

IFR naming and numbering schemes¹

A. Calcaterra, Lab. Nazionali di Frascati, INFN

1. Definitions

The IFR detector is divided into a **Barrel** and two **Endcaps**, a **Forward** one (in the direction of the Y_{4s} boost) and a **Backward** one. The layout of the detector in IR2 is shown in Figure 1.

The Barrel is made of 6 sections around ϕ : looking at the forward face of the detector from the outside in (looking N in Figure 1) sections are numbered from 0 to 5, clockwise, section 0 being the topmost one. Each section, divided in an inner and an outer sextant, houses 19 detection layers parallel to the beams: they are held by the iron structure as shown in Table 1.

Both Endcaps are divided in two halves, called from now on **FED** (**F**orward **E**ast **D**oor), **FWD**, **BWD** and **BED**. Each half has an upper section (**Top**), a lower one (**Bottom**) and a **Middle** one, as well as an inner and an outer part (see Table 2). Each section houses 18 detection layers orthogonal to the beams.

Generic slots in the IFR may have not only the same shape but also the same dimensions: in this case they belong to the same group, called an **Envelope**. They have a rectangular shape in most of the Barrel, and an approximately trapezoidal shape in the Endcaps.

Each slot in the iron contains a **Chamber**, made out of independent detector elements called **Modules**. A chamber in a Barrel envelope contains **three** modules, usually identical. A chamber in an Endcap envelope contains **two** modules: a **short** one and a

¹This note will be regularly updated, and the last version will be available at SLAC in `~acal/ifrdoc.ps`. Please consult it often to have always the latest information, and send your comments to "acal@Inf.infn.it".

long one in the Top or Bottom envelopes, two specular ones in the Middle envelope.

All dimensions given in this note are in mm.

2. Barrel IFR

2.1. Envelopes

Envelopes in the inner 18 layers of the Barrel IFR have the rectangular shape shown in Figure B1. The Z dimension is parallel to the beamline. The shapes of envelopes in layer 19 are quite irregular, and will not be given here. The dimensions of envelopes in layers 1-18 are given in Table B1.

Envelope names have four characters, and are of the type **CEnn**, where “**CE**” means “central envelope” (“**B**”, which would be a typical assignment for “Barrel” has been reserved for the “Backward” Endcap, see 3.1 below), and **nn** is a number from 01 to 19.

2.2. Layers and chambers

Layer numbers range from 1 (innermost layer) to 19 (outermost layer). Every layer in the Barrel consists of the 6 slots in the 6 φ sections at the same radial distance from the beam line. So one layer contains exactly 6 chambers.

The type of these 6 chambers is the same as that of the envelope to which the layer belongs (“CE01” to “CE19”), and the individual chambers in layer “**nn**” are called “**C0nn**” through “**C5nn**”, consistently with the above given BABAR rule for numbering sextants. We distinguish between chamber **type** (“CE01” to “CE19”) from chamber **name** (“C0nn” to “C5nn”) and chamber **ID**: this last one is assigned during chamber construction and goes from “**B001**” to “**Bxxx**”.

When referring to the **position** of individual modules into an already built chamber, we will call respectively “**position 1**” and “**position 3**” the ones covering the negative and positive Z semi-axes, according to the general BABAR convention, and “**position 2**” the one in between, covering both semi-axes.

2.3. Modules

There are 25 module types² in the IFR Barrel. Module types have the same name of the chamber (“CE01” up to “CE19”) which they form. Individual modules will be referred to according to the ID assigned in the database (“IFR001” up to about “IFR900”).

There is no “coded” correspondence between a particular ID and the precise position of the corresponding module in the IFR, to leave the chamber builders free to choose between all modules of a same type. The precise location in the detector of a module corresponding to a given ID will be stored both in the “construction” Xcel database and in the final PEP-II Oracle system (BABAR-wide).

Modules have the same *generic* shape of the envelope to which they belong. Module dimensions are shown in Table B2. The numbers in these Tables do not take into account cutting chamber corners, to allow space for HV gas connections. For *precise* shapes and dimensions refer to the appropriate drawings in the Appendix³.

Please note that in Table B2 the coordinate A_1 is parallel to Z in Figure B1, and to the beamline, while A_2 is parallel to A in Figure B1 and orthogonal to the beamline.

2.4. Strip layers

The **M(odule)-longitudinal** strips are glued on the modules directly at the factory: when installed into the detector, they will measure the direction along the beamline. Their width is 36.5 mm, and the gap between strips is 2 mm, for a total pitch of 38.5 mm: there are 32 longitudinal strips on every module, for a strip layer width of 1232 mm. They will end up being **D(etector)-transverse**.

The **M-transverse** strips will be glued across 3 barrel modules when chambers will be laminated at the SLAC facility, becoming **D-longitudinal** strips: they will measure the ϕ angle around the barrel, and will have variable widths and pitches (see Table B3), to give exactly 96 ϕ strips in each barrel layer.

2.5. Strip Numbering

The general rule⁴ is as follows:

- Strips measuring the direction along the beam (Z-strips) number from 1 to 96 going from the Backward Door to the Forward

² Modules in layer 18 belong to one of 2 subtypes, modules in layer 19 to one of 5.

³ The Appendix is too big to be kept on disk, a paper copy will be handed on request.

⁴ As defined by N.Cavallo, D.Piccolo (internal memo, Naples, January 1997)

Door: along the positive Z direction, Z-strip numbers **increase**. Strips 1 to 32, and odd strips from 33 to 63 are read out on the Backward side of the Barrel, even strips from 34 to 64, and all strips from 65 to 96 are read out on the Forward side of the Barrel.

• Strips measuring the ϕ angle, when seen from the forward, **increase** from 1 to 96 **counterclockwise** in the **top** sextants (5,0,1). So ϕ -strip numbers increase with ϕ in sextants 5,0,1. In the bottom sextants (2,3,4) instead ϕ -strip numbers **decrease** as ϕ increases: going from strip 1 to strip 96, they run **clockwise**. Odd strip numbers are read out on the Backward side of the Barrel, even strip numbers are read out on the Forward side.

Exceptions to this rule are:

1. For layers **1** and **5**, the read out **direction** for ϕ strips is the same as for all other layers, but even strip numbers are read out on the Backward side of the Barrel, and odd strip numbers are read out on the Forward side.
2. For layer **1**, additionally, odd Z strips 33 to 63 are brought out on the Forward side, while even Z strips 34 to 64 are brought out on the Backward side.
3. Layer 19: ϕ -strips are normal, as well as Z-strips 33 to 64; Z-strips from 1 to 32 and from 65 to 96 are divided longitudinally in 3 segments: segment A at low- ϕ , segment B at mid- ϕ and segment C at high- ϕ .

3. Endcap IFR

3.1. Envelopes

There are 27 distinct envelopes in the F.E. and 15 in the B.E., for a total of 42. Envelope names have four characters: the first one (**F** or **B**) identifies the particular Endcap, the second one (**T**, **M** or **B**) the Top, Middle or Bottom section of that Endcap. The remaining two characters are a progressive number. Every envelope contains exactly one chamber made of two modules.

Envelopes in the **T** and **B** class have the generic shape shown in Figure E1. Their names and dimensions, according to the above scheme, are given in Tables E1 and E3 (Forward Endcap) and E4 and E6 (Backward Endcap).

Envelopes in the **M** class have the generic shape shown in Figure E2. Their names and dimensions are given in Table E2

(F.E.) and E5 (B.E.). **All envelopes in both Endcaps have H = 1852.**

3.2. Layers and chambers

Layer numbers range from 1 (innermost layer) to 18 (outermost layer). Every layer in the Forward or Backward Endcap is made out of two halves, and each half contains 3 envelopes and 3 chambers. The chambers in the right or left half of a particular layer are shown in Tables E7 (Forward Endcap) and E8 (Backward Endcap). When referring to the **position** of individual modules into an already built chamber, we will call “**position 2**” the topmost one, and “**position 1**” the lowermost one (closer to the floor of the experimental hall).

3.3. Modules

There are 25 distinct module types in the F.E. and 23 in the B.E., for a total of 48. Module names have four characters: the first one (**F** or **B**) identifies the particular Endcap. The second one is **M** for the Middle section and **S** (short, small) or **L** (long, large) for the Top and Bottom sections. The last two characters are a progressive number.

When context requires, one additional letter (“**L**” or “**R**”) will identify the **chirality** of the module, defined as follows: looking at the (more or less trapezoidal) module from the side to which HV is connected (or, which is the same, the side with longitudinal strips), and with the longer base below the shorter base, a module is “**R(ight)**” if the diagonal cut at 60° is on the right, and “**L(eft)**” if the cut is on the left.

With this convention, both modules in Figure E1 would be “**R**” (assuming one is looking at the HV side). When looking at Figure E2 instead, (facing the HV side as before) module A (in position 2) would be “**R**” and module B (in position 1) would be “**L**”.

Figures E5 and E6 show the correct positioning of Left and Right modules in both doors: with this choice, all modules will be oriented having the HV side, carrying **horizontal** strips, toward the **outside** of the detector, and resting, or actually forced, against an iron surface. The GND side, with **vertical** strips, will be facing the **inside** of the detector, and will be separated from the next iron plate by a gap, in which the front-end cards will fit.⁵

⁵ Layer 18 in the Backward door is an exception to this rule: the whole layer faces the other way.

Modules in the **T** or **B** envelopes have the same *generic* shape of the envelope to which they belong, see Figure E1. For modules in the M envelopes, compare Figures E3 and E4. **All modules in both Endcaps have H = 921.**

Names and dimensions of modules are shown in Tables E9 (Forward Top and Bottom), E10 (Forward Middle), E11 (Backward Top and Bottom) and E12 (Backward Middle). Here too, the four corners are cut to leave space for HV and gas connections, and precise data are given in the drawings in the Appendix.

The modules in the right or left half of a particular layer are shown in Tables E13 (Forward Endcap) and E14 (Backward Endcap).

3.4. Spares

According to Tables E9 through E12, a slightly smaller module can be used as an acceptable spare for a slightly bigger one. This, in order to keep the number of spare modules to build close to 10% of the needed modules in the detector and to avoid leaving some less represented module type without a spare. The number of spares to build (for the 432 “official” modules in the endcap) is 48, bringing the total number of endcap modules to 480.

3.5. Strip layers

The longitudinal strips are glued on the HV side of the modules in Frascati: when installed into the detector, they will measure the vertical position of hits. Their width is 26.4 mm, and the gap between strips is 2 mm, for a total pitch of 28.4 mm: there are 32 longitudinal strips on every module, for a strip layer width of 908.8 mm.

The transverse strips will be glued across 2 modules, and on the Ground side, when chambers will be laminated at the SLAC facility: they will measure the horizontal position of hits, and have width and pitch of 36 and 38 mm.

There are at most 64 vertical strips in chambers in the Top and Bottom regions; when the maximum length of a given chamber is greater than $(64 \cdot 38) = 2432$ mm, some dead space is left in the chamber noses.

3.6. Strip numbering

3.6.1. Horizontal strips

Horizontal strip panels are glued on the HV side of the end-cap RPC's, as the ϕ strip panels in the barrel: individual strips are numbered from 1 to 32 in a module, and from 1 to 64 in a chamber, going from the acute corner to the obtuse one. This means that H-strip numbers always **increase** going **away** (either up or down) from the detector horizontal centerline.

There are **two** exceptions to this rule.

3.6.1.1. Exception 1

For chambers with ID's E001 up to E011 the contrary happens: H-strip numbers go from 1 to 64, going from the obtuse corner to the acute one, so they increase going towards the detector centerline.

3.6.1.2. Exception 2

Central chambers, of the "FMxx" or "BMxx" type, are cabled both ways: one half of H-strip numbers runs 1 to 32 going away from the centerline; the other half runs 33 to 64 going (again) away from the centerline, in other terms strips 1 and 33 are contiguous. For the Forward East door and the Backward West door, strips 1-32 are in the top half chamber. For the Forward West and the Backward East, they are in the lower half chamber.

3.6.2. Vertical strips

Vertical strip panels are glued onto the GND side of the end-cap RPC's, as the Z strip panels in the barrel: individual strips are numbered from 1 to 64 in a chamber.

3.6.2.1. Trapezoid chambers

Strip numbers increase from the 90° angles towards the 60°/30° ones. This means that V-strip numbers always **increase** going **away** (either left or right) from the detector centerline.

3.6.2.2. Central chambers

These have a variable number of V-strips, as well as a variable offset between the chamber innermost boundary and the first V-strip. See Tab.E15. Additionally, Middle chambers for the Backward door may have one of 2 possible configurations, described

as Type 1 or Type 2 in Tab.E15. The IFR database contains information about which one for a given chamber.

4. Database

The geometric files containing all details are accessible via WWW, but for their display (or modification) Autosketch version 1.0 or 2.1 is needed. Available as well is:

1. this note, as original Word or Postscript, in both Letter and A4 formats.
2. The database containing construction info on chambers, modules and Bakelite sheets, and also test summaries.
3. The database containing all test results and a few Xcel macros useful for obtaining histograms and plots.

A number of WWW forms have been written to facilitate maintenance and display of results. Feel free to visit

http://pccalcaterra.Inf.infn.it/WWW_ifr/

giving "ifrgroup" as username and "ckmckmckm" as password.

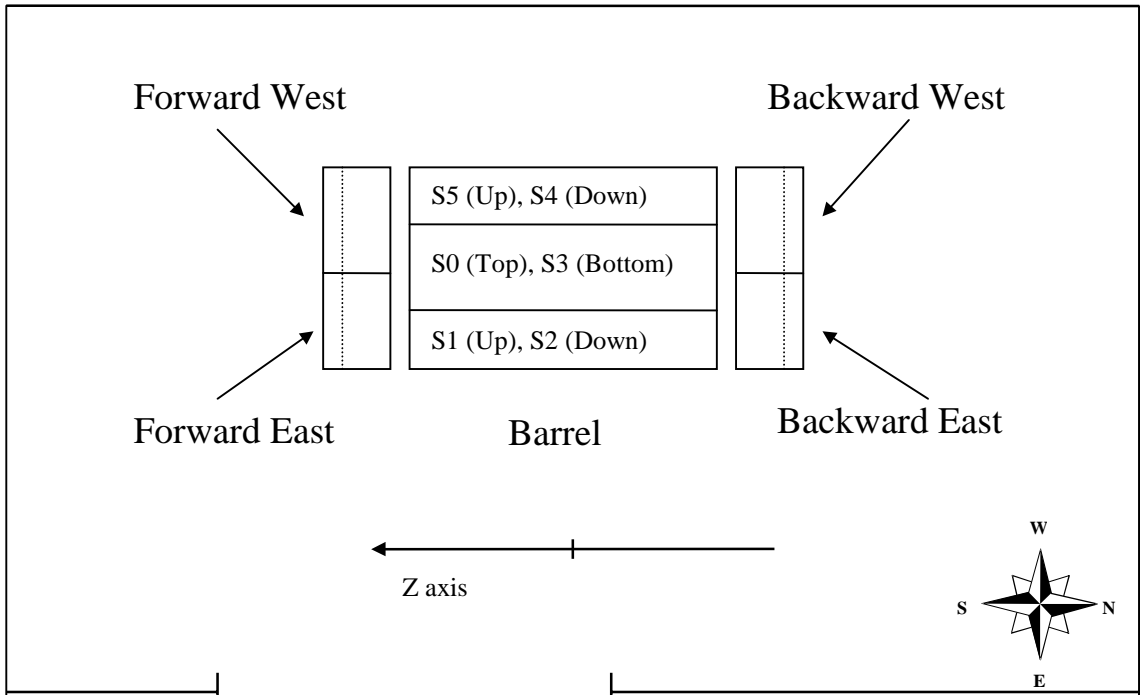


Fig.1. Layout of the Exp. Hall

Tab.1. Layers and gaps in the Barrel

Layers	Top Sextants (5,0,1)	Bottom Sextants (2,3,4)
1	Hanging from inner surface of inner sextants.	Resting on inner surface of inner sextants.
2 → 16	Resting in gap in inner sextants.	Resting in gap in inner sextants.
17	Resting on outer surface of inner sextants.	Resting on inner surface of outer sextants.
18	Resting in gap in outer sextants.	Resting in gap in outer sextants.
19	Resting on outer surface of outer sextants.	Resting on metal plates welded to BABAR cradle.

Tab.2. Layers and gaps in the Endcaps

Layers	Forward Door	Backward Door
1→ 12	Inside inner door gaps	Inside inner door gaps
13	In gap between inner and outer sections	In gap between inner and outer sections
14→ 17	Inside outer door gaps	Inside outer door gaps
18	Outside outer door	Outside outer door

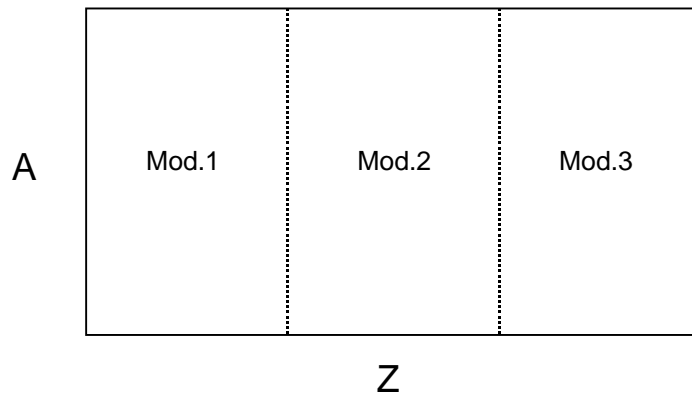


Fig. B1. Shape of a Barrel Envelope in layers 1–18.

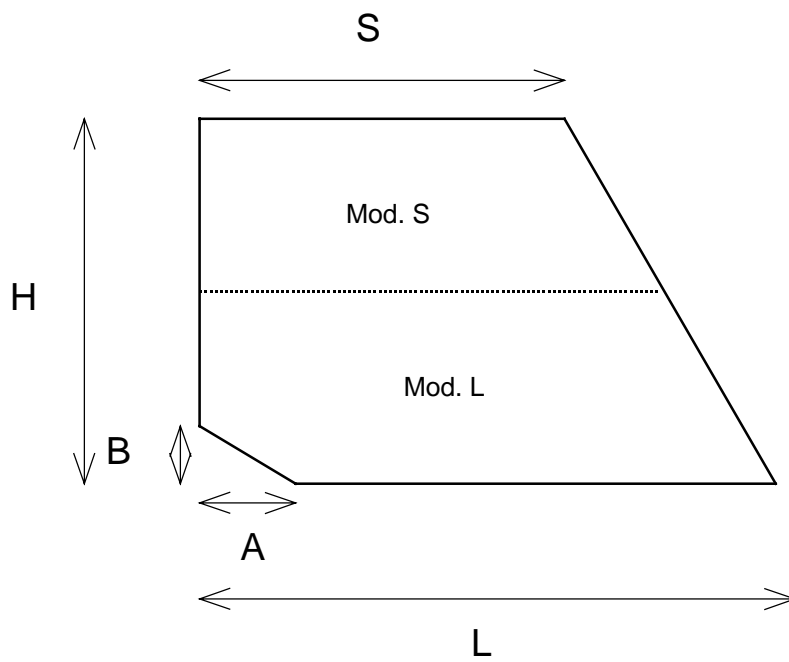


Fig. E1. Generic shape of an Endcap **T** or **B** envelope.

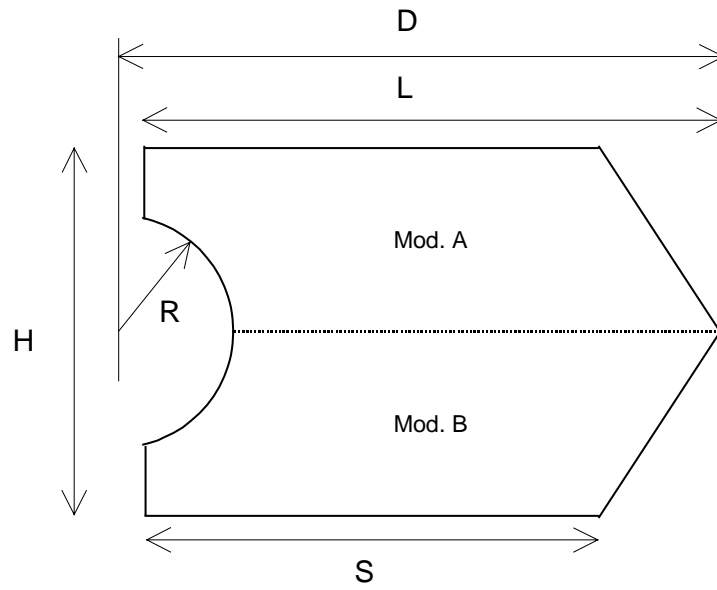


Fig. E2. Generic shape of a Forward Endcap **M** envelope.

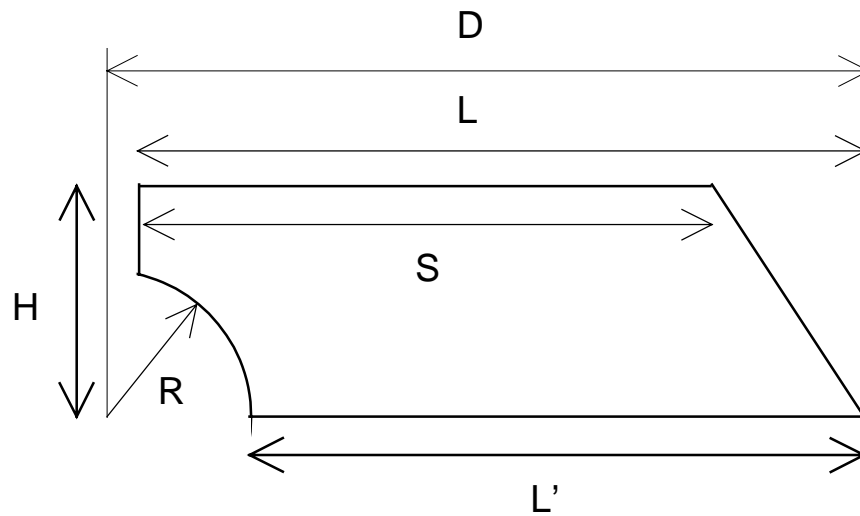


Fig. E3. Generic shape of a Forward Endcap **M** module.

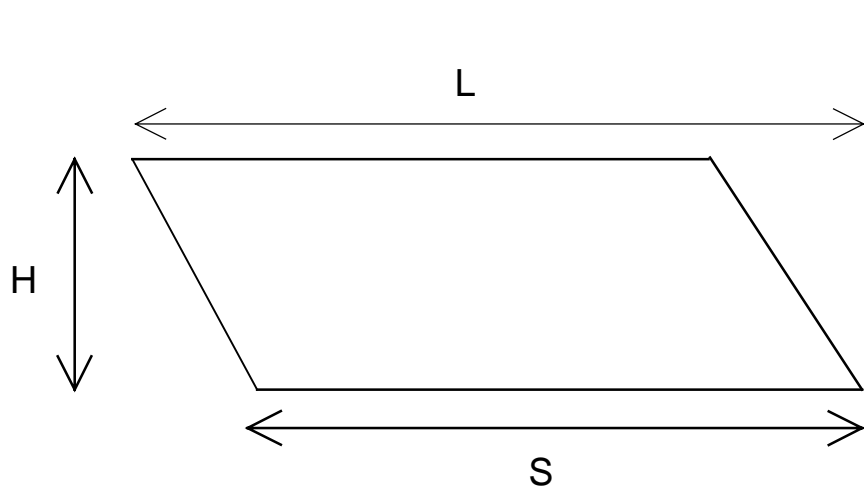


Fig. E4. Generic shape of a Backward Endcap **M** module.

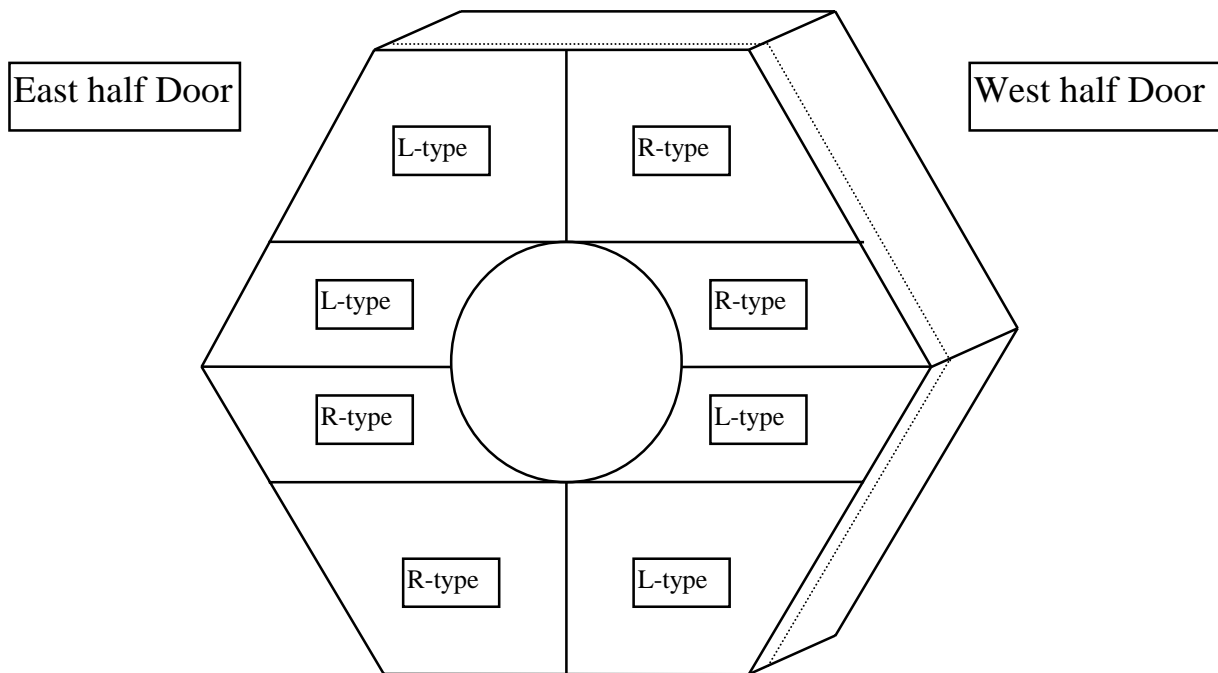


Fig. E5. Backward Door, seen from outside (looking South)

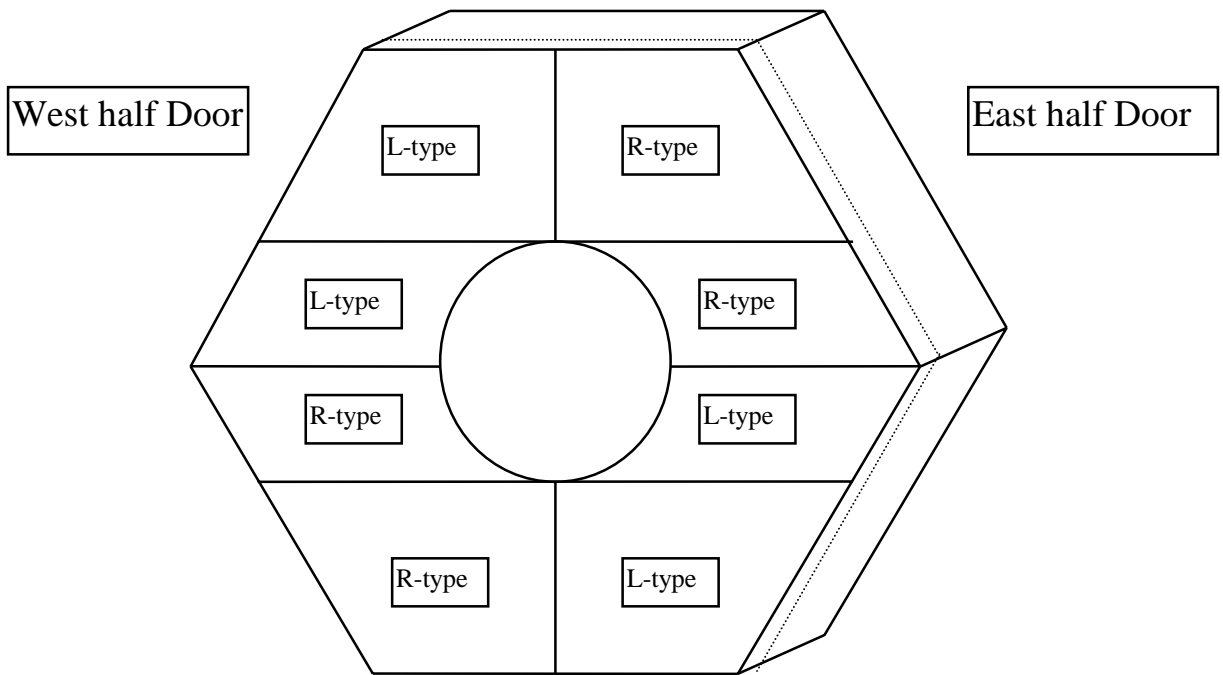


Fig. E6. Forward Door, seen from outside (looking North)

Tab. B1. Envelopes in the IFR Barrel, layers 1-18

Name	Z	A	Layer
CE01	3740	1918	1
CE02	3740	1976	2
CE03	3740	2039	3
CE04	3740	2103	4
CE05	3740	2166	5
CE06	3740	2230	6
CE07	3740	2293	7
CE08	3740	2357	8
CE09	3740	2420	9
CE10	3740	2484	10
CE11	3740	2559	11
CE12	3740	2630	12
CE13	3740	2702	13
CE14	3740	2773	14
CE15	3740	2868	15
CE16	3740	2963	16
CE17	3740	3027	17
CE18	3340	3134	18

Tab. B2. Modules in the IFR Barrel, layers 1-18

Name	A ₁	A ₂	Layer	N. needed	spares
CE01	1243	1908	1	18	2
CE02	1243	1966	2	18	2
CE03	1243	2029	3	18	2
CE04	1243	2093	4	18	2
CE05	1243	2156	5	18	2
CE06	1243	2220	6	18	2
CE07	1243	2283	7	18	2
CE08	1243	2347	8	18	2
CE09	1243	2410	9	18	2
CE10	1243	2474	10	18	2
CE11	1243	2549	11	18	2
CE12	1243	2620	12	18	2
CE13	1243	2692	13	18	2
CE14	1243	2763	14	18	2
CE15	1243	2858	15	18	2
CE16	1243	2953	16	18	2
CE17	1243	3017	17	18	2
CE18/1	1043.5	3124	18	12	2
CE18/2	1243	3124	18	6	1
Total:				324	37

Tab.B3 . Strip widths and pitches

Layer	Strip width (mm)	Strip pitch (mm)
1	17.7	19.7
2	18.3	20.3
3	19.0	21.0
4	19.7	21.7
5	20.3	22.3
6	21.0	23.0
7	21.6	23.6
8	22.3	24.3
9	23.0	25.0
10	23.6	25.6
11	24.4	26.4
12	25.1	27.1
13	25.9	27.9
14	26.6	28.6
15	27.6	29.6
16	28.6	30.6
17	29.3	31.3
18	30.4	32.4
19	30.8	32.8
19(S2/S4) ⁶	33.7	35.7

⁶ There are only $32+29+27 = 88$ ϕ strips in Sextants 2 and 4 of layer 19.

Tab. E1. Envelopes in the Forward Endcap, class **T**

Name	S	L	A	B	Layer
FT01	1517	2587	0	0	1—3
FT02	1577	2647	0	0	4—15
FT03	1577	2647	142	19	16
FT04	1577	2647	272	50	17
FT05	1577	2647	707	232	18

Tab. E2. Envelopes in the Forward Endcap, class **M**

Name	R	D	L	S	Layer
FM01	738	3295	3165	2630	1
FM02	754	3295	3165	2630	2
FM03	770	3295	3165	2630	3
FM04	786	3295	3225	2690	4
FM05	802	3295	3225	2690	5
FM06	818	3295	3225	2690	6
FM07	834	3295	3225	2690	7
FM08	850	3295	3225	2690	8
FM09	867	3295	3225	2690	9
FM10	886	3295	3225	2690	10
FM11	905	3295	3225	2690	11
FM12	924	3295	3225	2690	12
FM13	945	3295	3106	2572	13
FM14	970	3295	3006	2472	14
FM15	996	3295	2928	2394	15
FM16	1021	3295	2865	2330	16
FM17	1047	3295	2806	2272	17
FM18	1194	3295	2541	2007	18

Tab. E3. Envelopes in the Forward Endcap, class **B**

Name	S	L	A	B	Layer
FB01	1577	2647	0	0	1—15
FB02	1577	2647	142	19	16
FB03	1577	2647	272	50	17
FB04	1577	2647	707	232	18

Tab. E4. Envelopes in the Backward Endcap, class **T**

Name	S	L	A	B	Layer
BT01	1254	2323	0	0	1
BT02	1284	2353	0	0	2
BT03	1314	2383	0	0	3
BT04	1344	2413	0	0	4
BT05	1374	2443	0	0	5
BT06	1404	2473	0	0	6
BT07	1434	2503	26	6	7
BT08	1464	2533	57	12	8
BT09	1494	2563	90	18	9
BT10	1517	2587	117	22	10—17
BT11	1517	2587	413	121	18

Tab. E5. Envelopes in the Backward Endcap, class **M**

Name	R	D	L	S	Layer
BM01	1030	3295	2844	2309	1—17
BM02	1114	3295	2676	2141	18

Tab. E6. Envelopes in the Backward Endcap, class **B**

Name	S	L	A	B	Layer
BB01	1517	2587	117	22	1—17
BB02	1517	2587	413	121	18

Tab. E7. Chambers in the Forward Endcap layers

Layer	T chamber	M chamber	B chamber
01	FT01	FM01	FB01
02	FT01	FM02	FB01
03	FT01	FM03	FB01
04	FT02	FM04	FB01
05	FT02	FM05	FB01
06	FT02	FM06	FB01
07	FT02	FM07	FB01
08	FT02	FM08	FB01
09	FT02	FM09	FB01
10	FT02	FM10	FB01
11	FT02	FM11	FB01
12	FT02	FM12	FB01
13	FT02	FM13	FB01
14	FT02	FM14	FB01
15	FT02	FM15	FB01
16	FT03	FM16	FB02
17	FT04	FM17	FB03
18	FT05	FM18	FB04

Tab. E8. Chambers in the Backward Endcap layers

Layer	T chamber	M chamber	B chamber
01	BT01	BM01	BB01
02	BT02	BM01	BB01
03	BT03	BM01	BB01
04	BT04	BM01	BB01
05	BT05	BM01	BB01
06	BT06	BM01	BB01
07	BT07	BM01	BB01
08	BT08	BM01	BB01
09	BT09	BM01	BB01
10	BT10	BM01	BB01
11	BT10	BM01	BB01
12	BT10	BM01	BB01
13	BT10	BM01	BB01
14	BT10	BM01	BB01
15	BT10	BM01	BB01
16	BT10	BM01	BB01
17	BT10	BM01	BB01
18	BT11	BM02	BB02

Tab. E9. Modules in the Forward Endcap, class **T/B**

Name	S	L	A	B	N. Needed	spares
FS01	1509.5	2041.2	0.0	0.0	3"R"+3"L"	← BS10
FL01	2041.2	2573.0	0.0	0.0	3"R"+3"L"	← BL10
FS02	1569.5	2101.2	0.0	0.0	33"R"+33"L"	3"R"+ 3"L"
FL02	2101.2	2633.0	0.0	0.0	27"R"+27"L"	3"R"+ 3"L"
FL03	2101.2	2633.0	142.0	19.0	2"R"+2"L"	← FL05
FL04	2101.2	2633.0	272.0	50.0	2"R"+2"L"	← FL05
FL05	2101.2	2633.0	707.0	232.0	2"R"+2"L"	1"R"+ 1"L"
Total:					144	14

Tab. E10. Modules in the Forward Endcap, class **M**

Name	R	L	L'	S	N. needed	spares
FM01	743	3154.2	2546.2	2622.1	2"R"+2"L"	← FM09
FM02	759	3154.2	2530.2	2622.1	2"R"+2"L"	← FM09
FM03	775	3154.2	2514.2	2622.1	2"R"+2"L"	← FM09
FM04	791	3214.2	2498.2	2682.1	2"R"+2"L"	← FM09
FM05	807	3214.2	2482.2	2682.1	2"R"+2"L"	← FM09
FM06	823	3214.2	2466.2	2682.1	2"R"+2"L"	← FM09
FM07	839	3214.2	2450.2	2682.1	2"R"+2"L"	← FM09
FM08	855	3214.2	2434.2	2682.1	2"R"+2"L"	← FM09
FM09	872	3214.2	2417.2	2682.1	2"R"+2"L"	2"R"+2"L"
FM10	891	3214.2	2398.2	2682.1	2"R"+2"L"	← FM18
FM11	910	3214.2	2379.2	2682.1	2"R"+2"L"	← FM18
FM12	929	3214.2	2360.2	2682.1	2"R"+2"L"	← FM18
FM13	950	3095.2	2339.2	2564.1	2"R"+2"L"	← FM18
FM14	975	2995.2	2314.2	2464.1	2"R"+2"L"	← FM18
FM15	1001	2917.2	2288.2	2386.1	2"R"+2"L"	← FM18
FM16	1026	2854.2	2263.2	2322.1	2"R"+2"L"	← FM18
FM17	1052	2795.2	2237.2	2264.1	2"R"+2"L"	← FM18
FM18	1199	2530.2	2090.2	1999.1	2"R"+2"L"	2"R"+2"L"
Total:					72	8

Tab. E11. Modules in the Backward Endcap, class **T/B**

Name	S	L	A	B	N. needed	spares
BS01	1246.0	1777.7	0.0	0.0	1"R"+1"L"	1"R"+1"L"
BL01	1777.7	2309.5	0.0	0.0	1"R"+1"L"	1"R"+1"L"
BS02	1276.0	1807.7	0.0	0.0	1"R"+1"L"	← BS01
BL02	1807.7	2339.5	0.0	0.0	1"R"+1"L"	← BL01
BS03	1306.0	1837.7	0.0	0.0	1"R"+1"L"	← BS01
BL03	1837.7	2369.5	0.0	0.0	1"R"+1"L"	← BL01
BS04	1336.0	1867.7	0.0	0.0	1"R"+1"L"	← BS01
BL04	1867.7	2399.5	0.0	0.0	1"R"+1"L"	← BL01
BS05	1366.0	1897.7	0.0	0.0	1"R"+1"L"	← BS01
BL05	1897.7	2429.5	0.0	0.0	1"R"+1"L"	← BL01
BS06	1396.0	1927.7	0.0	0.0	1"R"+1"L"	← BS01
BL06	1927.7	2459.5	0.0	0.0	1"R"+1"L"	← BL01
BS07	1426.0	1957.7	0.0	0.0	1"R"+1"L"	← BS01
BL07	1957.7	2489.5	26.0	6.0	1"R"+1"L"	← BL01
BS08	1456.0	1987.7	0.0	0.0	1"R"+1"L"	← BS01
BL08	1987.7	2519.5	57.0	12.0	1"R"+1"L"	← BL01
BS09	1486.0	2017.7	0.0	0.0	1"R"+1"L"	← BS01
BL09	2017.7	2549.5	90.0	18.0	1"R"+1"L"	← BL01
BS10	1509.5	2041.2	0.0	0.0	27"R"+27"L"	3"R"+3"L"
BL10	2041.2	2573.0	117.0	22.0	25"R"+25"L"	3"R"+3"L"
BL11	2041.2	2573.0	413.0	121.0	2"R"+2"L"	1"R"+1"L"
Total:					144	18

Tab. E12. Modules in the Backward Endcap, class **M**

Name	L	S	N. needed	spares
BM01	2615.4	2087.2	34"R"+34"L"	3"R"+3"L"
BM02	2515.4	1987.2	2"R"+2"L"	1"R"+1"L"
Total:			72	8

Tab. E13. Modules in the Forward Endcap layers

Layer	T chamber		M chamber		B chamber	
	Mod.1	Mod.2	Mod.3	Mod.4	Mod.5	Mod.6
01	FS01	FL01	FM01	FM01	FL02	FS02
02	FS01	FL01	FM02	FM02	FL02	FS02
03	FS01	FL01	FM03	FM03	FL02	FS02
04	FS02	FL02	FM04	FM04	FL02	FS02
05	FS02	FL02	FM05	FM05	FL02	FS02
06	FS02	FL02	FM06	FM06	FL02	FS02
07	FS02	FL02	FM07	FM07	FL02	FS02
08	FS02	FL02	FM08	FM08	FL02	FS02
09	FS02	FL02	FM09	FM09	FL02	FS02
10	FS02	FL02	FM10	FM10	FL02	FS02
11	FS02	FL02	FM11	FM11	FL02	FS02
12	FS02	FL02	FM12	FM12	FL02	FS02
13	FS02	FL02	FM13	FM13	FL02	FS02
14	FS02	FL02	FM14	FM14	FL02	FS02
15	FS02	FL02	FM15	FM15	FL02	FS02
16	FS02	FL03	FM16	FM16	FL03	FS02
17	FS02	FL04	FM17	FM17	FL04	FS02
18	FS02	FL05	FM18	FM18	FL05	FS02

Tab. E14. Modules in the Backward Endcap layers

Layer	T chamber		M chamber		B chamber	
	Mod.1	Mod.2	Mod.3	Mod.4	Mod.5	Mod.6
01	BS01	BL01	BM01	BM01	BL10	BS10
02	BS02	BL02	BM01	BM01	BL10	BS10
03	BS03	BL03	BM01	BM01	BL10	BS10
04	BS04	BL04	BM01	BM01	BL10	BS10
05	BS05	BL05	BM01	BM01	BL10	BS10
06	BS06	BL06	BM01	BM01	BL10	BS10
07	BS07	BL07	BM01	BM01	BL10	BS10
08	BS08	BL08	BM01	BM01	BL10	BS10
09	BS09	BL09	BM01	BM01	BL10	BS10
10	BS10	BL10	BM01	BM01	BL10	BS10
11	BS10	BL10	BM01	BM01	BL10	BS10
12	BS10	BL10	BM01	BM01	BL10	BS10
13	BS10	BL10	BM01	BM01	BL10	BS10
14	BS10	BL10	BM01	BM01	BL10	BS10
15	BS10	BL10	BM01	BM01	BL10	BS10
16	BS10	BL10	BM01	BM01	BL10	BS10
17	BS10	BL10	BM01	BM01	BL10	BS10
18	BS10	BL11	BM02	BM02	BL11	BS10

Tab. E15. V-strip geometry for Endcap chambers

Chamber	V-strips (split/int/FECs)	V-strip offsets (meas.) (mm)	V-strip offsets (theor.) (mm)
FM01	32/64/6	48	50
FM02	32/64/6	not meas.	66
FM03	32/64/6	79	82
FM04	34/62/6	125	120
FM05	36/60/6	111	98
FM06	36/60/6	113	114
FM07	38/58/6	100	92
FM08	38/58/6	83	108
FM09	36/60/6	117	113
FM10	36/60/6	not meas.	132
FM11	32/59/6	107	94
FM12	32/59/6	68	53
FM13	32/57/6	not meas.	18
FM14	24/56/5	142	136
FM15	24/56/5	115	107
FM16	24/56/5	87	83
FM17	24/56/5	68	61
FM18	18/46/4	not meas.	88
BM01, T1	14/50/4	66	50
BM01, T2	14/50/4	28	12
BM02	14/50/4	28	12