Towards a realtime multi-messenger analyses framework

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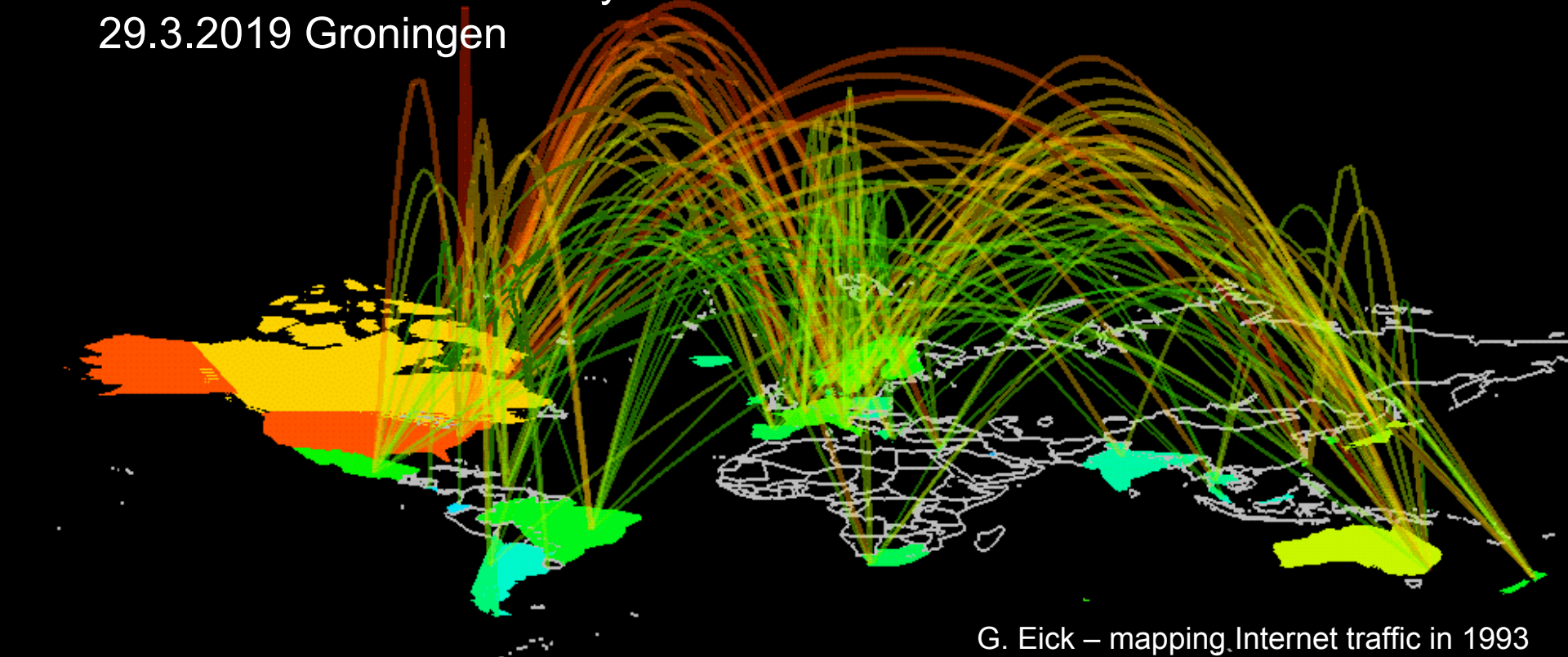
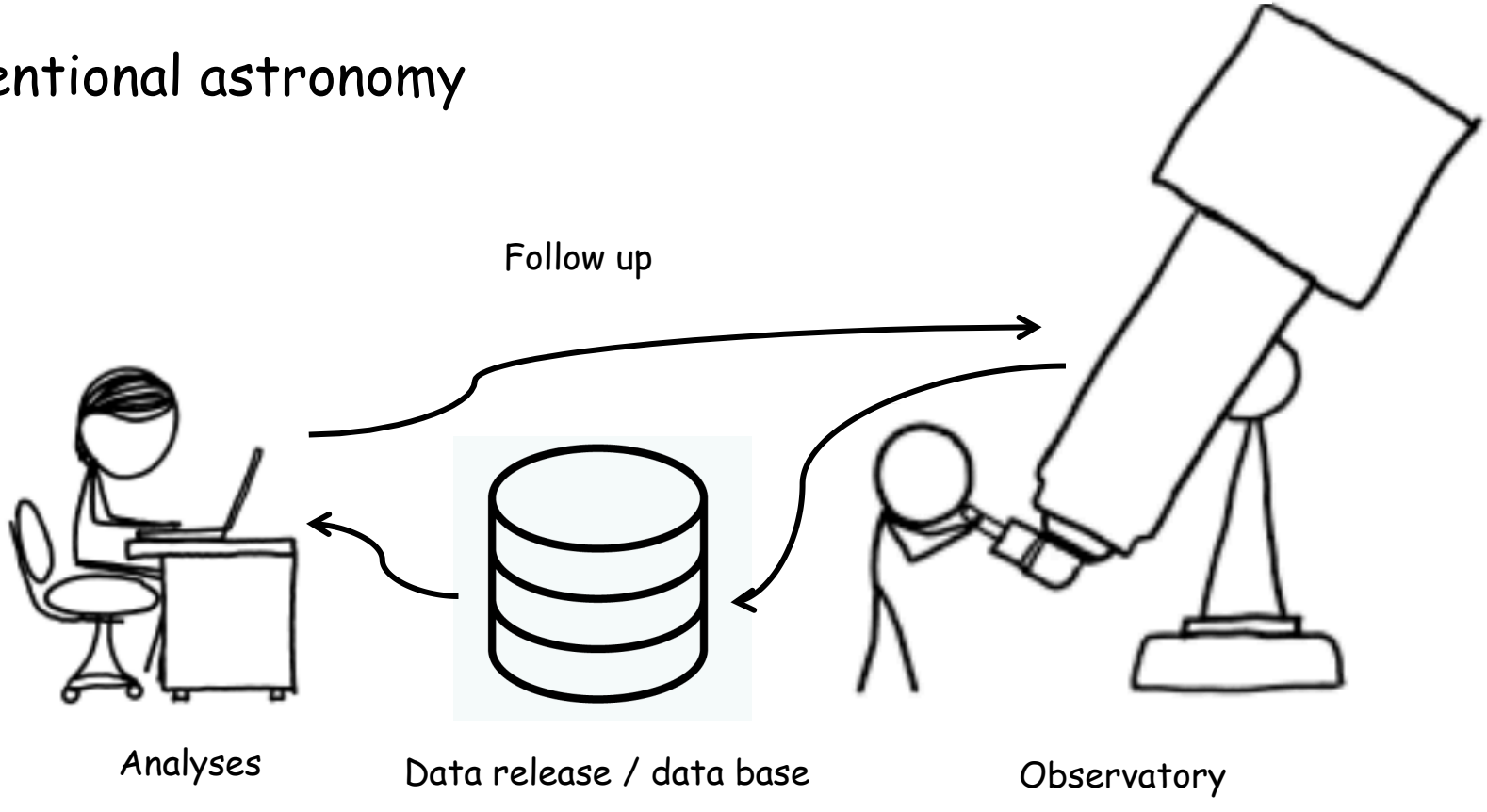
29.3.2019 Groningen



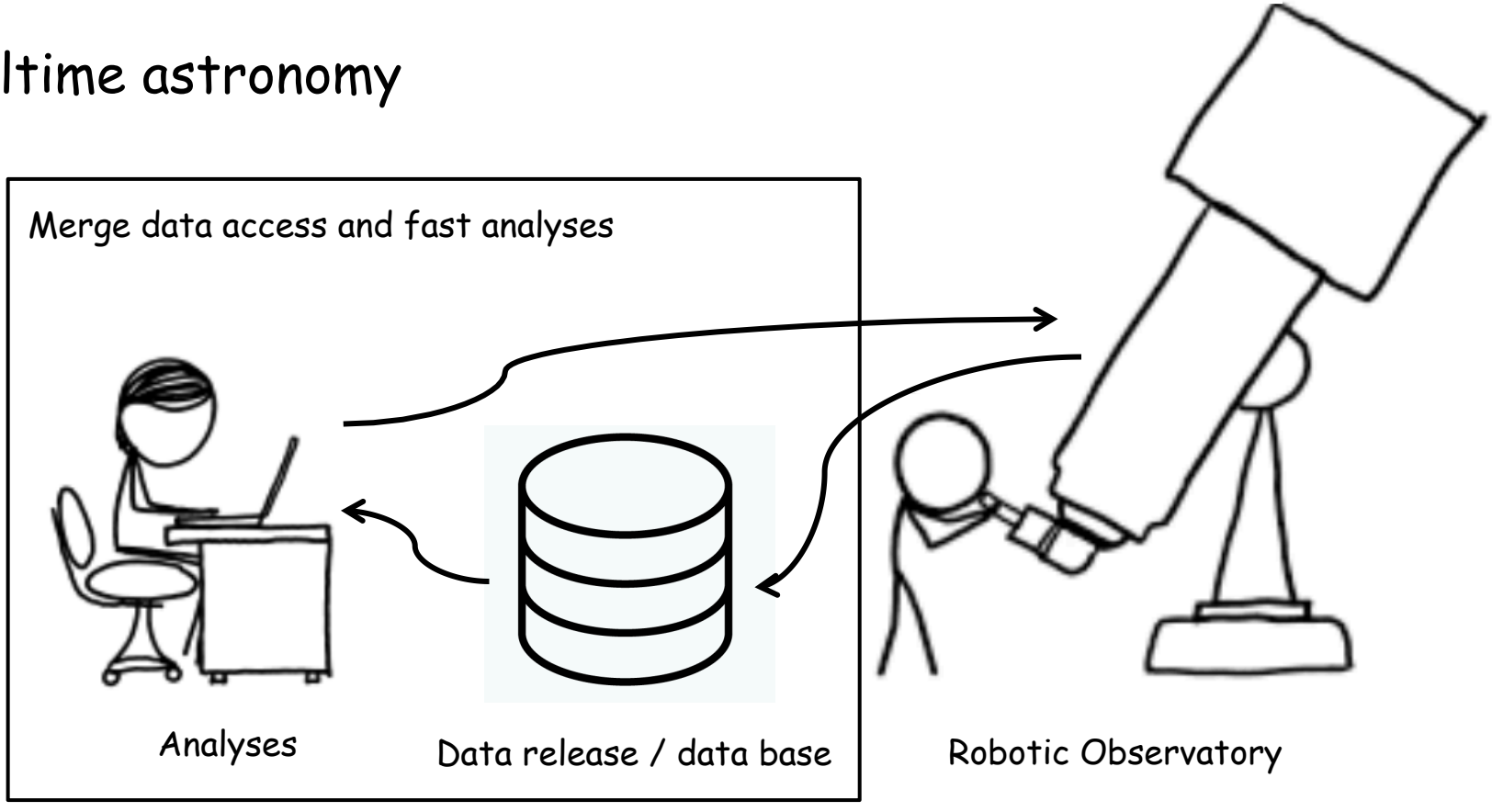
G. Eick – mapping Internet traffic in 1993

Conventional astronomy



Time scale > days; # transients ~100

Realtime astronomy



Time scale ~ minutes; # transients >> 1000

The Zwicky Transient Facility Experience…

Combining a public wide-field survey with robotic spectroscopic follow-up

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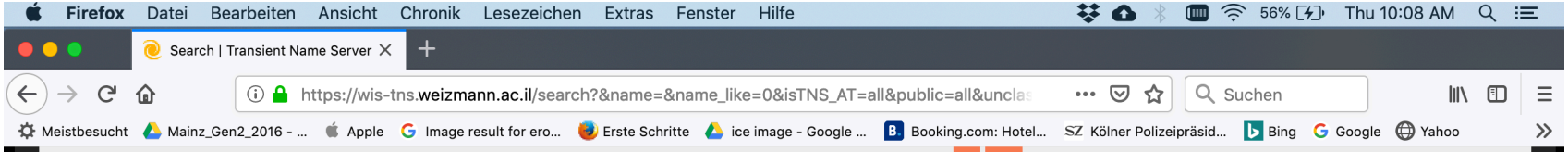
Combining a public wide-field survey with robotic spectroscopic follow-up



1 2 3 4 5 6 7 8 9 10 … > >>

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35430	SN 2019cem	1	1	13:16:36.304	+35:30:57.78	SN II	0.04468	ZTF	ZTF	Y	2019-03-25 06:38:52	ZTF_Bot1
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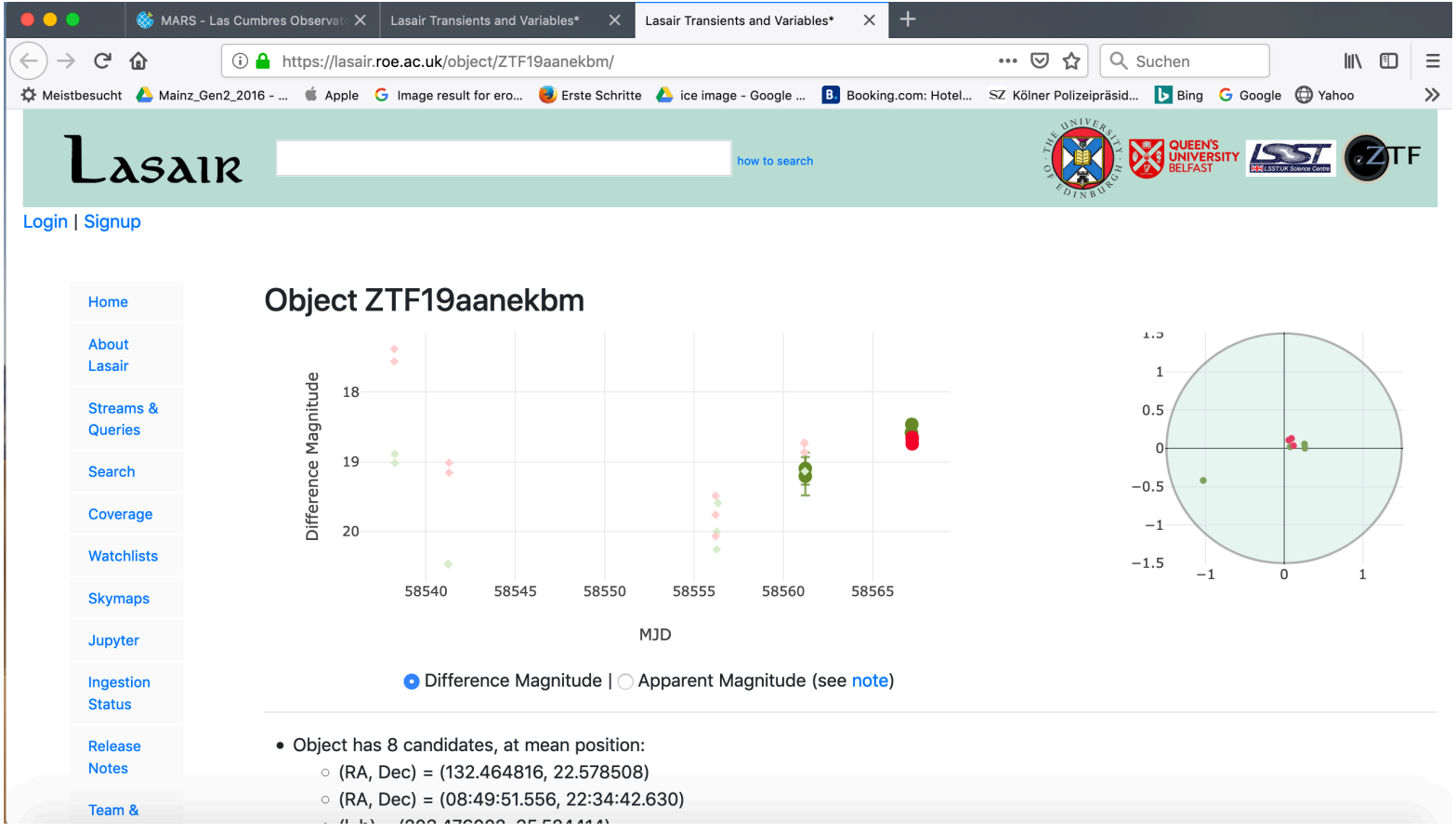
Brokers operating on the alert stream from ZTF

The broker landscape developed for ZTF (and LSST) is diverse and growing

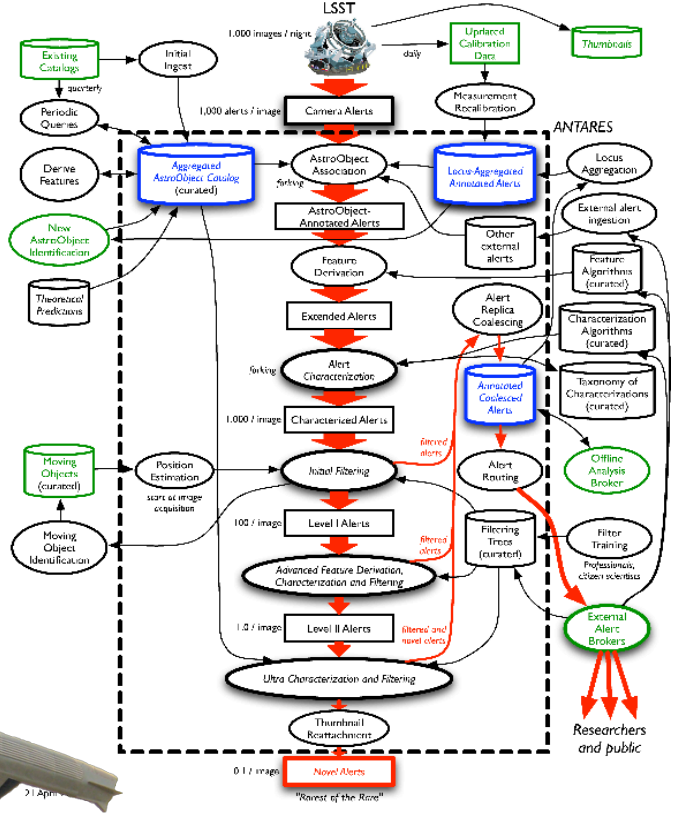


Brokers operating on the alert stream from ZTF

The broker landscape developed for ZTF (and LSST) is diverse and growing

- ANTARES (and Alerce?) are classical brokers
  - Information added to alerts (eg catalog matching)
  - Users select a fraction of the stream to receive
  - Strong focus on ML classification
- Mars and Lasair focus on interface
  - Subset of data saved to a DB (“unstreamed”)
  - Immediate, intuitive interface
- AMPEL can work as a broker…
  - … it’s really a framework for analysis of streamed data

See AMPEL talk by Ludwig Rauch



Goals for a MM analysis framework

...that operates in realtime

Make full use of streams of data (multi-wavelength / messenger)

- 1000+ alerts / s
- Parallel streams from different sources
- DIfferent data formats

Provenance / Repeatability

- Individual scientists don't need to grasp all details of a particular dataset
- Connect individual event to astronomical objects and other catalog data
- Create legacy datasets
- Go back in time, e.g. acknowledge versions of data and software

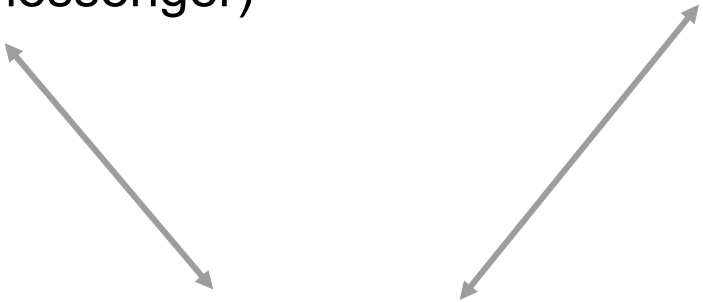
Flexibility

- Pick and choose among datasets: optical, gamma-rays, x-ray, radio, IR, neutrino, GW
- No single, predefined analysis; allow creativity
- Build on existing algorithms

Goals for a MM analysis framework

...that operates in realtime

Make full use of streams of data (multi-wavelength / messenger) ⟷ Provenance / Repeatability

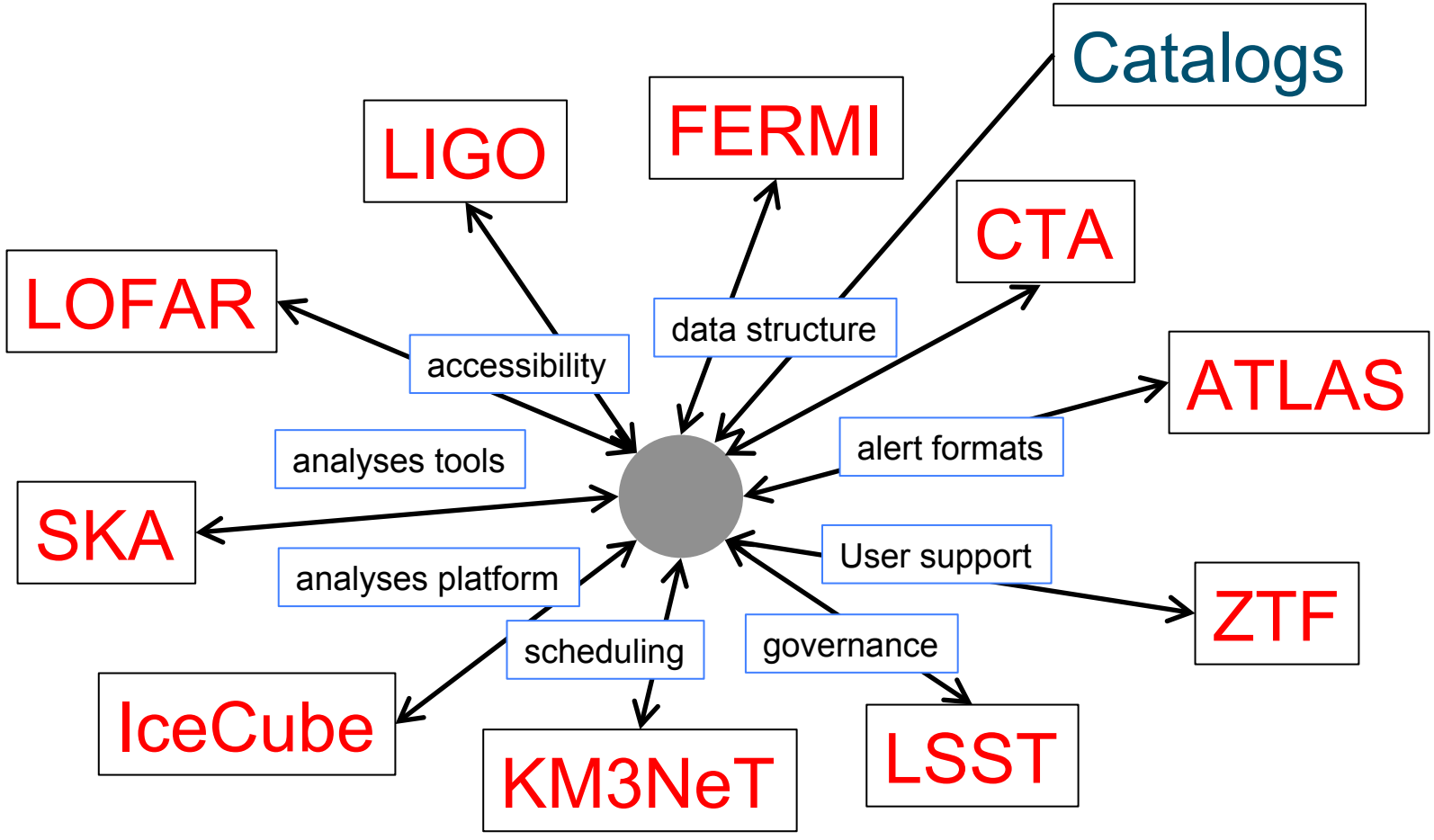


Flexibility

Challenge to meet requirements simultaneously due to strong entanglement of data and software

AMPEL design goals

Towards a generic realtime analyses framework



Data base / archive

Towards a generic realtime analyses framework

Conflicting requirements:

The local perspective:

- Local access to unleash productivity of individuals
- Observatory ownership

Centralizing the effort

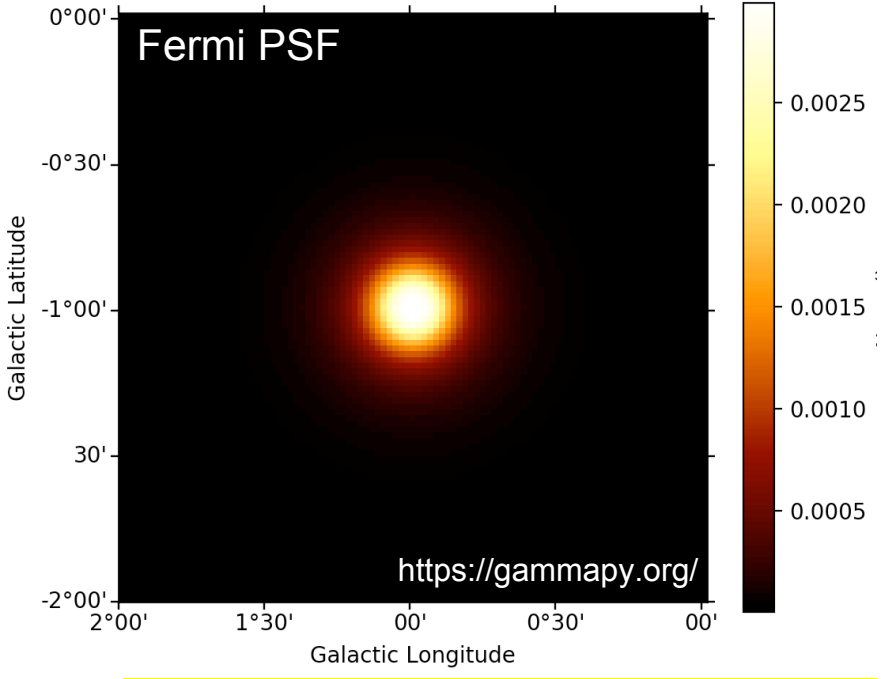
- Central archive / analysis for maximal speed
- Efficient use of computing / human resources

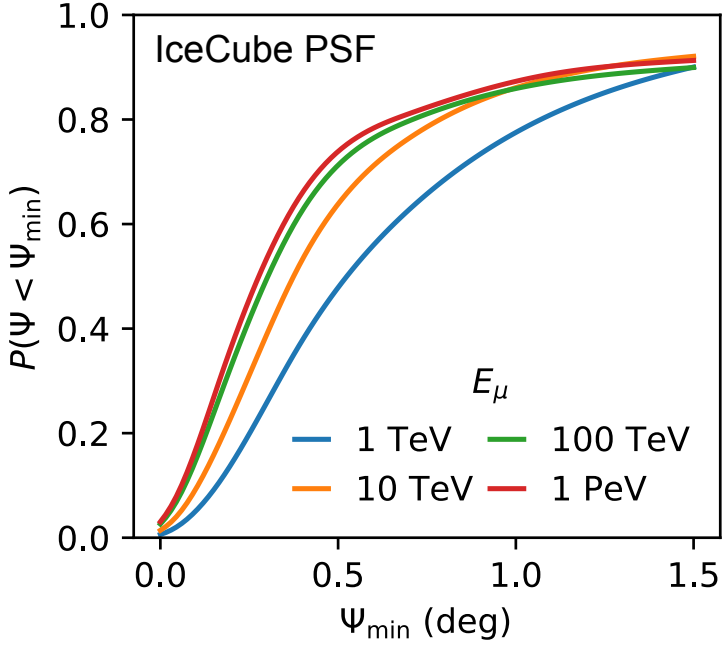
Portal for realtime (and archive) analyses operated through a virtual science data center, with good accessibility from the outside (data and software), as well as possible decentralized operation (respecting proprietary data).

Software

Towards a generic realtime analyses framework

- Many repeating requirements, e.g. cone searches, catalog access, light curfe fitting routines, ….
- Fermi/IACT/Neutrino MM data not so different at a high level (after event reconstruction)





➔Modular code, containers, open source, for maximal usability of community.

Conclusion

Growing experience with mass-scale, **realtime time multimessenger analyses**

To faciliate transient / MM analyses further:

- A virtual MM centre and server would pool resources
  - for optimal real-time analyses
  - provide a time-machine, e.g. history of observation campaigns
  - interfaces for teams to plan distributed campaigns.

@ Observatories: Make (large fraction of) alerts public

@ Communities: Establish more data / software consortia & governance to develop common software further.