Activities in 2014 on WP3/WP6
Firenze and Pisa/Siena groups

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CaloCube start-up meeting
Firenze, 2014-01-22

Summary

- **Main activities on WP3/WP6** (Firenze group).
  - (1) Optical characterization of scintillator and radiator materials.
  - (2) Development of light collection system.
  - (3) Study of space qualification for radiation.

- **(4) Mechanical/thermal design and space qualification of CaloCube system** (Pisa/Siena and Firenze group).

(1) Optical characterization

- **Purpose.**
  (a) Understand **optical properties** of candidate active materials of calorimeter: inorganic scintillators (including heavy scintillating glasses from E705), Cherenkov radiators, plastic scintillators (for thermal neutron):
  - **spectra** of light emission and self-absorption;
  - **time profile** of emitted light pulses.

  (b) Procurement and optical characterization (at external laboratories) of samples of candidate materials.

- **Output.**
  - Literature analysis / simulation / laboratory test results.
  - Help finding the best candidate materials / scenarios (i.e. combinations of scintillator / possible Cherenkov radiator / possible neutron detector) for CaloCube.

- **Inputs needed** from other CaloCube activities.
  - **From simulations on calorimeter and charge detector performance**: suggested scenarios and candidate active materials of calorimeter.

(2) Light collection system

- **Purpose.**
  Mechanical/optical design of **light guide system** (baseline: scintillating / "frosted glass" fibres):
  - **light transmission efficiency** (from scintillation / Cherenkov emission to employed photo-detector): guide material, interfaces (optical treatments), geometry;
  - **optimization of geometry:** compactness; dead volume between sensitive elements;
  - **space qualification;**
  - **for the scenario with Cherenkov light collection:** traditional wavelength shifter (bulk doping) as backup solution to surface treatment (**Napoli group**);
  - **for the scenario with unique active material producing both scintillation and Cherenkov light:** traditional UV filter (coloured glass etc.) as backup solution to dichroic filter (**Catania/Messina group**).
- **Output.**
  - Analysis, simulation and test results.
  - Prototype of detector module with light guide system.
- **Inputs needed** from other CaloCube activities.
  - **From studies of photo-detector / active materials:** geometry and optical properties .

(3) Space qualification for radiation

- **Purpose.**
  Study of applicable space qualification methods for **radiation**:
  – Single Event Effects (SEE) on **electronics**;
  – cumulative effects of charged/neutral particlesfluxes on **materials** and **micro/nano-structures**: electronics, optical parts (bulk volumes or surface layers), mechanical parts (affecting stiffness), induced outgassing etc.

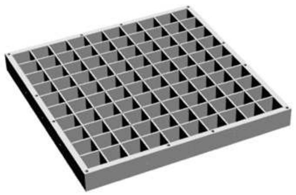
- **Output.**
  – Simulation of expected radiation environment along possible orbits (depends on sun activity) and consequent limits on SEE/cumulative sensitivity.
  – For candidate electronics, help understanding SEE sensitivity (through literature / simulation / irradiation test).
  – For candidate materials and structures, help understanding sensitivity to cumulative effects (though literature / simulation / irradiation test).

- **Inputs needed** from other CaloCube activities.
  – **Relevant specifications** of candidate electronics, materials, micro/nano-structures.

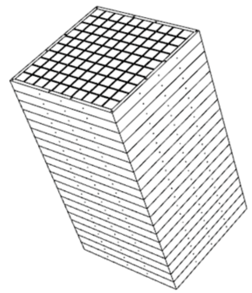
(4.1) Mechanical design

- **Design of the complete support frame** for detector elements (scintillator/radiator, wave guide, photo-detector and FE electronics).
- **Modular approach:** e.g. 4 towers, each tower consisting of 20 layers, each layer hosting 10 x 10 crystals.

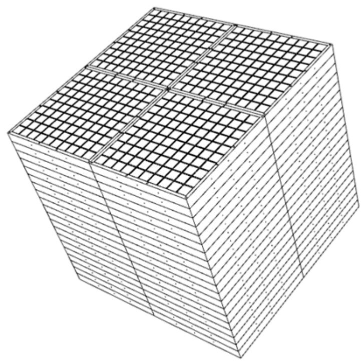
One layer (100 crystals):



One tower (20 layers):



4 towers:



(4.1) Mechanical design

- **Main requirements of support frame:**
  - compact, lightweight;
  - minimization of dead volumes;
  - minimization of energy loss in the support structure;
  - adequate stiffness (for launch in space);
  - efficient heat flow (from FE electronics).

- **Favored solution:**
  - low-Z, low-density carbon fibre structure with honeycomb core;
  - also composite materials such as CFRP (carbon fibre reinforced polymer) will be investigated.

(4.2) Mechanical/thermal qualification

- **Purpose.**
  Mechanical/thermal modeling and space qualification of CaloCube system:
  - **mechanical** stresses (e.g. launch), by considering possible spacecraft operation;
  - **thermal** stresses, by considering heat from internal electronic parts and external environment (spacecraft thermal behaviour, exposure to sunlight, pressure condition).

- **Output**
  - Study of expected mechanical stresses on critical parts (e.g. scintillator / light guide interface).
  - Thermal modeling of the system (bulk materials, conductive interfaces, radiated heat).
  - Study of thermal stresses on critical parts (e.g. optical interfaces), operating temperature range on single parts (e.g. electronics).
  - Undestand whether active cooling is needed or not.

- **Inputs needed** from other activities CaloCube activities.
  - **Admitted operating temperatures and gradients** for candidate electronics and other parts (e.g. optical couplings).