





# Data Knowledge Base for HENP Research Results and Interim Findings

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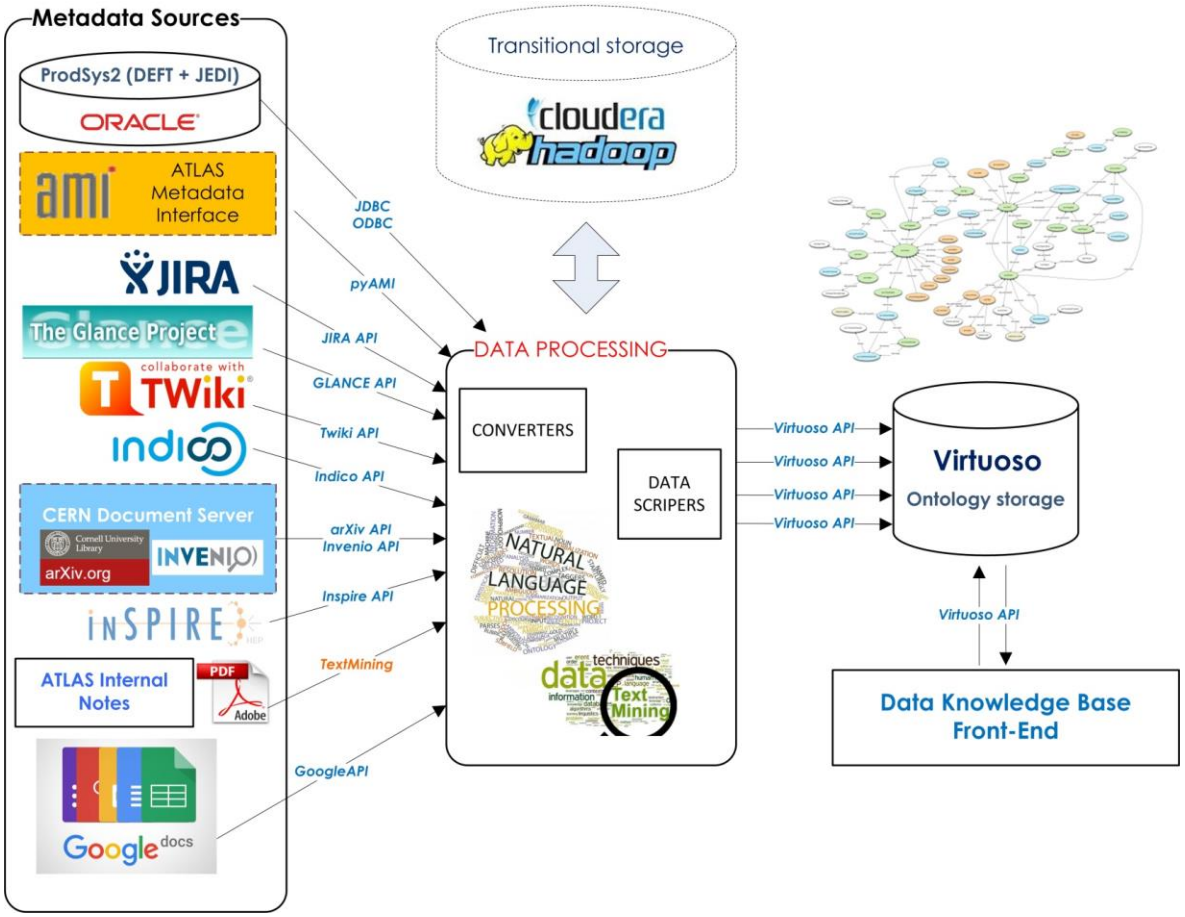
# Outline

- Previous architecture prototypes
  - Architecture Prototype v.1 (October 2016)
  - Architecture Prototype v.2 (February 2017)
- Ontological modelling
- Metadata extraction from PDF Documents
- Data Integration methods
- Current architecture prototype v.3 (April 2017)
- Dataflow (Apache Kafka) by Marina Golosova
- Near term plans
- Questions



# DKB architecture prototype v.1




## Ontology storage – OpenLink Virtuoso:

- Developed first prototype of the ontology for ATLAS Data Analysis.
- Virtuoso ontology storage installed in Tomsk Polytechnic University

## Transitional Hadoop Storage in Kurchatov Institute

- Production System metadata [datasets] was exported from Oracle DB and imported to Hadoop Storage

## ATLAS Internal Notes processing:

- Developed PDF Analyzer tool, based on PDFMiner, which extracts dataset names from full texts of ATLAS Internal Notes

## Data Processing:

- Developed tools, converting the metadata from GLANCE, CERN Document Server and Production System [datasets] to TTL format for Virtuoso storage
- Metadata consolidated in Virtuoso storage

# General Idea: use Semantic Web for Metadata Integration

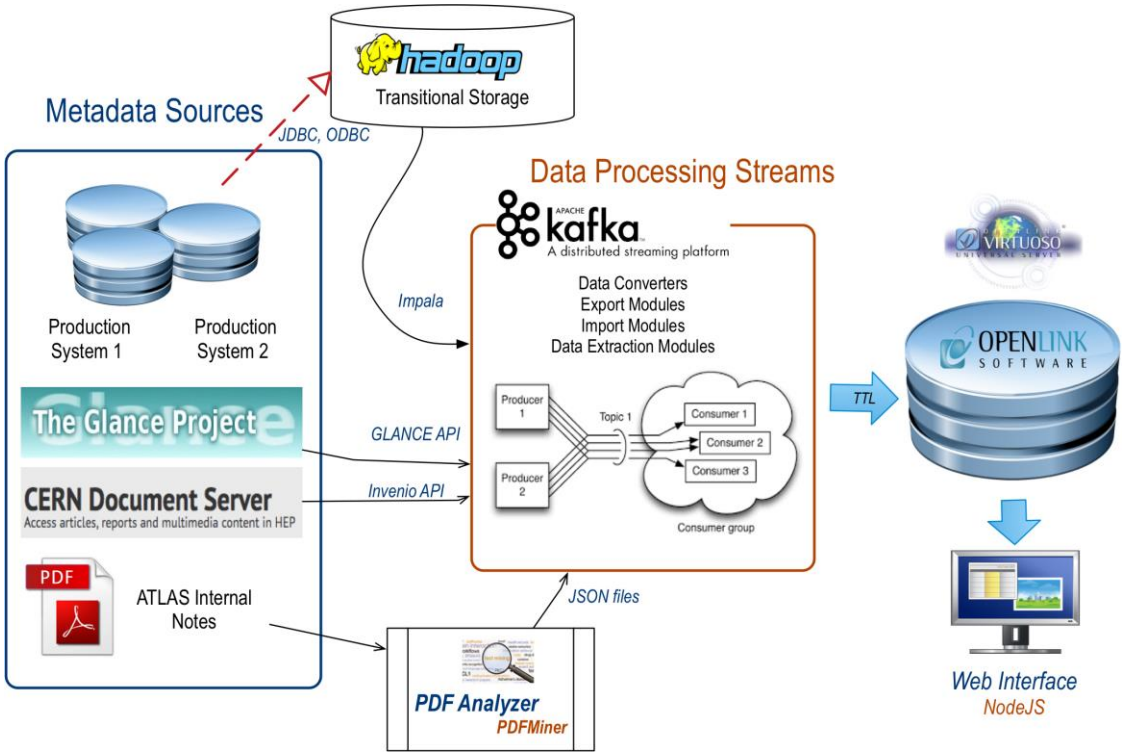
- *"The Semantic Web is an extension of the current web in which information is given well-defined meaning, better enabling computers and people to work in cooperation." // Berners-Lee, Scientific American, May 2001*
- Semantic Web consists primarily of three technical standards:
  - ***RDF (Resource Description Framework)***
  - ***SPARQL (SPARQL Protocol and RDF Query Language)***
  - ***OWL (Web Ontology Language)***
- RDF Statements are expressed in a "***triples***" <*subject, predicate, object*>.
- The entire universe can be described by triples because together, triples comprise a ***graph***.
- A graph can be linked to one or many other graphs on the World Wide Web and these graphs are a fundamental part of the Semantic Web.
- *Knowledge-oriented systems:* reasoning engines can be used to reason against assertions that have been made to infer new meaning, to find relationships and meaning far beyond the scope of the data, managed isolated.



# DKB architecture prototype v.2

## Data Processing:

- Implemented Metadata Integration Chain using data streaming based on Apache Kafka to automate data processing workflows
- Executed test data flow which export metadata from GLANCE and CDS, and import integrated metadata in TTL format in Virtuoso Storage




## Enhanced PDF Analyzer functionality:

- Extract metadata from PDF Tables

## Enhanced ontological model with metadata from AMI:

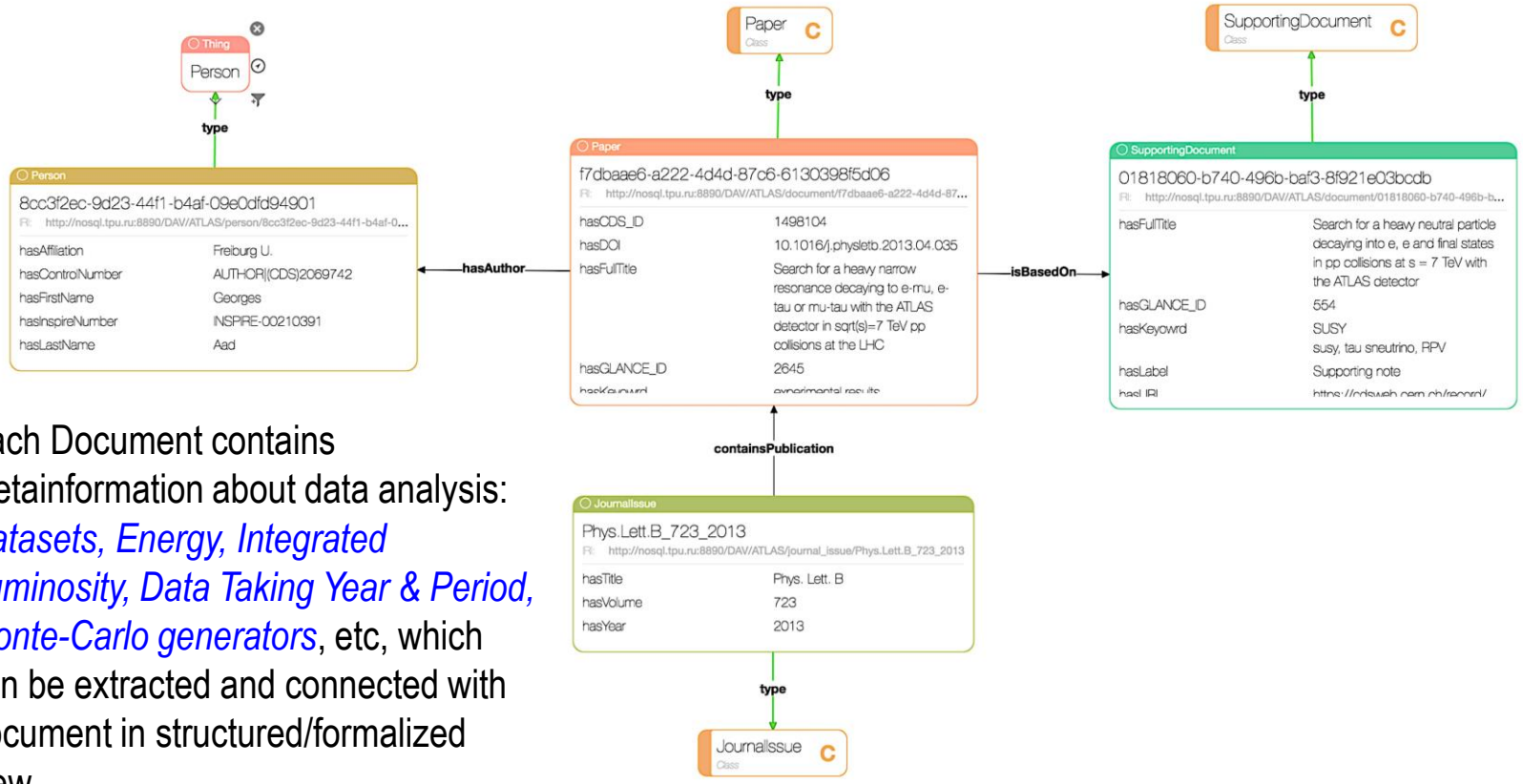
- Data taking periods
- Run Numbers
- Projects
- Campaigns

# Architecture prototype v2: Tasks assignments

- Data Processing modules for extracting/processing/converting metadata from GLANCE, CDS, ProdSys
  - Marina Golosova (NRC KI)
  - Maria Grigorieva (NRC KI)
- Kafka Streams for automated data processing
  - Marina Golosova (NRC KI)
- ATLAS Internal Notes PDF Analyzer
  - Vasily Aulov (NRC KI)
- Ontological model of data analysis in HEP
  - Maria Grigorieva (NRC KI)
  - Maxim Gubin (TPU)
- Web Interface
  - Maria Grigorieva (NRC KI)
- Virtuoso Server administration
  - Alexander Alexeev (TPU)
- Hadoop Transitional Storage administration
  - Marina Golosova (NRC KI)

# Ontological Modeling of ATLAS Data analysis metadata

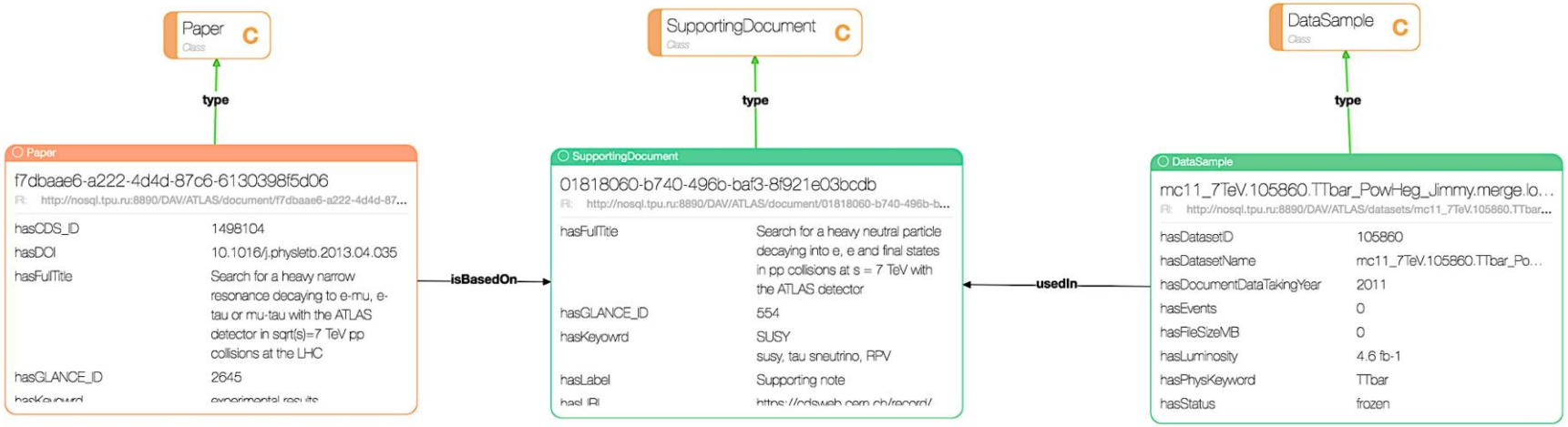
- ***Documents*** can be of different types.
- ***Scientific Paper*** is based on ***Supporting Documents***.
- Document's inheritance is provided by "***isBasedOn***" Object Attribute.




- Each Document contains metainformation about data analysis: *Datasets, Energy, Integrated Luminosity, Data Taking Year & Period, Monte-Carlo generators*, etc, which can be extracted and connected with document in structured/formalized view.

# Ontological Modeling of ATLAS Data analysis metadata

- ***DataSamples*** and ***Documents*** are connected by "***usedIn***"/"***referTo***" attributes.
- DataSample attributes are taken from ProductionSystem database:
  - hasDatasetID
  - hasStatus
  - hasEvents
  - hasTimestamp
  - ….
- In architecture prototypes v1 and v2 dataset's detailed metadata are consolidated in Virtuoso RDF-Storage.





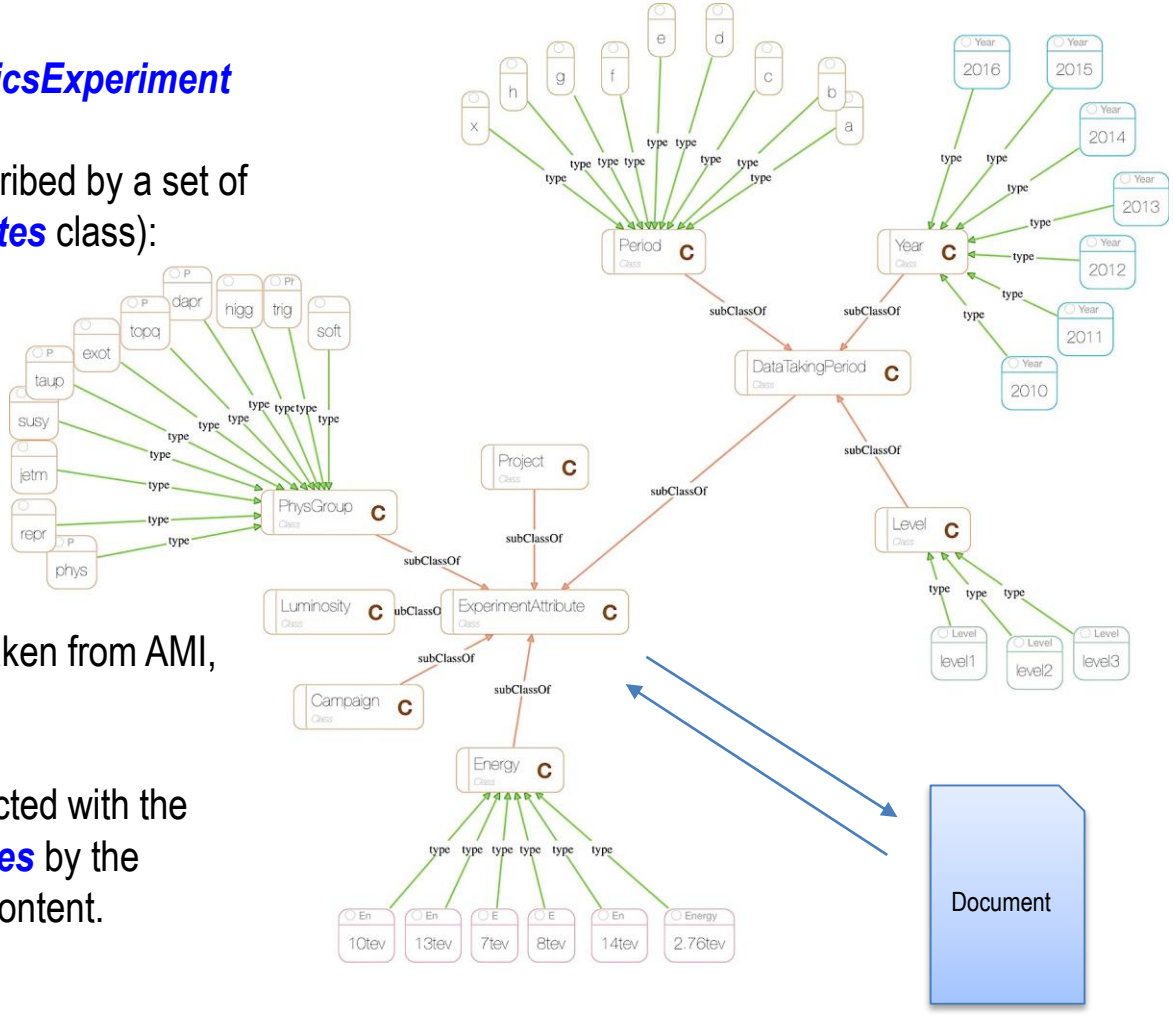

# Ontological Modeling of ATLAS Data analysis metadata

- Data Analysis in ATLAS = ***PhysicsExperiment*** class
- Each PhysicsExperiment is described by a set of parameters (***ExperimentAttributes*** class):

- Project *(ex: mc10_7TeV)*
- Campaign *(ex: mc11a)*
- Energy *(ex: 10TeV)*
- Integrated Luminosity
- Physics Group *(SUSY, HIGG,…)*
- Data Taking Period *(ex: 2010_A1_1)*
- *Other parameters are not defined yet*

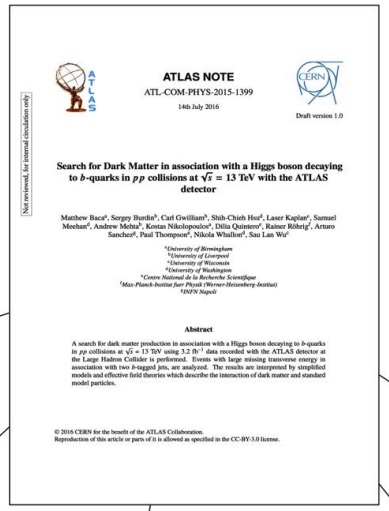
- ***ExperimentAttributes*** can be taken from AMI, Production System, Twiki pages.

- Each ***Document*** must be connected with the appropriate ***ExperimentAttributes*** by the parameters, extracted from the content.






# Document Contents



ATLAS NOTE
ATL-COM-PHYS-2015-1399
14th July 2016
Draft version 1.0

Search for Dark Matter in association with a Higgs boson decaying to $b$-quarks in $pp$ collisions at $\sqrt{s}$ = 13 TeV with the ATLAS detector

Abstract

A search for dark matter production in association with a Higgs boson decaying to $b$-quarks in $pp$ collisions at $\sqrt{s}$ = 13 TeV using 3.2 fb$^{-1}$ data recorded with the ATLAS detector at the Large Hadron Collider is performed. Events with large missing transverse energy in association with two $b$-tagged jets, are analyzed. The results are interpreted by simplified models and effective field theories which describe the interaction of dark matter and standard model particles.

hasContent

GRL used in this analysis is DATA15_13TEV.PERIODALLYEAR_DETSTATUS-V73-PRO19-08_DQDEFECTS-00-01-02_PHYS_STANDARDGRL_ALL_GOOD_25NS.XML

hasContent

**Abstract**

A search for dark matter production in association with a Higgs boson decaying to $b$-quarks in $pp$ collisions at $\sqrt{s}$ = 13 TeV using 3.2 fb$^{-1}$ data recorded with the ATLAS detector at the Large Hadron Collider is performed. Events with large missing transverse energy in association with two $b$-tagged jets, are analyzed. The results are interpreted by simplified models and effective field theories which describe the interaction of dark matter and standard model particles.

hasContent

| DSID | Sample Name | Tag |
|---|---|---|
| 341100 | Pythia8EvtGen_A14NNPDF23LO_WlvH125_bb | e3885_s2608_s2183_r6869_r6282_p2419 |
| 341101 | Pythia8EvtGen_A14NNPDF23LO_ZvvH125_bb | e3885_s2608_s2183_r6869_r6282_p2419 |
| 341102 | Pythia8EvtGen_A14NNPDF23LO_ZllH125_bb | e3885_s2608_s2183_r6869_r6282_p2419 |

Table 19: Monte Carlo samples used as baseline for Standard Model VH($\rightarrow bb$).

hasContent

hasContent

**L Monte Carlo Samples**

PYTHIA **6.423**

mc10_7TeV.105009.J0_pythia_jetjet.merge.NTUP_BTAG.e574_s934_s946_r1653_r1700_p370
..
mc10_7TeV.105016.J7_pythia_jetjet.merge.NTUP_BTAG.e574_s934_s946_r1653_r1700_p370

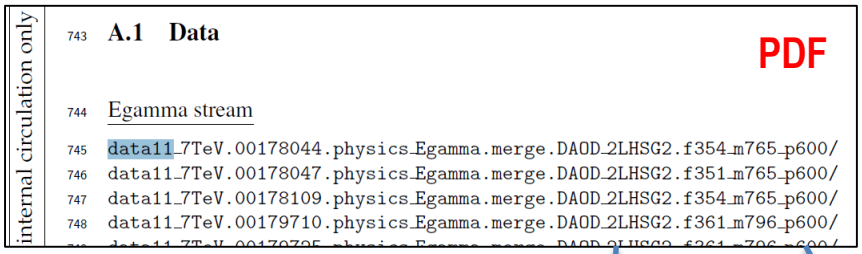
PYTHIA **6.423+PILEUP**

mc10_7TeV.105009.J0_pythia_jetjet.merge.NTUP_BTAG.e574_s934_s946_r1833_r1700_p370
..
mc10_7TeV.105016.J7_pythia_jetjet.merge.NTUP_BTAG.e574_s934_s946_r1833_r1700_p370

Real datasets

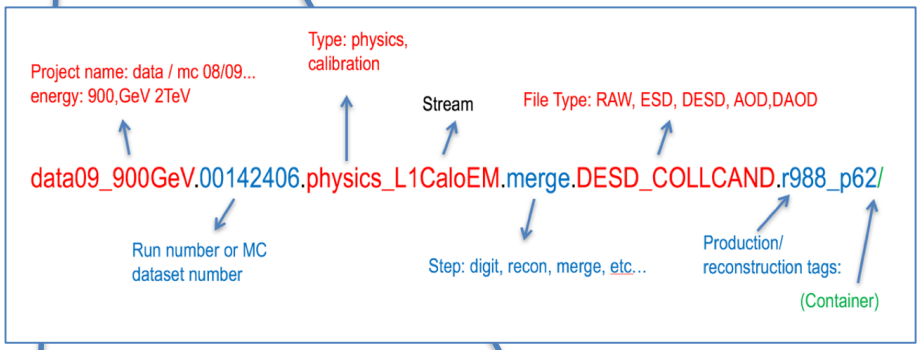
| DSID | Sample Name | Tag |
|---|---|---|
| 00279598 | physics_Main | f628_m1497_p2425 |
| 00279685 | physics_Main | f628_m1497_p2425 |
| 00279764 | physics_Main | f628_m1497_p2425 |
| 00279813 | physics_Main | f628_m1497_p2425 |
| 00279867 | physics_Main | f628_m1497_p2425 |
| 00279928 | physics_Main | f628_m1497_p2425 |
| 00279932 | physics_Main | f629_m1504_p2425 |
| 00279984 | physics_Main | f629_m1504_p2425 |
| 00280231 | physics_Main | f630_m1504_p2425 |
| 00280319 | physics_Main | f629_m1504_p2425 |
| 00280368 | physics_Main | f629_m1504_p2425 |
| 00280423 | physics_Main | f629_m1504_p2425 |
| 00280464 | physics_Main | f629_m1504_p2425 |
| 00280500 | physics_Main | f631_m1504_p2425 |
| 00280520 | physics_Main | f632_m1504_p2425 |
| 00280614 | physics_Main | f629_m1504_p2425 |

# Datasets extraction from PDF documents



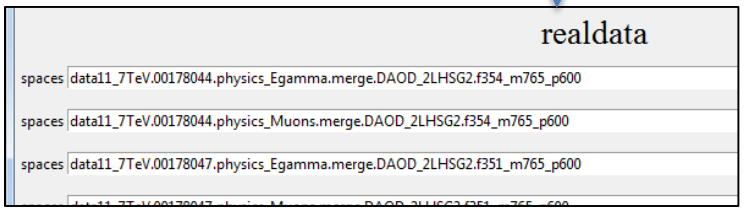

Regular expressions are constructed according to ATLAS dataset nomenclature. These expressions are used to extract the dataset names from the text.

***PDFMiner*** is a tool for extracting information from PDF documents.




**GUI interface:**

- Edit dataset names
- Delete datasets from the list
- Export resulted list to JSON file




**JSON**

{ "content": { "real_datasets": [
"data11_7TeV.00178044.physics_Egamma.merge.DAOD_2LHSG2.f354_m765_p600",
"data11_7TeV.00178047.physics_Egamma.merge.DAOD_2LHSG2.f351_m765_p600",
"data11_7TeV.00178109.physics_Egamma.merge.DAOD_2LHSG2.f354_m765_p600",
"data11_7TeV.00179710.physics_Egamma.merge.DAOD_2LHSG2.f361_m796_p600",
"data11_7TeV.00179725.physics_Egamma.merge.DAOD_2LHSG2.f361_m796_p600",
.....

# Extraction of data from tables

| Signal Point $M(\tilde{g})$ [GeV] | Signal Point $M(\tilde{\chi}_1^0)$ [GeV] | Run Number | Cross Section (LO) [pb] | Signal Point $M(\tilde{g})$ [GeV] | Signal Point $M(\tilde{\chi}_1^0)$ [GeV] | Run Number | Cross Section (LO) [pb] |
|---|---|---|---|---|---|---|---|
| 400 | 50 | 123078 | 6.00 | 900 | 50 | 138568 | $6.19\times10^{-3}$ |
| 400 | 75 | 123079 | 5.95 | 900 | 100 | 138569 | $6.14\times10^{-3}$ |
| 400 | 100 | 123080 | 6.00 | 900 | 150 | 138570 | $6.10\times10^{-3}$ |
| 400 | 125 | 123081 | 6.02 | 900 | 200 | 138571 | $6.08\times10^{-3}$ |
| 400 | 150 | 118430 | 6.03 | 900 | 300 | 138572 | $5.92\times10^{-3}$ |

Table 26: GGM signal samples. Each signal point is defined by the gluino and lightest neutralino mass. The run number and LO cross section is given.

```
<?xml version="1.0" encoding="utf-8" ?>
<pages>
  <page id="1" bbox="0.000,0.000,612.000,792.000" rotate="0">
    <textbox id="0" bbox="229.080,675.825,366.146,691.074">
    <textline bbox="229.080,675.825,366.146,691.074">
      <text font="MGTNRE+CMSSBX10" bbox="229.080,675.825,244.226,691.074" size="15.249">A</text>
      <text font="MGTNRE+CMSSBX10" bbox="242.273,675.825,257.419,691.074" size="15.249">T</text>
      <text font="MGTNRE+CMSSBX10" bbox="257.386,675.825,269.391,691.074" size="15.249">L</text>
      <text font="MGTNRE+CMSSBX10" bbox="269.396,675.825,284.541,691.074" size="15.249">A</text>
      <text font="MGTNRE+CMSSBX10" bbox="284.509,675.825,297.134,691.074" size="15.249">S</text>
    </textline>
    </textbox>
    <figure name="R5" bbox="70.920,642.800,155.880,750.800">
      <image width="84" height="108" />
    </figure>
    <layout>
      <textgroup bbox="73.080,185.033,522.095,691.074">
      <textgroup bbox="73.080,380.838,522.095,691.074">
    </layout>
  </page>
```

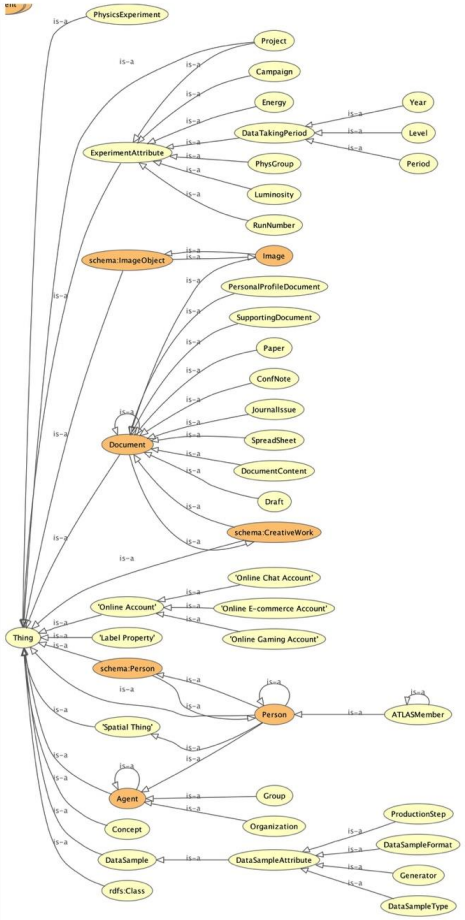
Tables are found by looking for their descriptions in text. After finding the description, the page containing the table is extracted into XML format and the table is reconstructed using the information from it.


```
"table_26": [
   "Table 26: GGM signal samples. Each signal point i
   [
      [
         "Signal",
         "Point",
         "Run Number",
         "Cross Section (LO)",
         "Signal",
         "Point",
         "Run Number",
         "Cross Section (LO)"
      ],
      [
         "M( \u02dcg)",
         "M( \u02dc\u03c701)",
         "EMPTY",
         "[pb]",
         "M( \u02dcg)",
         "M( \u02dc\u03c701)",
         "EMPTY",
         "[pb]"
      ],
      [
         "[GeV]",
         "[GeV]",
         "EMPTY",
         "EMPTY",
         "[GeV]",
         "[GeV]",
         "EMPTY",
         "EMPTY"
      ],
      [
         "400",
         "50",
         "123078",
         "6.00",
         "900",
         "50",
         "138568",
         "6.19\u00d710\u22123"
      ],
      [
         "400",
         "75",
         "123079",
         "5.95",
         "900",
         "100",
         "138569",
         "6.14\u00d710\u22123"
      ],
```




# Virtuoso Server = http://nosql.tpu.ru:8890/

SCHEMA GRAPH:
http://nosql.tpu.ru:8890/DAV/home/dba/ATLAS

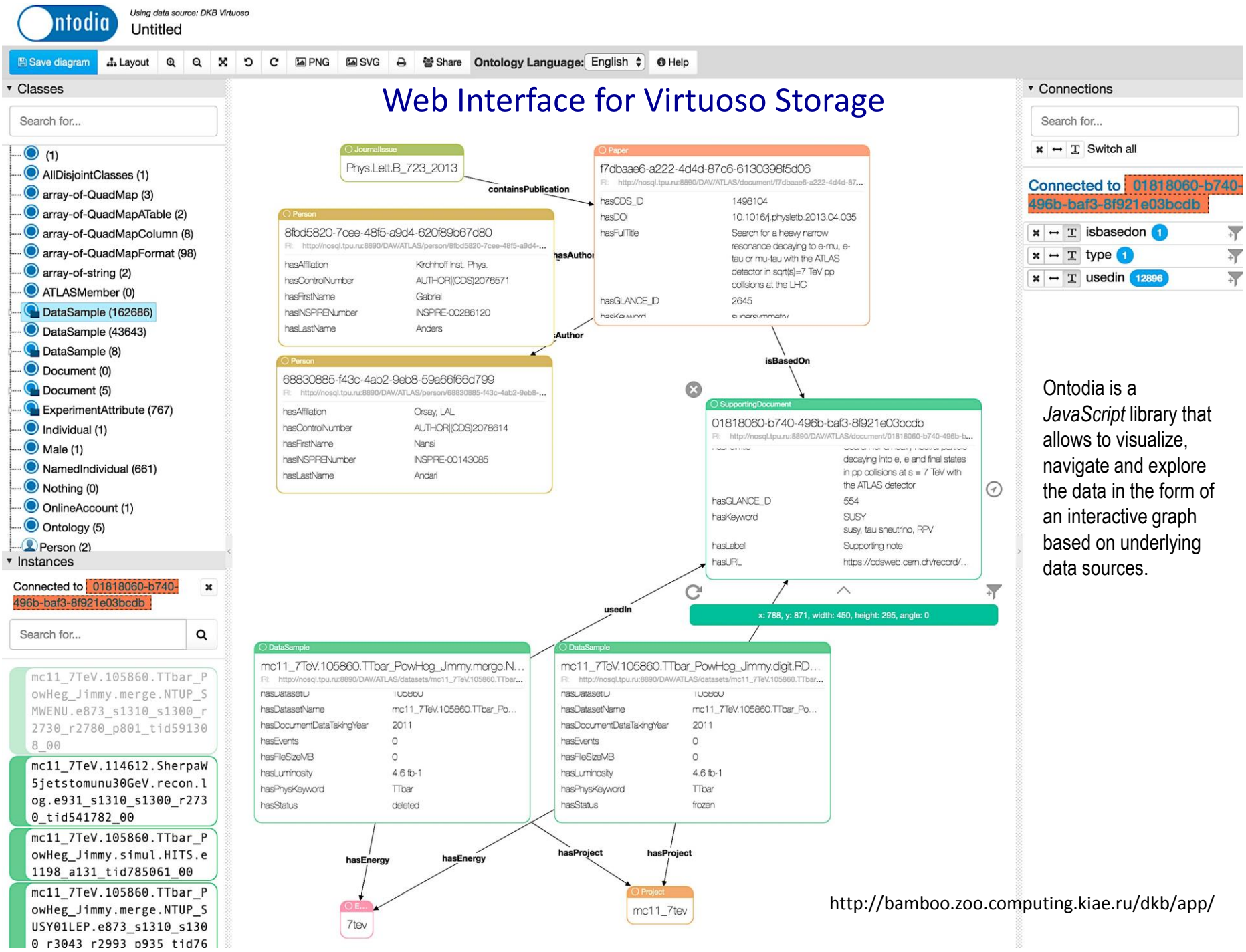



RESOURSE GRAPH:
http://nosql.tpu.ru:8890/DAV/ATLAS

| Subject | Predicate | Object |
|---|---|---|
| Document/CERN-EP-2016-181 | hasType | Paper |
| Document/CERN-EP-2016-182 | hasTitle | Search for dark matter in association with a Higgs boson decaying to b-quarks in pp collisions at sv=13 TeV with the ATLAS detector |
| Document/CERN-EP-2016-183 | hasArXiv | arXiv:1609.04572 |
| Document/CERN-EP-2016-184 | hasKeyword | exotics |
| Document/CERN-EP-2016-185 | isBasedOn | Document/ATL-COM-PHYS-2015-1399 |
| Document/ATL-COM-PHYS-2015-1399 | hasType | SupportingDocument |
| Document/ATL-COM-PHYS-2015-1400 | hasTitle | Search for dark matter in association with a Higgs boson decaying to b-quarks in pp collisions at sv=13 TeV with the ATLAS detector |
| Document/ATL-COM-PHYS-2015-1401 | useGRL | data15_13TeV.periodAllYear_DetStatus-v73-pro19-08_DQDefects- 00-01-02_PHYS_StandardGRL_All_Good_25ns.xml |
| Document/ATL-COM-PHYS-2015-1402 | hasEnergy | 13TeV |
| Document/ATL-COM-PHYS-2015-1403 | hasPublicationYear | 2016 |
| Document/ATL-COM-PHYS-2015-1404 | hasContent | |
| Document/ATL-COM-PHYS-2015-1405 | | Content/ATL-COM-PHYS-2015-1399_Table_19 |
| Content/ATL-COM-PHYS-2015-1399_Table_19 | hasDescription | Monte Carlo samples used as baseline for Standard Model VH(→ bb) |
| Content/ATL-COM-PHYS-2015-1399_Table_20 | mentionsDataSample | DataSample/ATL-COM-PHYS-2015-1399_341100 |
| Content/ATL-COM-PHYS-2015-1399_Table_21 | mentionsDataSample | DataSample/ATL-COM-PHYS-2015-1399_341101 |
| Content/ATL-COM-PHYS-2015-1399_Table_22 | mentionsDataSample | DataSample/ATL-COM-PHYS-2015-1399_341102 |
| DataSample/ATL-COM-PHYS-2015-1399_341100 | hasType | MC |
| DataSample/ATL-COM-PHYS-2015-1399_341100 | hasProject | MC15_13TeV |
| DataSample/ATL-COM-PHYS-2015-1399_341100 | hasDataSampleID | 341100 |
| DataSample/ATL-COM-PHYS-2015-1399_341100 | hasSampleName | Pythia8EvtGen_A14NNPDF23LO_WlvH125_bb |
| DataSample/ATL-COM-PHYS-2015-1399_341100 | hasTag | e3885_s2608_s2183_r6869_r6282_p2419 |

SPARQL Endpoint:
http://nosql.tpu.ru:8890/sparql

# Web Interface for Virtuoso Storage




Ontodia is a *JavaScript* library that allows to visualize, navigate and explore the data in the form of an interactive graph based on underlying data sources.

http://bamboo.zoo.computing.kiae.ru/dkb/app/

# Data Integration Techniques

***Data Consolidation*** captures data from multiple source systems and integrates it into a single persistent data store

+ Optimal performance and stability

- Requested data might be out of date because of the complexity of providiing data synchronization with various data sources

***Data Federation*** provides a single virtual view of one or more source data sources

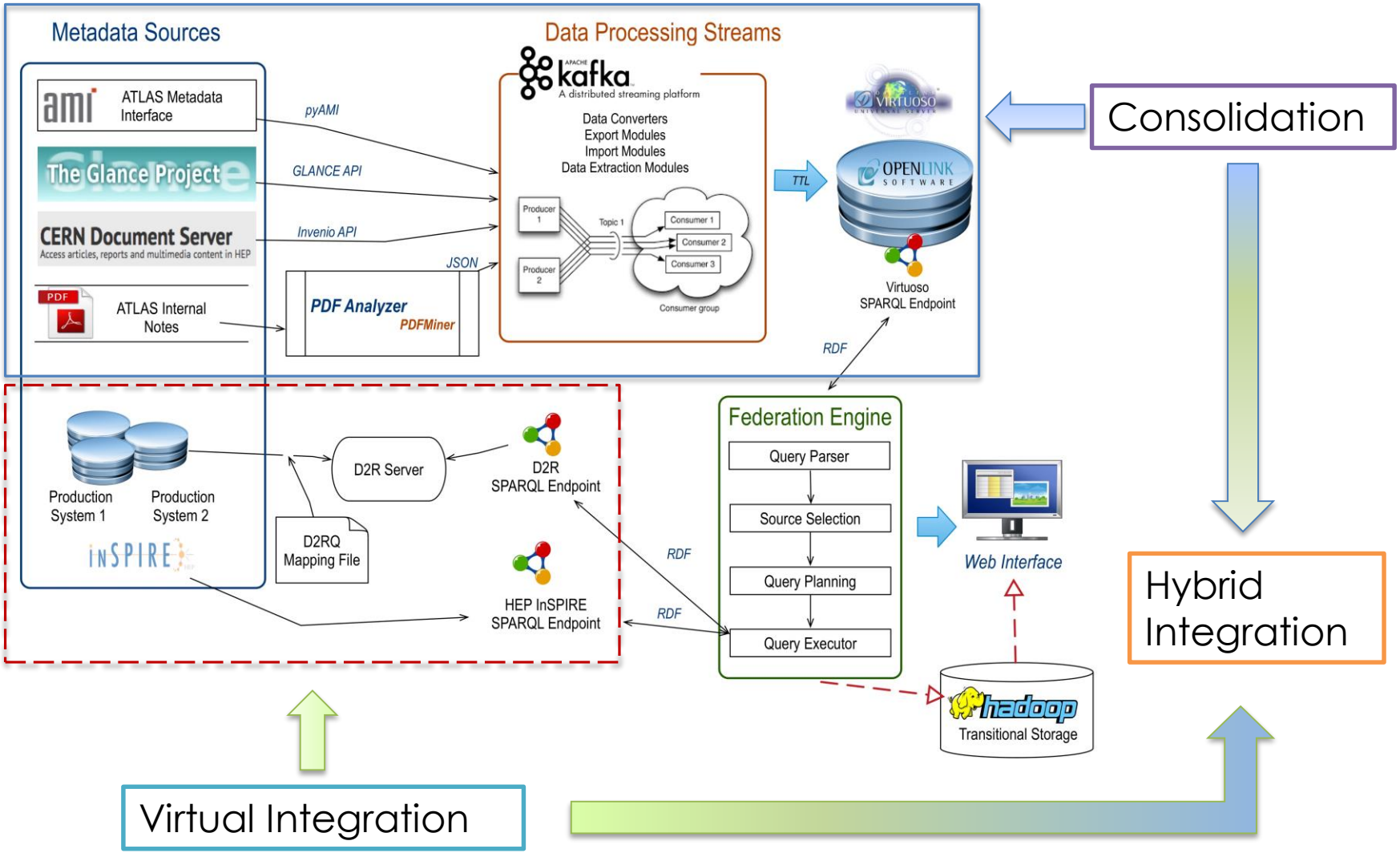
+ Federated requests always return the actual data – data integrity support remains on the data source side

- The performance of federated queries depends on the communication channels and the queries execution rate on the side of data sources

***Hybrid Data Integration:***

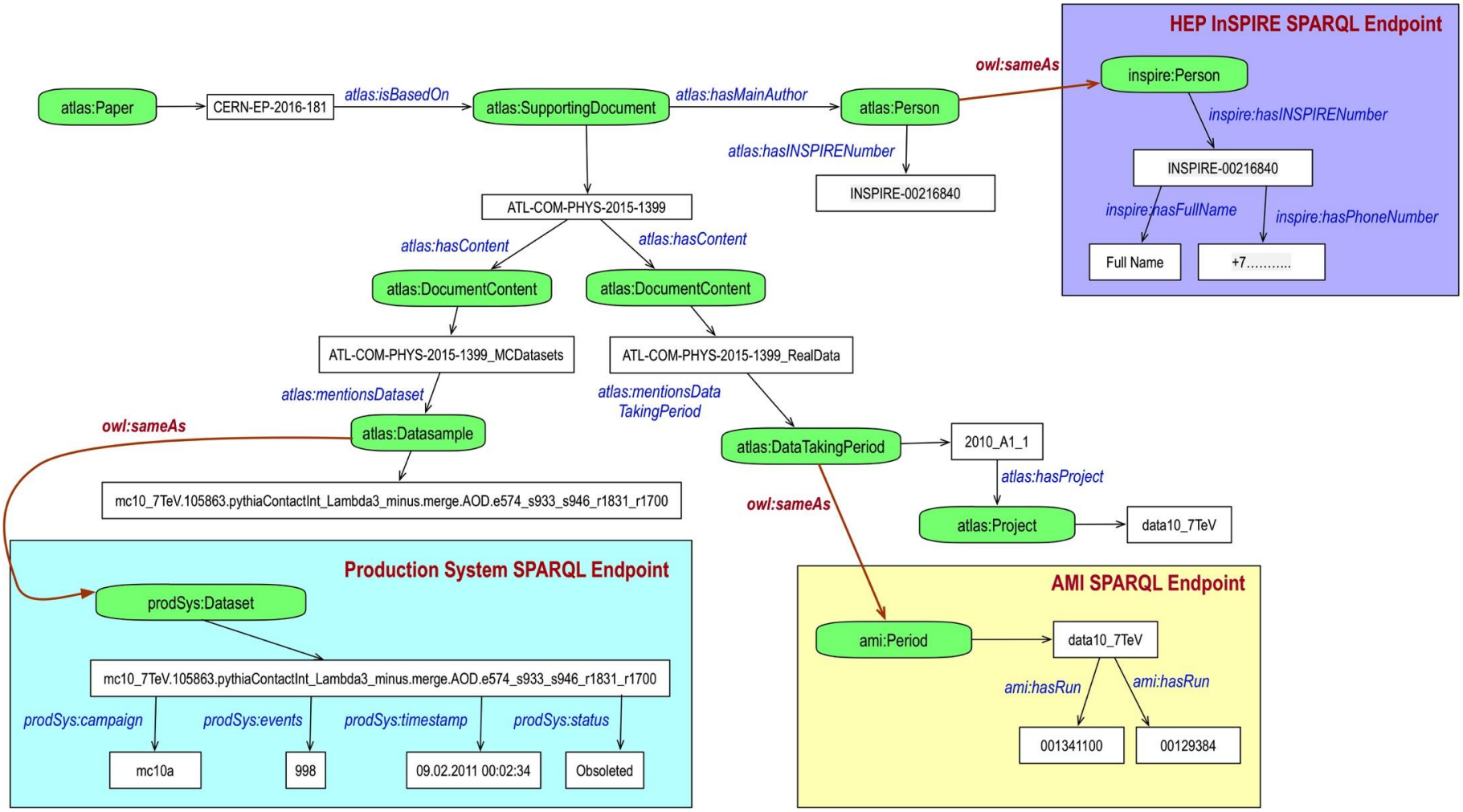
- Unchangeable data about global objects is consolidated:
  - Experiment Attributes
  - Links between documents
  - Documents general parameters from CDS
  - Metadata extracted from document's content
- Changing and auxiliary data is federated:
  - Detailed documents and authors metadata from HEP InSPIRE system
  - Dataset's detailed metadata from ProdSys/AMI/Rucio

# Current architecture prototype v.3






# Federated Requests Prototype







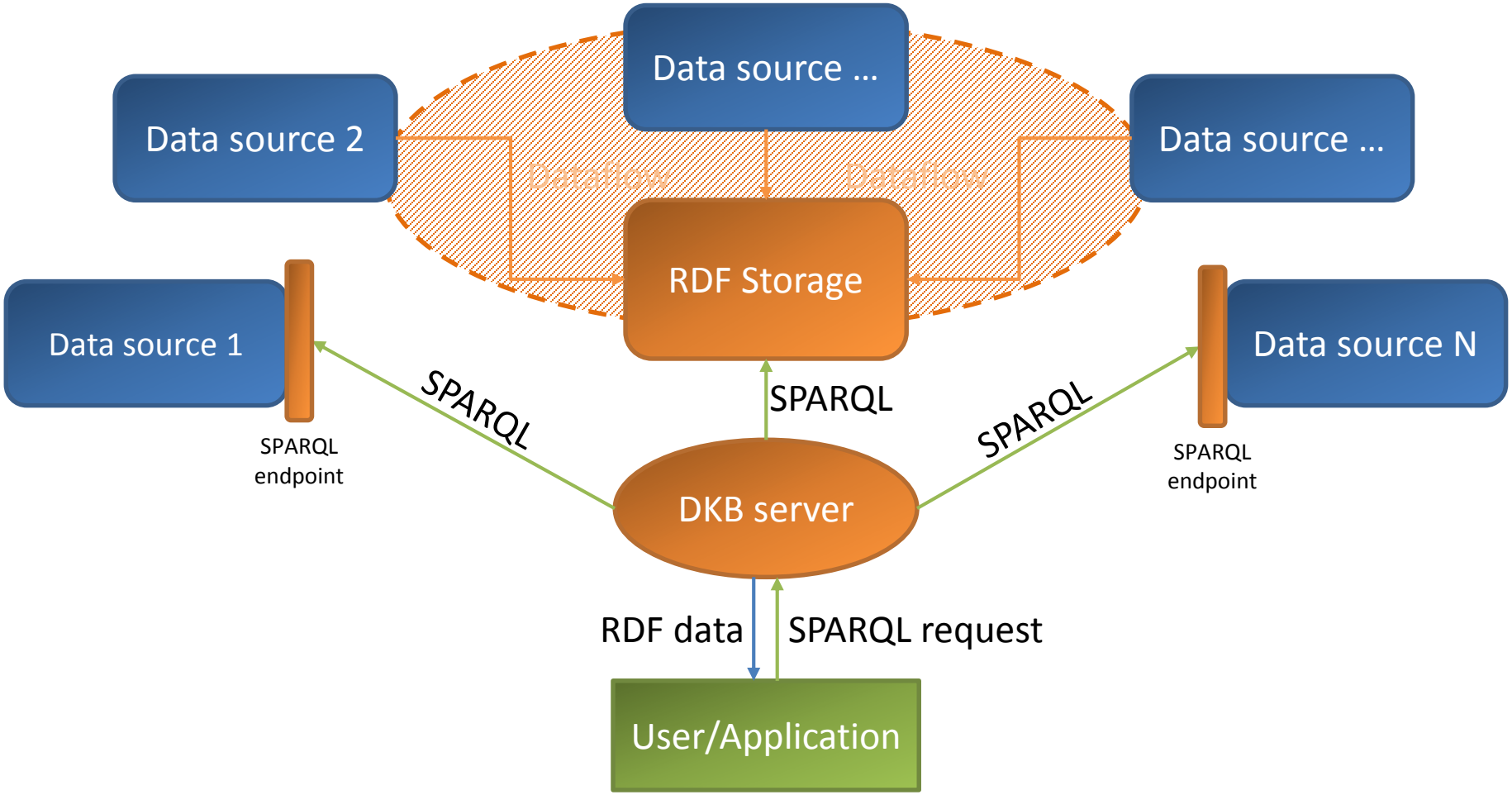





# Dataflow

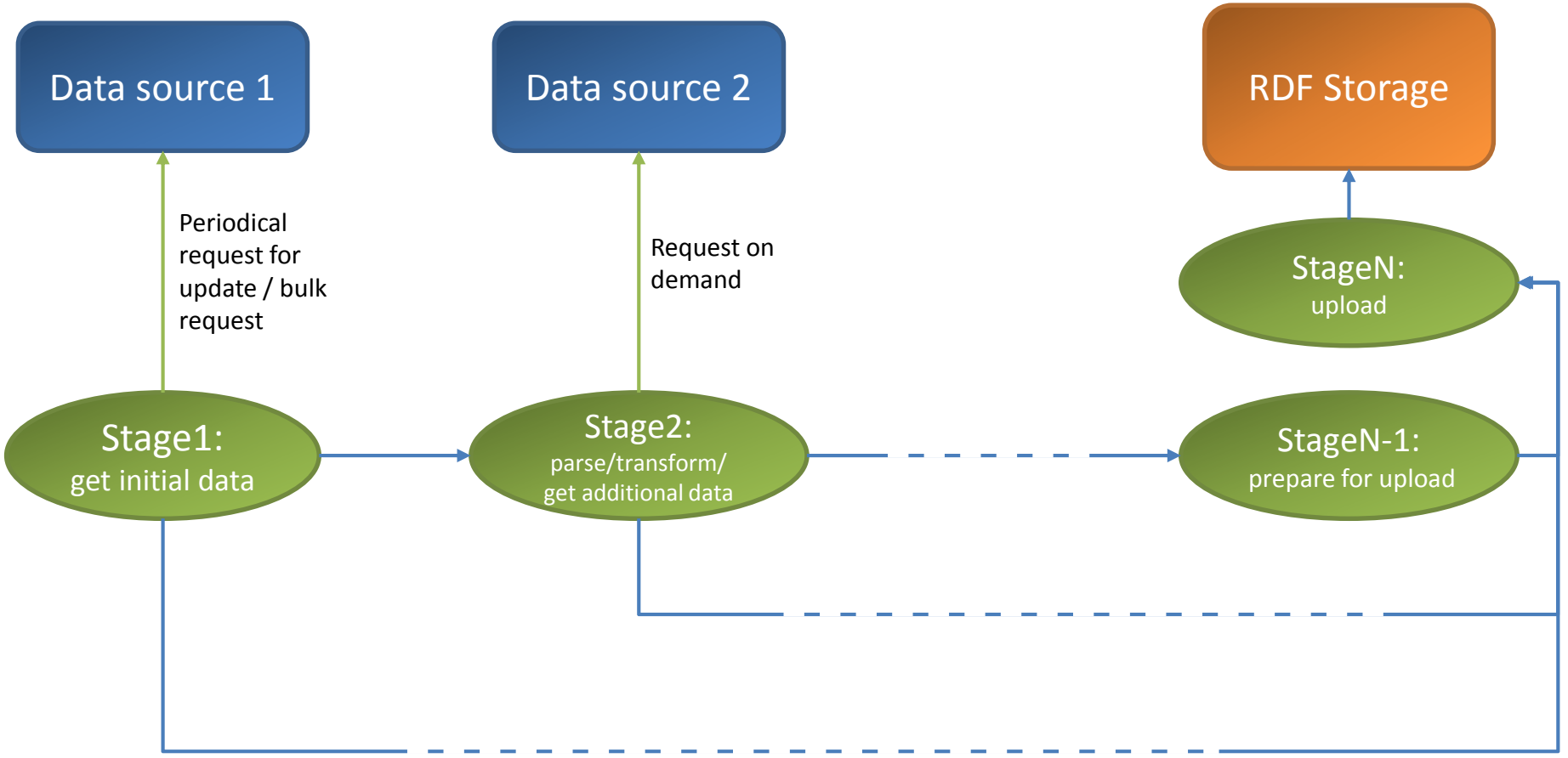
*Marina Golosova (NRC KI)*

# DKB schematic






# Dataflow schematic





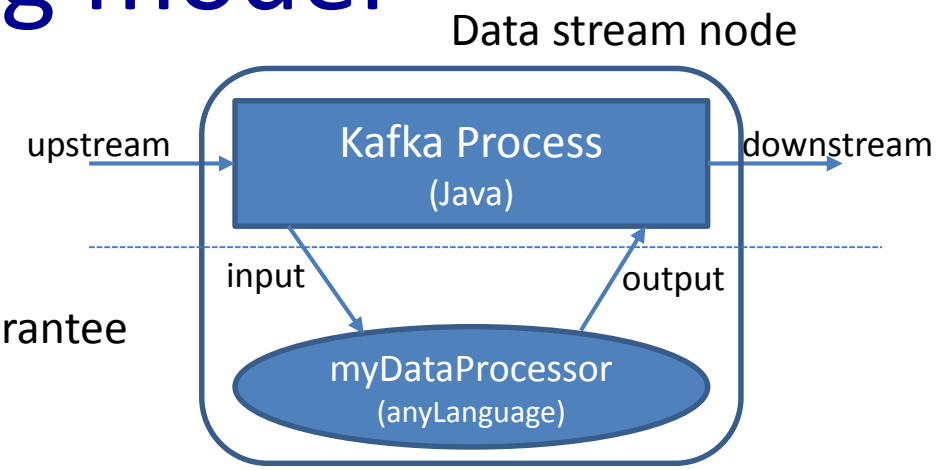

# Dataflow tasks

- Data transfer from "upstream" to "downstream" stages
- Obsolete data removal
- Data preservation between stages
- Guarantee of reprocessing on data/process update
- Processing delay
- Failure recovery



# Streaming model

APACHE kafka™
A distributed streaming platform




- ✓ **Message broker**
  data preservation and delivery guarantee
- ✓ **Stream processing**
  automation and delay minimizing;
  no need to use additional processing systems (Spark, …)
- ✓ **Distributed system**
  scalability and reliability

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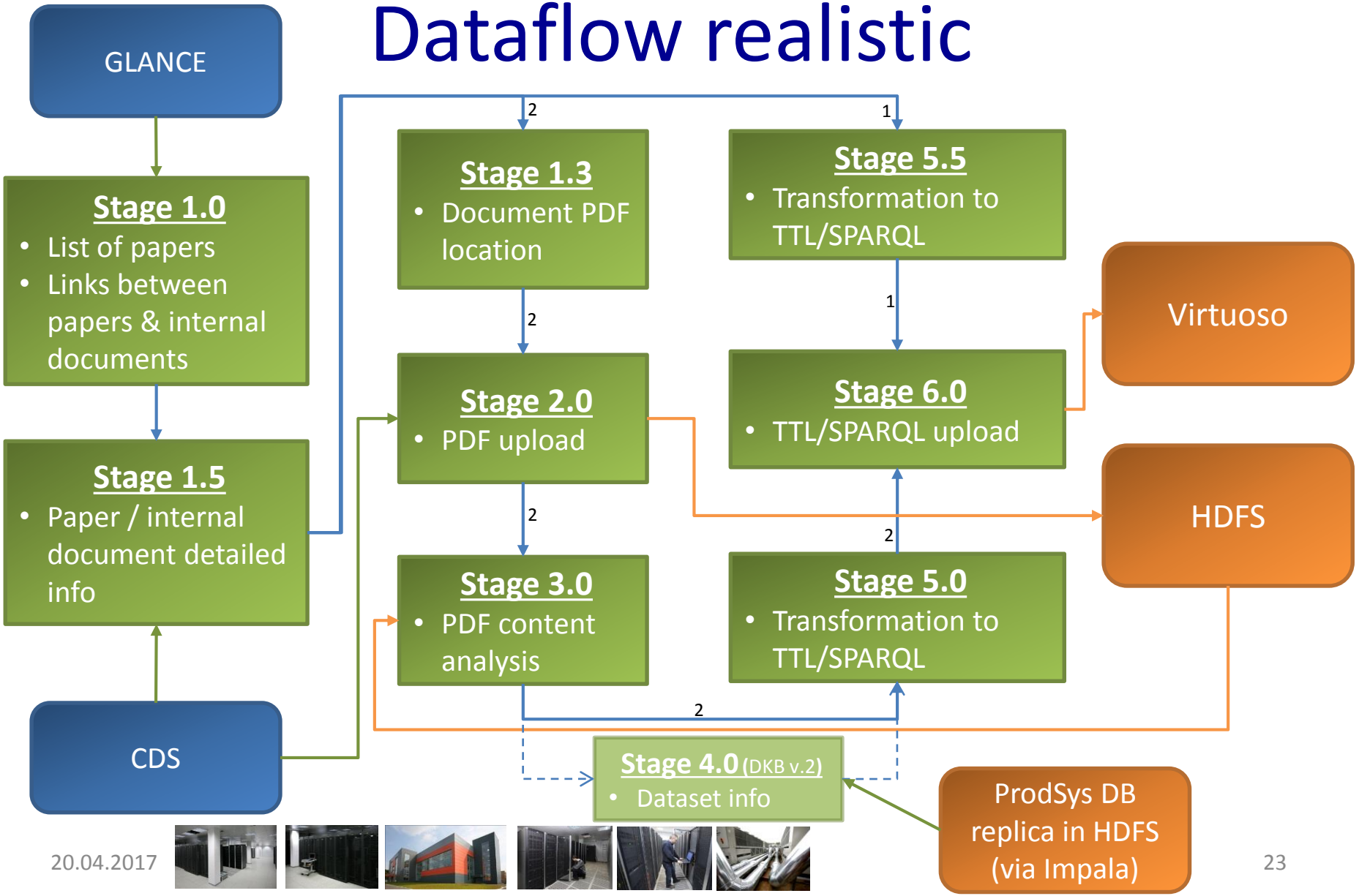
**Developed**: adapters to reuse existing data processing (extracting, transforming, uploading, …) modules within Kafka-driven dataflow
**Developed**: management utility to run the dataflow stages
**Formulated**: basic rules to write dataflow modules (concerning data in/output, mainloop organization, error handling, …)



# Dataflow realistic



# Near term plans

- Continue development of a global integration model of metadata, based on hybrid data integration approach
- Development of the ontological data models for various sources of ATLAS metadata
- Data schemes mismatch conflicts resolution
- Completion of the Kafka Streams dataflows automation components implementation
- Execution of the consolidation dataflow, based on metadata from GLANCE, CDS, PDF Analyzer
- The choice of technology and implementation of a SPARQL endpoint for ProdSys1&2 / Rucio / AMI (?), HEP InSPIRE / CDS (?)
- Enhancing semi-automatic PDF Analyzer functionality: providing better GUI, allowing users to correct the results of automatic data extraction
- Execution of the federated SPARQL requests:
  - get all datasets and their's attributes from ProdSys, which mentions in Supporting Documents for some scientific Paper
  - get all Documents, which refers to data analysis based on real data, taken from detector in 2014, period C
  - get all Documents, having physics group "SUSY", published in 2015 and refers to datasets, which status in ProdSys is "deleted"
  - get detailed information about **main** authors for Paper from InSPIRE and return titles of all theirs ATLAS publications, relates to project "mc10_7TeV"
  - get all Documents where dataset "data11_7TeV.00178044.physics_Egamma.merge.DAOD_2LHSG2.f354_m765_p600" is mentioned, with detailed metadata about this dataset from ProdSys, and find metadata about main authors of this document in InSPIRE

# Questions:

- Which set of parameters is enough to [uniquely] identify data analysis (PhysicsExperiment)
  - Project (ex: mc10_7TeV)
  - Campaign (ex: mc11a)
  - Energy (ex: 10TeV)
  - Integrated Luminosity
  - Physics Group (SUSY, HIGG)
  - Data Taking Period (ex: 2010_A1_1)
- What are the preferred metadata sources for:
  - ATLAS Projects (full description – AMI, Twiki Pages, COMA) ?
  - ATLAS Campaigns (full description – AMI, Twiki Pages, COMA) ?
  - ATLAS Data Taking Periods (AMI, COMA) ?
  - Datasets (ProductionSystem/Rucio/AMI) ?
  - Authors & Publications (CDS/InSPIRE) ?

# Questions:

- Metadata, which must be extracted from PDF Documents:
  - Data Taking Year
  - Projects (MC, Data)
  - Campaigns
  - Physics Groups
  - Good Run Lists
  - Software Release
  - The center-of-mass Energy
  - Integrated Luminosity
- Datasets:
  - MC
    - Full dataset names
    - Dataset ID
    - MC generators
    - AMI tags
    - Type (signal/background)
  - Real Data
    - Full dataset name
    - Data Taking period
    - Run Numbers
    - Triggers



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  - Eygene Ryabinkin
  - Anatoly Tuzovsky



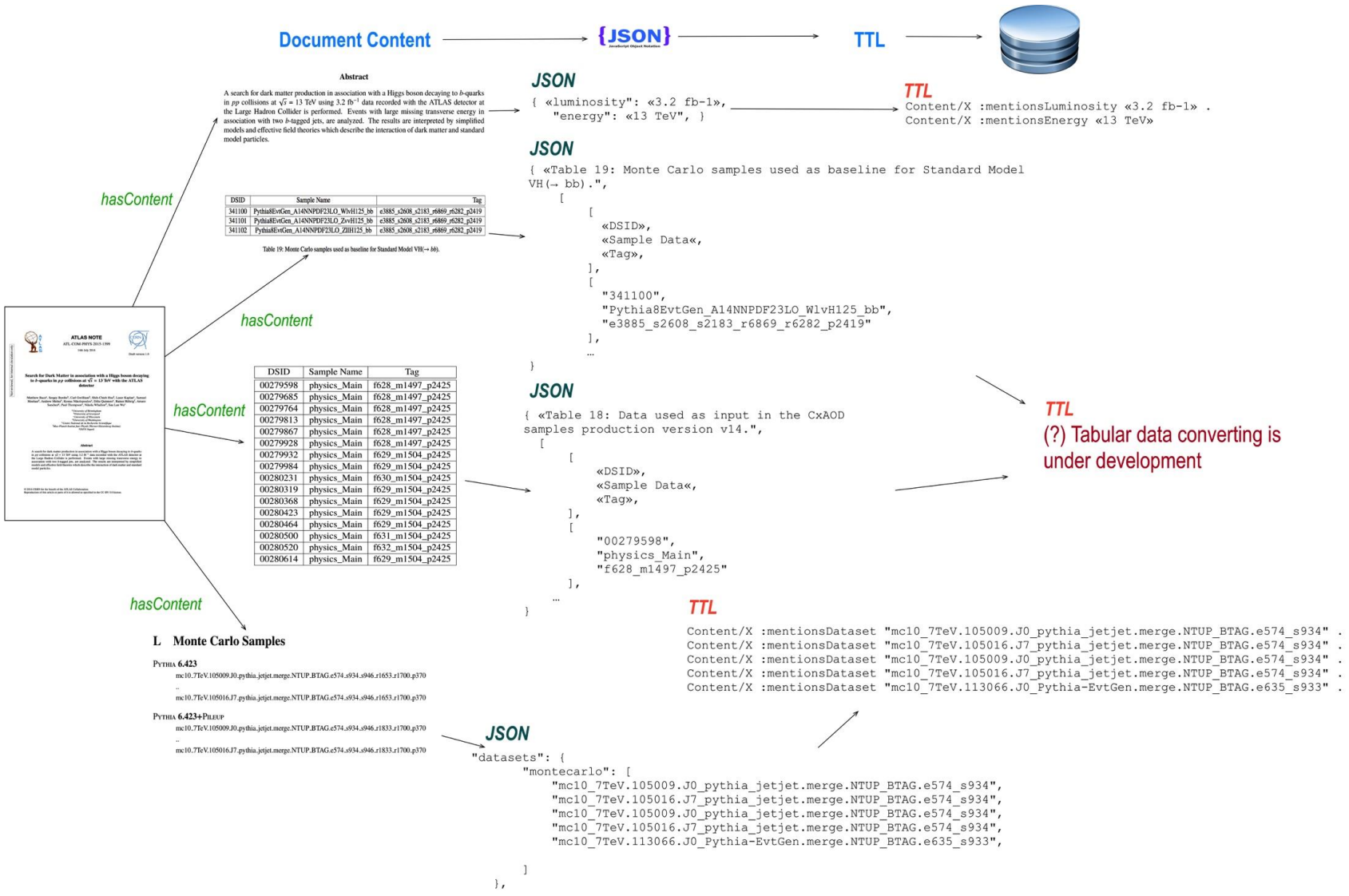







# ADDITIONAL SLIDES

# Document Contents Analysis






# Reconstruction of the real and MC datasets from document content

## B Signal MC Samples

Table 21 shows a full list of signal MC samples of MC11a used in the council conf note. For the paper, MC11b is used. The difference on AMI tag is `r2920_r2900_p756` instead of `r2730_r2700_p756`.

Table 21: List of signal MC samples used (MC11b production).

| | Process | Dataset ID | Generator | Filter | AMI tag |
|---|---|---|---|---|---|
| $m_H$=100 GeV | $gg \to H$ | 116866 | PowHeg | - | e873_s1310_s1300_r2920_r2900_p756 |
| | VBF | 125170 | PowHeg | - | e893_s1310_s1300_r2920_r2900_p756 |
| | $WH$ | 125329 | Pythia | - | e825_s1310_s1300_r2920_r2900_p756 |
| | $ZH$ | 125489 | Pythia | - | e825_s1310_s1300_r2920_r2900_p756 |
| | $t\bar{t}H$ | 116064 | Pythia | PhotonFilter | e893_s1310_s1300_r2920_r2900_p756 |
| $m_H$=105 GeV | $gg \to H$ | 116867 | PowHeg | - | e873_s1310_s1300_r2920_r2900_p756 |
| | VBF | 125171 | PowHeg | - | e893_s1310_s1300_r2920_r2900_p756 |
| | $WH$ | 125330 | Pythia | - | e825_s1310_s1300_r2920_r2900_p756 |
| | $ZH$ | 125490 | Pythia | - | e825_s1310_s1300_r2920_r2900_p756 |
| | $t\bar{t}H$ | 116065 | Pythia | PhotonFilter | e825_s1310_s1300_r2920_r2900_p756 |

Not unique values:
could repeat in
different projects

Campaign Description from AMI

```
…
}, {
   "MC11a": {
      "mc11_7TeV": {
         "digit": {
            "RDO": ["d579", "d580"]
         },
         "merge": {
            "AOD": ["r2700", "r2780"]
         },
         "recon": {
            "*": ["a128", "a131", "a133", "a134",
...]
         }
      }
   }
},
…
```

Project

mc11_7TeV.116866.*.*.*.e873_s1310_s1300_r2920_r2900_p756
mc11_7TeV.125170.*.*.*.e893_s1310_s1300_r2920_r2900_p756
mc11_7TeV.125329.*.*.*.e825_s1310_s1300_r2920_r2900_p756
mc11_7TeV.125489.*.*.*.e825_s1310_s1300_r2920_r2900_p756
mc11_7TeV.116064.*.*.*.e893_s1310_s1300_r2920_r2900_p756

# Reconstruction of the real and MC datasets from document content

**Measurement of underlying event characteristics using charged particle jets in pp collisions at $\sqrt{s} = 7$TeV with the ATLAS detector at the LHC**

All data used in this analysis were taken during the 2010 LHC running period A (run numbers 152166-153200) and period B (run numbers 153565-155160), with the May reprocessing (release 16).

Project Name
"data10_7TeV"

Period's Description from AMI


```
[{"period": "A",
  "periodLevel": "2",
  "projectName": "data10_7TeV",
  "description": "unsqueezed stable beam data
(beta*=10m): typical beam spot width in x and
y is 50-60 microns.",
  "status": "locked"},
{"period": "B",
 "periodLevel": "2",
 "projectName": "data10_7TeV",
 "description": "first squeezed stable beams
(beta*=2m): typical beam spot width in x and y
is 30-40 microns.",
 "status": "locked"}, {
```


Real data

| generator | configuration | sample number |
|---|---|---|
| Pythia 6 | AUET2B | 126169, 126346-126349 |
| Pythia 6 | Z1 | 126172, 126358-126361 |
| Pythia 6 | Perugia2011 | 126170, 126354-126357 |
| Pythia 6 | Perugia2011 NOCR | 126171, 126350-126353 |
| Herwig++ | UE7000 | 113906-113909 |
| Pythia 8.145 | 4C | 108316-108318, 108351, 113118-113125 |

Table 2: EVGEN Monte Carlo samples

underlying physics distributions by using different MC *tunes* (configurations) as control samples. We use Pythia 6 (MC09) as the primary control sample because it has the best available statistics (19.6M events) compared to the data (42.6M events). More information about the MC samples can be found in Table 1.

Project Name
"mc09_7TeV"

MC

# ATLAS NOTE

ATL-COM-PHYS-2010-685

March 9, 2011

## $W \to \mu\nu$ and $Z \to \mu\mu$ cross-sections measurements in proton-proton collisions at $\sqrt{s} = 7$ TeV with the ATLAS Detector

**Abstract**

This paper presents the measurements of $W$, $W^+$ and $W^-$ to muon and $Z \to \mu^+\mu^-$ inclusive cross-sections with the ATLAS detector in proton-proton collisions at $\sqrt{s}=7$ TeV. The results presented are based on an integrated luminosity of 310 nb$^{-1}$ for the W analysis and 331 nb$^{-1}$ for the Z analysis, collected in April-July 2010 with fully operational detector and stable beam conditions. There are 1181 $W$ and 109 $Z$ candidate events in the muon decay channel. The distributions for the main observables are compared to a PYTHIA Monte Carlo simulation at different stages of the selection. We measure $\sigma_W \times BR(W \to \mu\nu) = 9.58 \pm 0.30(\text{stat}) \pm 0.50(\text{sys}) \pm 1.05(\text{lum})$ nb and $\sigma_{Z/\gamma^*} \times BR(Z/\gamma^* \to \mu^+\mu^-) = 0.87 \pm 0.08(\text{stat}) \pm 0.05(\text{sys}) \pm 0.10(\text{lum})$ nb, consistent with the Standard Model expectations.

| Process | Dataset | Generator | Cross-section (pb) | $N_{\text{evt}}$ ($\times 10^6$) | note |
|---|---|---|---|---|---|
| $W \to \mu\nu$ | 106044 | PYTHIA | 10 454 | 7 | |
| $Z \to \mu\mu$ | 106047 | PYTHIA | 989 | 7.9 | $\sqrt{\hat{s}} > 60$ GeV |
| $W \to \tau\nu$ | 106022 | PYTHIA | 10 454 | 5 | single lepton filter ($\varepsilon = 0.877$) times lepton branching ratio |
| $Z \to \tau\tau$ | 106052 | PYTHIA | 989 | 7.9 | $\sqrt{\hat{s}} > 60$ GeV |
| $t\bar{t}$ | 105861 | POWHEG | 161 | 0.2 | $m_t = 172.5$ GeV/c$^2$, single lepton filter $\varepsilon = 0.538$ |
| $b\bar{b}$ | 108405 | PYTHIA | $7.39 \times 10^4$ | 4.4 | 15 GeV/c single muon filter |
| $c\bar{c}$ | 106059 | PYTHIA | $2.84 \times 10^4$ | 1.5 | 15 GeV/c single muon filter |
| J0 | 105009 | PYTHIA | $9.75 \times 10^9$ | 0.4 | 8 < parton $p_T$ < 17 GeV |
| J1 | 105010 | PYTHIA | $6.73 \times 10^8$ | 0.4 | 17 < parton $p_T$ < 35 GeV |
| J2 | 105011 | PYTHIA | $4.12 \times 10^7$ | 0.4 | 35 < parton $p_T$ < 70 GeV |
| J3 | 105012 | PYTHIA | $2.19 \times 10^6$ | 0.4 | 70 < parton $p_T$ < 140 GeV |
| J4 | 105013 | PYTHIA | $8.79 \times 10^4$ | 0.4 | 140 < parton $p_T$ < 280 GeV |
| J5 | 105014 | PYTHIA | $2.33 \times 10^3$ | 0.4 | 280 < parton $p_T$ < 560 GeV |
| J6 | 105015 | PYTHIA | $3.39 \times 10^2$ | 0.4 | 560 < parton $p_T$ < 1120 GeV |
| J0mu | 109276 | PYTHIA | $9.86 \times 10^9$ | 0.5 | 8 GeV/c single $\mu$ filter $\varepsilon = 7.93 \times 10^{-5}$ |
| J1mu | 109277 | PYTHIA | $6.78 \times 10^8$ | 0.5 | 8 GeV/c single $\mu$ filter $\varepsilon = 1.23 \times 10^{-3}$ |
| J2mu | 109278 | PYTHIA | $4.10 \times 10^7$ | 0.5 | 8 GeV/c single $\mu$ filter $\varepsilon = 5.44 \times 10^{-3}$ |
| J3mu | 109279 | PYTHIA | $2.20 \times 10^6$ | 0.5 | 8 GeV/c single $\mu$ filter $\varepsilon = 1.29 \times 10^{-2}$ |
| J4mu | 109280 | PYTHIA | $8.77 \times 10^4$ | 0.5 | 8 GeV/c single $\mu$ filter $\varepsilon = 2.22 \times 10^{-2}$ |
| J5mu | 109281 | PYTHIA | $2.35 \times 10^3$ | 0.5 | 8 GeV/c single $\mu$ filter $\varepsilon = 2.98 \times 10^{-2}$ |

Table 2: Monte Carlo samples used in this note. The cross-sections quoted are the ones used to normalize estimates of expected number of events. The cross-sections for the QCD samples ($b\bar{b}$, $c\bar{c}$, and the JX samples) are directly from PYTHIA. Sources for the other cross-sections are discussed in the text.

| | Integrated Luminosity (nb$^{-1}$) | |
|---|---|---|
| Run number range | W GRL | Z GRL |
| A-C: 152844-156682 | 16.65 | 17.60 |
| D1: 158045-158392 | 26.89 | 28.64 |
| D2: 158443-158582 | 29.03 | 31.76 |
| D3: 158632-158975 | 32.85 | 34.71 |
| D4: 158041-159086 | 79.40 | 87.82 |
| D5: 159113 | 28.04 | 28.38 |
| D6: 159179-159224 | 97.05 | 101.85 |
| Total: 152844-159224 | 310.0 | 330.8 |

Table 1: Integrated luminosity for the runs in periods A to D for the W and Z Good Run Lists. The total integrated luminosity for this dataset is 310.0 nb$^{-1}$ for the W and 330.8 nb$^{-1}$ for the Z.

# NodeJS Web Interface Prototype (previous)

Data Knowledge Base for ATLAS | Home | About | Contact

Data Knowledge Base Prototype for ATLAS Collaboration. Processing papers & internal documents full text, search data samples, used in the data analysis.

Paper

| | |
|---|---|
| **document** | http://nosql.tpu.ru:8890/DAV/ATLAS/document/95f92719-1075-418b-810b-ed2ab8c82223 |
| **type** | http://nosql.tpu.ru/ontology/ATLAS#Paper |
| **fullTitle** | Search for a heavy narrow resonance decaying to e-mu, e-tau or mu-tau with the ATLAS detector in sqrt(s)=7 TeV pp collisions at the LHC |
| **creationDate** | 2012-12-07T07:39:39 |
| **abstract** | This letter presents the results of a search for a heavy particle decaying into an $e^\pm \mu^\mp, e^\pm\tau^\mp$, or $\mu^\pm\tau^\mp$ final state in pp collisions at $\sqrt{s}$ = 7 TeV. The data were recorded with the ATLAS detector at the LHC during 2011 and correspond to an integrated luminosity of 4.5/fb. No significant excess above the Standard Model expectation is observed, and exclusions at 95% confidence level are placed on the cross section time branching ratio for the production of an R-parity-violating supersymmetric tau sneutrino. These results considerably extend constraints from Tevatron experiments. |
| **DOI** | 10.1016/j.physletb.2013.04.035 |
| **GLANCE_ID** | 2645 |
| **ArXivCode** | arXiv:1212.1272 |
| **CDSInternal** | ATLAS-SUSY-2012-20-004 |
| **keywords_list** | experimental results<br>lepton production<br>supersymmetry |

Supporting Document

| | |
|---|---|
| **label** | Supporting note |
| **URL** | https://cdsweb.cern.ch/record/1473263 |
| **GLANCE_ID** | 554 |

Get Datasets

Datasets

mc11_7TeV.105860.TTbar_PowHeg_Jimmy.digit.RDO.e873_s1310_s1300_d580_tid541913_00
mc11_7TeV.105860.TTbar_PowHeg_Jimmy.digit.log.e873_s1310_s1300_d580_tid541913_00
mc11_7TeV.105860.TTbar_PowHeg_Jimmy.evgen.EVNT.e1105_tid730643_00
mc11_7TeV.105860.TTbar_PowHeg_Jimmy.evgen.EVNT.e1198_tid784995_00
mc11_7TeV.105860.TTbar_PowHeg_Jimmy.evgen.EVNT.e1198_tid784996_00
mc11_7TeV.105860.TTbar_PowHeg_Jimmy.evgen.EVNT.e873_tid491343_00
mc11_7TeV.105860.TTbar_PowHeg_Jimmy.evgen.EVNT.e873_tid645914_00
mc11_7TeV.105860.TTbar_PowHeg_Jimmy.evgen.EVNT.e873_tid648301_00
mc11_7TeV.105860.TTbar_PowHeg_Jimmy.evgen.log.e1105_tid730643_00
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mc11_7TeV.105860.TTbar_PowHeg_Jimmy.evgen.log.e873_tid648301_00
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mc11_7TeV.105860.TTbar_PowHeg_Jimmy.merge.AOD.e873_a131_s1353_a139_r2900_tid600627_00
mc11_7TeV.105860.TTbar_PowHeg_Jimmy.merge.AOD.e873_s1310_s1300_r2730_r2700_tid517950_00
mc11_7TeV.105860.TTbar_PowHeg_Jimmy.merge.AOD.e873_s1310_s1300_r2730_r2700_tid517951_00
mc11_7TeV.105860.TTbar_PowHeg_Jimmy.merge.AOD.e873_s1310_s1300_r2730_r2780_tid541655_00
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