CTA Data Model

The Cherenkov Telescope Array

Mathieu Servillat

Catherine Boisson, Michèle Sanguillon, Johan Brégeon
Pierre Le Sidaner, Cyril Chauvin, Renaud Savalle, Régis Haigron

Observatoire de Paris
Laboratoire Univers et Théories
VO-Paris Data Center
High Energy Astrophysics

- Violent, transient, non-thermal phenomena
- Matter under extreme conditions
- Particle Acceleration
- Fundamental Physics
- Role of Black Holes in the structuration of the Universe
- Two arrays of 100 (South) et 20 (North) Cherenkov telescopes (4, 12 et 24 m in diametre)
- End of 2015: Site Selection, Namibia or Chile (under negotiations)
- 2016: Construction
- Current experiments: H.E.S.S., MAGIC, VERITAS
  H.E.S.S.: experiment with 4+1 telescopes (4 x 12 m + 1 x 28 m)
- Event Reconstruction: photon, particle shower, Cherenkov light (faint, few nanoseconds)
- Atmosphere = calorimetre Simulations, assumptions
- Complex Metada, need to be structured
### Very high energy data

<table>
<thead>
<tr>
<th>Radio</th>
<th>Micro-ondes</th>
<th>Submill.</th>
<th>IR</th>
<th>V</th>
<th>UV</th>
<th>X</th>
<th>HE</th>
<th>γ</th>
</tr>
</thead>
<tbody>
<tr>
<td>km</td>
<td>m</td>
<td>mm</td>
<td>µm</td>
<td>nm</td>
<td>Å</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>eV</td>
<td>keV</td>
<td>MeV</td>
<td>GeV</td>
<td>TeV</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- Several orders of magnitude
- Photon counting
- Low count statistics, high background
- **Event lists**
  - (coordinates, time, energy)

**Images**

**Energy spectra**

**Lightcurves**
Knowledge in Very High Energies and VO

- H.E.S.S. experiment
- High level **VO data access** prototype
  http://hess.obspm.fr/

- **VO standards vs VHE?**
  - Complex **hierarchy** of related products
  - Complex **metadata** to be structured
  - **Queryable** metadata?

**CTA data access prototype**

- **CTA data model** implementation
- Test VO compliance
CTA Data Model

- Provenance
  - Project
  - Array Configuration
  - Ambient Conditions
  - Processing
  - Analysis
CTA DM - Project

```
ObservingProposal
#obsPropID: integer
+ownerName: String
+sciProjID: integer

sciProjID 0..1

describes

Target
#targetID: integer
+name: varchar(50)
+targetRA: double
+targetDec: double
+targetEpoch: float
+targetRADecsys: varchar(20)

targetID 0..1
is observed

ScientificProject
#sciProjID: integer
+owner: String

sciProjID 1

Observation
#obsID: Integer
+targetID: integer
+ownershipEndDate: Time
+startTime: Time
+endTime: Time
+onTime: float
+liveTime: float

obsID 1..*

<<postgres:typemap>>

<<postgres:pre>>
```
CTA Data Model – Processing Provenance?

- Provenance
- Project
- Array Configuration
- Ambient Conditions
- Processing
- Analysis

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CTA VO data access prototype

- **CTA Data Model** (not complete, still evolving)
  - **Automatic** Conversion UML to SQL
  - Relational database implemented (PostgreSQL)
- **Data Ingestion**: CTA 1DC data/metadata
- **VO Compliance**
  - ObsCore Data Model
  - GAVO DaCHS server: TAP, ADQL
- **Web Client** (Django, jQuery, BootStrap)
- **Online Analysis**: UWS, SAMP
- **Single Sign On** with SAML2/Shibboleth

➤ Complete solution based on VO standards/protocols
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CTA Data Model

15 June 2015
**Web Client**


- Django, jQuery, BootStrap3
- **Name resolver**
  - Simbad through Sesame
- **Builds and Sends the ADQL query**
2. VO diffusion for CTA

Web Client – Job List

« ctbin » processes DL3 data to create an image
However Provenance / Data links have been lost
CTA Data Model – Processing Provenance?

- Project
- Array Configuration
- Ambient Conditions
- Processing
- Analysis
# CTA data levels and workflow

<table>
<thead>
<tr>
<th>Data Level</th>
<th>Short Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level 0 (DL0)</td>
<td>DAQ-RAW</td>
<td>Data from the Data Acquisition hardware/software.</td>
</tr>
<tr>
<td>Level 1 (DL1)</td>
<td>CALIBRATED</td>
<td>Physical quantities measured in each separate camera: photons, arrival times, etc., and per-telescope parameters derived from those quantities.</td>
</tr>
<tr>
<td>Level 2 (DL2)</td>
<td>RECONSTRUCTED</td>
<td>Reconstructed shower parameters (per event, no longer per-telescope) such as energy, direction, particle ID, and related signal discrimination parameters.</td>
</tr>
<tr>
<td>Level 3 (DL3)</td>
<td>REDUCED</td>
<td>Sets of selected (e.g. gamma-ray-candidate) events, along with associated instrumental response characterizations and any technical data needed for science analysis.</td>
</tr>
<tr>
<td>Level 4 (DL4)</td>
<td>SCIENCE</td>
<td>High Level binned data products like spectra, sky maps, or light curves.</td>
</tr>
<tr>
<td>Level 5 (DL5)</td>
<td>OBSERVATORY</td>
<td>Legacy observatory data, such as CTA survey sky maps or the CTA source catalog.</td>
</tr>
</tbody>
</table>
IVOA Provenance DM (based on W3C)
Use Cases

- **Users:** astronomer, quality control, database managers
- **Examples:**
  - Create an image (DL3 → DL4)
  - All datasets with run_id = …
  - From DL4 image, go back to DL3 and redo
  - All products using Pipeline version …
- **Questions:**
  - Metadata propagation
  - Access to Provenance (Obscore fields, DataLink)