High Energy Astrophysics (HEA) Data

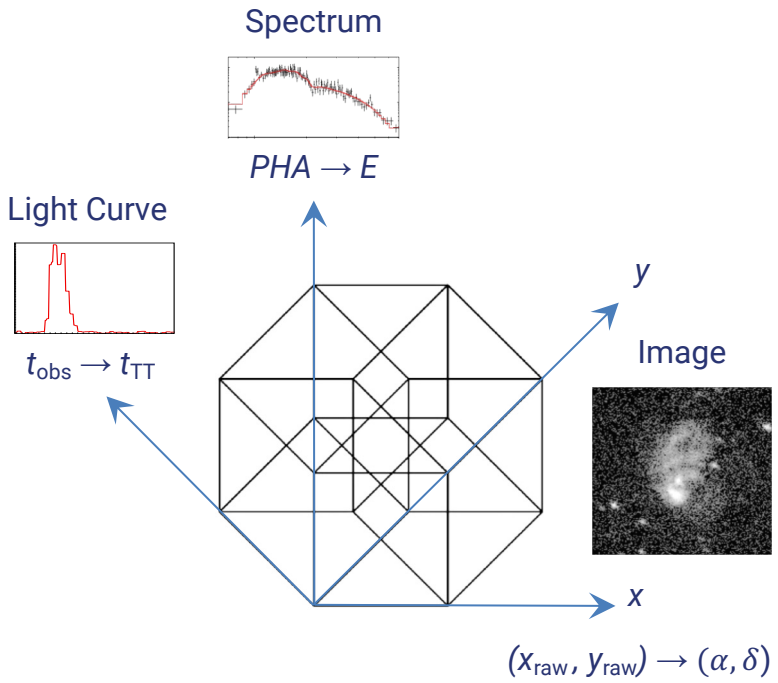
- HEA instrumentation usually identifies individual particles (*e.g.*, photons) with energies ~0.1 keV and higher (up to TeV+)
  - The primary datasets are **event-lists** that record detected particle event properties (*e.g.*, spatial, spectral, time information) for each event

    $\Longrightarrow$ **there are multiple observables per dataset**
  - In some HEA energy regimes, event-lists may often include **calibrated spatial and temporal axes** but have an **uncalibrated spectral axis** with photometric units of counts; nevertheless, these event lists are typically considered to be ``**calibrated**'' in those regimes

HEA Response Functions

- Mappings from physical attributes (*e.g.*, real particle energy) to observables (*e.g.*, measured pulse height [PHA]) are often **probabilistic** and **not invertible**
- Instrument **response functions** provide the mappings and depend on specific observation details and conditions

  ⟹ there must be a way to associate these data products with the event-lists
- Evaluating response functions *may* require scientific input, potentially necessitating creation by the end user, using additional data products that similarly should be associated with the event-lists



The HEA tesseract

HEA Data Characteristics

- HEA detections often have very few counts
  - The combination of complex data and the **extreme Poisson regime** necessitates the use of **statistically robust methods** (*e.g.*, Bayesian analysis) along with a **precise definition of confidence intervals**
    - Techniques that are computationally intensive result in data providers being more inclined to produce meticulously curated **advanced science-ready data products** and openly distribute them
      - Note that these data products are not exclusive to HEA; other wavebands are beginning to offer similar products
    - Catalogs may include tens of millions of these data products that users seek to **access independently** from the original observations
    - These advanced data products may be generated by combining numerous individual observations (possibly spanning decades) making **detailed knowledge of actual time coverage** potentially critical

HEIG ObsCore Extension Note Status

- A draft note is available that includes suggested HEA-specific extensions and updates to core ObsCore definitions (such as dataproduct_type)
- Some sections contain only placeholders based on earlier feedback
- A limited number of use cases are currently provided
- The note requires broader examination by the IVOA HEA community, with further contributions needed to develop placeholders and create more use cases
- Considerable additional input is necessary for the sections on vocabulary, UCD, and MIME-type enhancements
- There are currently no implementations underway or planned (the work is still in the early stages)

Open Questions

- How do we best coordinate across different wavebands for updates that extend beyond just the HEA waveband, even if HEA “arrives first”?
- What is the plan for converging ObsCore dataproduct_types and the data product type vocabulary?
- We have some concerns regarding the absence of clear definitions (for instance, in vocabulary entries) that may impact HEA data products, as prevailing assumptions from other wavebands may not apply
    - For example, the messenger may not always be photons, and “calibrated” data often lacks calibrated spectral axes or photometry
    - What is the most effective approach to tackle these cross-waveband issues?