FLUKA
Combinatorial Geometry
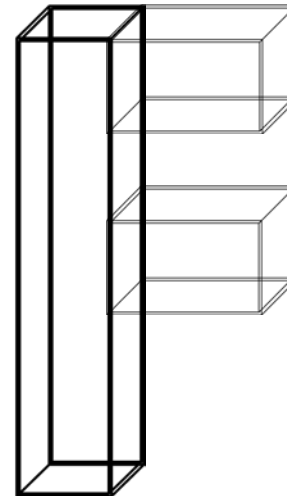
FLUKA Beginner's Course

Introduction

Principle of Combinatorial Geometry

Basic objects called bodies (such as cylinders, spheres, parallelepipeds, etc.) are combined to form more complex objects called regions

This combination is done using Boolean operations:

union, intersection, and subtraction

1 complex
object

3 basic
objects

Introduction

Initially, FLUKA Combinatorial Geometry was similar to the package developed at ORNL for the neutron and gamma-ray transport program Morse (M.B. Emmett ORNL-4972 1975).

It was based on the original combinatorial geometry by MAGI (Mathematical Applications Group, Inc., W. Guber et al, MAGI-6701 1967).

The present FLUKA CG package has been highly improved:
- addition of "infinite bodies"
- possibility of using body and region names instead of numbers and getting rid of alignment rules,
- availability of parentheses
- expansion and roto-translation of bodies
- comments
- repetition of patterns (lattices)
- voxels

Geometry input format

- The input file format for the geometry is different from the one adopted anywhere else in FLUKA (i.e. the number and length of the input fields is different)

- Different formats can be used (due to backward compatibility)

  - **Fixed format**
    - Alignment is mandatory
    - Bodies and regions are identified by numbers (rather than names), this makes geometry editing more difficult

  - **Name based format**
    - **It is the recommended format**
    - **It is NOT the default!**

Name based format

It has many advantages, the main are:

- input parameter alignment is not necessary
- bodies and regions are identified by names
- possible to edit the input sequence without affecting the region description (e.g. inserting a new body)
- parentheses can be used to perform complex Boolean operations in the description of regions.

Name based format input is used for both body and region

It is activated
either by a GLOBAL command at the beginning of the input file
or putting SDUM = COMBNAME in the GEOBEGIN card

GEOBEGIN	Log: ▼	Acc:	Opt: ▼
	Inp: ▼	Out: ▼	Fmt: COMBNAME ▼
Title:			

```
*...+....1....+....2....+....3....+....4....+....5....+....6....+....7....+....
GEOBEGIN                                                         COMBNAME
    0     0
```

Basic Concepts

Four concepts are fundamental in the FLUKA CG:

- **Bodies**: basic convex objects, plus infinite planes, infinite cylinders, and generic quadric surfaces
- **Zones**: sub-regions defined only via bodies intersection and subtraction
- **Regions**: defined as Boolean operations on bodies (union of zones)
- **Lattices**: duplication of existing objects (translated & rotated), will be explained in a separate lecture

In the original CG (Morse) bodies were convex solid bodies (i.e. finite portions of space completely delimited by surfaces of first or second degree, i.e. planes or quadrics)

FLUKA has been extended to include: infinite cylinders (circular and elliptical), planes (half-spaces), and generic quadrics (surfaces described by 2nd degree equations)

Use of "infinite bodies" is encouraged: input are less error-prone and tracking is faster and more accurate.

Basic Concepts: The Black Hole

All particles entering a black-hole are absorbed (they vanish)

FLUKA geometry MUST be embedded into a BLCKHOLE region
(to avoid tracking particles to infinity)

The outer surface of the BLCKHOLE region must be a single
closed body (e.g. a sphere).

Further black-hole regions can be defined by the user if desired

Combinatorial Geometry Input

CG input must respect the following structure:

GEOBEGIN card
VOXELS card (optional, see advanced geometry lecture)
Geometry title (and reading format options)
Body data
END card
Region data
END card
LATTICE cards (optional, see advanced geometry lecture)
Region volumes (optionally requested by a flag in the Geometry title, used together with the SCORE command)
GEOEND card

Reminder for txt format input files:
an asterisk (*) in the 1st column comments the line

GEOBEGIN card

```
GEOBEGIN                    Log: ▼              Acc:              Opt: ▼
                            Inp: ▼              Out: ▼            Fmt: COMBNAME ▼
         Title:
*...+....1....+....2....+....3....+....4....+....5....+....6....+....7....+....
GEOBEGIN                                          COMBNAME
    0    0
```

WHAT(1)   not used

WHAT(2)   set accuracy parameter – use with extreme care !

WHAT(3)   logical unit for the geometry input.
          Geometry input can be read from file; should be >20.0

WHAT(4)   logical unit for the geometry output

          Log feature; should be >20.0 ; Default is standard output

WHAT(5)   Parenthesis optimization level (see FLUKA manual)

WHAT(6)   not used

SDUM   COMBNAME or COMBINAT

   COMBNAME selects name based format, COMBINAT fixed format

   Default: COMBINAT (!)

   Is overwritten by WHAT(5) of a possible GLOBAL card

Geometry TITLE card

This card has no keyword, it is the line that follows the GEOBEGIN card (unless voxels are used) and its format is (2I5, 10X, A60)

The card gets three inputs: IVLFLG, IDBG, TITLE

IVLFLG (Input VoLumes FLAG) triggers the normalization of the quantities scored in regions by the option SCORE

IVLFLG= 0 → no normalization applied

IVLFLG= 3 → results divided by region volumes given before GEOEND. Volume value for each region must be provided, format: (7E10.5).

IDBG select different kinds of geometry fixed format input:

IDBG = 0 : default fixed format

IDBG = -10 or -100 : high accuracy fixed format

```
GEOBEGIN                              Log: ▼                    Acc: ▼                         Opt: ▼
                                      Inp: 21 ▼                 Out: ▼                         Fmt: COMBNAME ▼
         Title: Geometry title
```

```
*...+....1....+....2....+....3....+....4....+....5....+....6....+....7....+....
GEOBEGIN                          21.                              COMBNAME
     0     0         Geometry title
```

Bodies

Bodies

- Each body divides the space into two domains: inside and outside.
- 3-character code of available bodies:
    - RPP: **R**ectangular **P**arallele**P**iped
    - SPH: **SPH**ere
    - XYP, XZP, YZP: Infinite half space delimited by a coordinate plane
    - PLA: Generic infinite half-space, delimited by a **PLA**ne
    - XCC, YCC, ZCC: Infinite Circular Cylinder, parallel to coordinate axis
    - XEC, YEC, ZEC: Infinite Elliptical Cylinder, parallel to coordinate axis
    - RCC: **R**ight **C**ircular **C**ylinder
    - REC: **R**ight **E**lliptical **C**ylinder
    - TRC: **T**runcated **R**ight angle **C**one
    - ELL: **ELL**ipsoid of revolution
    - QUA: **QUA**dric
- Other (deprecated) bodies: ARB, RAW, WED, BOX

  Do not use them, because they can cause rounding problems

Bodies

The input for each body consists of:

- the 3-letter code indicating the body type (RPP, ZCC...)
- a unique "body name" (alphanumeric identifier, 8 character maximum, **case sensitive**)
- a set of geometrical quantities defining the body
  (the number depends on the body type, see next slides)

Different items can extend over as many lines as needed
  (Maximum 132 characters per line accepted)

Different items have to be separated by one or more blanks,
  or by one of the separators , / ; :

All values are in cm!

Infinite half-space parallel to coordinate axis

There are 4 kinds of infinite half-spaces

Three are delimited by planes perpendicular to the coordinate axes:
1. Delimited by a plane ⊥ to the x-axis. **Code: YZP**
2. Delimited by a plane ⊥ to the y-axis. **Code: XZP**
3. Delimited by a plane ⊥ to the z-axis. **Code: XYP**

All defined by a single number:
  Vx (resp. Vy, or Vz),
  coordinate of the plane on the
  corresponding perpendicular axis

Points for which:
x < Vx   (resp. y < Vy, or z < Vz)
are "inside the body"

inside   outside
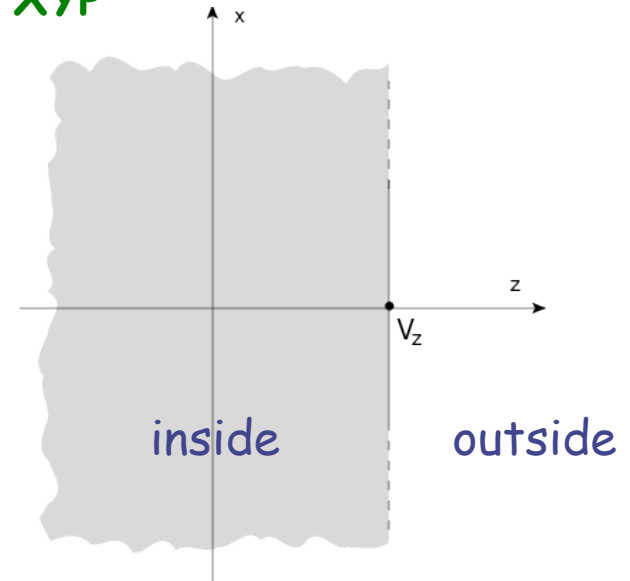
```
XYP          eg_XYP                                  z: 10.0
*...+....1....+....2....+....3....+....4....+....5....+....6....+....7....+....
XYP eg_XYP      10.0
```

Arbitrarily orientated infinite half-space: **PLA**

outside

$\vec{H}$
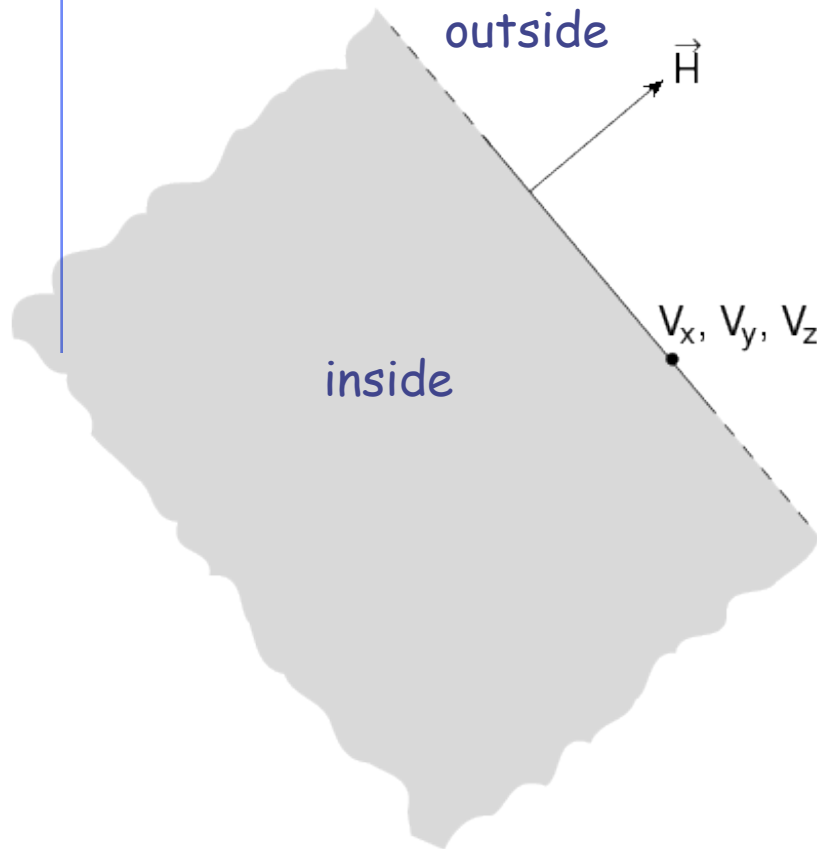
V_x, V_y, V_z

inside

A PLA defines the infinite half space delimited by a generic plane

A PLA is defined by 6 numbers:

Hx, Hy, Hz (vector ⊥ to the plane, arbitrary length);

Vx, Vy, Vz (any point lying on the plane)

The half-space "inside the body" is that from which the vector is pointing (i.e. the vector points "outside").

PLA	eg_PLA	Nx: 0.0	Ny: 1.0	Nz: 1.0
		x: 1.	y: 2.	z: 3.

```
*...+....1....+....2....+....3....+....4....+....5....+....6....+....7....+....
PLA eg_PLA    0.0 1.0 1.0 1.  2.  3.
```

Rectangular Parallelepiped: **RPP**

An RPP has its edges parallel to the coordinate axes

It is defined by 6 numbers in the following order:

$$X_{min}, \ X_{max}, \ Y_{min}, \ Y_{max}, \ Z_{min}, \ Z_{max}$$

(min and max coordinates delimiting the parallelepiped)

```
RPP          eg_RPP              Xmin:-5.0                    Xmax: 5.0
                                 Ymin: 0.0                    Ymax: 10.0
                                 Zmin:-30.0                   Zmax: 30.0

◁                                                                      ▷

*....+....1....+....2....+....3....+....4....+....5....+....6....+....7....+....
RPP eg_RPP      -5.0 5.0 0.0 10.0 -30.0 30.0
```
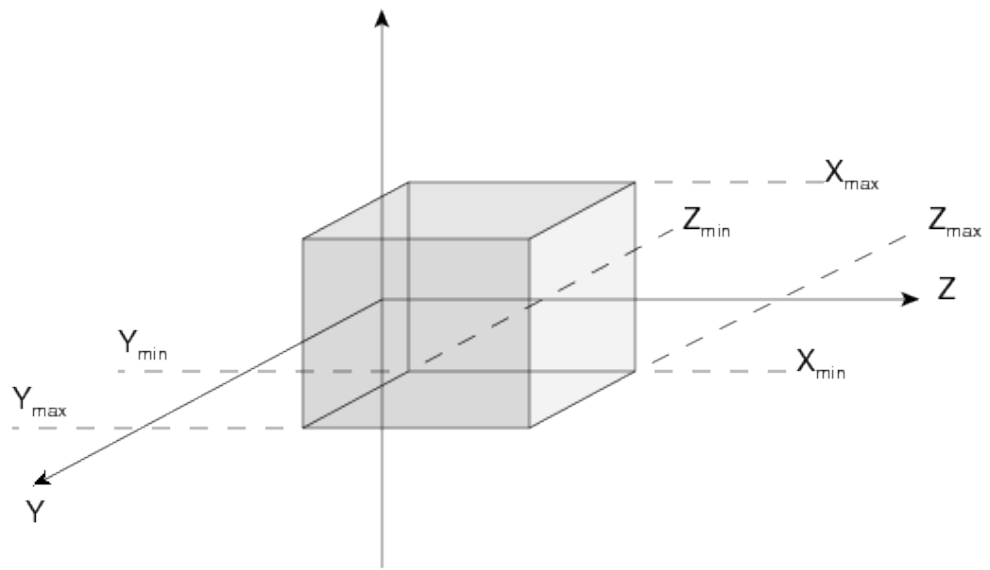
Rectangular Parallelepiped: **RPP**

```
RPP        eg_RPP                    Xmin:-5.0                    Xmax:5.0
                                     Ymin:0.0                     Ymax:10.0
                                     Zmin:-30.0                   Zmax:30.0
```

```
*...+....1....+....2....+....3....+....4....+....5....+....6....+....7....+....
RPP eg_RPP     -5.0 5.0 0.0 10.0 -30.0 30.0
```

An RPP definition extends over one single card in default fixed format, or over two cards in high-accuracy body fixed format

Example in fixed format (the comment lines shown are allowed input lines):

```
*...+....1....+....2....+....3....+....4....+....5....+....6....+....7....+.
   RPP      4        -20.0        +20.0        -50.0        +50.0        -38.5        +38.5
* (a parallelepiped centered on the origin)
```

High-accuracy fixed format

```
*...+....1....+....2....+....3....+....4....+....5....+....6....+....7....+.
   RPP      4                          -20.0                    +20.0                    -50.0
                                       +50.0                    -38.5                    +38.5
```

Sphere

Sphere: SPH

A SPH is defined by 4 numbers:

Vx, Vy, Vz (coordinates of the centre), R (radius)
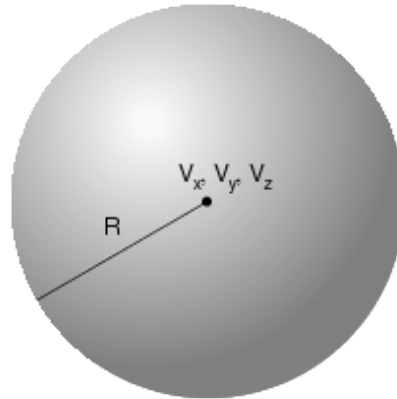

```
SPH        eg_SPH              x: 0.0                        y: 0.0                        z: 0.0
                              R: 10.0
*....+....1....+....2....+....3....+....4....+....5....+....6....+....7....+....
SPH eg_SPH     0.0 0.0 0.0 10.0
```

Circular cylinder

Right circular cylinder: RCC

An RCC can have any orientation in space

Limited by a cylindrical surface and two plane faces ⊥ to its axis.

Each RCC is defined by 7 numbers:

Vx, Vy, Vz (centre of one face);

Hx, Hy, Hz (vector corresponding to the cylinder height, pointing toward the other face);

R (cylinder radius).
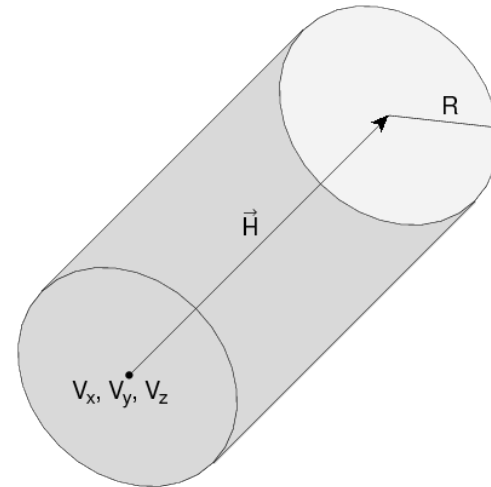
RCC	eg_RCC	x: 0.0	y: 0.0	z: 0.0
		Hx: 0.0	Hy: 10.0	Hz: 10.0
		R: 2.0		

```
*...+....1....+....2....+....3....+....4....+....5....+....6....+....7....+....
RCC eg_RCC      0.0 0.0 0.0 0.0 10.0 10.0 2.0
```

Infinite cylinders

Infinite Circular Cylinder parallel to coordinate axis: **XCC, YCC, ZCC**

Each XCC (YCC, ZCC) is defined by 3 numbers:

Ay, Az for XCC

(Az, Ax for YCC, Ax, Ay for ZCC) (coordinates of the cylinder axis),

R (cylinder radius)
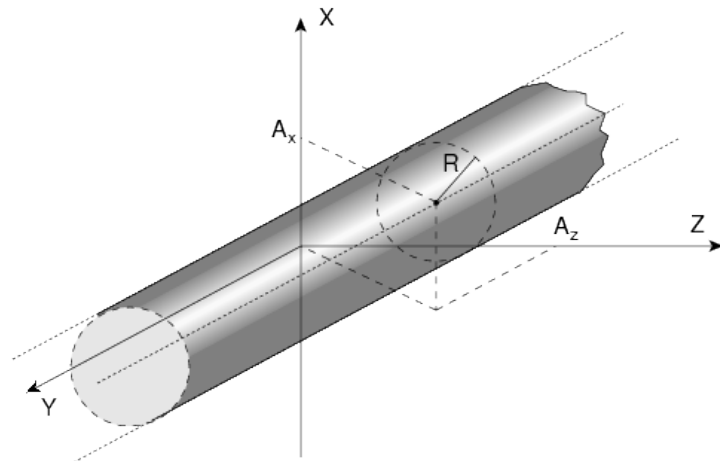
Infinite Elliptical Cylinder parallel to coordinate axis: **XEC, YEC, ZEC**

Each XEC (YEC, ZEC) is defined by 4 numbers: Ay, Az for XEC

(Az, Ax for YEC, Ax, Ay for ZEC) (coordinates of the cylinder axis);

Ly, Lz for XEC

(Lz, Lx for YEC, Lx, Ly for ZEC) (semi-axes of the ellipse)
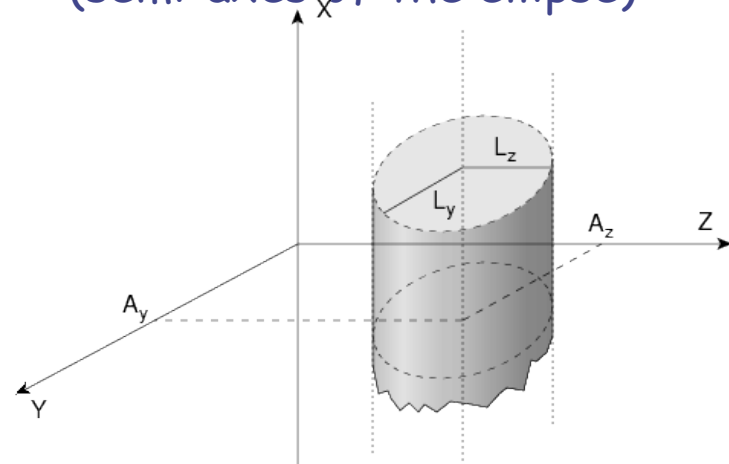
ZCC	eg_ZCC	x: 0.0	y: 0.0	R: 20.0

```
*...+....1....+....2....+....3....+....4....+....5....+....6....+....7....+....
ZCC eg_ZCC    0.0 0.0 20.0
```

Arbitrary generic quadric: **QUA**

A QUA allows to insert a quadric surface

This is defined by a 2nd degree equation F(x,y,z) = 0

Each QUA is defined by 10 numbers:

$A_{xx}, A_{yy}, A_{zz}, A_{xy}, A_{xz}, A_{yz}, A_x, A_y, A_z, A_0$

corresponding to the equation:

$$A_{xx}\, x^2 + A_{yy}\, y^2 + A_{zz}\, z^2 + A_{xy}\, xy + A_{xz}\, xz + A_{yz}\, yz +$$
$$+ A_x\, x + A_y\, y + A_z\, x + A_0 = 0$$

A QUA definition extends over two cards in default fixed format, and over 4 cards in high-accuracy body fixed format.

Regions

Concept

Regions are defined as combinations of bodies obtained by boolean operations:

	Union	Subtraction	Intersection
Name based format	|	–	+
Fixed format	OR	–	+
Mathematically	∪	–	∩

Regions are not necessarily simply connected (they can be the union of two or more non contiguous or partially overlapping zones) but must be of homogeneous material composition

Each point of space must belong to one and only one region!

Regions

Input for each region starts on a new line and extends on as many continuation lines as are needed. It is of the form:

REGNAME NAZ boolean-zone-expression

or

REGNAME NAZ boolean-zone-expression | boolean-zone-expression | …

- REGNAME is the region "name"
  alphanumeric identifier, 8 character maximum, **case sensitive**
  Must start by an alphabetical character
- NAZ See next slide
- "boolean-zone-expression" See next slides

Regions

- **NAZ** (Number of Adjacent Zones) is a rough estimate of the number of zones a particle can enter when leaving the current region zones (5 by default). What actually matters is the NAZ sum over all regions, defining the size of the *contiguity list*

- While tracking, the program searches in the contiguity list for the neighbor zones of each zone. If the zone is not yet in the list, the whole geometry is scanned and it is added to the list with its neighbor zones

- When the NAZ limit is reached (i.e. the list is full) the code prints a warning: GEOMETRY SEARCH ARRAY FULL. This is not lethal: the calculation continues but with a reduced efficiency

- If you have more than 1000 regions, you must issue a GLOBAL card putting in WHAT(1) a higher limit (not beyond 10000)

Regions Boolean expression

- **zones** are defined by intersections and/or subtraction of bodies, each body being preceded by its **+** or **–** sign

- **| (OR)** operators are used to join **zones**

- In evaluating the expressions, the highest operator precedence is given to parentheses, followed by +, - and the | operator

- Parentheses are available in name based format (use with care!)

- If one line is not sufficient, any number of continuation lines can be added

- Blanks are ignored

Meaning of + and - operators

If a body number (or name) appears in a zone description preceded by a **+** operator, it means that the zone being described is wholly contained inside the body.

If a body number appears in a zone description preceded by a **–** operator, it means that the zone being described is wholly outside the body.

Zones must be finite: normally in the description of each zone and hence of each region the symbol **+** must appear at least once.

Meaning of the + and − operators

Target 5 +Outer +CutPlane
* (the above region is the part of space common to bodies Outer and
* CutPlane)

Regex 5 +Red -Blue -Green +Yellow
* (the above region is the part of space common to body Red and Yellow,
* excluding however what is inside body Blue and what is inside Green)

Air 5   +Room
* (the latter region coincides entirely with body Room)

Meaning of + and - operators
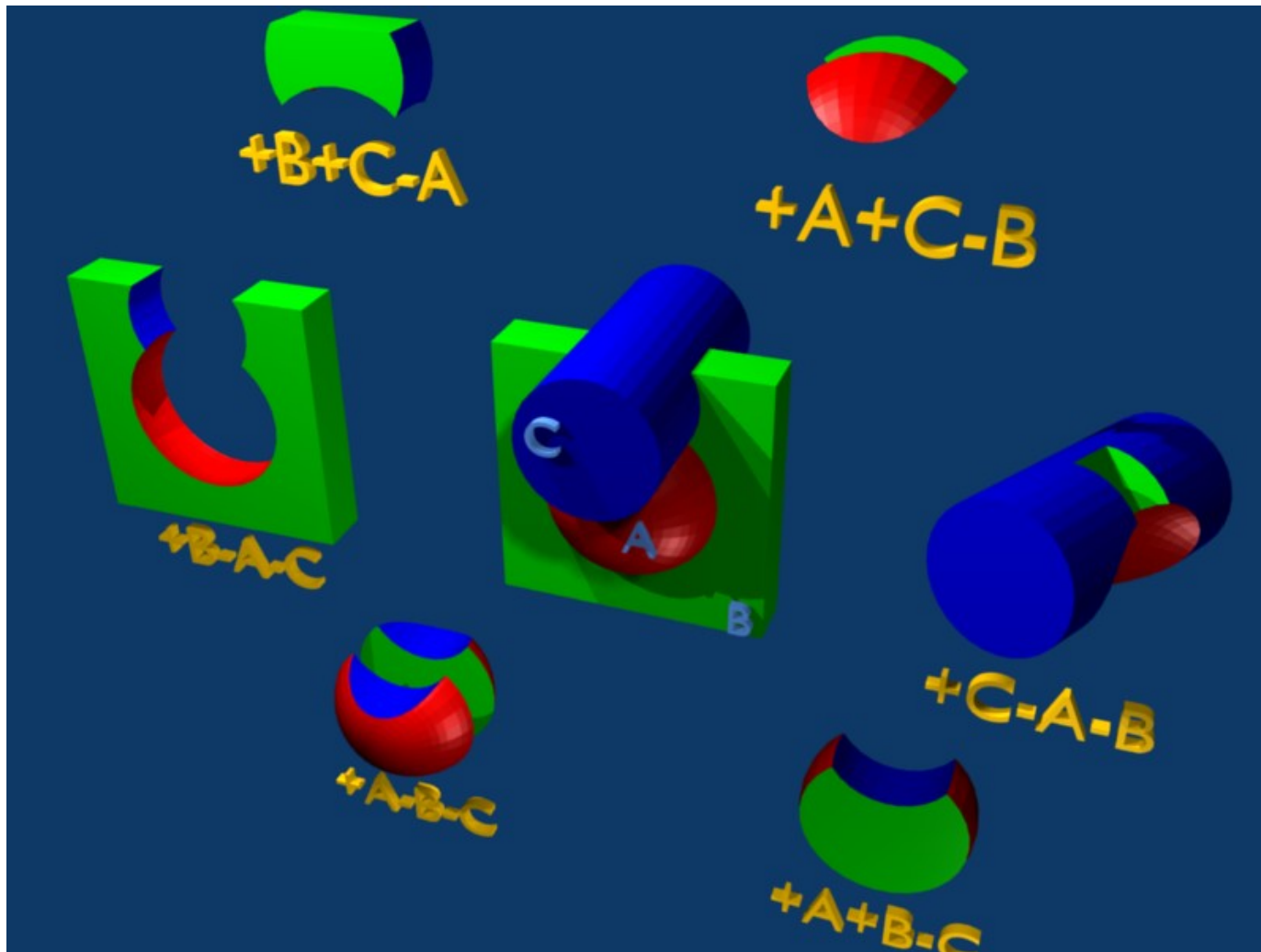
Meaning of the | (OR) operator

The **|** (or OR) operator is used as a Boolean **union** operator in order to combine **zones** (**sub regions** partially overlapping or not).

Zones are formed as body intersections or subtractions as previously explained

The **regions** are formed by the union of these **zones**.

Examples:

```
Ground 5 | +Body9 | +Body15 | +Body1 | +Body8 -Body2 | +Body8 -Body3
*          <- 1st -><-  2nd -><- 3rd -><----  4th ----><----  5th --->
* (continuation line)
         | +Body8 +Body18  | +Body12 -Body10 -Body11 -Body13 -Body14
*          <-----  6th -----><------- 7th and last zone      ------->
```

Geometry Example "F" shaped target
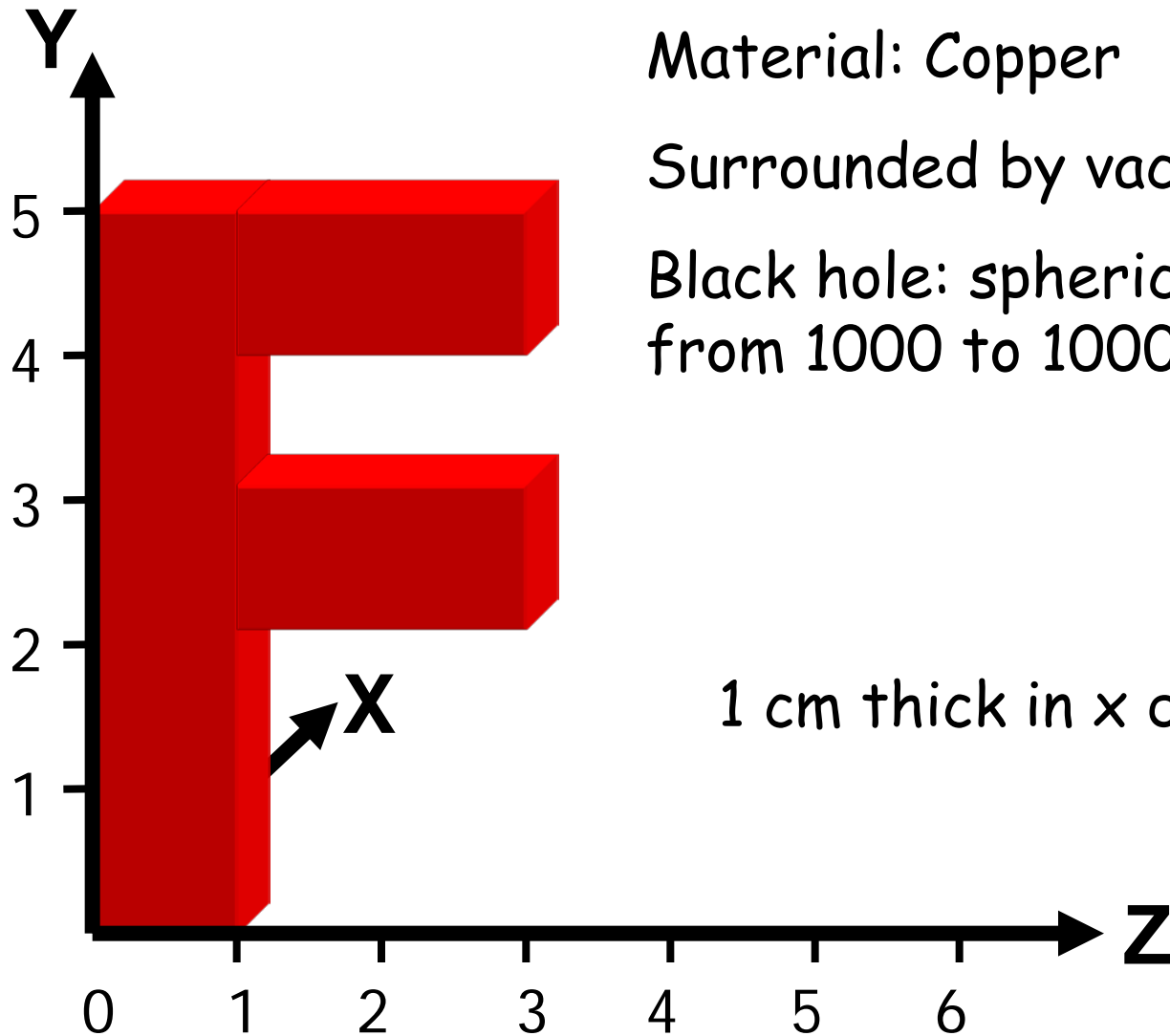
Material: Copper

Surrounded by vacuum

Black hole: spherical shell from 1000 to 10000 cm radius

1 cm thick in x direction

Geometry example "F": Bodies

Several possibilities for bodies, e.g.:
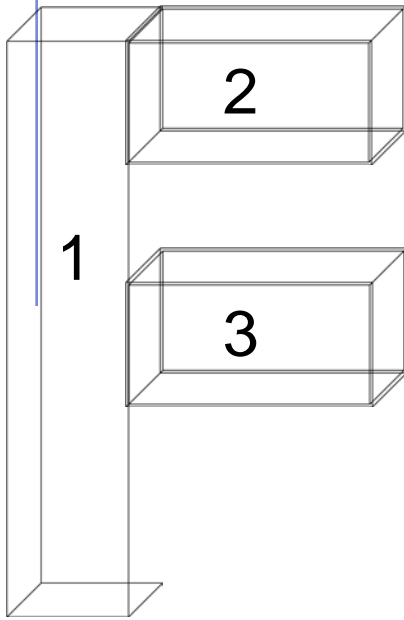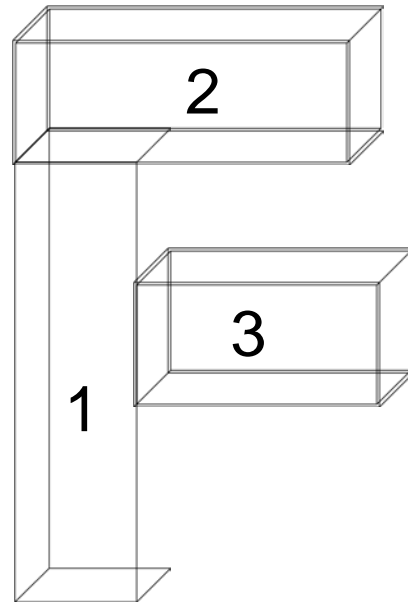
(A) Separated bodies   (B) Separated bodies   (C) overlapping   (D) subtraction
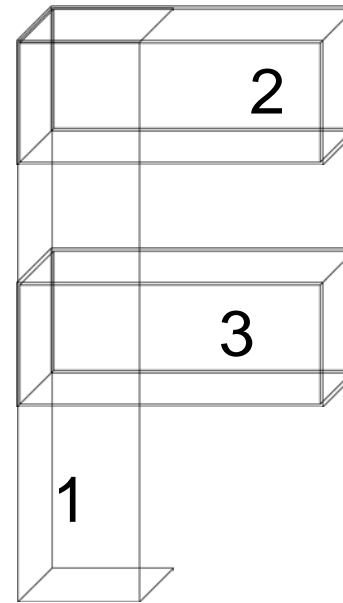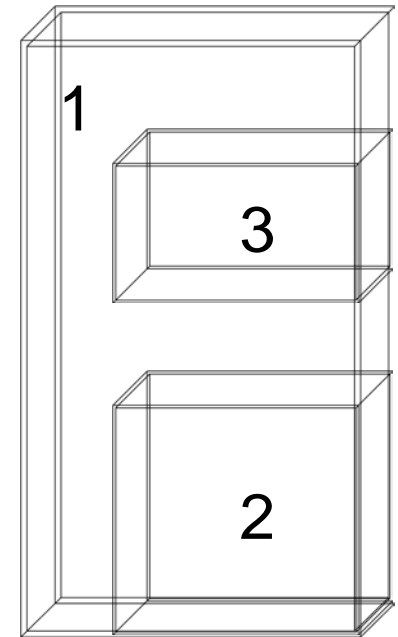
The 4 options are equivalent. We will use C.

Geometry example "F": REGIONS
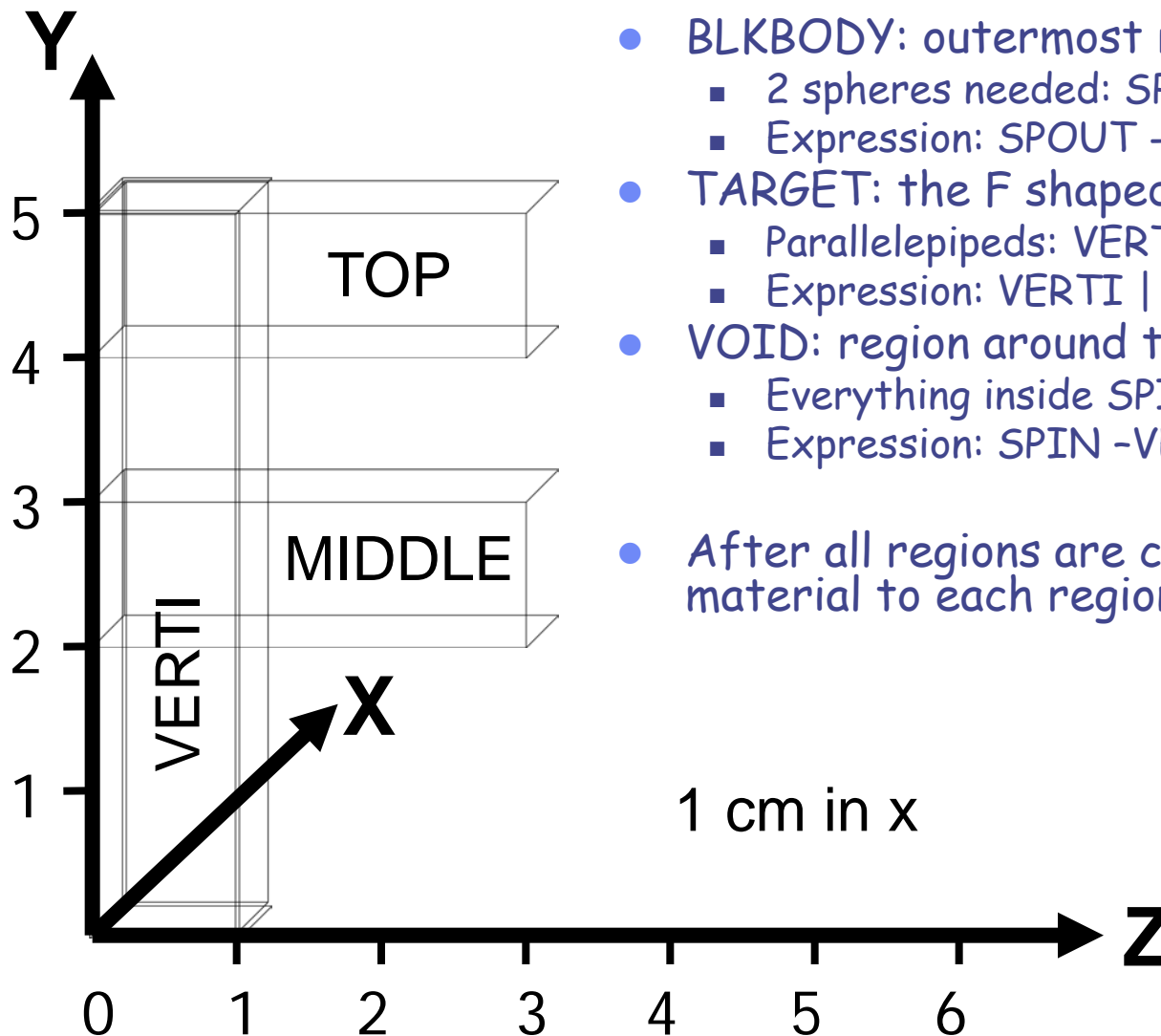
- BLKBODY: outermost region like a shell
  - 2 spheres needed: SPOUT, SPIN
  - Expression: SPOUT - SPIN
- TARGET: the F shaped object
  - Parallelepipeds: VERTI, TOP, MIDDLE
  - Expression: VERTI | TOP | MIDDLE
- VOID: region around the target
  - Everything inside SPIN that is not target
  - Expression: SPIN –VERTI – TOP –MIDDLE

- After all regions are created: assign material to each region with ASSIGNMA

1 cm in x

Geometry example "F": input file

```
GEOBEGIN                                            COMBNAME
    0    0              The copper F
SPH SPIN        0.0 0.0 0.0 1000.
SPH SPOUT       0.0 0.0 0.0 10000.
RPP VERTI       0.0 1. 0.0 5. 0.0 1.
RPP TOP         0.0 1. 4. 5. 0.0 3.
RPP MIDDLE      0.0 1. 2. 3. 0.0 3.
END
* Black hole
BLKBODY      5  +SPOUT -SPIN
* Void around
VOID         5  +SPIN -TOP -VERTI -MIDDLE
* Target
TARGET       5 TOP | VERTI | MIDDLE
END
GEOEND
ASSIGNMA     BLCKHOLE    BLKBODY
ASSIGNMA      VACUUM        VOID
ASSIGNMA      COPPER      TARGET
```

| **BEAMPOS** | | x: | y: | z: |
| | | cosx: | cosy: | Dirz: POSITIVE ▼ |

GEOBEGIN		Log: ▼	Acc:	Opt: ▼
		Inp: ▼	Out: ▼	Fmt: COMBNAME ▼
	Title: The copper F			

| **SPH** | SPOUT | x: 0 | y: 0 | z: 0 |
| | | R: 10000 | | |

| **SPH** | SPIN | x: 0 | y: 0 | z: 0 |
| | | R: 1000 | | |

RPP	VERTI	Xmin: 0	Xmax: 1	
		Ymin: 0	Ymax: 5	
		Zmin: 0	Zmax: 1	

RPP	TOP	Xmin: 0	Xmax: 1	
		Ymin: 4	Ymax: 5	
		Zmin: 0	Zmax: 3	

RPP	MIDDLE	Xmin: 0	Xmax: 1	
		Ymin: 2	Ymax: 3	
		Zmin: 0	Zmax: 3	

Black hole
| **REGION** | | Name: BLKBODY | Neigh: 5 | Volume: |
| | Expr: +SPOUT -SPIN | | | |

Void around
| **REGION** | | Name: VOID | Neigh: 5 | Volume: |
| | Expr: +SPIN -TOP-VERTI -MIDDLE | | | |

Target
| **REGION** | | Name: TARGET | Neigh: 5 | Volume: |
| | Expr: TOP |VERTI |MIDDLE | | | |

| **GEOEND** | ▼ | | | |

..+....1....+....2....+....3....+....4....+....5....+....6....+....7..

| **ASSIGNMA** | | Mat: BLCKHOLE ▼ | Reg: BLKBODY ▼ | to Reg: ▼ |
| | | | Step: | Field: ▼ |

| **ASSIGNMA** | | Mat: VACUUM ▼ | Reg: VOID ▼ | to Reg: ▼ |
| | | | Step: | Field: ▼ |

| **ASSIGNMA** | | Mat: COPPER ▼ | Reg: TARGET ▼ | to Reg: ▼ |
| | | | Step: | Field: ▼ |

| **USRBIN** | | | Unit: 21 BIN ▼ | Name: edep |
| | Type: X-Y-Z ▼ | Xmin: -10 | Xmax: 10 | NX: 100 |

Example: Igloo
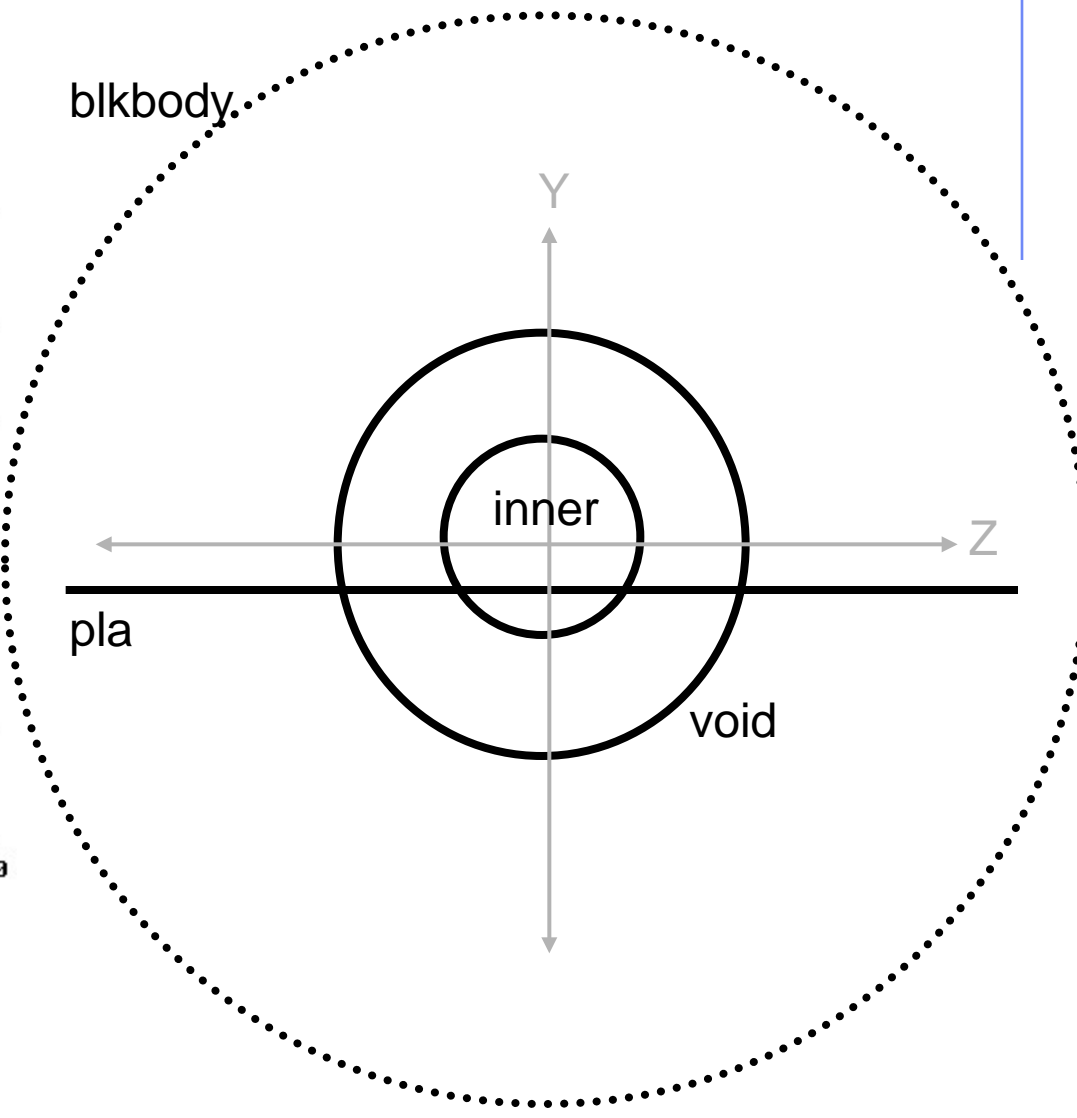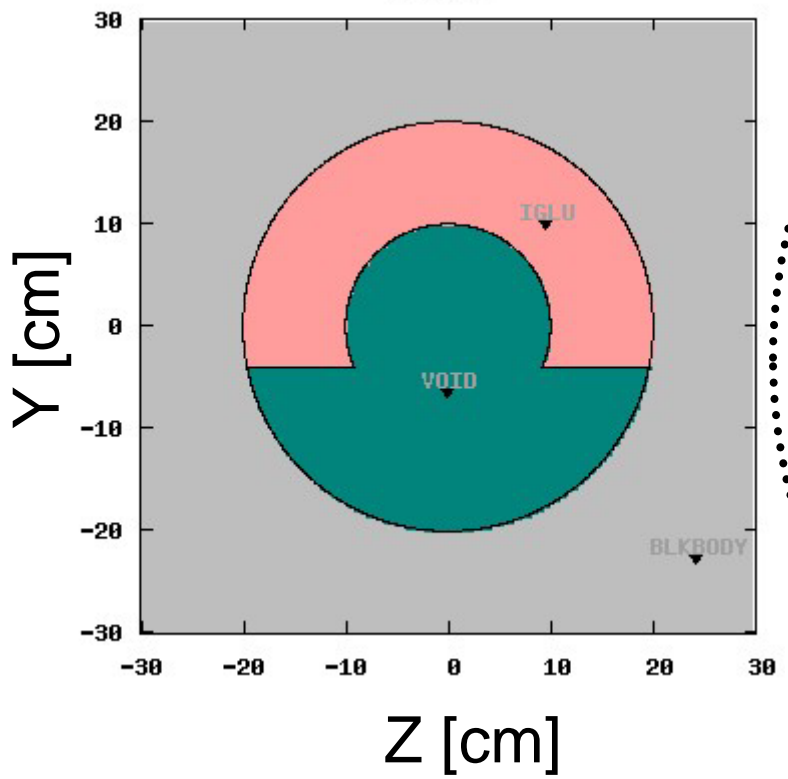
Example: Igloo

GEOBEGIN		Log: ▼	Acc:	Opt: ▼
		Inp: ▼	Out: ▼	Fmt: COMBNAME ▼
	Title:			

Black body

SPH	blkbody	x: 0.0	y: 0.0	z: 0.0
		R: 1000.0		

Void sphere

SPH	void	x: 0.0	y: 0.0	z: 0.0
		R: 20.0		

SPH	inner	x: 0	y: 0	z: 0
		R: 10		

XZP	pla	y: -4		

Black hole

REGION		Name: BLKBODY	Neigh: 5	Volume:
	Expr: +blkbody -void			

Void around

REGION		Name: VOID	Neigh: 5	Volume:
	Expr: +void +pla |+inner			

Target

REGION		Name: IGLU	Neigh: 5	Volume:
	Expr: +void -pla -inner			

GEOEND	▼			

Remarks

Important Notes

- Whenever it is possible, the following bodies should be preferred:

> PLA, RPP, SPH, XCC, XEC, XYP
>
> XZP, YCC, YEC, YZP, ZCC, ZEC, QUA

These bodies make the tracking faster, since for them extra coding ensures that unnecessary boundary intersection calculations are avoided when the length of the next step is smaller than the distance to any boundary of the current region.

- Always use as many digits as possible in the definition of the body parameters, particularly for body heights (RCC, REC, TRC), and for direction cosines of bodies with slant surfaces. The name based format or the high-accuracy fixed format should always be used in these cases.

Precision Errors

Modeling assumptions

RCC   RCC

A   B
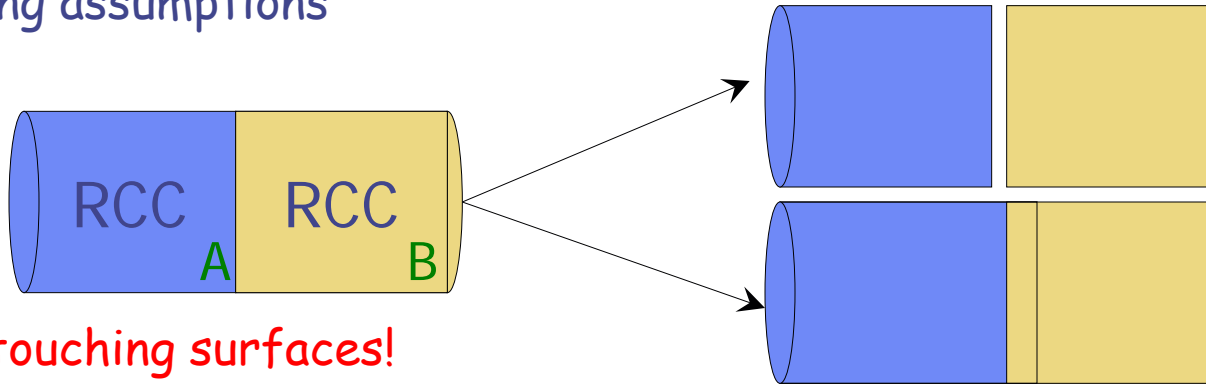
Avoid touching surfaces!

When floating point operations are involved.

- Use cutting surface B instead

B PLA

A

RCC

+A+B   +A-B

- Or force partial overlap of bodies

A

A-B

B

+B
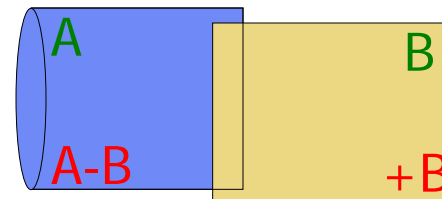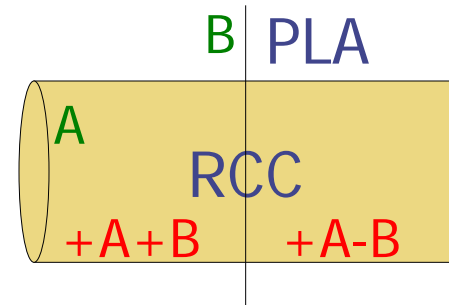
Tracking accuracy

❑ FLUKA uses systematically double precision mathematic
    (i.e. 16 significant digits)

❑ GEOBEGIN's WHAT(2)*10^{-6}cm is the *absolute accuracy (AA)*
    requested for tracking and boundary identification

❑ The *relative accuracy (RA)* achievable in double precision is
    of the order of 10^{-14}-10^{-15}.

❑ *AA* should be larger than *RA*L* , being *L* the largest coordinate value
    in the considered problem, i.e. the whole geometry size
    (The outer blackhole shell containing the system does not count)

❑ For very large and very small geometries, you may, respectively,
    need to increase or decrease the WHAT(2) default value of 0.0001.

Geometry Errors and Debugging

Geometry Errors

During execution the code always needs to know the region where a particle is located at every step

- The program will stop only if a particle position does not belong to any region
  An error message will be printed in the .err file with the particle position

- IMPORTANT! It will not stop if a particle position belongs to more than one region. It will accept the first region it finds but the results will completely unreliable!!
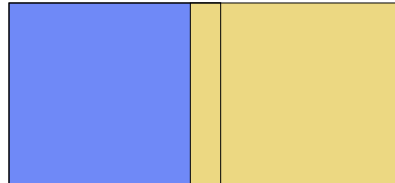
Geometry Errors

Further types of errors

- Problem space not enclosed by a black body region
- Never start a primary particle along a surface. You could get a geometry error even if the geometry is correct because FLUKA cannot determine the region
- Precision errors
- Lattice replica ←→ basic cell mismatch

    (see advanced geometry lecture)

Debugging Tools

- GEOEND card with the DEBUG option

    (*handled through a dedicated Flair frame*)

- Error messages during simulation in the .err file
- Geometry plotting by Flair

    (automatically invoking the PLOTGEOM card)

- **FLAIR Geometry Editor** (very powerful! See dedicated lecture)
- Simplegeo

Debugging with FLUKA

GEOEND card activates the geometry debugger. Detects both undefined or multiple defined points in a selected X,Y,Z mesh

- Two cards are needed
  First card

WHAT(1)=X_{max}	WHAT(2)=Y_{max}	WHAT(3)=Z_{max}
WHAT(4)=X_{min}	WHAT(5)=Y_{min}	WHAT(6)=Z_{min}

  SDUM = DEBUG

- Second Card

WHAT(1)=Nx	WHAT(2)=Ny	WHAT(3)=Nz

  SDUM = &

```
GEOEND Xmax  Ymax  Zmax  Xmin  Ymin  Zmin  DEBUG
GEOEND Nx    Ny    Nz                            &
```

WARNING!
The program stops if too many errors are found
A message will be issued on the output unit

Debugging with FLUKA

- If **no error** is found, no **.err** file will be created

- REMINDER: If the debugger does not find any error it does not mean that the geometry is error free!

- One has to test, changing the GEOEND settings especially for critical and complicated regions

- Errors will be listed in the .err file in the form:

  > **** Lookdb: Geometry error found ****
  > **** The point: -637.623762 -244.554455 -96.039604 ****

  - Point is contained in more than one region
    > **** is contained in more than 1 region ****
    > **** (regions: 6 7) ****

  - Not contained in any region
    > **** is not contained in any region

Debugging with FLUKA

It can be easily run through Flair

Auxiliary program: *SimpleGeo*

Auxiliary program: *SimpleGeo*

- SimpleGeo is an interactive solid modeler which allows for flexible and easy creation of the models via drag & drop, as well as on-the-fly inspection

- Imports existing geometries for viewing

- Creating new geometries from scratch

- Export to various formats (FLUKA, MCNP, MCNPX)

- Download, Tutorials, etc.: http://theis.web.cern.ch/theis/simplegeo

- Operating system: Windows only