CATIA-GDML geometry builder

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Problem

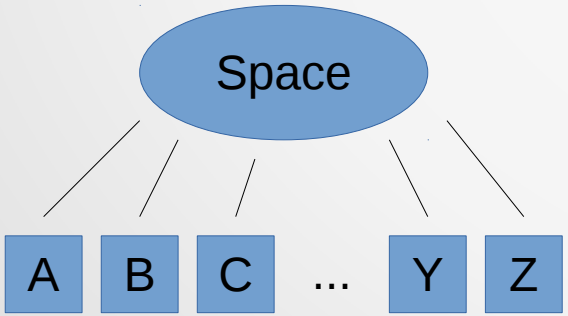
- Incompatible geometry representations
  - BREP in a single infinite space – CAD systems (CATIA)

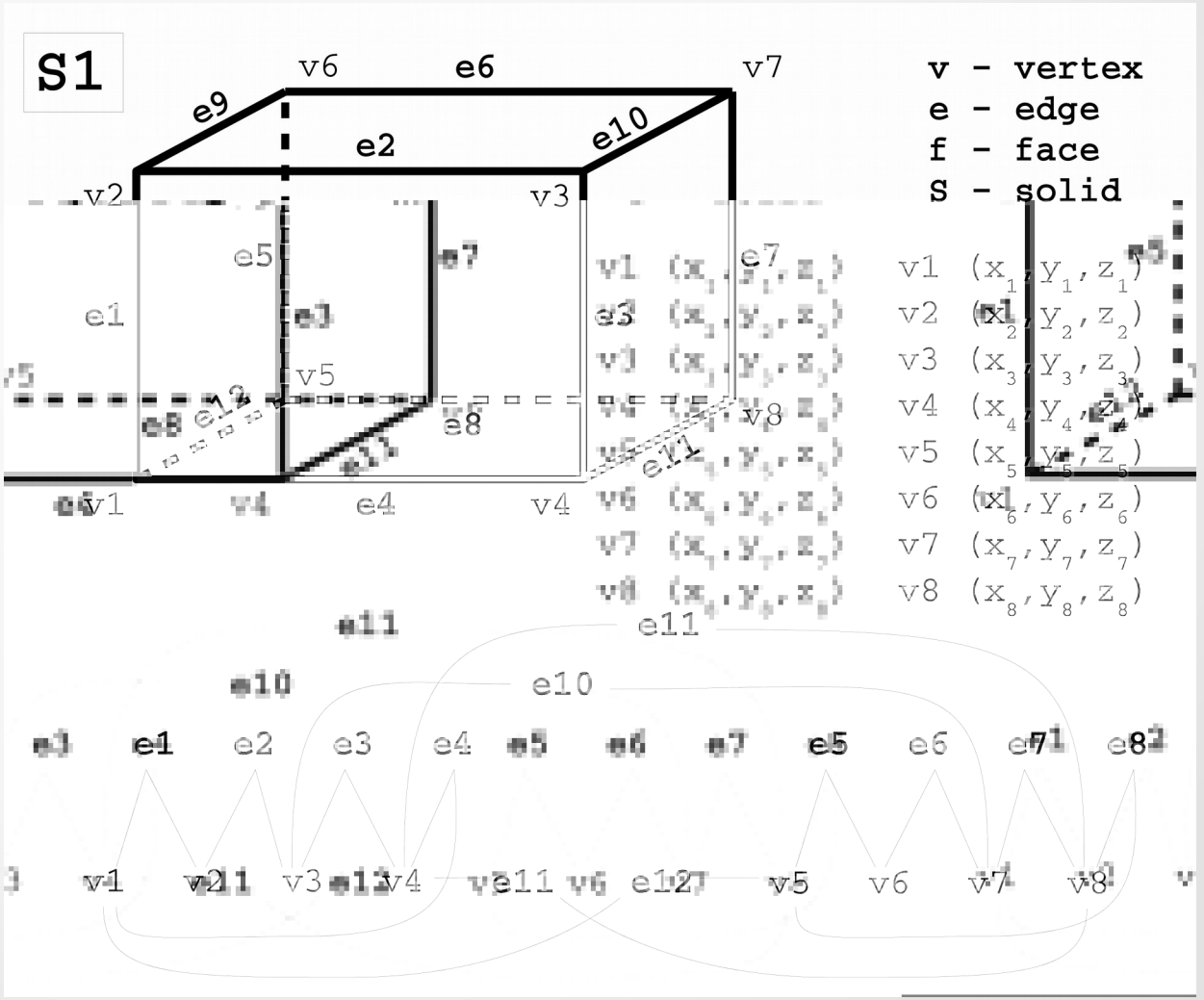
    vs.
  - CSG with volume hierarchy – particle propagation simulation systems (GEANT4/ROOT, VMC)

- The problem is twofold:
  - Shape definition – BREP vs. CSG
  - Volumes' relation – single space vs. volume hierarchy

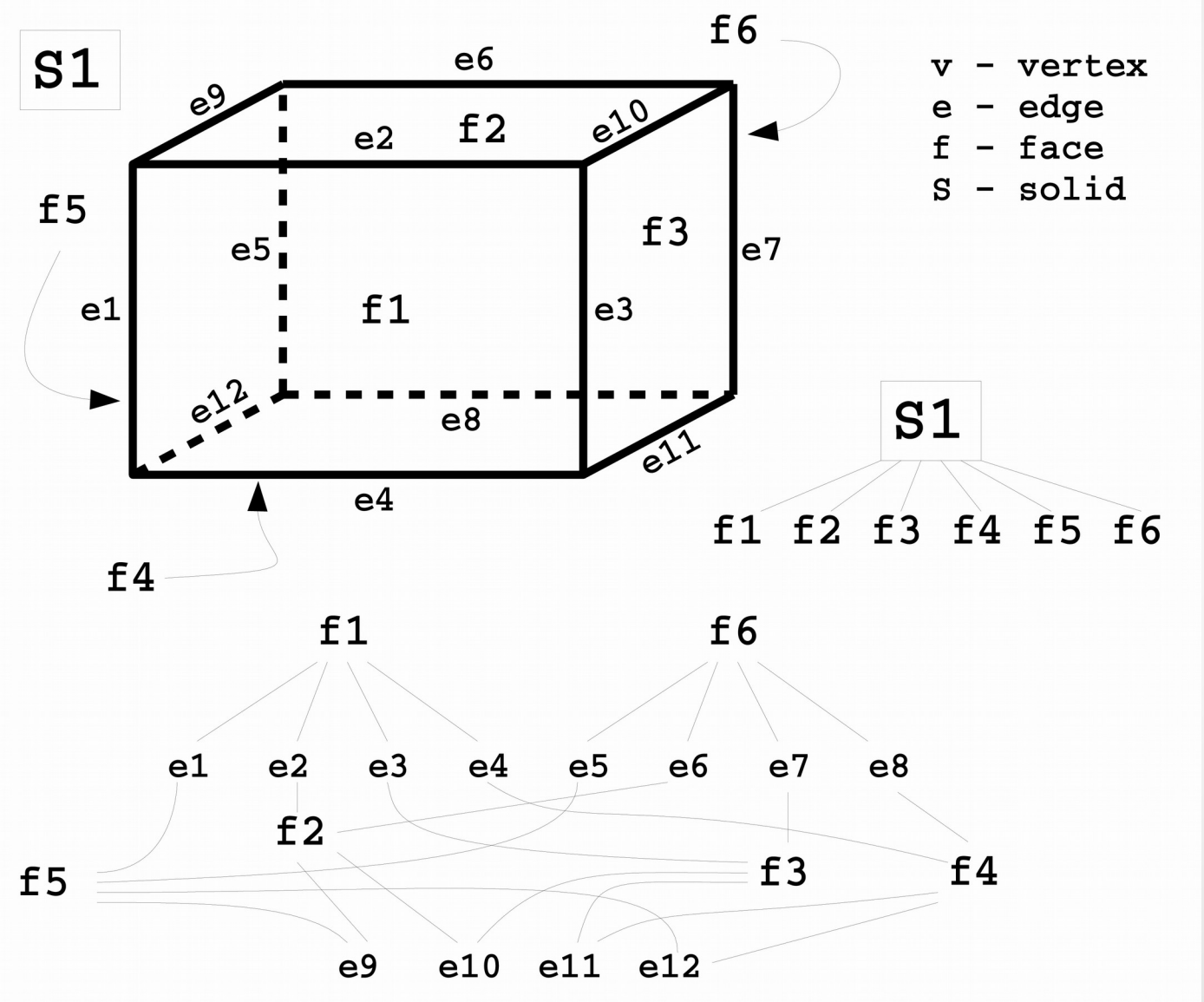
BREP in a single infinite space

- Similar to real life, every object is positioned in a single infinite space (made of vacuum)
- A volume is a part of space bounded by the closed shell of faces.



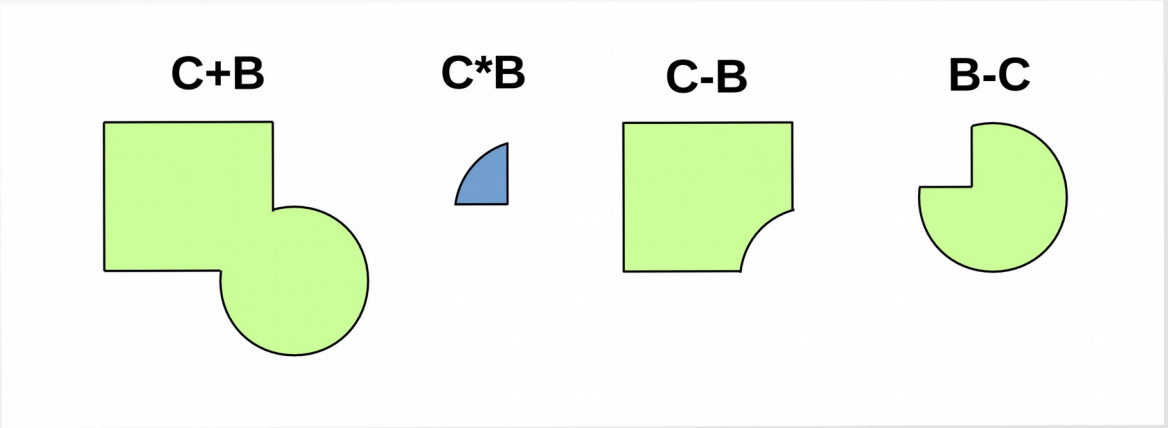


BREP in a single infinite space



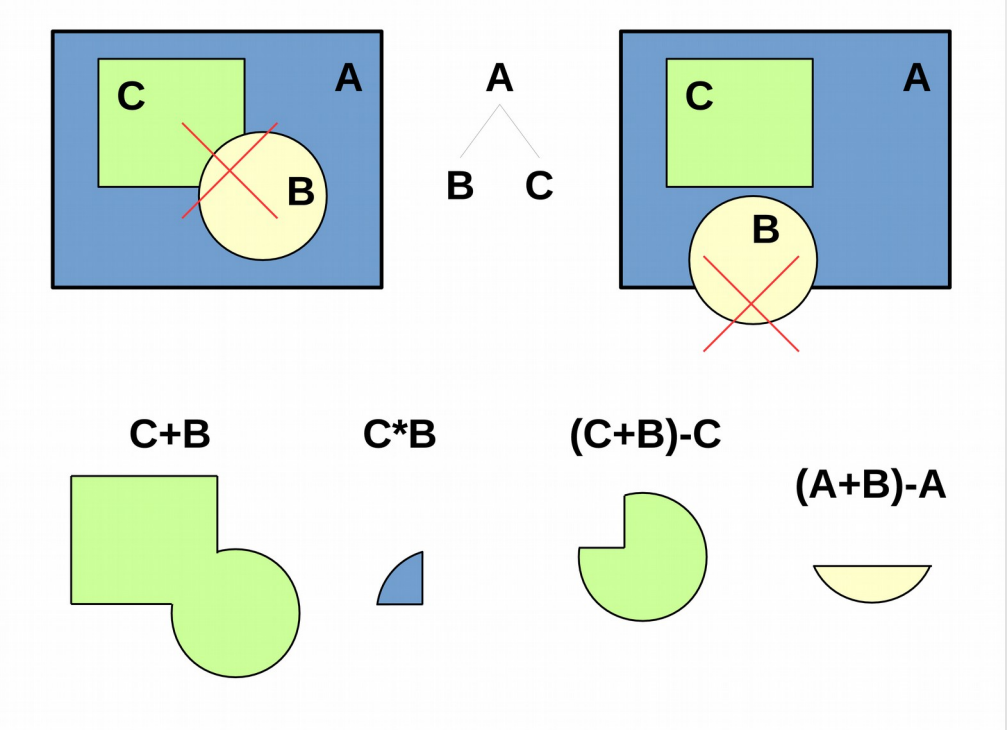
CSG with volume hierarchy: shape

- List of pre-defined primitives, implemented in corresponding classes:
  - box, cone section, tube section, sphere section, trapezoids (trd, trap), parallelepiped, orb, twisted primitives, etc…
- Boolean operations



CSG with volume hierarchy: volume hierarchy

- There is only one top volume, there is nothing outside of it.
- A volume can be positioned inside another volume.
- A daughter volume can not intersect the boundaries of its mother volume.
- Two or more daughter volumes can not intersect each other.



One possible solution: “CATIA-GDML geometry builder”

- A set of CATIA templates, including primitives.
- A set of rules allowing to create a GEANT4/ROOT-compatible model inside the CATIA environment.
- Main macros: **CATIA2GDML** and **GDML2CATIA** converters.
- Other macros, including those to facilitate:
  - Creation of a new volume;
  - Creation of a shape;
  - Inserting one volume into another;
  - Creation of multiple-volumes instantiation (arrays, replica);
- Documentation, tutorials, examples – currently being rewritten, extended and tested on real new users.

“CATIA-GDML geometry builder”

is not a converter

from CATIA into GDML or

from GDML to CATIA.

“CATIA-GDML geometry converter” is a set of tools which helps the user to create GEANT4-ROOT compatible models in the CATIA environment.
It does not solve the mathematical problem of conversion of a geometrical model between BREP and CSG descriptions.

“CATIA-GDML geometry builder”

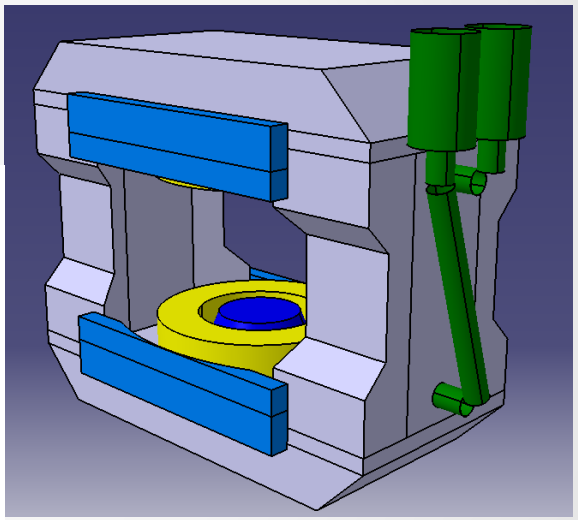
- Pros:
  - Free and (almost) open-source by itself.
  - Allows to work with the engineer’s CAD model and the physicist’s MC-model simultaneously, comparing and developing them both at the same time.
  - Fastens the process of MC-geometry creation up to 20 times compared to classical MC-geometry building using geo-files or ROOT/GEANT C++ code.
- Cons:
  - Requires CATIA v5.
  - Requires some basic CATIA v5 knowledge.
  - Requires at least basic understanding of CAD and MC geometry representations.

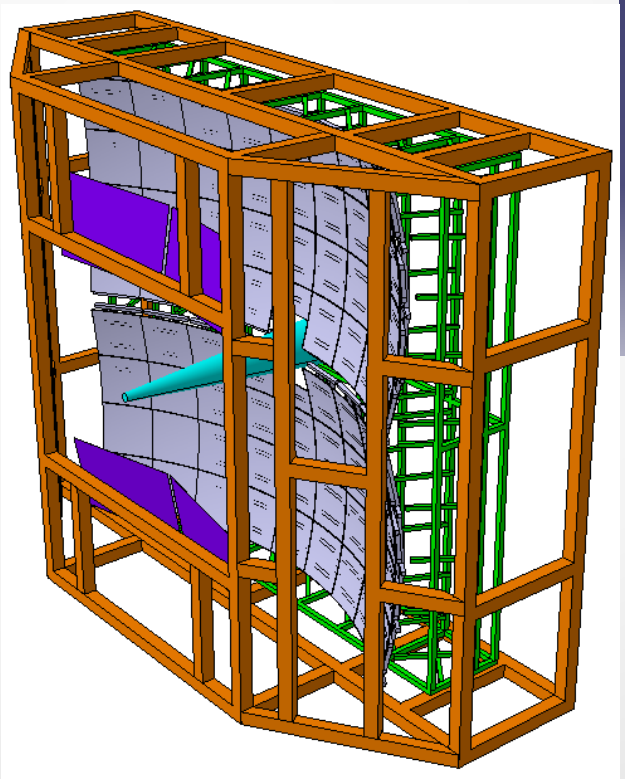
Most recent developments

- Since a few months the “CATIA-GDML geometry builder” repository is available online: https://gitlab-hybrilit.jinr.ru/cad2gdml/
- Detailed documentation has been written and now available online: https://gitlab-hybrilit.jinr.ru/cad2gdml/CATIA-GDML_geometry_builder/wikis/home
- CMS beam pipe and CMS MUCH started collaborating with us working about the existing CAD and MC geometry verification

Use-cases throughout 2010-2017

- Main use-case which has been driving the development during last 4 years – **CBM RICH** detector;
- CBM dipole magnet
- R3B GLAD cryostat
- PANDA MUCH
- CMS beam pipe and CMS MUCH (2017!)





Use-cases throughout 2010-2017

- Other CBM subsystems:
  - Vacuum chamber, MVD, vacuum beam pipe, ECAL mechanical structure