GEOMETRY DESCRIPTION FOR MCFAST

Abstract

This document contains a description of MCFast geometry structures and geometry files.

MCFast v4_3 and above
May 12, 1999

1 MCFast Geometry Description

The basic geometry shapes recognized by MCFast are planes, cylinders and cones. They can be combined to form detectors elements such as silicon trackers, drift chambers, and calorimeters. Detectors other than silicon devices are generally described by the outer box and the detector volume inside. Materials are included as either thin scatterers or as thick absorbers. Beam pipes and magnets are included as separate elements.

The detectors are assumed to be in regions of constant field. Magnets can be solenoids and dipoles. Detector elements and magnets are described in simple ASCII geometry files. The expected formats of the files and a brief description of the input is given in this document.

MCFast tracking currently converts detector layers and scatterers into infinitely thin planes or cylinders. They are put into two ordered lists or radial planes and Z-planes. (See the routine $MCFAST_DIR/mcfast/src/geom/geo_trkorder.F). The calorimetry is the only part of MCFast that is volume based. MCFast can handle two tracking elements that are at the same radius or at the same z position. MCFast allows does not check for overlapping volumes or planes, however, so be careful when defining your detector.

Geometry files in the DBin format are identified by the file extension *.db*. Examples of MCFast geometry files can be found in $MCFAST_DIR/examples/mcfast. (To define $MCFAST_DIR *setup mcfast*.)

The geometry input variables are defined by templates. The template definitions for the various geometry geometry can be found in $MCFAST_DIR/mcfast/db. A link to $MCFAST_DIR/mcfast/db must be made inside the local directory where you plan to run MCFast. (ln -s $MCFAST_DIR/mcfast/db db)

Some geometry structures are nested which is defined in the templates by a parent/child relationship. The silicon barrel detector, for example, has several levels: barrel detector elements, layers and wafers. Because we are working in fortran, the maximum number of elements is defined inside the template. If you exceed this number, strange things may happen.

This can be a confusing point. The maximum number in the template is the total number of that element that can be defined in the detector. There is also a maximum number that is allowed per layer or per device that is defined internally to MCFast. For ordinary non-nested structures, these numbers should be the same. For nested structures, these numbers are different and have been set to reasonable values as determined by the authors. These numbers as they are implemented in the v2.6 version are given below.

Changing a MCFast Geometry Template If you would like to increase this number then you will need to contact one of the authors or you can make your own version of MCFAst libraries and change the template files yourself. Remember that the geometry structures are defined in the template files and separately in the include files. The geometry input is read in through condensed structures defined in the templates, and MCFast itself uses similar but less condensed structures which can be found in $MCFAST_DIR/mcfast/inc/geom. The translation between the two structure formats is done in the $MCFAST_DIR/mcfast/src/geom load_*.F routines. Since we are currently using Fortran, the maximum size of the arrays must be set for both structures. We have had to do this in two separate places which can cause problems when something needs to be changed.

For experts and the very brave To change a template yourself, you will need to make your own copy of the mcfast files and have set the environment variable MCFAST_DIR to your new directory. In $MCFAST_DIR/mcfast/src/dbin_mcfast you will find the main template file (template.db) and the code that is autogenerated by dbin. Create a link in this directory to the directory containing your new template: ln -s $MCFAST_DIR/mcfast/db db. Once you have changed the template in $MCFAST_DIR/mcfast/db and checked it against the corresponding fortran include file, run ~bphyslib/util/dev/dbin template.db. You should now rebuild all MCFast libraries and object files to be certain that there is no mismatch of version.

Units Mcfast uses standard units of cm, nsec, grams, GeV and Tesla. Angles are in radians.

2 MCFast Geometry Input

Absorber The Absorber geometry structure describes cylindrical and conical inactive material. Absorbers are treated in two ways inside MCFast. Thin absorbers (type 41,42) are treated as scattering sites and NO showers will be initiated inside them. In v2_6 thick absorbers are treated as calorimeters without readout and showering can occur. (See EMCAL structures.) In v2_5_1 they are included in the graphics and the muon_offline code.

template **Absorber** (Max=25) thick absorbers or thin scatterers(cylindrical/conic)

- char **name** name
- char **shape** "TUBE" or "CONE"
- int **type** 1=barrel, 2=forward, 41= barrel scatterer, 42= forward scatterer
- real **rmin(2)** minimum radius at low z, high z
- real **rmax(2)** maximum radius at low z, high z
- real **z0** z at center
- real **zlen** length in z
- material **material** from material list

end template

include file $MCFAST_DIR/mcfast/inc/geom/absorber.inc, absorber_struct.inc

The AbsorberBox (new in v2_6) geometry structure describes rectangular inactive material. Absorbers are treated in two ways inside MCFast. Thin absorbers (type 41,42) are treated as scattering sites and NO showers will be initiated inside them. Thick box absorbers are treated as calorimeters without readout and showering can occur. (See EMCALBox structures.)

template **AbsorberBox** (Max=25) thick absorbers or thin scatterers(cylindrical/conic) char **name** name

char **shape** “BOX” only

int **type** 2=forward, 42= forward scatterer

real **xlimit(2)** xmin, xmax

real **ylimit(2)** ymin, ymax

real **xlimit_gap(2)** inner gap xmin, xmax

real **ylimit_gap(2)** inner gap ymin, ymax

real **z0** z at center

real **zlen** length in z

material **material** from material list

end template

include file $MCFAST_DIR/mcfast/inc/geom/absorber.inc, absorber_struct.inc

Beampipe The beampipe is treated as a scatterer.

template **BPipe** (Max=2) beam pipe (cylindrical)

char **name** name

real **rmin** minimum radius (usually = 0)

real **rmax** radius of inner wall

real **z0** z at center

real **zlen** length in z

material **mat_fill** fill material (“VACU” for example)

real **bndrthk(4)** wall thickness at rmin, rmax, front, back

material **matrbnd(4)** at rmin, rmax, front, back

end template

include file $MCFAST_DIR/inc/geom/beampipe.inc

Detector This is where you will enter a general description of the detector including its name.

template **detector** Defines detector type for tracing

char **name** Detector Name

char **geom_id** Detector type
"CENTRAL" cylindrical geometry (solenoids)
"FORWARD" z planes (dipoles)
"COMBINED" both In early version of MCFast, this was used to describe the geometry, now it simply serves as a switch for trk_offline. Combined (wtk) fitting is much slower and is not very reliable.

end detector

include file $MCFAST_DIR/mcfast/inc/geom/detector_general.inc

Dipole

template **Dipole** (Max=20) Dipole magnets

char **name** name

real **bfield** magnitude of B field

real **dircos(3)** direction of b-field (current version assumes fields along x or y axis)

real **xmin** minimum x for field region

real **xmax** maximum x for field region

real **ymin** minimum y for field region

real **ymax** maximum z for field region

real **z0** central value for z

real **zlen** length of field region in z material **mat_fill** fill material usually “AIR”

real **thick_boun(6)** Yoke thickness at: xmin, xmax, ymin, ymax, zmin, zmax

material **mat_boun(6)** Yoke material at: xmin, xmax, ymin, ymax, zmin, zmax

end template

include file $MCFAST_DIR/mcfast/inc/geom/dipole.inc, dipole_struct.inc

Drift Chambers Central Drift Chamber (cylindrical)

template **Drift** (Max=10)

int **num** Chamber number

char **name** Name

int **num_anode** Number of anode layers

child **LayerDRFAno** Link to daughter structure : no entry in .db file

child **OffsetDRFAno** Link to daughter structure: no entry in .db file

int **num_cathode** number of cathode layers (can be zero)

child **LayerDRFCatho** Link to cathode structure

real **rmin** minimum radius of drift volume

real **rmax** maximum radius of drift volume

real **z0** central Z position

real **zlen** length of chambers

material **material** fill material

real **thick_boun(4)** boundary thinkness at rmin, rmax, zmin, zmax

material **mat_boun(4)** boundary material rmin, rmax, zmin, zmax

end template

include file $MCFAST_DIR/mcfast/inc/geom/drift.inc, drift_struct.inc

Drift chamber substructure:

- Drift_cathode

  template **LayerDRFCatho** (Max=2 total, max= 2 per device) Drift Chamber Cathode (not used currently)

  int **det** Pointer to parent Drift chamber

  parent **Drift** parent structure: no entry in .db file int **lyr** Cathode layer number

real **delta_r**

real **zlen** cathode length in z

int **nstrips** number of strips in z

int **n_phi_segm** number of segments in phi

int **ID_anode** points to corresponding anode layer

int **cell_offset** phi offset of strips

real **eff_hit** efficiency

real **resa**

real **resb**

real **resc**

end template

include file $MCFAST_DIR/mcfast/inc/geom/drf_cathode_struct.inc

- Drift_layer

template **LayerDRFAno** (Max=100 total, Max= 100 per device)

int **det** pointer to Drift chamber

parent **Drift** Parent Structure: No entry in .db file

int **lyr** Anode layer number

real **radius** radius of layer

real **zlen** length of anode

real **cell_height** height of cell

int **nwires** number of wires in layer

int **ID_readout** readout side +1 = zmax, -1 = zmin

int **ID_cathode** cathode plan corresponding to this anode

real **phi0** phi offset (phi of wire 0)

real **stereo_tau**

real **stereo_offset**

real **eff_hit** hits efficiency

real **eff_dedx** efficiency for dedx info

real **siga** $\sigma = \sigma_a + \sigma_b \times drift + \sigma_c \times drift^2$ $(drift = (drifttime)/max(drifttime)$

real **sigb**

real **sigc**

end template

include file $MCFAST_DIR/mcfast/inc/geom/drf_anode_struct.inc

- Drift_offset

template **OffsetDRFAno** (Max=100 total, Max = 100 per device)
Drift Chamber offsets (defaults to zero offset)

int **det** pointer to Drift chamber

parent **Drift** Parent Structure: no entry in structure

int **lyr** anode layer

real **cell_offset**

real **sag**

real **offset(3)**

real **dircos(3)**

end template

include file $MCFAST_DIR/mcfast/inc/geom/drf_anode_struct.inc

Electromagnetic Calorimeters The basic Cylindrical Calorimeter Structure is called EMCal. This will serve as the model a new calorimeter structure that will be developed for future versions.

template **EMCal** (Max=40)

> char **name** Name of calorimeter
>
> char **shape** Shape “TUBE” or “CONE”
>
> int **type** central (=1), forward or backward(=2)
>
> real **rmin(2)** minimum radius at lo z, hi z
>
> real **rmax(2)** maximum radius at lo z, hi z
>
> real **z0** central z position
>
> real **zlen** length in z
>
> material **material** average mixture of calorimeter material
>
> material **active** active material
>
> int **nphi** number of segments in phi
>
> int **neta** number of segments in eta
>
> real **siga_em** resolution for electromagnetic showers
>
> real **sigb_em** offset for electromagnetic showers
>
> real **siga_had** resolution for hadronic showers
>
> real **sigb_had** offset for hadronic showers
>
> real **em_had_ratio** e/pi ratio

end template

include file $MCFAST_DIR/mcfast/inc/geom/emcal.inc, emcal_struct.inc

The basic Boxlike Calorimeter Structure is called CalorBox (New in v2_6).

template **CalorBox** (Max=40)

char **name** Name of calorimeter

char **shape** Shape "BOX" only

int **type** forward or backward(=2)

real **xlimit(2)** xmin, xmax

real **ylimit(2)** ymin, ymax

real **xlimit_gap(2)** inner gap xmin, xmax

real **ylimit_gap(2)** inner gap ymin, ymax

real **z0** central z position

real **zlen** length in z

material **material** average mixture of calorimeter material

material **active** active material

int **ncr1** number of segments in x

int **ncr2** number of segments in y

real **siga_em** resolution for electromagnetic showers

real **sigb_em** offset for electromagnetic showers

real **siga_had** resolution for hadronic showers

real **sigb_had** offset for hadronic showers

real **em_had_ratio** e/pi ratio

end template

include file $MCFAST_DIR/mcfast/inc/geom/emcal.inc, emcal_struct.inc

Forward tracking

template **FTrk** (Max=100) Forward tracking devices – Box-like

> int **det** Detector number (1...100)
>
> char **name** Detector name
>
> int **nlyr** number of detection planes
>
> child **LayerFTRK** detection plane structure (no entry in .db file)
>
> real **xmin** xmin of the device
>
> real **xmax** xmax of the device
>
> real **ymin** ymin of the device
>
> real **ymax** ymax of the device
>
> real **z0** central z position
>
> real **zlen** length in z
>
> material **mat_fill** fill material or gas mixture
>
> real **thick_boun(6)** thickness of box at: xmin, xmax, ymin, ymax, zmin, zmax
>
> material **mat_boun(6)** material of box at: xmin, xmax, ymin, ymax, zmin, zmax
>
> real **siga** resolution
>
> real **sigb**
>
> real **sigc**

end template

include file $MCFAST_DIR/mcfast/inc/geom/for_trk.inc, for_trk_struct.inc

Forward tracking layer structure:

- Ftrk_layer
  Detection planes for box-like forward chambers.

template **LayerFTRK** (Max=500 total, max= 100 per device)

int **det** pointer to FTrk

parent **FTrk** FTrk structure (no entry in .db file)

int **lyr** layer number

real **z_local** local z wrt to center of FTrk Box

real **thick** thickness of detection layer

real **xmin** xmin of detection plane

real **xmax** xmax of detection plane

real **xmin_gap** xmin of gap in detection plane

real **xmax_gap** xmax of gap in detection plane

real **ymin** ymin of detection plane

real **ymax** ymax of detection plane

real **ymin_gap** ymin of gap in detection plane

real **ymax_gap** ymax of gap in detection plane

real **stereo** stereo angle in radians

int **ncell** number of cells

real **coord0_x** x coordinate of 1st cell

real **coord0_y** y coordinate of 1st cell

int **type** type ???

real **eff_hit** hit efficiency

real **siga** $\sigma = \sigma_a + \sigma_b * (driftdist) + \sigma\_c * (driftdist)^2$ if σ is zero $\sigma = cellsize/\sqrt{12}$

real **sigb**

real **sigc**

end template

include file $MCFAST_DIR/mcfast/inc/geom/for_trk_lyr_struct.inc

Hadron calorimeter The Hadron calorimetry structure is now obsolete.

Hits on track Sets minimum number of hits required for an “offline” track

template **HitsOnTrack** (Max=2)

int **all** Minimum number of hits required in track fit

int **z** Minimum number of stereo hits – USER cut only

int **svx** Minimum number of silicon hits – USER cut only

end template

include file $MCFAST_DIR/mcfast/inc/geom/track_minhit.inc

Materials List of Materials and Mixtures

template **Material** (Max=50)

char **name** Name

real **a** A

real **z** Z

real **density** density [g/cm^3]

real **radlen** radiation length [cm]

real **abslen** absorbtion length [cm]

real **collen** collision length [cm]

real **dedx** dedx [GeV/cm]

end Material

include file $MCFAST_DIR/mcfast/inc/geom/material.inc, material_struct.inc

Example of a material list

	name	A	Z	density	RadLen	AbsLen	ColLen	Dedx
Material	"VACU"	0.1000E-15	0.1000E-15	0.1000E-15	0.1000E+17	0.1000E+17	0.10E+17	0.1000E-15
Material	"AIR"	0.1461E+02	0.7300E+01	0.1250E-02	0.3042E+05	0.6750E+05	0.10E+17	0.2190E-05
Material	"ALUM"	0.2698E+02	0.1300E+02	0.2700E+01	0.8900E+01	0.3720E+02	0.10E+17	0.4370E-02
Material	"IRON"	0.5585E+02	0.2600E+02	0.7870E+01	0.1760E+01	0.1710E+02	0.10E+17	0.1165E-01
Material	"SILI"	0.2809E+02	0.1400E+02	0.2330E+01	0.9360E+01	0.3000E+02	0.10E+17	0.3870E-02
Material	"SCIN"	0.1200E+02	0.6000E+01	0.1032E+01	0.4240E+02	0.7940E+02	0.10E+17	0.2010E-02
Material	"CU"	0.6354E+02	0.2900E+02	0.8960E+01	0.1430E+01	0.1030E+02	0.10E+17	0.1290E-01
Material	"TITA"	0.4790E+02	0.2200E+02	0.4540E+01	0.3560E+01	0.2750E+02	0.10E+17	0.6850E-02
Material	"BE"	0.9010E+01	0.4000E+01	0.1848E+01	0.3530E+02	0.3670E+02	0.10E+17	0.2970E-02
Material	"CARB"	0.1201E+02	0.6000E+01	0.2265E+01	0.1880E+02	0.3820E+02	0.10E+17	0.4030E-02
Material	"CFIB"	0.1201E+02	0.6000E+01	0.2265E+01	0.2140E+02	0.4990E+02	0.266E+02	0.4030E-02
Material	"MXSO"	0.5572E+02	0.2550E+02	0.6026E+01	0.2372E+01	0.2481E+02	0.10E+17	0.9875E-02
Material	"ARGON"	39.95	18.0	1.78E-3	11706.	5.E+4	1.E+16	2.70E-6
Material	"C2H6"	30.8	18.0	1.36E-3	34035.	5.E+4	1.E+16	3.05E-6
Material	"MIX1"	0.5077E+02	0.2368E+02	0.4451E+01	0.3380E+01	0.3181E+02	0.10E+17	0.1053E-01

Mixtures Mixtures

template **Mixture** (Max=20)

> char **name** mixture name
>
> int **nmat** number of materials
>
> material **matnames(5)** material names
>
> real **prop(5)** proportion by volume

end template

include file $MCFAST_DIR/mcfast/inc/geom/material.inc, material_struct.inc

Muon Very Simple Muon Detector In v2_5_1 the muon detector is completely separate from the tracking and the muon_offline code estimates the amount of absorber and calorimeter material the muon sees and does a rough calculation of dedx. In v2_6 this will be more integrated into the tracking and tracing code.

template **MUON** (Max=40) cylindrical geometry

> char **name**
>
> char **shape** Shape "TUBE" or "CONE"
>
> int **type** central = 1, forward or backward = 2
>
> real **rmin(2)** minimum radius at lo z, hi z
>
> real **rmax(2)** maximum radius at lo z, hi z
>
> real **z0** central z position
>
> real **zlen** length in Z
>
> material **material** average material (not used)
>
> int **nlayer** number of layers

end template

include file $MCFAST_DIR/mcfast/inc/geom/muon.inc, muon_struct.inc

Silicon barrel detectors Silicon barrel detectors are described as collections of planar wafers that are positioned such that their normal vector is in the xy plane. See figures 1 and 2. For purposes of tracking the wafers are treated as infinitessimally thin objects. However the description of the wafer does include a thickness, which is only used in the computation of the expected multiple scattering and energy loss; these are applied as if they occured at the infinitessimally thin plane. Also, the quantity β in the db file is not the same as the β which appears in the include file; see figure 2 and the discussion about include files, which begins on page 37. Finally, figure 3 gives a graphical represention of the connections between the components of the silicon barrel description.

template **SiBarrel** (Max=15)

int **num**

char **name**

int **nlyr**

child **LayerSiB**

real **z0_global** central z position for detector

end template

include file $MCFAST_DIR/mcfast/inc/geom/si_barrel.inc, si_barrel_struct.inc

Silicon Barrel layers:

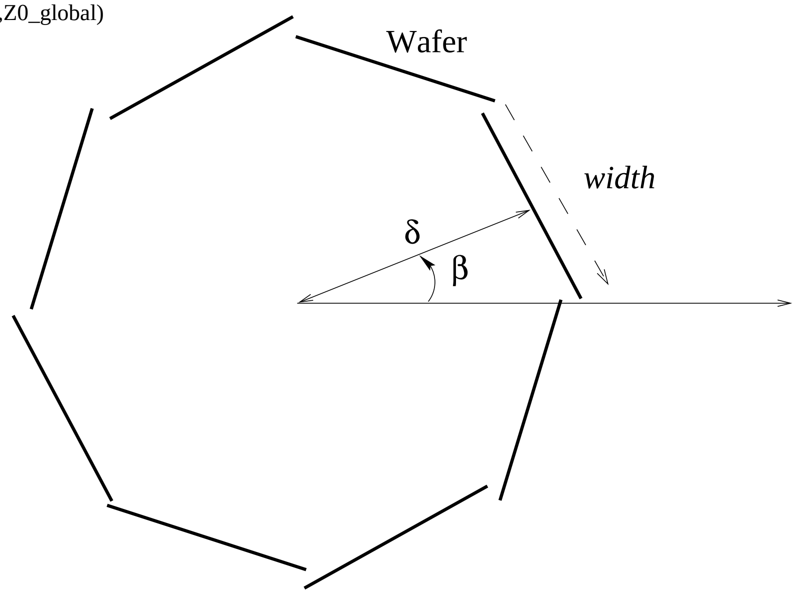
- Siblayers Layers for Silicon Barrel

  template **LayerSiB** (Max=30 total, max 30 per device)

  int **det**
  parent **SiBarrel**
  int **lyr**
  material **mat** material of layer

Silicon Barrel

Centered on (O,O,Z0_global)



Silicon Barrel input variables:

Beta is the angle in the x-y plane between the x axis and the center of the first wafer
Tilt is the rotatation angle of the wafer about the center point of the wafer
    tilt equals zero when beta is perpendicular to the plane
    tilt is positive for counterclockwise rotations - see next figure.

Delta is the distance from the origin to the wafer along beta

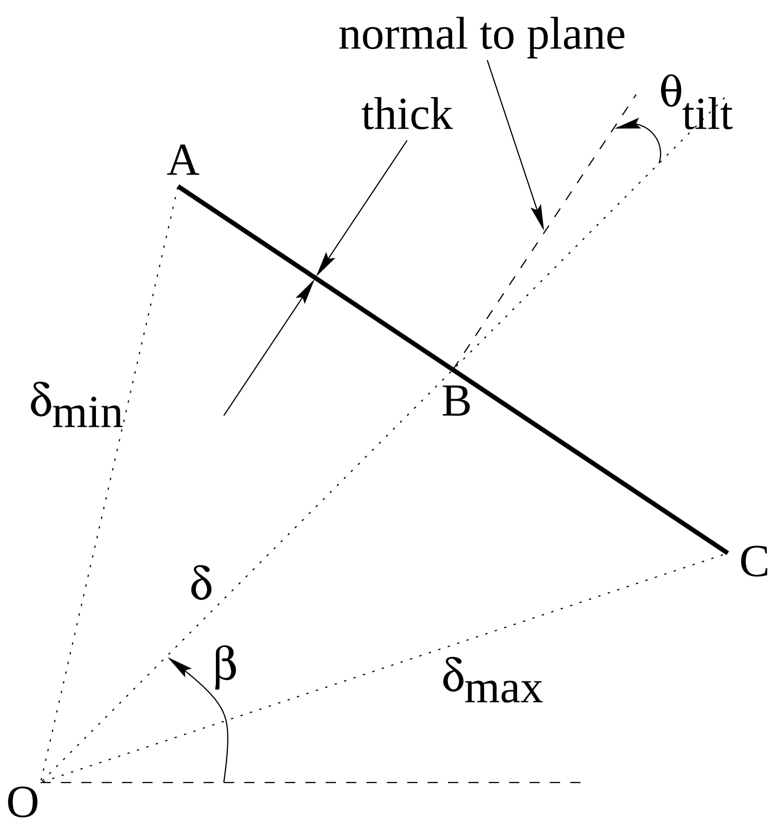
Width is the full width of the wafer

Z_length is full length of the wafer

Wafers can overlap if they are tilted.

The angle between the centers of adjacent wafers is 2π / nwafer

Figure 1: Silicon Barrel description, part 1 of 3. See the next figure for an important caveat about β.



.db file parameter beta = β

But, sib_par(idet).lyr(ily).wafer.(iw).beta = $\beta + \theta_{tilt}$

rplane_par(ipln).radius = $(\delta_{min} + \delta_{max})/2$

Figure 2: Silicon Barrel description, part 2 of 3. This figure shows additional elements found in the db file. It also shows some of the derived quantities which are stored in the silicon barrel and rplane include files.

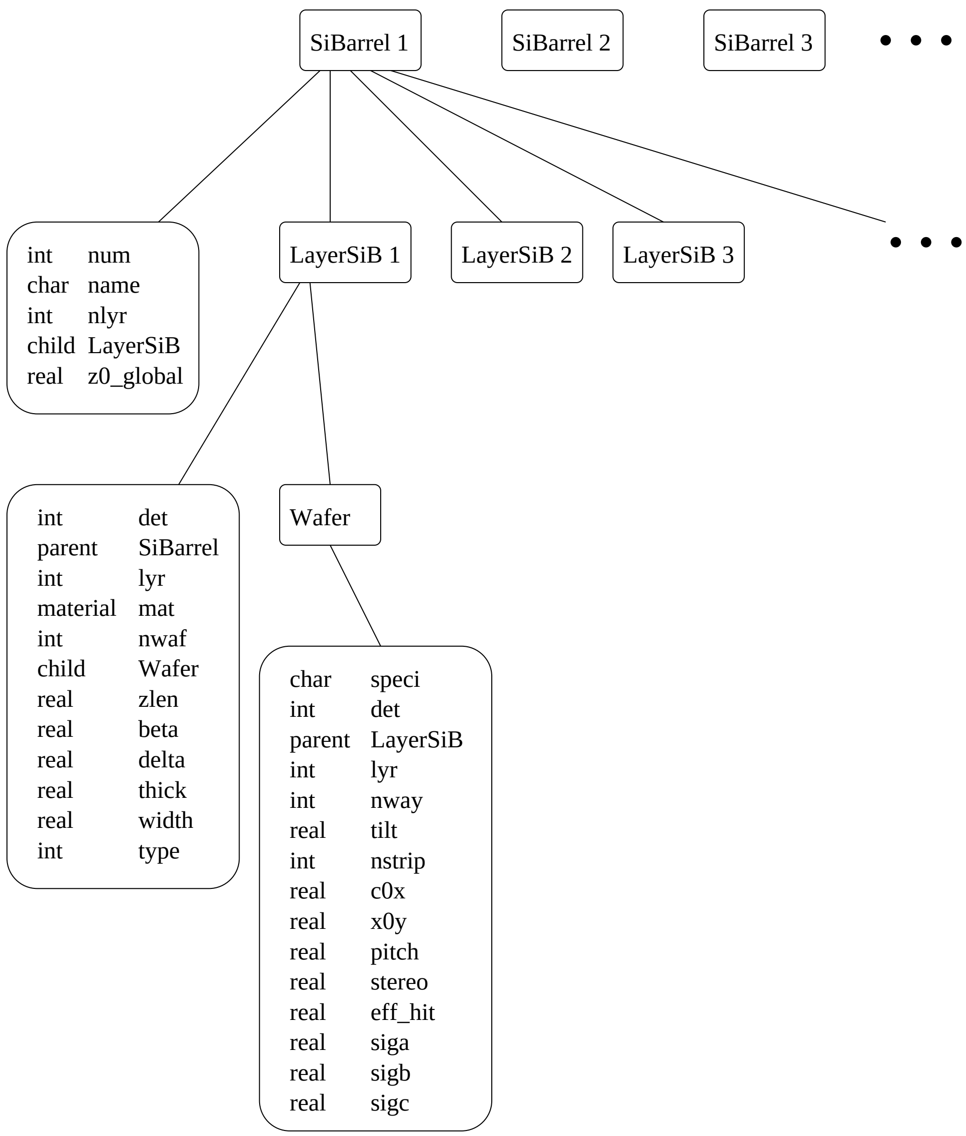


Figure 3: Silicon Barrel description, part 3 of 3. This figure shows a graphical representation of the various elements of the description of a silicon barrel detector.

int **nwaf** number of wafers in layer

child **Wafer**

real **zlen** full length in Z – all wafers in one layer have the same length

real **beta** phi angle from the x axis to the center of wafer(1) in the xy plane

real **delta** radial distance in x-y plane to the center of each wafer

real **thick** layer thickness

real **width** width of each wafer – wafers can overlap

int **type** type == 1= r/phi or stereo, 2 = z measurement only; you can use STEREO angle instead of type = 2

end template

include file $MCFAST_DIR/mcfast/inc/geom/sib_lyr_struct.inc

Silicon Barrel Wafers:

- Wafer

  Planes (or Wafers) that make up the layers in a silicon barrel detector. Wafers can overlap inside each layer.

  template **Wafer** (Max=200 total in db file, Max = 110 per layer)

  char **speci**

  int **det**

  parent **LayerSiB** Parent structure

  int **lyr** Parent layer

  int **nwaf** used only for speci=SPC, but ALWAYS present.

  real **tilt** positive tilt is counterclockwise

  int **nstrip** number of strips in layer

  real **c0x** distance from midpoint of wafer to strip number 0 (measured quantity corresponding to strip 0 in local coordinates)

  real **x0y** needed for z measurement– type = 2

  real **pitch** pitch of strips

real **stereo** stereo angle in radians of strips – relative to ϕ measurement

real **eff_hit**

real **siga** resolution in cm – see below

real **sigb**

real **sigc**

$\sigma = \sigma_a + \sigma_b \times |\cos\theta| + \sigma_c \times cos^2\theta$
$\cos\theta = pz/p$

end template

include file $MCFAST_DIR/mcfast/inc/geom/sib_plane_struct.inc

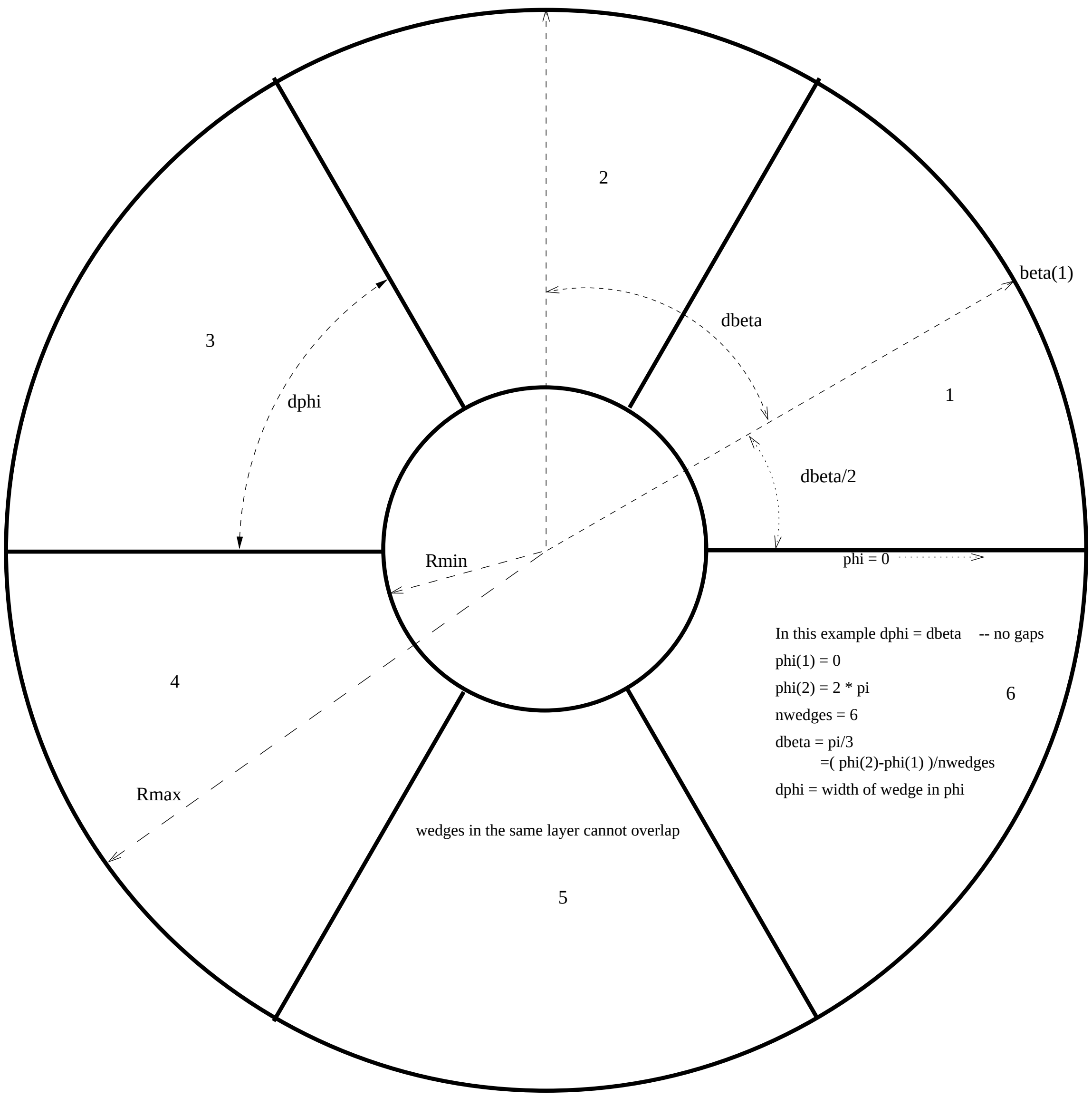


Figure 4: Silicon Disk description

Silicon forward disks Silicon forward disks are described by layers of non-overlapping wedges. (See figures 4, 5 and 6.) The disks are perpendicular to the z axis.

template **SiDisk** (Max=32)

int **num**

char **name**

int **nlyr**

real **zpos** Z posiiton of detector

end template

include file $MCFAST_DIR/mcfast/inc/geom/sicir_disk.inc, sicir_disk_struct.inc

Layers in Silicon Disks Detectors:

- Sidisk_layer
  Layers that make up the forward disk detectors

  template **LayerSiDi** (Max=80 , max = 80 per device)

  int **det** pointer to SiDisk device number

  parent **SiDisk** Parent structure

  int **lyr** layer number

  material **mat** material ("SILI" for example)

  int **nwed** number of wedges in this layer

  child **Wedge** Wedge structure

  real **z_local** z of layer relative to detector Z position

  real **thick** thickness of silicon in layer

  real **rmin** minimum radius (for type 1-3; distance to edge for type 4)

  real **rmax** maximum radius (for type 1-3: distance to edge for type 4) real **phi(2)** ϕ coverage of layer (0,2π) for full coverage

real **dphi** ϕ coverage of one wedge: $(\phi(2) - \phi(1))$/nwed for full coverage with no gaps. First wedge is centered at $\phi(1) + (\phi(2) - \phi(1))/2$nwed

int **type** measurment type

1 r measurement – code under development

2 phi measurement

3 U/V measurements– radial edges at rmin/rmax

4 U/V measurements– straight edges at rmin/rmax

end template

include file $MCFAST_DIR/mcfast/inc/geom/sicir_lyr_struct.inc

Wedges of silicon disk layers:

– Sidisk_wedge

Wedges in one layer cannot overlap. Strip number is calculated relative to an outer corner of the disk and should be positive. For positive stereo ($0 <$ stereo $< \pi/2$) nstrip counts from the outer corner at low phi.

template **Wedge** (Max=80 total in db file, Max= 80 per layer)

char **speci** "SPC" do define each one or "ALL" for all

int **det** SiDisk number

parent **LayerSiDi** Parent structure

int **lyr** layer number

int **nwed** wedge number: only used for speci="SPC", but ALWAYS present

int **nstrip** number of strips on wedge

real **c0_r** – width of dead region in R

– will make symmetric dead regions at inner and outer edge

real **c0_phi** – width of dead region in phi

– will make symmetric dead regions at phi edges

real **pitch** strip pitch

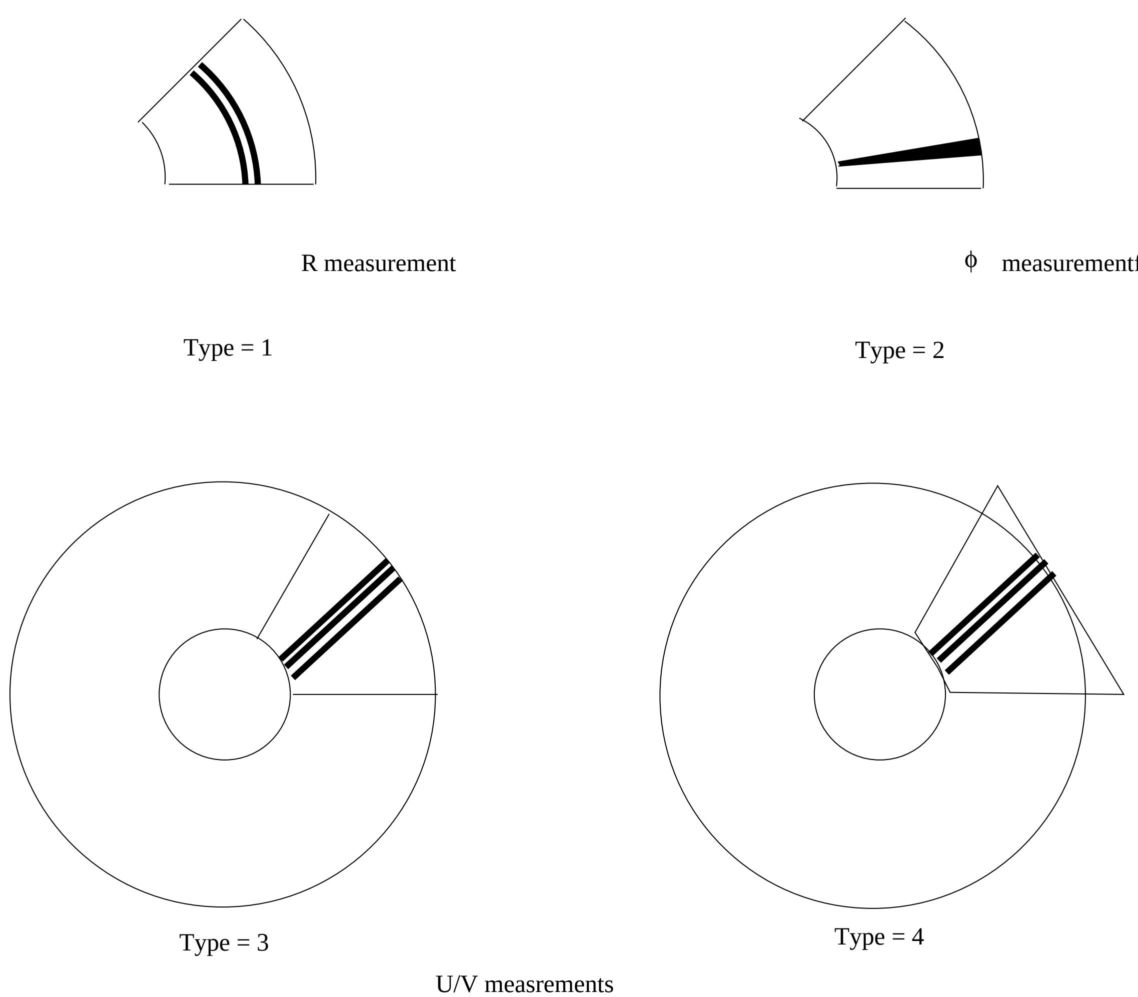


Figure 5: Silicon Disk Types

real **stereo** stereo angle in radians– for type 3 and 4 only

real **eff_hit** hit efficiency

real **siga** – type 2 in radians

real **sigb**

real **sigc** $\sigma = \sigma_a$ in cm for type 3-4, in radians for type = 2

end template

include file $MCFAST_DIR/mcfast/inc/geom/sicir_wedge_struct.inc

At present only siga is used in trk_make_sidisk_hit.F.

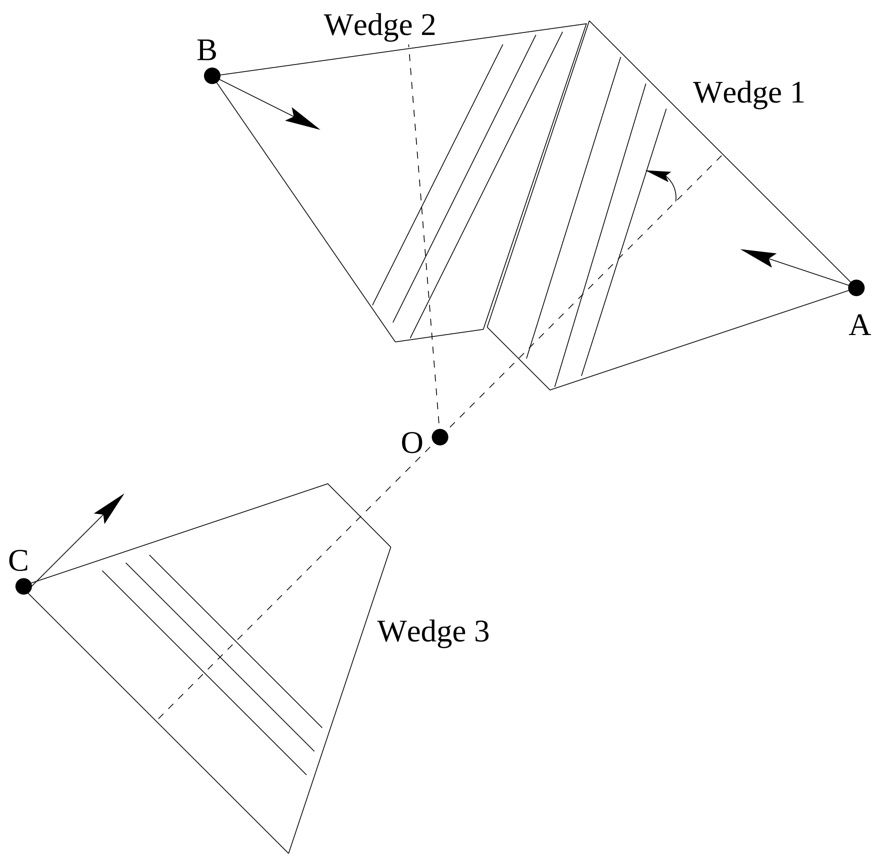


Figure 6: Coordinate systems for forward silicon detectors of wedge type 4. The figure shows cartoons of three wedges in the xy plane. The point labelled O is the beam spot. The dashed lines show the center lines of the wafers. The solid lines show several of the sense strips on the wafers. The curved arrow on wedge 1 shows the sense of a positive stereo angle, clockwise wrt the center line; wedge 1 shows an example of a positive stereo angle and wedge 2 shows an example of a negative stereo angle. Wedge 3 shows a stereo angle of $+90°$. The point A and the arrow attached to it show the orgin of the coordinate system and the positive sense of measurements for wedge 1. Similarly the points B and C show, respectively, the origins and positive sense for wafers 2 and 3.

Silicon planes (xy) Planar Silicon detectors are described by rectangular surfaces perpendicular to the z axis. These detectors can be strips or pixels.

template **SiXY** (Max=100)

> int **num** station number
>
> char **name** station name
>
> int **nly** number of layers in each station
>
> child **LayerSiXY**
>
> real **zpos** z postion of station

include file $MCFAST_DIR/mcfast/inc/geom/sixy_disk.inc, sixy_disk_struct.inc

end template

Silicon xy plane layers:

- Sixy_layer

  template **LayerSiXY** (Max = 500 total, max = 100 per device)

  > int **det** station id
  > parent **SiXY**
  > int **lyr** layer id
  > material **mat** material
  > real **z_local** local z position relative to station position
  > real **thick** layer thickness
  > real **stereo** stereo
  > int **type** type
  > real **eff_hit** efficiency
  > real **xmin** x min of layer
  > real **xmax** x max of layer
  > real **xmin_gap** x min of gap

real **xmax_gap** x max of gap

int **nsegm_x** number of strips or pixels in x

real **pitch_x** pitch of pixels in x

real **coord0_x** local coordinate 0 for x

real **sigma_x** resolution in x (see below)

real **ymin** y min of layer

real **ymax** y max of layer

real **ymin_gap** u min of gap

real **ymax_gap** y max of gap

int **nsegm_y** number of segments in y

real **pitch_y** pitch in y

real **coord0_y** local coordinate 0 for y coordinate

real **sigma_y** resolution in y (see below)

end template

include file $MCFAST_DIR/mcfast/inc/geom/sixy_disk_layer_struct.inc

If either sigma_x or sigma_y is negative, then the user routine usr_siz_rect_res.F will be called to compute the measurement and the error on the measurement. This hook can be used, for example, to generate clusters of hit strips rather than just throwing a gaussian resolution.

Silicon Rectangular Z-Planes (SiZRect) Planar Silicon detectors can also be described by rectangular surfaces (silicon wafers) perpendicular to z axis but not nesseceraly centered about z axis. Wafers form a layer; layers form a station. For the purpose of tracking wafers are treated as infinitessimally thin objects. However the description of the wafer does include a thickness, which is only used in the computation of the expected multiple scattering and energy loss; these are applied as if they occured at the infinitessimally thin plane.

template **SizRect** (Max=100)

int **num** station number

char **name** station name

int **nlayers** number of layers in the station

child **LayerSizRect**

real **xpos** x-position of station's center (in global coordinate system)

real **ypos** y-position of station's center (in global coordinate system)

real **zpos** z-position of station's center (in global coordinate system)

end template

include file $MCFAST_DIR/mcfast/inc/geom/siz_rect.inc, siz_rect_struct.inc

Silicon rectangular layers :
Layers that make up the rectangular silicon detectors. A layer may have a rectangular inner gap. The gap's center coincides the center of layer. Three types of gaps are supported - X, Y, and window (see note below). A layer may be tilted about z axis. Layers are build from wafers. Wafers may overlap in x and/or y inside each layer if there is no gap or there is a gap of type x or y. For a layer with window-type gap overlapping wafers are not allowed. See figure 7. The first wafer in each layer is laid in the upper left corner. Ordering of wafers goes across the layer in x, then down in y. Wafers may be tiled, i.e. z-position of each tile in layer may be different from average z-position of layer. See figure 8 and description of wafers below.

- Siz_rect_layer

  template **LayerSizRect** (Max=500, max=20 per device)

    int **det** station id

    parent **SizRect**

    int **lyr** layer id

    int **nWaferX** number of segments along x-direction

    int **nWaferY** number of segments along y-direction

    real **zLayerLocal** local z-position of layer relative to station position

    real **rotation** rotation of layer about z axis

    real **Xlen** layer full length along x

    real **Ylen** layer full length along y

    real **GapXlen** full width along x of gap in layer (see note below)

    real **GapYlen** full width along y of gap in layer (see note below)

    char **StaggeringPattern** may be either "X", "Y", "CH", or "NONE". "X"-pattern means that wafers in x-row are tiled while wafers in y-column are at the same z. "Y"-pattern means that wafers in y-column are tiled while wafers in x-row are at the same z. "CH" means a checkered board pattern. "NONE" means that all wafers in the layer are at the same z.

  end template

  Note: In order to specify X-gap there should be **GapXlen>0** and **GapYlen=Ylen**; for Y-gap there should be **GapXlen=Xlen** and **GapXlen=Xlen**; for window-gap one should specify **0<GapXlen<Xlen** and **0<GapYlen<Ylen**.

  include file $MCFAST_DIR/mcfast/inc/geom/siz_rect_layer_struct.inc

Silicon rectangular wafers :
Wafers that make up layers. One may suggest that all wafers in the layer are identical and specify only one wafer with the keyword "ALL". However, a possibility to define a specific wafer is reserved; in this case the keyword should be "SPC". Specific wafers must be defined **after** "ALL"-type wafers.

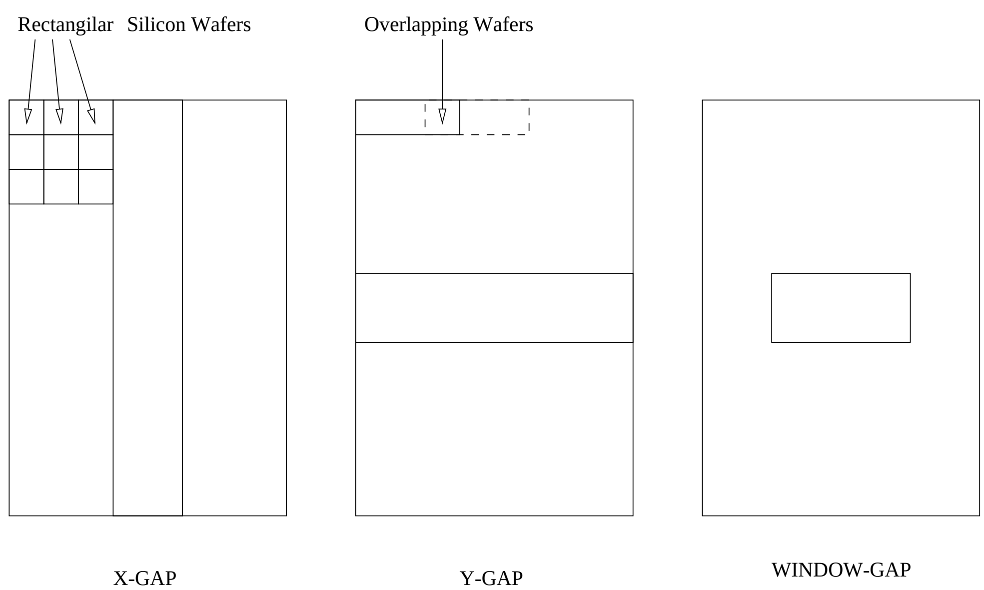


Figure 7: Rectangular Silicon Layers with Gaps (front view)

Z-position (relative to z of layer) of first wafer is specified by zOffset which may be either negative, positive, or zero (i.e. all wafers in the layer are at the same z); absolute value of zOffset is the distance between z-center of wafer and nominal z of layer. In case of identical wafers Z-positions of other than first wafers are calculated with respect to zOffset and StaggeringPattern specified for given layer. In case of specific wafer z-position is defined directly by zOffset.

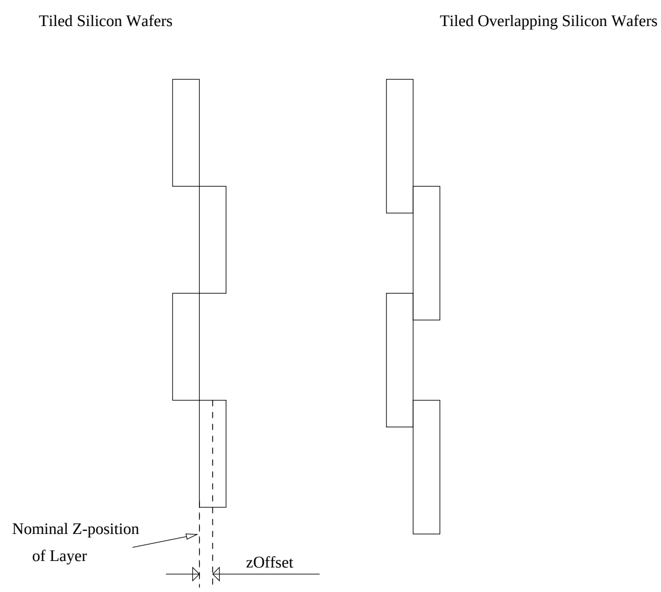


Figure 8: Tiled Silicon Wafers (side view)

- Siz_rect_wafer

  template **WfrSizRect** (Max=500, max=200 per layer)

  char **speci** defines whether it's a specific wafer ("SPC") or all wafer wafers are identical ("ALL")

  int **det** station id

  parent **LayerSizRect**

int **lyr** layer id

int **waferX** wafer id along x (in layer coordinate system); ignored for "ALL"-wafer, should be non-zero for "SPC"-wafer

int **waferY** wafer id along y (in layer coordinate system); ignored for "ALL"-wafer, should be non-zero for "SPC"-wafer

int **type** 1=pixel, 2=strips

material **mat** (for example, "SILI")

real **eff_hit** efficiency

real **stereo** strips orientation wrt x axis

real **Xlen** length of wafer along x

real **Ylen** length of wafer along y

real **Xlen** z-thickness of wafer

real **zOffset** z-position of fisrt("ALL") or given("SPC") wafer relative to nominal z of layer

int **nsegm_x** number of strips or pixels along x

real **pitch_x** pitch of strips of pixels in x

real **coord0_x** local coordinate of first strip of pixel for x

real **sigma_x** resolution in x (see below)

int **nsegm_y** number of strips or pixels along y

real **pitch_y** pitch of strips of pixels in y

real **coord0_y** local coordinate of first strip of pixel for y

real **sigma_y** resolution in y (see below)

end template

include file $MCFAST_DIR/mcfast/inc/geom/siz_rect_wafer_struct.inc

If either sigma_x or sigma_y is negative, then the user routine usr_siz_rect_res.F will be called to compute the measurement and the error on the measurement. This hook can be used, for example, to generate clusters of hit strips rather than just throwing a gaussian resolution.

Solenoid magnet

template **Solenoid** (Max=10)

- char **name** Name
- real **bfield** Magnitude of B -field
- real **rmin** minimum radius of solenoidal field (should be 0.0)
- real **rmax** maximum radius of solenoidal field
- real **z0** Central z position of field region
- real **zlen** length in Z
- material **mat_fill** material inside solenoid (not used)
- real **thick_boun(4)** boundary thickness at rmin=0 , rmax(coil), zmin =0, zmax =0
- material **mat_boun(4)** material at boundary rmin=' ', rmax(coil material), zmin=' ', zmax=' '

include file $MCFAST_DIR/mcfast/inc/geom/solenoid.inc

end template

3 The Include files

Silicon barrel detectors The include files listed below show the structures which describe a silicon barrel detector; see figures 1 and 2. Recall that the parameter β means one thing in the .db file and another in the data structures below. (The description of the .db file begins on page 17.) Finally, figure 9 shows the relationships between the structures which describe a complete silicon barrel detector.

include file: $MCFAST_DIR/mcfast/inc/geom/si_barrel.inc, si_barrel_struct.inc

structure /si_barrel_struct/ (Max=15)

integer **numlyr** Number of layers

integer **nchan** Total number of channels

record /sib_lyr_struct/ **lyr(max_sib_lyr)** Layer parameters

character*40 **name** Name of device

real **z** Global z-position of center of device

end structure si_barrel_struct.inc

template file: $MCFAST_DIR/mcfast/db/sibarrel.db

include file: $MCFAST_DIR/mcfast/inc/geom/sib_lyr_struct.inc

structure /sib_lyr_struct/ (Max=30)

integer **numplane** Number of planes in the layer

integer **nchan** Number of channels in this layer

integer **chan0** Channel number of 1st strip

record /sib_plane_struct/ **plane(max_sib_plane)** Parameters of each plane in the layer

end structure

template file: $MCFAST_DIR/mcfast/db/siblayers.db

include file: $MCFAST_DIR/mcfast/inc/geom/sib_plane_struct.inc

structure /sib_plane_struct/ (Max=110)

- integer **type** 1 = r-phi measurement; 2 = z measurement
- real **dmin** dmin of plane (in r-phi direction)
- real **dmax** dmax of plane (in r-phi direction)
- real **zmin** zmin of plane
- real **zmax** zmax of plane
- real **beta** Angle between normal to plane and x axis
- real **xpos(3)** Center of wafer.
- real **eta(3)** Direction cosines of normal to plane
- real **delta_min** Minimum distance from origin to edge of plane
- real **delta_max** Maximum distance from origin to edge of plane
- real **thick** Thickness of plane
- real **tilt** Tilt angle for plane
- real **eff_hit** Hit efficiency
- real **siga** Constant a in resolution formula
- real **sigb** Constant b in resolution formula
- real **sigc** Constant c in resolution formula
- integer **material** Material composing plane
- real **coord0_x** Local x-coordinate of strip 0
- real **coord0_y** Local y-coordinate of strip 0
- real **pitch** Spacing of strips
- integer **nstrip** Number of strips in this plane
- integer **nchan** Number of channels in this plane
- integer **chan0** Channel number of the 1st strip in plane

real **stereo** Stereo angle in rad

real **cos_stereo** cos(stereo)

real **sin_stereo** sin(stereo)

end structure

template file: $MCFAST_DIR/mcfast/db/wafer.db

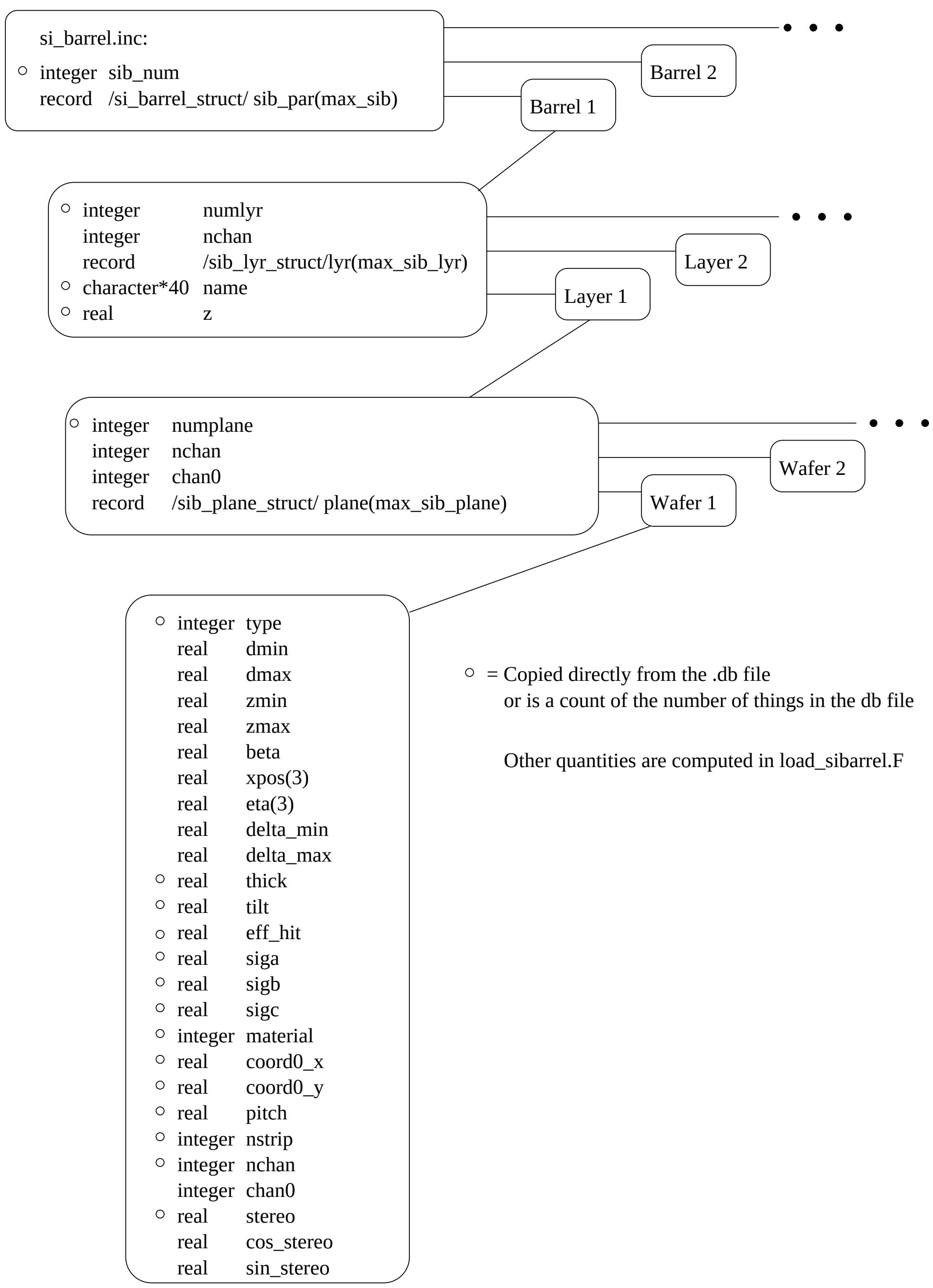


Figure 9: Silicon Barrel description. This figure shows the relationships between the elements which describe a silicon barrel detector.