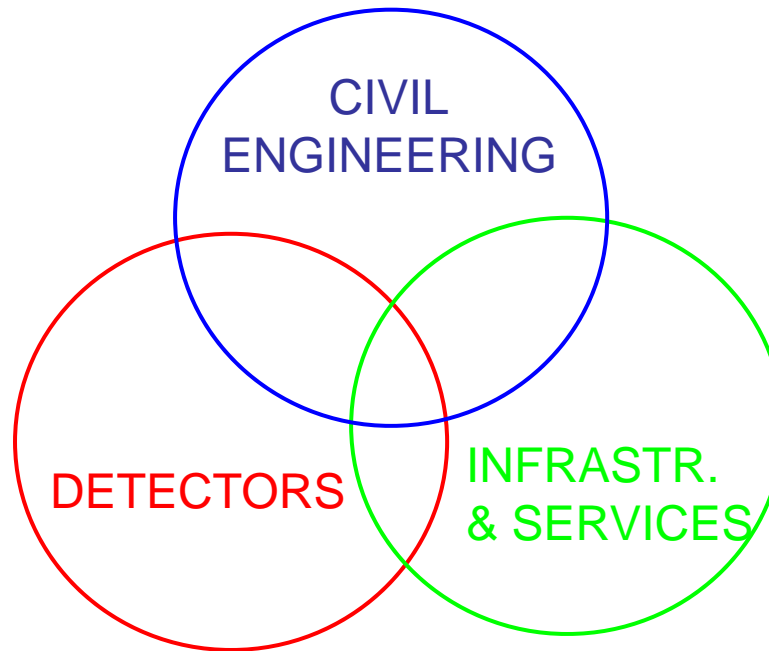




IRENG07 Workshop

An integrated design for ILC detectors services



Andrea Gaddi, CERN Physics
Dept.



Introduction

This talk concerns a tentative arrangement of services in underground and surface areas, based on very basic assumptions on actual requirements from the 4 detector concepts and from the experience of CMS experiment at CERN.

Detector services must be integrated into civil engineering plans and the detectors layout from the beginning of the design of the Experimental Area.

Feedback from detector groups necessary to match their needs



Contents

Primary and secondary services for HEP experiments
On-board services and cable-chains
Detector powering
Cryogenics for detectors
Ventilation in the experimental hall
Proposal for ILC Experimental Area



Distinction between primary and secondary services

A primary service plant ensures the availability of basic “utilities” for the experiments and other site facilities.

A secondary service plant provides a specific detector, and its various sub-detectors, with its own “fluids & power”, according to requirements, that are often very different from a detector to another.



Examples of primary services

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, ...



Location of primary services

Plants providing these services are usually located on surface, due to their dimensions and related risks.

The depth of the experimental cavern plays also a role.

For levels down to -30 m most of detector specific services can

be installed on surface, with relatively short transfer lines.

For deeper sites, secondary services are usually located underground.



Examples of secondary services

- Temperature-stable cooling water for sensitive detectors
- Gas mixtures for drift-chambers
- L-He and AC-DC power converters for superconducting coil(s)

Secondary service plants need often to be close to the detector

(low-voltage/high-current lines, cryogenics lines, etc...) and they are located in the underground areas. Due to the push-pull

design of the Interaction Region, these services must be permanently connected and run into cable-chains toward the detector, regardless of their position in the Hall. To keep flexible pipes and cables in the chains within a reasonable

length (<50m) a secondary service cavern on the side

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On-board services

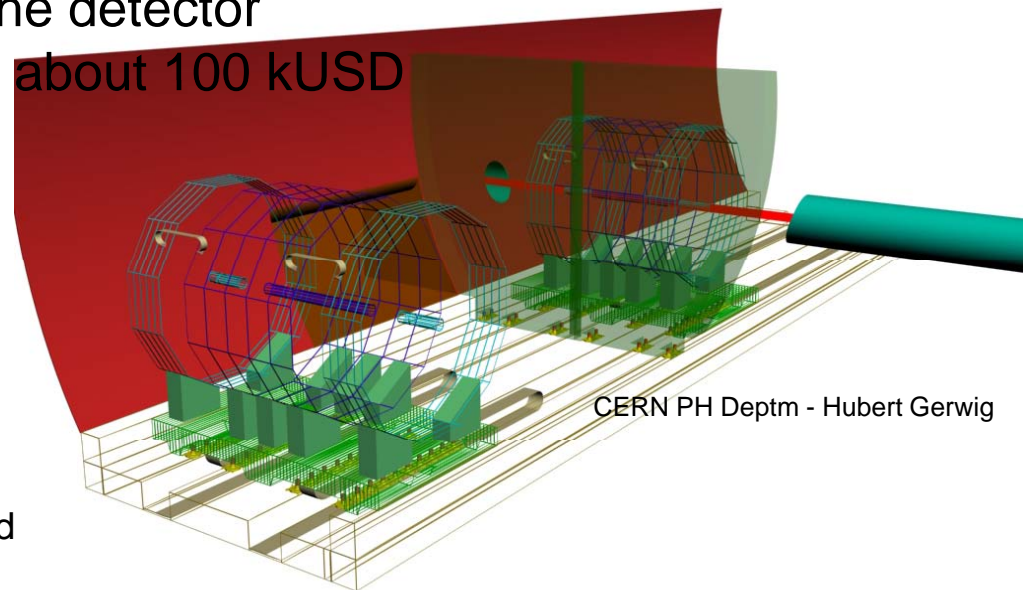
Some secondary services must be situated near the detector as well, if the connection lines through the cable-chains is technically difficult or too expensive (examples: L-He transfer line serving superconducting magnets, LV power cables). However this makes the size of the moving detector bigger with risks of inducing vibrations and electrical noise and should be limited to a few special utilities, in a push-pull scenario, where detectors move every month or so.



Cable-chains

The main benefits of having connections via cable-chains are:

- The detector is permanently connected to all its services and readout cables
- Services are located in a separated area, easy to access, with independent ventilation and lifting equipments (crane)
- Chains can be equipped with cables and hoses when the detector is still under construction on surface
- The cavern floor is clean and without obstructions
- No flying cables/hoses around the detector
- Two aluminum alloy chains cost about 100 kUSD



CERN PH Deptm - Hubert Gerwig

Andrea Gad



Detector Powering

Different power utilities:

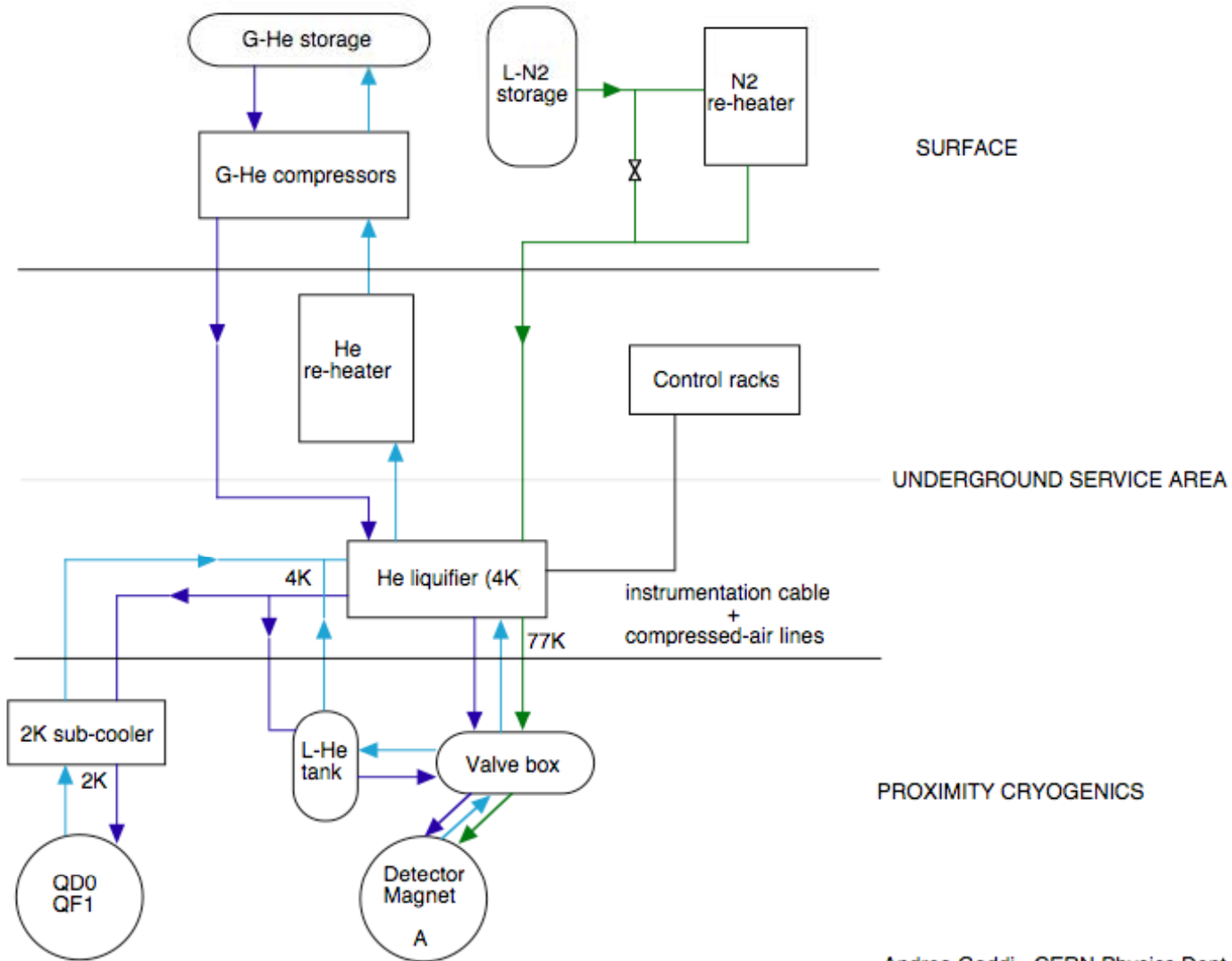
- Power to Front End Electronics (FEE)
- Power to Counting Rooms and Site Control Centres
- Power to auxiliaries & services

Different power sources:

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



Cryogenics block diagram





Cavern ventilation

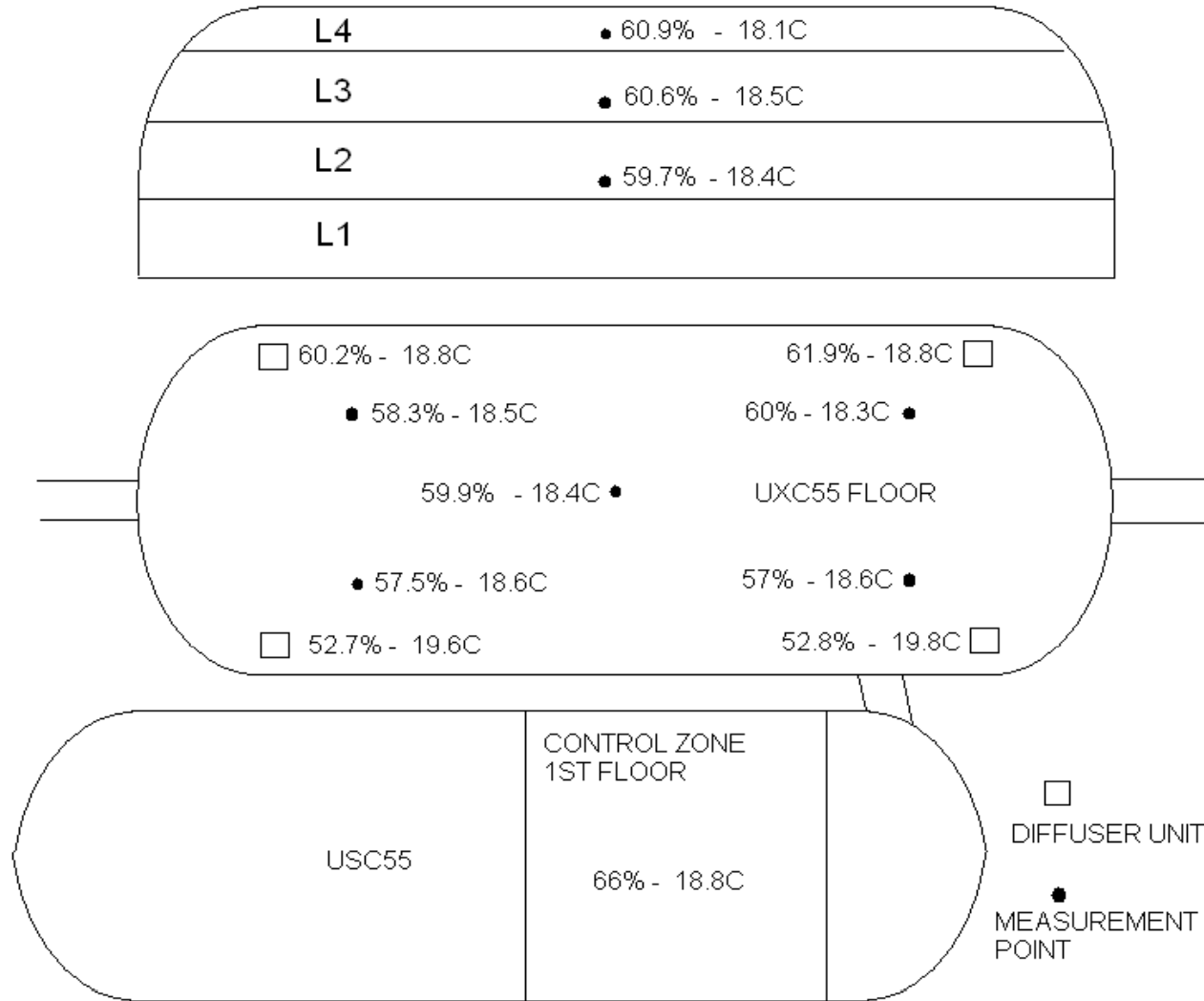
Temperature stability of the cavern air plays a role in the calibration of most of the detectors. Vertical gradients are usually accepted, but not large temperature fluctuations.

Low humidity (dew-point) is also important to prevent water condensation on cold surfaces (typically water pipes)

The bigger the cavern, the more difficult the problem is.



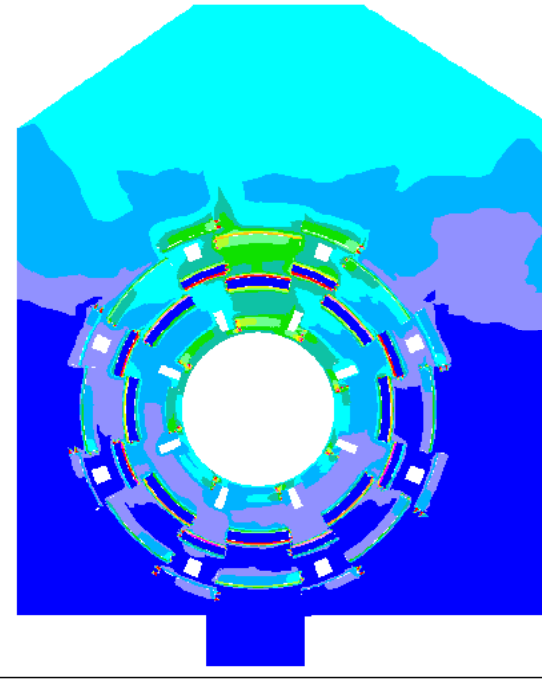
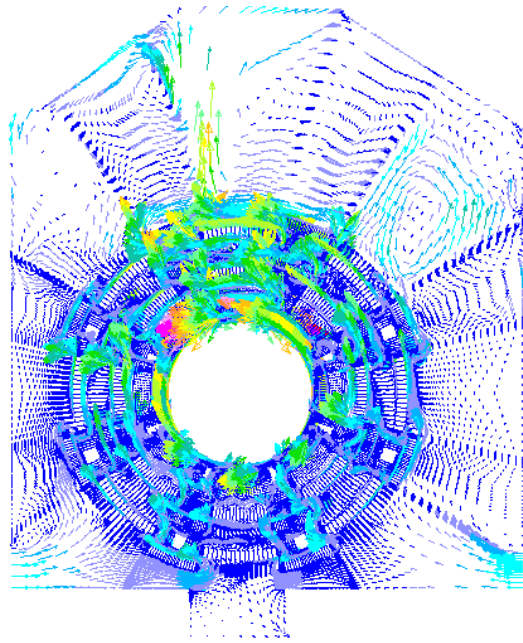
Typical temperature/humidity distribution



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



Example of temperature distribution



L.Vila Nova Goncalves, CERN TS Deptm.

Intercept heat with water at the source rather than heat-up the ca
Be aware of chimney effect of large pits, there a cover helps.
Consider also the huge transversal dimension of the cavern.

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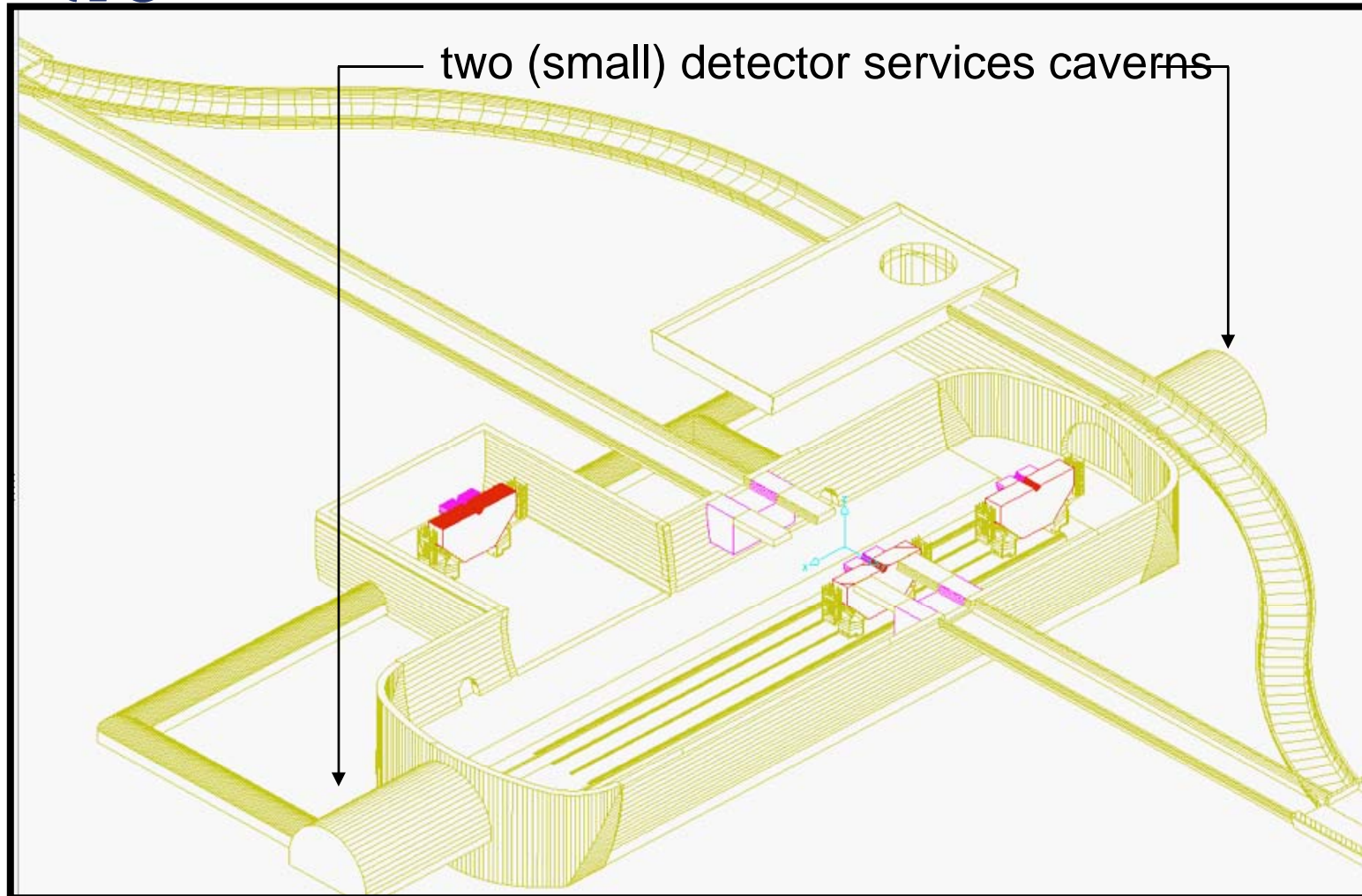


Layout for ILC detector services

The following slides are the outcome of the latest phone-meetings held with ILC detectors representatives and the work done by CERN CE Office.



Service caverns



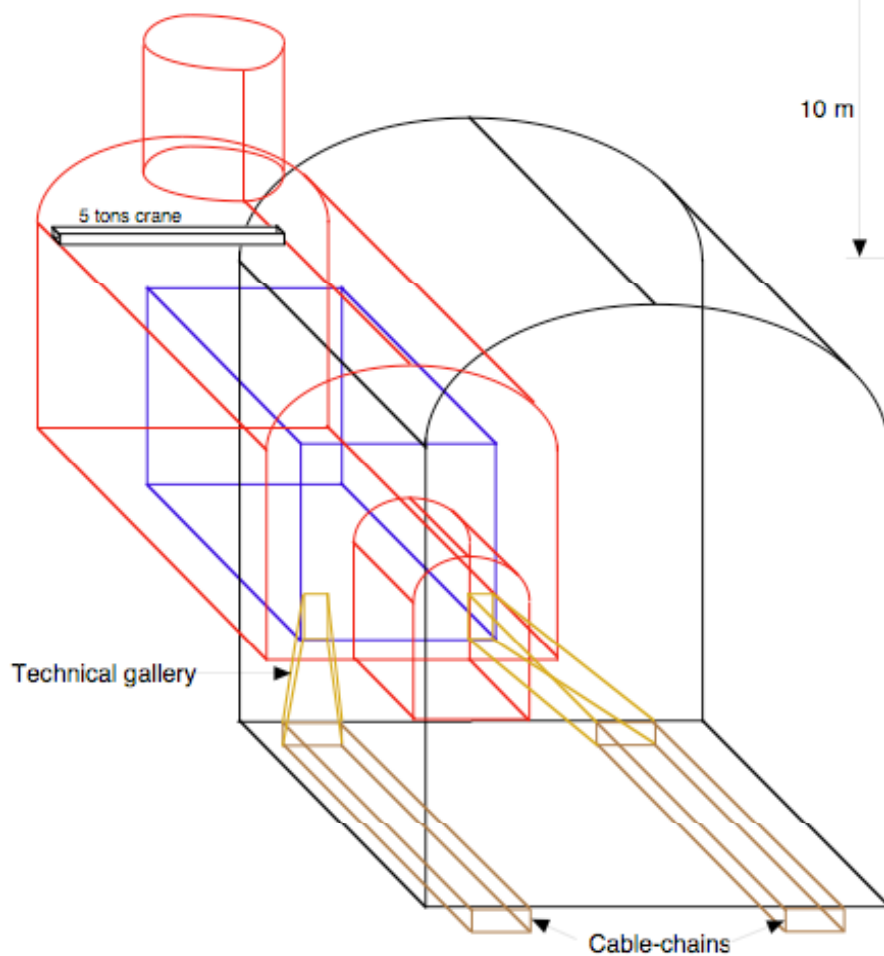
CERN CE Group - John Osborne

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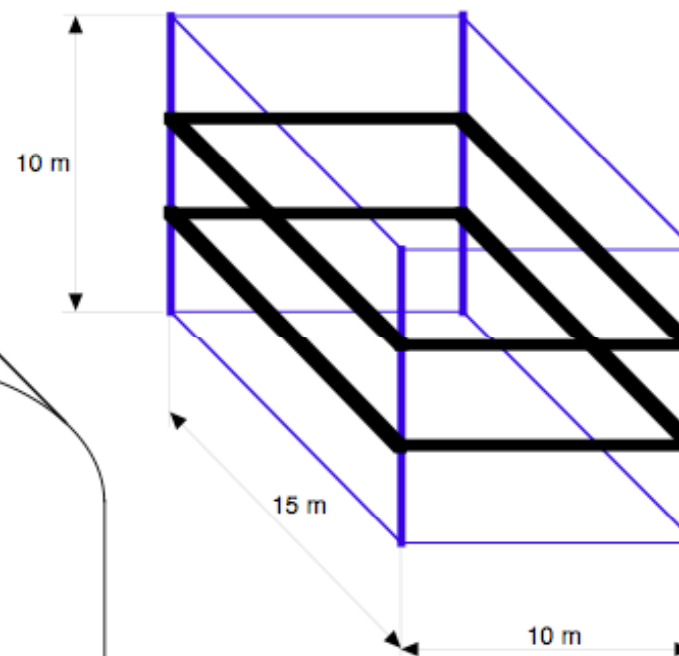


Service cavern layout

SERVICE CAVERN FOOTPRINT: 25 x 15 M2



Detector services block:
I-beam metallic structure
3 levels 3m high + false-floor



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

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

top floor:
electronics racks + miscellanea



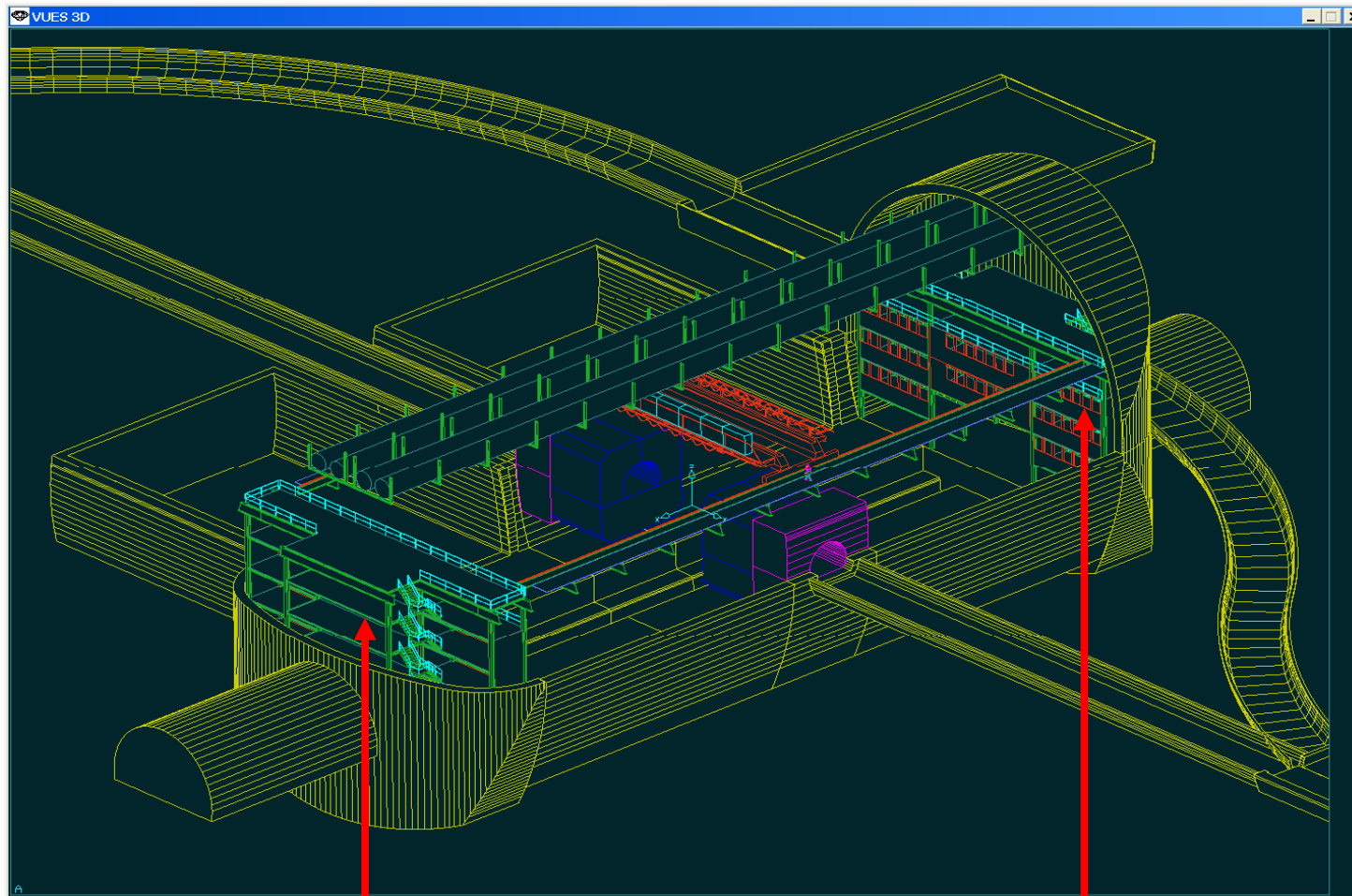
List of services housed in the “block”

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 liquefier, rough vacuum pumps, ...
- Electrical room for magnet power circuit: AC/DC power converter, breakers, ...
- 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, ...



Cavern balconies



Limited crane coverage

Only for light weight infrastructures (electronics racks)

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CMS Infrastructures

These slides have been presented during one of the phone meetings preparatory to this workshop. They give an overview of the CMS Infrastructures and can be used as a basis to define ILC detectors needs.



How much power

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)*

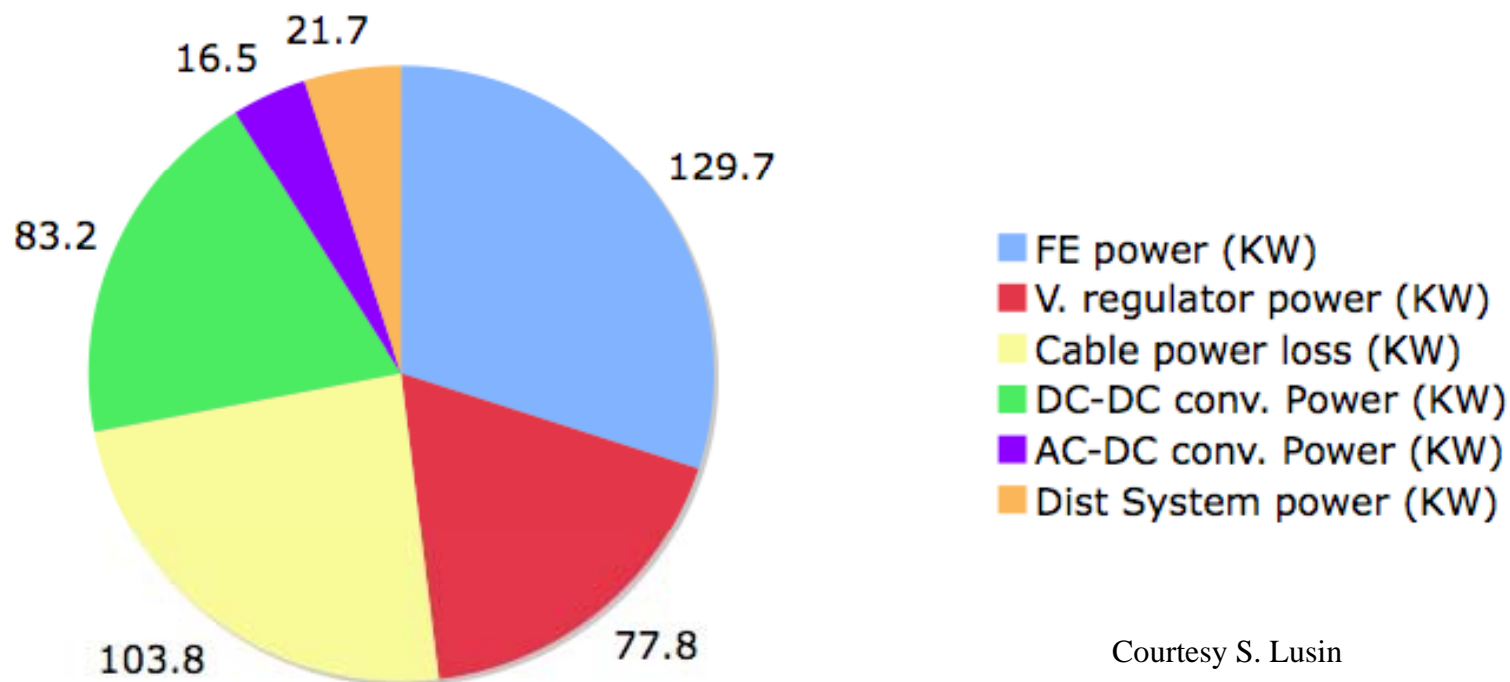
(*) refers to transient operations (cooling down, powering up, etc.)



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

ECAL Power Distribution



Courtesy S. Lusin

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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

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Dept.



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

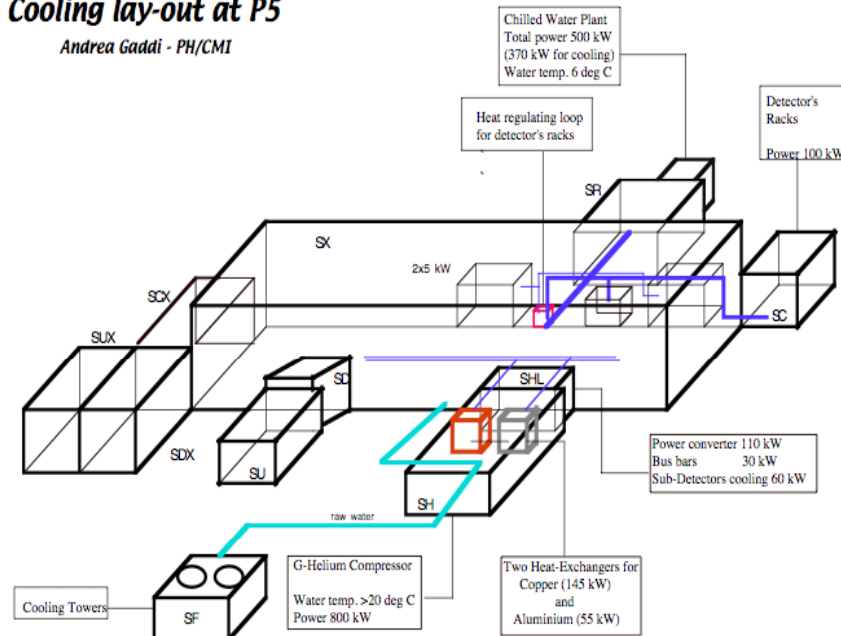


Cooling Infrastructures at CMS

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. 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.

Cooling lay-out at P5

Andrea Gaddi - PH/CMI





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.



Coil system components (20kA)

Equipment		Dimensions (cm)	Notes
DCCT	⇒	200x200x275(H)	
CP1-CP2	⇒	265X160X275(H)	per unit (2)
TRANSFORMER		185X270X270(H)	
MAIN BREAKER		70X285X270(H)	
COIL HEATER		90X280X270(H)	
POWER CONVERTER	⇒	200X160X240(H)	per unit (4)
PRIMARY PUMPS	⇒	100X140X120(H)	per unit (2)
48V BATTERIES			
CONTROL RACK		60X90X210(H)	per unit (12)

↓
More than 25m² required on the detector if on-board



Conclusions

IR infrastructures have to be defined by detectors and integrated at the earliest into the civil engineering design. A compromise between on-board services and a remote “service block” has to be found, making use also of cable-chains that assure permanent connections with the service block, allowing a smooth movement of the detector during the push-pull operation.

Heat has to be intercepted by water channels, preventing cavern heating-up.



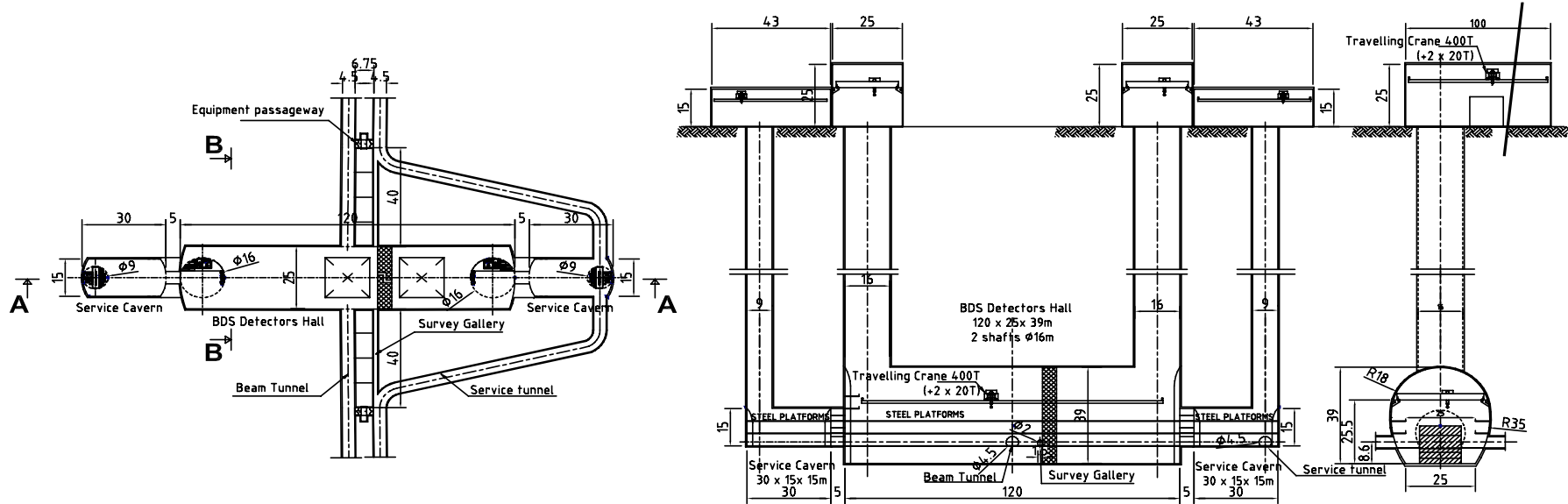
Back-up slides

Andrea Gaddi, CERN Physics
Dept.



Section A-A

Section B-B



ILC - BDS - DETECTORS HALL AREA LAYOUT AND SECTIONS (PUSH PULL OPTION) ALTERNATIVE 2 SERVICE CAVERNS

EUROPEAN REGION



PROJECT NO. ILC-CE-1.1600.0008
 SUPERVISOR : J. BALDY
 DESIGNER : N. BADDAMS

SCALE : 1/1000(A2) FORMAT DATE : 16 JULY 2007
ILC-CE-1.1600.0008 2 -

CERN CE Group - John Osborne

Andrea Gaddi, CERN Physics
 Dept.