AIDA INRNE, Sofia, Bulgaria
Radiation Sensors for GIF+

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Group members:
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Working Program – part of WP 8.5.3

1.Assembling at INRNE and test with local Cs-137 source of 1 radiation sensor with an electronics and PC based acquisition.	M1 – M18	1 Detector with electronics and PC based acquisition
2. Test and calibration at CERN Gif	M6 – M18	Report
3. Assembling at INRNE – Sofia of 8-10 sensors for Gif++	M12 – M36	8-10 radiation sensors in 3 control modules + microcontroller and CANBUS communication with DAQ
4. Installation and commissioning of the radiation sensors at DAQ of the Gif++	M12 – M48	Report

Radiation Sensors for GIF++
(Project)

GIF++ Location: SPS North Area, H4 Beam Line

The intensity of the source will be about **10 TBq** providing up to **2 Gy/h** at a distance of **50 cm**.

The ~10 times higher outcoming uniform photon flux than in the previous GIF corresponds to the expected step in intensity while moving to sLHC conditions.

The Cesium source of GIF++ should provide uniform gamma irradiation on a vertical surface of 7,5 m wide by 4 m high at a distance of 5m through the front of the irradiator.

A secondary collimator located in the opposite direction should provide a spherically noncorrected spot of 2,6 m at a distance of 7 m.

Ceiling clearance will be 4 m everywhere inside the bunker.

A second irradiation beam will be available at 180 degrees to the main photon beam axis. This area shall be defined by a separate collimator that allows irradiation of detectors with a higher flux but over a smaller area. It shall be possible to activate or isolate the second irradiation beam using a separate shutter.

Max. expected doses at sLHC	Equivalent time at GIF++ (~ 50 cm from source)
Si-trackers: ~ MGy/y	>> years
Calorimeters: ~ 20 kGy/y	< 1 year
Muon systems: ~ 0.1 Gy/y	~ minutes

Radiation Sensors for the LHC experiments

The sensors for the LHC experiments at CERN are of two types:

- **Thick-Oxide RadFETs** (manufactured by CNRS-LAAS, France):
  - — Range up to 10 Gy ($\Delta V < 10$ V);
  - — Initial sensitivity of 500 mV/Gy (5mV/rad);
  - — Readout current of 100 μA injected over 1 sec;
  - — Initial $V_{th} \sim 2.5$ V;
  - — Accuracy of ± 10%.

- **Thin-Oxide RadFETs** (produced by REM, UK):
  - — Range up to 20 kGy [0.25 μm] and 200 kGy [0.13 μm][2] at $\Delta V = 25$ V;
  - — Initial sensitivity of 20 mV/Gy (0.2 mV/rad) [0.25 μm] and 10 mV/Gy (0.1 mV/rad) [0.13 μm];
  - — Readout current of 160 μA injected over 5 sec;
  - — Initial $V_{th} \sim 3$ V;
  - — Accuracy of ± 10%.

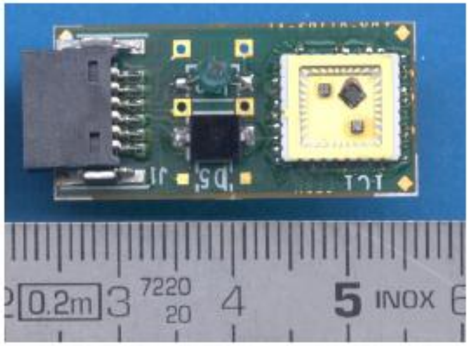
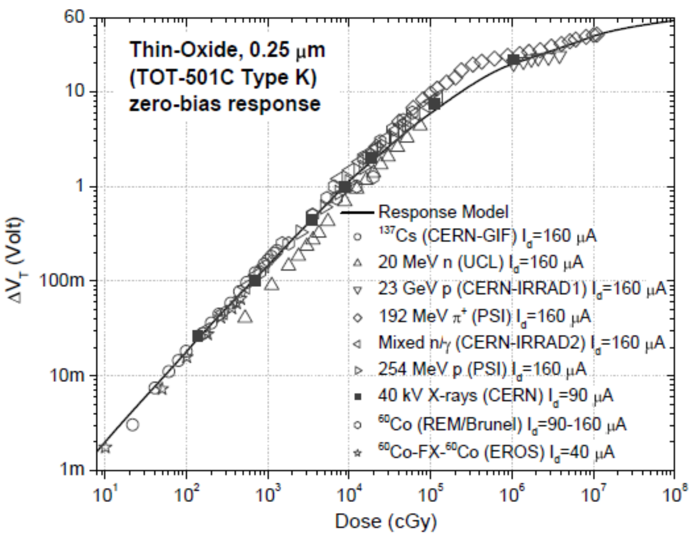
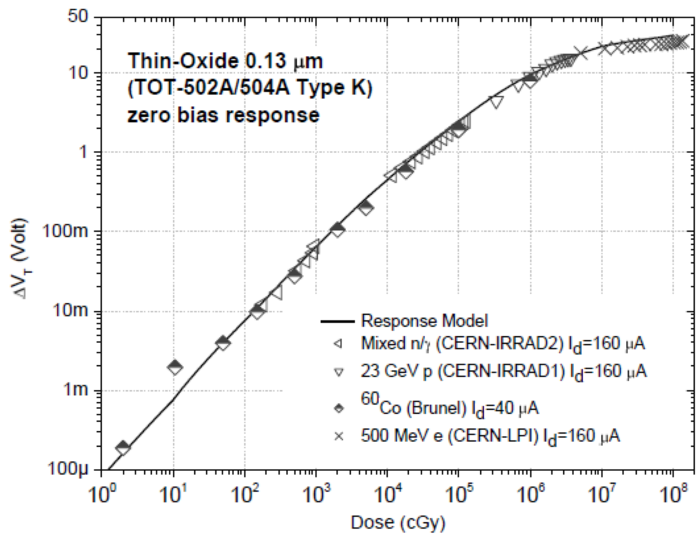
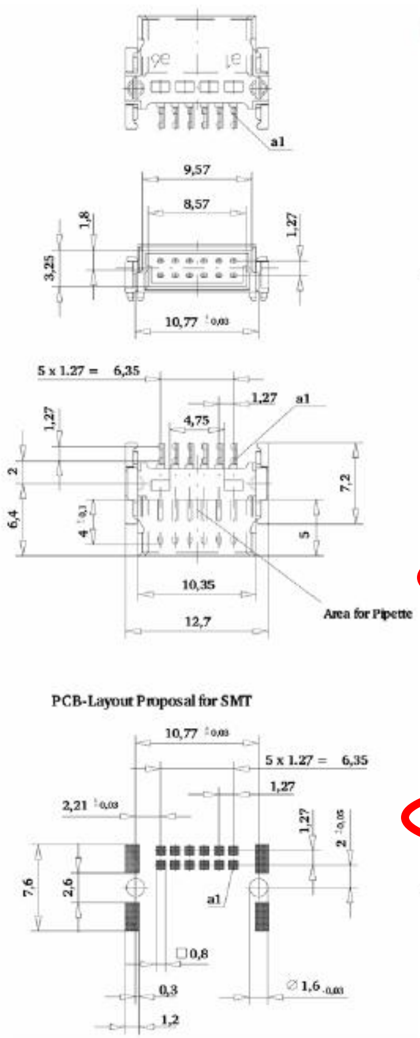


Fig. 3: Integrated Sensor Carrier (ISC)





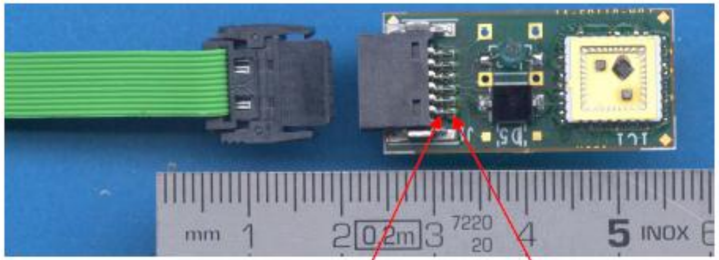
INTEGRATED SENSOR PCB
Connections Layout



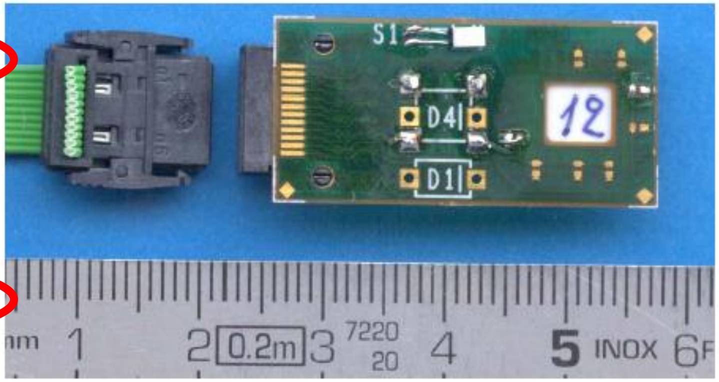
pin-out ERNI
Male Connector
SMC-B 12 contacts
(model: 054594)

ERNI	PCB	Device
a1	gnd	
a2	D5	pin diode
a3	D3	pin diode
a4	D4	pin diode
a5	D1	pin diode
a6	IC1	C3 (REM)
b1	S1	T. probe
b2	IC1	C4 (LAAS)
b3	n.c.	free
b4	D2	pin diode
b5	IC1	C1 (REM)
b6	IC1	C2 (LAAS)

FRONT



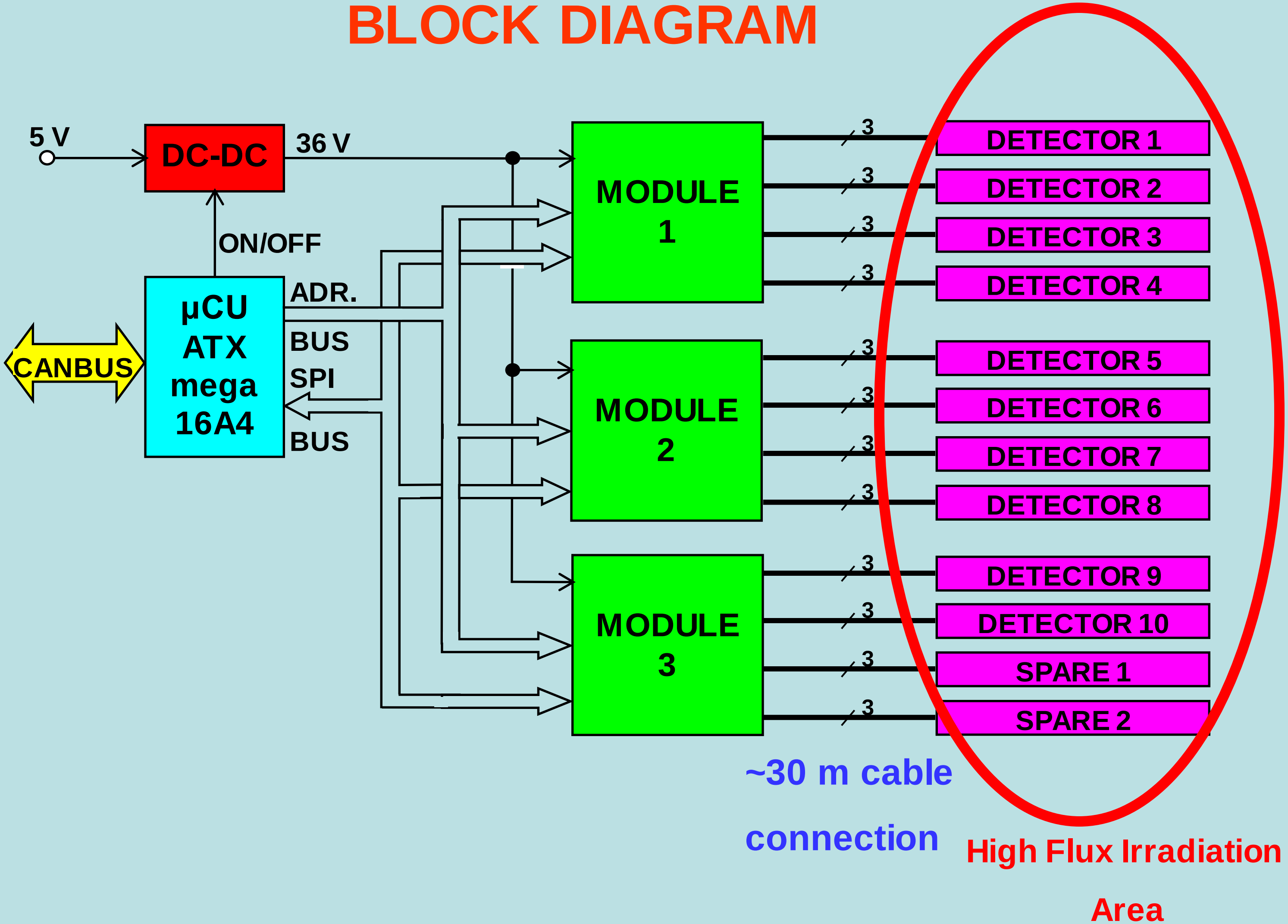
BACK   *a1*   *b1*



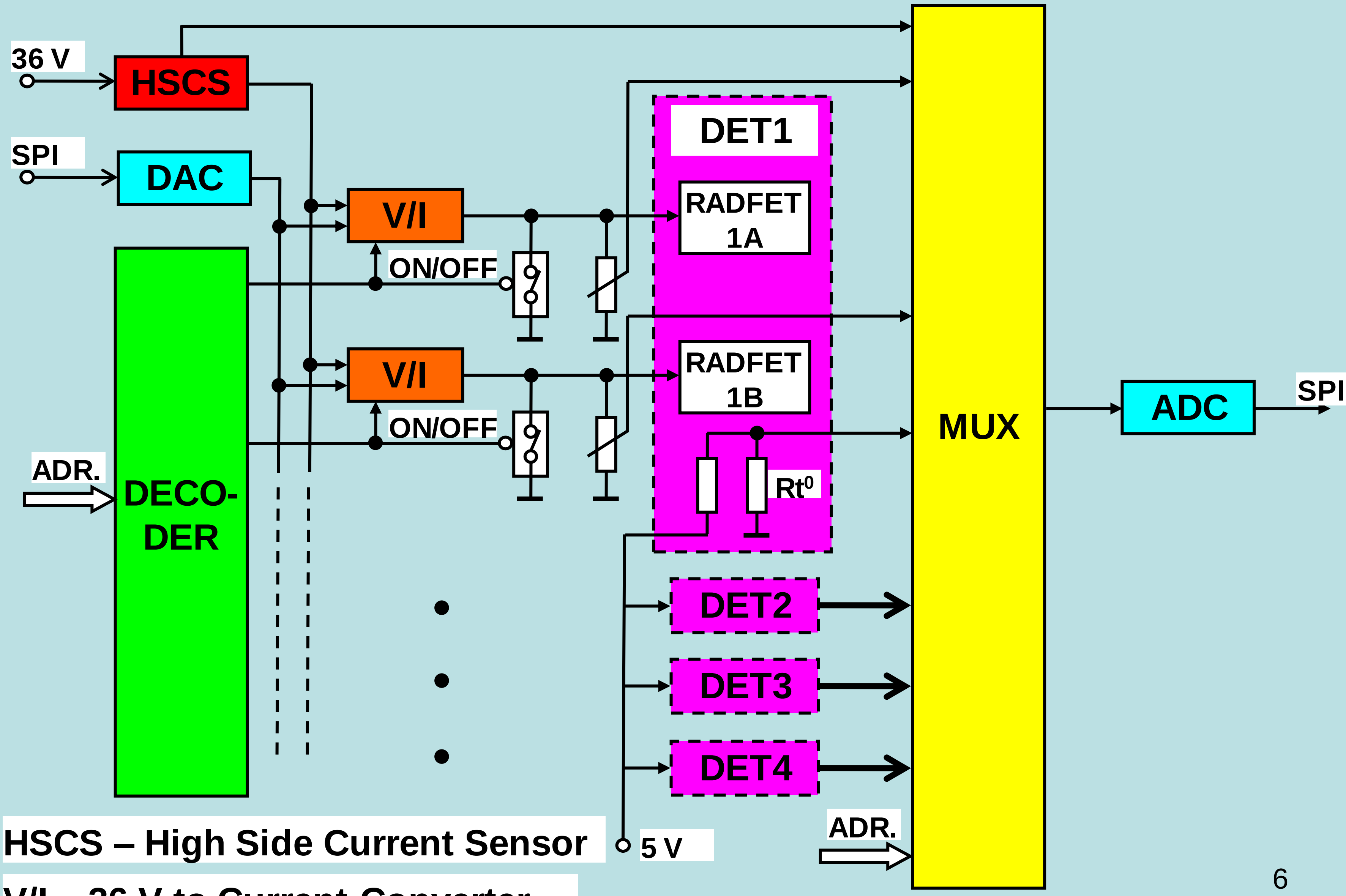
NOTE: Devices to be supplied with negative currents !

F.Ravotti, M.Glaser (72058)
CERN - August 2006

RADIATION SENSORS BLOCK DIAGRAM



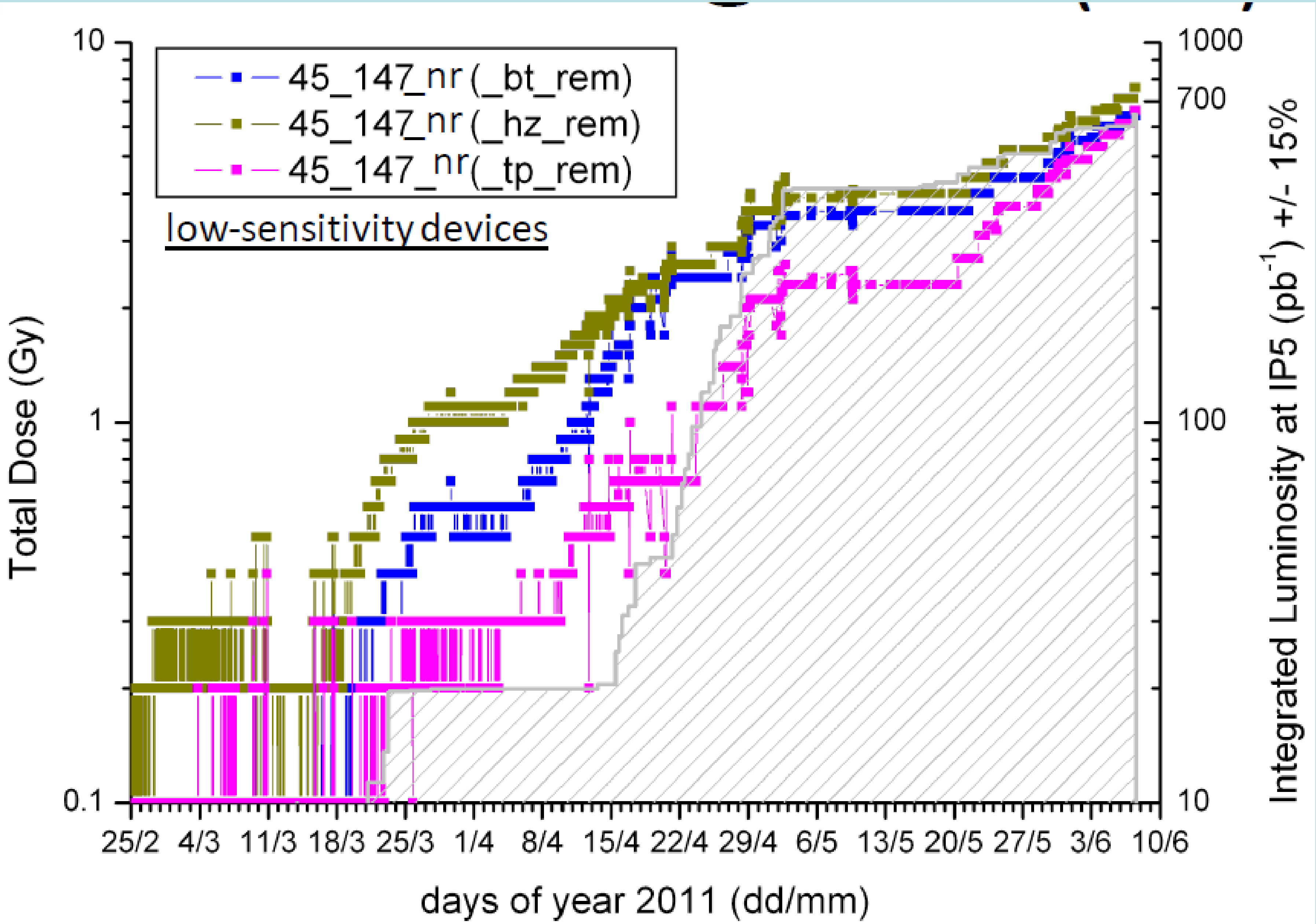
MODULE BLOCK DIAGRAM



HSCS – High Side Current Sensor

V/I – 36 V to Current Converter

BACKUP SLIDES



45_147_nr (_bt_rem)
45_147_nr (_hz_rem)
45_147_nr(_tp_rem)
low-sensitivity devices
Total Dose (Gy)
10
1
0.1
1000
700
100
10
Integrated Luminosity at IP5 (pb-1) +/- 15%
25/2 4/3 11/3 18/3 25/3 1/4 8/4 15/4 22/4 29/4 6/5 13/5 20/5 27/5 3/6 10/6
days of year 2011 (dd/mm)

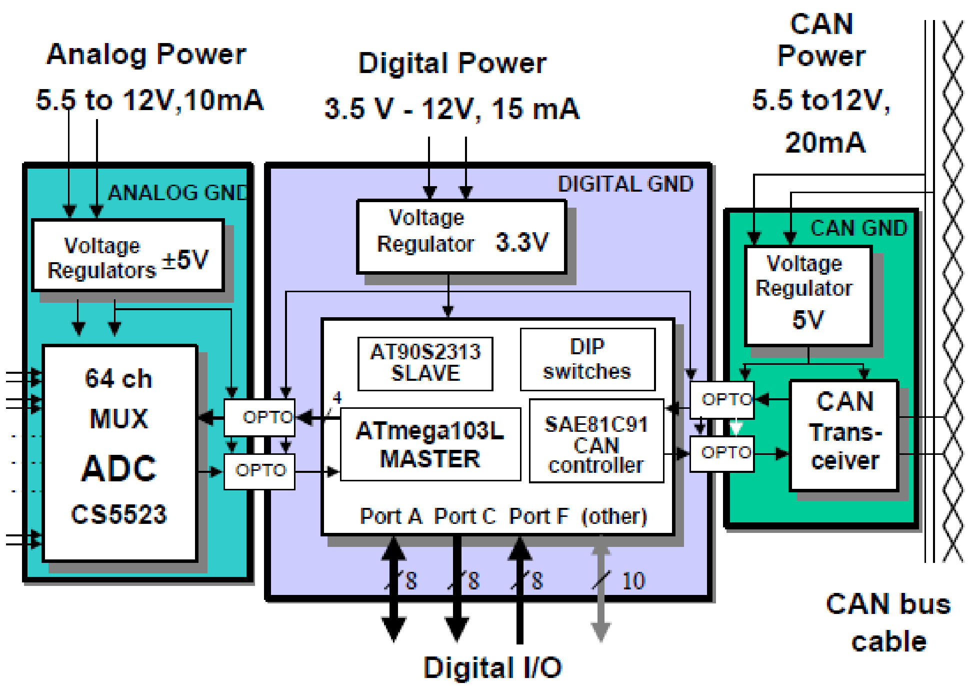


Figure 1: Simplified block diagram of the ELMB module

Figure 3: The front side of the ELMB

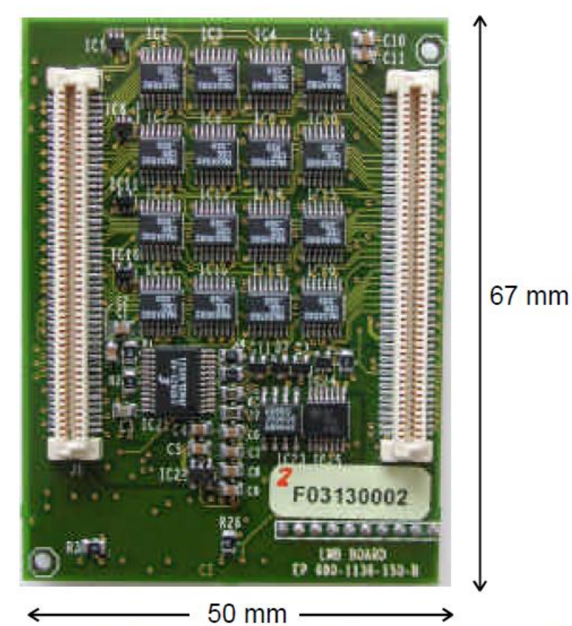
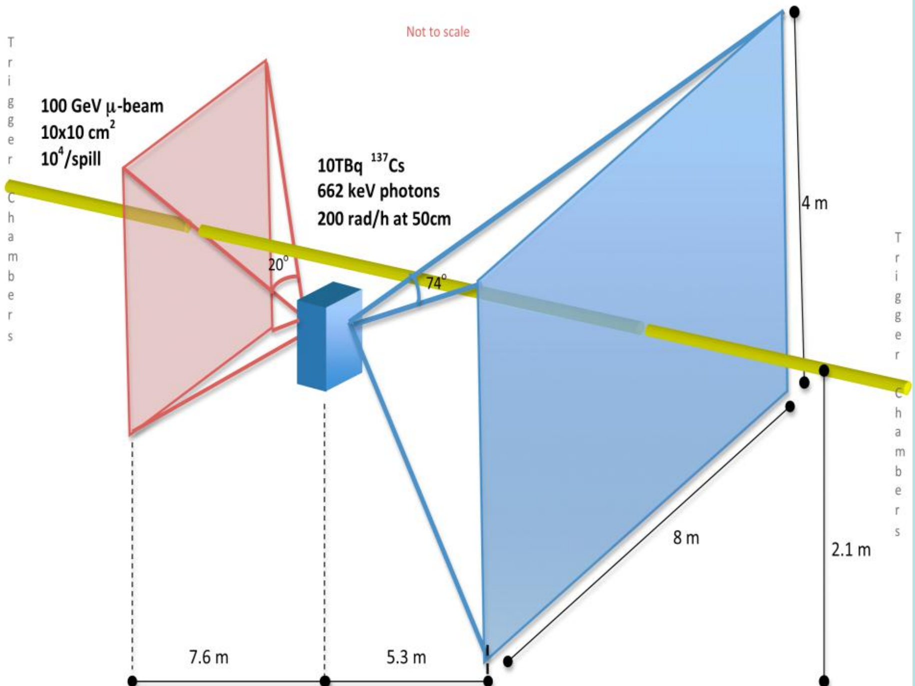
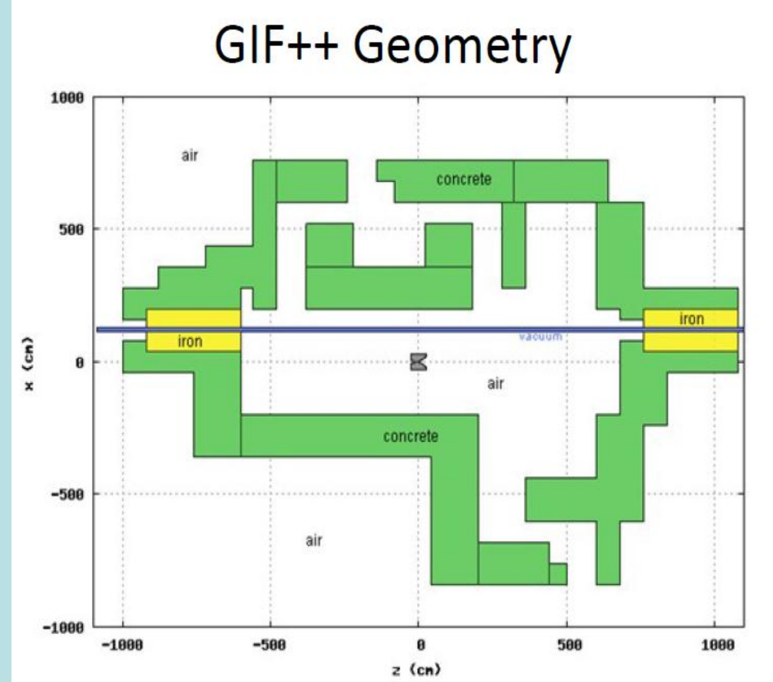
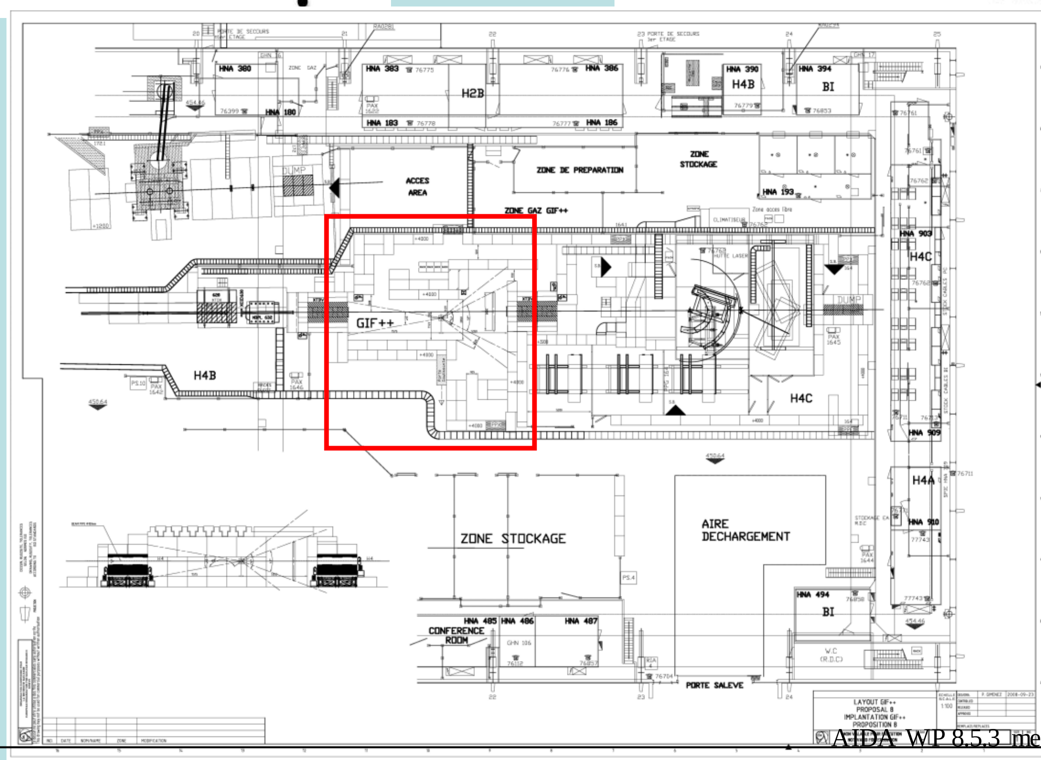


Figure 2: The back side of the ELMB printed circuit board


Not to scale
Trigger Chambers
100 GeV μ-beam
10x10 cm²
10⁴/spill
10TBq ¹³⁷Cs
662 keV photons
200 rad/h at 50cm
20°
74°
4 m
8 m
2.1 m
7.6 m
5.3 m
Trigger Chambers

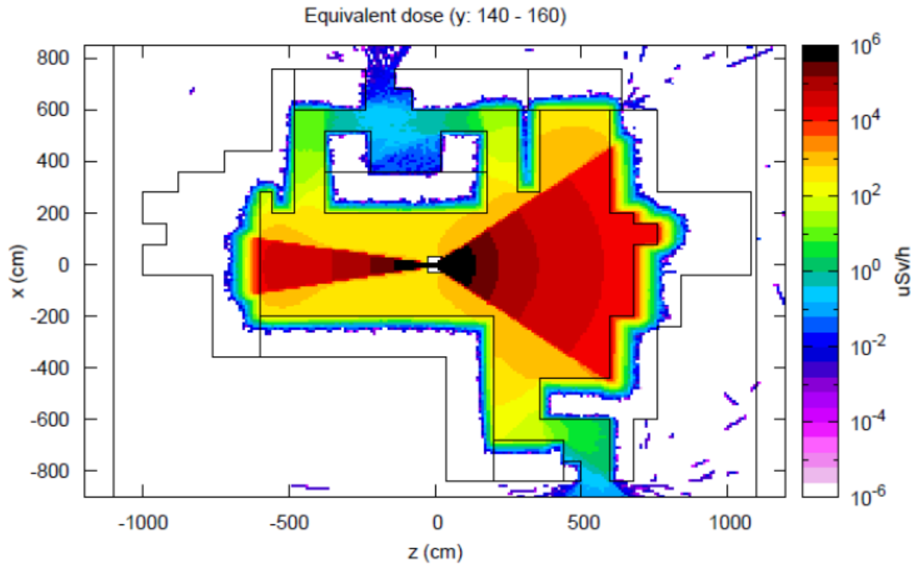

GIF++ Geometry
air
concrete
iron
iron
vacuum
air
concrete
air
x (cm)
z (cm)
1000
500
0
-500
-1000
-1000
-500
0
500
1000

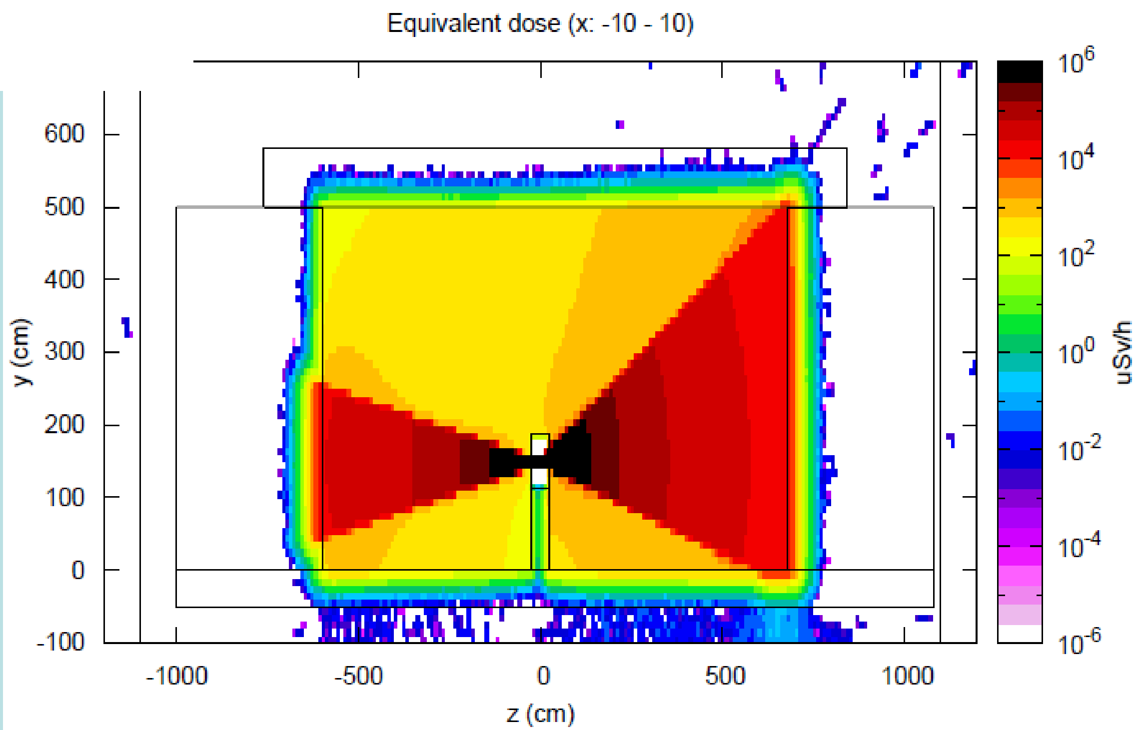

H2B
H4B
BI
ACCES AREA
ZONE DE PREPARATION
ZONE STOCKAGE
ZONE GAZ GIF++
GIF++
H4B
H4C
H4C
H4A
ZONE STOCKAGE
AIRE DECHARGEMENT
CONFERENCE ROOM
BI
PORTE SALEVE
LAYOUT GIF++

Control system, a total of **7-wires (6 to the DCS + 1 reference)** must be available in the counting room for the full readout of the elements of the ISC. The detailed connectivity of this ISC configuration is shown in Table 1.

RPMB PAD	BURNDY RPMB	ERNI RADMON	PCB Serigraphy	Back-Board Connection	TOTEM Device
B10	1	B6	IC1-C2	12	LAAS
B11	—	B5	IC1-C1	10	—
B12	2	B4	D2	8	CMRP
B13	—	B3	IC1-36	6	—
B14	3	B2	IC1-C4	4	REM250
B15	—	B1	S1	2	—
B16	—	A6	IC1-C3	11	—
B17	4	A5	D1	9	RESIS1K
B18	5	A4	D4	7	SPARE3
B19	6	A3	D3	5	BPW34
B20	7	A2	D5	3	NTC
B21	8	A1	GND	1	RGND

Table 1: Connectivity table of the RADMON ISC in "Redundancy" configuration for TOTEM.

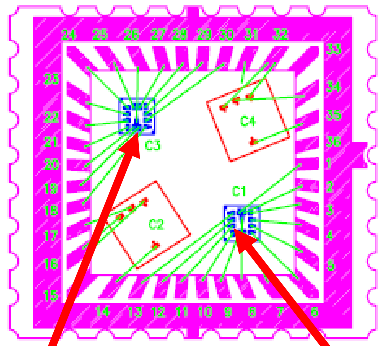




Max. expected doses at sLHC	Equivalent time at GIF++ (~ 50 cm from source)
Si-trackers: ~ MGy/y	>> years
Calorimeters: ~ 20 kGy/y	< 1 year
Muon systems: ~ 0.1 Gy/y	~ minutes

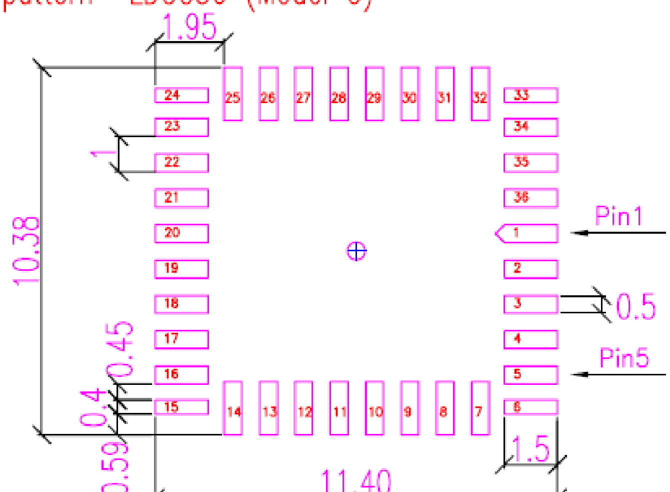
Part bounding (Model 0)

01-C1-D3-K	19-C3-D3-K
02-C1-S2-K	20-C3-S2-K
03-C1-G2-K	21-C3-G2-K
04-C1-D2-K	22-C3-D2-K
05-C1-S1-R	23-C3-S1-R
06-C1-G1-R	24-C3-G1-R
07-C1-D1-R	25-C3-D1-R
08-C1-BULK	26-C3-BULK
09-C1-S4-R	27-C3-S4-R
10-C1-G4-R	28-C3-G4-R
11-C1-D4-R	29-C3-D4-R
12-C1-S3-K	30-C3-S3-K
13-C1-G3-K	31-C2C4-BULK
14-C2-S	32-C4-G
15-FREE	33-FREE
16-C2-G	34-C4-D
17-C2-D	35-C4-S
18-C3-G3-K	36-FREE



C1-REM-TOT501C/504A
C2-LAAS
C3-REM-TOT501C/504A
C4-LAAS

Land pattern LDCC36 (Model 0)



Part Dimensions
36 pin square Ceramic Chip Carrier
MIL-STD-105 D