The 4-th International Workshop
Data Life Cycle, June 8-10, 2020

AstroDS - A Distributed Storage for Astrophysics of Cosmic Rays. Current Status.

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[*]Supported by RSF-18-41-06003
[**]Supported by HRSF-0027

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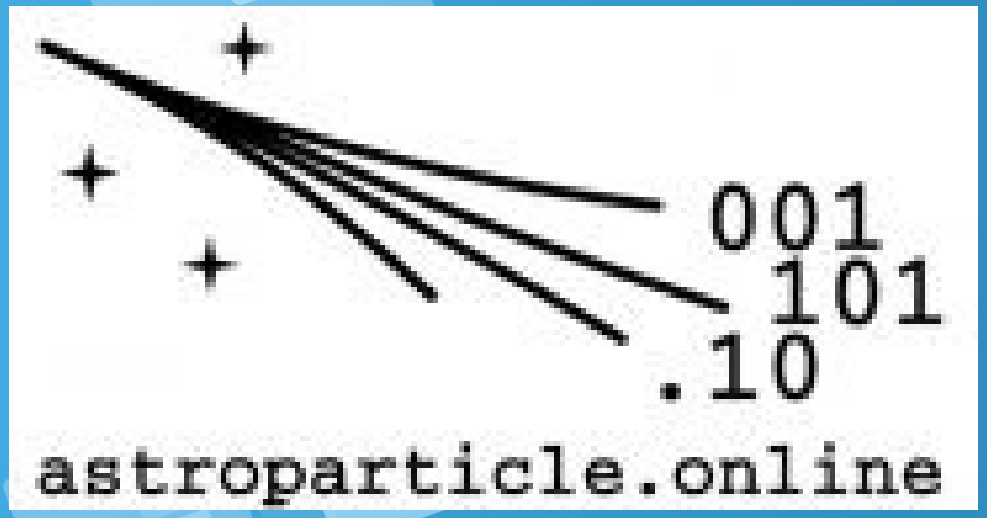
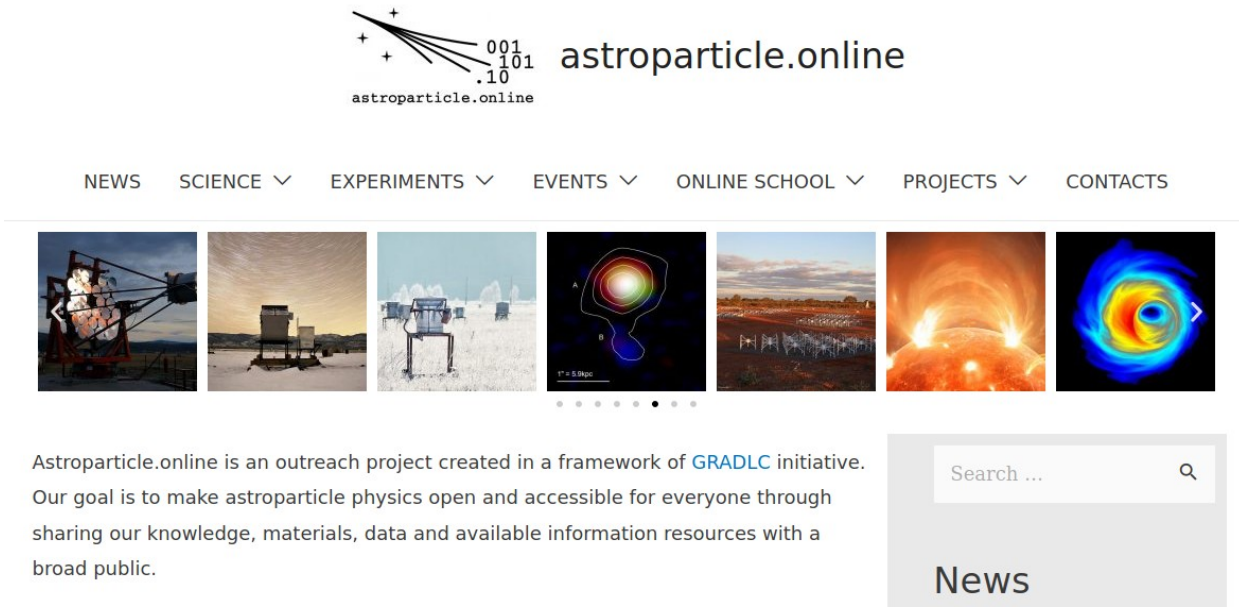


Outline

- Motivation
  - DLC Project
  - Multi-messenger astronomy and data challenge
  - TAIGA experiment
- AstroDS
  - The main ideas
  - Structure of AstroDS
    - Adapters to distributed storage
    - Meta Data Catalog
      - Extractors
    - Aggregation service/Web GUI
    - KCDC specifics
- Current status
- Conclusion

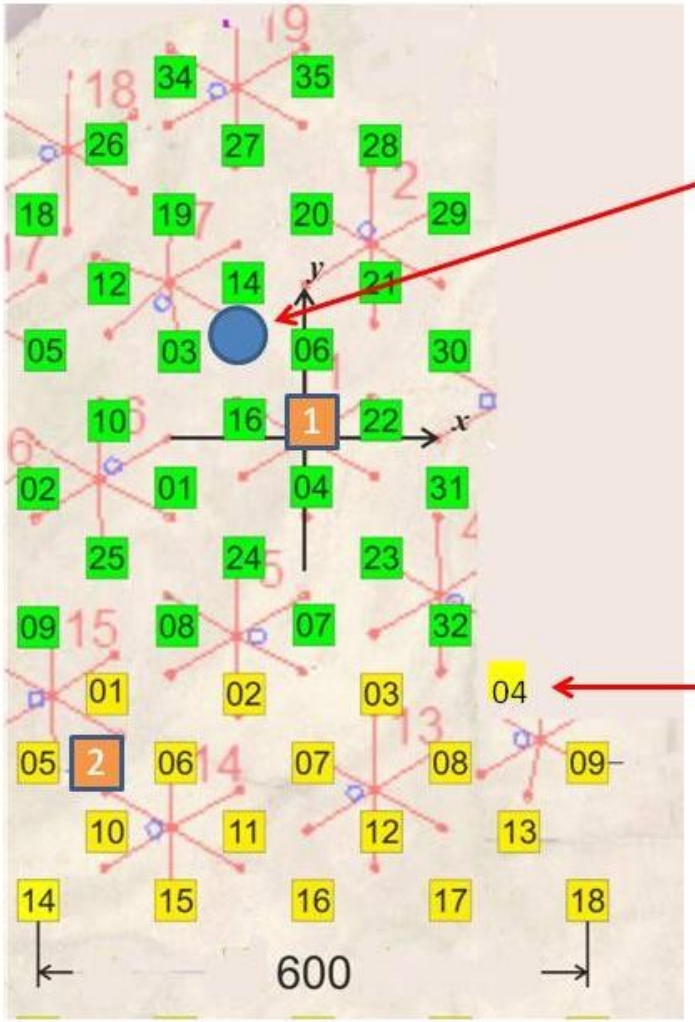
Astroparticle.online

- Karlsruhe-Russian Astroparticle Data Life Cycle Initiative
  - Supported by RSF (18-41-06003) and Helmholtz Society (HRSF-0027)
  - Participants: SINP MSU, ISU, ISDCT SB RAS, KIT
- Main aims
  - Develop a distributed (cloud) storage for astroparticle physics.
  - Develop ML approaches for analysis of gamma events in gamma-astronomy and multi-messenger analysis
  - Support data management over full life cycle from collecting to archiving
  - Provide resources for education and outreach in astroparticle physics



Multi-messenger astronomy

TAIGA: Experimental facilities (2019)



- IACT:
  - S of mirrors 8.5 m^2
  - Focus 4.75 m
  - FOV 9.5°
  - One pixel 0.36°
    560 pixels (in 22 clusters)
  - PSF ~0.1°
  - CCD – for checking telescope pointing direction.
- HiSCORE station:
  - 4 PMTs of 8'' size with Winston cones (light collection 0.5 m^2)
  - FoV ~0.6 sr

TAIGA: Data flow (per season)

- Row data 30 TB
  - before 2019 there was about 5TB
- Primary processing data 5.5 TB
- Total date on storage (at the end of 2019) 45 TB
- Thus, we need about 200 TB data storage for provide all activity of TAIGA collaboration for nearest 5 years at least.
  - It is not so many but not to small.

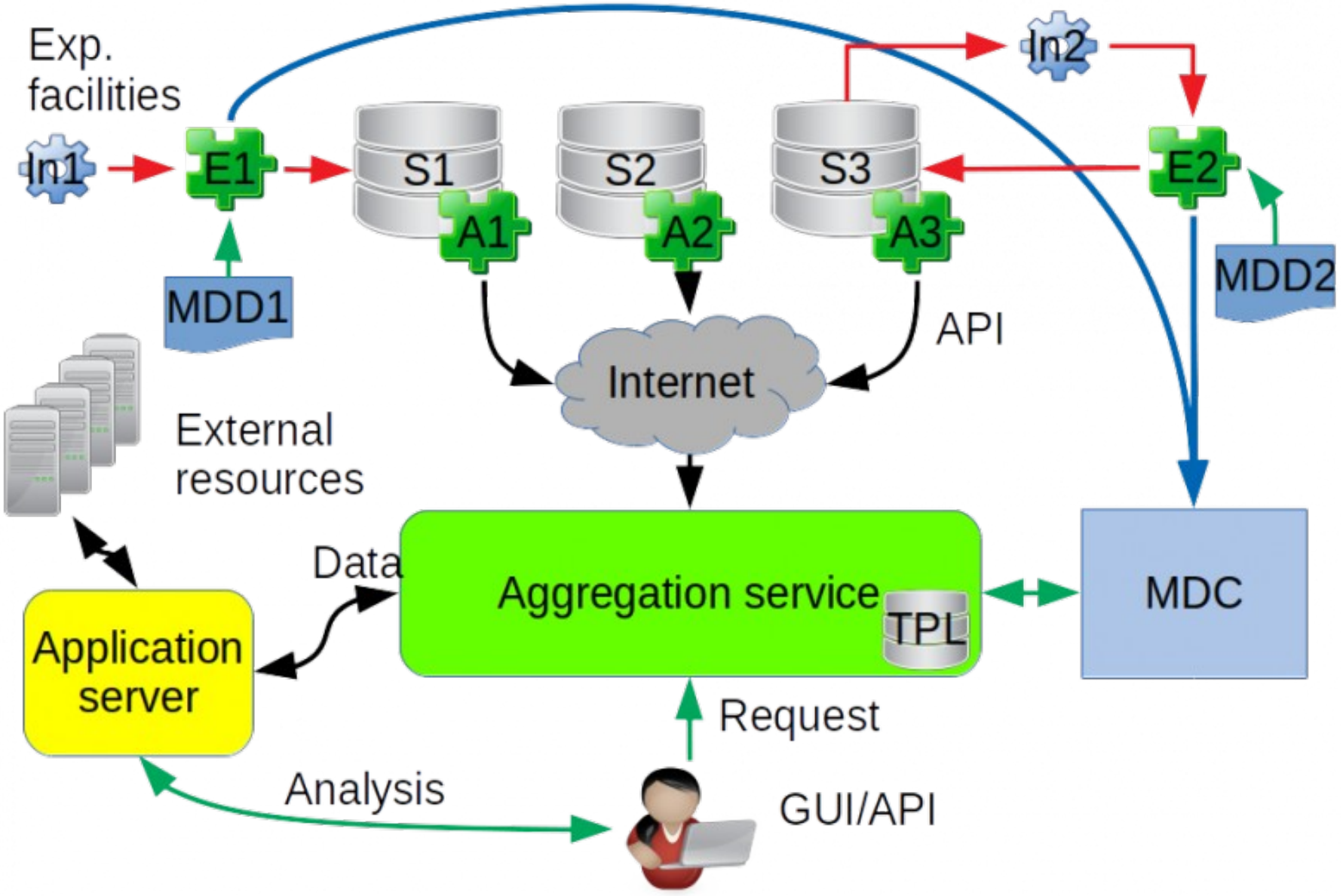
Structure of DS for middle size experiments in astroparticle physics

Motivation

- Modern medium-sized experiments generate tens and hundreds of terabytes of data. Collaboration brings together dozens of researchers from many organizations. Therefore, it is necessary to organize share access to data for scientists who use these repositories for data analysis.
- Most collaborations store data as a set of files.
  - Special case: DB-oriented storage like KCDC.
- Collaboration has a long history and established practice of working with data.
  - So, no changes to the existing infrastructure of the site, only additions
- Provide data access through both a web interface and API.

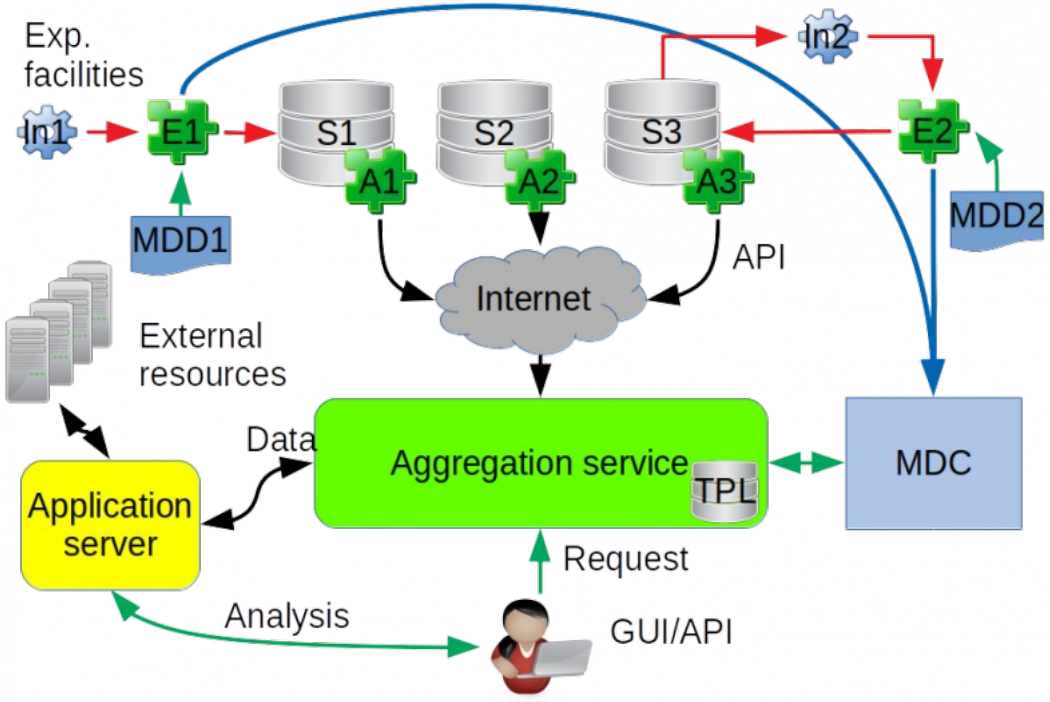
The main ideas that are embedded in the architecture

- Read-only oriented distributed(cloud) storage (DS).
  - Remote access to data as local file systems
  - On-demand data transfer by requests only
- No intervention into local storage, special adapters are used to access data.
- User requests are processed on a dedicated server based on metadata only.
  - Metadata is extracted from primary and/or secondary data in semi-automatic mode.
  - Binary format description language is used for serialize/deserialize binary data.


Exp.
facilities
In1
E1
S1
S2
S3
A1
A2
A3
In2
E2
MDD1
MDD2
API
Internet
External
resources
Data
Aggregation service
TPL
MDC
Application
server
Request
Analysis
GUI/API

Adapters

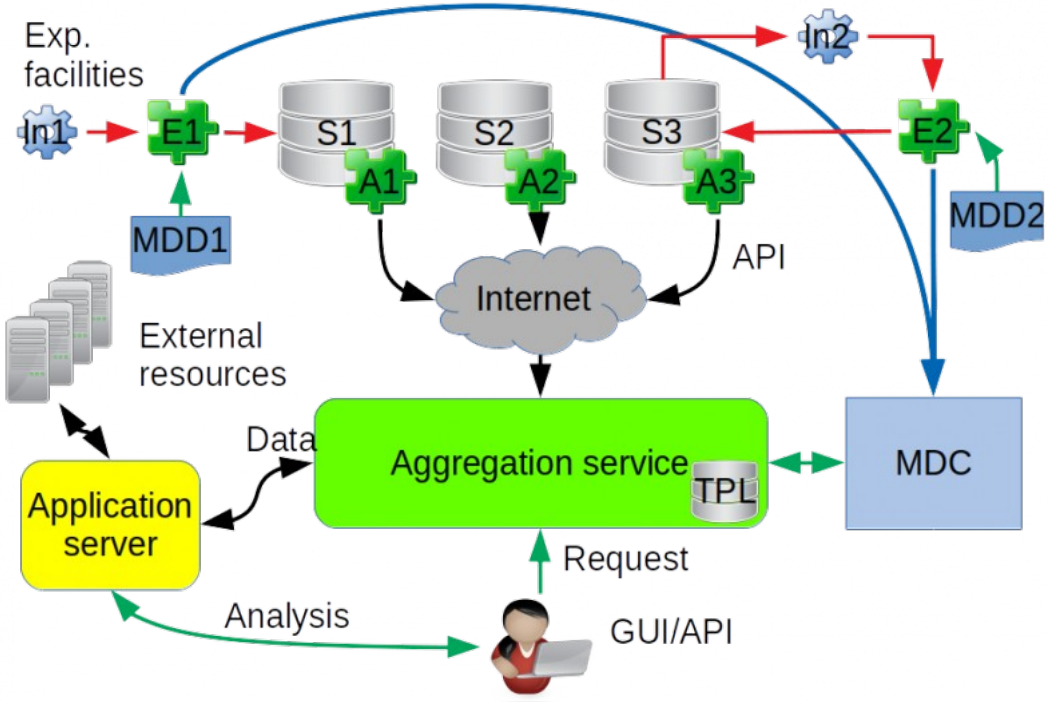
- CERN VM-FS as an adapter
  - Data are left untouched in their own file system
  - CernVM-FS indexes the data and changes, stores only the metadata (indices, checksums, locations, etc.) and data tree
  - CernVM-FS uses HTTP as the data transfer protocol, so there's no firewall problem
  - Data transfer starts only on actual reads
  - Multilevel cache-proxy servers



- Another type of adapters
  - FTP
  - NFS (for local network only)
  - SSH

Metadata catalog

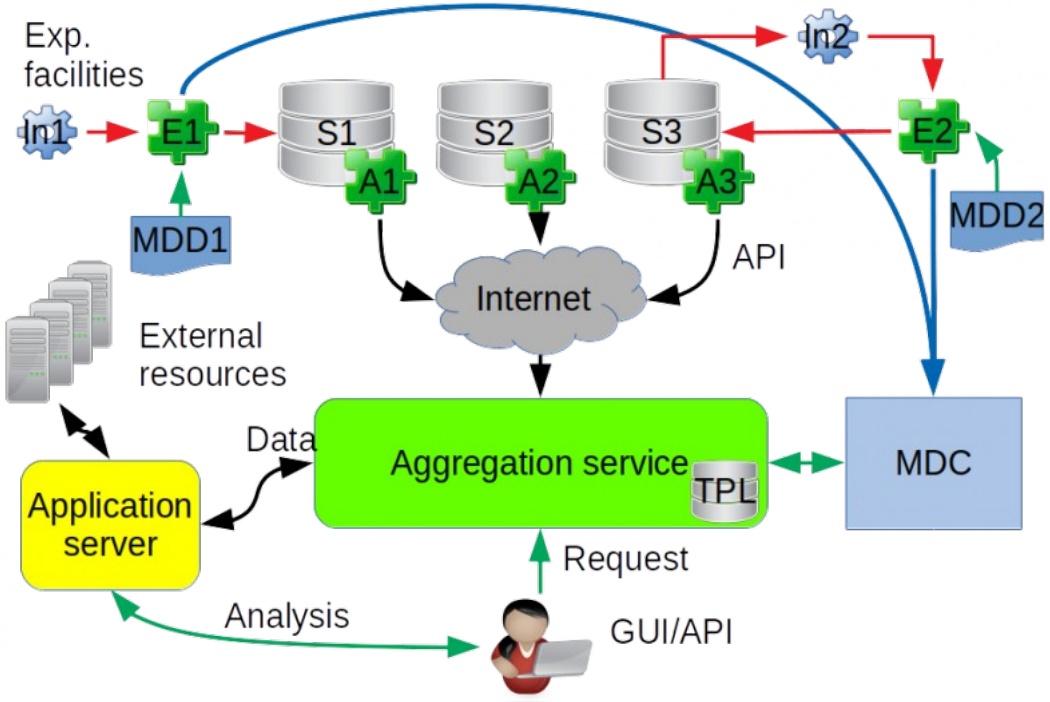
- Metadata catalogue (MDC) service.
  - No direct request to the local storage.
  - We use special programs called extractors to extract metadata.
- Two level metadata:
  - File level MD (experiment, detector, date, session,...)
  - Event level MD (energy, type of primary particle, ...)



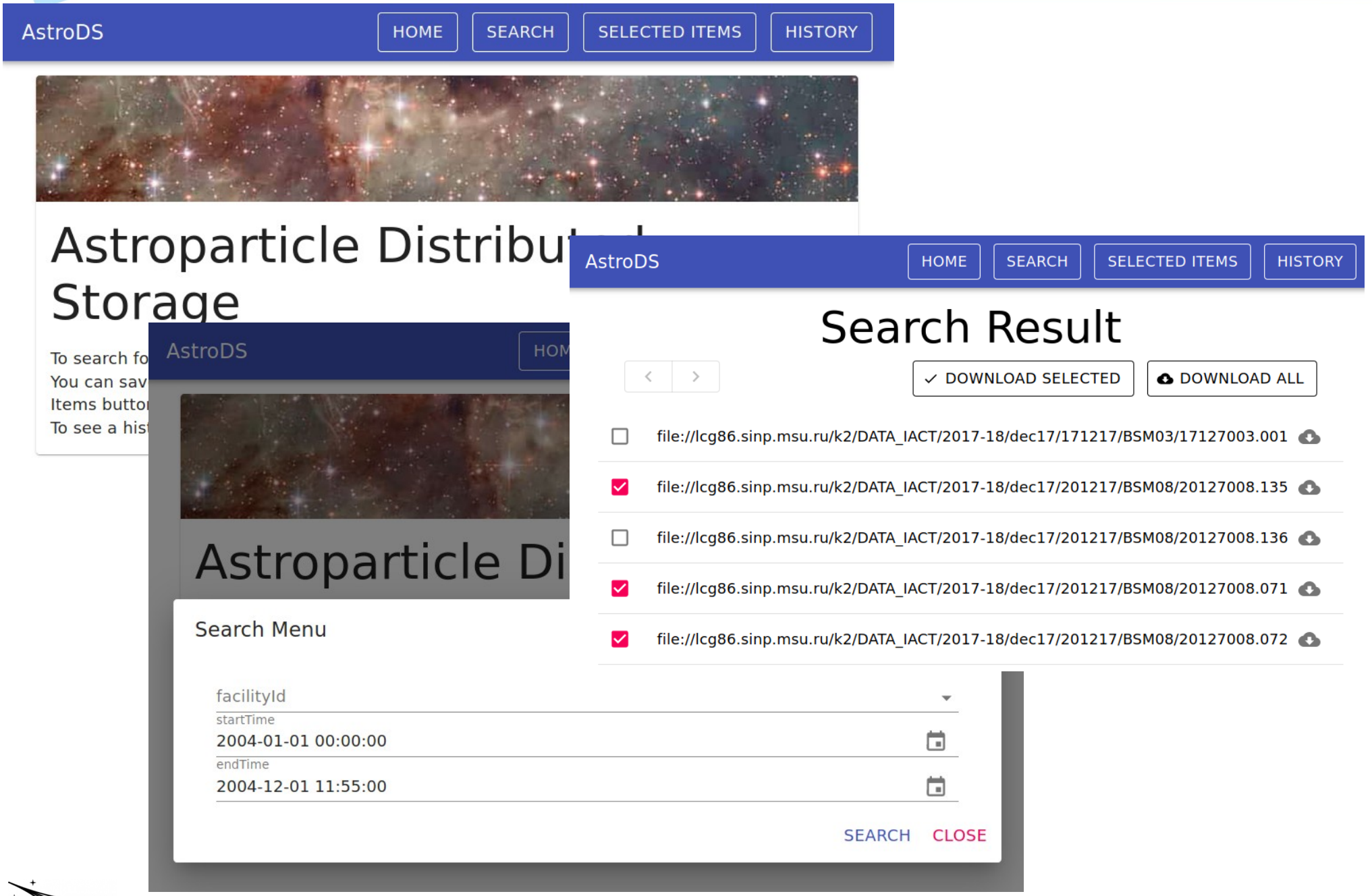
- Extractors
  - Extractors scan data and extract metadata from it.
  - Metadata is transferred to the MDC, where it is used to search for the necessary data at the requests of users.

Aggregator

- Two main functions
  - Composite the request and send it to MDC
  - Provide user of requested data
- Two level metadata:
  - File level MD (experiment, detector, date, session,...)
  - Event level MD (energy, type of primary particle, ...)



- Processing of user requests
  - MDC returns a list of URLs where the required data is located.
    - File level requests
      - The aggregation service re-exports to the user only those files that are in the list, obtained from MDC.
  - Event level requests.
    - The aggregation service scans these files and extracts those events that satisfy the user's request.


AstroDS
HOME
SEARCH
SELECTED ITEMS
HISTORY
Astroparticle Distribut
Storage
To search fo
You can sav
Items butto
To see a hist
AstroDS
HOM
Astroparticle Di
Search Menu
facilityId
startTime
2004-01-01 00:00:00
endTime
2004-12-01 11:55:00
SEARCH
CLOSE
AstroDS
HOME
SEARCH
SELECTED ITEMS
HISTORY
Search Result
DOWNLOAD SELECTED
DOWNLOAD ALL
file://lcg86.sinp.msu.ru/k2/DATA_IACT/2017-18/dec17/171217/BSM03/17127003.001
file://lcg86.sinp.msu.ru/k2/DATA_IACT/2017-18/dec17/201217/BSM08/20127008.135
file://lcg86.sinp.msu.ru/k2/DATA_IACT/2017-18/dec17/201217/BSM08/20127008.136
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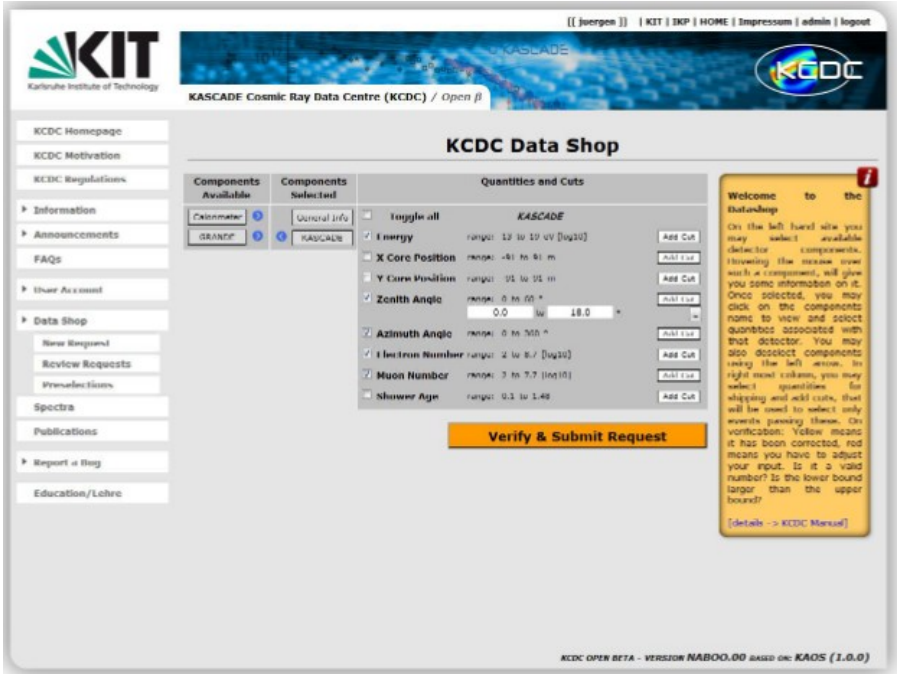
file://lcg86.sinp.msu.ru/k2/DATA_IACT/2017-18/dec17/201217/BSM08/20127008.072

KCDC

- KCDC is a database (event) - oriented of data storage
- Any requests for data will scan DB and select required events
- No available events metadata from KCDC on MDC
- Current solution:
  - We redirect all user requests to KCDC for processing.
  - If there are necessary events, then KCDC prepare files which contain the events and return the reference for it
  - MDC combine this reference with others and return to aggregator.



- KCDC plays two roles
  - As a storage
  - As a secondary MDC
- The data transfer from KCDC to Aggregator via FTP

Current status (2020)

- We have a prototype of AstroDS including
  - 2 storage with 40TB data in total
    - adapters based on CVM-FS, NFS and FTP
    - extractors of MD for TAIGA IACT and HiScore
  - integrate DB-oriented storage - KCDC
  - aggregation service
    - web GUI and API
  - meta data catalog
- The system has restricted functionality
  - restricted set of filters
  - non-final version of the Web-GUI
- AstroDS ready for trial by TAIGA users

Current status (2020)

TAIGA-IACT

Stor1

Stor2

KCDC

Internet

Aggregator

Web-browser

MDC

Conclusion

- Modern information technologies can provide scientists with convenient access to large data distributed throughout the world.
- Distributed storage provides analysis of multi-messengers and intelligent management of data access rights.
- A custom data request can contain both file level filters and more detailed filters, such as events.
- AstroDS will provide the storage service for middle size experiments for multi-messenger analysis of data.


Thank you!
Questions?