The Abdus Salam
International Centre for Theoretical Physics

United Nations
Educational, Scientific and
Cultural Organization

IAEA
International Atomic Energy Agency

1858-12

School on Physics, Technology and Applications of Accelerator Driven Systems (ADS)

19 - 30 November 2007

Engineering Design of the MYRRHA (Building & Containment Design) Part VII

Didier DE BRUYN

Myrrha Project Coordinator,
Nuclear Research Division, SCK CEN
BE-2400 Mol (Belgium)

SCK • CEN
STUDIECENTRUM VOOR KERNENERGIE
CENTRE D'ÉTUDE DE L'ÉNERGIE NUCLÉAIRE

MYRRHA – DRAFT 2
Building & Containment Design

Didier De Bruyn, H. Aït Abderrahim

On behalf of MYRRHA team and MYRRHA support

http://www.sckcen.be/myrrha

Presented at the Workshop on "Technology and Applications of Accelerator Driven Systems" Trieste, 17-28 October 2005

The Building section in "Draft-1" was not much elaborated …

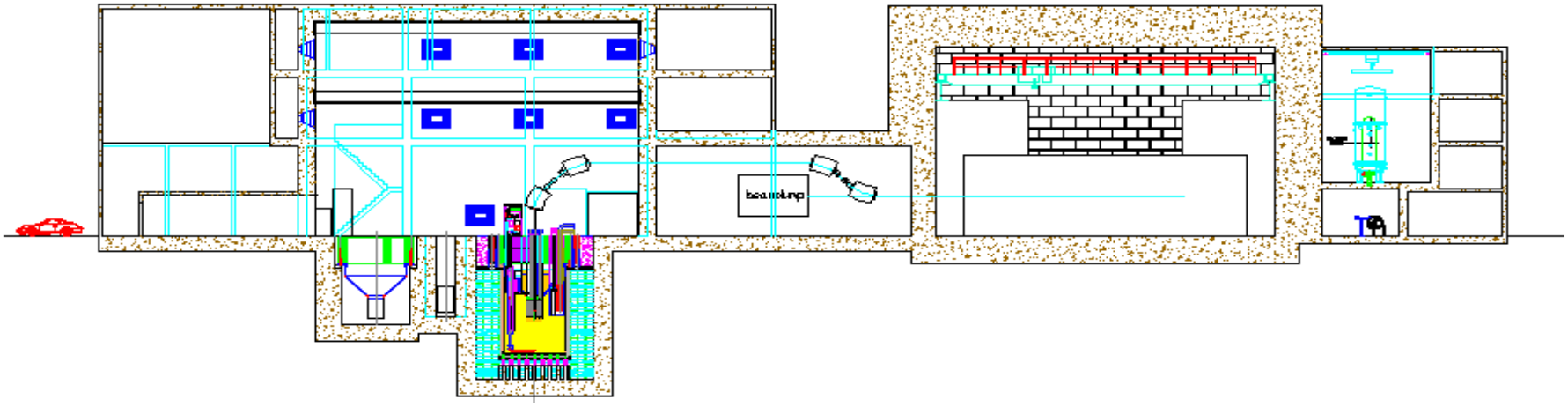
- A discussion between using an existing building (BR2, BR3) or erecting a new one;
  - the existing ones have limitations in dimensions
  - and are not compatible with RH
  - so a new one is required.
- still based on the cyclotron for the accelerator;
- so we got a rather surface building with just a reactor pit (see next slide).

A typical drawing from that time…

main dimensions:

length: 45 m; width: 40 m;

height: 30 m of which 12 m underground



This slide was presented by HAA at the ADTTA 2001 conference

SCK•CEN
STUDIECENTRUM VOOR KERNENERGIE
CENTRE D'ÉTUDE DE L'ÉNERGIE NUCLÉAIRE

We have progressed since then:

MYRRHA

- With the OTL study (2002), we got a reference configuration, partly underground;
- the Tractebel 2003 study has proven its technical feasibility;
- and the 2004 study has given a reasonable cost estimate (see later today);
- here at SCK•CEN, we have developed two alternative configurations:
  - "full underground"
  - "square building".

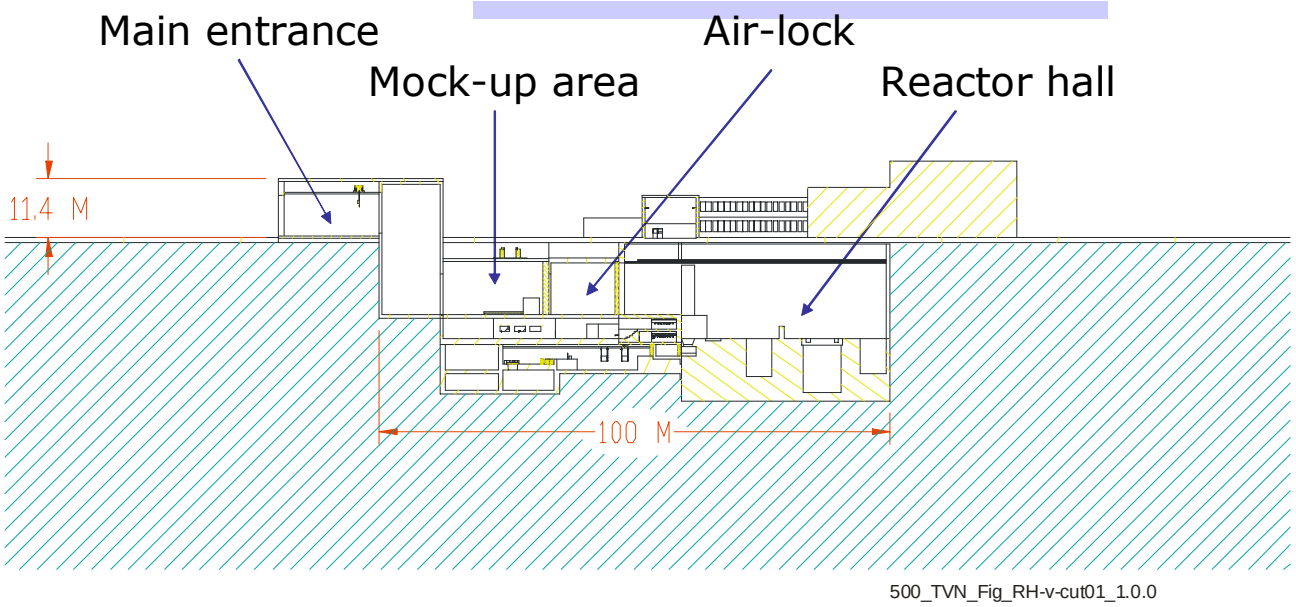
SCK • CEN
STUDIECENTRUM VOOR KERNENERGIE
CENTRE D'ÉTUDE DE L'ÉNERGIE NUCLÉAIRE

The hypotheses of the OTL building:

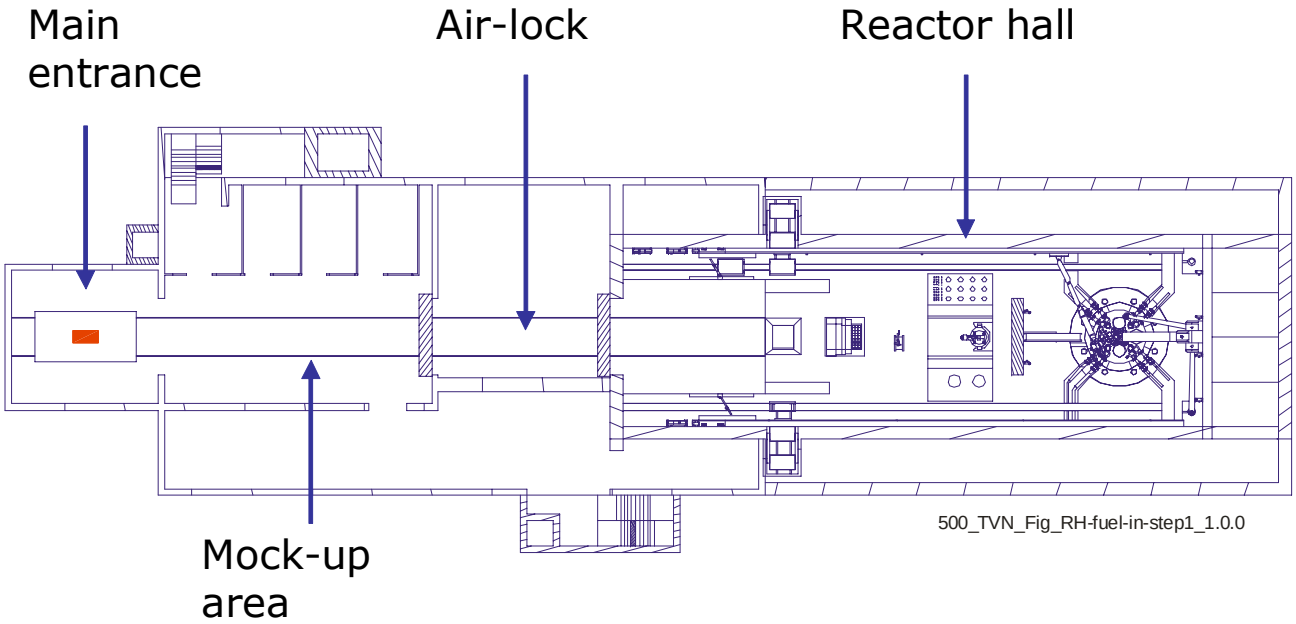
MYRRHA

- Using RH for all operation, inspection & maintenance has implications on the infrastructure around MYRRHA;
- target: 30 year lifetime without manual intervention in the MYRRHA hall;
- building includes facilities such as waste packaging, assembly hall, active workshop, …
- beam line arrives at ground level;
- last bending magnet in building roof;
- spallation loop can be removed as a whole.

So this is our reference configuration:



500_TVN_Fig_RH-v-cut01_1.0.0



500_TVN_Fig_RH-fuel-in-step1_1.0.0

main dimensions

length: 105 m

width: 38 m

height: 40 m

30 m underground

SCK•CEN
STUDIECENTRUM VOOR KERNENERGIE
CENTRE D'ÉTUDE DE L'ÉNERGIE NUCLÉAIRE

Two potential locations on the SCK•CEN technical domain:

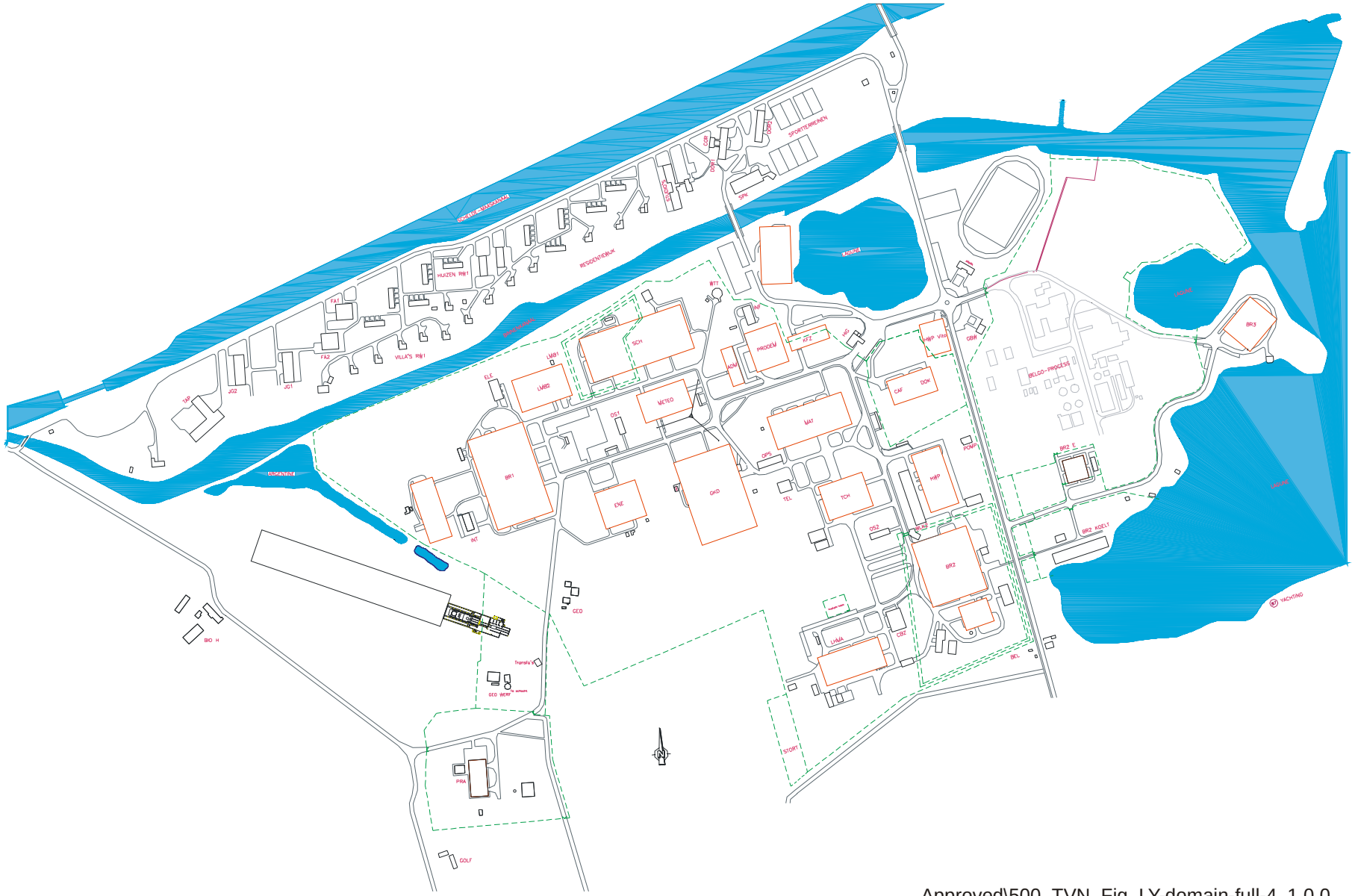
MYRRHA

- Between the LHMA, GKD and TCH buildings
  - vicinity may be an advantage during the operational phase because of transport,
  - but the construction will be more delicate (limiting the settlements of those buildings);
- Or between the BR1 building and the GEO
  - almost opposite remarks (available area without buildings in the immediate vicinity).

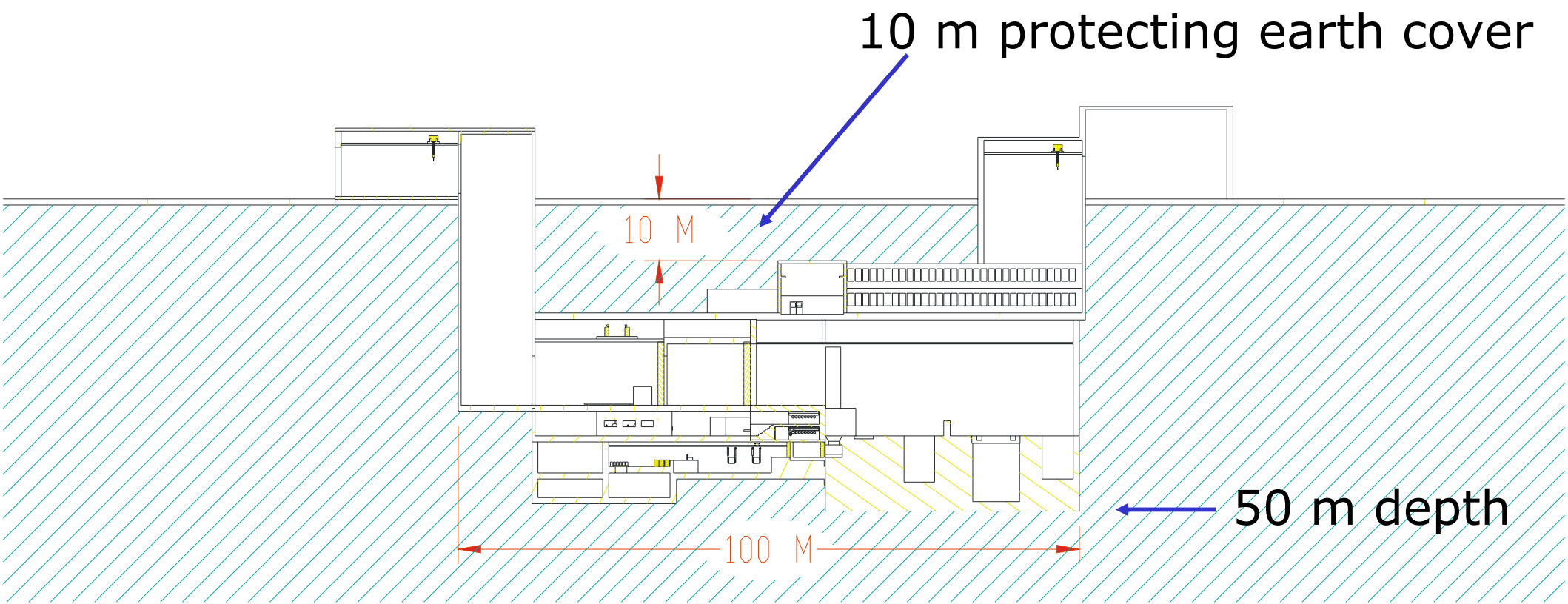
SCK • CEN
STUDIECENTRUM VOOR KERNENERGIE
CENTRE D'ÉTUDE DE L'ÉNERGIE NUCLÉAIRE

This last location:

MYRRHA



Our original "full underground" alternative



Approved\500_TVN_Fig_RH-v-cut03_1.0.0

The potential techniques on the SCK•CEN technical domain:

- Sand layers up to 160 m depth, good quality for bearing capacity, but …
- Water table almost at surface level, so …
- Only some construction techniques are available for the reference option;
- And even less for the totally underground option.
- 30 m depth is OK, 50 m not!

SCK • CEN
STUDIECENTRUM VOOR KERNENERGIE
CENTRE D'ÉTUDE DE L'ÉNERGIE NUCLÉAIRE

Several techniques have been examined:

MYRRHA

\Walls Slab	Diaph. walls	Pneum. caisson	Open well caisson	Ground freezing	Secant piles	Sheet piles
Water concrete slab						
Two phases slab						
Dewatering + plain concrete						
Jet grouting						
Consolidation grouting						
Pipe jacking						
Ground freezing						
Secant piles						

possible (-30) / limit (-50)

severe impact on environment

not recommended

for the whole: no/ locally: yes

SCK • CEN
STUDIECENTRUM VOOR KERNENERGIE
CENTRE D'ÉTUDE DE L'ÉNERGIE NUCLÉAIRE

Some illustrations (1)

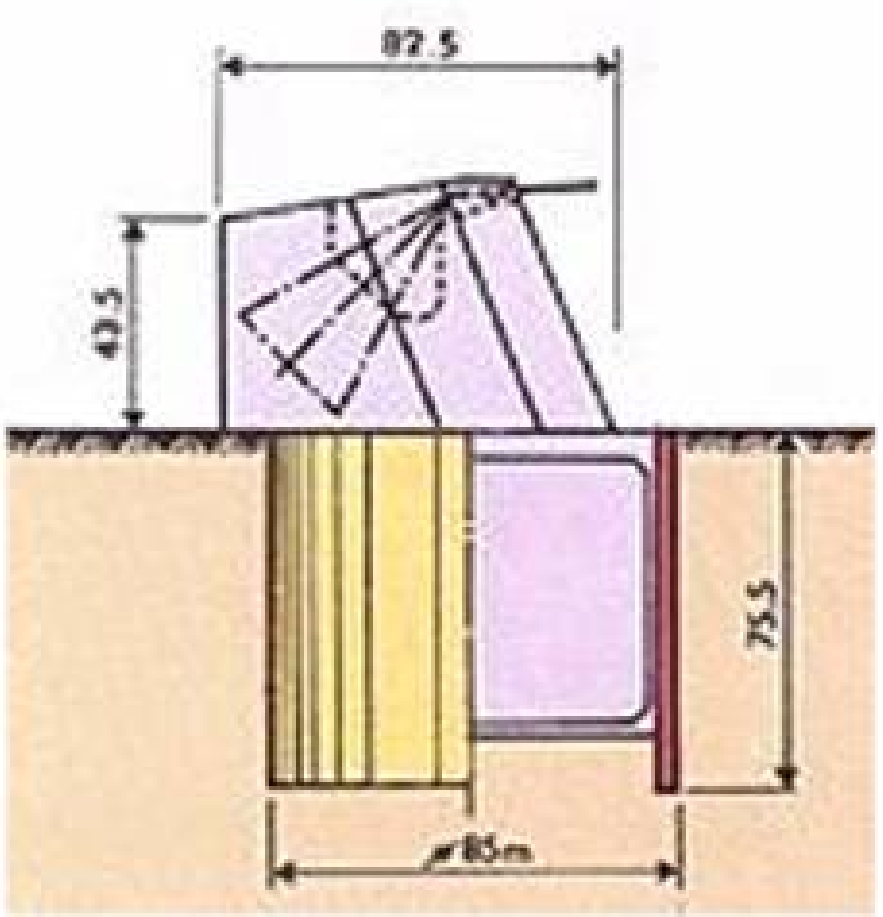
MYRRHA

- Reinforced diaphragm walls;
- where: Monaco;
- depth: 34 m
- contractor: Soletanche-Bachy

SCK • CEN
STUDIECENTRUM VOOR KERNENERGIE
CENTRE D'ÉTUDE DE L'ÉNERGIE NUCLÉAIRE

Some illustrations (2)

MYRRHA



diaphragm walls; Akashi bridge (Japan)

85 m diameter; depth 75,5 m

Why going further with the "full underground" alternative?

- We were not aware that a 30 m depth was feasible but 50 m depth almost impossible
  - (not only technically: the wall thickness becomes huge if we build it as a rectangle);
- The limit that lies between 30 & 50 m may be depending on the technique chosen;
- We also learned during a PDS-XADS meeting that the beam line should also be covered (4 m thickness for a 350 MeV beam line);
- So we tried to re-arrange the different functions in a more quadratic shape.

SCK • CEN
STUDIECENTRUM VOOR KERNENERGIE
CENTRE D'ÉTUDE DE L'ÉNERGIE NUCLÉAIRE

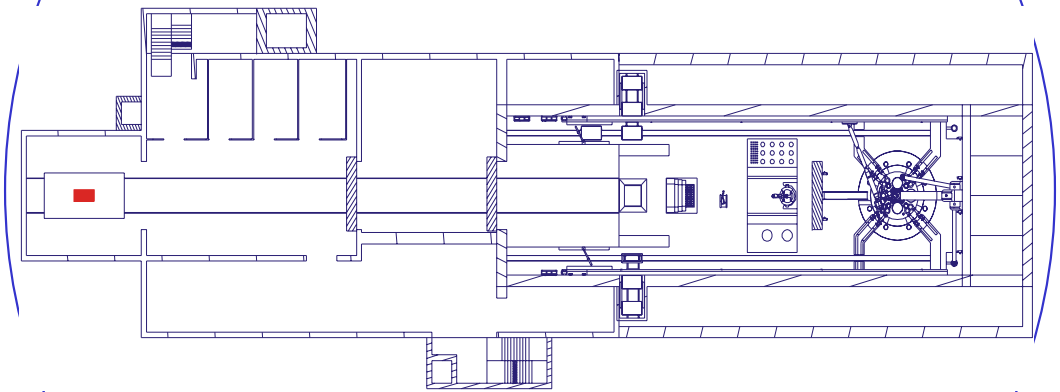
What we did and the consequences:

MYRRHA

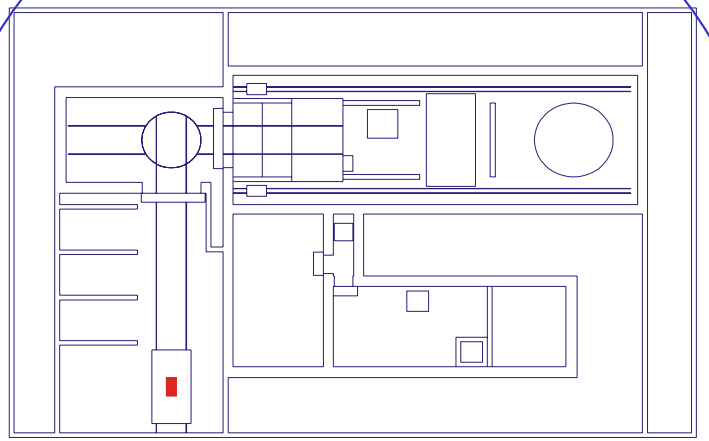
- We kept the reactor hall but discarded the requirement "horizontal movement in only one direction" that ensures a smooth movement of pieces within the whole building;
- So the "thin" shape (105 m long by 38 m wide) becomes more quadratic (70 m long by 47 m wide, see next slide);
- However the main airlock is now equipped with a rotating table;
- And the transfer from the hall to the active workshops is also more complicated.

Building more quadratic, so circle around smaller

112 m diameter



84 m diameter



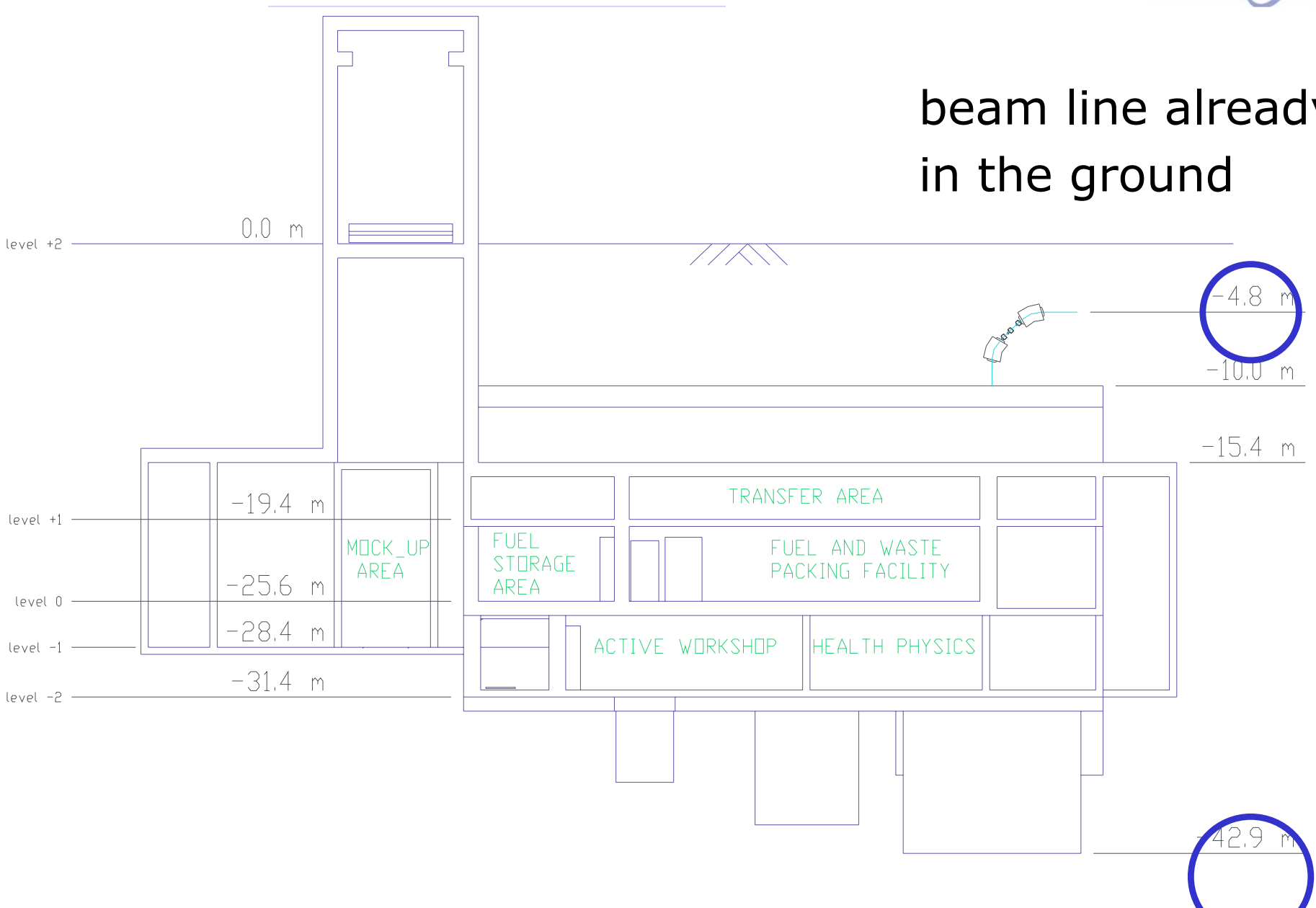
Shape of diaphragm walls

SCK • CEN
STUDIECENTRUM VOOR KERNENERGIE
CENTRE D'ÉTUDE DE L'ÉNERGIE NUCLÉAIRE

Second result of this iteration: less than 50 m depth

MYRRHA

beam line already in the ground



SCK • CEN
STUDIECENTRUM VOOR KERNENERGIE
CENTRE D'ÉTUDE DE L'ÉNERGIE NUCLÉAIRE

Our reference configuration is still incomplete:

MYRRHA

- Several items are indeed still in the shadow:
  - beam line entry;
  - air lock concept;
  - gas filtering;
  - Δp between building parts or
  - external & internal loadings to be taken into account.
- but my main message is: **do not wait the end of the design to discuss with the civil engineering!**