

# Tutorial 1

## The Data IMPORT Functionality of the Integrated Nonlinear Analysis (INA) tool

INA is a toolbox designed to analyze spacecraft and geomagnetic time-series provided by various databases. INA is customized to ingest data files formatted for specific spacecraft (Cluster, Ulysses, Venus Express and ACE) or Geomagnetic Indices (AE and Dst). Although INA will not interrogate itself the databases, the IMPORT functions are adapted to the precise format of data available from the ESA and NASA databases. INA is also able to ingest general CDF, ASCII and .MAT files. In addition to external data, INA can also generate custom synthetic signals. There is also a section devoted to importing data files that have been previously exported from INA, which can be used to easily exchange and visualize specific analysis results. For other file types or formats, the user can check the section labeled **OTHER**, where he can also make requests for specific file formats to be implemented in future versions.

The data import functionality is divided into four levels giving the user the chance to choose the Data Type (from spacecraft, from file, synthetic, other) -> Mission -> Experiment -> Data Source as shown in the diagram below:

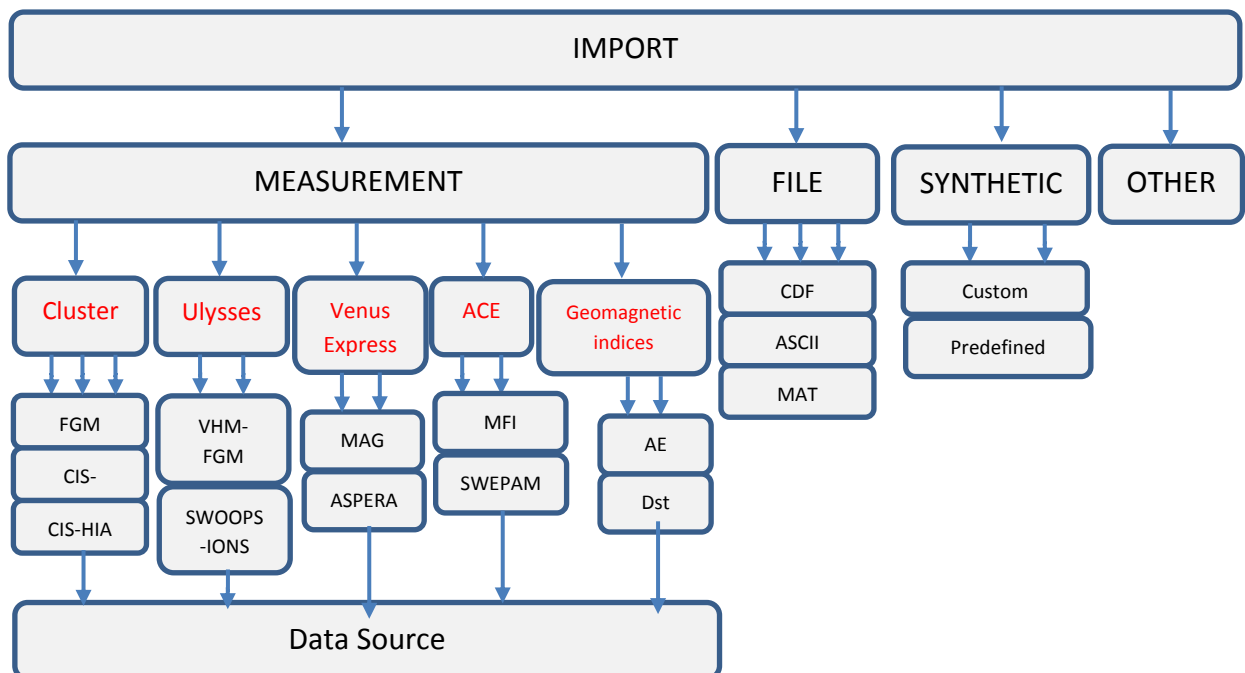


Diagram depicting the structure of the import functionality currently implemented in INA.

All throughout INA, the left panel is a general, “fixed” panel, permanently displayed by INA, which allows a quick navigation between data import, time selection and various types of analysis. The central panel is context sensitive and displays the analysis results or brief explanations of the functionality of the panel at the right of the window. The panel at the right is the “control” panel, and its content changes with the selected INA functionality. Figure 1 shows the INA page that opens when the user clicks “IMPORT” in the left menu.

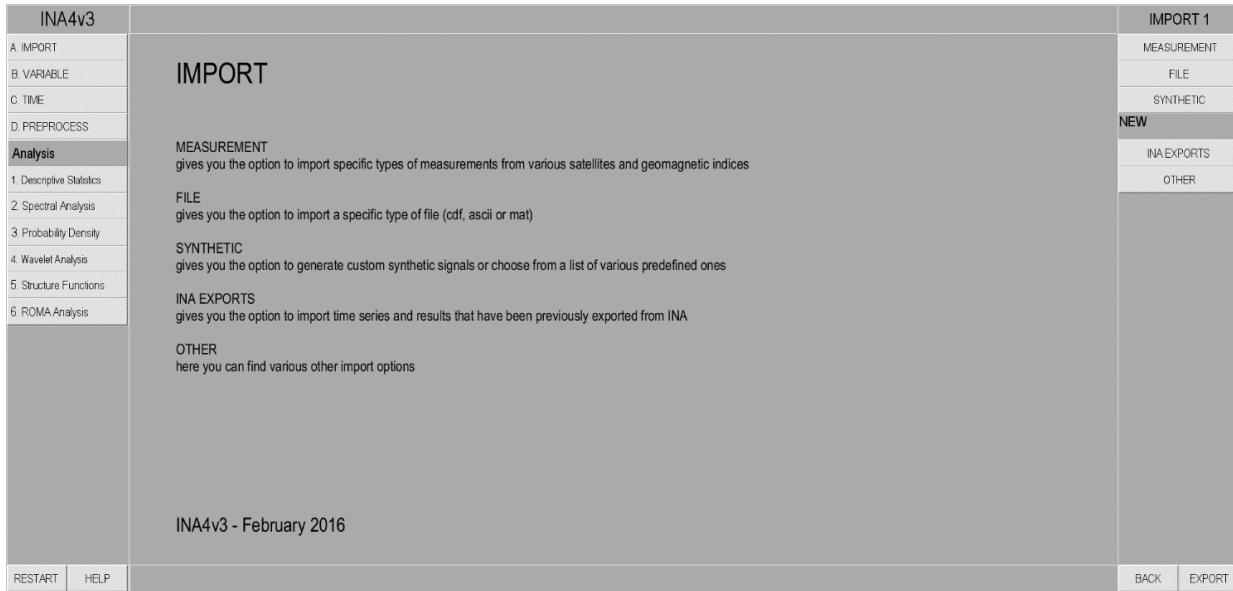


Figure 1. Main page of the IMPORT functionality. The left panel is a general “fixed” panel displayed permanently by INA; it allows a quick navigation between data import, time selection and various types of analysis. The central part of the window is context sensitive and displays a brief explanation on the functionality of the panel at the right of the window. The panel at the right is the “control” panel, and its content changes with the selected INA functionality. In the example shown above the “control” panel displays options relevant for the IMPORT functionality, i.e. links to five different types of uploadable data: (1) data provided by measurements performed by spacecraft and available from a local directory, (2) data stored by the user in some local directory, (3) synthetic times series customized by the user or selected from 10 predefined signals; (4) data saved previously by INA, (5) other types of data – to be defined in the future.

This page is devoted to importing various types of data. Below we give a short description of the menu inserted in the right hand side of the page:

1. **MEASUREMENT** – gives the user the option to import specific measurements provided by solar system plasma missions and WDCs for Geomagnetism. Currently the user has a choice between the missions (Cluster, Venus Express, Ulysses, ACE) and Geomagnetic Indices (AE, Dst) targeted by the FP7 project STORM.

2. **FILE** - this option gives the user the possibility to load three different types of data files: CDF, ASCII, MAT. The latter is a binary format specific for matlab. (Note that for the case of the ASCII file import there are some restrictions regarding to the file structure.)

3. **SYNTHETIC** – offers the possibility to define a synthetic signal or to choose between ten predefined ones.
4. **INA EXPORTS** – this functionality is defined for loading data files previously exported from INA itself.
5. **OTHER** – this section is dedicated to other file types and formats, mainly a developer tool.

This short tutorial focuses on the functionality of the **MEASUREMENT** section. Thus we follow the sequence of windows and options linked to this functionality. The **HELP** pages include however some details on the other sections. Note also that the structure of all other sections follows the same principles as the **MEASUREMENT** layer. Besides the main **HELP** functionality, we also integrate help pages at any **IMPORT** level for a quick info on the functionality associated with the various buttons.

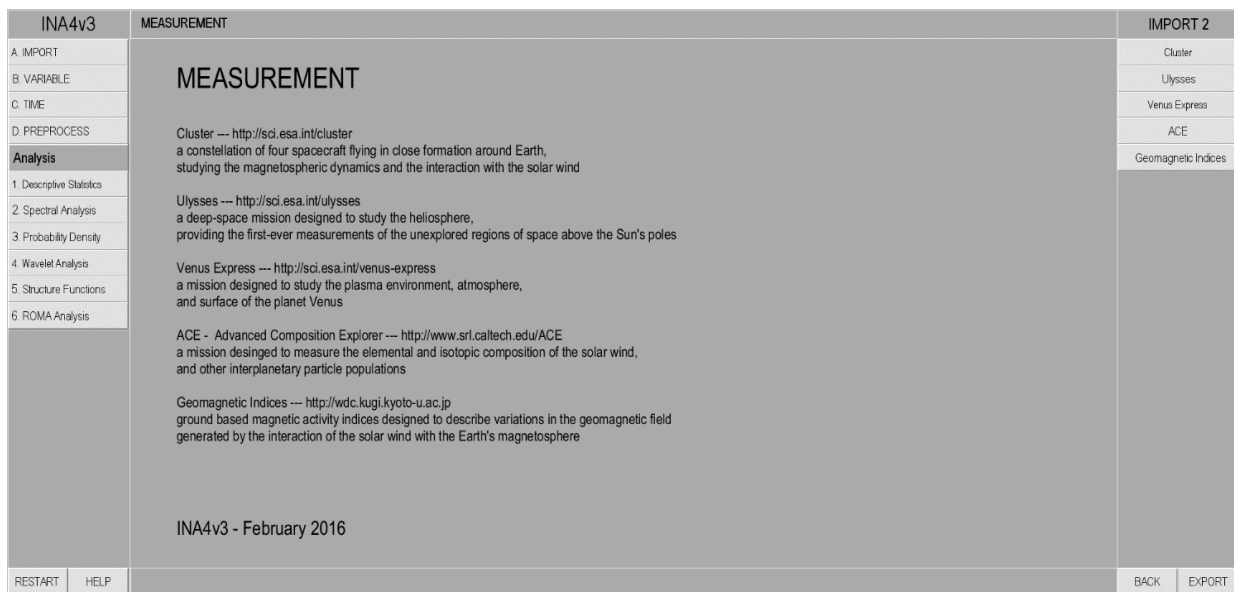


Figure 2. If the user selects “MEASUREMENT” on the right panel of Figure 1, a new page opens and is shown in this figure. The left panel is unchanged as described in Figure 1, the central panel displays some indications on the functionality of the buttons included in the right panel. The latter offers the possibility to select five different data providers, four spacecraft (Cluster, Ulysses, Venus Express, ACE) and one ground based (geomagnetic indices)

If the user chooses to upload data from measurements provided by spacecraft and clicks “MEASUREMENT” in the right panel shown in Figure 1, a new window opens as displayed in Figure 2. It gives access to interfaces designed to upload data provided by four spacecraft and one ground based databases:

1. **Cluster** - a constellation of four spacecraft flying in close formation around Earth, studying the magnetospheric dynamics and the interaction with the solar wind (<http://sci.esa.int/cluster>). The main data repository for Cluster is maintained by ESA at <http://www.cosmos.esa.int/web/csa>.

2. **Ulysses** - a deep-space mission designed to study the heliosphere, providing the first-ever measurements of the unexplored regions of space above the Sun's poles (<http://sci.esa.int/ulysses>). The main data repository for Ulysses is maintained by ESA at <http://ufa.esac.esa.int/ufo/>

3. **Venus Express** - a mission designed to study the plasma environment, atmosphere, and surface of the planet Venus (<http://sci.esa.int/venus-express>). The main data repository for Venus Express is maintained by ESA at <http://www.sciops.esa.int/index.php?project=PSA&page=vex>

4. **Advanced Composition Explorer (ACE)** - a mission designed to measure the elemental and isotopic composition of the solar wind and other interplanetary particle populations (<http://www.srl.caltech.edu/ACE>). Data from ACE are available from OMNI data base: <http://omniweb.gsfc.nasa.gov/>

5. **Geomagnetic Indices** - ground based magnetic activity indices designed to describe short-time variations in the geomagnetic field, generated basically by the interaction of the solar wind with the Earth's magnetosphere. Geomagnetic indices are available from <http://wdc.kugi.kyoto-u.ac.jp>

By clicking the **Cluster** button a new window opens that gives the user the chance to choose between magnetic field and plasma ion measurements from Cluster:

1. **Fluxgate Magnetometer (FGM)** - is the link that enables loading data from Cluster fluxgate magnetometer;

2. **Cluster Ion Spectrometry (CIS) – CODIF**: is the link that enables loading the data from the Cluster ion composition analyzer (CODIF), data that enables the discrimination among different species according to their masses.

3. **CIS-HIA** is the link that enables loading the data from the Cluster Hot Ion Analyzer, spectrometer data that do not discriminate between species.

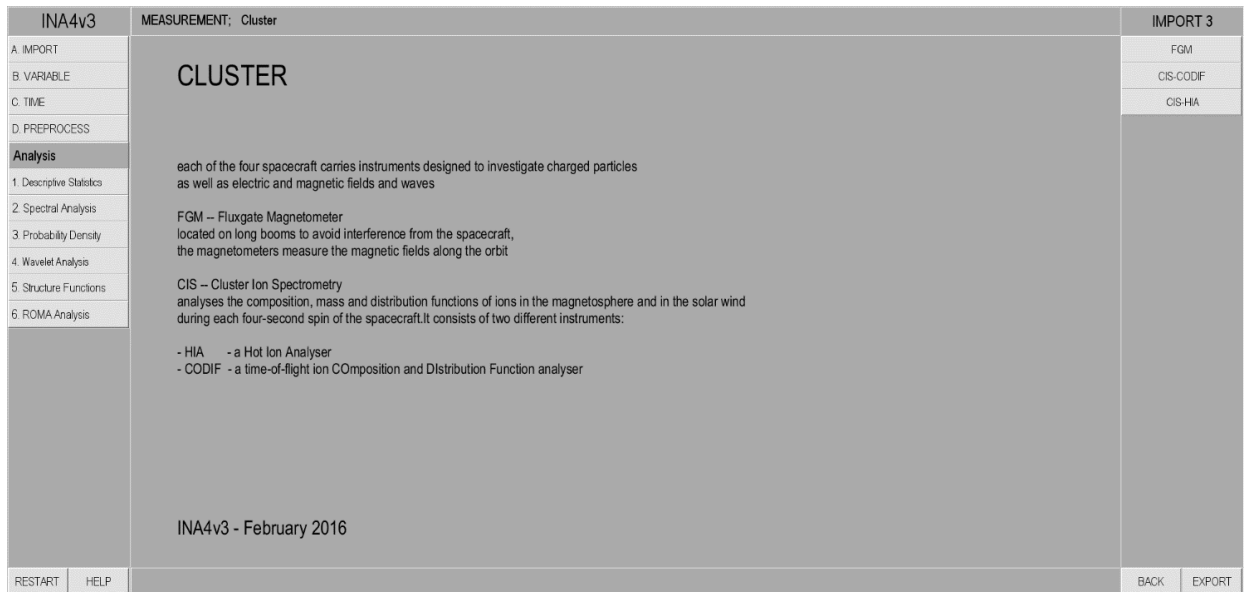


Figure 3. When the user selects “Cluster” in the right panel of figure 4 a new window opens as illustrated above. The central panel describes the 3 instruments for which data can be ingested by INA: the link to the respective data are included in the panel displayed at the right of the figure.

By clicking on the **FGM** button a new window opens where the user can select the Cluster data source and implicitly the data format as shown by Figure 4. INA incorporates dedicated reading routines for data provided by three online data sources:

**CSA** – Users should click this button if they use Cluster data downloaded from the Cluster Science Archive (<http://www.cosmos.esa.int/web/csa/access>) maintained by ESA.

**CDAWeb** - Users should click this button if they use Cluster data downloaded from the Coordinated Data Analysis Web (<http://cdaweb.gsfc.nasa.gov>); the NASA/GSFC Space Physics Data Facility (SPDF) web-based system for data retrieval.

**AMDA** - Users should click this button if they use Cluster data downloaded from the Automated Multi-Dataset Analysis (<http://amda.cdpp.eu>); a web-based service provided by the CDPP (Centre de Données de la Physique des Plasmas), capable of retrieving data from various sources.

After the selection of the data source, the user can upload a corresponding local file. Figure 5 depicts the file upload wizard for a Cluster FGM data file downloaded from CSA. After the **IMPORT** phase, the user is automatically sent to the **VARIABLE** layer, described in Tutorial 2.

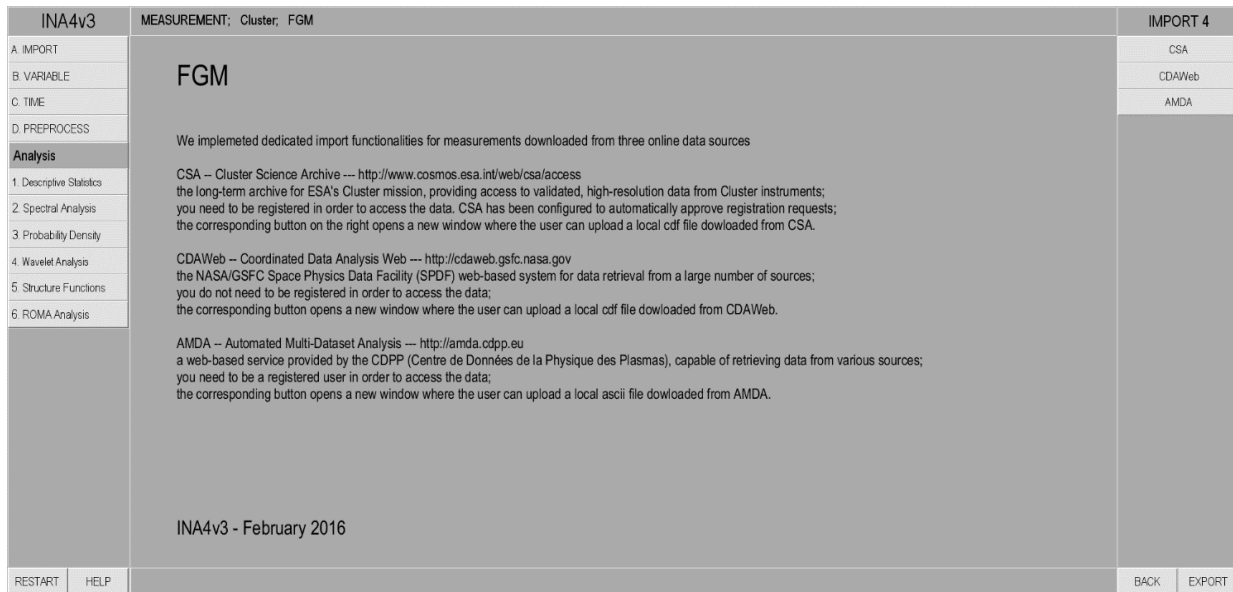


Figure 4. If the user clicked the FGM button of the right panel of Figure 3, a new page opens as shown above. The central panel describes the 3 possible data sources for Cluster magnetometer data. The buttons at the right panel open links to upload the corresponding data file from a local directory.

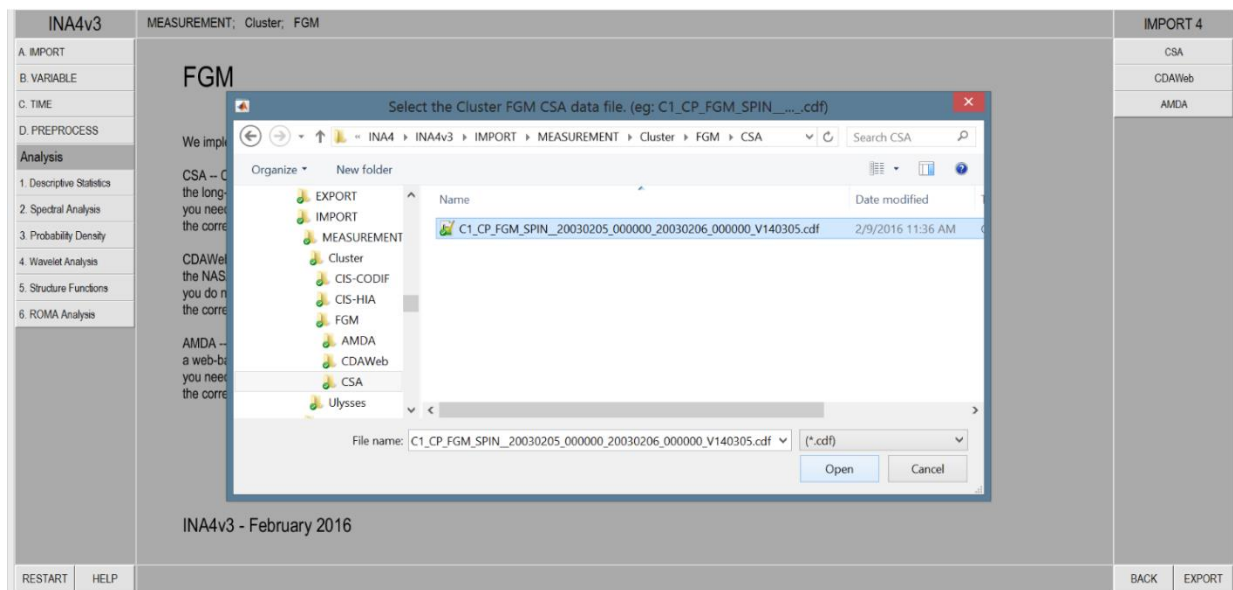


Figure 5. The “last” level of the IMPORT functionality implemented in INA, where the user finally selects the data file to be uploaded in the program, in the example shown above a Cluster FGM data file downloaded from CSA.