cherenkov telescope array

Kavli-IAU Workshop

International co-ordination of multi-messenger transient observations in the 2020s and beyond

Ulisses Barres de Almeida, for the CTA Consortium

with special thanks to W. Hofmann, R. Ong, J. Knödlseder and R. Zanin, F. Longo & F. Schüssler.

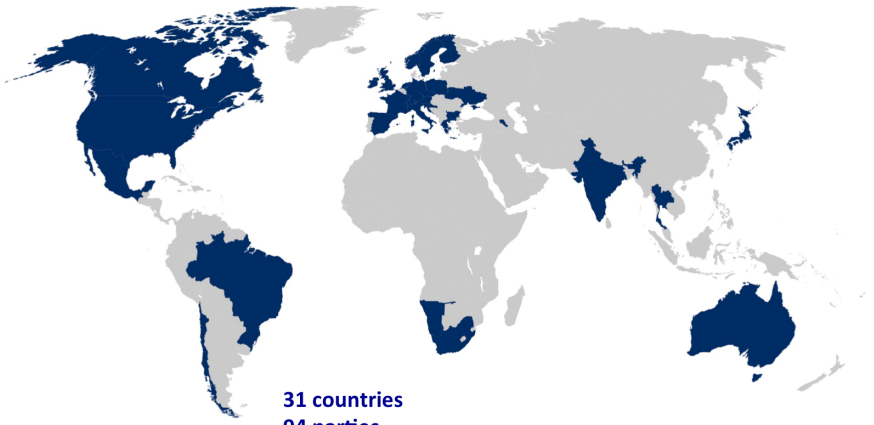
cherenkov telescope array

Session 11: Broadening the Scope of International Coordination

International Participation in CTA

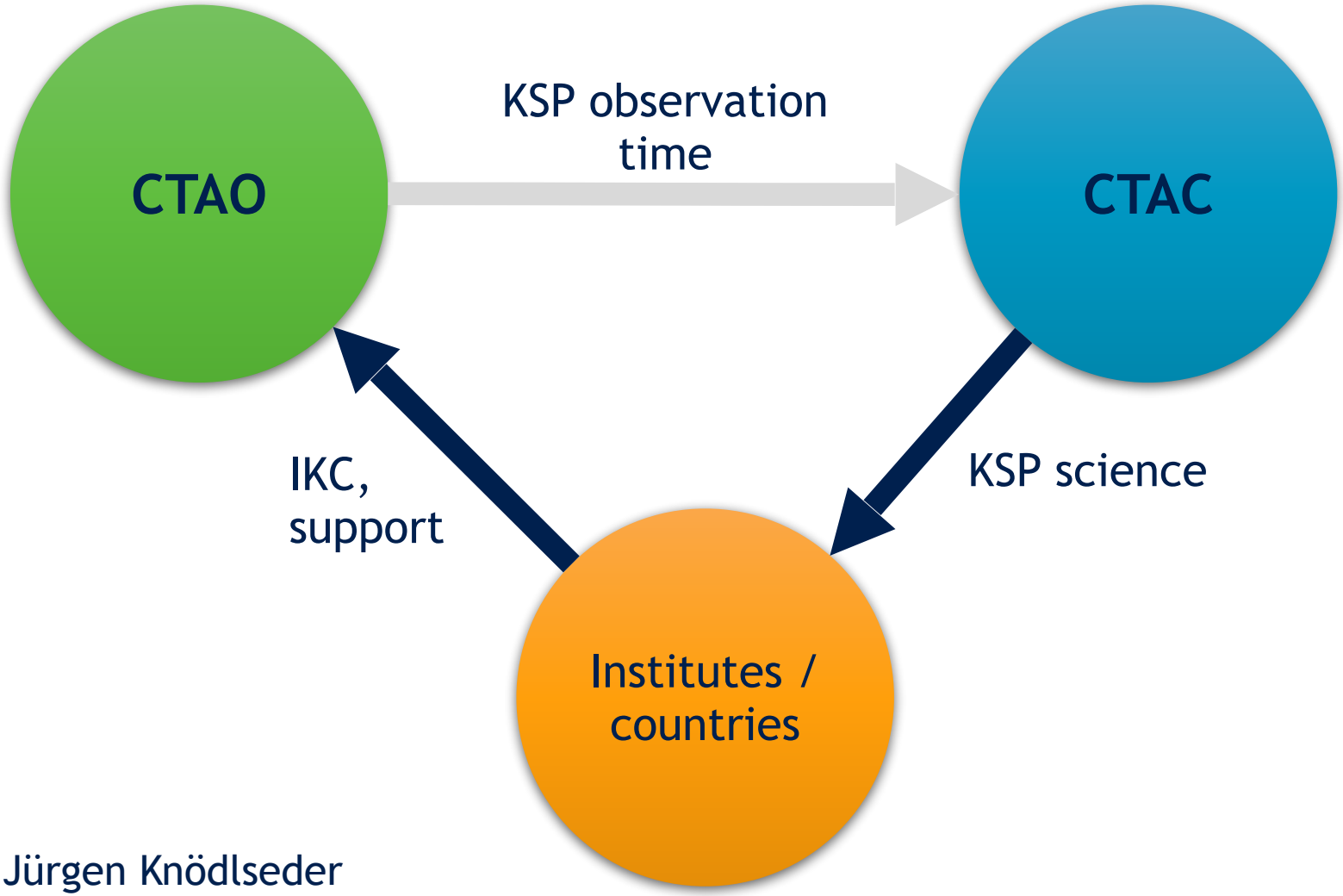
CTA Structure

- **CTAO**
  - **The CTA-Observatory**
    - A legal entity
    - Headquarters in Bologna and Science Data Center in Berlin
    - Is the responsible entity for building and operating CTA
- **CTAC**
  - **The CTA-Consortium**
    - Constituted by a group of institutes
    - Proposed and designed CTA
    - Responsible for the actual building of most of the software and hardware of CTA
    - Will be one of the users of CTA



31 countries
94 parties
206 institutes
1501 members (535 FTE)

Relationships among CTA entities



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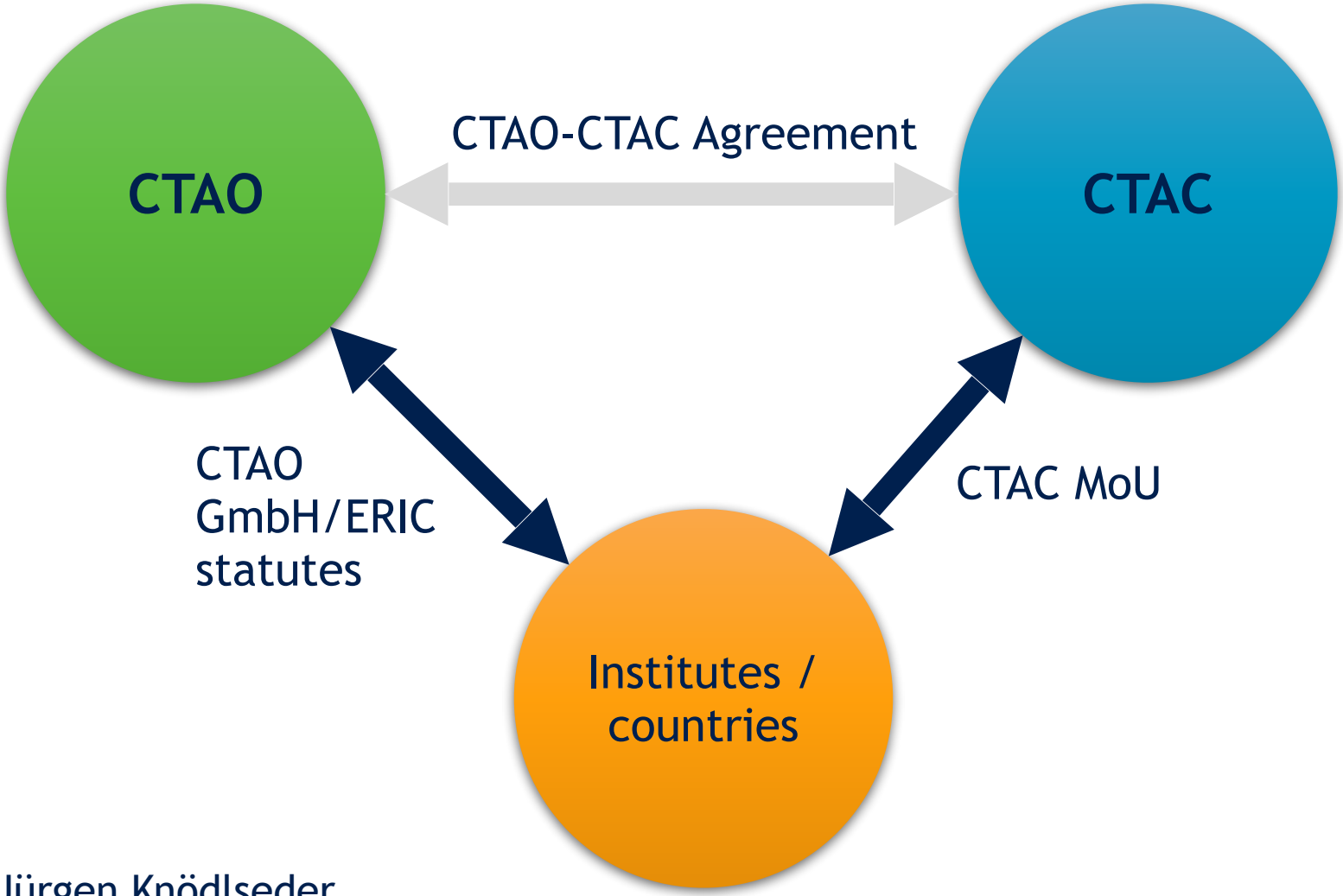

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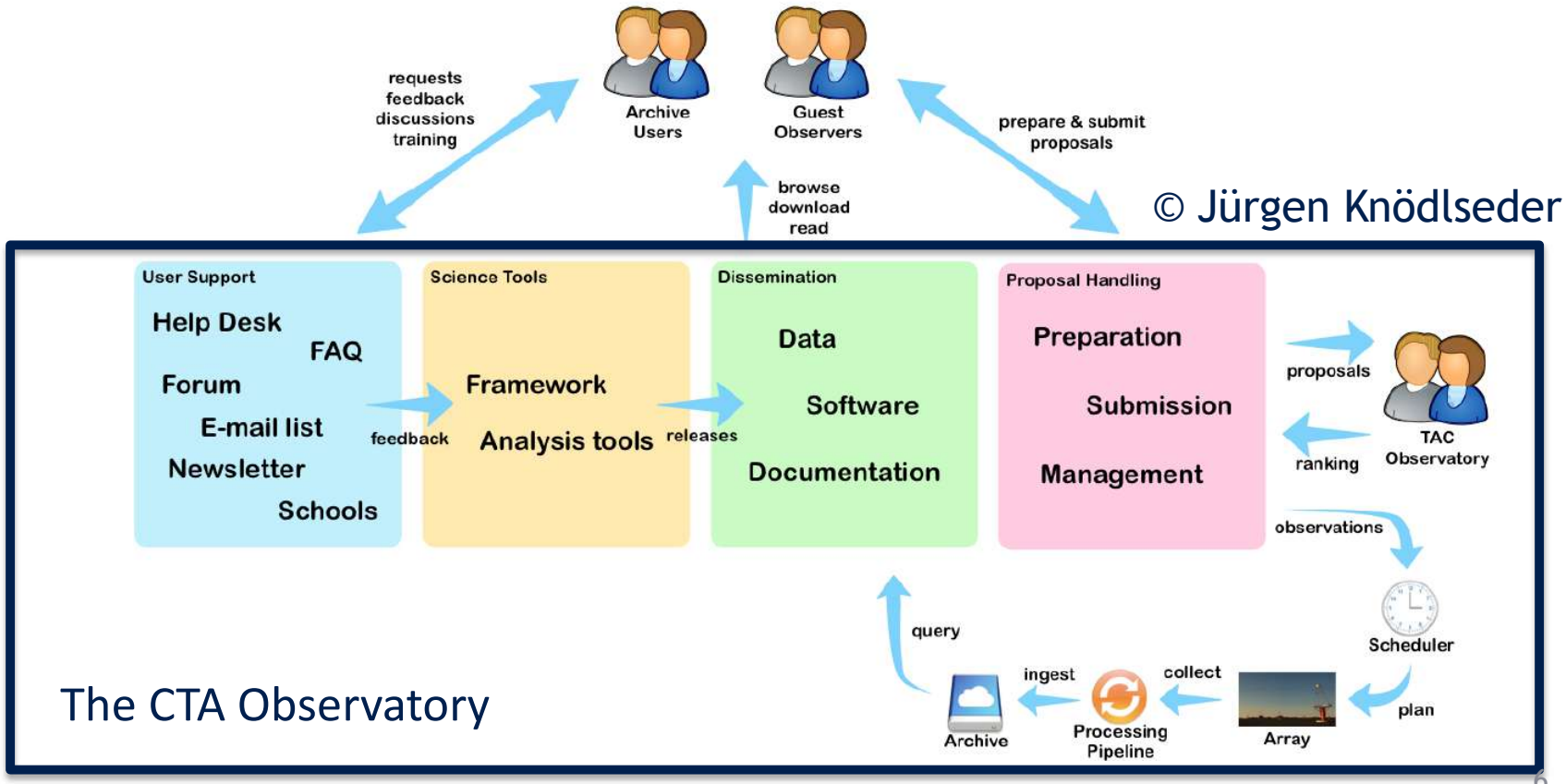
The first VHE Observatory

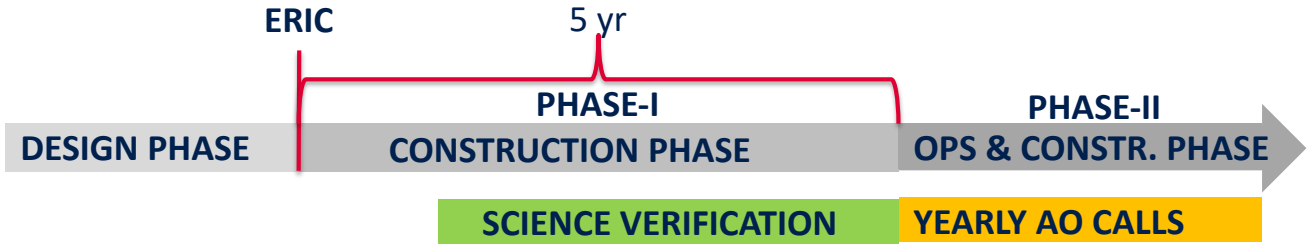
- **CTA will service the global astronomical community**
  - **The Observatory will be run by professional operators and maintained by dedicated engineers and technicians**



CTA Project Status

2005

- Major milestones achieved
  - ESFRI landmark
  - CTAO gGmbH established
  - Site decisions taken and host agreements signed
- Upcoming milestone
  - Creation of an European Research Infrastructure Consortium (ERIC)
- Two construction phases (bound by funding reality)
  - Phase 1 construction of reduced-baseline configuration expected to start in late 2020
  - Phase 1 operation expected by 2025 + construction towards final baseline



We are here

  - Phase 1 already represents significant performance improvement wrt current facilities

2025

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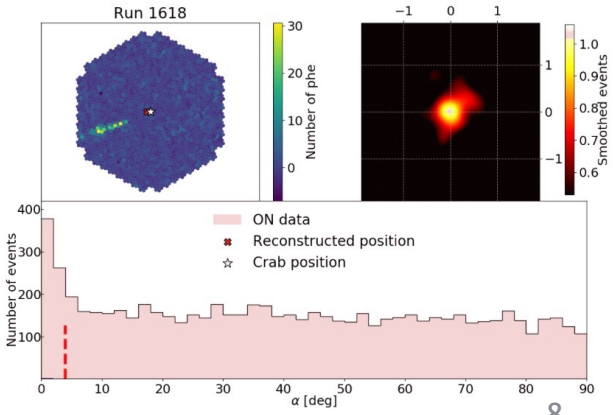
2025



CTA-O Legal Entity

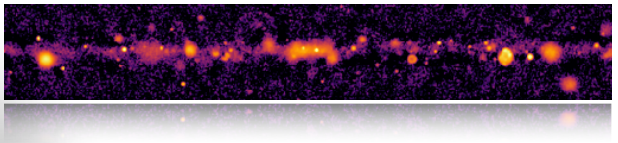
- **ERIC** will be the final legal entity of CTA
  - ERIC is an international legal entity where states are the members
  - Non-EU states can be associated but EU states are required to hold majority voting rights
  - CTA set to become the 2nd largest ERIC, out of the several tens already existing (largest example is the ESS - European Spallation Source)

- Lessons learned
  - The way to a final legal entity that could accommodate all members and all requirements by CTA was time-consuming
  - It is never too early to start with defining and creating a legal framework for the project (or, perhaps simpler, making use of an existing entity)
  - In this regard, one could conceive the creation of an international legal entity dedicated to support Astroparticles or MM science in general (realistic?)

CTA Multi-messenger coordination

A priority among CTA's current activities

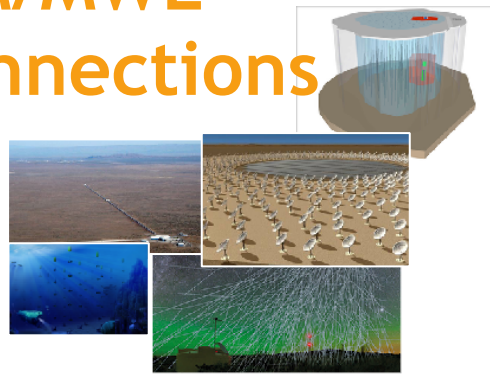
PHYS IRFs Simulations



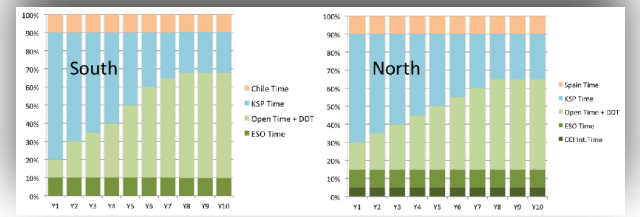
Consortium publications

Priorities

MM/MWL connections



KSP reassessment

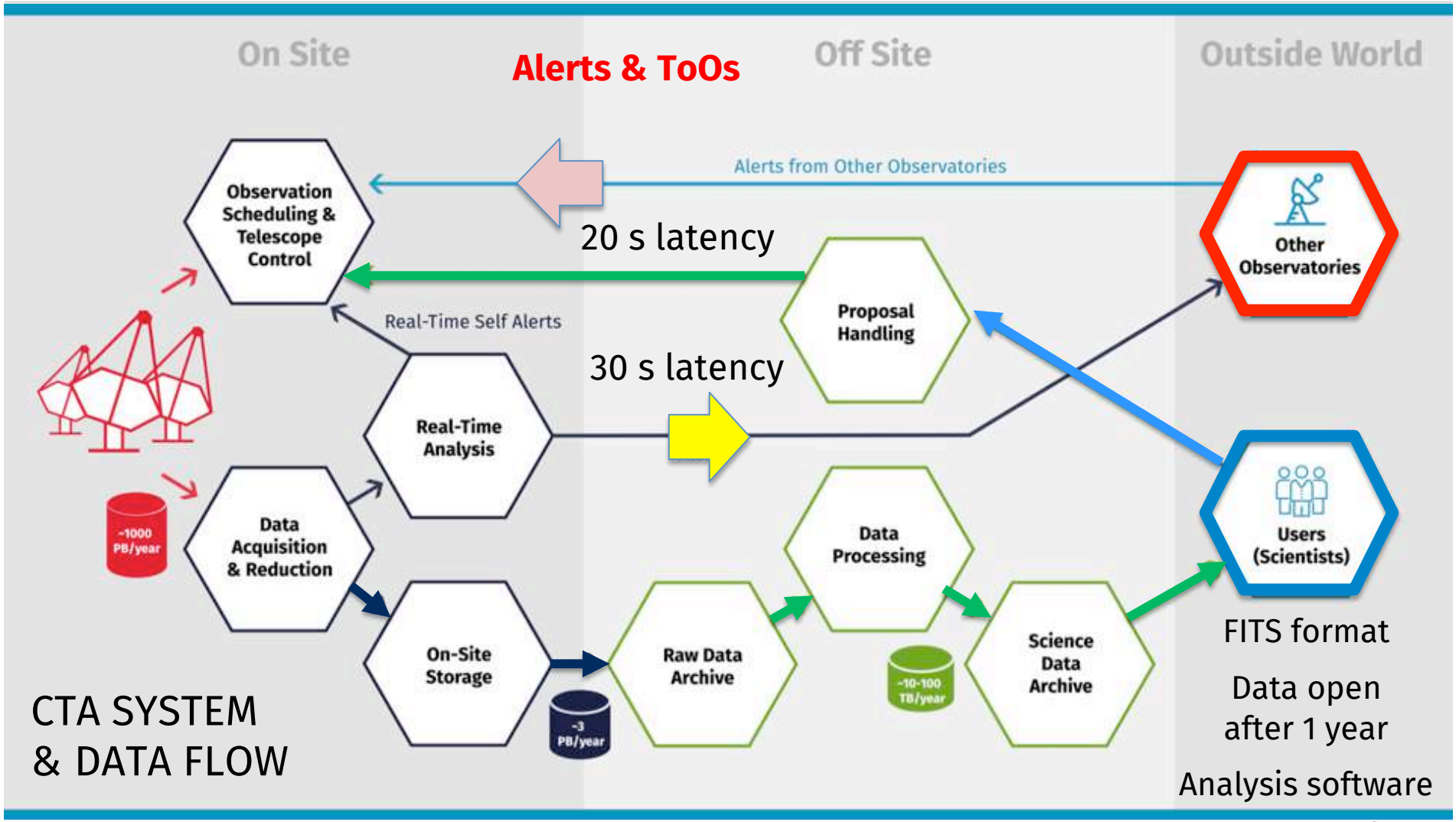


+ Phase 1 Configuration

MWL / MM Coordination Requirements

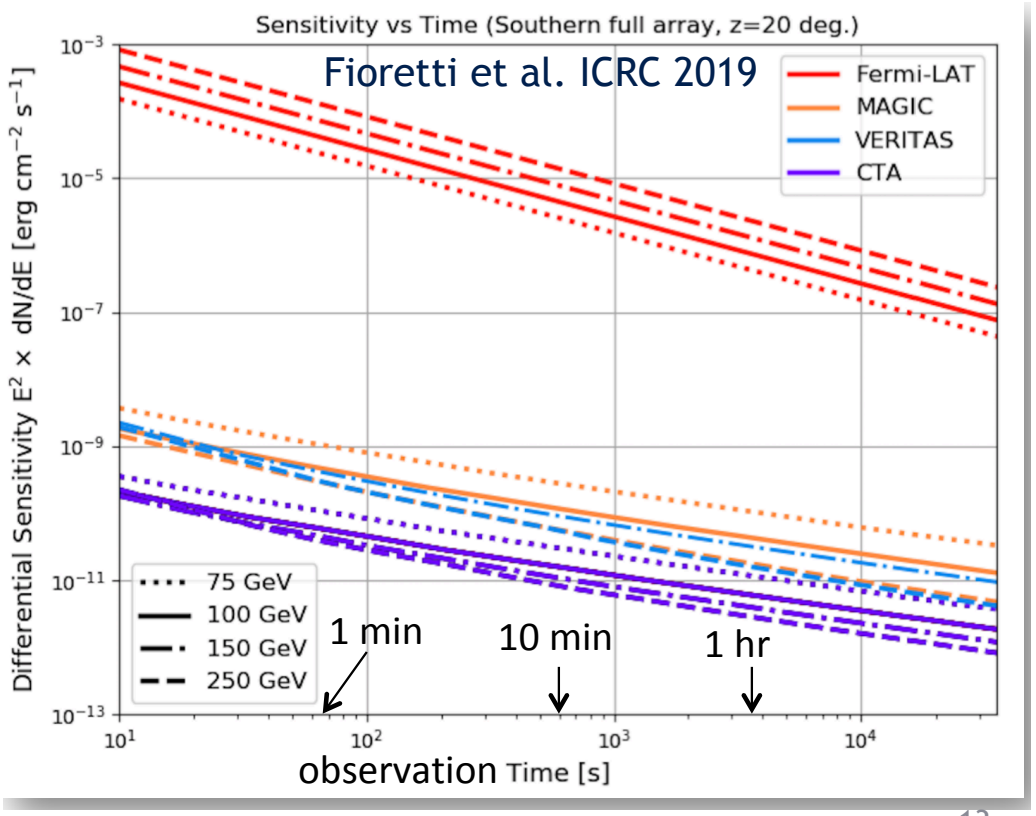
Band or Messenger	Astrophysical Probes	Galactic Plane Survey	LMC & SFRs	CRs & Diffuse Emission	Galactic Transients	Starburst & Galaxy Clusters	GRBs	AGNs	Radio Galaxies	Redshifts	GWs & Neutrinos
Radio	Particle and magnetic-field density probe. Transients. Pulsar timing.	●	●	●	●	●	●	●			●
(Sub)Millimetre	Interstellar gas mapping. Matter ionisation levels. High-res interferometry.	●	●		●	●	●	●	●		
IR/Optical	Thermal emission. Variable non-thermal emission. Polarisation.	●	●		●	●	●	●	●	●	●
Transient Factories	Wide-field monitoring & transients detection. Multi-messenger follow-ups.				●		●	●			●
X-rays	Accretion and outflows. Particle acceleration. Plasma properties.	●	●	●	●	●	●	●	●		●
MeV-GeV Gamma-rays	High-energy transients. Pion-decay signature. Inverse-Compton process	●	●		●	●	●	●	●		●
Other VHE	Particle detectors for 100% duty cycle monitoring of TeV sky.	●	●		●	●	●	●			●
Neutrinos	Probe of cosmic-ray acceleration sites. Probe of PeV energy processes.	●	●	●		●	●	●			●
Gravitational Waves	Mergers of compact objects (Neutron Stars). Gamma-ray Bursts.						●				●

CTA coordination and usage



Coordination actions by CTA

- Roles by CTAO
  - CTAO will handle ToO alerts
  - Alerts issued by CTAO to be released to the entire community within 2' in a VO-compliant format



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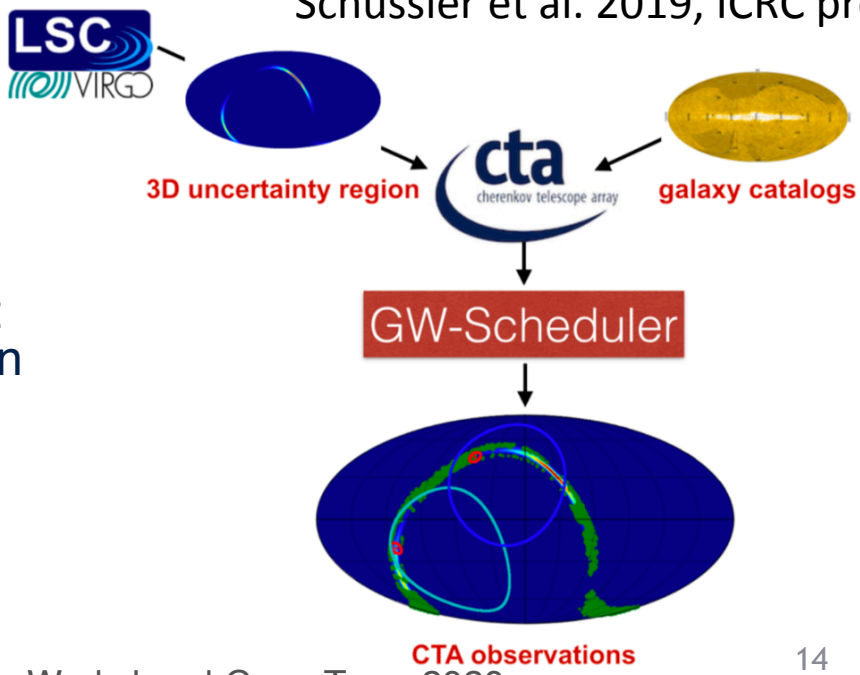
    - CTA relevant even for coarse transient localisation triggers
      - fast reaction time (< 30s)
      - multiple instruments in divergent mode >> arcmin level localisation

Schussler et al. 2019, ICRC proc



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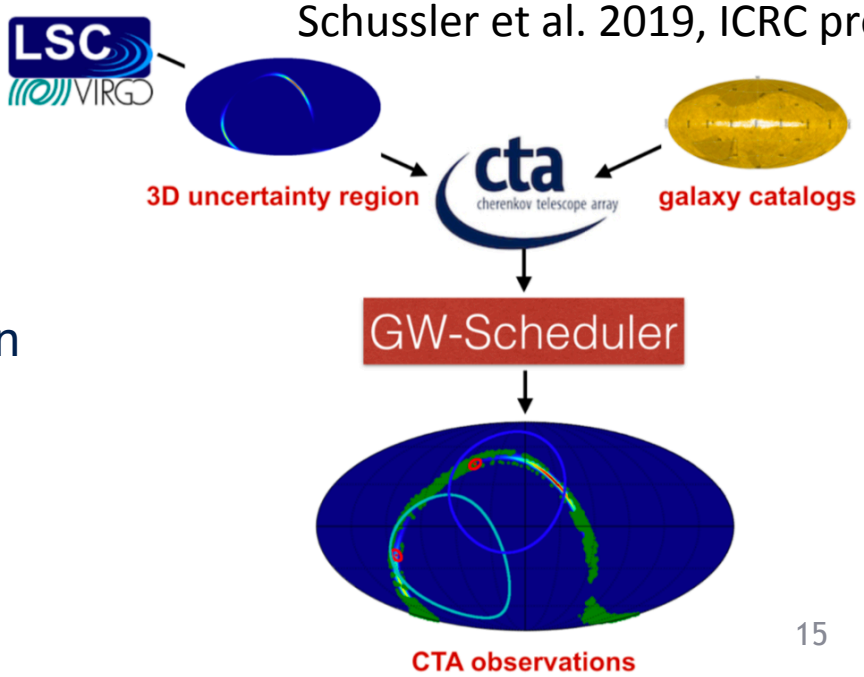
The CTA Real-Time Analysis and rapid communication of some preliminary information (particulary in the case of a detection) is the key system

Schussler et al. 2019, ICRC proc



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  - SKAO - CTAO cooperation: possible synergies in science; similarities in the observatory experience to be shared; short-term MoU under discussion

Data rights and international Collaboration

Data rights are to be defined by the ERIC council

After 20% host time data reduction (Chile and ESO):

- About 50% open programme
  - In principle open to the ERIC member/partner countries through PI-led proposals, plus a fraction open to entire world-wide community;
  - Specific rules TBD by the ERIC council.
- About 50% for KSPs by CTAC
  - KSP Programme to run for the first 10 years or so of the project
- All data fully open after 1 yr proprietary time
  - Public available to everybody, through the CTA science portal
- The above is to be the case for the CTA Operations Phase; Data access during Construction Phase is not defined yet.

International funding cadence and predictability

CTA approach was to define a “threshold implementation” (a scalable project)

- CTA is mostly an European project, but coordination of funding cadence is challenging even within Europe
- Threshold is viable and fundable
  - Successive expansions of the array towards the baseline configuration follows as more funding is available
- Operations funding under discussion
  - Expected to reflect both contributions to construction (IKCs) as well as use, rather than GDP
- No stable organisation behind during the pre-ERIC phase (e.g., CERN, ESO) that guarantees stable funding *ab initio.*

Note on ownership and operations

CTAO is the legal entity to which data and instrumentation formally belong

- Authorship rights are with the PIs / CoIs of individual projects
  - Special case is with the KSPs that follow specific rules by CTAC