SESP2017
BIBLOS

INNOVATING SOLUTIONS

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BIBLOS

BIBLOS

WHAT IS BIBLOS?

- **BIBLOS** is a **library** of SW models for **Earth Observation End-to-End Simulators**

- Part of ESA's effort to **reduce the reengineering effort**, promote **reuse**, and **standandarisation**.

- Other activities within ESA with this goal:
  - **ARCHEO** – Reference Architecture for Earth Observation Missions
  - **SS-E2ES** – Reference Architecture for Space Science Missions
  - **OpenSF** – Simulation Framework
  - **EOCFI** – Library for Mission Analysis for Earth Observation

THE BIBLOS PROJECT

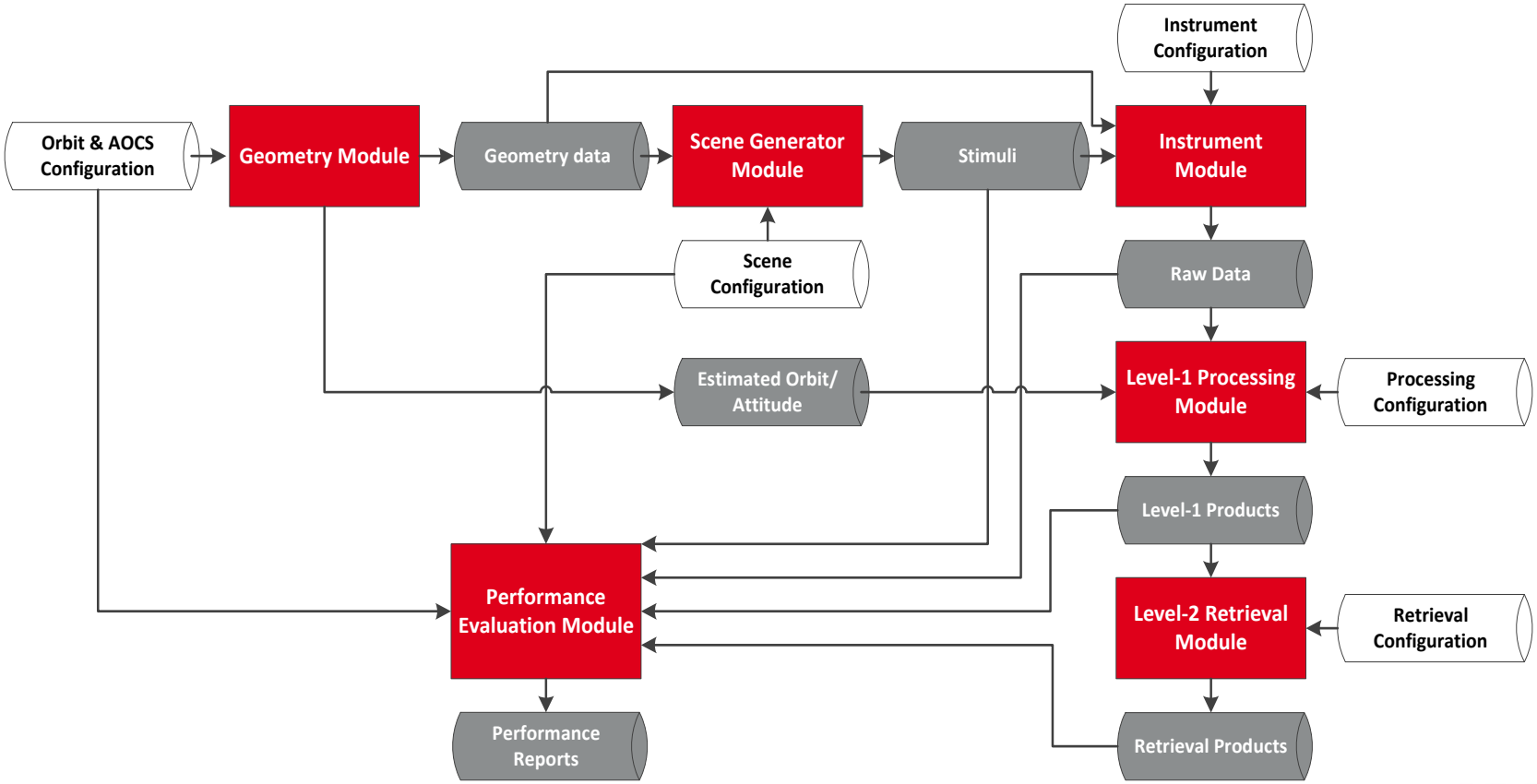
- **BIBLOS** stands for **B**u**I**lding **BL**ocks for Earth **O**bservation mission performance **S**imulators.

- BIBLOS helps the user define the **architecture**, and provides validated **units of software** to help the user build its E2ES at a lower cost.

- A first phase of BIBLOS produced models for **Passive Optical** instruments.

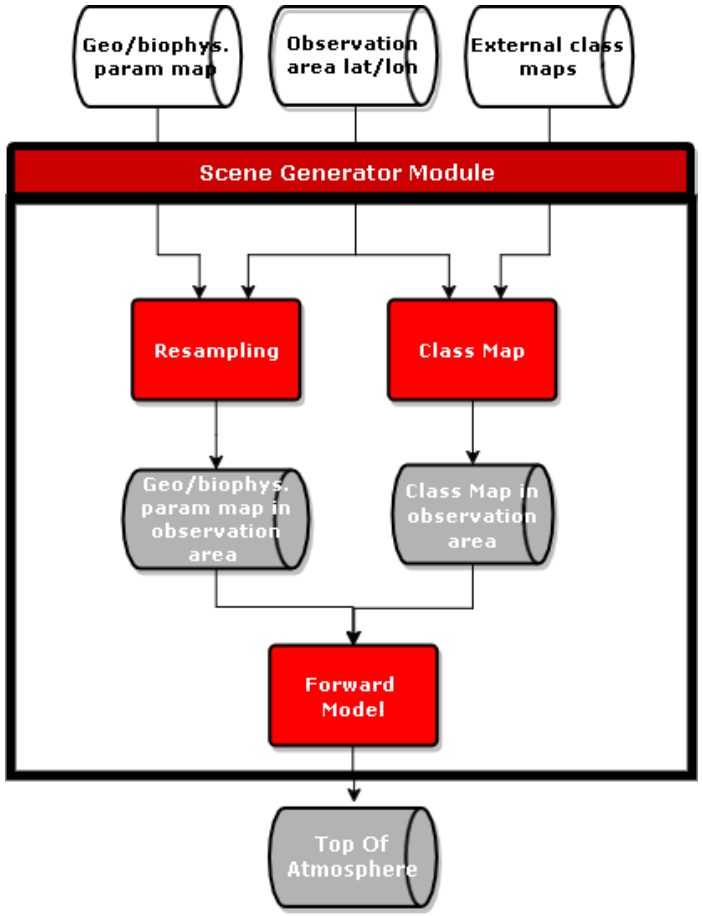
Currently a second phase of the project (BIBLOS2) is developing additional models.

REFERENCE ARCHITECTURE



MODULES & BUILDING BLOCKS

- The library of software models for BIBLOS is composed of high-level **Modules**, that themselves are constituted of low-level **Building Blocks**.



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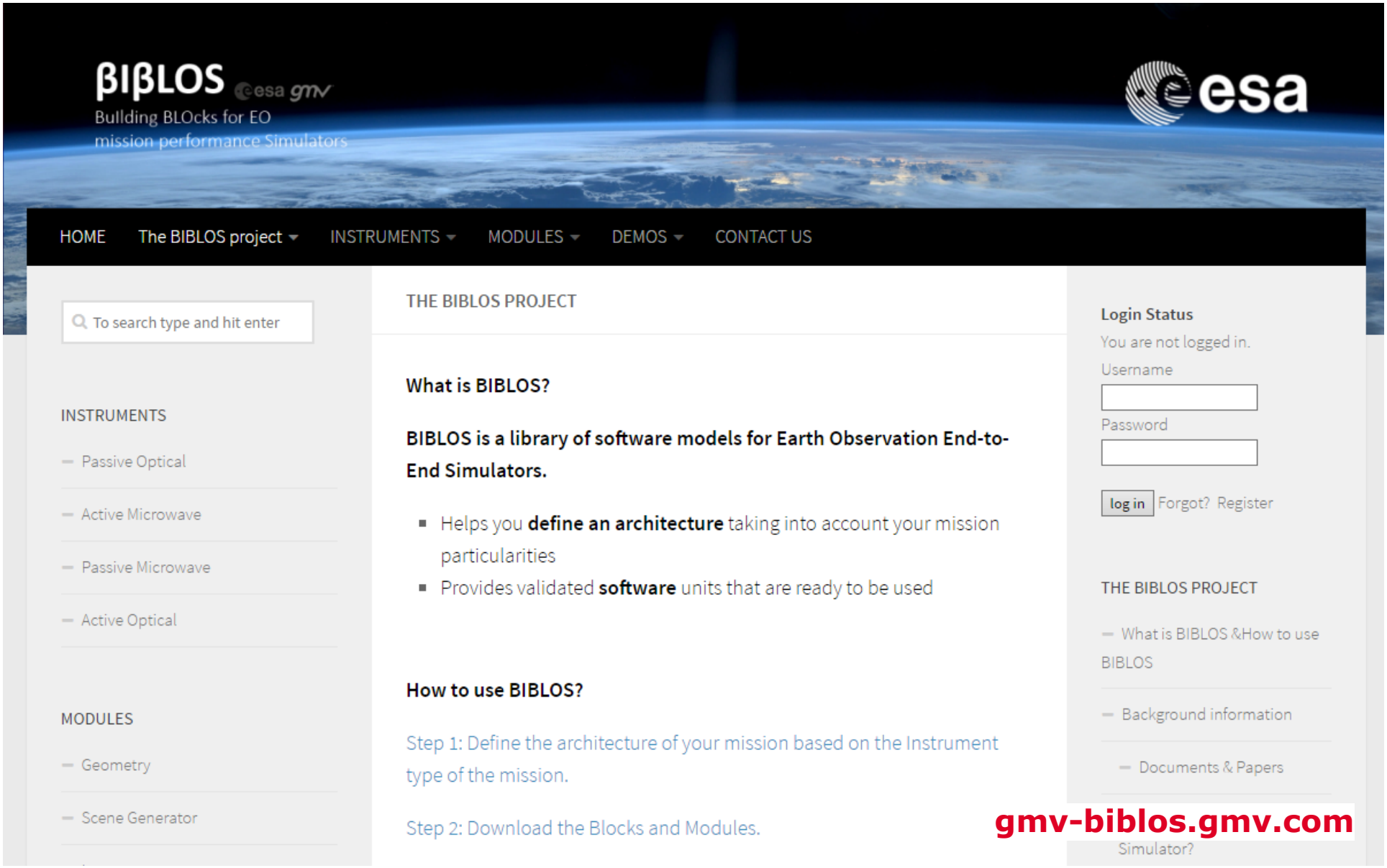
USE OF BIBLOS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THE BIBLOS PROJECT
What is BIBLOS?
BIBLOS is a library of software models for Earth Observation End-to-End Simulators.
Helps you define an architecture taking into account your mission particularities
Provides validated software units that are ready to be used
How to use BIBLOS?
Step 1: Define the architecture of your mission based on the Instrument type of the mission.
Step 2: Download the Blocks and Modules.
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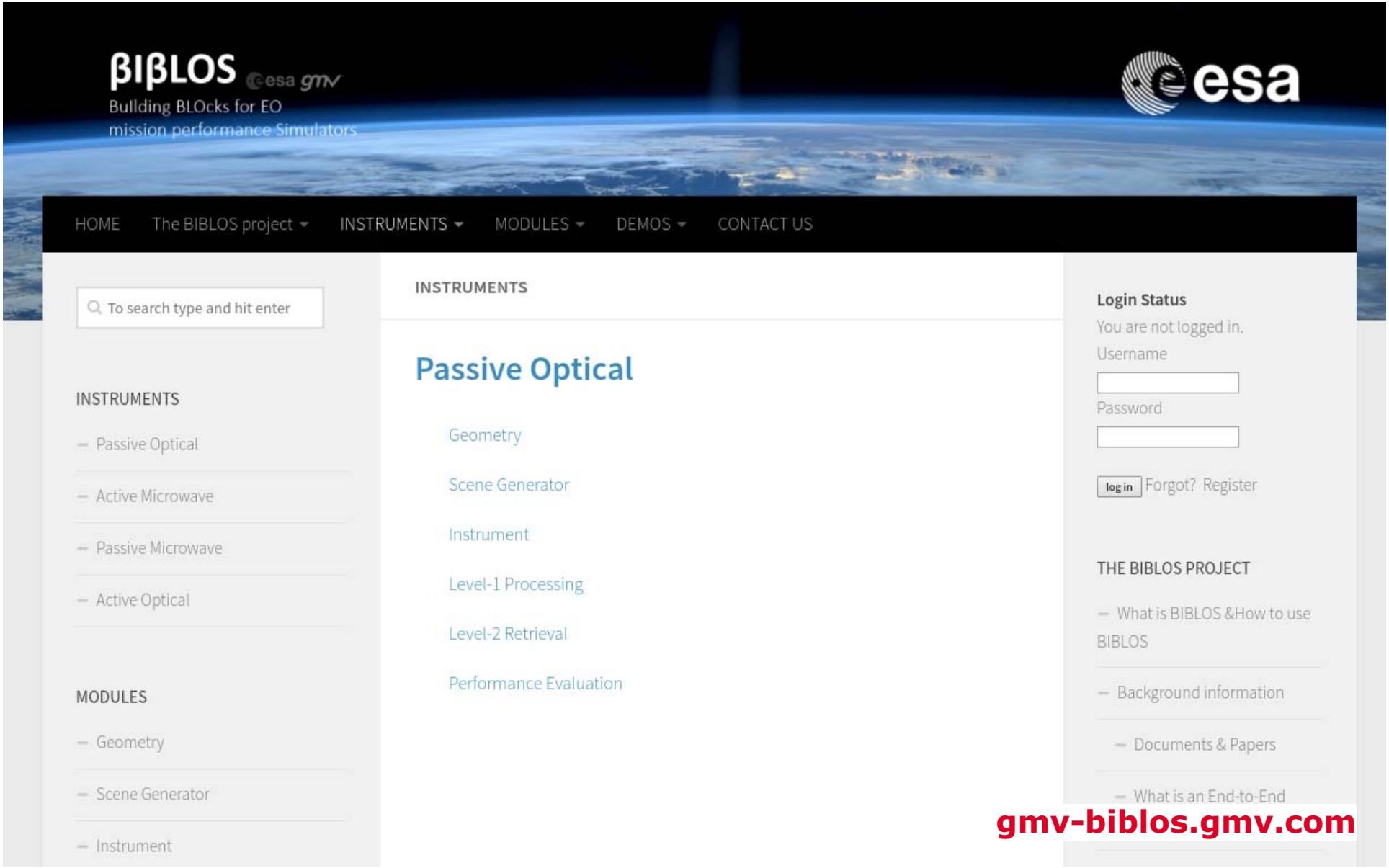
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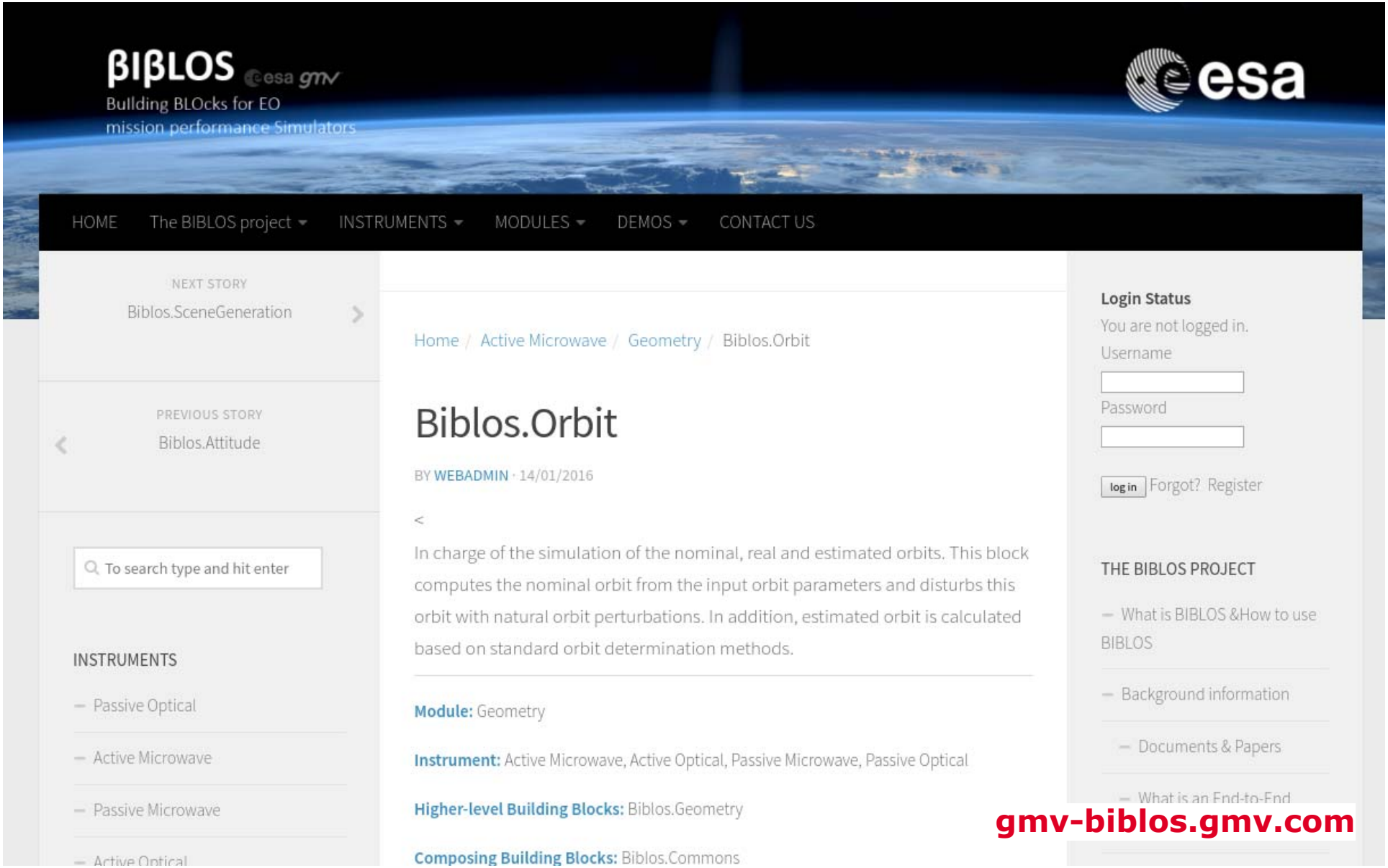

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HOW TO USE BIBLOS

- Step 1: Define the architecture of the mission based on the Instrument type of the mission.
- Step 2: Download the Blocks and Modules.
- Step 3: Get started, instructions to execute BIBLOS software
- Step 4: Integration in OpenSF
- Step 5: Adapting the software for specific needs (development of new blocks, modification of blocks, reuse of software, etc.)

- License: **ESA Software Community License**

BIBLOS

BIBLOS2 SCOPE

BIBLOS2 SCOPE

ACTIVE MICROWAVES

- Development on the Geometry Module to support **multistatic** configurations.
- Scene Generation Module: parameterized scene generation (complex permittivity, conductivity), from which the complex sigma_0 can be retrieved as a function of geometrical parameters and polarization states (retrieviation in the Instrument Module).
- Scene topography based on DEM to calcualte normal vector to surface in interpolated grid.
- TOPS (Terrain Observation by Progressive Scan) mode
- Polarization: co-pol (VV, HH) and x-pol (VH, HV)
- Performance evaluation functionalities (Diamond diagrams, 2D resolution plots, Noise-Equivalent Sigma Zero, Ambiguity ratios, Swath geometry, Impulse Response Function, ...).
- Demo tailored for a mission based on Sentinel-1, with C-band SAR, in Stripmap (SM) and Interferometric Wide (IW) modes.

PASSIVE MICROWAVES

- Typical conical scanning microwave radiometer
- Microwave or millimetre wave part of the spectrum at constant incidence angle, with spatial, spectral and radiometric resolutions varying for the mission.
- Scene Generation Module: Dual polarization brightness temperatures of the Earth's surface and radiative transfer models of the atmosphere so as to generate the brightness temperatures top of the atmosphere (TOA) in the antenna reference frame.
- Instrument Module & Level-1 : Receiver chain model, including thermal drifts, a noise model as a function of the integration time (i.e. Allan's variance model), and a digital back-end with a number of radio-frequency interference detection and mitigation techniques.
- Demo: tailored for a mission based on EUMETSAT Polar System-Second Generation Microwave Imager instrument (MWI).

PASSIVE OPTICALS

- Evolution to the current developments for the Instrument Module
- Enhanced spectral response modelling.
- Modelling of effects through MTFs (diffraction, aberrations, defocusing, realisation, detector MTF, smearing, motion blur, desynchronisation, binning).
- Radiometric modelling to include Signal-to-Noise Ratio (SNR), Noise Equivalent Difference Temperature (NEDT) and non-linearity.
- Demo: based on a Multi-band imager instrument with 5 bands (Panchromating, Red, Green, Blue, NIR).

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PERFOR MANCES

BIBLOS COMPUTATIONAL PERFORMANCE

Block name	Execution time (20km orbit)
Orbit Block	~30 seconds
Attitude Block	~30 seconds
AOCS/Instrument Coupling Block	~60 seconds
Scene Interaction Block	~36 hours
Resampling Block	~1 hour
Atmosphere Simulator Block	~2 hours
Spatial Block	~360 seconds
Radiometric Block	~13 seconds

PARALLEL COMPUTING

- Two most common hardware solutions to increase the software performance by applying parallel computing:
- Multi-core Central processing units (CPUs) – typically 2-64 cores
- Graphics processing units (GPUs) – typically 512-3072 cores per single GPU

The GPU Devotes More Transistors to Data Processing than data controlling activities, Fig. 3 in *CUDA C Programming Guide* [online] http://docs.nvidia.com/cuda/cuda-c-programming-guide

BIBLOS COMPUTATIONAL PERFORMANCE

Technology	Advantages	Disadvantages
CUDA	1. Best performance. 2. Support.	1. Implementation effort. 2. Compatibility.
OpenCL	1. Very good performance. 2. Compatibility.	1. Implementation effort. 2. Support.
CPU technologies (OpenMP, SSE/AVX extensions)	1. Performance*. (on the other hand can be remarkable worse than GPU) 2. Implementation effort* (parallel extensions from standard library)	1. Implementation effort*. (OpenMP API, SSE/AVX Extensions). 2. Performance*.

- OpenCL in BIBLOS-2: very good performance, compatibility with MAC computers (AMD graphic cards).

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FUTURE

CONCLUSIONS & FUTURE STEPS

- The BIBLOS project is a practical guide for users who want to develop an Earth Observation performance simulator.
- BIBLOS already has available for the user community models for the Passive Opticals, and as this activity progresses, it will include models for the other two types of instruments.
- The second phase has an ambitious scope that includes the three most relevant types of instrument in the Earth Observation domain: Active Microwaves, Passive Microwaves and Passive Opticals.
- This activity will have an impact in the saving of reengineering effort in future EO E2ES.

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THANK YOU

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