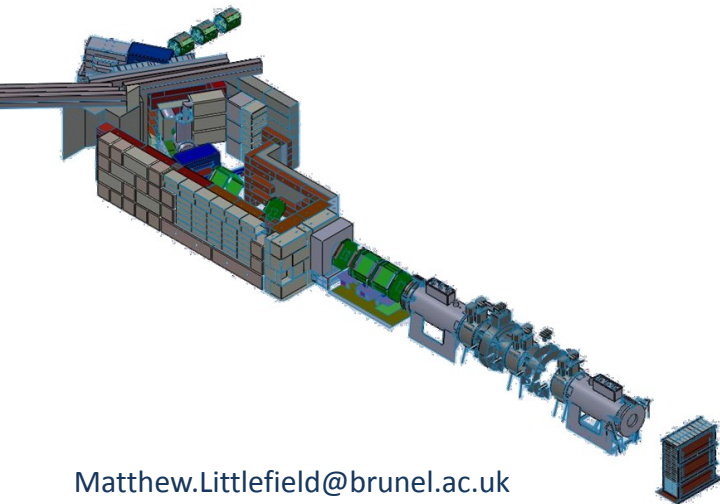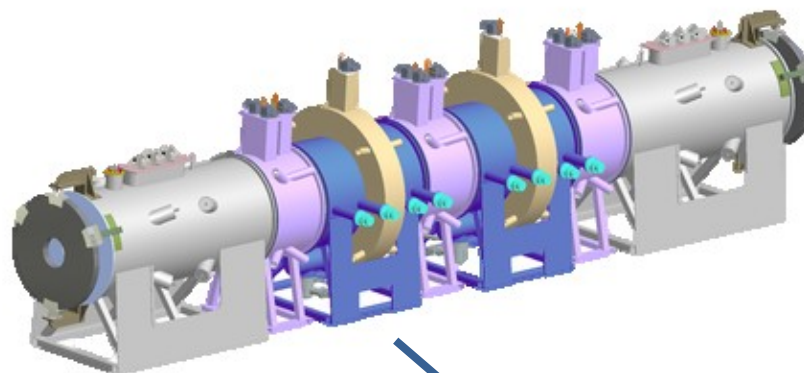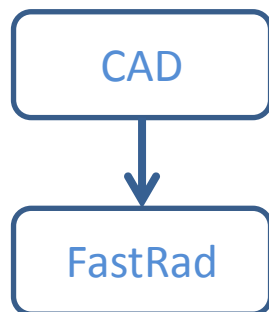# MAUS Geometry Import

This presentation shall describe;

- The steps needed to go from a Computer Aided Design (CAD) drawing to MAUS

- How this will be incorporated into the geometry handling system being developed for MAUS
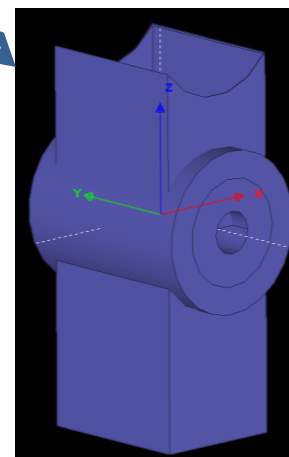
Matthew.Littlefield@brunel.ac.uk

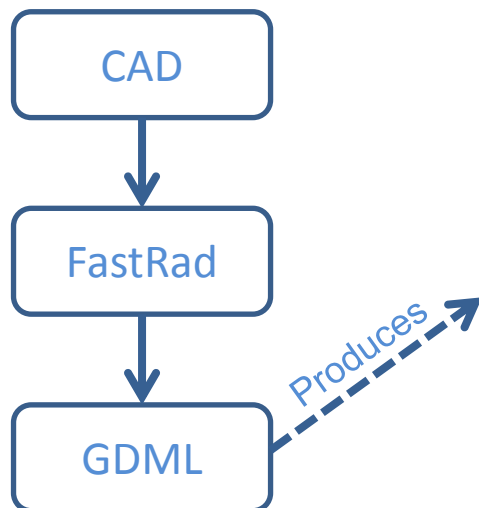**Brunel** UNIVERSITY

CAD to MAUS
Stage 1

CAD

FastRad

Above, CAD example.

Right, test case of simple cooling channel geometry taken from FastRad used in initial investigation
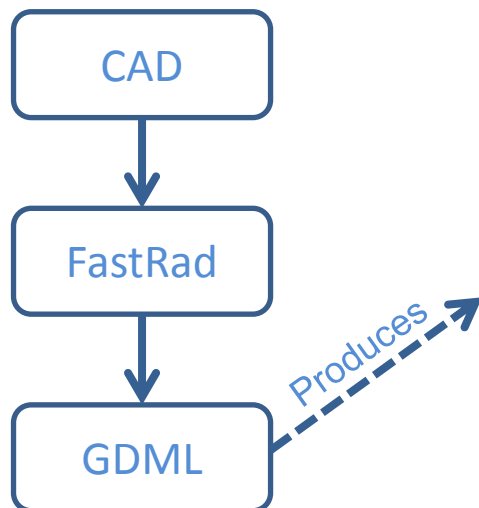
CAD to MAUS
Stage 2

CAD

↓

FastRad

↓

GDML

Produces ⟶

Configuration File

```
:structure>

    <volume name="Structure_225373016">
        <materialref ref="Vacuum"/>
        <solidref ref="WorldSphereRef"/>

        <physvol>
            <file name="Step_0.gdml"/>
            <position name="posRef_1" x="0.0000" y="0.0000" z="0.0000"/>
        <rotationref ref="identity"/>
        </physvol>
        <physvol>
            <file name="Step_1.gdml"/>
            <position name="posRef_2" x="0.0000" y="0.0000" z="0.0000"/>
        <rotationref ref="identity"/>
        </physvol>
        <physvol>
            <file name="Step_2.gdml"/>
            <position name="posRef_3" x="-0.0000" y="-0.0000" z="-1207.5000"/>
        <rotationref ref="identity"/>
        </physvol>
        <physvol>
            <file name="Step_3.gdml"/>
            <position name="posRef_4" x="0.0000" y="0.0000" z="0.0000"/>
        <rotationref ref="identity"/>
        </physvol>
        <physvol>
            <file name="Step_4.gdml"/>
            <position name="posRef_5" x="0.0000" y="0.0000" z="0.0000"/>
        <rotationref ref="identity"/>
        </physvol>
        <physvol>
            <file name="Step_5.gdml"/>
            <position name="posRef_6" x="-0.0000" y="-0.0000" z="757.5000"/>
        <rotationref ref="identity"/>
        </physvol>
```
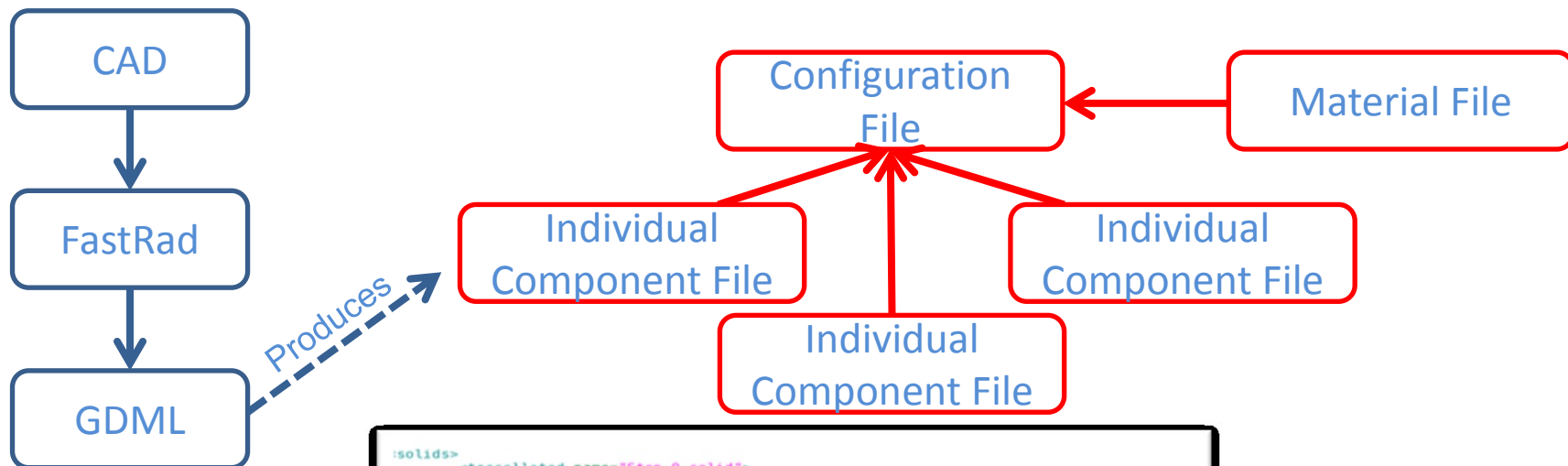
GDML = Geometry Markup Description Language

Developed at CERN specifically for transferring CADs to G4. It is an extended XML governed by a GDML schema

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CAD to MAUS
Stage 2


```
1   <?xml version="1.0" encoding="UTF-8"?>
2   |
3 ▽ <!--    GDML materials definition from the Fastrad file : "fastradModel.ray"
4           Processed the 14/01/2011 at 10h17 by the GDML module of Fastrad 3.1.0.2 -->
5
6 ▽ <materials>
7 ▽     <element name="videRef" formula="VACUUM" Z="1">
8             <atom value="1"/>
9         </element>
10 ▽    <element name="aluminum" formula="Al" Z="13">
11            <atom value="26.9815"/>
12        </element>
13 ▽    <element name="silicon" formula="Si" Z="14">
14            <atom value="28.0855"/>
15        </element>
16
17 ▽    <material name="Vacuum" formula="Vacuum">
18            <D value ="1E-25" unit="g/cm3"/>
19            <fraction n="1.0" ref="videRef"/>
20        </material>
21 ▽    <material name="ALUMINUM" formula="ALUMINUM">
22            <D value ="2.7000" unit="g/cm3"/>
23            <fraction n="1.0000" ref="aluminum"/>
24        </material>
25 ▽    <material name="SILICON" formula="SILICON">
26            <D value ="2.3300" unit="g/cm3"/>
27            <fraction n="1.0000" ref="silicon"/>
28        </material>
29    </materials>
30
31
```

CAD → FastRad → GDML

Produces

Configuration File ← Material File

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CAD to MAUS
Stage 2

CAD → FastRad → GDML

GDML *Produces* → Individual Component File

Configuration File ← Material File

Individual Component File → Configuration File

Individual Component File → Configuration File

Individual Component File → Configuration File

```
:solids>
    <tessellated name="Step_0_solid">
    <!-- Face 0 -->
        <triangular vertex1="v11" vertex2="v23" vertex3="v12" type="ABSOLUTE"/>
        <triangular vertex1="v10" vertex2="v22" vertex3="v23" type="ABSOLUTE"/>
        <triangular vertex1="v8" vertex2="v20" vertex3="v21" type="ABSOLUTE"/>
        <triangular vertex1="v7" vertex2="v19" vertex3="v20" type="ABSOLUTE"/>
        <triangular vertex1="v9" vertex2="v21" vertex3="v22" type="ABSOLUTE"/>
        <triangular vertex1="v11" vertex2="v12" vertex3="v0" type="ABSOLUTE"/>
        <triangular vertex1="v10" vertex2="v23" vertex3="v11" type="ABSOLUTE"/>
        <triangular vertex1="v9" vertex2="v8" vertex3="v21" type="ABSOLUTE"/>
        <triangular vertex1="v22" vertex2="v10" vertex3="v9" type="ABSOLUTE"/>
        <triangular vertex1="v7" vertex2="v20" vertex3="v8" type="ABSOLUTE"/>
        <triangular vertex1="v7" vertex2="v6" vertex3="v18" type="ABSOLUTE"/>
        <triangular vertex1="v19" vertex2="v7" vertex3="v18" type="ABSOLUTE"/>
        <triangular vertex1="v4" vertex2="v16" vertex3="v17" type="ABSOLUTE"/>
        <triangular vertex1="v3" vertex2="v15" vertex3="v16" type="ABSOLUTE"/>
        <triangular vertex1="v1" vertex2="v13" vertex3="v14" type="ABSOLUTE"/>
        <triangular vertex1="v0" vertex2="v12" vertex3="v13" type="ABSOLUTE"/>
        <triangular vertex1="v2" vertex2="v14" vertex3="v15" type="ABSOLUTE"/>
        <triangular vertex1="v17" vertex2="v6" vertex3="v5" type="ABSOLUTE"/>
        <triangular vertex1="v17" vertex2="v5" vertex3="v4" type="ABSOLUTE"/>
        <triangular vertex1="v15" vertex2="v3" vertex3="v2" type="ABSOLUTE"/>
        <triangular vertex1="v13" vertex2="v1" vertex3="v0" type="ABSOLUTE"/>
        <triangular vertex1="v1" vertex2="v14" vertex3="v2" type="ABSOLUTE"/>
        <triangular vertex1="v3" vertex2="v16" vertex3="v4" type="ABSOLUTE"/>
        <triangular vertex1="v18" vertex2="v6" vertex3="v17" type="ABSOLUTE"/>
    <!-- Face 1 -->
        <triangular vertex1="v29" vertex2="v30" vertex3="v16" type="ABSOLUTE"/>
        <triangular vertex1="v16" vertex2="v30" vertex3="v17" type="ABSOLUTE"/>
        <triangular vertex1="v29" vertex2="v16" vertex3="v28" type="ABSOLUTE"/>
        <triangular vertex1="v31" vertex2="v18" vertex3="v17" type="ABSOLUTE"/>
        <triangular vertex1="v18" vertex2="v31" vertex3="v32" type="ABSOLUTE"/>
        <triangular vertex1="v31" vertex2="v17" vertex3="v30" type="ABSOLUTE"/>
        <triangular vertex1="v27" vertex2="v14" vertex3="v26" type="ABSOLUTE"/>
        <triangular vertex1="v15" vertex2="v27" vertex3="v28" type="ABSOLUTE"/>
        <triangular vertex1="v13" vertex2="v26" vertex3="v14" type="ABSOLUTE"/>
        <triangular vertex1="v25" vertex2="v13" vertex3="v12" type="ABSOLUTE"/>
```
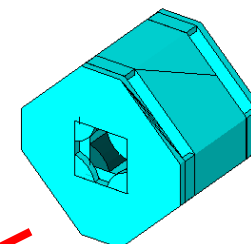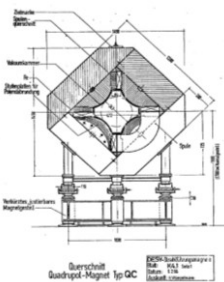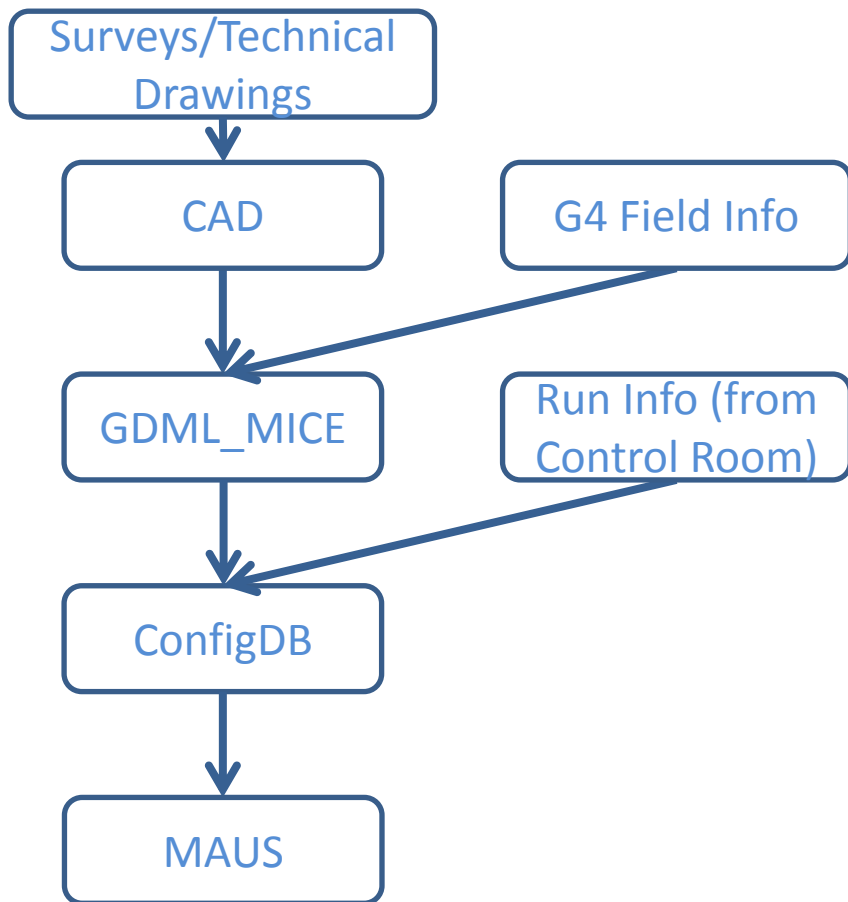
CAD to MAUS
Stage 3

XSLT = eXstensible Stylesheet
Language Transformations

Transforms XML(GDML) into
desired formats.

How can we use this?

To use this transfer in an efficient manner a new geometry handling system has been designed.

Surveys/Technical Drawings

CAD

G4 Field Info

GDML_MICE

Run Info (from Control Room)

ConfigDB

MAUS

Above: Technical Drawing of Quad
Right: CAD Drawing of Quad
Below: G4MICE Simulation Example

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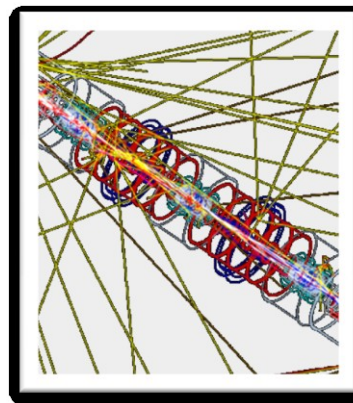
User/Developer Interaction

Developers will:

1. Run CAD through FastRad

2. Run one executable upon the GDML files
which will upload the geometry to the CDB

Users will be able to:

1. Download current geometry directly into MAUS or download a local copy

2. Download an old geometry directly into MAUS or download a local copy

3. Download geometry, from a particular run number, directly into MAUS or
download a local copy

Current Status

Back end of system is 90% complete
- An executable exists which uploads to the CDB
- Majority of the classes needed for front and back end have been written

Front end of system is 75% complete.
- Executable for each of the user downloads need to be written, classes for them already exist
- Integration into MAUS needs to be done

As a side, a Step 4 geometry is being rushed through to begin simulations and to test the system. It is currently in MAUS Module form

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Any Questions?

Thank You for Listening

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```xml
                <rotationref ref="identity"/>
            </physvol>
            <physvol>
                    <file name="Step_3.gdml"/>
                    <position name="posRef_4" x="0.0000" y="0.0000" z="0.0000"/>
                <rotationref ref="identity"/>
            </physvol>
            <physvol>
                    <file name="Step_4.gdml"/>
                    <position name="posRef_5" x="0.0000" y="0.0000" z="0.0000"/>
                <rotationref ref="identity"/>
            </physvol>
            <physvol>
                    <file name="Step_5.gdml"/>
                    <position name="posRef_6" x="-0.0000" y="-0.0000" z="757.5000"/>
                <rotationref ref="identity"/>
            </physvol>
        </volume>
</structure>

<field>
        <Type name="quad"/>
        <Pole num="5"/>
        <MaxEndPole num="2"/>
        <Magnitude tesla="5"/>
        <Height mm="5"/>
        <Width mm="6"/>
        <Length mm="7"/>
        <EndLength mm="6"/>
        <EndFieldType name="Enge"/>
        <EffectiveWidth num="3"/>
        <Enge1 num="3"/>
        <Enge2 num="3"/>
        <Enge3 num="3"/>
        <Enge4 num="3"/>
</field>


<setup name="Default" version="1.0">
        <world ref="Structure_224400784"/>
</setup>
```

```
Module QuadTypeIV_Boolean
{
  Volume          Box
  Dimensions      1.5 1.5 1.046 m

  PropertyDouble    RedColour    0.0
  PropertyDouble    GreenColour  1.0
  PropertyDouble    BlueColour   1.0
  PropertyBool      Invisible    1
  PropertyString    Material     Galactic

//Field model
  Module QCField
  {
    Volume None
    Position 0.0 0.0 0.0 mm
  //Field model
    PropertyString FieldType         Multipole
    PropertyInt    Pole              2 //Quad field
    PropertyInt    MaxEndPole        6 //Simulate end field up to octupole order
    PropertyDouble Magnitude         -2.237294e-04    //normalised to Opera Field map
    PropertyDouble Height            0.54    m
    PropertyDouble Width             0.54    m
    PropertyDouble Length            5.633106e+02  mm
    PropertyDouble EndLength         1.772302e+02
    PropertyString EndFieldType      Enge
    PropertyDouble EffectiveWidth    1.538410e+01  mm
    PropertyDouble Enge1             1.075890e-01
    PropertyDouble Enge2             5.710438e-02
    PropertyDouble Enge3             2.734375e-06
    PropertyDouble Enge4             1.367187e-08
  }
}
```

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