VIII International Geant4 School
Belgrade-Serbia
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Materials and geometry

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User classes (starting…)

At initialization

G4VUserDetectorConstruction

G4VUserPhysicsList

G4VUserActionInitialization

Global: only one instance exists in memory, shared by all threads.

At execution

G4VUserPrimaryGeneratorAction

G4UserRunAction

G4UserEventAction

G4UserStackingAction

G4UserTrackingAction

G4UserSteppingAction

Thread-local: an instance of each action class exists for each thread.

Note: Geant4 basic types

- Aliases for the primitive data types to provide cross-platform compatibility:
  - G4double, G4float, G4int, G4bool, G4long
- Enhanced version of string called G4String
  - inherits from std::string ⇒ all methods and operators
  - several additional methods
- G4ThreeVector is a three-component class corresponding to a real physics vector (example later)

```
G4ThreeVector dimensions {1.0, 2.0, 3.0 };
```

Please, use these types for best compatibility (e.g. G4int instead of int, etc., G4ThreeVector when it makes sense etc.)

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Part 1: Units and Materials

Units in Geant4

- Don't use default units!
  - When specifying dimensions, always multiply by an appropriate unit:

```
G4double width = 12.5 * m;
G4double density = 2.7 * g/cm3;
```

  - Most common units are defined in CLHEP library (included in Geant4):
    - ► G4SystemOfUnits.hh
    - ► CLHEP/SystemOfUnits.hh
  - You can define new units (not shown here)
- Output data in terms of a specific unit:
  - divide a value by the unit

```
G4cout << dE / MeV << " (MeV)" << G4endl;
```

System of units

Basic units:

- nanosecond (ns)
- unit charge (eplus)
- megaelectronvolt (MeV)
- radian
- kelvin
- millimetre (mm)
- candela
- steradian

- All other units derived from the basic ones.
- Useful feature: Geant4 can select the most appropriate unit to use
  - specify the category for the data (Length, Time, Energy, etc…):

```
G4cout << G4BestUnit(StepSize, "Length");
```

- `StepSize` will be printed in km, m, mm or … fermi, depending on its actual value

Materials

- Different levels of material description:
  - isotopes → **G4Isotope**
  - elements → **G4Element**
  - molecules, compounds and mixtures → **G4Material**
- Attributes associated:
  - temperature, pressure, state, density
- **G4Isotope** and **G4Element** describe properties of the atoms:
  - Atomic number, number of nucleons, mass of a mole, shell energies, cross-sections per atoms, etc…
- **G4Material** describes the macroscopic properties of the matter:
  - Temperature, pressure, state, density
  - Radiation length, absorption length, etc…
- **G4Material** is used by tracking, geometry and physics

Making elements

- Isotopes can be assembled into elements

```
G4Isotope (const G4String& name,
                  G4int      z,     // atomic number
                  G4int      n,     // number of nucleons
                  G4double   a );   // mass of mole
```

Not number of neutrons!

Do not forget unit (g/mole)

- … building elements as follows:

```
G4Element (const G4String& name,
           const G4String& symbol, // element symbol
                 G4int     nIso ); // n. of isotopes
G4Element::AddIsotope(G4Isotope* iso,   // isotope
                  G4double relAbund); // fraction of atom per mass
```

- Otherwise, create G4Element with natural isotopic abundance:

```
G4Element (const G4String& name,
           const G4String& symbol,
           G4int      z,     // atomic number
           G4double   a );   // mass of mole
```

Do not forget unit (g/mole)

Elements and compounds

- Single-element material

```
G4double z, a, density;
density = 1.390*g/cm3;
a = 39.95*g/mole;
G4Material* lAr = new G4Material("liquidAr", z=18, a, density);
```

- Molecule material (composition by number of atoms):

```
a = 1.01*g/mole;
G4Element* elH = new G4Element("Hydrogen", symbol="H", z=1., a);

a = 16.00*g/mole;
G4Element* elO = new G4Element("Oxygen", symbol="O", z=8., a);

density = 1.000*g/cm3;
G4Material* H2O = new G4Material("Water", density, ncomponents=2);
H2O->AddElement(elH, natoms=2);
H2O->AddElement(elO, natoms=1);
```

Mixtures

- Composition by fraction of mass

```
a = 14.01*g/mole;
G4Element* elN  = new G4Element(name="Nitrogen",symbol="N", z= 7., a);
a = 16.00*g/mole;
G4Element* elO  =  new G4Element(name="Oxygen",symbol="O", z= 8., a);
density = 1.290*mg/cm3;
G4Material* Air = new G4Material(name="Air", density, ncomponents=2);
Air->AddElement(elN, 70.0*perCent);
Air->AddElement(elO, 30.0*perCent);
```

- Composition of mixtures

```
G4Element* elC  = …;   // define “carbon” element
G4Material* SiO2 = …;  // define “quartz” material
G4Material* H2O = …;   // define “water” material
density = 0.200*g/cm3;

G4Material* aerogel = new G4Material("Aerogel",
                                     density, ncomponents=3);
aerogel->AddMaterial(SiO2,fractionmass=62.5*perCent);
aerogel->AddMaterial(H2O, fractionmass=37.4*perCent);
aerogel->AddElement (elC, fractionmass= 0.1*perCent);
```

An example: a gas

- Necessary to specify temperature and pressure
  - affect dE/dx calculations, thermal scattering

```
G4double density = 27. * mg/cm3;
G4double temperature = 325. * kelvin;
G4double pressure = 50. * atmosphere;

G4Material* CO2 = new G4Material("CO2Gas", density,
    ncomponents=2, kStateGas, temperature, pressure);
CO2->AddElement(C, natoms = 1);
CO2->AddElement(O, natoms = 2);
```

- Absolute vacuum does not exist: gas at very low ρ !
  - Cannot define materials with ρ=0

```
G4double rho = 1.e-25*g/cm3;
G4double pr = 3.e-18*pascal;
G4Material* Vacuum = new G4Material(“interGalactic",Z, A,   rho,
kStateGas, temperature, pr);
```

NIST material database

- No need to predefine elements and materials
- Retrieve elements and materials from NIST manager:

```
G4NistManager* manager = G4NistManager::Instance();
G4Material* H2O =    manager->FindOrBuildMaterial("G4_WATER");
G4Material* air =    manager->FindOrBuildMaterial("G4_AIR");
G4Material* vacuum = manager->FindOrBuildMaterial("G4_Galactic");
G4Element* Si = manager->FindOrBuildElement("Si");
```

- UI commands:

`/material/nist/printElement` ← print defined elements

`/material/nist/listMaterials` ← print defined materials

▶ G4NistManager.hh

NIST material database

- NIST database for materials is imported inside Geant4
  - * http://physics.nist.gov/PhysRefData
- UI commands specific for handling materials
- The best accuracy for the most relevant parameters guaranteed:
  - * Density
  - * Mean excitation potential
  - * Chemical bounds
  - * Element composition
  - * Isotope composition
  - * Various corrections

Z		A	m	error	(%)	A_{eff}
14	Si	22	22.03453	(22)		28.0855(3)
		23	23.02552	(21)		
		24	24.011546	(21)		
		25	25.004107	(11)		
		26	25.992330	(3)		
		27	26.98670476	(17)		
		28	27.9769265327	(20)	92.2297 (7)	
		29	28.97649472	(3)	4.6832 (5)	
		30	29.97377022	(5)	3.0872 (5)	
		31	30.97536327	(7)		
		32	31.9741481	(23)		
		33	32.978001	(17)		
		34	33.978576	(15)		
		35	34.984580	(40)		
		36	35.98669	(11)		
		37	36.99300	(13)		
		38	37.99598	(29)		
		39	39.00230	(43)		
		40	40.00580	(54)		
		41	41.01270	(64)		
		42	42.01610	(75)		

- Natural isotope compositions
- More than 3000 isotope masses

http://geant4.cern.ch/UserDocumentation/UsersGuides/ForApplicationDeveloper/html/apas08.html

NIST materials

- NIST elementary materials:
  - * H → Cf (Z = 1 → 98)
- NIST compounds:
  - * e.g. "G4_ADIPOSE_TISSUE_IRCP"
- HEP and Nuclear materials:
  - * e.g. Liquid Ar, PbWO
- Possible to build mixtures of NIST and user-defined materials

```
=====================================
### Elementary Materials from the NIST Data
=====================================
 Z Name  ChFormula       density(g/cm^3)  I(eV)
=====================================
1   G4_H   H_2            8.3748e-05      19.2
2   G4_He                 0.000166322     41.8
3   G4_Li                 0.534           40
4   G4_Be                 1.848           63.7
5   G4_B                  2.37            76
6   G4_C                  2               81
7   G4_N   N_2            0.0011652       82
8   G4_O   O_2            0.00133151      95
9   G4_F                  0.00158029      115
10  G4_Ne                 0.000838505     137
11  G4_Na                 0.971
```

```
=====================================
### Compound Materials from the NIST Data Base
=====================================
 N Name      ChFormula       density(g/cm^3)  I(eV)
=====================================
13 G4_Adipose_Tissue             0.92          63.2
          1    0.119477
          6    0.63724
          7    0.00797
          8    0.232333
          11   0.0005
          12   2e-05
          15   0.00016
          16   0.00073
          17   0.00119
          19   0.00032
          20   2e-05
          26   2e-05
          30   2e-05
4  G4_Air                        0.00120479    85.7
          6    0.000124
          7    0.755268
          8    0.231781
          18   0.012827
2  G4_CsI                        4.51          553.1
          53   0.47692
          55   0.52308
```

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Part II: Geometry

Describe your detector

- A detector geometry is made of a number of volumes
- The largest volume is called World volume
  - It must contain all other volumes
- Derive your own concrete class from **`G4VUserDetectorConstruction`** abstract base class
- Implementing the pure virtual method **`Construct()`**:
  - Define shapes/solids required to describe the geometry
  - Construct all necessary materials
  - Construct and place volumes of your detector geometry
  - (Define "sensitivity" properties associated to volumes)
  - (Associate magnetic field to detector regions)
  - (Define visualization attributes for the detector elements

Geometry – implementation basics

- Implement a class inheriting from the abstract base class **G4VUserDetectorConstruction**:

```
class MyDetector : public G4VUserDetectorConstruction {
public:
    virtual G4VPhysicalVolume* Construct();       // required

    virtual void ConstructSDAndField();           // optional
    // ...
};
```

- Create an instance in the main program:

```
MyDetector* detector = new MyDetector();
runManager->SetUserInitialization(detector);
```

- Note: Split the implementation into more classes and methods! (good programming practice)
  - especially for complex geometries!

G4VUserDetectorConstruction

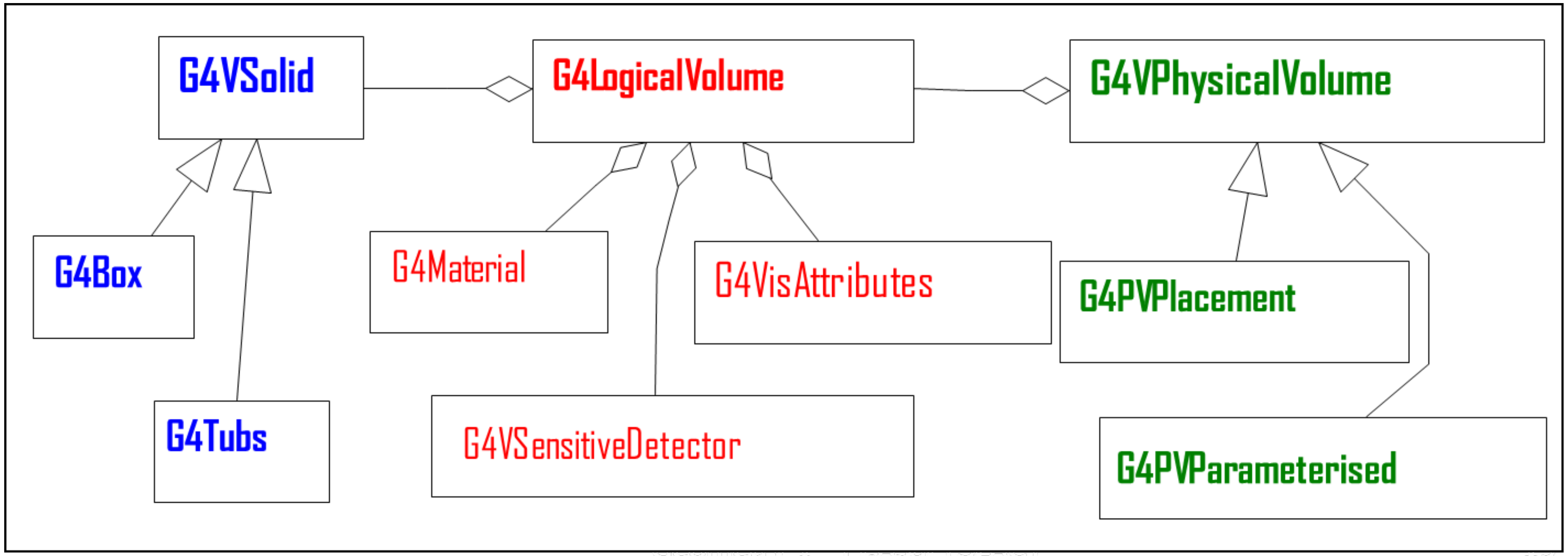
- Method **`Construct()`**
  - Define materials
  - Define solids and volumes of the geometry
  - Build the tree hierarchy of volumes
  - Define visualization attributes
  - Return the world physical volume!

- Method **`ConstructSDAndField()`** MT
  - Assign magnetic field to volumes / regions
  - Define sensitive detectors and assign them to volumes

▶ `G4VUserDetectorConstruction.hh`

Three conceptual layers

- **G4VSolid**
  - Shape, size
- **G4LogicalVolume**
  - Hierarchy of volumes, material, sensitivity, magnetic field
- **G4VPhysicalVolume**
  - Position, rotation. The same logical volume can be placed many times (repeated modules)

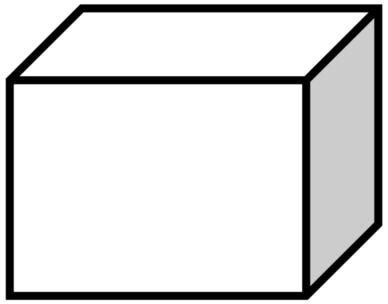


Define detector geometry

- Basic strategy

```
G4VSolid* pBoxSolid =
  new G4Box("aBoxSolid",
         1.*m, 2.*m, 3.*m);
```

Solid: shape and size.



Step 1
Create the geom. object: box

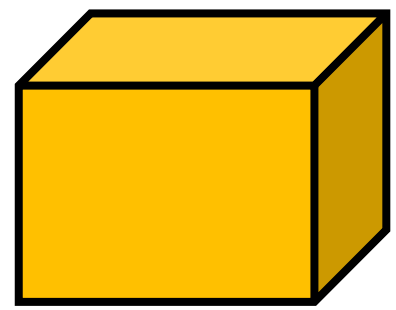
Define detector geometry

Logical volume : + material, sensitivity, etc.

- Basic strategy

```
G4VSolid* pBoxSolid =
  new G4Box(“aBoxSolid”,
        1.*m, 2.*m, 3.*m);
```

```
G4LogicalVolume* pBoxLog =
   new G4LogicalVolume( pBoxSolid,
   pBoxMaterial, “aBoxLog”, 0, 0, 0);
```



Step 1
Create the geom. object: box

Step 2
Assign properties to object : material

Define detector geometry

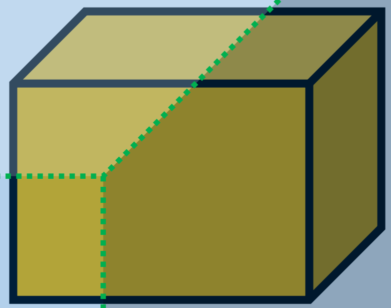
Physical volume : + rotation and position

- Basic strategy

```
G4VSolid* pBoxSolid =
   new G4Box("aBoxSolid",
         1.*m, 2.*m, 3.*m);
```

```
G4LogicalVolume* pBoxLog =
    new G4LogicalVolume( pBoxSolid,
    pBoxMaterial, "aBoxLog", 0, 0, 0);
```

```
G4VPhysicalVolume* aBoxPhys =
     new G4PVPlacement(pRotation,
     G4ThreeVector(posX, posY, posZ),
       pBoxLog,"aBoxPhys", pMotherLog, 0, copyNo);
```



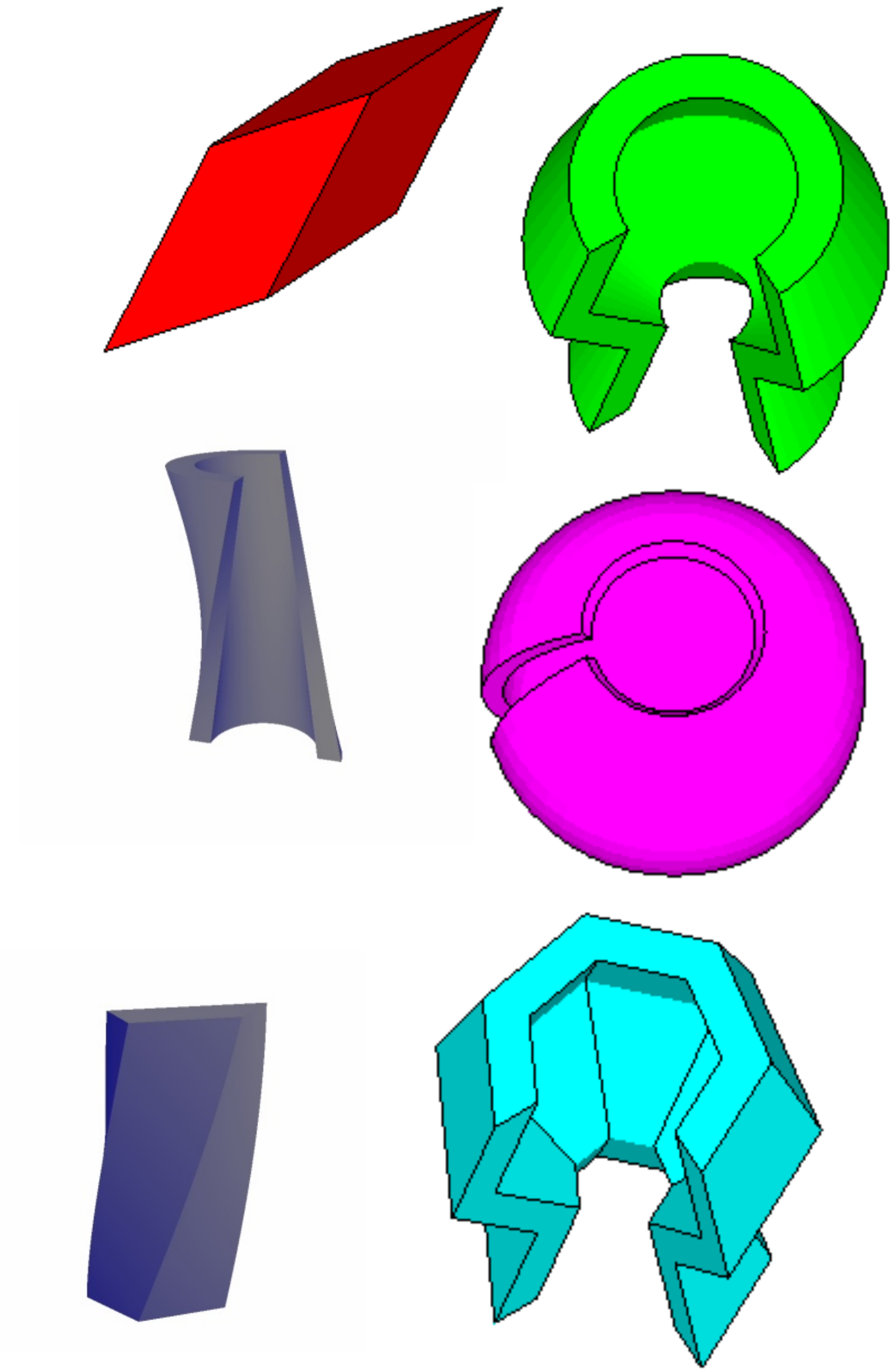
Step 1
Create the geom. object: box

Step 2
Assign properties to object : material

Step 3
Place it in the coordinate system of mother volume

Solids

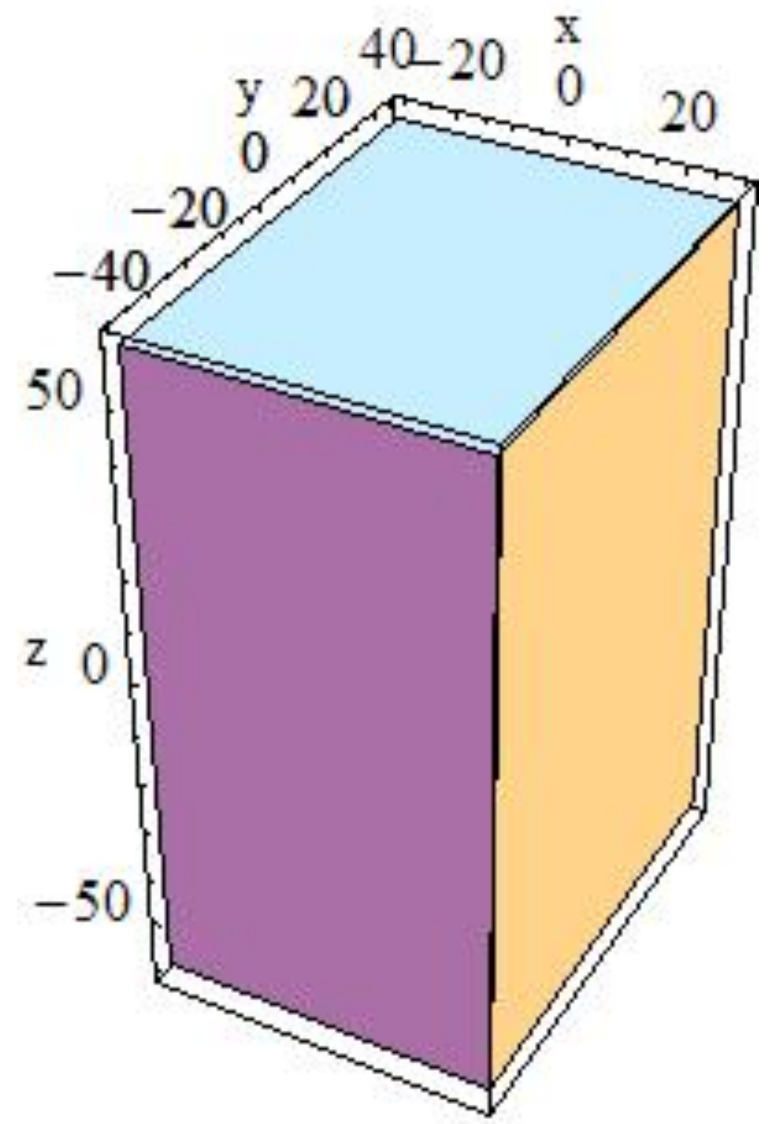
- CSG (Constructed Solid Geometry) solids
  - G4Box, G4Tubs, G4Cons, G4Trd, …
  - Analogous to simple GEANT3 CSG solids
- Specific solids (CSG like)
  - G4Polycone, G4Polyhedra, G4Hype, …
  - G4TwistedTubs, G4TwistedTrap, …
- BREP (Boundary REPresented) solids
  - G4BREPSolidPolycone, G4BSplineSurface, …
  - Any order surface
- Boolean solids
  - G4UnionSolid, G4SubtractionSolid, …



CGS: G4Box

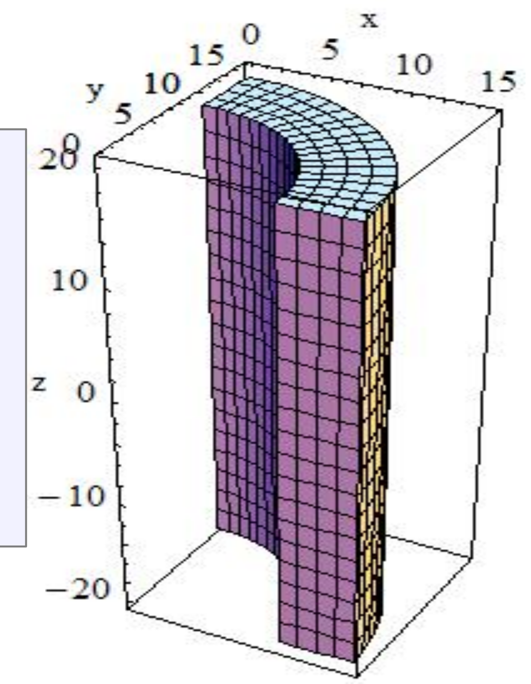

```
G4Box(const G4String& pname,  // name
             G4double  pX, // half-length in X
             G4double  pY, // half-length in Y
             G4double  pZ, // half-length in Z);
```

Note the half-length!

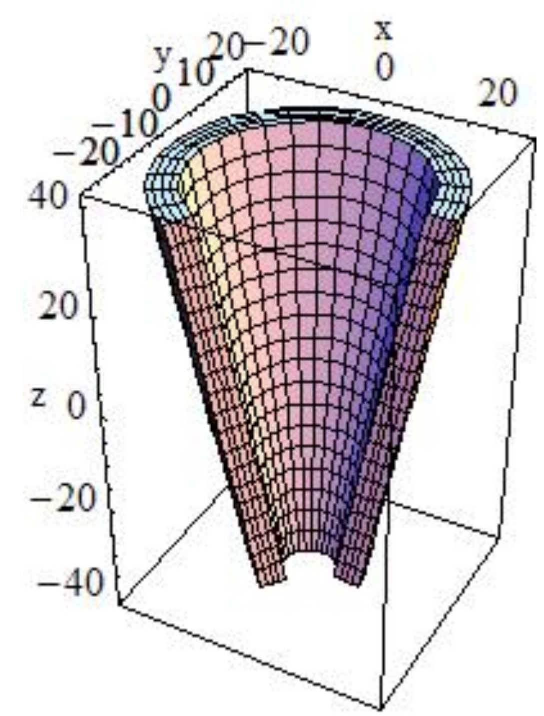


CGS: G4Tubs & G4Cones

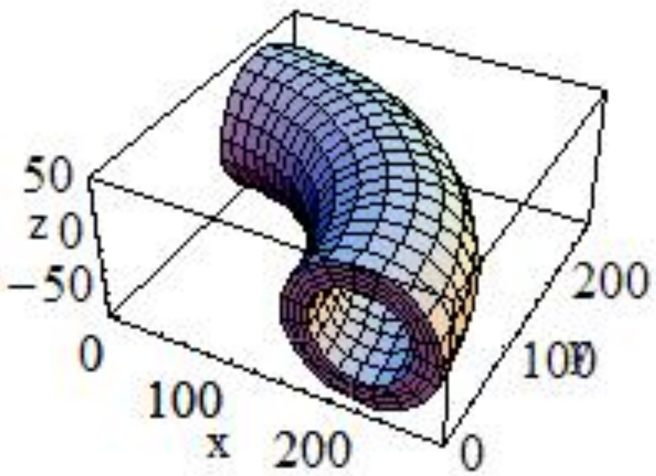

```
G4Tubs(const G4String& pname,   // name
             G4double  pRmin,   // inner radius (0)
             G4double  pRmax,   // outer radius
             G4double  pDz,     // Z half! length
             G4double  pSphi,   // starting Phi (0)
             G4double  pDphi);  // segment angle (twopi)
```



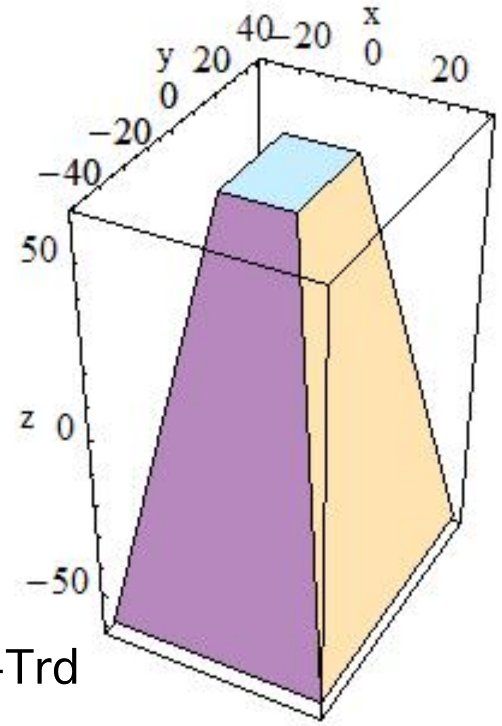

```
G4Cons(const G4String& pname,   // name
             G4double  pRmin1,  // inner radius -pDz
             G4double  pRmax1,  // outer radius -pDz
             G4double  pRmin2,  // inner radius +pDz
             G4double  pRmax2,  // outer radius +pDz
             G4double  pDz,     // Z half length
             G4double  pSphi,   // starting Phi
             G4double  pDphi);  // segment angle
```



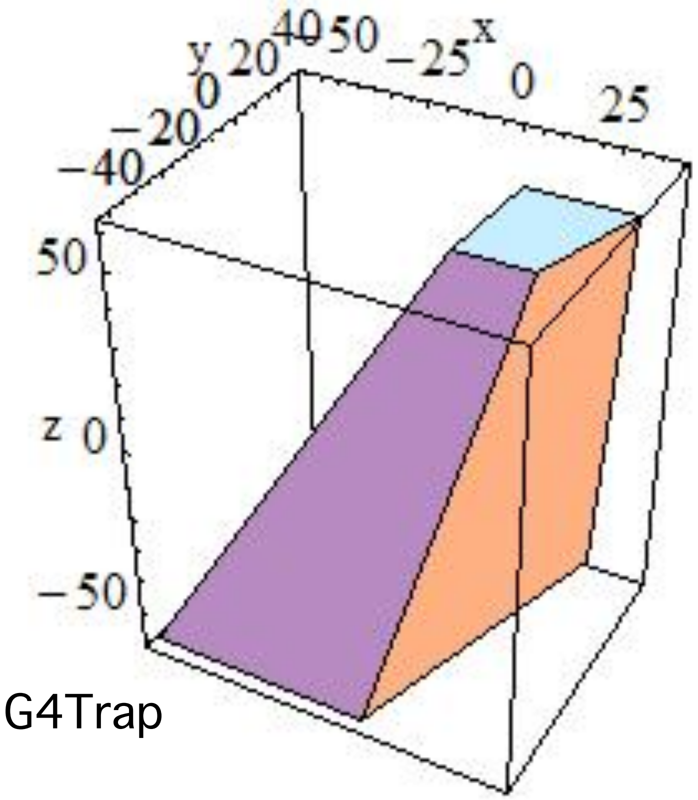
Other CGS solids



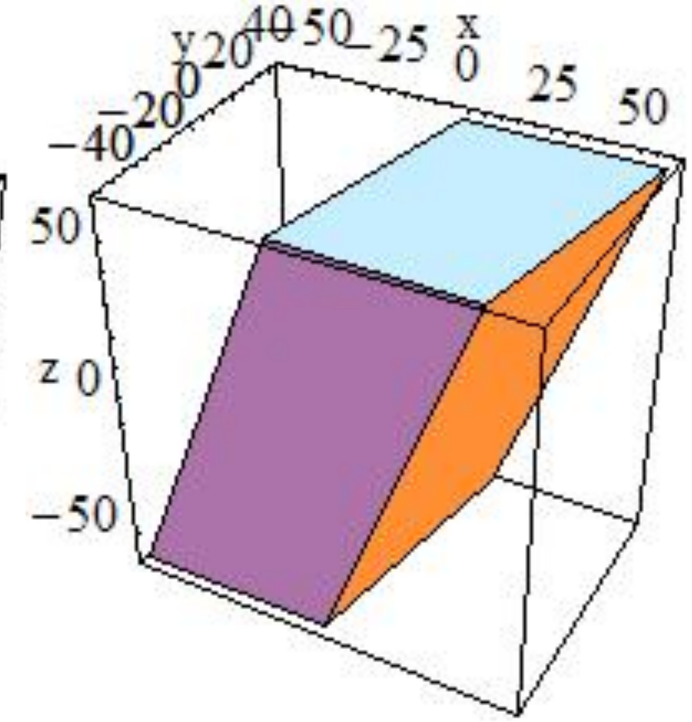
G4Torus



G4Trd

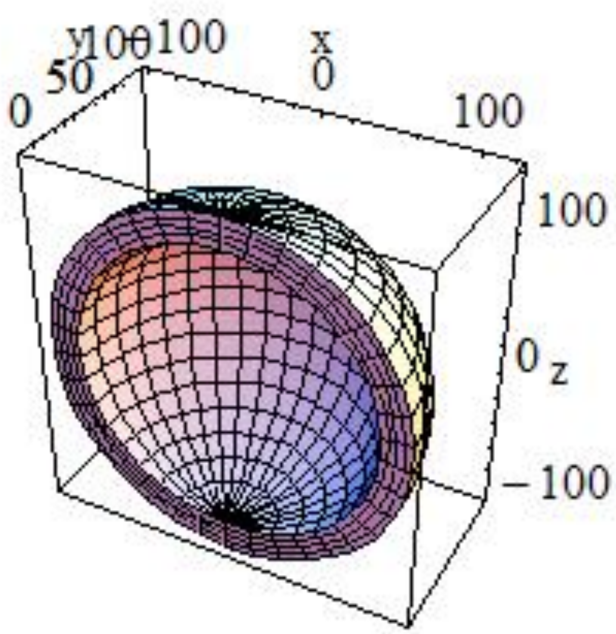


G4Trap

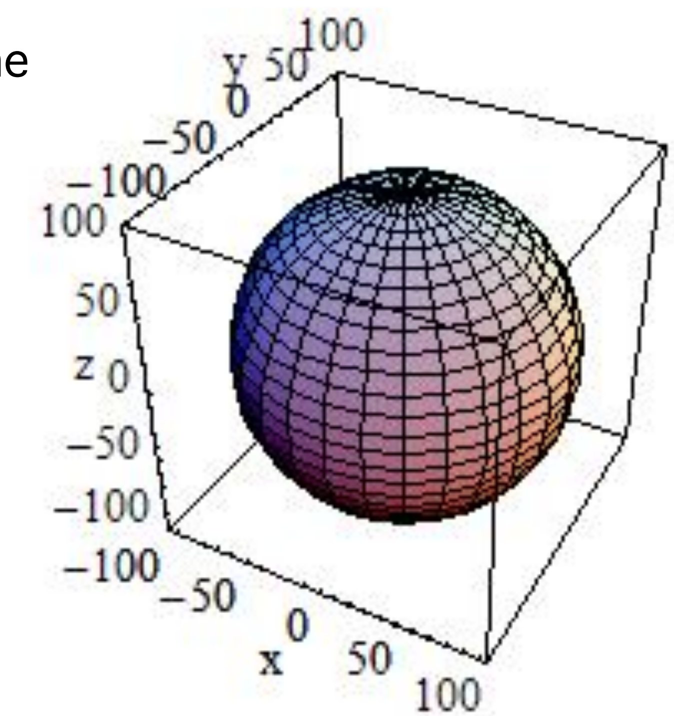


G4Para
(parallelepiped)

G4Sphere



G4Orb
(full solid sphe

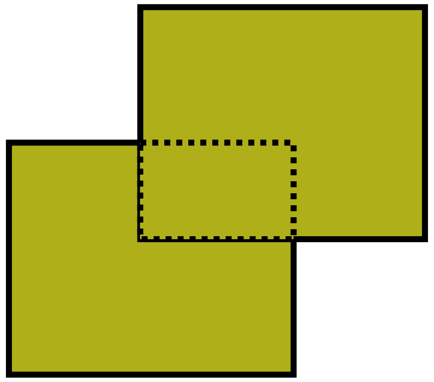


Check Section 4.1.2 of Geant4 Application Developers Guide for all available shapes

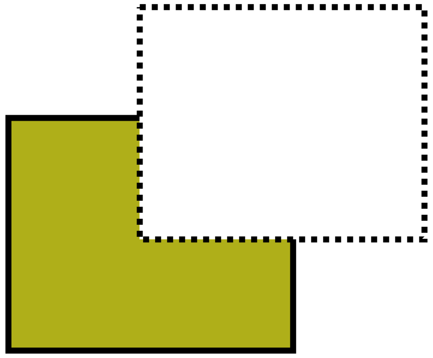
Boolean solids

- Solids can be combined using boolean operations:
  - **G4UnionSolid, G4SubtractionSolid, G4IntersectionSolid**
  - Requires: 2 solids, 1 boolean operation, and an (optional) transformation for the 2nd solid
  - 2nd solid is positioned relative to the coordinate system of the 1st solid
  - Result of boolean operation becomes a solid → re-usable in a boolean operation
- Solids to be combined can be either CSG or other Boolean solids
- Note: tracking cost for the navigation in a complex Boolean solid is proportional to the number of constituent CSG solids

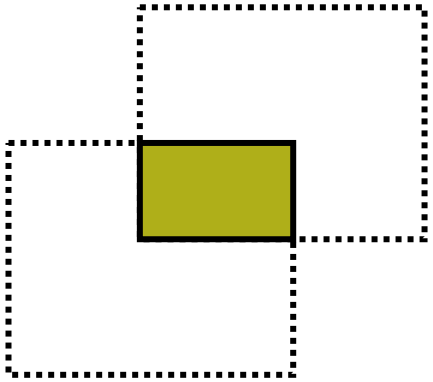
G4UnionSolid



G4SubtractionSolid



G4IntersectionSolid



Boolean solids – an example

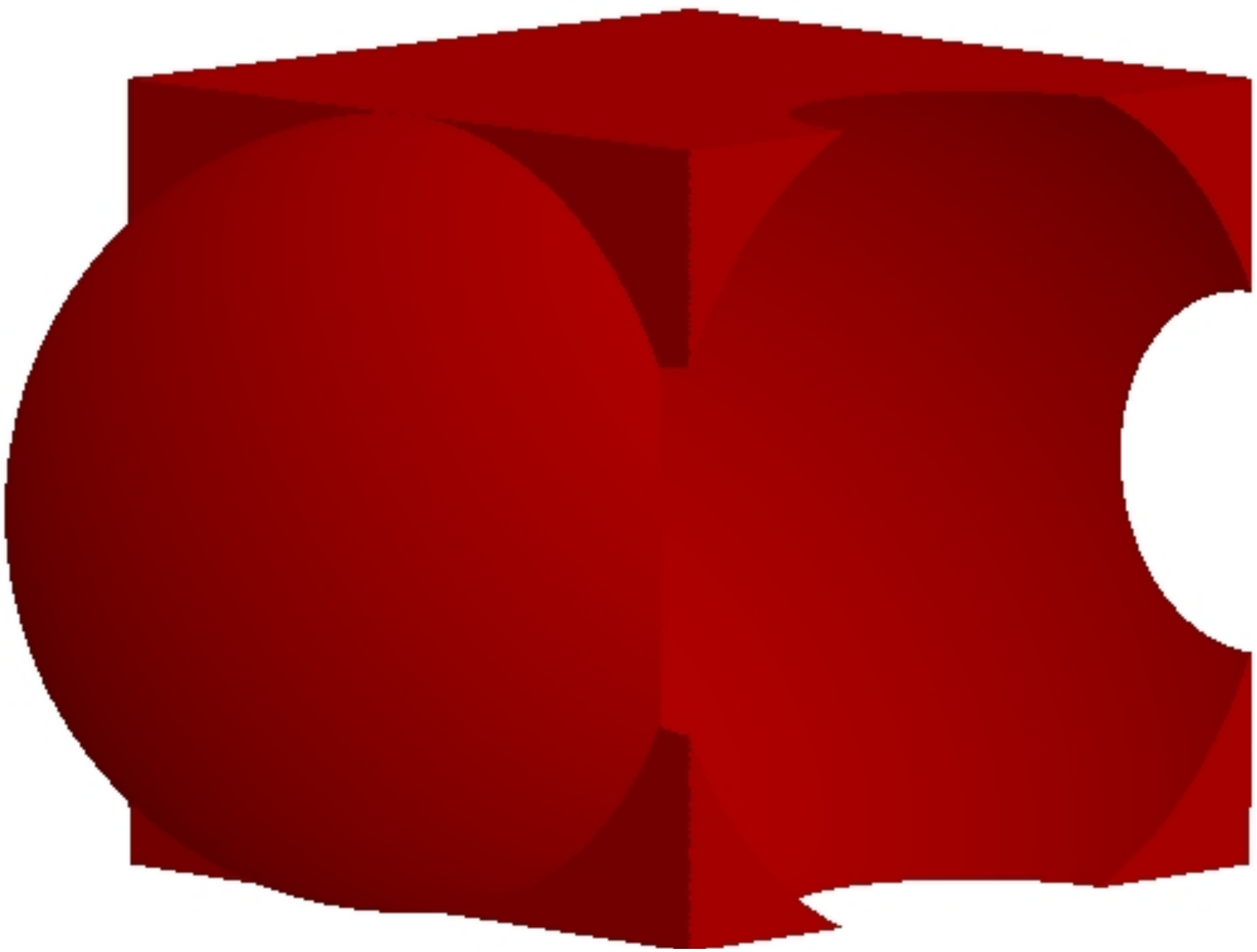

```
G4VSolid* box = new G4Box("Box",50*cm,60*cm,40*cm);
G4VSolid* cylinder =
    new G4Tubs("Cylinder",0.,50.*cm,50.*cm,0.,twopi);

G4VSolid* union =
    new G4UnionSolid("Box+Cylinder", box, cylinder);

G4VSolid* subtract =
    new G4SubtractionSolid("Box-Cylinder", box, cylinder,
        0, G4ThreeVector(30.*cm,0.,0.));

G4RotationMatrix* rm = new G4RotationMatrix();
rm->RotateX(30.*deg);
G4VSolid* intersect =
    new G4IntersectionSolid("Box&&Cylinder",
        box, cylinder, rm, G4ThreeVector(0.,0.,0.));
```

Boolean solid - example



Logical volumes

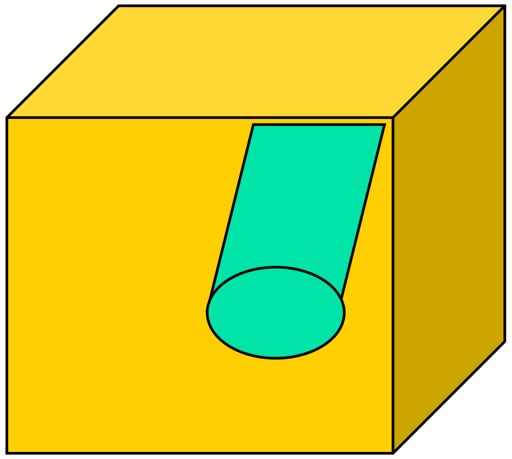
- Contains all information of volume except position:
  - Shape and dimension (**G4VSolid**)
  - Material, sensitivity, visualization attributes
  - Position of daughter volumes
  - Magnetic field, User limits
- Physical volumes of same type can share a logical volume.
- The pointers to solid and material must be not nullptr

```
G4LogicalVolume(G4VSolid* pSolid,
                G4Material* pMaterial,
                const G4String& name,
                G4FieldManager* pFieldMgr=0,
                G4VSensitiveDetector* pSDetector=0,
                G4UserLimits* pULimits=0,
                G4bool optimise=true);
```

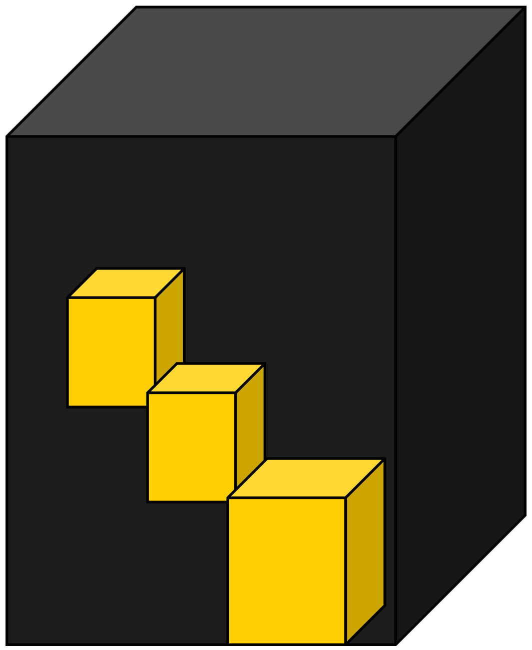
optional (applies to pFieldMgr, pSDetector, pULimits, optimise)

Physical volumes

- A physical volume is a positioned instance of a logical volume inside another logical volume (the mother volume)
- Placement (**G4PVPlacement**)
  - it is one positioned volume
- Repeated: a volume placed many times
  - can represent any number of volumes
  - reduces use of memory
  - **G4PVReplica** (= simple repetition)
  - **G4PVParameterised** (= more complex pattern)
    - **G4PVDivision**



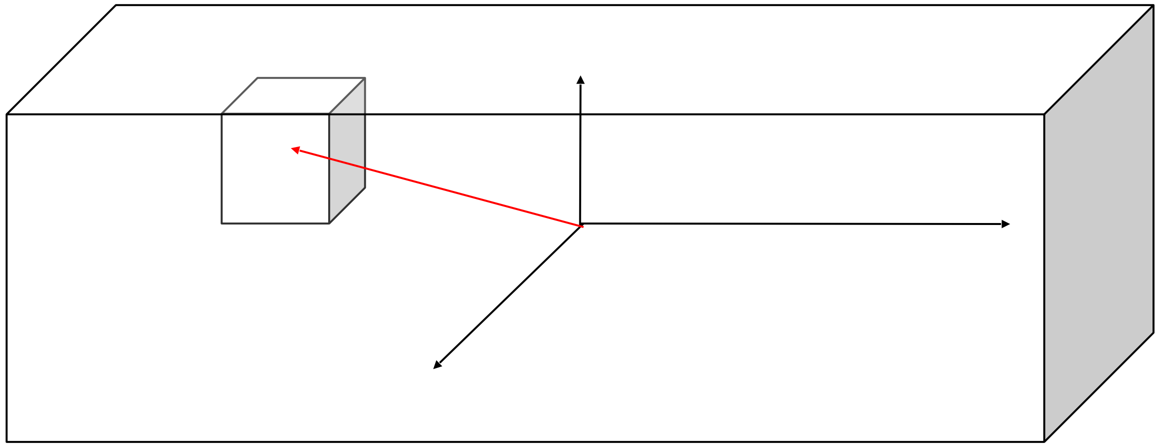
placement



repeated

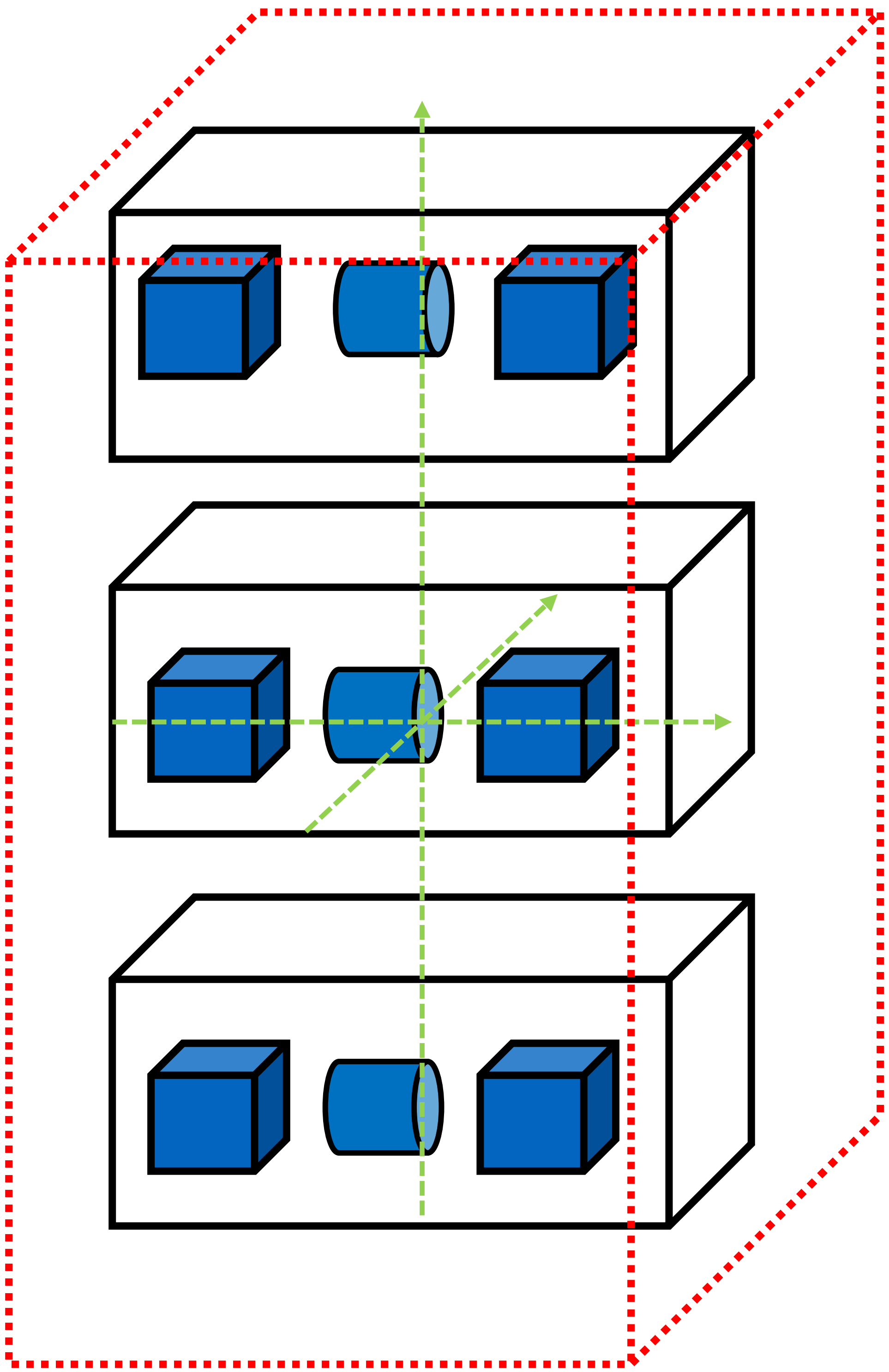
Geometry hierarchy

- A volume is placed in its mother volume
  - Position and rotation of the daughter volume is described with respect to the local coordinate system of the mother volume
  - The origin of the mother's local coordinate system is at the center of the mother volume
  - Daughter volumes cannot protrude from the mother volume
  - Daughter volumes cannot overlap
- The logical volume of mother knows the daughter volumes it contains
  - It is uniquely defined to be their mother volume



Geometry hierarchy

- One logical volume can be placed more than once. One or more volumes can be placed in a mother volume
- The mother-daughter relationship is an information of **G4LogicalVolume**
  - If the mother volume is placed more than once, all daughters by definition appear
- The world volume must be a unique physical volume which fully contains all other volumes (root volume of the hierarchy)
  - The world volume defines the global coordinate system. The origin of the global coordinate system is at the center of the world volume
  - Position of a track is given with respect to the global coordinate system



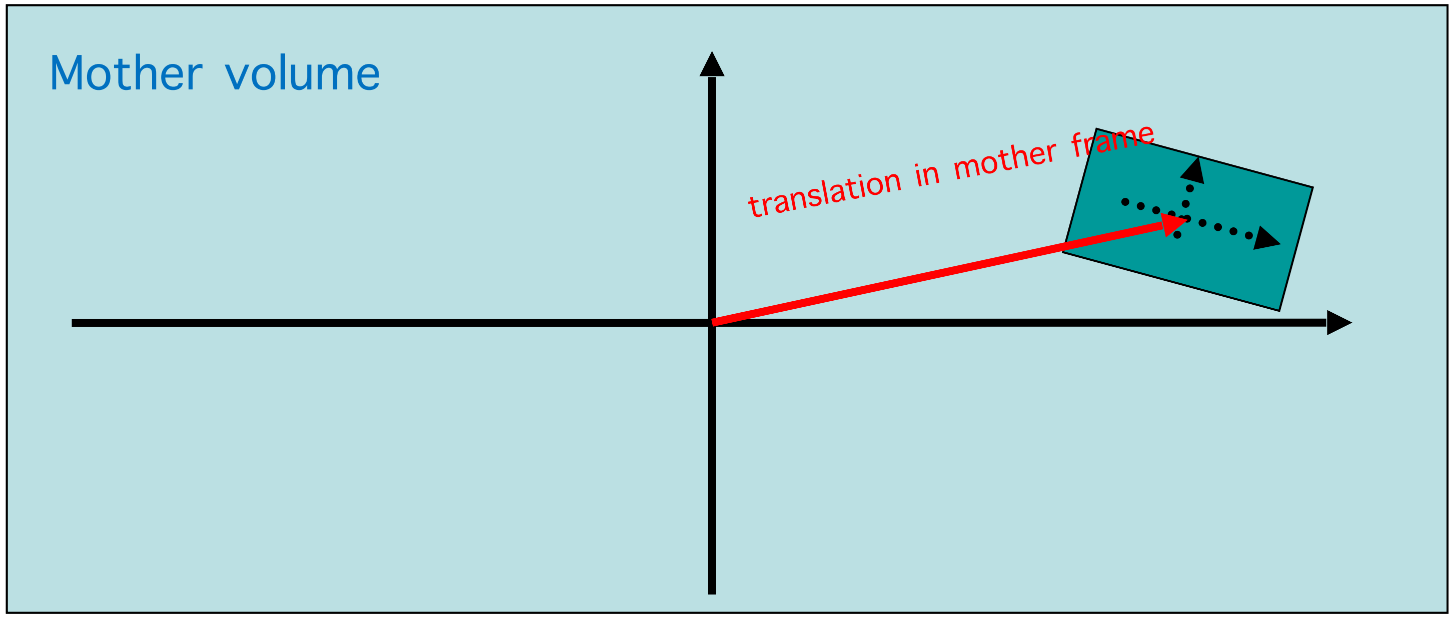
G4PVPlacement

- Single volume positioned relatively to the mother volume
  - In a frame rotated and translated relative to the coordinate system of the mother volume
- A few variants available:
  - Using **`G4Transform3D`** to represent the direct rotation and translation of the solid instead of the frame (alternative constructor)
  - specifying the mother volume as a pointer to its physical volume instead of its logical volume
- Four constructors available
  - logical OR physical volume as mother
  - active OR passive transformation of the coordinate system

G4PVPlacement: Rotation of mother frame …

- Single volume positioned relatively to the mother volume (passive transformation)

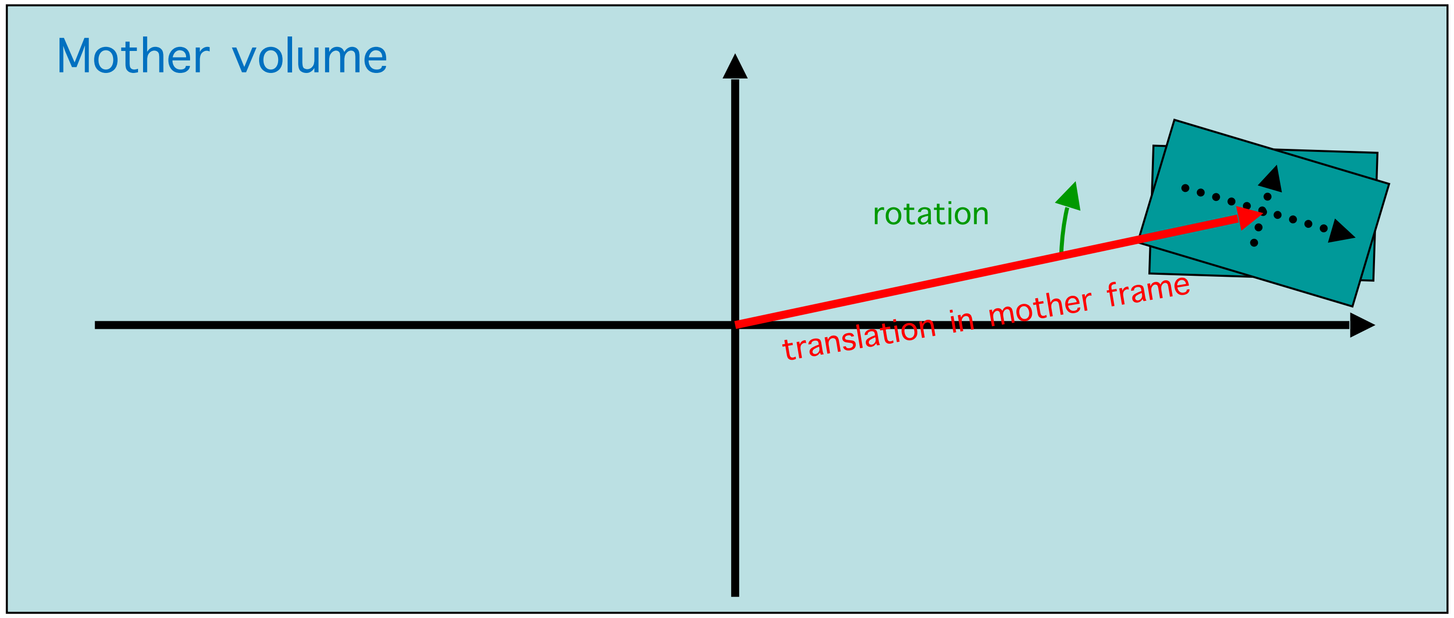
```
G4PVPlacement(G4RotationMatrix* pRot,          // rotation of mother frame
              const G4ThreeVector& tlate,      // position in mother frame
              G4LogicalVolume* pCurrentLogical,
              const G4String& pName,
              G4LogicalVolume* pMotherLogical,
              G4bool pMany,                // not used. Set it to false…
              G4int pCopyNo,               // unique arbitrary index
              G4bool pSurfChk=false ); // optional overlap check
```



G4PVPlacement: Rotation in mother frame …

- Single volume positioned relatively to the mother volume (active transformation)

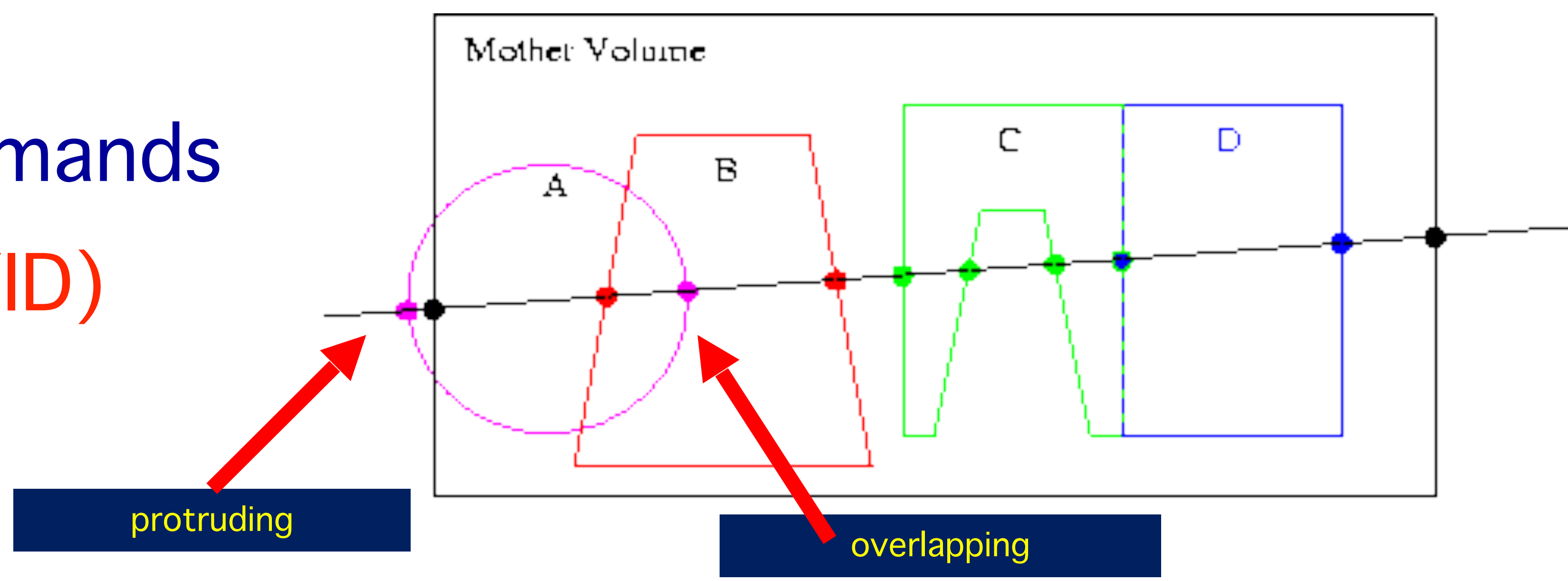
```
G4PVPlacement(G4Transform3D(
            G4RotationMatrix &pRot,        // rotation in daughter frame
                 const G4ThreeVector &tlate),    // position in mother frame
              G4LogicalVolume *pDaughterLogical,
              const G4String &pName,
              G4LogicalVolume *pMotherLogical,
              G4bool pMany,                          // not used, set it to false…
              G4int pCopyNo,                         // unique arbitrary integer
              G4bool pSurfChk=false );               // optional overlap check
```



Geometry problems

- Geant4 does not allow for malformed geometries, neither protruding (daughter/mother) not overlapping (sisters)
  - The behavior of navigation is unpredictable for such cases
- The problem of detecting overlaps between volumes is bounded by the complexity of the solid models description
- Utilities are provided for detecting wrong positioning
  - Optional checks

    at construction
  - Kernel run-time commands
  - Graphical tools (DAVID)



Tools for geometry check

- Constructors of **G4PVPlacement** and **G4PVParameterised** have an optional argument "**pSurfChk**"

```
G4PVPlacement(G4RotationMatrix* pRot,
  const G4ThreeVector &tlate,
  G4LogicalVolume *pDaughterLogical,
  const G4String &pName,
  G4LogicalVolume *pMotherLogical,
  G4bool pMany, G4int pCopyNo,
  G4bool pSurfChk=false);
```

  * If this flag is true, overlap check is done at the construction
  * Some number of points are randomly sampled on the surface of creating volume
- This check requires lots of CPU time, but it is worth to try at least once
- Built-in run-time commands to activate verification tests for the user geometry:
  * **/geometry/test/run** or **/geometry/test/grid_test**
  * start verification of geometry for overlapping regions based on a standard grid setup, limited to the first depth level
  * **/geometry/test/recursive_test** for all depth levels (CPU intesive!)

Tools for geometry check

Source

```
void MyDetectorConstruction::CheckOverlaps()
{
  G4PhysicalVolumeStore* thePVStore = G4PhysicalVolumeStore::GetInstance();
  G4cout << thePVStore->size() << " physical volumes are defined" << G4endl;
  G4bool overlapFlag = false;
  G4int res = 1000;
  G4double tol = 0.;       // tolerance
  for (size_t i=0; i<thePVStore->size(); i++)
  {
      overlapFlag = (*thePVStore)[i]->CheckOverlaps(res,tol,fCheckOverlapsVerbosity)
          | overlapFlag;
  }
  if (overlapFlag)
      G4cout << "Check: there are overlapping volumes" << G4endl;
}
```

Output

```
Checking overlaps for volume BeamLineSupport ... OK!
Checking overlaps for volume BeamLineCover ... OK!
Checking overlaps for volume BeamLineCover2 ... OK!
Checking overlaps for volume VacuumZone ... OK!
Checking overlaps for volume FirstScatteringFoil ... OK!
……
-------- WWWW ------- G4Exception-START -------- WWWW -
*** G4Exception : GeomVol1002    issued by : G4PVPlacement::CheckOverlaps()
Overlap with volume already placed !
          Overlap is detected for volume BrassTube2
          with HoleNozzleSupport volume's
          local point (12.6381,12.8171,-25.1867), overlapping by at least: 3.5 mm
*** This is just a warning message  ***
-------- WWWW -------- (
```

This method can be called at any point after run-

Regions

- A region is a sub-set of the geometry
- It may have its specific
  - Production thresholds (cuts)
  - User limits
    - Artificial limits affecting to the tracking, e.g. max step length, max number of steps, min kinetic energy left, etc.
  - Field manager
- World logical volume is recognized as the default region. User is not allowed to define a region to the world logical volume

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Part III: EM Field

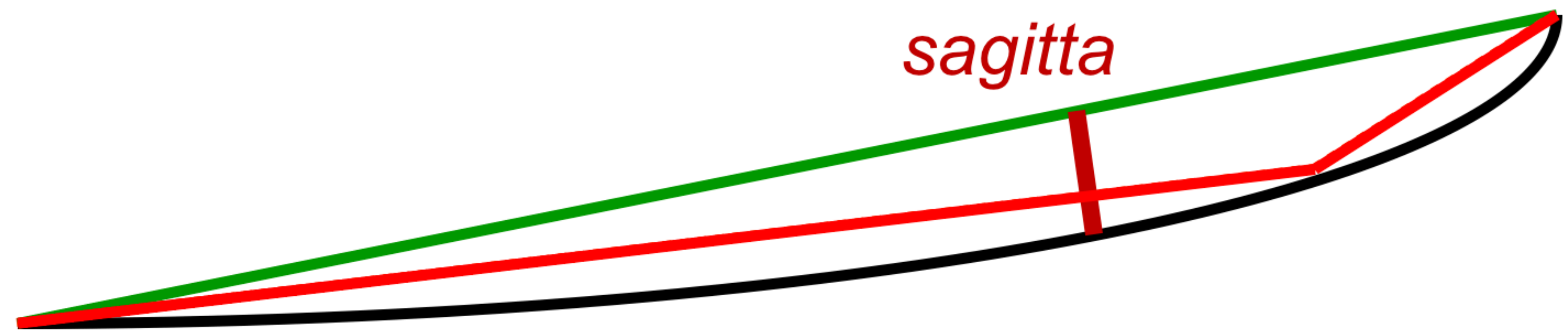
EM-field

- Divide the trajectory of the particle in “steps"
  Straight free-flight tracks between consecutive physics interactions

- In presence of EM fields, the free-flight part between interactions is not straight:
  => Change of direction (B-field) or energy (E-field)
  => Effect of fields must be incorporated into the tracking algorithm

Tracking field

- In order to propagate a particle inside a field the equation of motion of the particle in the field is integrated numerically
- In general this is best done using a Runge-Kutta (RK) method for the integration of ordinary differential equations
  - Other methods are also available
- Once the curved path is calculated, Geant4 breaks it up into **linear chord segments**



- The chord segments are determined to closely approximate the curved path
  - In some cases, one step could be split in several helix-turns

Creating a Magnetic Field for a Detector

The simplest way to define a field for a detector involves the following steps:

1. create a field:

```
G4UniformMagField* magField
  = new G4UniformMagField(G4ThreeVector(0.,0.,fieldValue));
```

2. set it as the default field:

```
G4FieldManager* fieldMgr
  = G4TransportationManager::GetTransportationManager()
    ->GetFieldManager();
   fieldMgr->SetDetectorField(magField);
```

3. create the objects which calculate the trajectory:

```
fieldMgr->CreateChordFinder(magField);
```

To change the accuracy of volume intersection use the `SetDeltaChord` method:

```
fieldMgr->GetChordFinder()->SetDeltaChord( G4double newValue);
```

Customization

- It is possible to define a field inside a logical volume (and its daughters)
  - This can be done creating a local **G4FieldManager** and attaching it to a logical volume

```
MyField* myField = new MyField();
G4FieldManager* localFieldMgr =
            new G4FieldManager(myField);
G4bool allLocal = true;
logicVolWithField
 ->SetFieldManager(localFieldMgr, allLocal);
```

If true, field assigned to all daughters
If false, field assigned only to daughters w/o their own field manager

===> Task1

Link to the Tasks : http://geant4.lngs.infn.it/belgrade2019/task1

Task 1 - Geometry

- Defining and using materials
- Constructing a volume using solids, logical and physical volumes
- Magnetic fields