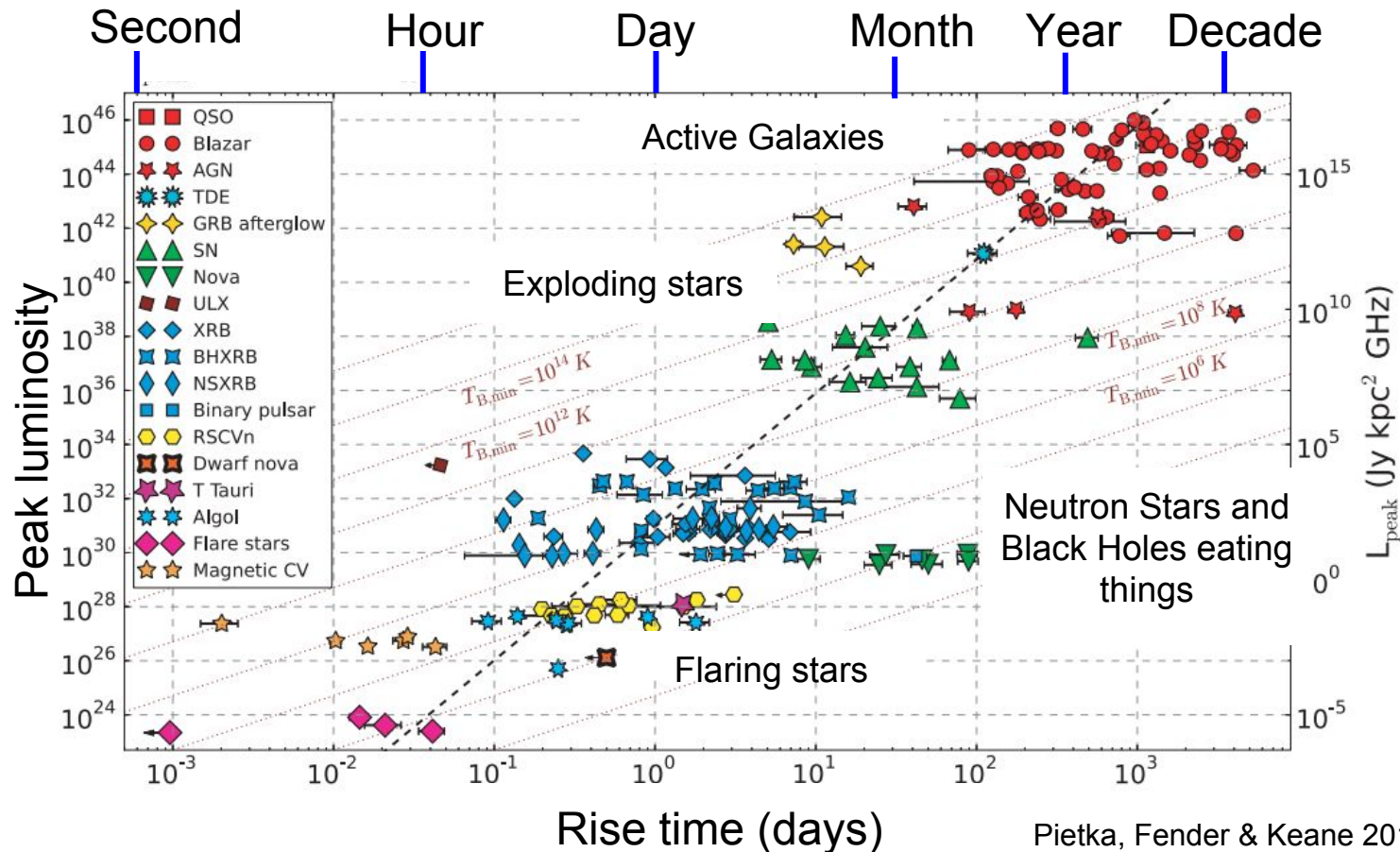
$$I_{\nu}(l, m) = \int \int \frac{V_{\nu}(u, v)}{\sqrt{1 - l^2 - m^2}} e^{-2i\pi(ul + vm)} dl dm$$

Transform Visibilities into Images

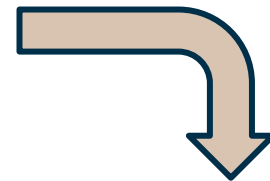
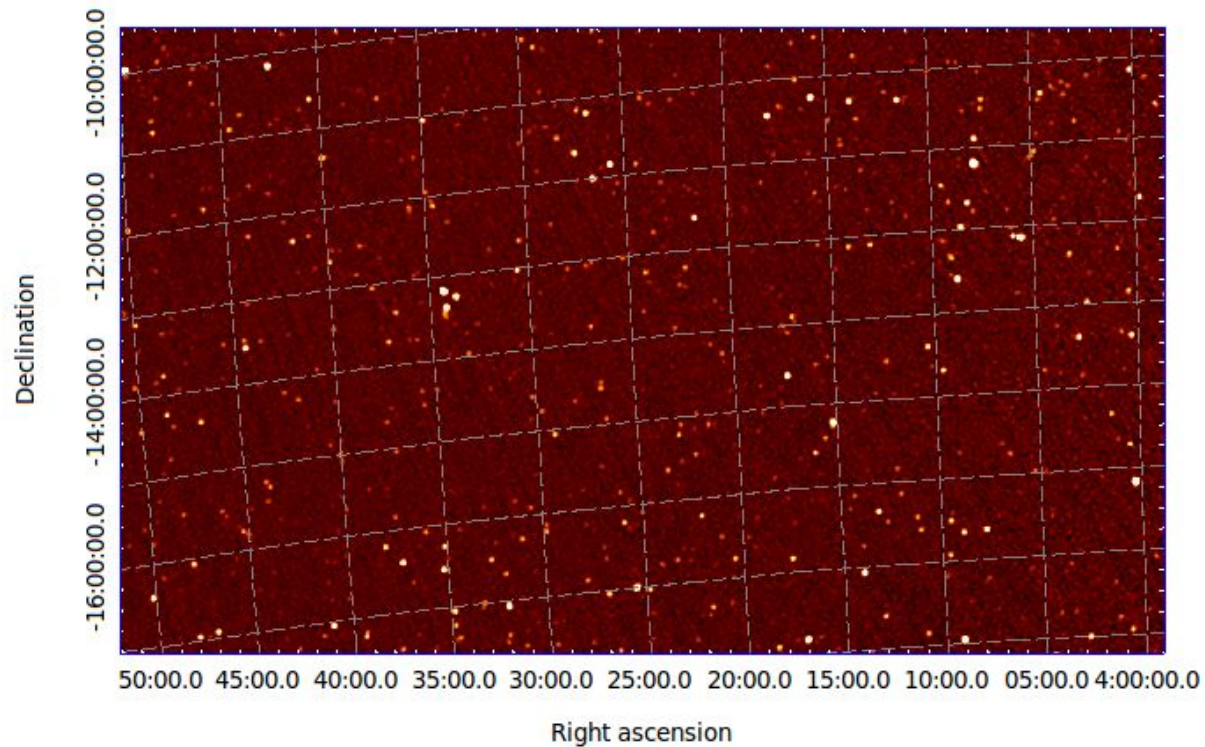
GLEAM v1.0



What changes in the sky?

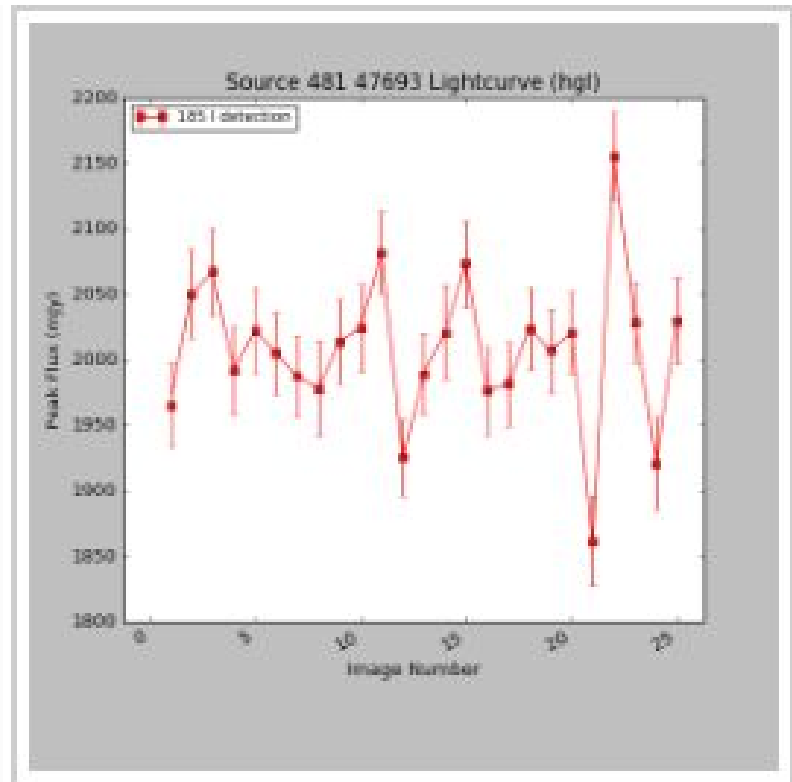
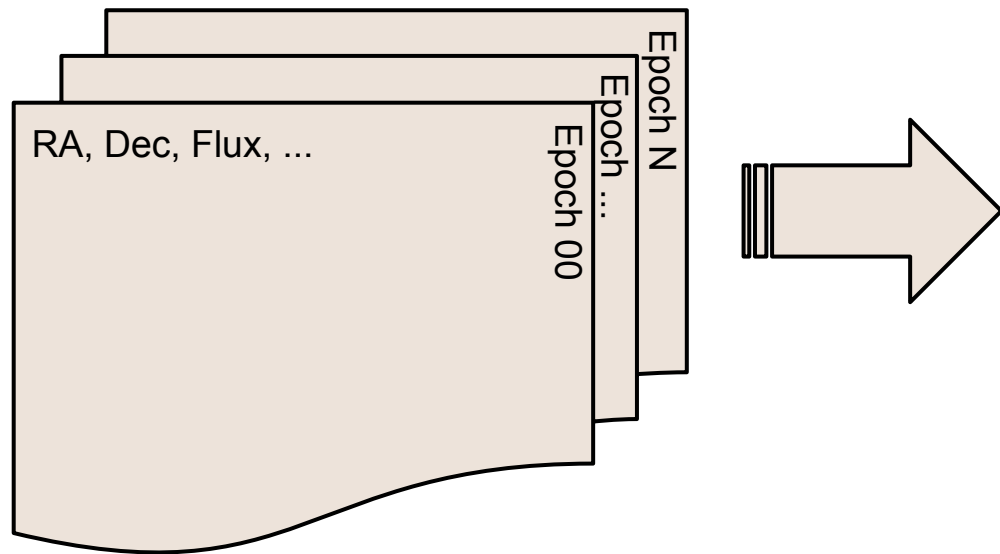


Making catalogues



RA, Dec, Flux, ...

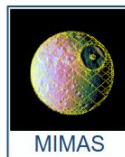
Making light curves = crossmatching



Our workflow

Survey image processing with the VAST pipeline

1. Create images.
Exclude areas that are not of interest by: trimming, masking, or using MIMAS* region files.
(not part of pipeline)

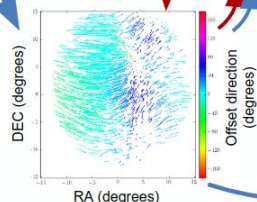


2. Create background and noise images using BANE*. **Source finding** and characterisation using Aegean*. If existing catalogues are found, then source finding is not duplicated.



*see github.com/PaulHancock/Aegean
Hancock et al 2012, MNRAS, 422, 1812

3. (optional, but recommended!) Crossmatch new measurements with a reference catalogue, and perform **astrometry and gain corrections**. This can reduce the ionospheric induced positional offsets from as much as 1arcmin, down to 5arcsec.



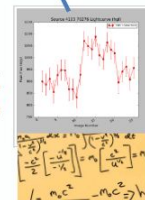
Two approaches can be used: a **stream processing approach** (blue flow) designed for real-time ingestion of images, and a **batch processing approach** (red flow) designed for already completed surveys.



7. **Publish** awesome results!
(not part of pipeline, awesomeness subject to input data)



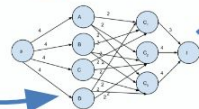
6. **Generate light curves and calculate variability statistics** for each source. Statistics include a measure of the magnitude and confidence of variability.



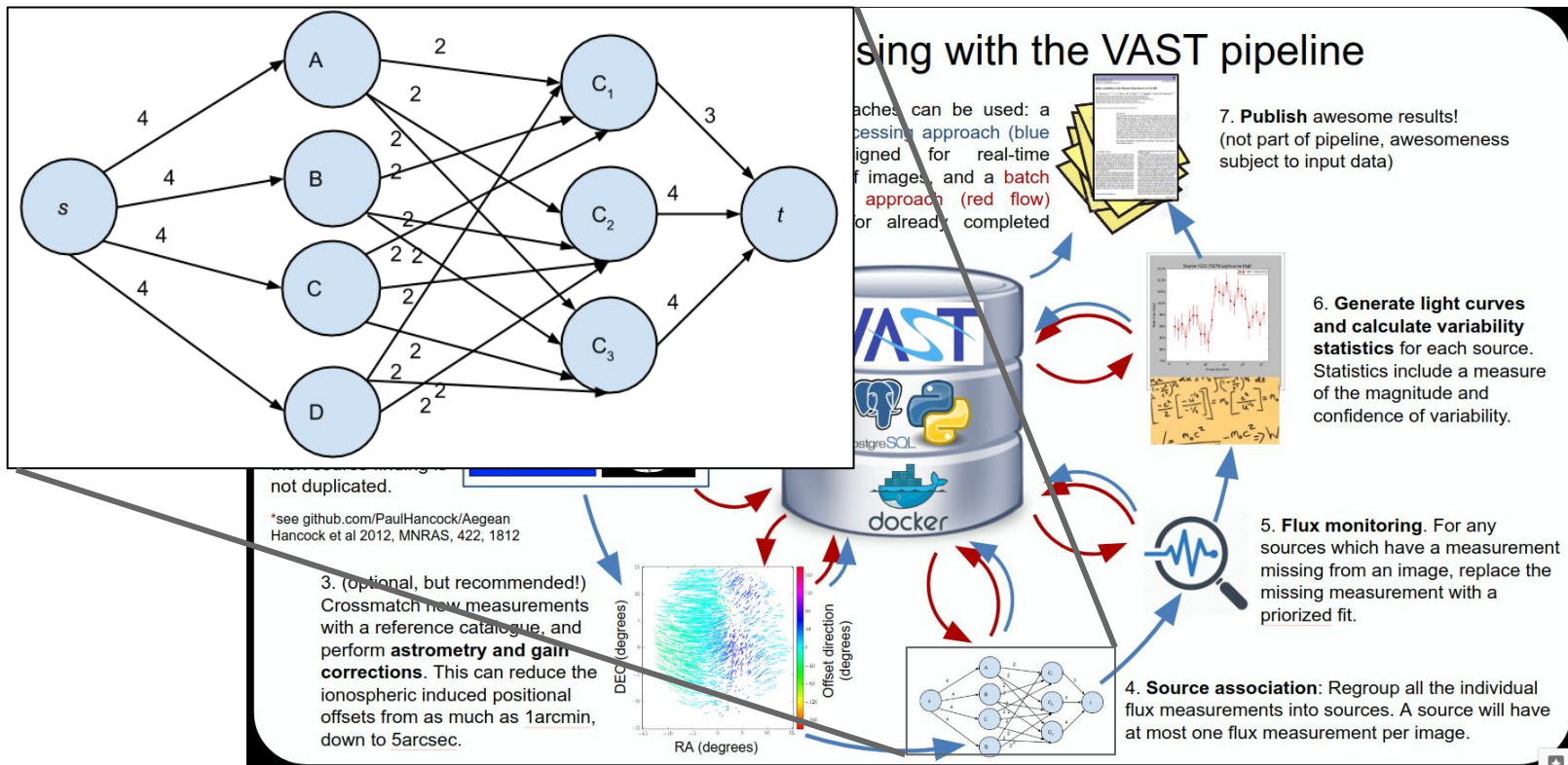
5. **Flux monitoring**. For any sources which have a measurement missing from an image, replace the missing measurement with a prioritized fit.



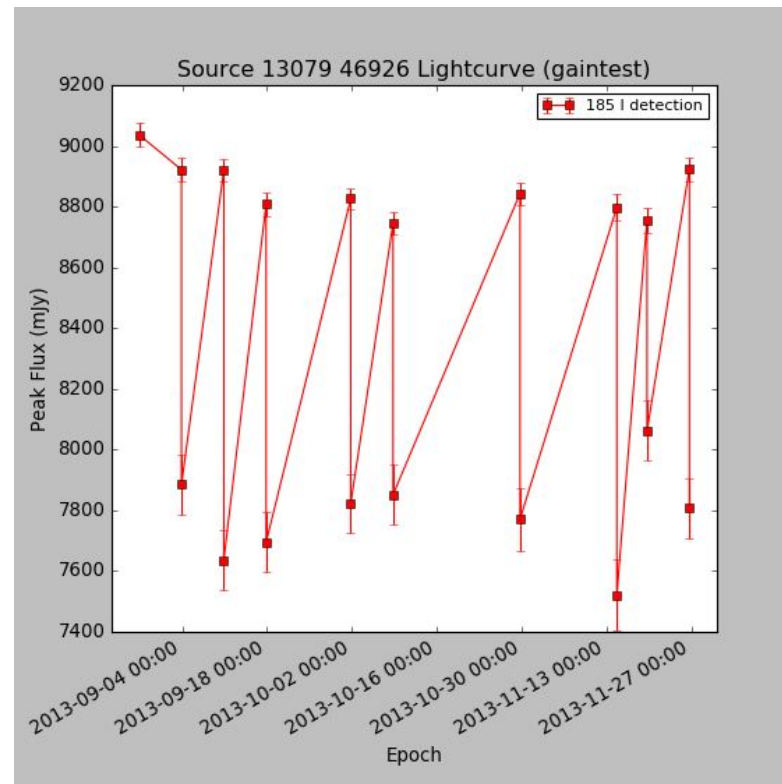
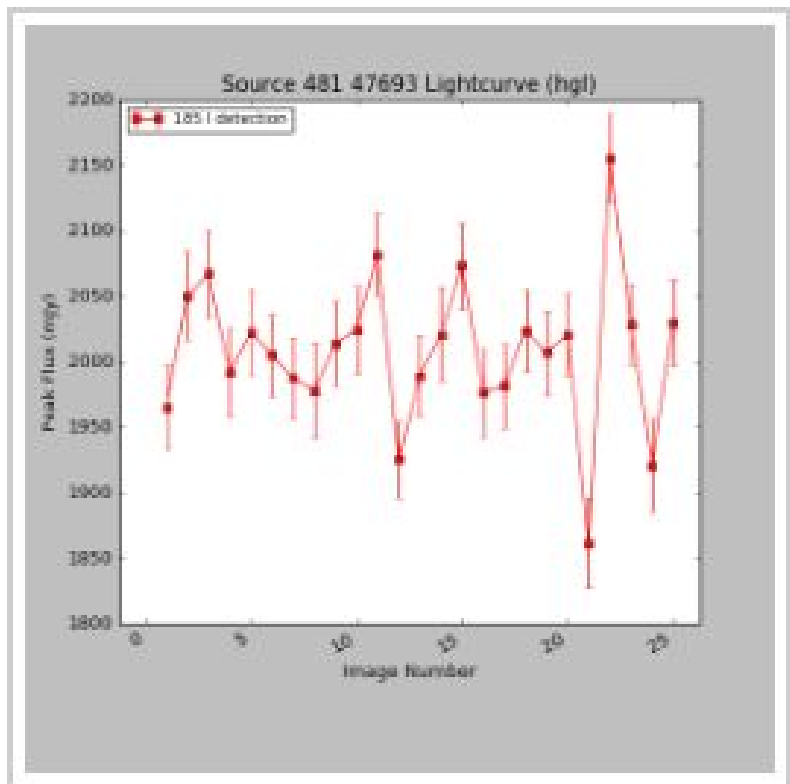
4. **Source association**: Regroup all the individual flux measurements into sources. A source will have at most one flux measurement per image.



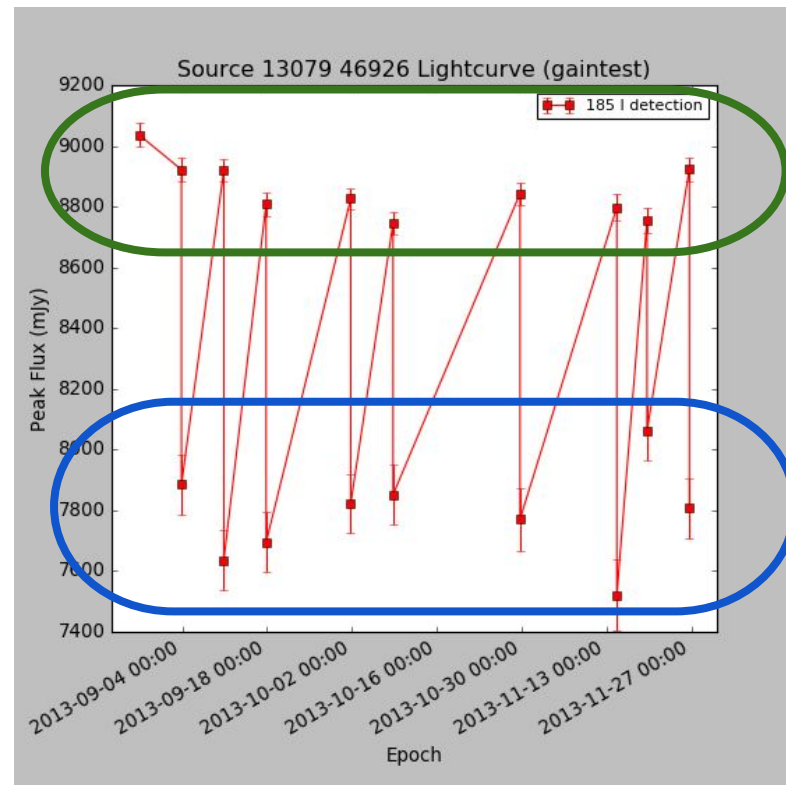
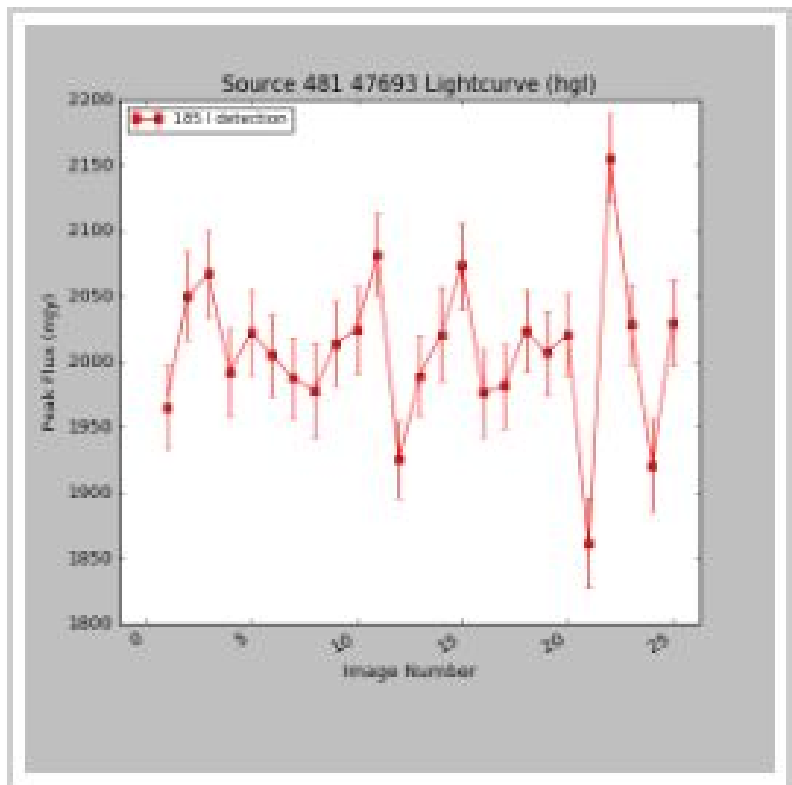
The bottleneck



Good vs Bad

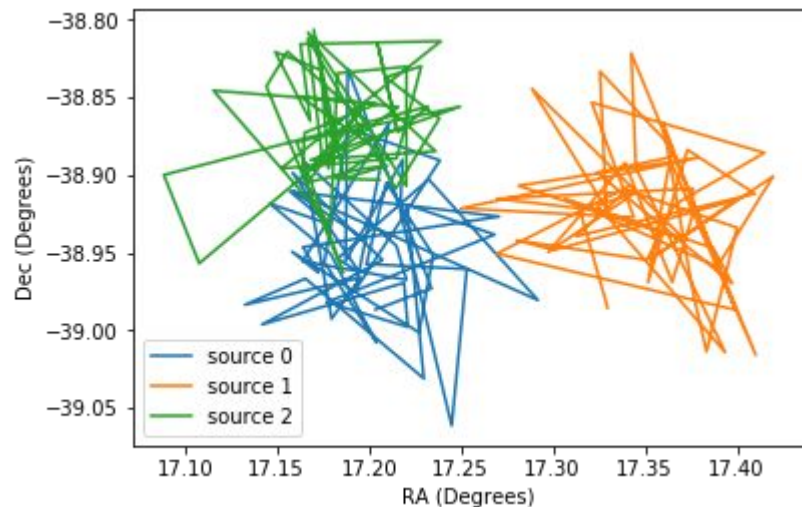


Good vs Bad

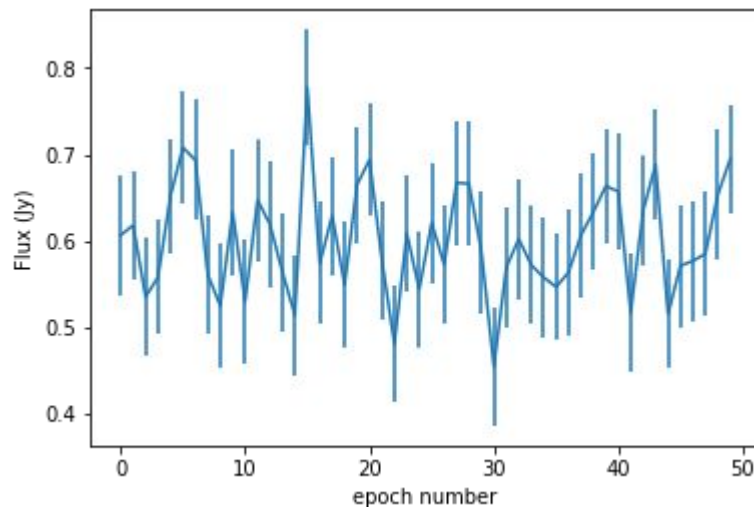


Residual effects: position/flux 'jitters'

Position shifts can confuse nearby sources



A real light curve is not always flat

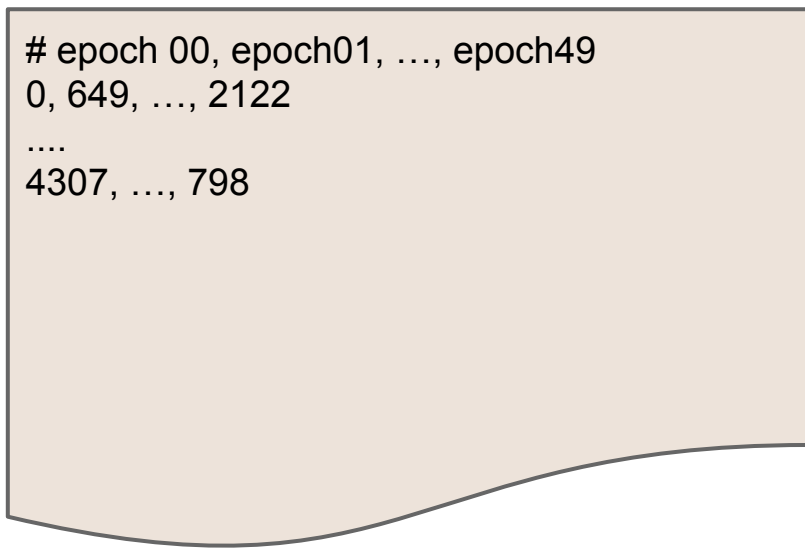
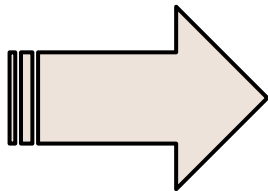
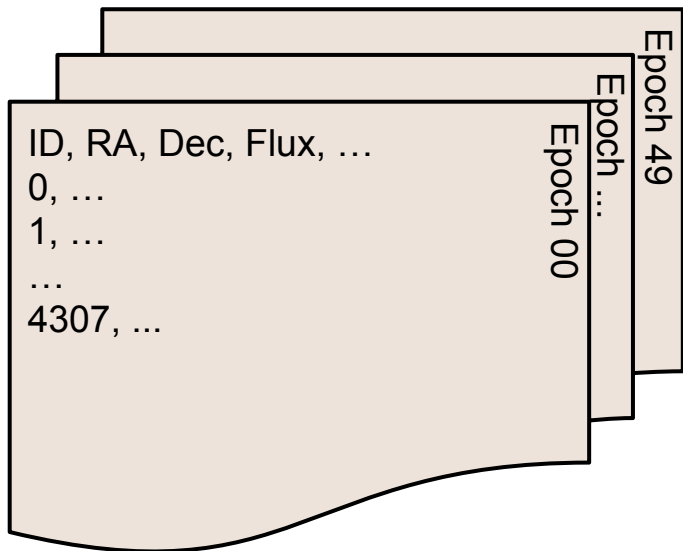


Your task:

Take the 50 catalogues

- crossmatch them and create light curves with a unique measurement in each epoch,
- report back the row ID for each source in each epoch,
- sort your answer key by epoch00 row ID

Save as a .csv



Celestial Coordinates and distances

- RA/Dec = Lat/Long
 - projected onto the sky
- RA/Dec are in degrees:
 - Dec in degrees of arc
 - RA in degrees of "time"
 - $\text{arcdeg(RA)} = \text{RA} * 15 * \cos(\text{dec})$
- Distances are Great Circle Distances
 - en.wikipedia.org/wiki/Great-circle_distance
 - en.wikipedia.org/wiki/Haversine_formula

