AGDD The detector description framework

- Goal
- The design pattern
- The architecture
- The generic model
- Positioning volumes
- Graphical tools
- The C++ framework

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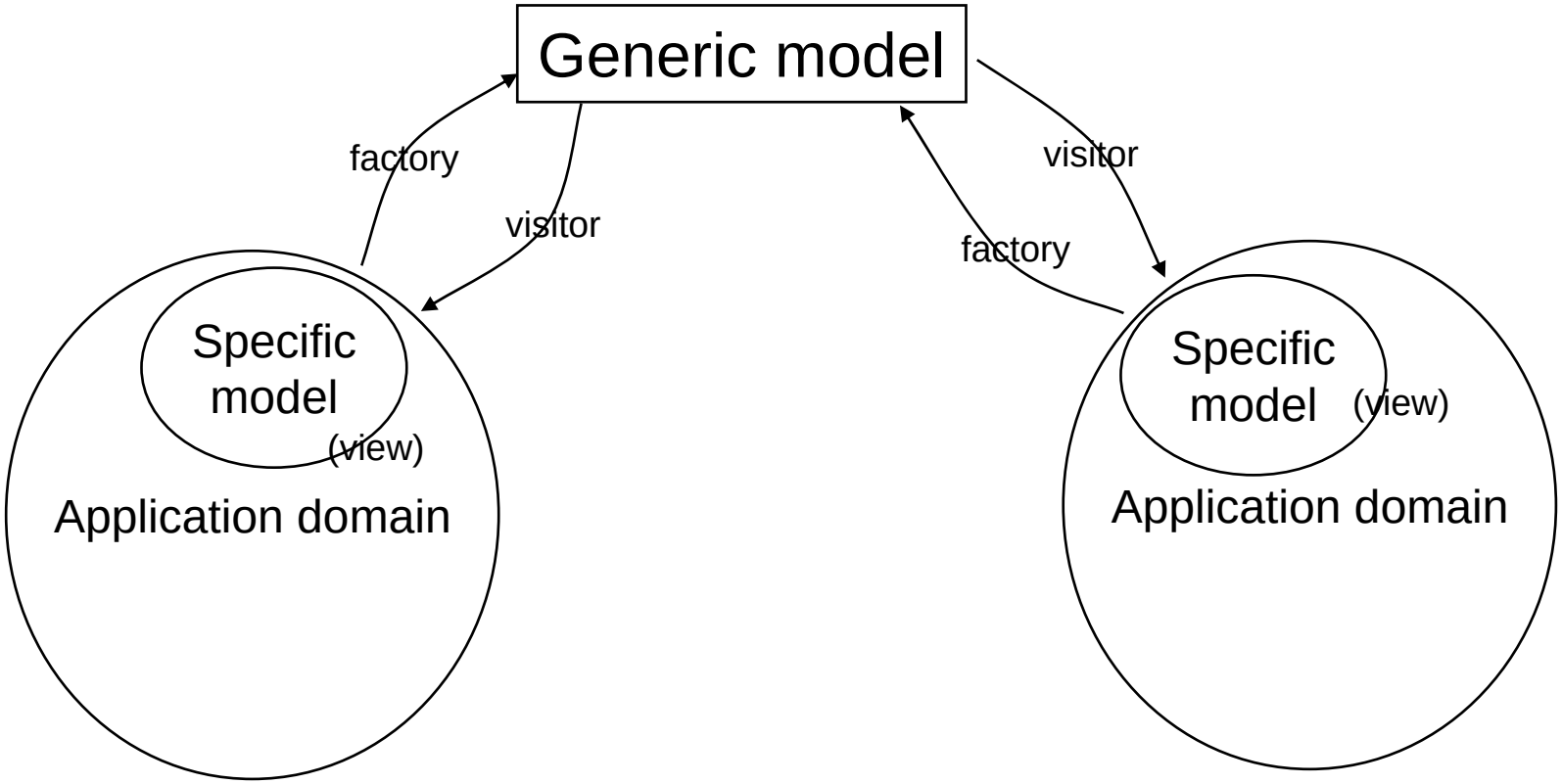
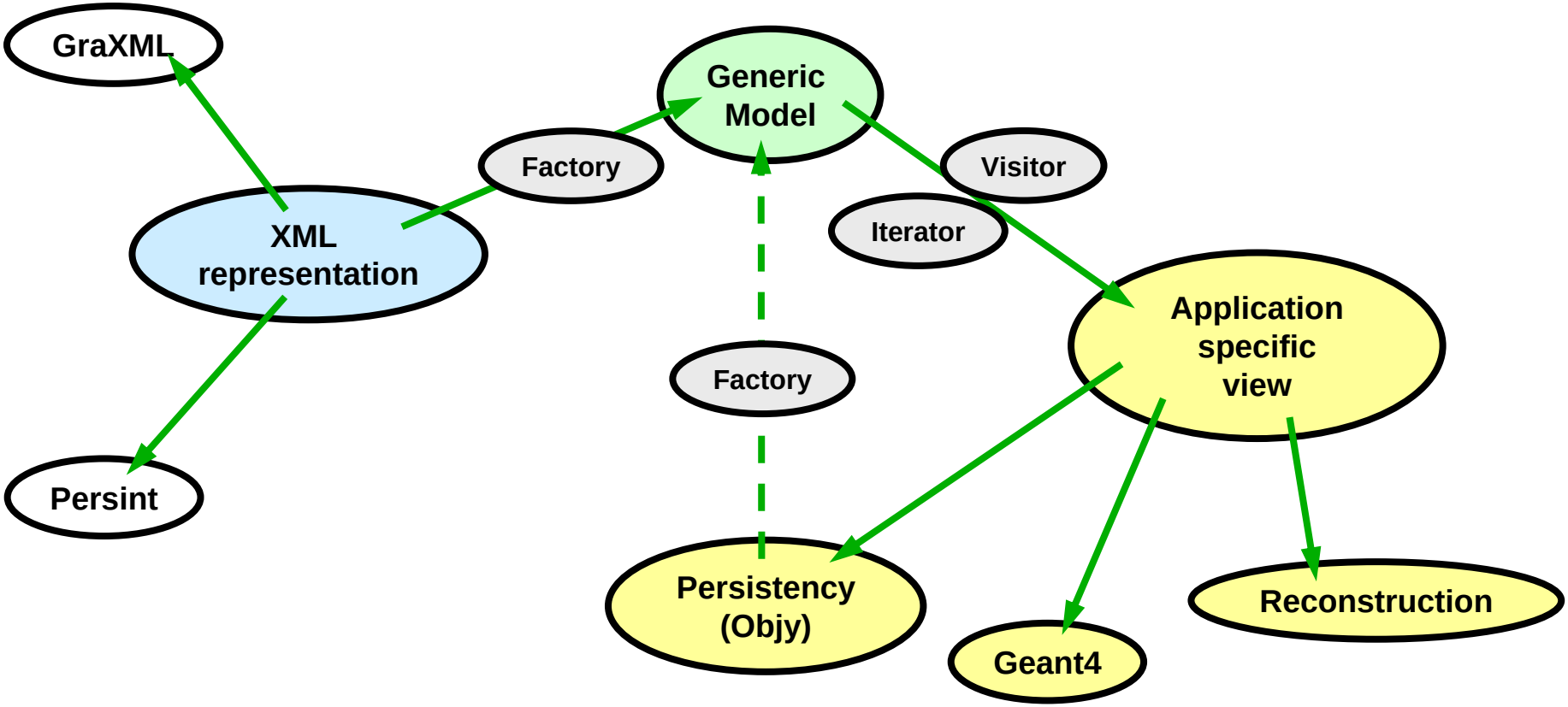
AGDD The detector description framework

- **Goals**
  - **provide a generic and common framework for describing all detector description information, independently of specific applications**
  - **should not be dependent on specific constraints (such as Geant optimisations, reconstruction algorithms, ...)**
  - **should not be limited to geometrical information**
    - » **logical organisation of the detector**
    - » **naming scheme(s)**
    - » **multiple views (structural, read-out, trigger, ...)**
    - » **physical properties of the detectors**
  - **should support simple relationships with alignment data**
  - **simple and portable implementation**

AGDD The design pattern



AGDD The architecture



AGDD The Geometry Database

Inspired by Geant4:

1 Creation of Volumes:

⇒ generic and descriptive

- **Elementary solids**

  Basic building blocks characterized by shape, dimension and material

  - box
  - tube
  - trapezoid ...

- **Boolean solids**

  boolean operations on 2 or more volumes

  - union
  - intersection ...

- **Logical grouping of volumes**

  - composition
  - stack

2 Positioning of Volumes:

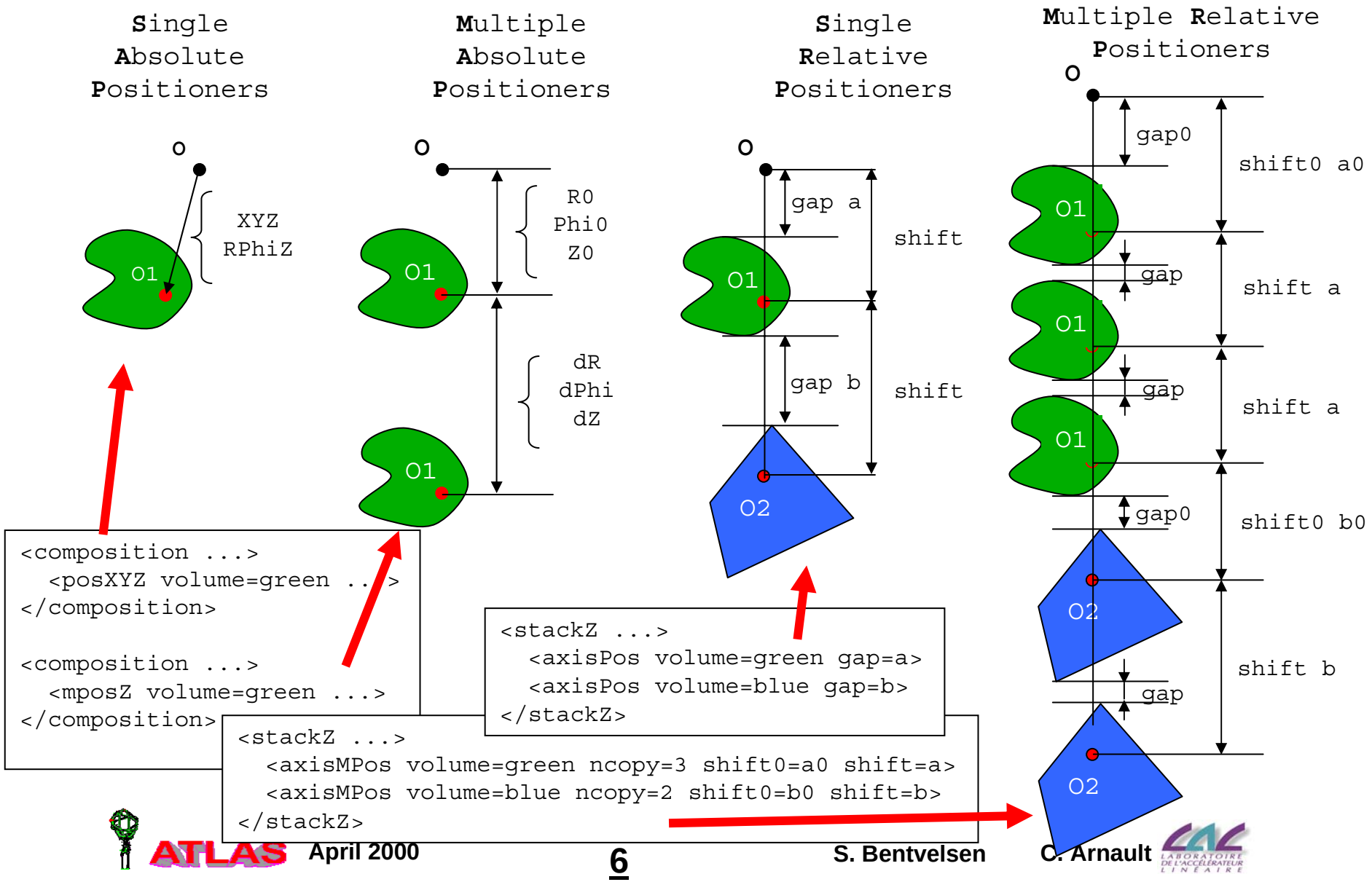
⇒ description of the instantiation of the volumes

- **Absolute or relative, single or multiple positioners**

  Define how the coordinate origin and the transformation matrix of a composed volume is computed from the origin of the constituents, through parameterized algorithms

  - posXYZ
  - posRZPhi
  - mposPhi
  - mposZ
  - axisPos
  - axisMPos

AGDD Positioning volumes



AGDD Simple example XML implementation

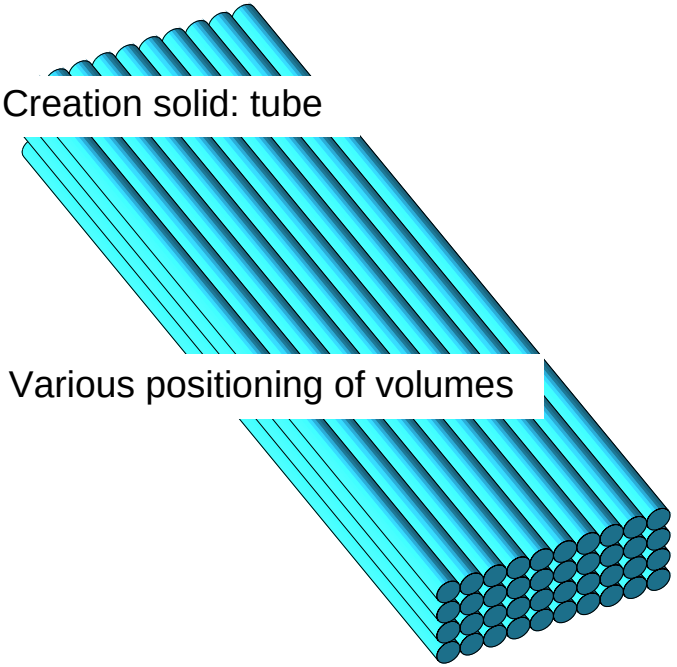
```
<?xml version="1.0"?>
<!DOCTYPE AGDD SYSTEM "AGDD_1.04.dtd">

<AGDD DTD_version="v4">

<!--  Workshop example file
      **********************
-->
<section name       = "WK"
         version    = "1.0"
         date       = "Wed Oct 27"
         author     = "Detector Description group"
         top_volume = "ATLAS"
         DTD_version= "v4"     >


<tubs name="WK_tube" material="Aluminum" Rio_Z="0. 15. 1000." />

<composition name="WK_layer" >
     <mposZ volume="WK_tube" ncopy="10" dZ="30." rot="0 90 0" />
</composition>

<composition name="WK_multilayer" >
     <posXYZ volume="WK_layer" X_Y_Z=" 0 0 0" />
     <posXYZ volume="WK_layer" X_Y_Z=" 0 30 0" />
     <posXYZ volume="WK_layer" X_Y_Z=" 0 60 0" />
     <posXYZ volume="WK_layer" X_Y_Z=" 0 90 0" />
</composition>

<composition name="ATLAS" >
     <posXYZ volume="WK_multilayer" />
</composition>

</section>
</AGDD>
```

AGDD Header, version of DTD

Section: sub-detector + author + version

Creation solid: tube

Various positioning of volumes



AGDD The generic model

- **The generic model**
  - **It is derived from the definitions installed in the AGDD.dtd file**
  - **Since XML is *not* object-oriented, some *tuning* was needed (eg. To supply inheritance relationships)**
  - **Naming convention combines the original naming (defined in the DTD) with the C++ naming conventions (prefixing with AGDD_, capitalising, member prefixing, etc...)**

```
AGDD
AGDD_Section
AGDD_Units
```

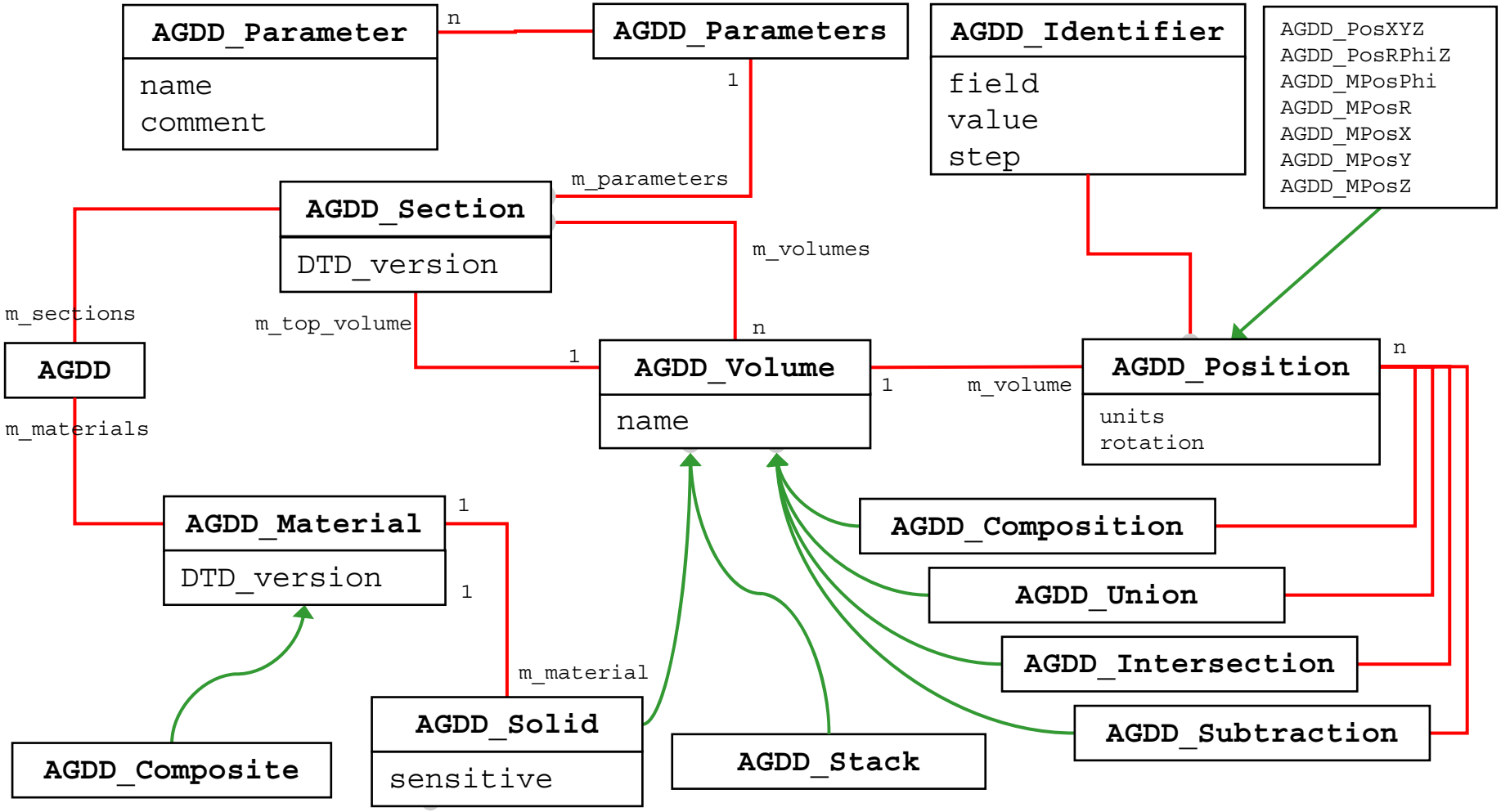
```
AGDD_Volume
          AGDD_Solid
          AGDD_Composition
          AGDD_Union
          AGDD_Intersection
          AGDD_Subtraction
          AGDD_Stack
```

```
AGDD_Solid
          AGDD_Box
          AGDD_Trapezoid
          AGDD_Tubes
          AGDD_Cons
```

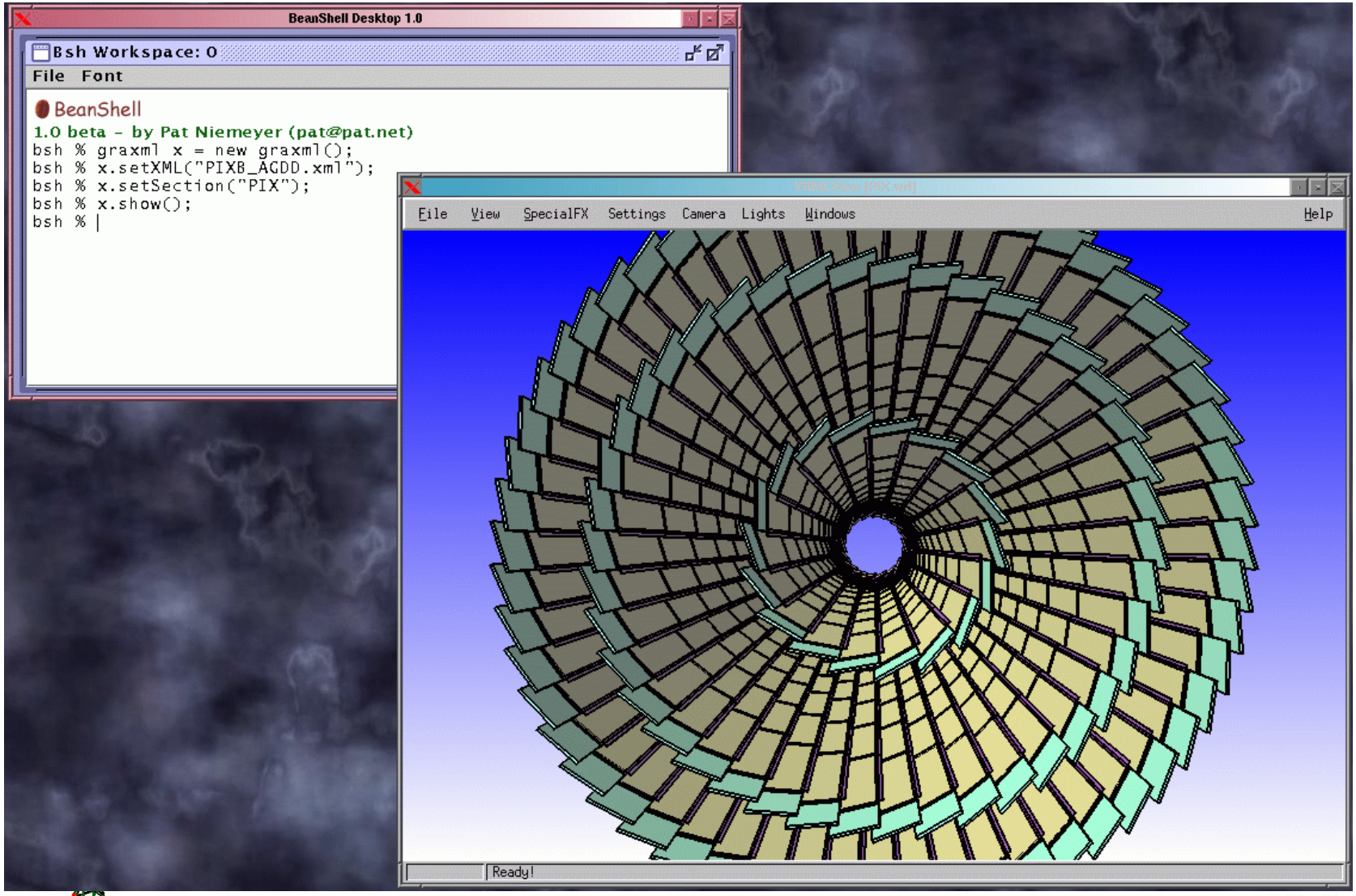
```
AGDD_Position
          AGDD_PosXYZ
          AGDD_PosRPhiZ
          AGDD_MPosPhi
          AGDD_MPosR
          AGDD_MPosZ
```

```
AGDD_Material
          AGDD_Element
          AGDD_Composite

AGDD_AddMaterial
```

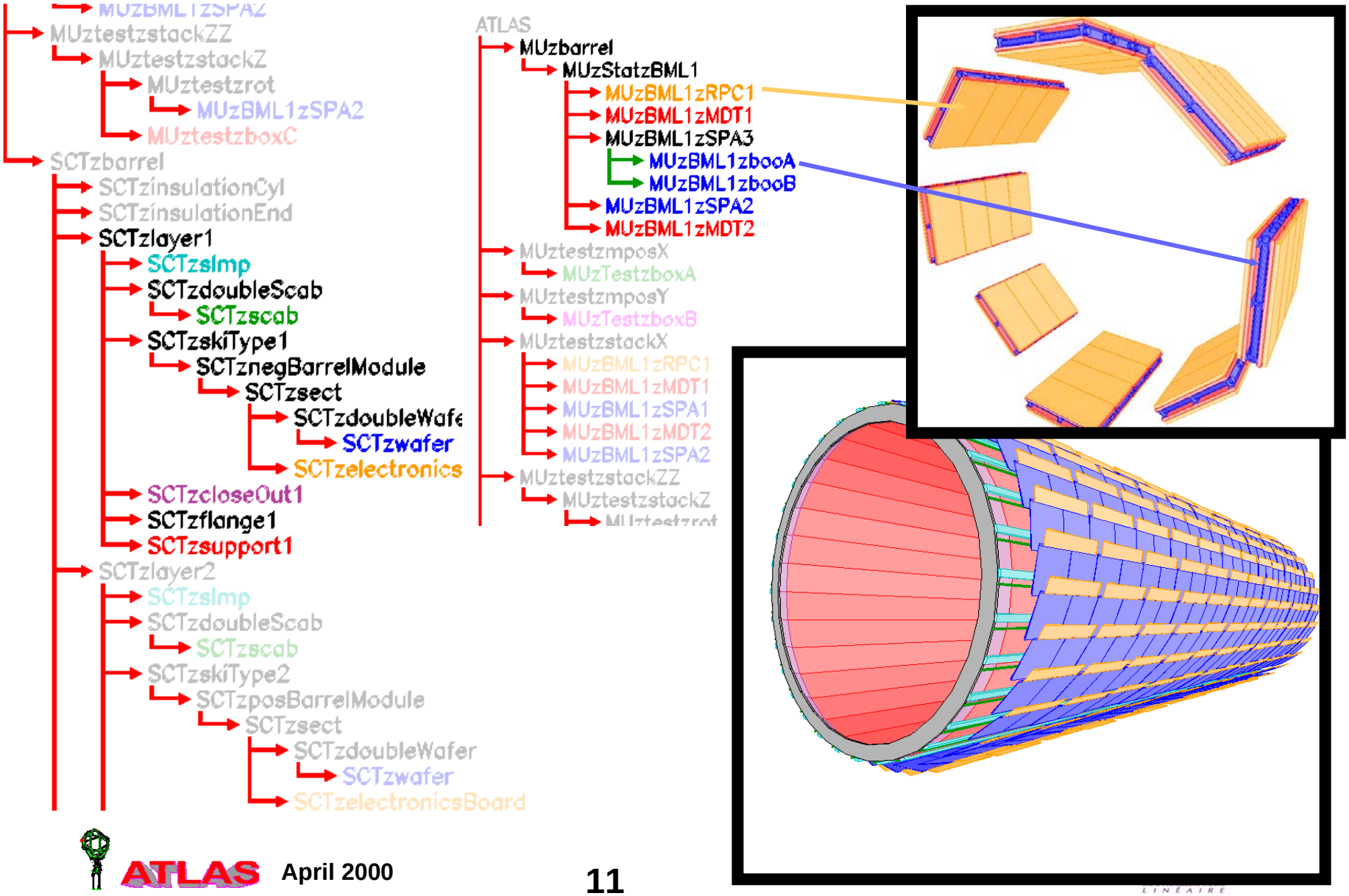
AGDD The generic model



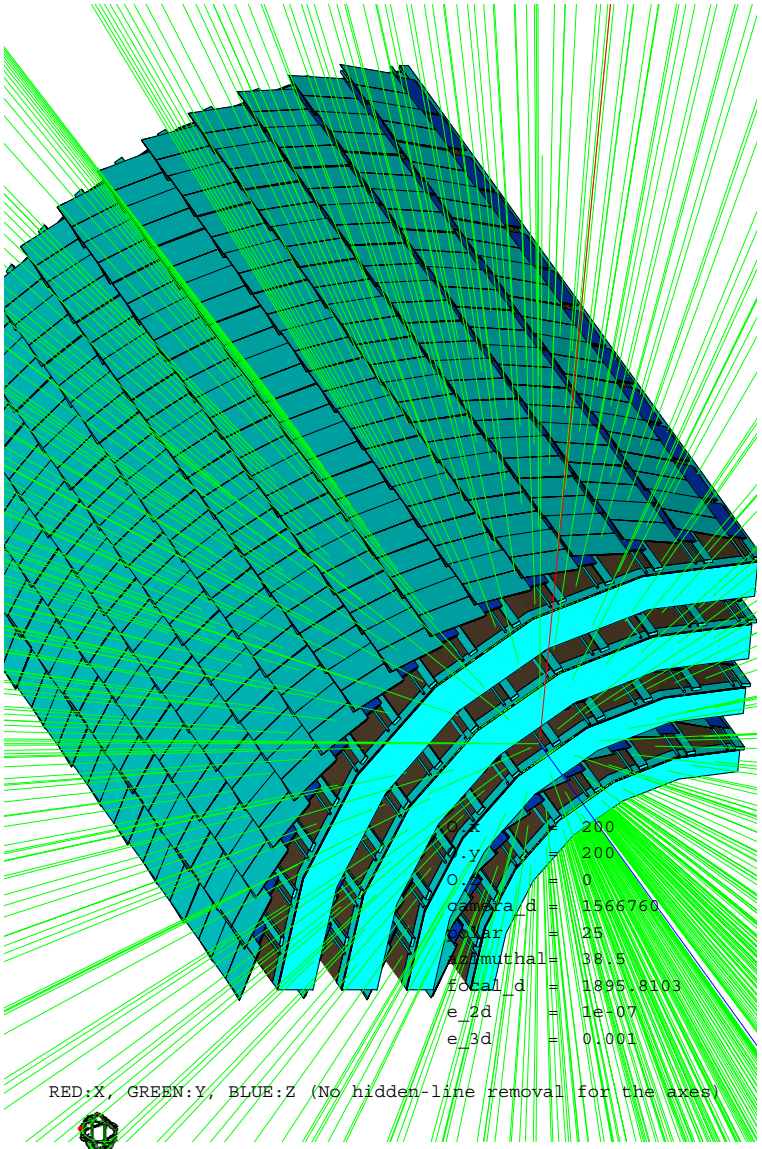
AGDD Graphical tools : GraXML (Java)



AGDD Graphical tools : Persint



AGDD G4Builder: interface to GEANT4



- **Set of classes, as client to the generic model, to transform the AGDD description to Geant4 geometry**
  - **Make use of the Material database in AGDD**
- **Generic, i.e. Detector independent.**
  - **Price paid in speed**
- **Track particles through geometry**
  - **Example: Scan geantinos in (η,φ) to determine characteristics of the ATLAS SCT geometry**

AGDD The DTD

```
<!ENTITY % DTD_constraint 'DTD_version ( v4 ) #REQUIRED'>

<!ELEMENT  AGDD ( materials | section )+>
<!ATTLIST  AGDD %DTD_constraint;>

<!ELEMENT  section  ( box | trd | tubs | cons | union | intersection | subtraction |
                      composition | stackX | stackY | stackZ | parameters )+>
<!ATTLIST  section name CDATA #REQUIRED top_volume IDREF #REQUIRED %DTD_constraint;>

<!ENTITY % units 'unit_length ( mm  | m ) "mm" unit_angle ( deg | mrad ) "deg"'>

<!ELEMENT identifier EMPTY>
<!ATTLIST identifier field  CDATA  #REQUIRED value CDATA "0" step CDATA "0">

<!ENTITY % solid_properties '%volume_properties;
                             material IDREF #REQUIRED
                             sensitive ( true | false ) "false"'>
<!ELEMENT  box EMPTY >
<!ATTLIST  box X_Y_Z CDATA #REQUIRED %solid_properties; %units;>

<!ENTITY % any_position ' posXYZ | posRPhiZ | mposR | mposPhi | mposX | mposY | mposZ '>

<!ELEMENT  composition ( %any_position; )+ >
<!ATTLIST  composition %volume_properties; envelope IDREF #IMPLIED>

<!ENTITY % any_relative_position ' axisPos | axisMPos '>

<!ELEMENT  stackX ( %any_relative_position; )+ >
<!ATTLIST  stackX %volume_properties;>

<!ENTITY % position_properties 'volume IDREF #REQUIRED rot CDATA "0 0 0" %units; '>

<!ELEMENT  posXYZ ( %any_identifier; )* >
<!ATTLIST  posXYZ X_Y_Z CDATA "0 0 0" %position_properties;>
```

DTD keyword

element or entity

attribute

value

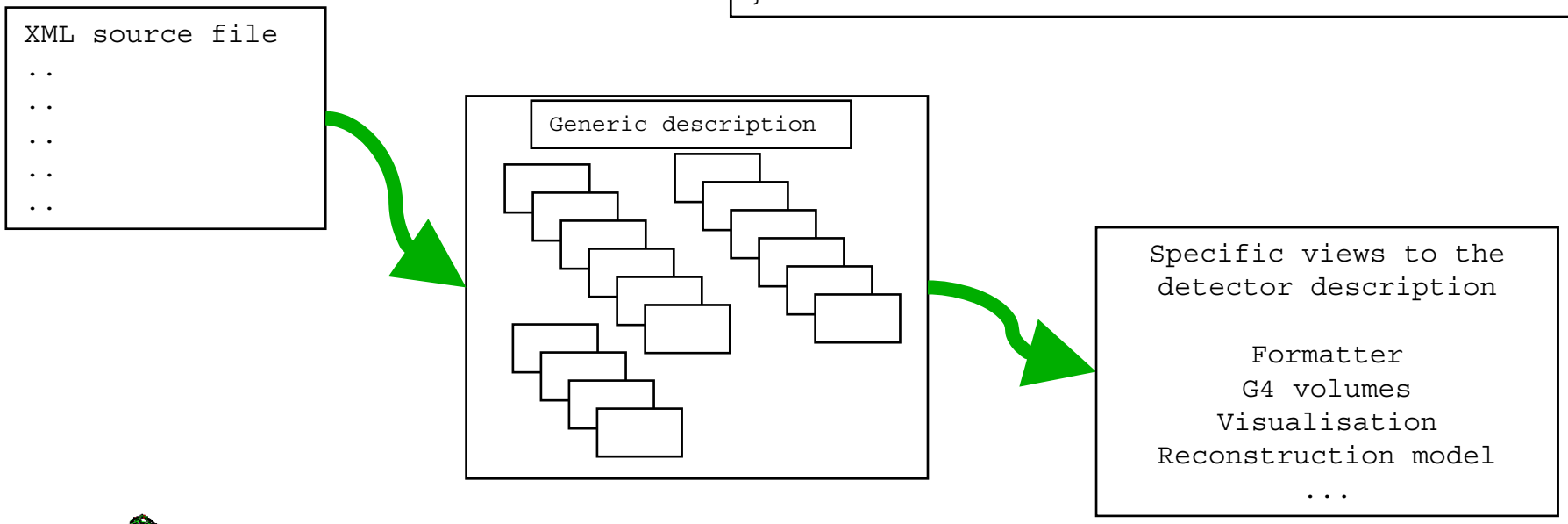
reference

AGDD The C++ framework

AGDD_Factory

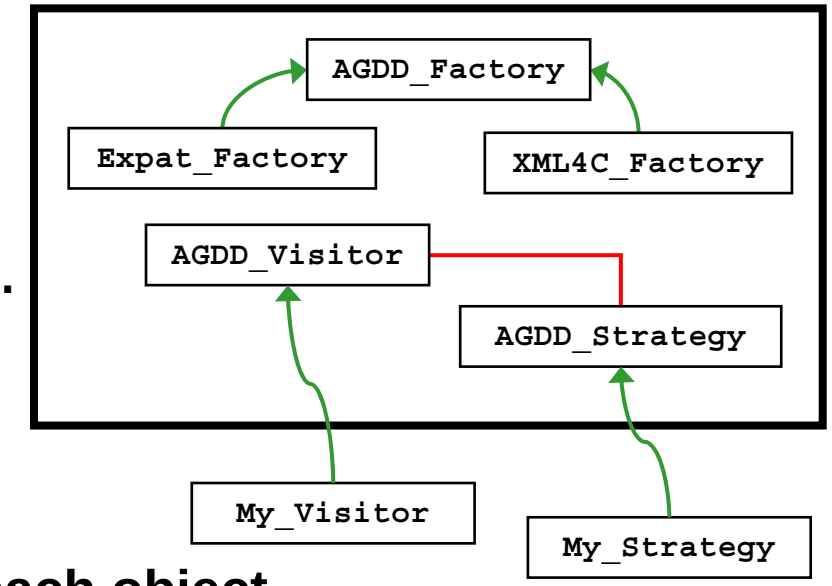
```
AGDD_Factory& Expat_instance ();
AGDD_Factory& XML4C_instance ();

void build_materials (file_name);
void build_detector_description (file_name

AGDD* get_detector_description ();
```

```
Void main ()
{
  G4_BuildMaterial material_builder;
  G4_BuildDetector detector_builder;

  AGDD* agdd = factory.get_detector_description ();

  material_builder.run (agdd);
  detector_builder.run (agdd);
}
```



AGDD The C++ framework

- **The Factory**
  - **decodes the source file**
  - **instanciates objects**
    - » **sections, volumes, positions, ...**



- **The visitor**
  - **navigates the generic model**
  - **applies specific algorithms on each object**
- **The strategy**
  - **defines how to navigate the model**

```
class G4_BuildMaterial : public AGDD_Visitor
{
  void visit_element (AGDD_Element* material);
  void visit_composite (AGDD_Composite* material);
};

class G4_BuildDetector : public AGDD_Visitor
{
  void visit_section (...) { std::cout << ... }
  void visit_solid (...);
};
```

AGDD The identification scheme

- **Logical identifiers**
  - numbering of tree-structured objects
  - independent from the specific design of the tree
  - ordered (can be used to key a map)
- **Ranges of identifiers**
  - specify a sub-set within a collection
- **Specialized collection**
  - contains identifiable objects
  - interfaced with ranges

```
Identifier a ("4/5/5");
Identifier b;

b << 1;
b << 23;
b << 4;
int system_id = a[0];
if (a < b) ...

IdentifierMap detectors;

detectors[a] = ecal;
detectors[b] = muon;
```

```
Range r1 ("1/*/3-4");
Range r2;

r2.add (1);
r2.add ();
r2.add (3, 4);
if (r2.match (a)) ...
```

```
MuonSpectrometer/StationName/eta/phi_sector/MDT/multilayer/tube_layer/tube
MuonSpectrometer/StationName/eta/phi_sector/RPC/doublet/strip_layer_pair/strip_layer/strip
MuonSpectrometer/StationName/eta/phi_sector/TGC/chamber_layer/chamber/strip
```

AGDD The identification scheme

Identifier

```
Identifier ();
Identifier (const Identifier& other);
Identifier (int numbers, ...);
Identifier (const char* text);
void add (int value);
Identifier& operator << (int value);
int& operator [] (int index);
void clear ();
int operator [] (int index) const;
int fields () const;
int operator == (const Identifier& other) const;
int operator != (const Identifier& other) const;
int operator < (const Identifier& other) const;
int operator > (const Identifier& other) const;
error_code last_error () const;
operator string () const;
```

Range

```
Range (const char* text);
Range (const Identifier& min, const Identifier&
max);
void add ();
void add (int value);
void add (int minimum, int maximum);
void add_minimum (int minimum);
void add_maximum (int maximum);
int match (const Identifier& id) const;
const field& operator [] (int index) const;
int fields () const;
Identifier minimum () const;
Identifier maximum () const;
identifier_factory factory_begin ();
const_identifier_factory factory_begin ()
const;
identifier_factory factory_end ();
const_identifier_factory factory_end () const;
operator string () const;
```