

The background of the slide is a stylized world map in shades of blue and black, set against a bright blue sky with white sun rays emanating from the center. At the top, there is a dark horizontal banner with the text 'OKTAL SYNTHETIC ENVIRONMENT' in a light, glowing font.

OKTAL SYNTHETIC ENVIRONMENT

Multi-spectral simulation software
SE-Workbench for IR

General objectives of SE-Workbench

◆ SE-Workbench : Multi-sensor battlefield modeling

- ☞ Synthesis of 3D scene observed by a sensor
 - ☒ 3D scene physical behavior characterization
 - ☒ Computation of the physical signal received by a sensor
- ☞ Multi-spectral unification: optronic, electromagnetic, acoustics
 - ☒ Use a unique 3D scene: common kernel + physical extensions
 - ☒ Use a common technology : common kernel + physical extensions

◆ SE-Workbench: sharing R&D effort

- ☞ User Group community
 - ☒ Federation of the needs and of the effort
 - ☒ Global maintenance and development handling
- ☞ Cross validity insurance
 - ☒ Experience and knowledge sharing
 - ☒ Data sharing

Past, Present, Future

◆ History

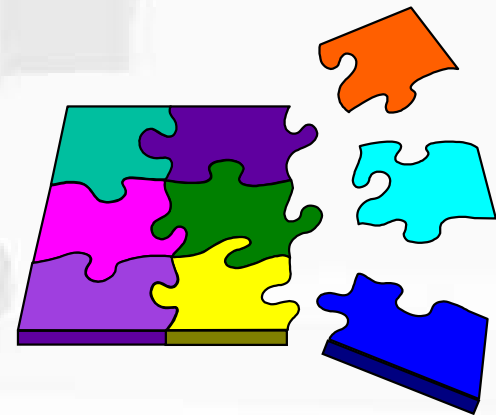
- ☞ 1994 first development
- ☞ 2000 Infrared main development
- ☞ 2000 first EM studies
- ☞ 2001 SCALP program development
- ☞ 2003 first acoustic development
- ☞ 2004 MUSES coupling

◆ On going effort

- ☞ Optical modeling of pyrotechnic countermeasures
- ☞ Global OCM for major customers

◆ For the future

- ☞ Electromagnetic full integration
- ☞ Active imagery & LIDAR



General concepts

Looking for realism



General concepts

Validity domain control

◆ Theoretical validation

- ☞ Development of physical models
- ☞ General modeling and simulation knowledge
- ☞ Elementary tests and validity assessment



◆ Validation by experiments

- ☞ SCALP/EG missile (Fr)
- ☞ Storm Shadow missile (UK)
- ☞ AASM missile (Fr)



◆ State level validation

- ☞ Qualification of the tracking algorithm for the SCALP/EG by simulation

General concepts

Real Time – Non real time duality

Ray-Tracing

Graphic board technology (Open GL)



Realism
evaluation

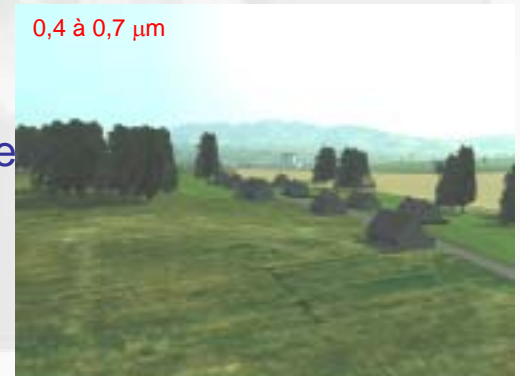
Scenario
preview

General concepts

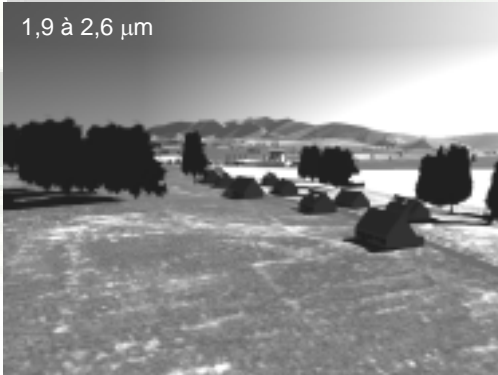
Multi-sensor unification

- ◆ **Independence to the instrument**
 - ☞ Split the environment and sensor modeling to ease the simulation
 - ☞ Generate the same signal for different sensor technologies
- ◆ **Many applications**
 - ☞ Air, Sea and Ground based sensor modeling
 - ☞ Air, Sea and Ground based 3D scene and environment
- ◆ **Multi spectral need**

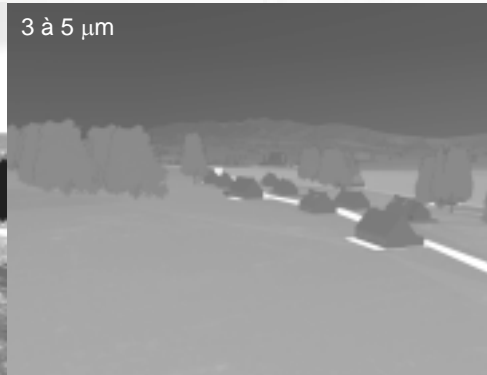
0,4 à 0,7 μm



1,9 à 2,6 μm



3 à 5 μm



8 à 12 μm



Interactive and API modes

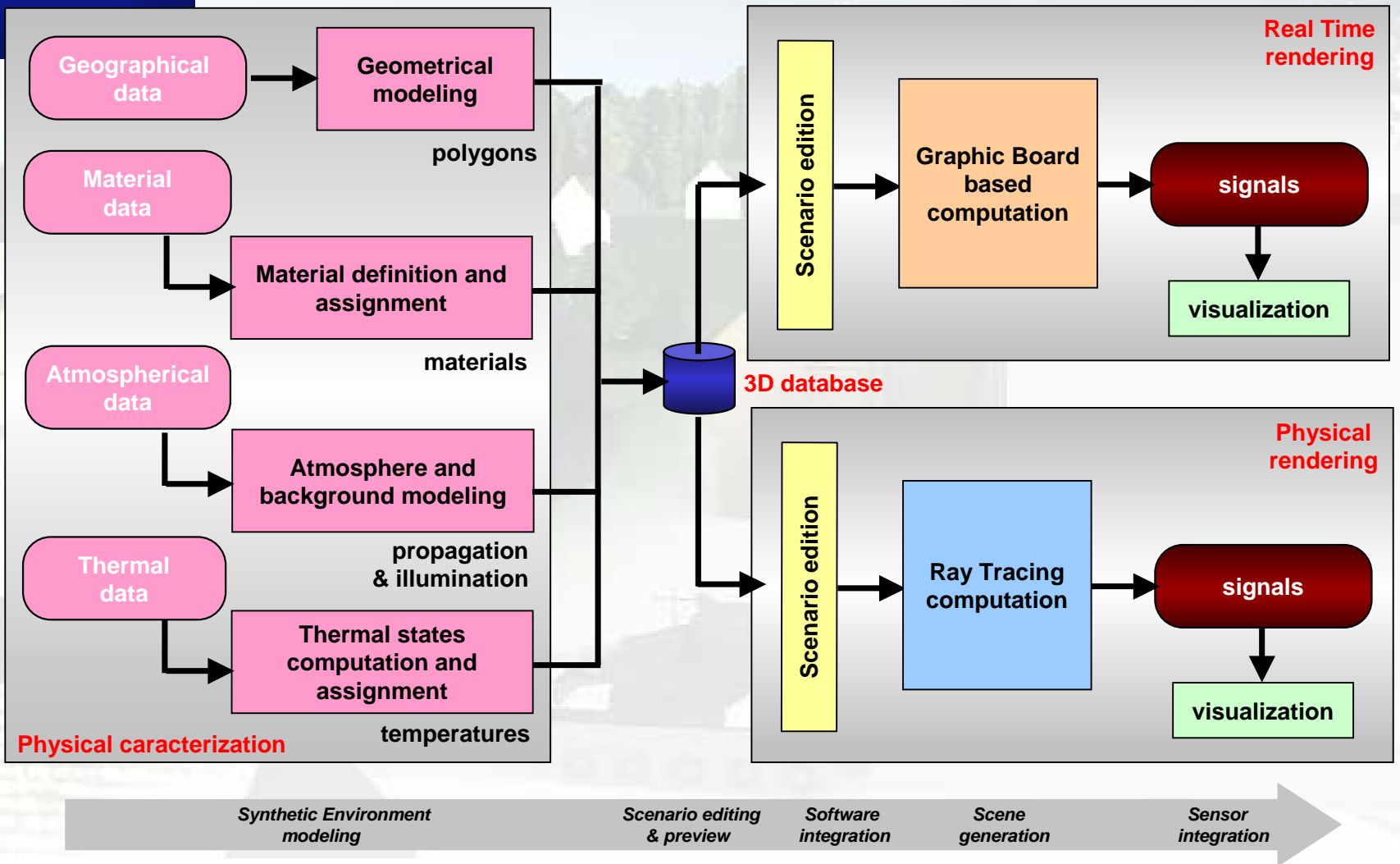
◆ Interactive simulation

- ☞ Scenario development and assessment
- ☞ Database development and enhancement
- ☞ Unitary tests for validation
- ☞ Demonstration and understanding

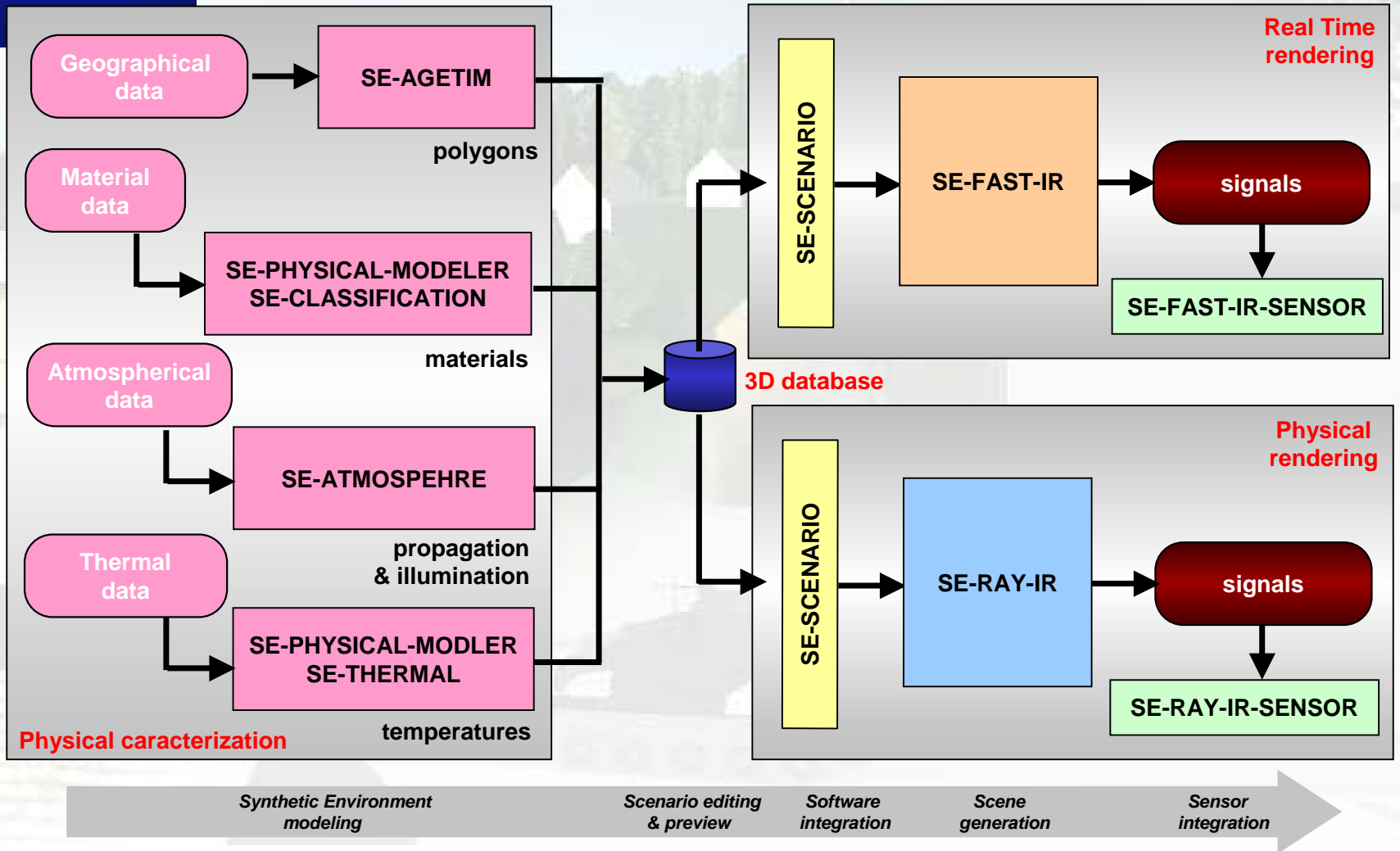
◆ Batch and API mode usage

- ☞ Massive computation
- ☞ Remote control of image sequence generation
- ☞ Software in the Loop applications
- ☞ Hardware in the Loop applications

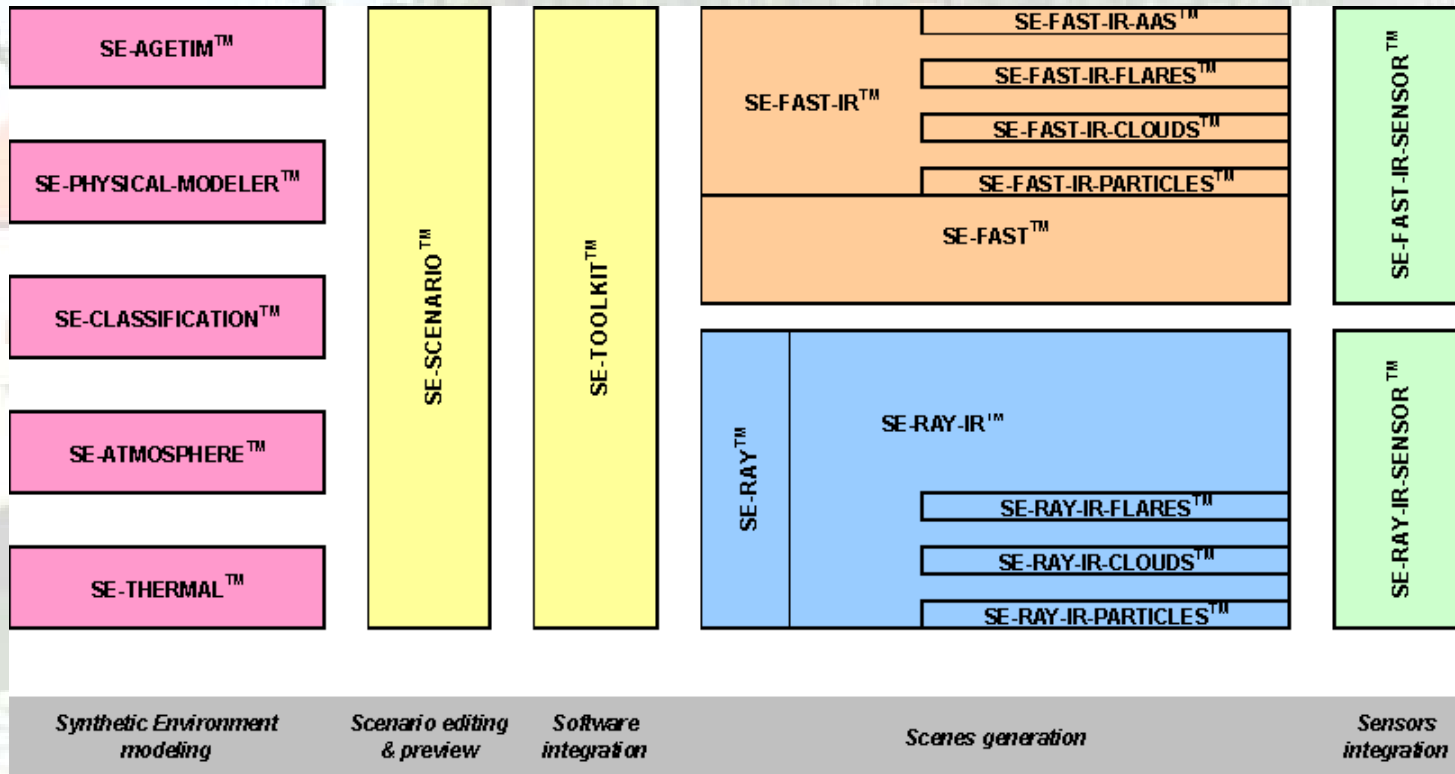
Functional architecture



Functional software architecture

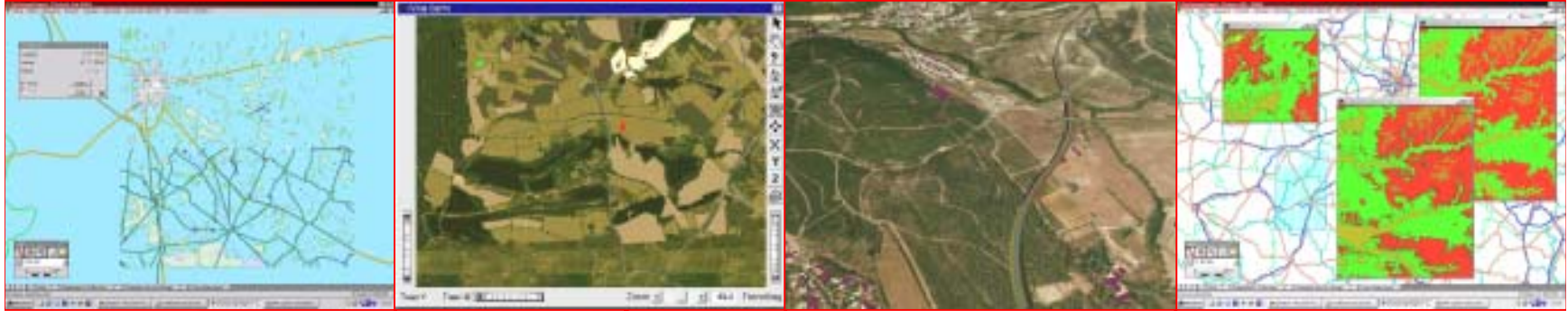


Software offer: SE-Workbench IR



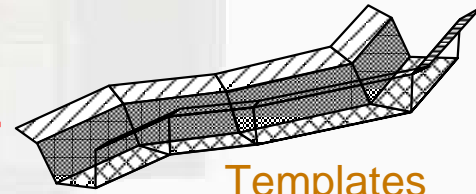
SE-AGETIM : multi-sensor 3D meshed terrain generation

GIS level: cartography
altimetry, planimetry, images



Objects library

SE-AGETIM

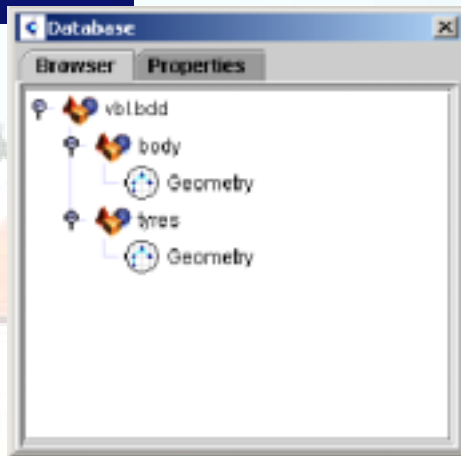


Templates



3D level: meshing

SE-PHYSICAL-MODELER: physical materials handling



Material Edit dialog box for material 'carrosserie'. The Radiation tab is active, showing Emissivity settings and a graph of emissivity vs wavelength.

Material Name: carrosserie

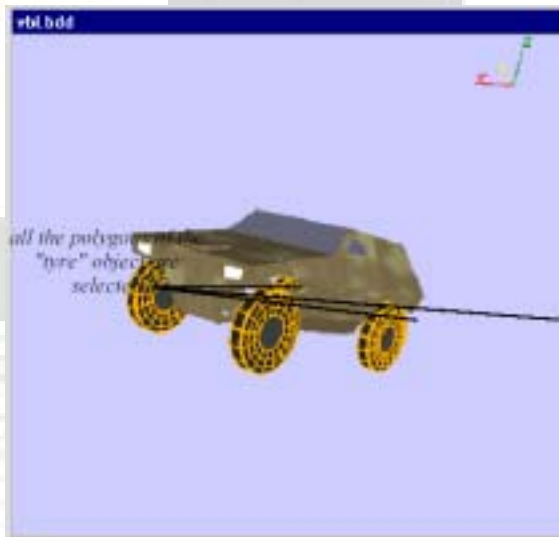
Material Properties: RGB, Optronic, Layers, Roughness, Electromagnetic, Acoustic

Material Type: Radiation, Diffuse BRDF, Specular BRDF, Transmission

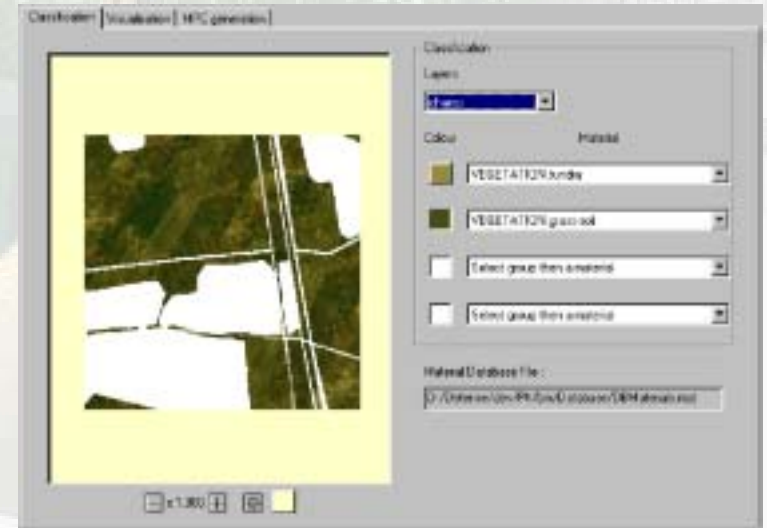
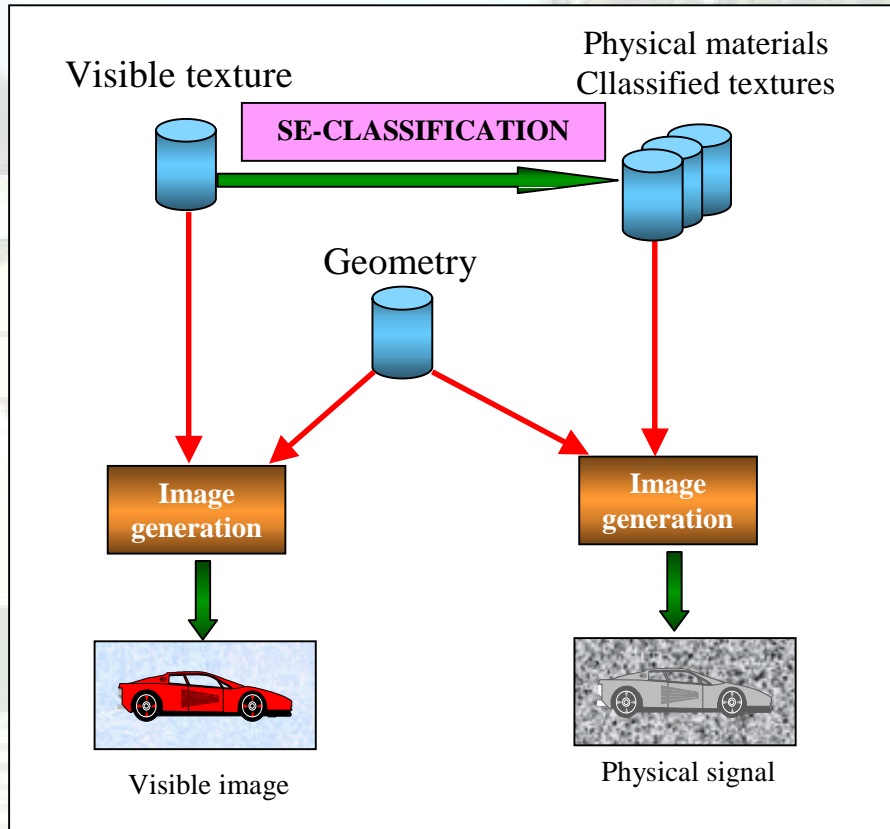
Emissivity: Emissivity, Intensity, Luminance

λ	Radiation	Interpolation
3e-6	0.98	<input type="checkbox"/>
5e-6	0.98	<input type="checkbox"/>
8e-6	0.98	<input type="checkbox"/>
1.2e-5	0.98	<input type="checkbox"/>

Graph of Emissivity $\epsilon(\lambda)$ vs Wavelength λ :



SE-CLASSIFICATION : generation of physical textures

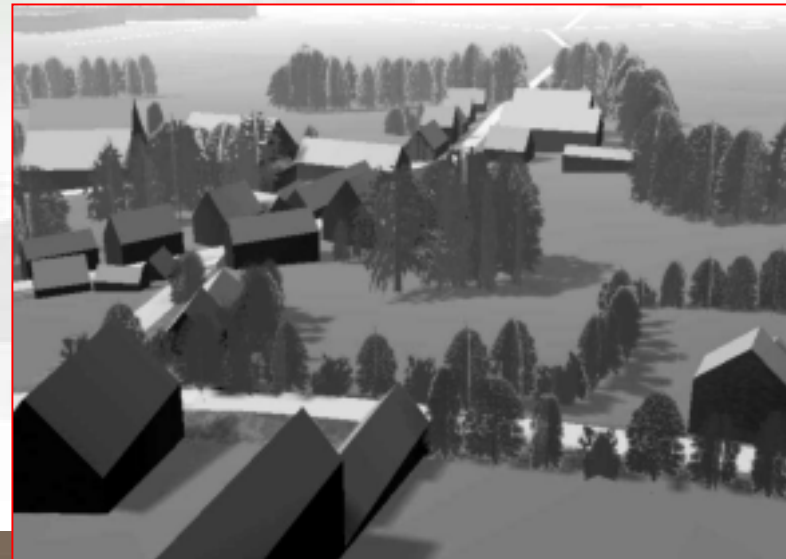
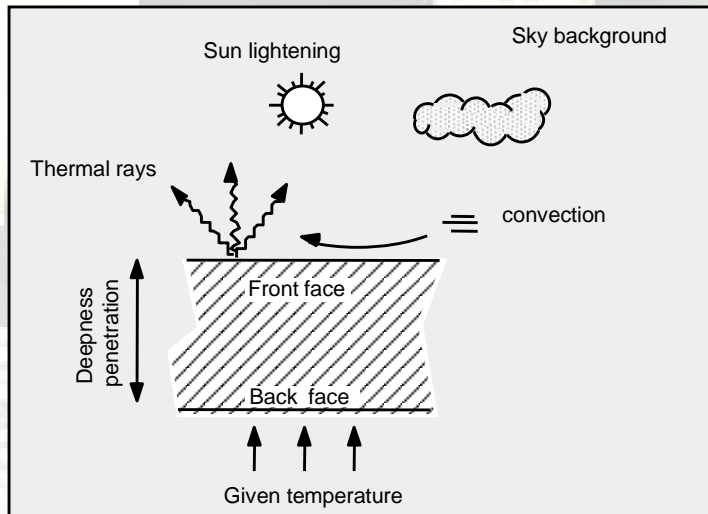


SE-THERMAL : thermal pre-computing

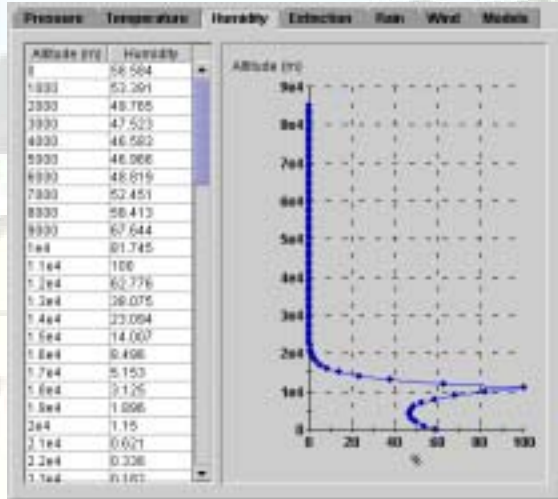
◆ Resolution of the heat transfer equation

- ☞ 1D computation in the thickness direction
- ☞ Non static states on 24 hours or more
- ☞ Finite differences on each layer method

$$\frac{d^2T(x, t)}{dx^2} = \frac{1}{a} * \frac{dT(x, t)}{dt}$$



SE-ATMOSPHERE: atmospheric modeling



SE-RAY-IR: computation of physical signal

The menu bar: File Tools Generation Help

The tool bar: [Icons for file operations and simulation control]

test_tot.scn

- Objects
 - terrain
 - vert
 - traif
 - rouge
- Sensors
 - visible
 - visible
- Atmospheric propagation
 - 12h.atm
- Horizon
 - horizon_sol.bed
- Thermal features

The "scenario" node

The "objects" node

an "object"

a "trajectory"

The "sensors" node

a "sensor"

an "atmospheric"

The "horizon" node

an "horizon"

Snap computation

Time of simulation

Time: 0.0 s to 2.0 s

Start Stop Quit

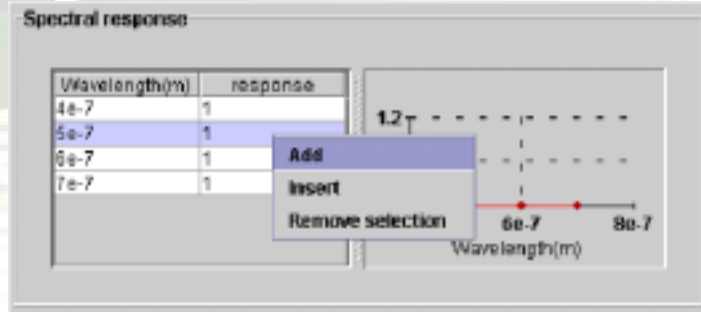
Computation Progress

100%

70%

0%

C:\Documents and Settings\loktaise\Bureau\Composants\Wkr



Spectral computation

Time of simulation

Beginning: 0.0 s to 2.0 s

End: 0.0 s to 2.0 s

Start Stop Stop at end of image Quit

SE-RAY-IR: dynamic element handling

◆ Positioning

- ☞ Fixed position
- ☞ Relative to a sensor or a moving target

◆ Orientation

- ☞ Fixed
- ☞ On one point of the environment
- ☞ On one moving object

◆ Trajectory

- ☞ Suite of discreet positions
- ☞ Possible constraints
 - ☒ Scale factor
 - ☒ Speed
 - ☒ Date
 - ☒ Attitude
 - ☒ Distance



Very easily handling of articulated parts (helicopter rotor, tank turret, ...)

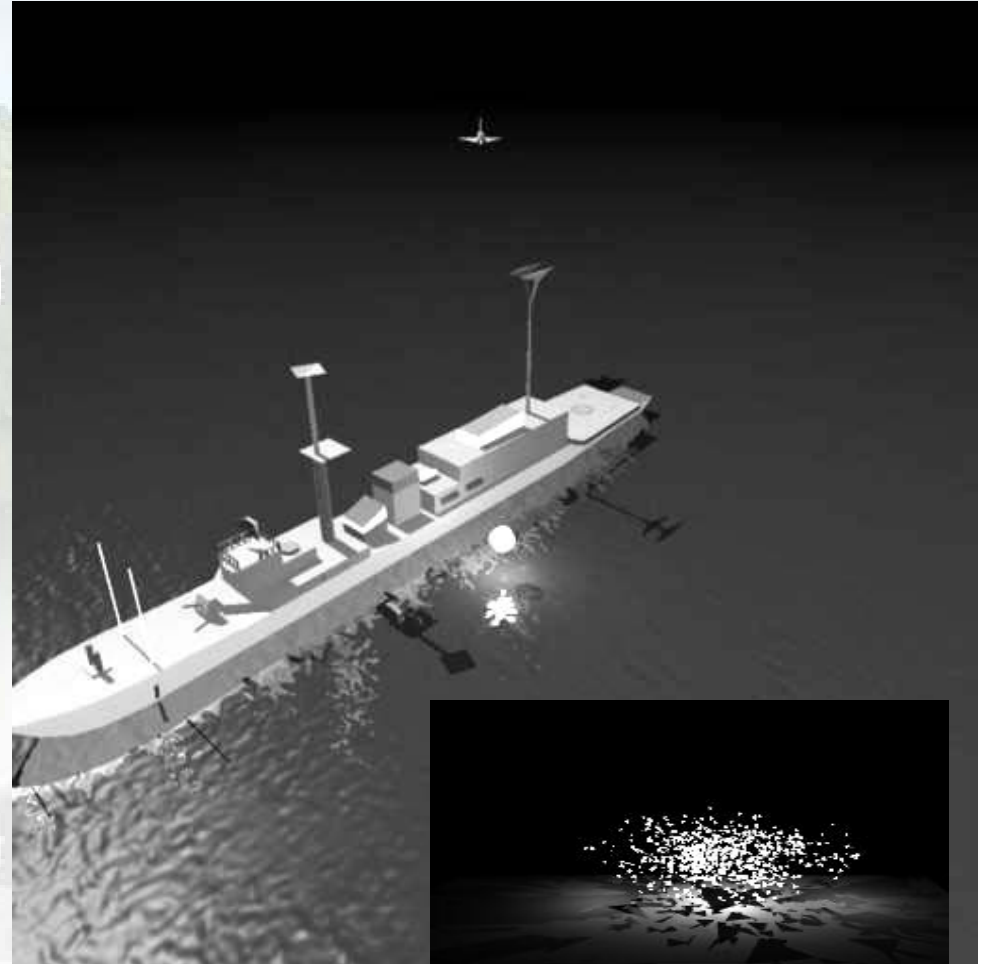
SE-RAY-IR-FLARES: countermeasures modeling

Countermeasure

Cylinder or sphere

Time dependant evolution

- ◆ shape
- ◆ spectral lighting
- ◆ spectral luminance



SE-RAY-IR-CLOUDS: clouds modeling

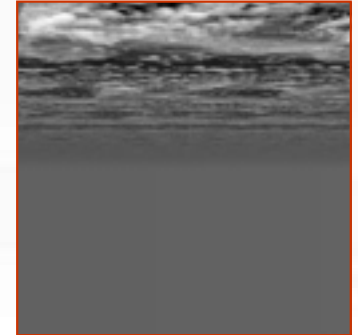
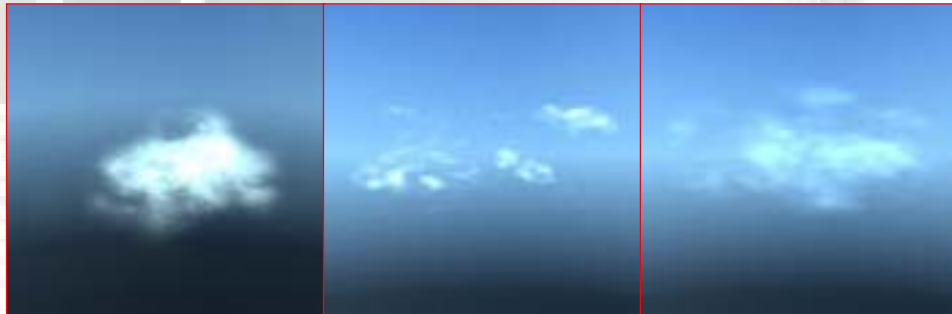
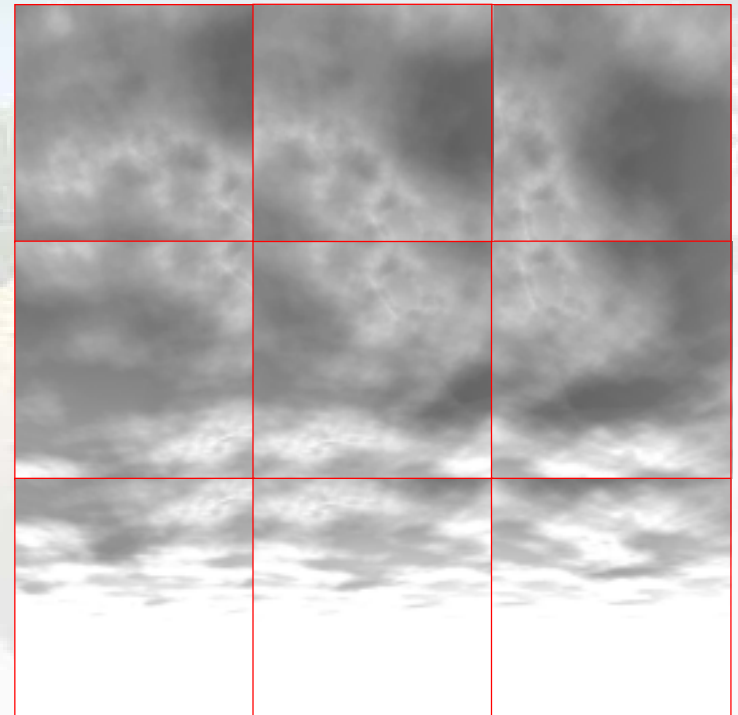
Clouds and Particles

Temporal suite of states
(growing, cycles, descent)

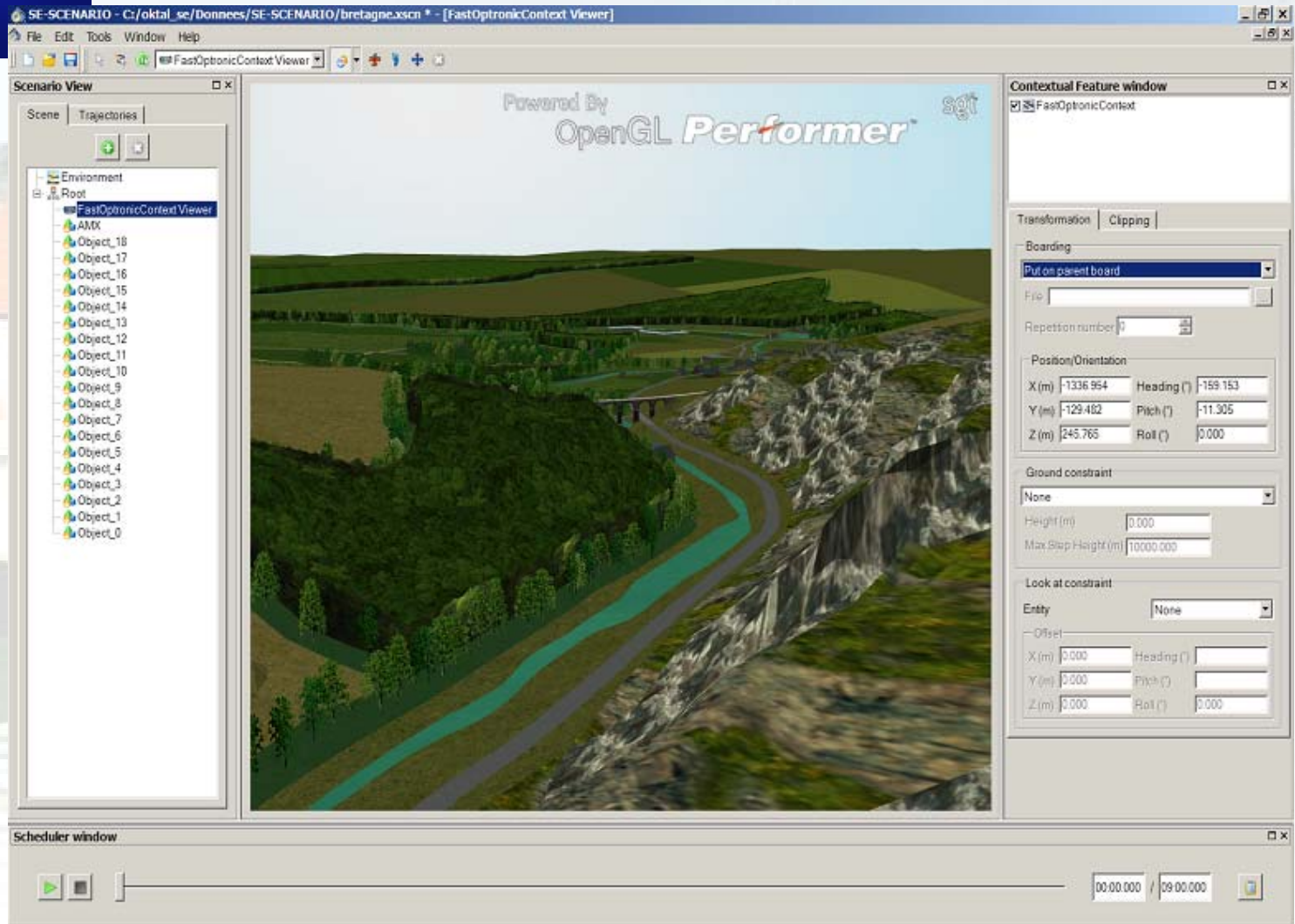
each state is modeled by
a number of Voxels

Each voxel owns :

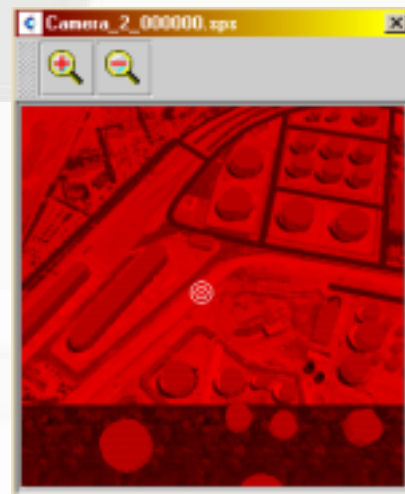
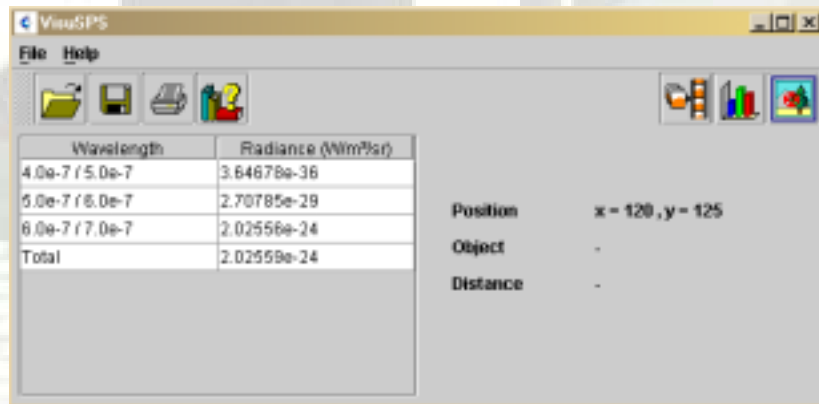
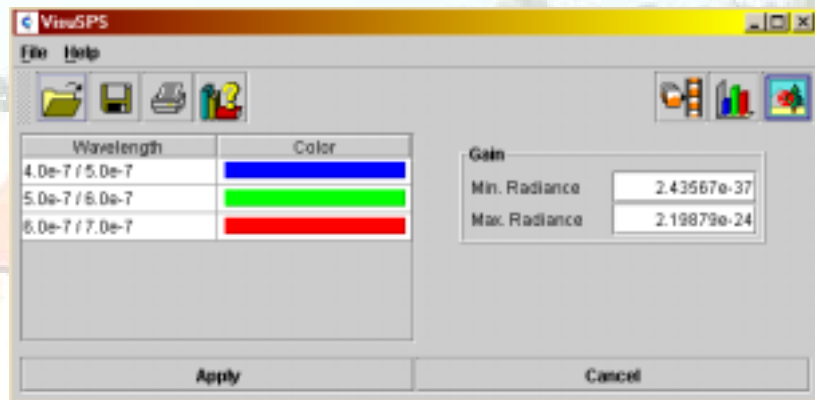
- ◆ a temperature
- ◆ spectral characteristics:
 - absorption coefficient
 - diffusion coefficient
 - Axial dissymmetry parameter



SE-SCENARIO : scenario settings and interactive visualization

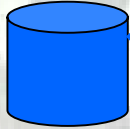
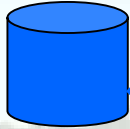


SE-SCENARIO: visualization and signal analysis



SE-FAST-IR: fast time infrared visualization

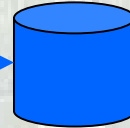
Physical database



Thermal database

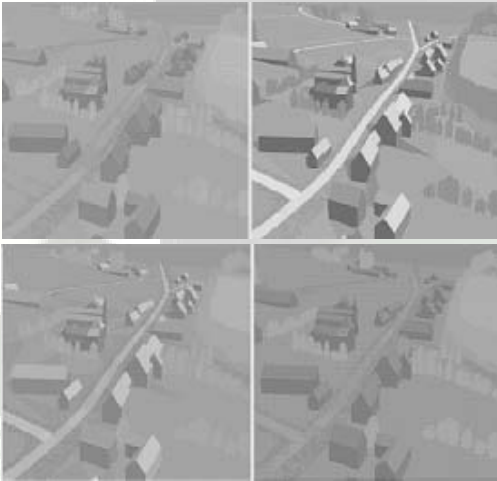
SE-THERMAL

Ready 3D database

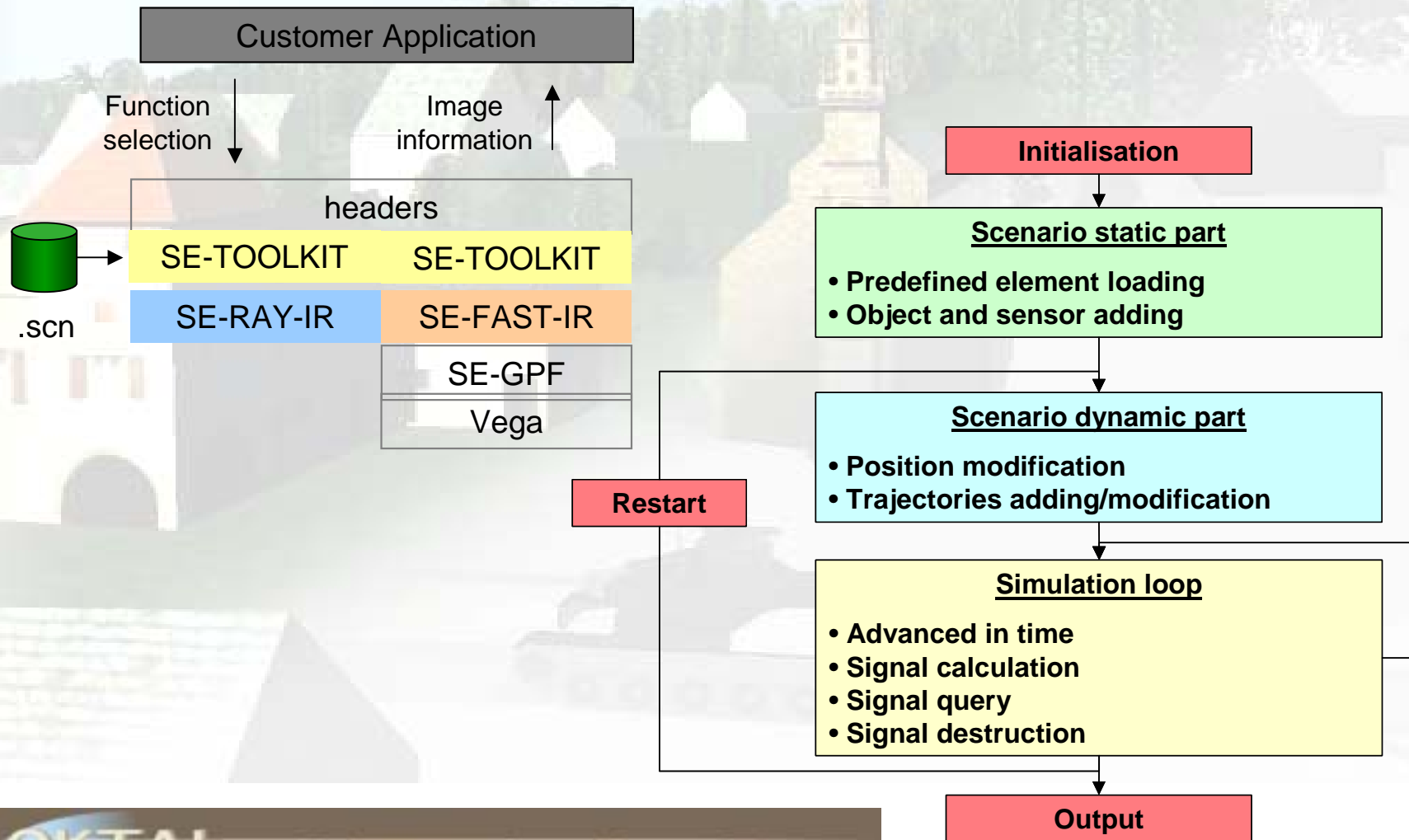


SE-FAST-IR

Real time
Infrared images



SE-TOOLKIT: generic API



SE-RAY-IR-SENSOR: generic sensor transfer function modeling

