Detectors Infrastructures & Services

Baseline to design detectors infrastructures.

Tentative arrangement of services in underground cavern,
based on very basic assumptions on specific requirements from
the 4 detector concepts and
on what was done at CERN for CMS.

Feedback from detector groups required to match their needs.

Primary facilities (on surface)

Facility	Output	Users
Water chillers	Water at 6 - 10 deg C	HVAC Electronics racks cooling Detector specific cooling (chilled fluids in range -30 / +25 deg C)
High to medium voltage power transformers	18 kV / 400V AC tri-phase	Lifts, cranes, general services Cooling & HVAC stations Primary power to detector electronics
Diesel & UPS facility	Secured power for valuable systems	
He storage & compressor plants	High pressure He at room temperature	He liquifier
Gas & compressed-air plants	Gas mixtures Compressed-air	Detectors chambers Process control valves, moving systems, ...

Detector Powering

Different power utilities:

- ❑Power to Front End Electronics (FEE)
- ❑Power to Counting Rooms and Site Control Centres
- ❑Power to auxiliaries & services

Different power sources:

- ❖Uninterruptible Power (battery back-up)
- ❖Secured Power (diesel-generator back-up)
- ❖Non-secured Power

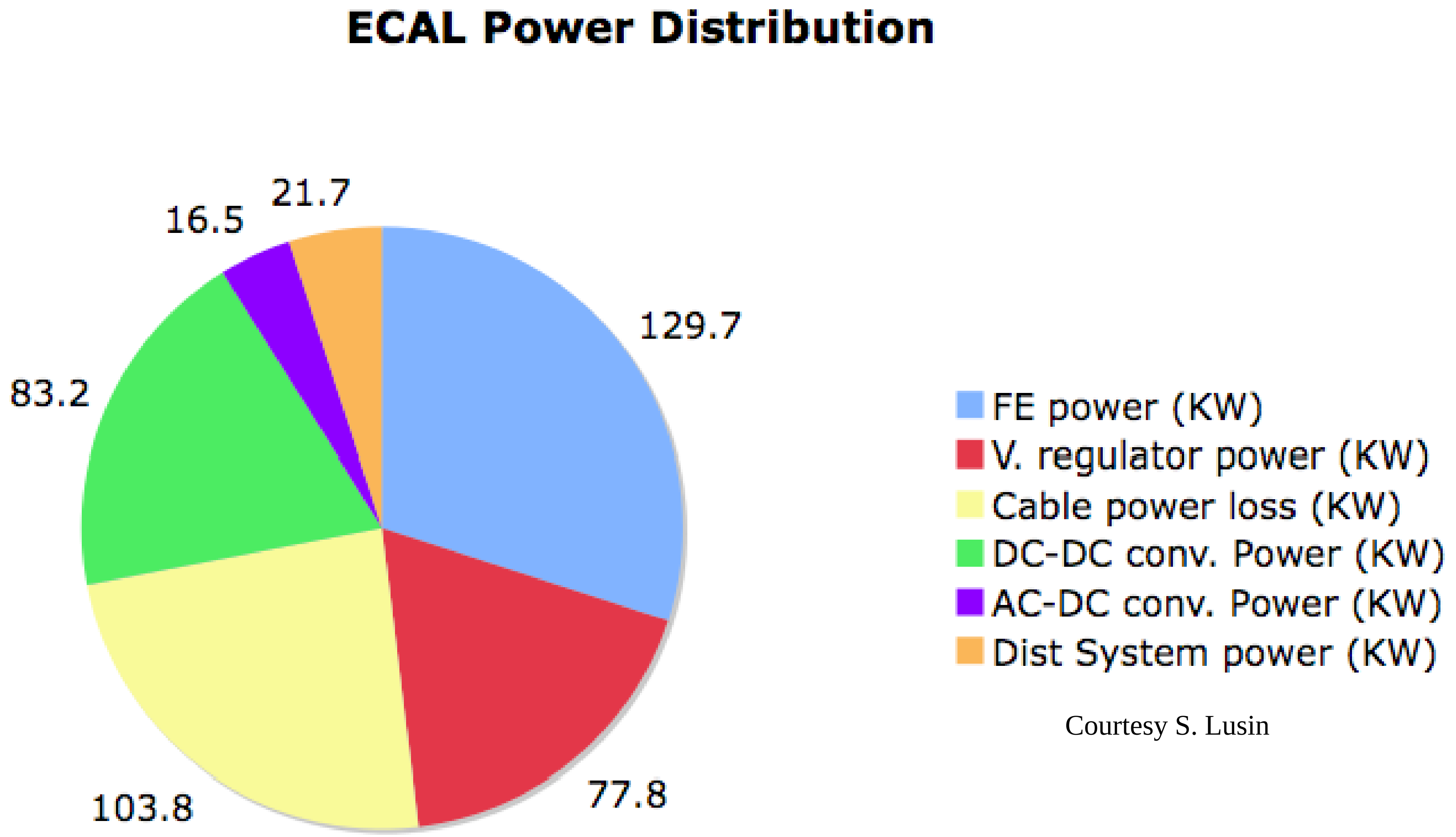
How much power (CMS)

System	Rated power (kW)
General services on site (lifts, cranes, lights, …)	2,200
Electronics racks	2,300
Low Voltage to front-end electronics	1,000
Magnet + Cryogenics	800 (1,250)*
Ventilation units (inc. smoke extraction)	1,250 (3,000)*
Surface cooling stations	4,000
Underground cooling stations:	
(water)	600
(C6F14)	600 (900)*
Total	12,750 (15,250)*

(*) refers to transient operations (cooling down, powering up, etc.)

Power Losses

Consider a factor 2 wrt final end user to design transformers and power lines.
As an example, CMS Ecal use 207 kW over a total available of 432 kW



Courtesy S. Lusin

Low voltage to front-end electronics

The distribution of low voltage / high current power to front-end electronics is by far the most critical issue when designing the powering and cooling system of a modern HEP detector.
As electronics evolves very quickly, people tend to make their choice at the very last moment, when the overall design of the detector is consolidated and often infrastructures on site have already been built.
Modern custom electronics may require even lower voltages.
It is essential to keep low voltage power cables as short as possible, possibly installing AC/DC converters and LV regulators into racks on the detector itself.

Detector Cooling

Front End Electronics Cooling
Electronics Racks Cooling
Caverns Ventilation

Cryogenics

FEE Cooling at CMS

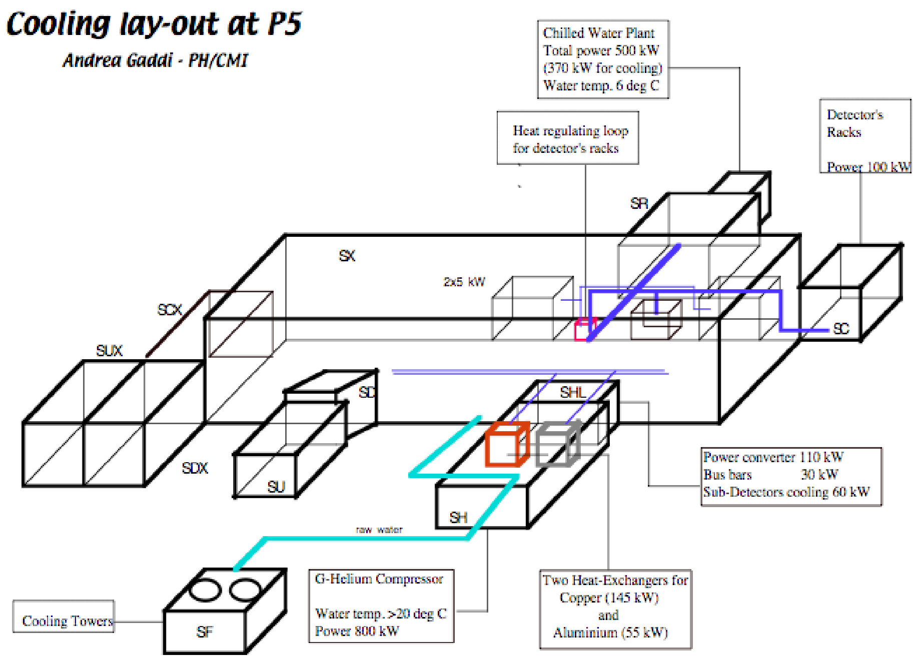
More than 1 MWatt is dissipated into heat by CMS Front Electronics boards. This large amount of heat needs to be transferred away from the Detector via appropriate cooling fluids (water or CxFy, depending on working temperature).

CMS has 6 independents cooling loops, serving the following systems:

Muon Endcaps	water	16 deg	100 kW
Muon Barrel	water	16 deg	50 kW
HCal + Yoke Barrel	water	16 deg	60 kW
ECal	water	16 deg (±0,05)	300 kW
Racks system	water	16 deg	1600 kW
Si-Tracker, Pixels, ES	C6F14	-15/-30 deg	150 kW

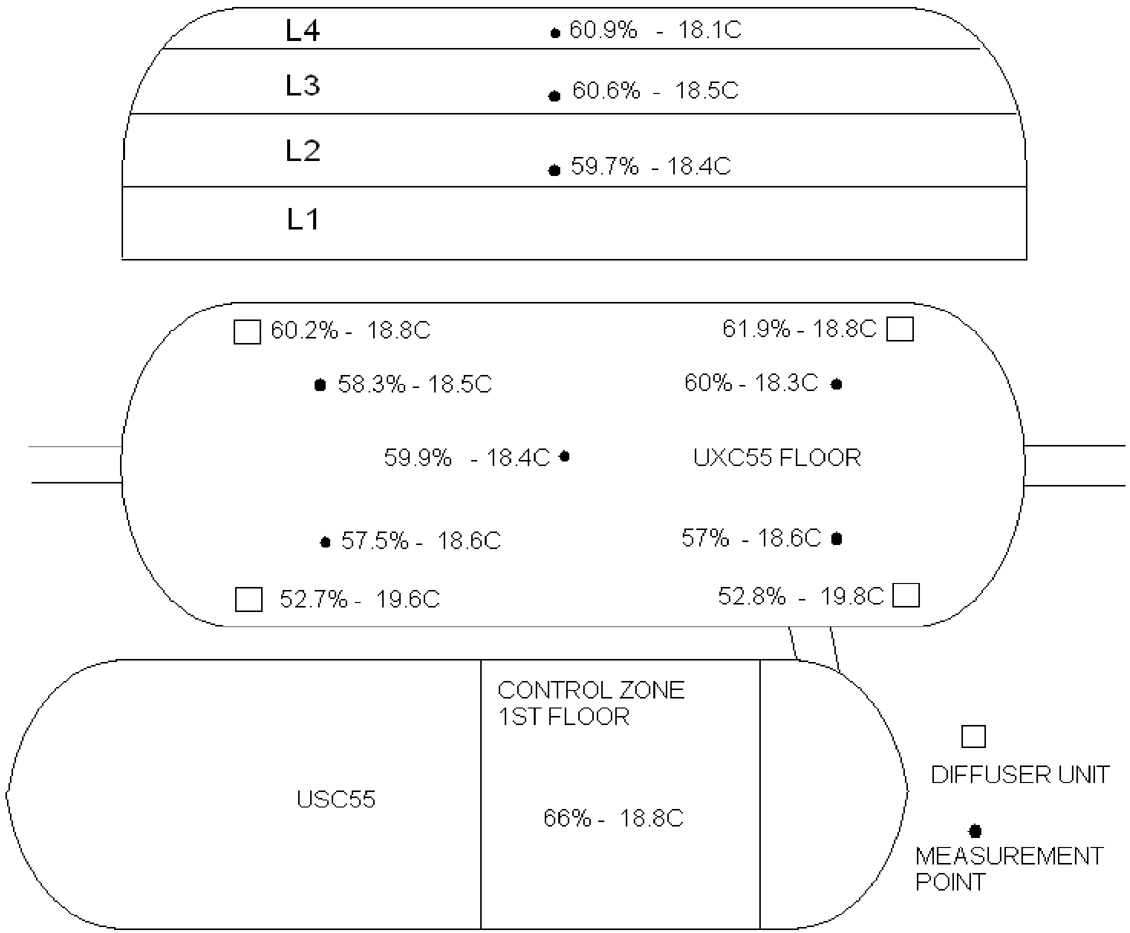
Cooling Infrastructures at CMS

Chilled water at 6 deg is produced on surface and dispatched to the different cooling stations present on site (above and below ground) that finally produce water at 16 deg for the different cooling loops. <u>This arrangement has made possible to test a significant part of CMS on surface, before lowering the Detector down into the cavern without having a large impact on infrastructure costs.</u>



Caverns Ventilation at CMS

Humidity and temperature controls: keep dew point below13 deg C)



POINT 5 CAVERN TEMPERATURE/HUMIDITY VALUES
DATE 19/09/06 RECORDED BY: RDE
TIME 14:00

Cryogenics at CMS

The cryogenic plant at CMS site has the function to cool down and keep at 4.5 K the 230 tons of the CMS Superconducting Coil.

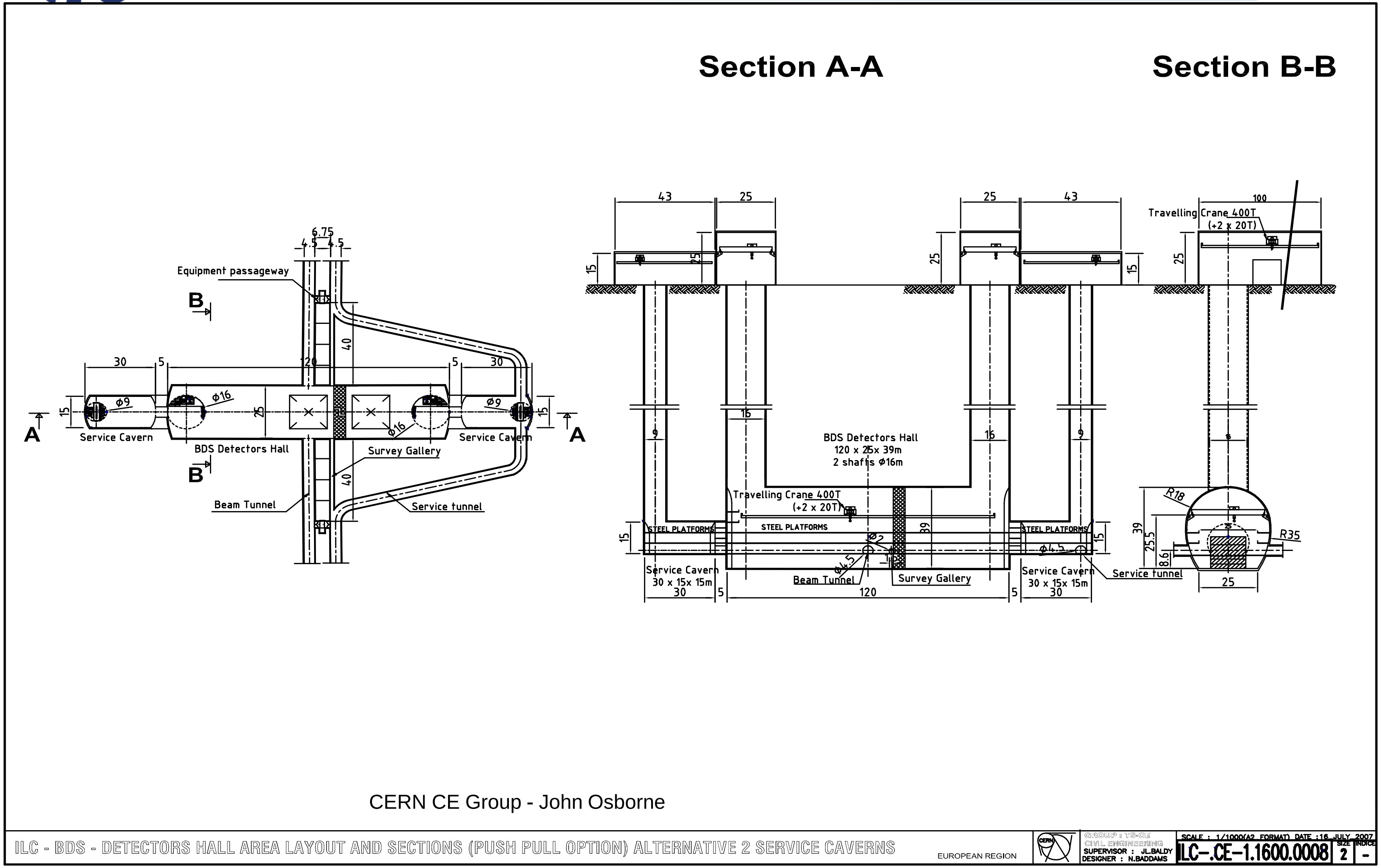
The refrigerator system can deliver a cooling power of 800 W at 4.5 K, plus 4500 W at 60 K to cool the Coil thermal screens and in addition to that 4 g/sec of L-He to cool the 20 kA Coil Current Leads.

Cooling the Coil down from ambient temperature takes 3 weeks, with a maximum thermal gradient inside the cold mass of 15 deg.

In case of quench, the temperature rises up to 70 K and 3 days are necessary to bring the cold mass down to 4.5 K

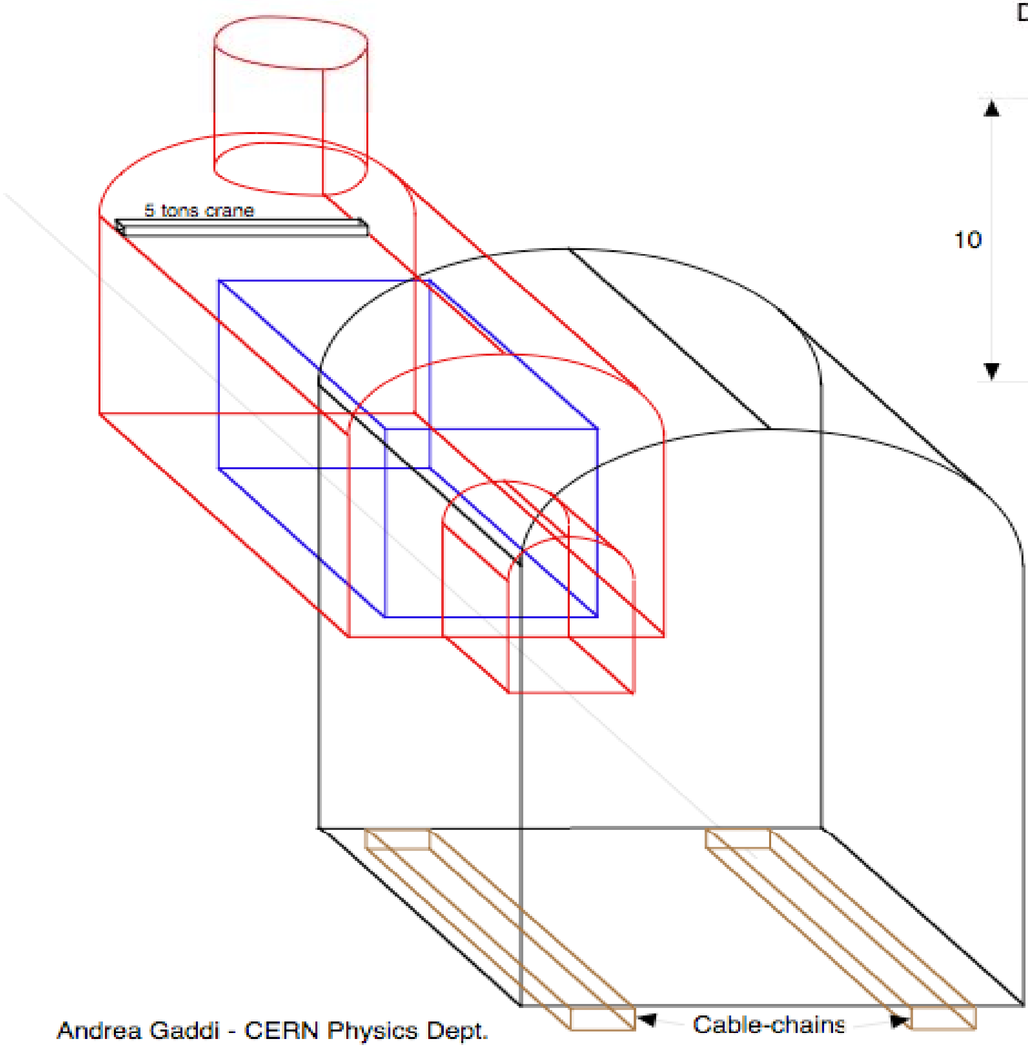
A 6,000 lt L-He storage tank sits close to the cold mass to allow a slow-discharge from full current without warming up the coil.

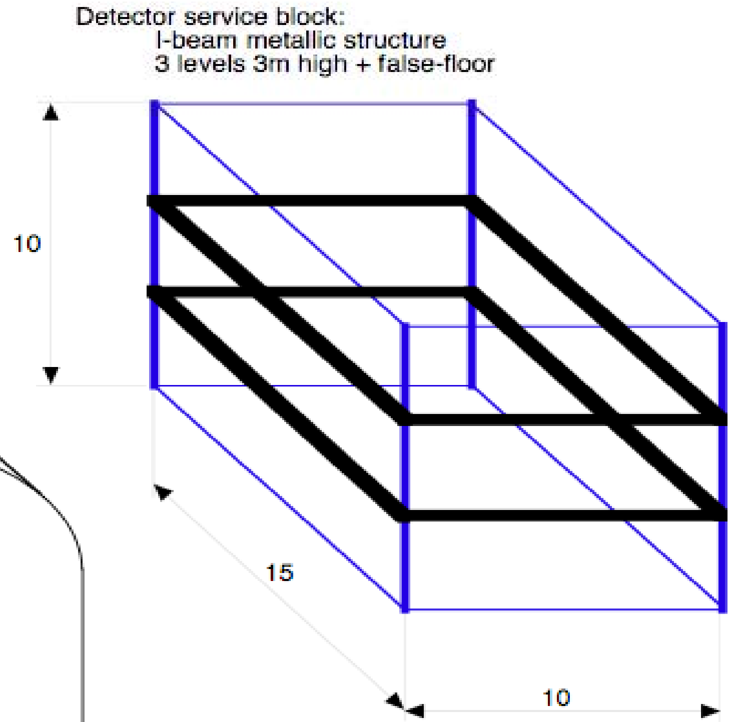
ILC Detectors hall layout



CERN CE Group - John Osborne

Detector service block





ground floor:
heavy components (transformers + cryo + ventilation)

mid floor:
cooling skids + gas + laser + safety rooms

top floor:
electronics racks + miscellanea

Detector service cavern (cont'd)

Detector facilities located into the service cavern (not exhaustive list…):

Electrical room for transformers & switchboards (LV system, electronics racks, UPS, …)
Cryogenics & vacuum system for magnet (He liquifier, rough vacumm pumps, …)
Electrical room for magnet power circuit: AC/DC power converter, breakers, (the dump resistors should be situated at the surface)
Ventilation & air-treatment skids
Cooling skids for detector circuits (heat-exchangers, pumps, controls)
Gas room for gas mixture distribution/regulation
Laser room for detector calibration
Safety room (radiation monitoring, smoke detection, fire-fighting)