

# The IMPEX Data Model and Protocol

*A common standard for the analysis of simulated and observational space plasma physics data*

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- 3) Centre National de la Recherche Scientifique, France (CESR-CDPP; LATMOS)
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## Scientific focus of IMPEX: plasma and magnetic environments of...

- **Mercury** (BepiColombo)
- **Venus** (VenusExpress)
- **Earth** (Cluster, Themis)
- **Mars** (MarsExpress)
- **Jupiter** and **Ganymede** (Galileo, JGO)
- **Saturn** and **Titan** (Cassini)
- **Comet 67P** (Rosetta)

## IMPEX enables

- **Selection, downloading, visualization and analysis** of data from **observations and modelling runs**
- Support in **finding matching modelling runs** and **request of specific runs**
- **Superimposing** modelling data with spacecraft measurements (*visual*)
- **Scientific tools and functionalities** for the support of preparation and operation of space missions (**virtual spacecraft** in modelled environment, *3DView*)

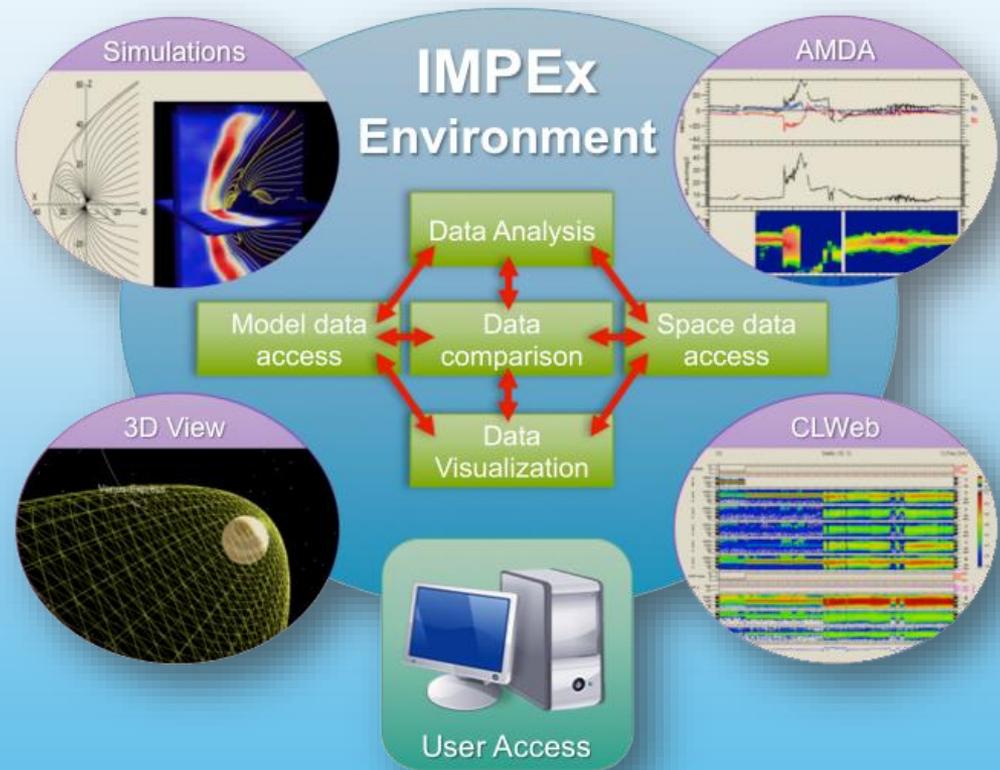
## Relation between the *current* set of models, tools and databases in IMPEX

### Simulation Models and Databases

- **3D hybrid & MHD** platforms  
(*FMI*, Finland)
- **3D hybrid code** (*CNRS/LATMOS*)
- **Paraboloid Magnetospheric Model**  
(*SINP*, Russia)

### IMPEX enabled tools

- **AMDA** sci. data access  
(*CNRS/IRAP-CDPP*)
- **3DView** visualization
- **CLWeb** data analysis
- **IMPEX Portal** (*under construction*)



## Mandatory features of the IMPEX infrastructure

- **Extendibility** (easily adding of **new models, databases and analysis tools**)
- In-line with **worldwide trends and standards** (e.g. *IVOA*)
- **Generality** of approaches and **interoperability** with existing tools
- **Web-based** applications in a **service-oriented** environment

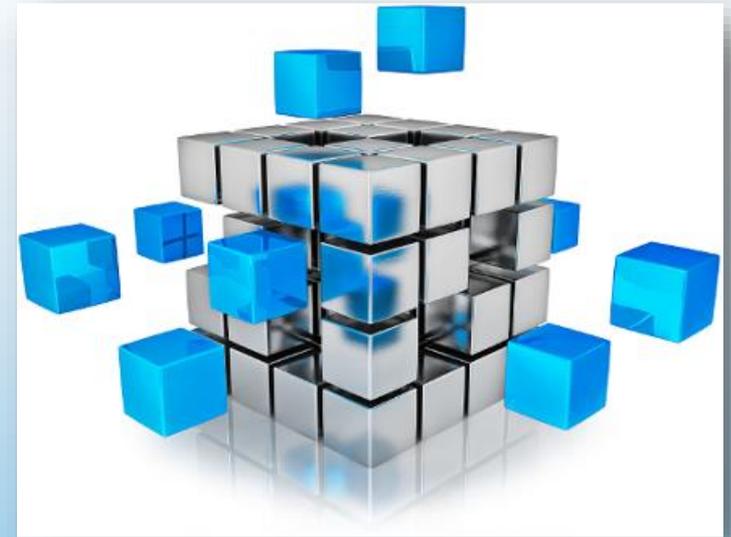


Can be seen as a prototype for a *general infrastructure* capable of operating a broad spectrum of *data and models*.

# The IMPEX Data Model

<http://impex-fp7.oeaw.ac.at>

- ❖ A common **metadata standard** was developed for the description of **simulation models** and **archived datasets**.
- ❖ **IMPEX Data Model** is based on **SPASE** (xml) that originated from the **Heliospheric community**.
- ❖ **SPASE** was developed for the **description of observational data**
- ❖ Ideal to add ability to describe respective simulation data on top and use it as a **unified Data Model** in the context of IMPEX.



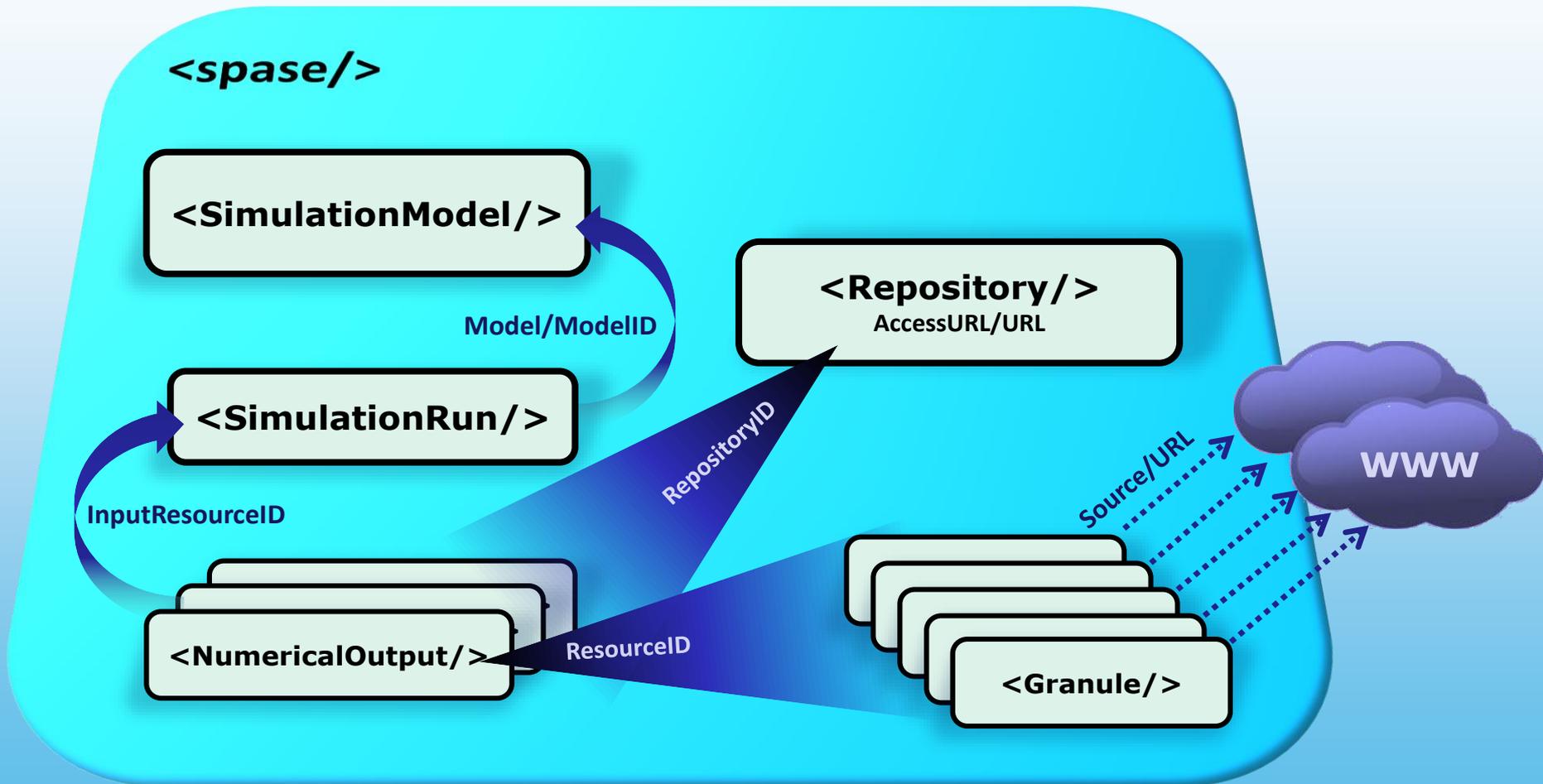
# The IMPEX Data Model

<http://impex-fp7.oeaw.ac.at>

- ❖ First **consistent data model** to unify **observational data** and **simulation outputs**
- ❖ Based on **SPASE 2.2.8 - Version 1.3** available since **July 2015**
- ❖ **Main components** of the are:
  - **<SimulationRun/>** Information about the **parameters used for the run**, refers to **detailed model description**
  - **<SimulationModel/>** Information about the simulation model, tracks the **version** used
  - **<NumericalOutput/>** Detailed information about a set of data files, refers to **simulation run** that generated the dataset.
  - **<Granule/>** Basic information about a data file (defines order within a data set) - refers to the **actual file and data set** containing the numerical output
- ❖ **Further extensions** regarding e.g. large data sets are being discussed for the **next update** (v1.4, 2017?).
- ❖ **IMPEX DM** scheduled to be integrated into **next major update of SPASE**

# The IMPEX Data Model

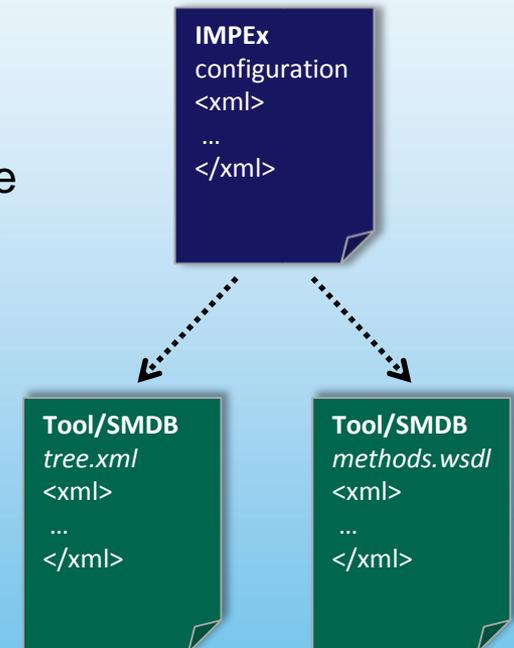
<http://impex-fp7.oeaw.ac.at>



# IMPEX Protocol

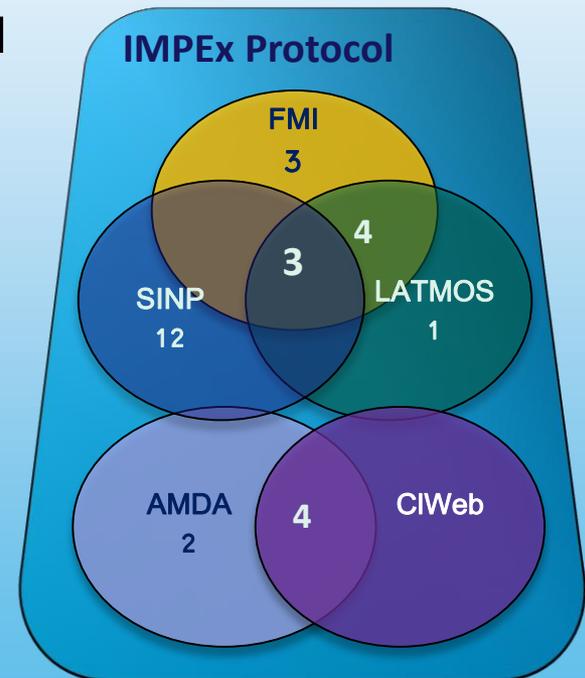
## Central configuration file for access to methods and data

- ❖ The **IMPEX configuration file** (*impexconf.xml*) contains basic access information for every tool and every SMDB
  - The configuration file is **existing only once** for the whole system, the **caching policy** is part of the definition (see **Technical Documentation** on website)
  - Also includes the **technical protocol** to use for access and **basic information** about the service
- ❖ All data is accessible via the (static) **tree.xml** files. All data in the trees is stored **compliant with IMPEX DM**
- ❖ All available functionalities and methods are **accessible as a web service** as defined in the *methods.wsdl* file



## Common set of web services for SMDB and Tools access

- ❖ A very **challenging task** – diverse software systems (SMDBs) had to be unified under a common umbrella, i.e. **communication protocol**
- ❖ There are **28 methods** defined in total, **3 are shared** between all SMDBs and constitute the **core part**
  - **getDataPointValue**: Generic method to return data from 0D (given point) up to 3D (volume)
  - **getSurface**: Generates a meshgrid and compute interpolation for one or several parameters.
  - **getDataPointValueSpacecraft**: Interpolates simulation values along a given (spacecraft) *trajectory*.
- ❖ **AMDA** provides further methods for **data exchange** (i.e. *virtual workspace*).



## Usage of standard exchange formats and communication protocols

❖ The **main exchange formats** used by all methods defined in *method.xml* file are:

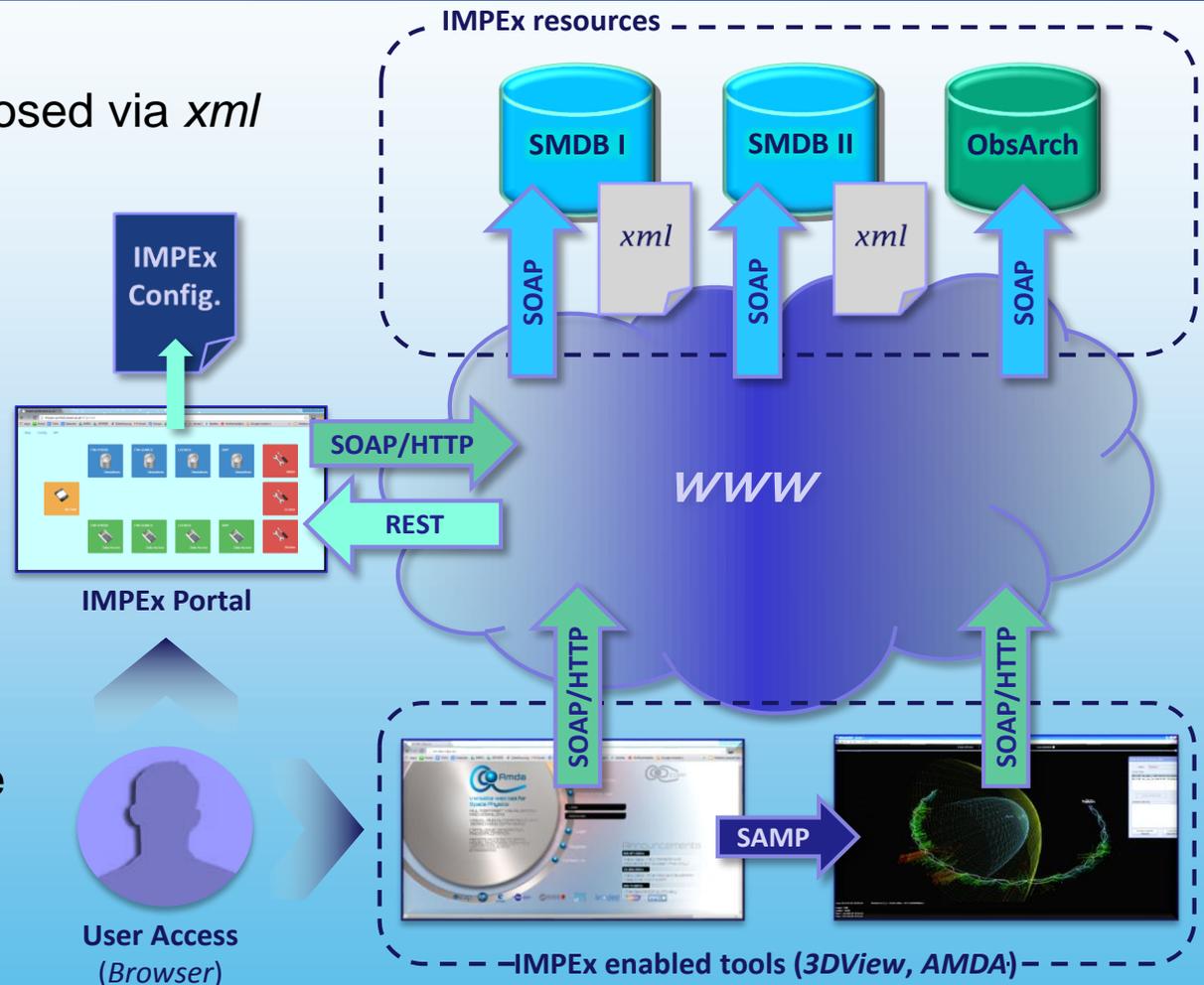
- **VOTable** - XML standard for the interchange of data represented as a set of tables
- **NetCDF** - software libraries and self-describing, machine-independent data formats

❖ On the client side **IMPEX uses SAMP** (*Simple Application Messaging Protocol*) for **inter-tool communication**

- **AMDA** and **3DView** use e.g. *SAMP* to exchange commands and data



- ❖ **Database structures** exposed via *xml* (**IMPEX DM**)
- ❖ **Web Service interface** (**SOAP/REST**)
- ❖ **IMPEX enabled tools**
- ❖ **Central administration** via **IMPEX configuration**
- ❖ **Central Access** to **SMDB's** via **IMPEX Portal**
- ❖ **SAMP Hubs** for client side communication



<http://impex-fp7.oeaw.ac.at>

## IMPEX Webpage

<http://impex-fp7.oeaw.ac.at>

Developed by **IWF-Team** in **Graz**  
based on *Typo3 CMS*.

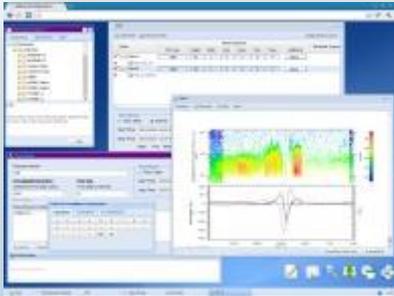
## Information about

### ❖ Technical Documentation

- ❖ Project activities and news
- ❖ Project meetings
- ❖ Publications and talks
- ❖ Project science news
- ❖ Collaborations with other projects
- ❖ Podcast

# The IMPEX Tool-Set

<http://impex-fp7.oeaw.ac.at>



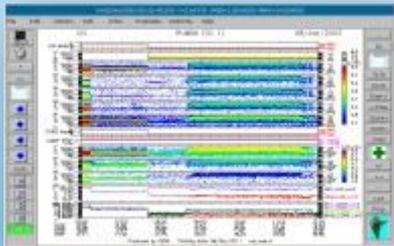
**AMDA** - <http://cdpp-amda.cesr.fr/>



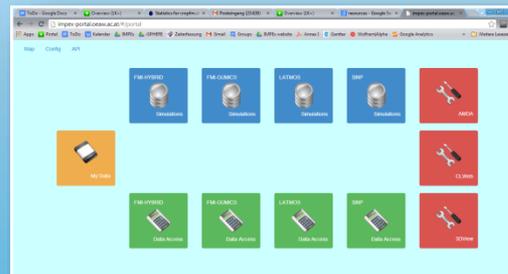
**HWA** - <http://hwa.fmi.fi/>



**3DView** - <http://3dview.cesr.fr/>



**CLWeb** - <http://clweb.cesr.fr/>



**Portal** - <http://impex-portal.oeaw.ac.at>

**Space Monitoring Data Center**  
Shubertov Institute of Nuclear Physics MSU

Physical value	UNIT	Units, limits
Universal time	23	hour, 0-23
Year	1965	year
Month	11	months, 1-12
Day	23	months, 1-31
Solar wind density	10	1/cm <sup>3</sup> , 0-100
Solar wind velocity	340	km/s, 0-2000
Bz-component of the IMF	5	nT, -50-+50
Dst-index	140	nT, -600-+50
A1-index	400	nT, -2000-+50

Coordinates of the point where calculations are performed  
 X= 7 Earth's radii  
 Y= 2 Earth's radii  
 Z= 0 Earth's radii

**SINP** - <http://smdc.sinp.msu.ru/>

