



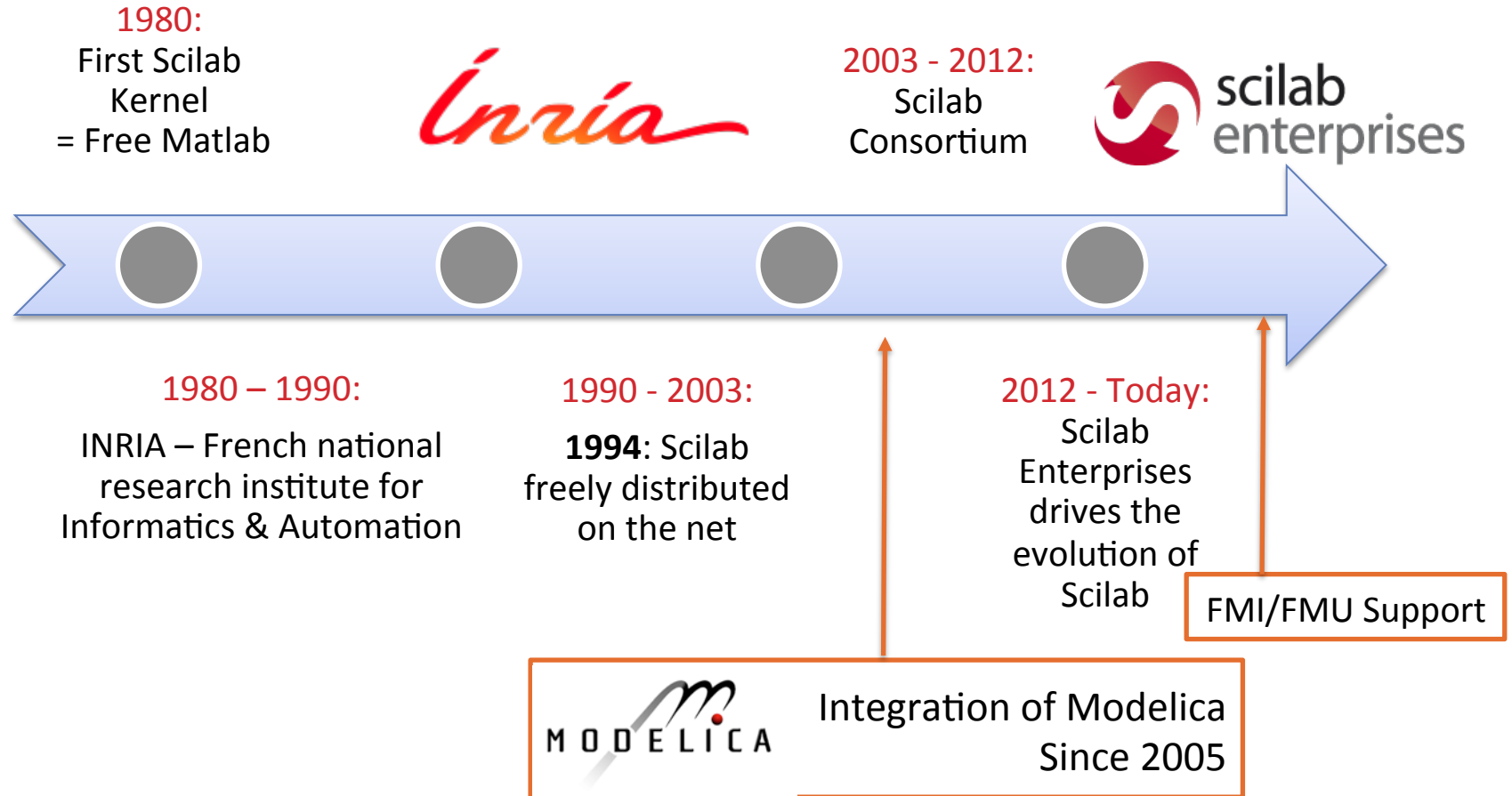
Scilab Open-Source Modeling and Simulation Platform

Scilab Enterprises
Yann Debray

March 2016

- Scilab Introduction
- Scilab Use Cases in Aero & Space
- Scilab Software

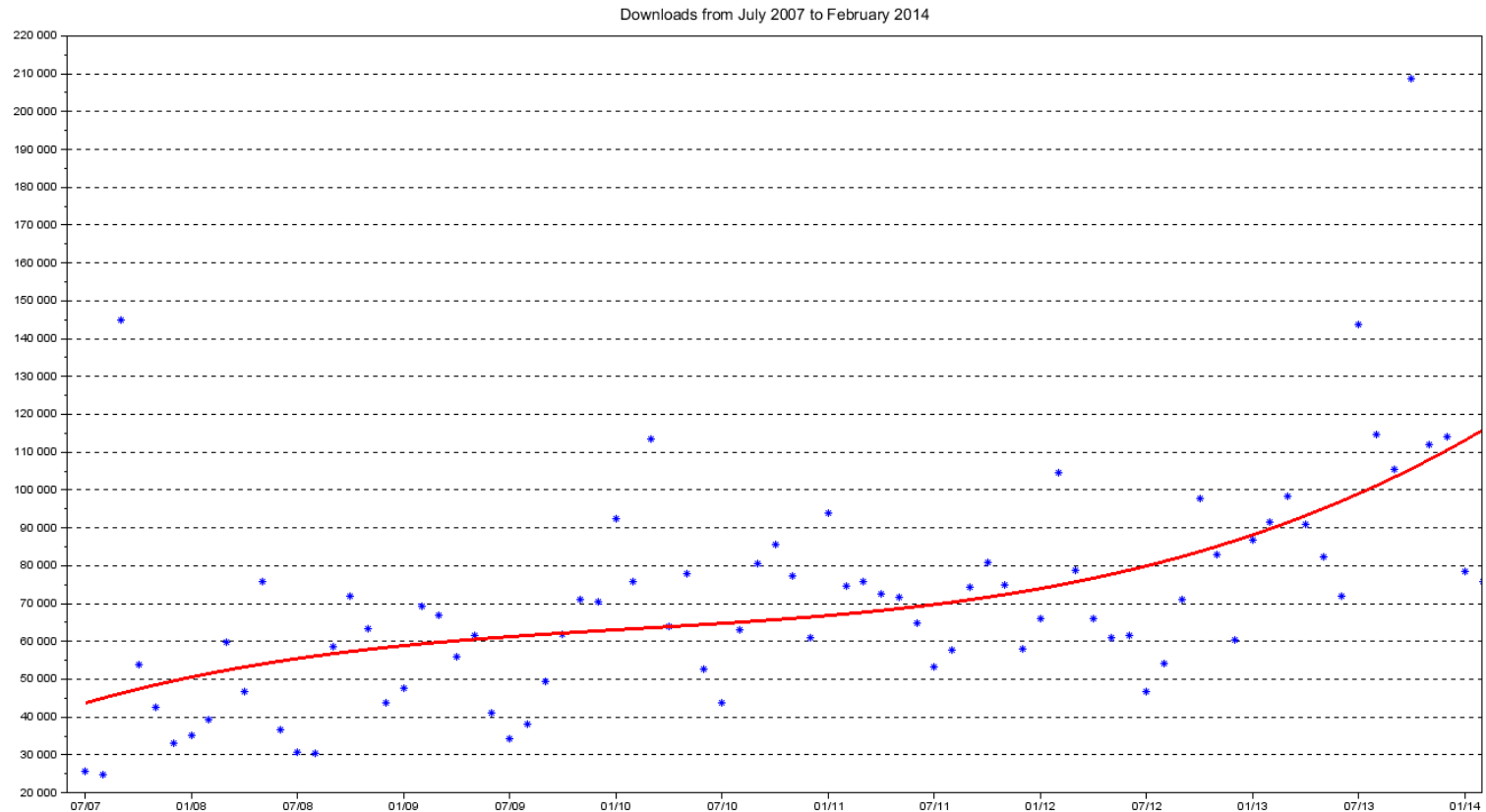
Scilab History



SciLab Today

From www.scilab.org

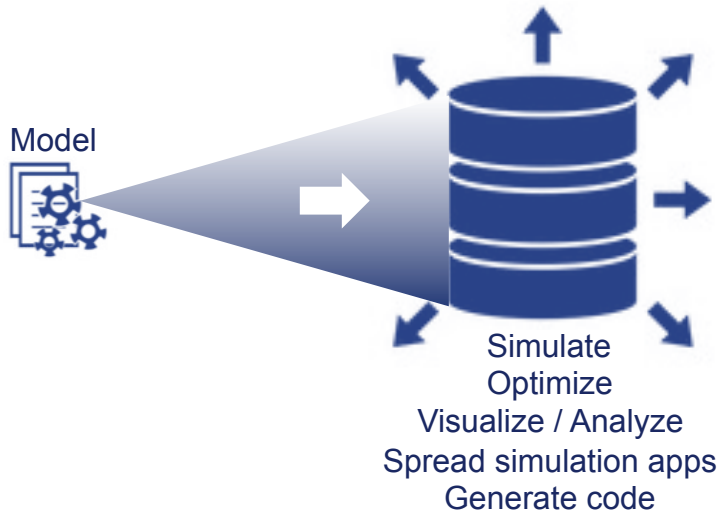
➤ ~ 100 000 monthly installations from 150 countries



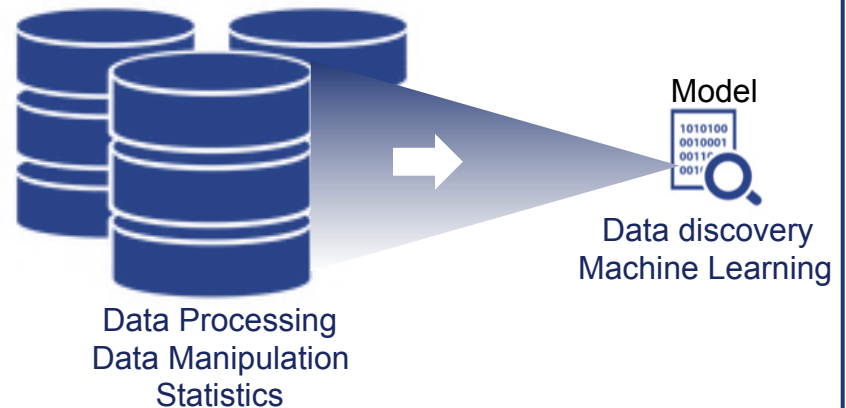
High-level view of Scilab

Scilab Modeling & Simulation Platform for Engineers & Scientists

Modeling & Simulation



Data Analytics



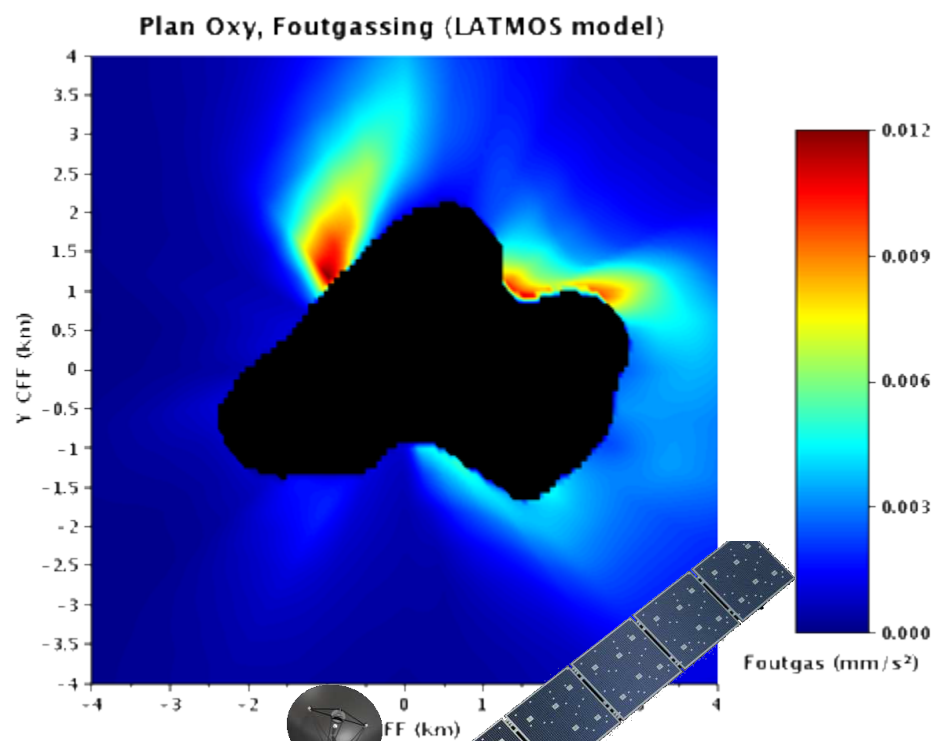
Decision & Design Support System

SciLab in Aero & Space

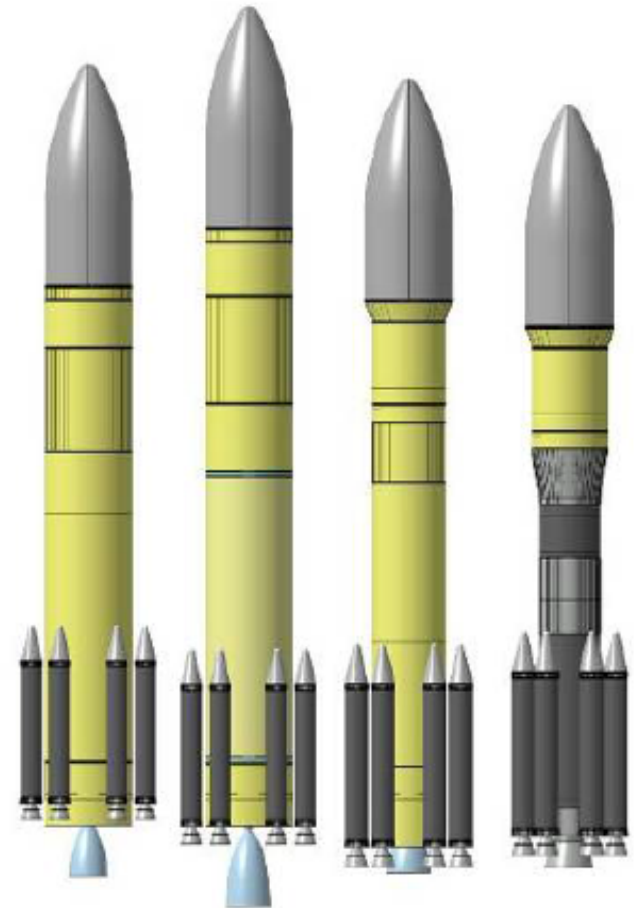
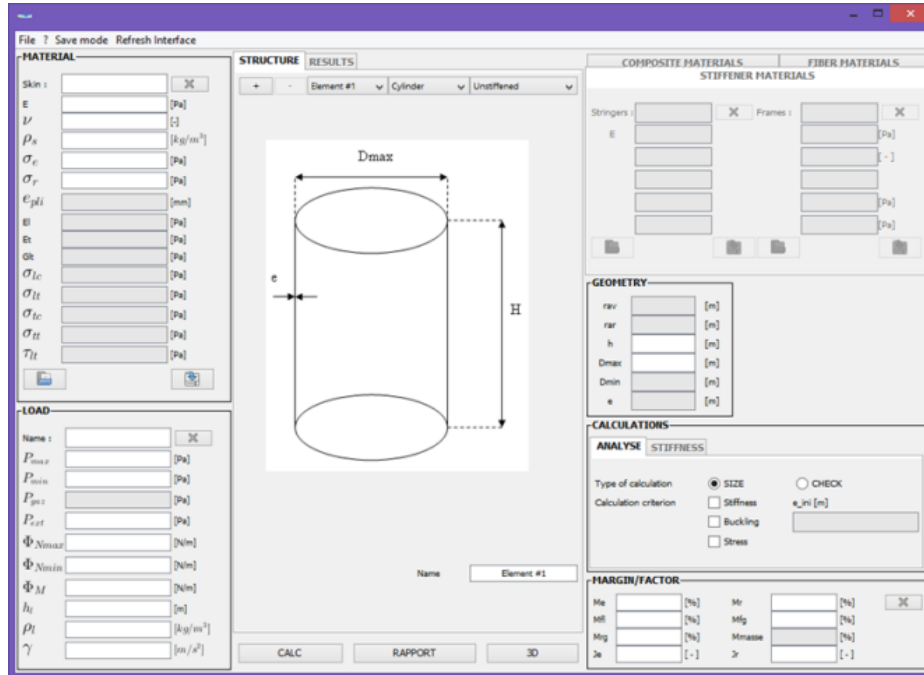
- CNES Rosetta mission
- AIRBUS DS Ariane 6 pre-sizing
- CNES post-processing
- CNES Celestlab Flight dynamics
- DASSAULT AVIATION Design of Experiment & Cluster Deployment
- DLR & CNRS cases of Image Processing
- DLR Code Generation

SciLab used for the mission ROSETTA

- Reading/writing inputs/ outputs data of Flight Dynamics System (proprietary)
- Mission frames transformation
- Comets environments
- Comets topography and Digital Terrain Model
- Statistic and probability analysis
- Geometry computations



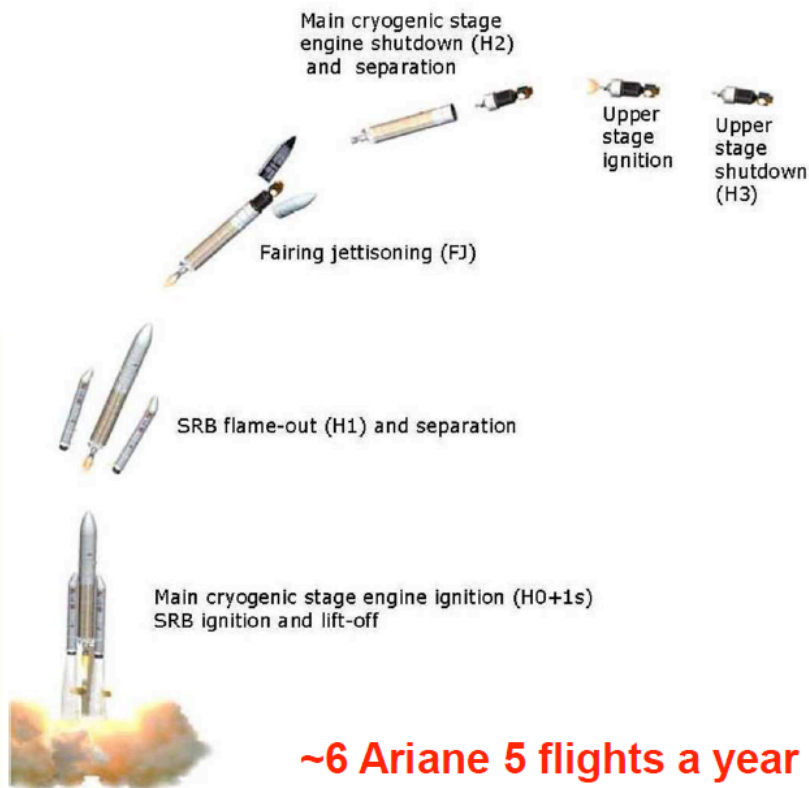
Sizelab: Application for mechanical pre-sizing



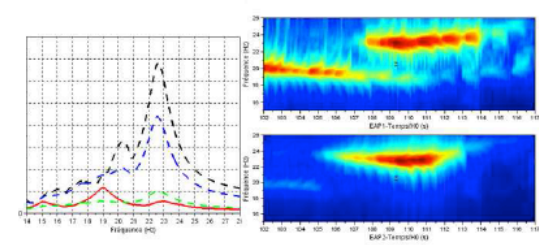
ALEX: CNES tool for Flight Data Analysis

Flight data measurement
(accelerations, temperature, pressure, etc)

Measurement database creation

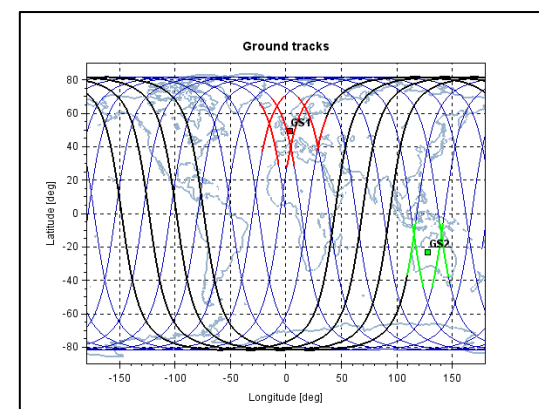
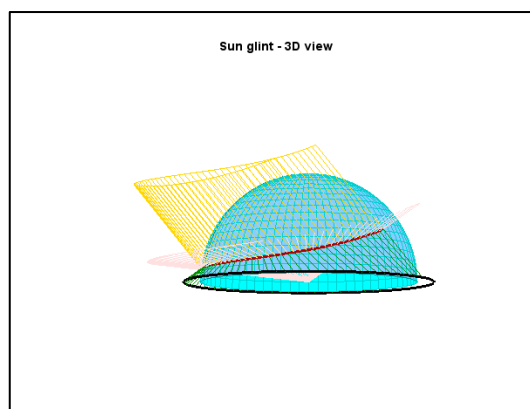
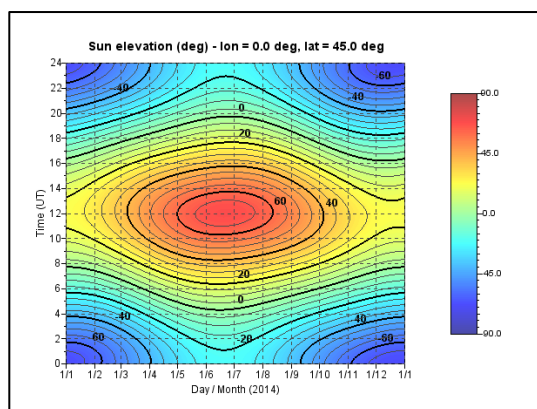


Time	Value	Unit	Channel	Comment	...
00:00:00	1.2345	m/s²	Acc1	...	...
00:00:01	2.3456	m/s²	Acc2	...	...
00:00:02	3.4567	m/s²	Acc3	...	...
00:00:03	4.5678	m/s²	Acc4	...	...
00:00:04	5.6789	m/s²	Acc5	...	...
00:00:05	6.7890	m/s²	Acc6	...	...
00:00:06	7.8901	m/s²	Acc7	...	...
00:00:07	8.9012	m/s²	Acc8	...	...
00:00:08	9.0123	m/s²	Acc9	...	...
00:00:09	0.1234	m/s²	Acc10	...	...
00:00:10	1.2345	m/s²	Acc11	...	...
00:00:11	2.3456	m/s²	Acc12	...	...
00:00:12	3.4567	m/s²	Acc13	...	...
00:00:13	4.5678	m/s²	Acc14	...	...
00:00:14	5.6789	m/s²	Acc15	...	...
00:00:15	6.7890	m/s²	Acc16	...	...
00:00:16	7.8901	m/s²	Acc17	...	...
00:00:17	8.9012	m/s²	Acc18	...	...
00:00:18	9.0123	m/s²	Acc19	...	...
00:00:19	0.1234	m/s²	Acc20	...	...

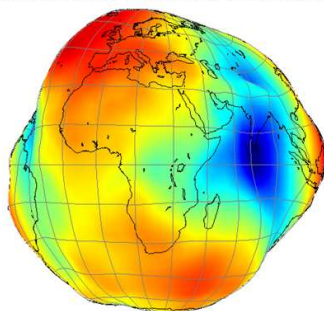


Correlations established between launcher characteristics and measurements

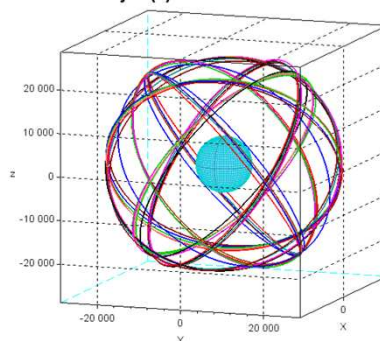
Celestlab: open source Scilab library for flight dynamics



Geoid heights / reference ellipsoid (m) - EGM96s (30x30)



Object(s): GPS - Frame = TEME

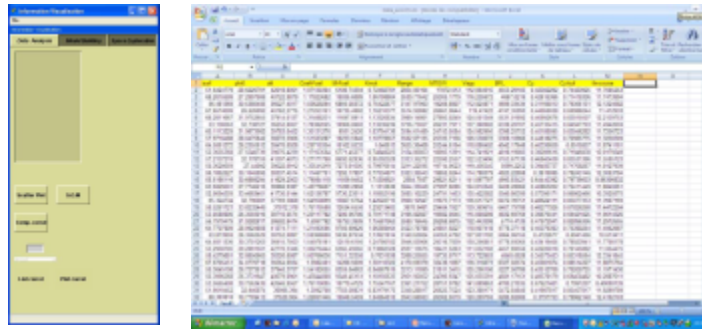


Library used by

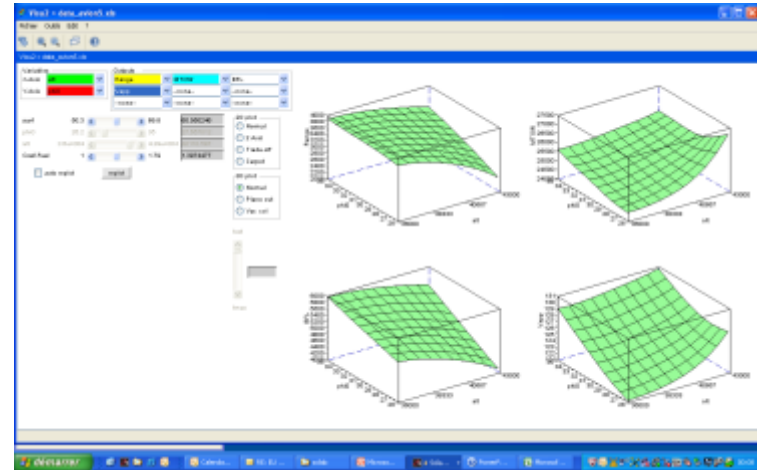
- industrial partners:
 - o SNECMA
 - o Cospas-Sarsat
- Students: learning flight dynamics

DoE, post-processing and visualization

Development of a GUI to explore simulation results (Excel imported)



GUI, graphics, advanced mathematics

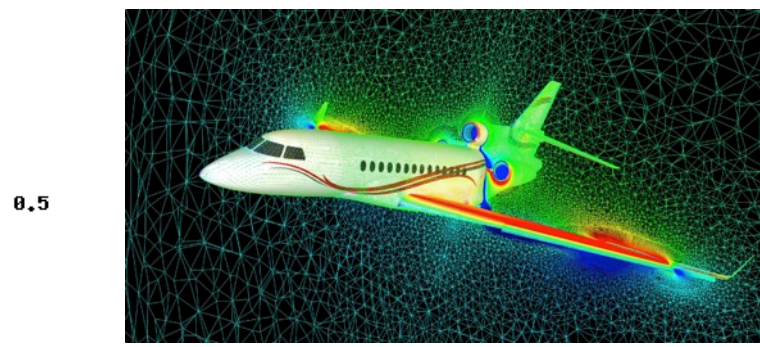
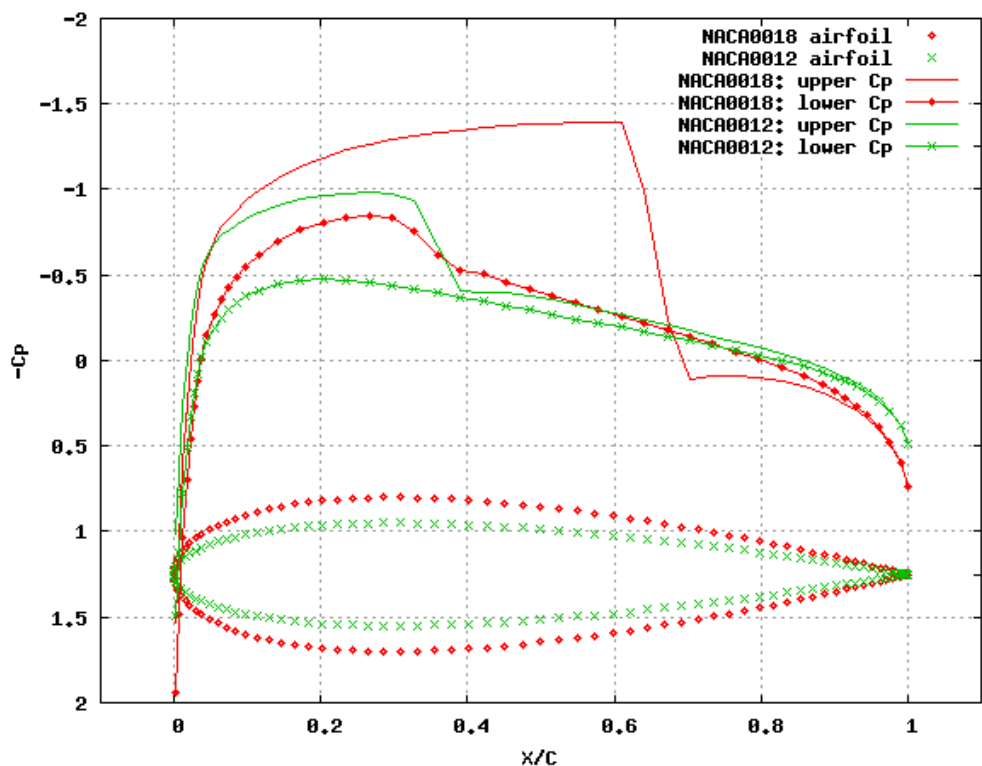


Modules used

- DACE (ATOMS): kriging
- NSGA2 : multi-objective optimization
- TOPSIS : multicriteria decision making (specific development)

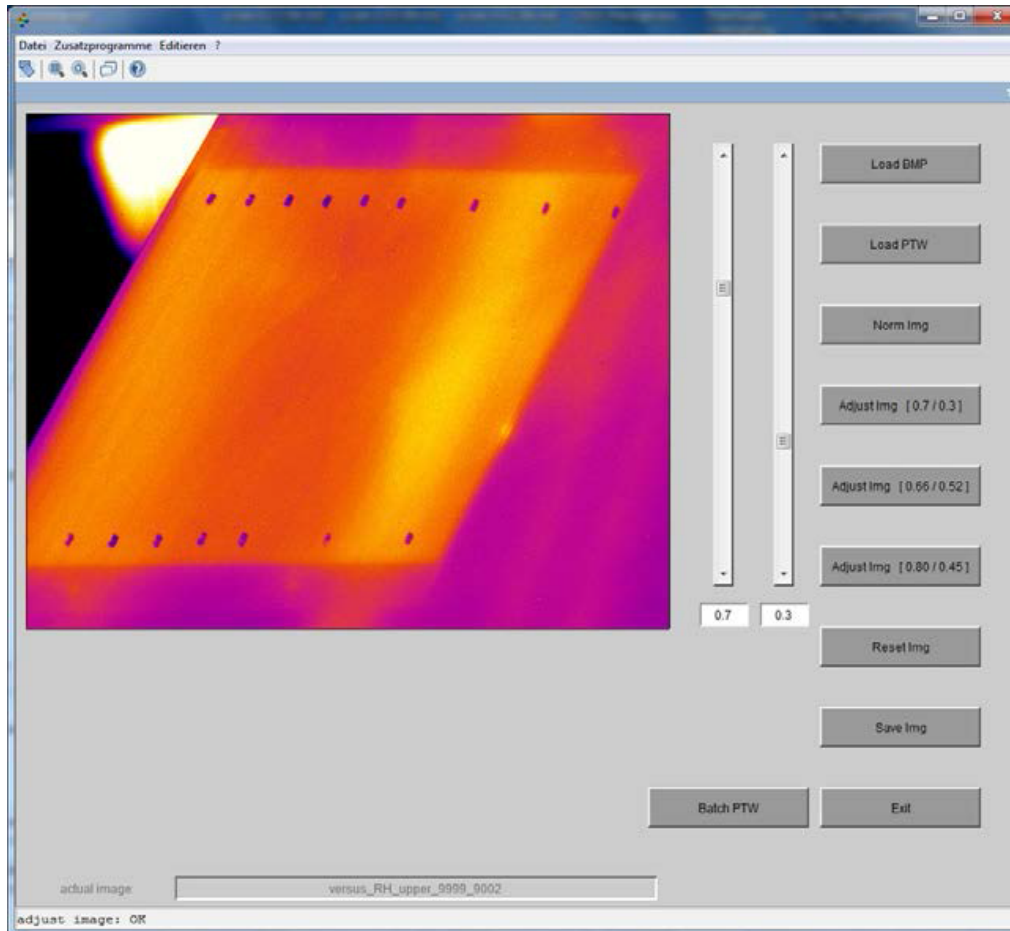
Scilab Cluster Deployment

NACA airfoils ($M=0.75$, $\alpha=1\text{deg}$) : pressure distributions



Dassault Aviation speeds up its computations for their design by a **factor of 6 with sciGPGPU** on heterogeneous (CPU+GPU) nodes & by a **factor of 10 with Scilab/MPI** using 10 MPI processes spread over several CPU nodes.

Infra-Red Image post-processing GUI



- single or batch conversation ptw-to-bmp
- image enhancement
 - remove noise
 - adjust contrast
 - differential images
- data implementation
- data procesing with a Graphical User Interface

Automatic detection and characteristics extraction of archaeological structures

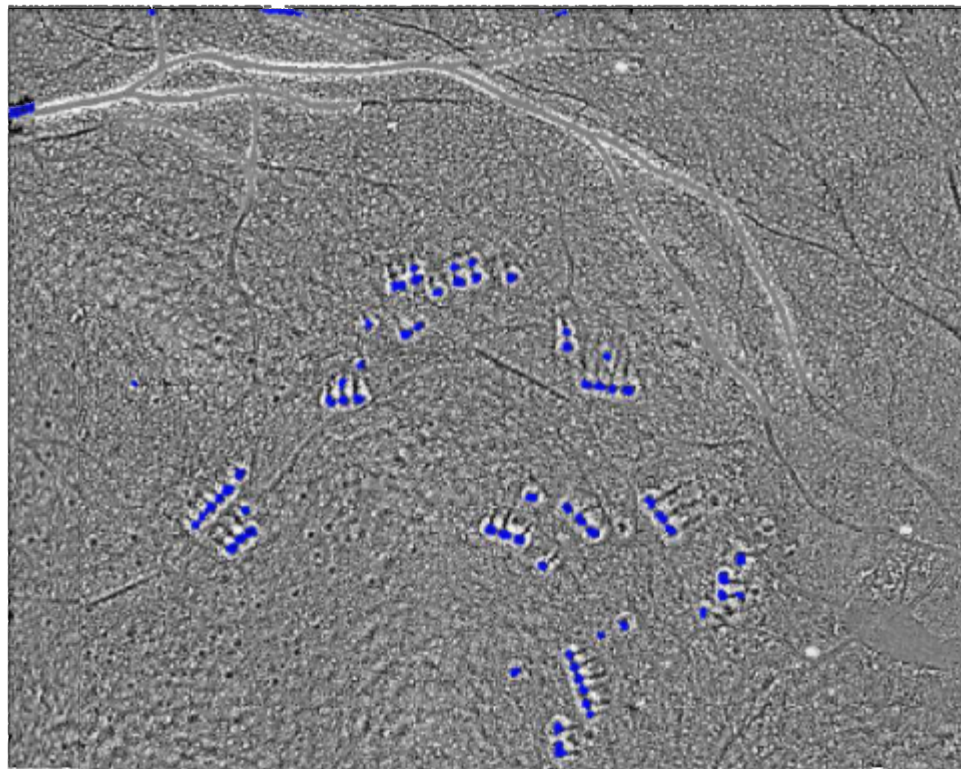


Automatic extraction of the item main properties

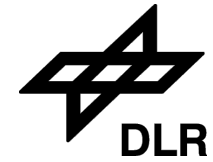
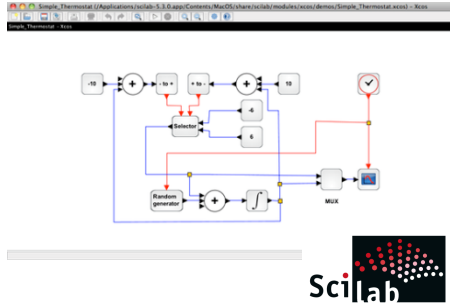
Local Relief Model binarization

Detection and suppression of linear elements (roads)

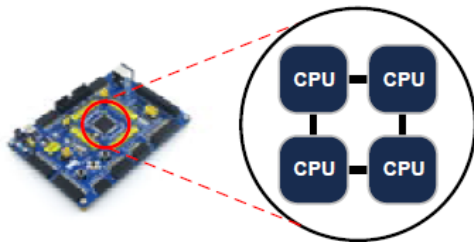
Detection of archaeological structures



DLR Code generation for Air Vehicule Simulator



**Code Generation
and Deployment**



Scilab Software

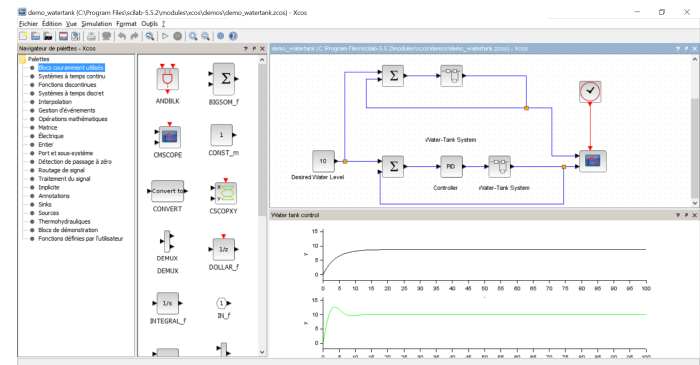
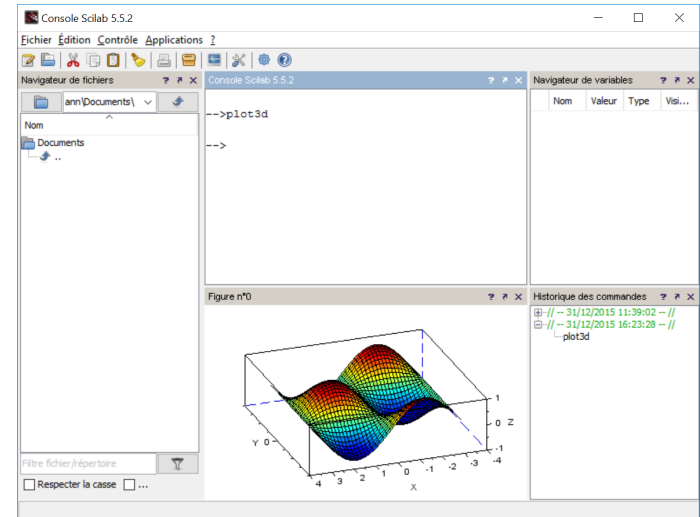
- Satellite orbit ODE
- ESA Aerospace Blockset
- Scilab capabilities
- Xcos capabilities

Scilab Open Source Distribution

Workstation Software:

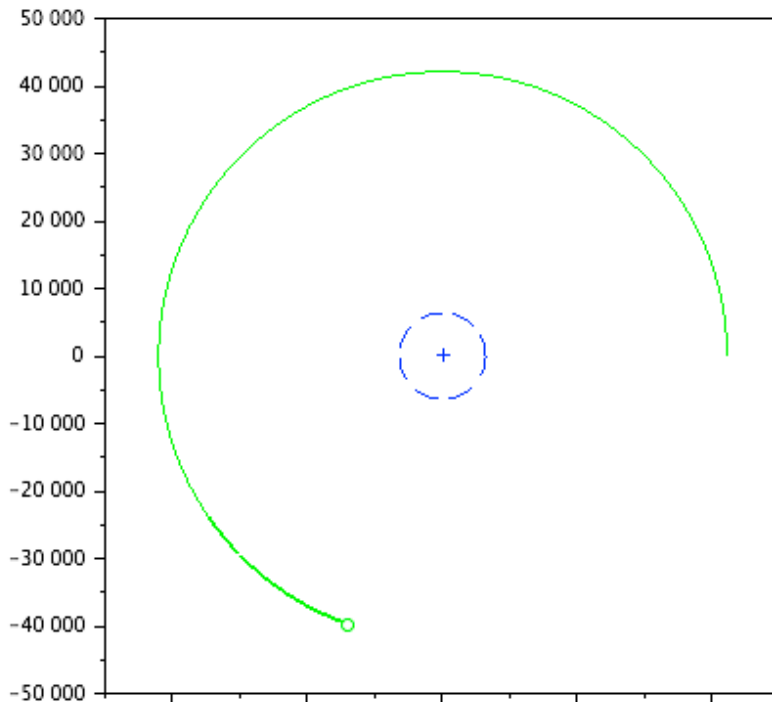
- Scilab
 - Powerful Computation Engine with script-based language

- Xcos by Scilab
 - Dynamic Systems Modelling and Simulation through Model-Based Design



Simple ODE script modeling approach

Satellite orbit Ordinary Differential Equation



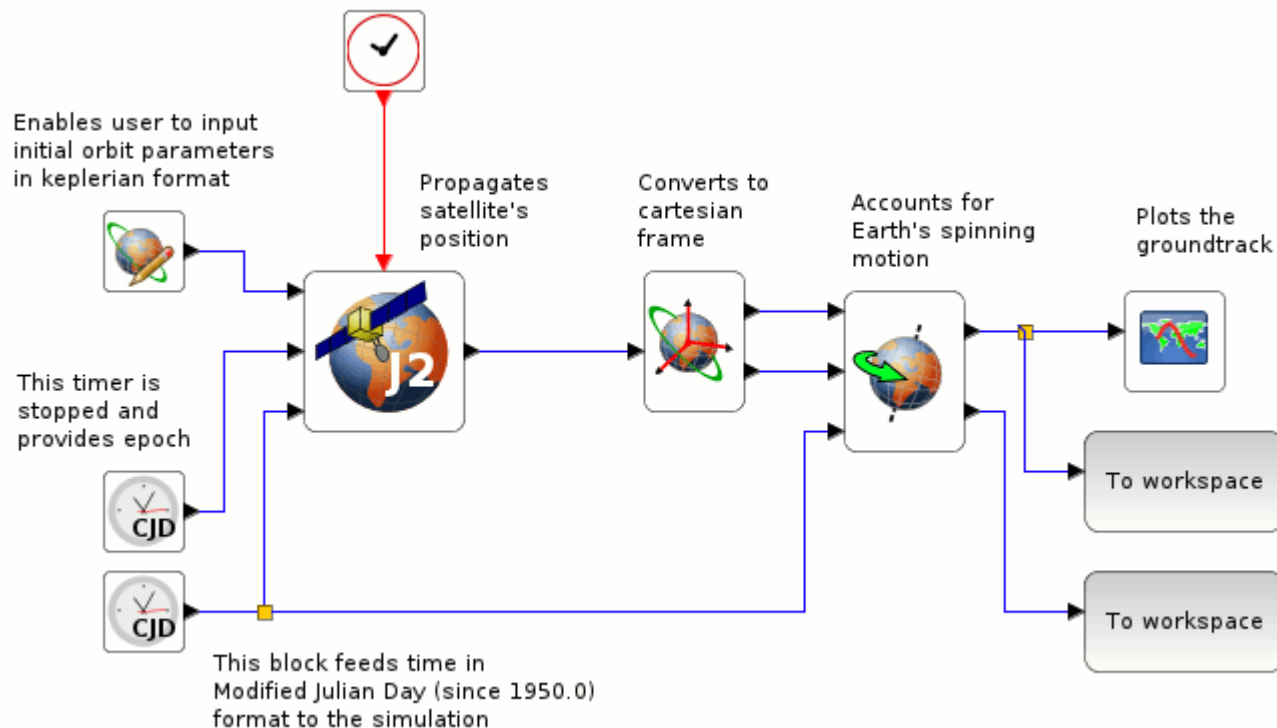
https://help.scilab.org/docs/5.5.2/en_US/ode.html

```
function udot=f(t, u)
    G = 6.67D-11; //Gravitational constant
    M = 5.98D24; //Mass of the Earth
    c = -G * M;
    r_earth = 6.378E6; //radius of the Earth
    r = sqrt(u(1)^2 + u(2)^2);
    //relationship between udot and u
    A = [[0    0    1 0];
         [0    0    0 1];
         [c/r^3 0    0 0];
         [0    c/r^3 0 0]];
    udot = A*u;
endfunction
```

ESA: Aerospace Blockset for Xcos

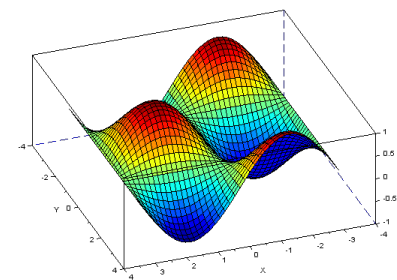
Aerospace Blockset is an external Scilab module providing aerospace palette for Xcos. It is based on CelestLab aerospace library :

- Example: simulate satellites position on the Earth's orbit



Scilab capabilities

More than 2,000 Mathematical and Scientific functions



Specific functional domains

Mathematics

Optimization

Statistics

Signal
Processing

Control
systems

Graphical capabilities

2D-3D
Visualization

Graphical User
Interface

Simulation acceleration

Message Passing
Interface

GPU Processing

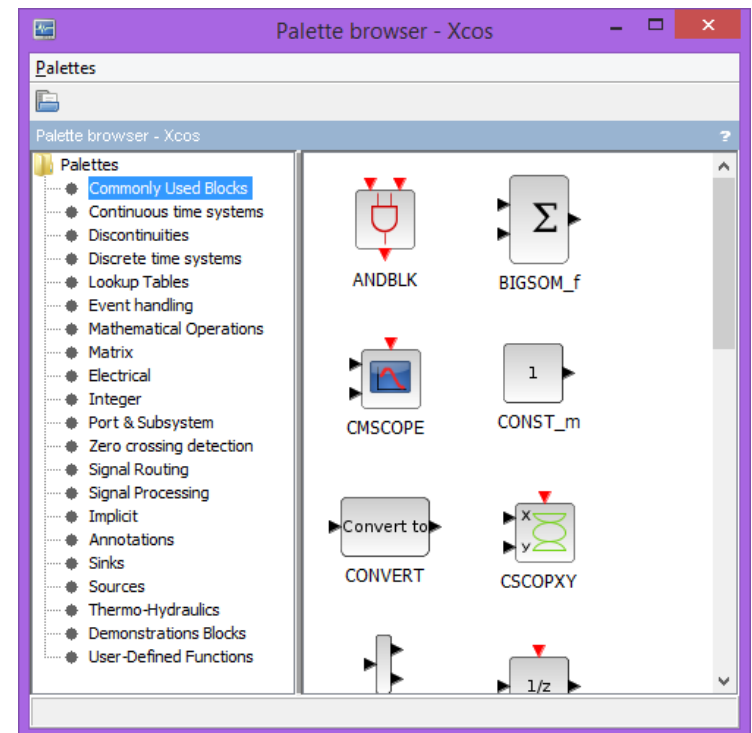
Xcos capabilities

Xcos features

Graphical Editor	Hybrid Simulation	Graphical Output
Multiphysics simulation	Customizable Palettes	Simulation Acceleration

Xcos external modules

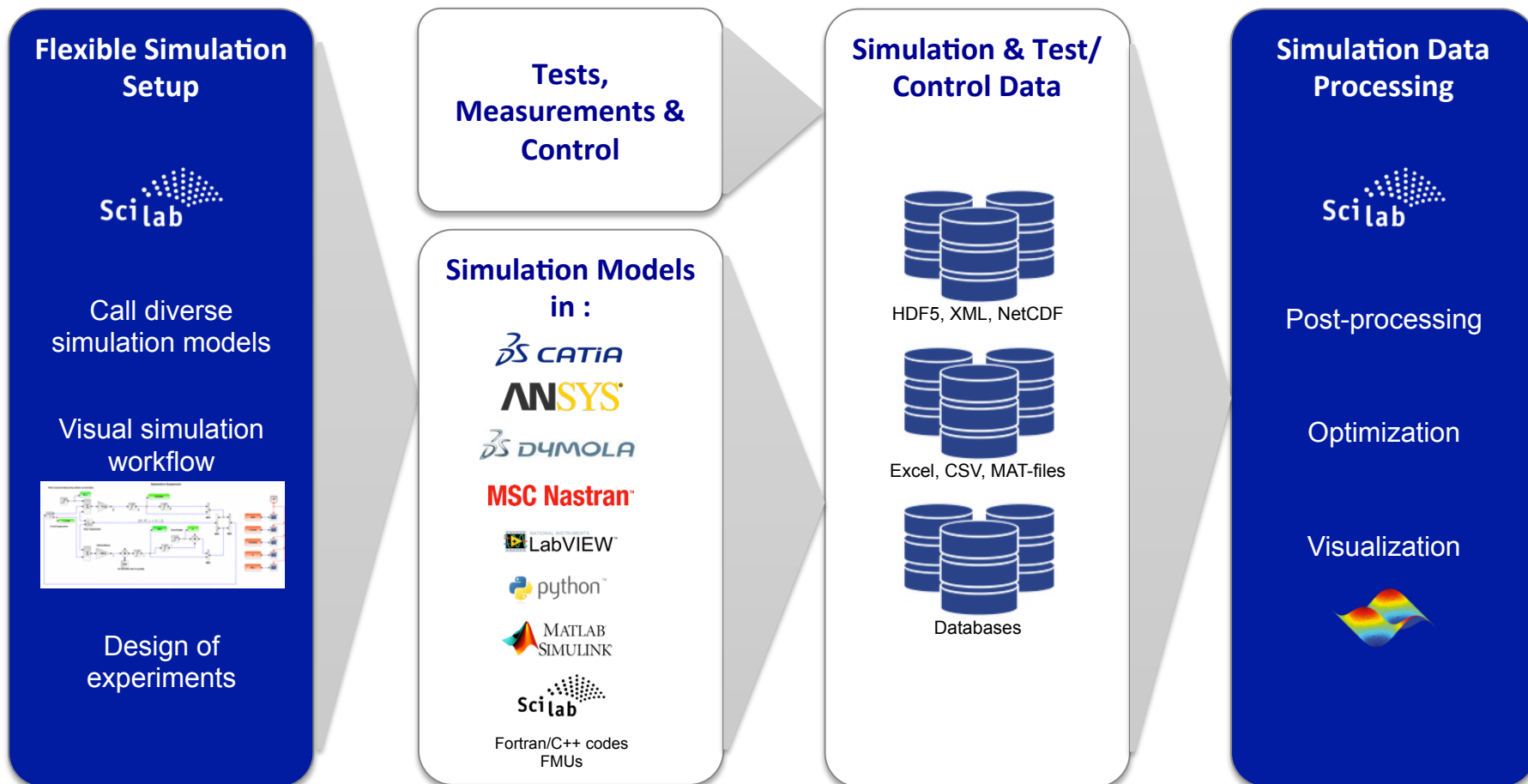
Functional Mockup Interface	Embedded Code Generation	Finite State Machine
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Conclusion

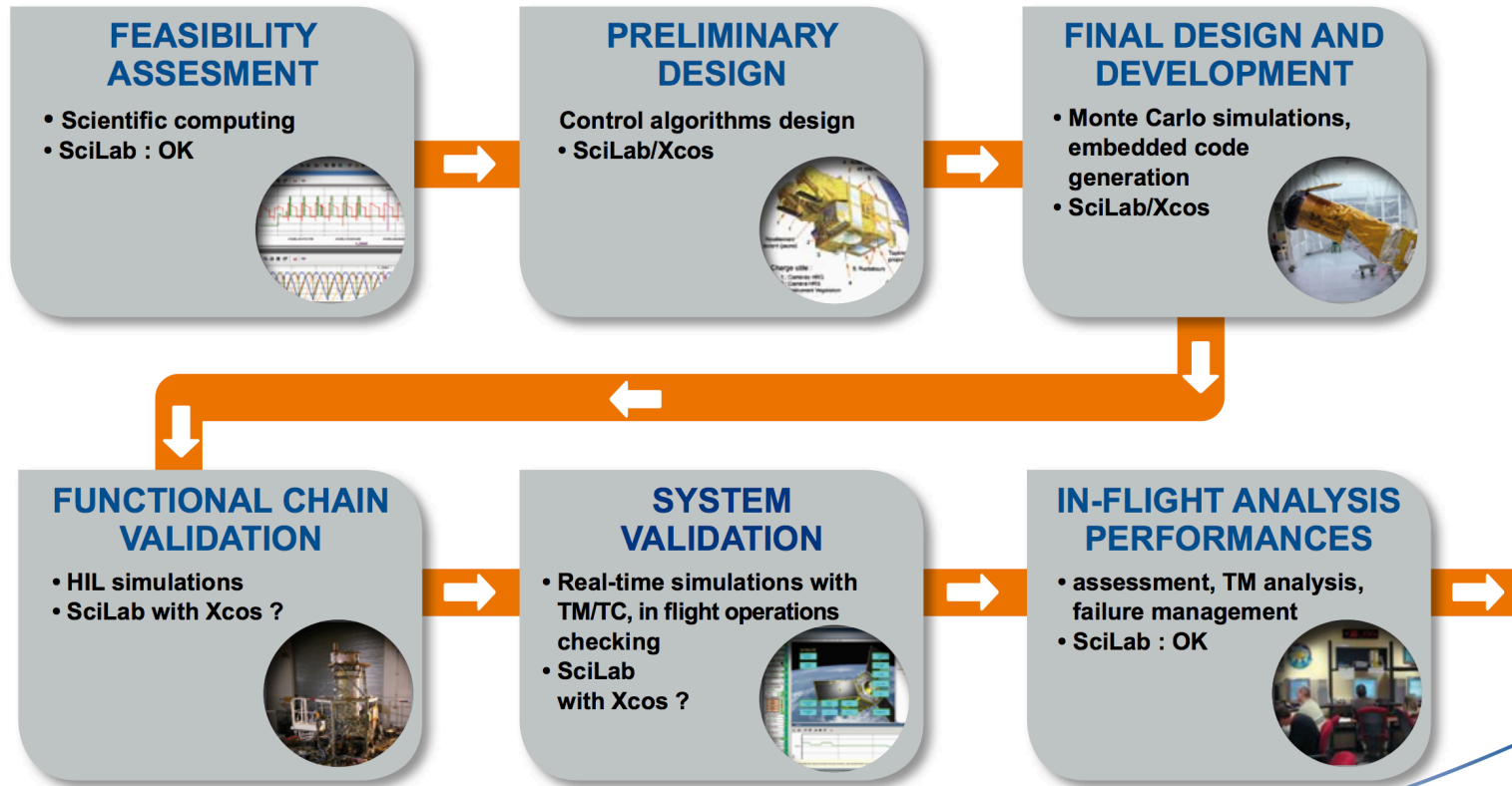
Flexible Integration platform for simulation workflow

(as seen with CNES' CelestlabX, Dassault Aviation, ArcelorMittal)



End-to-end use potential of Scilab @ CNES

(excerpt from ScilabTec presentation)



Thank you

www.scilab.org

www.scilab-enterprises.com

