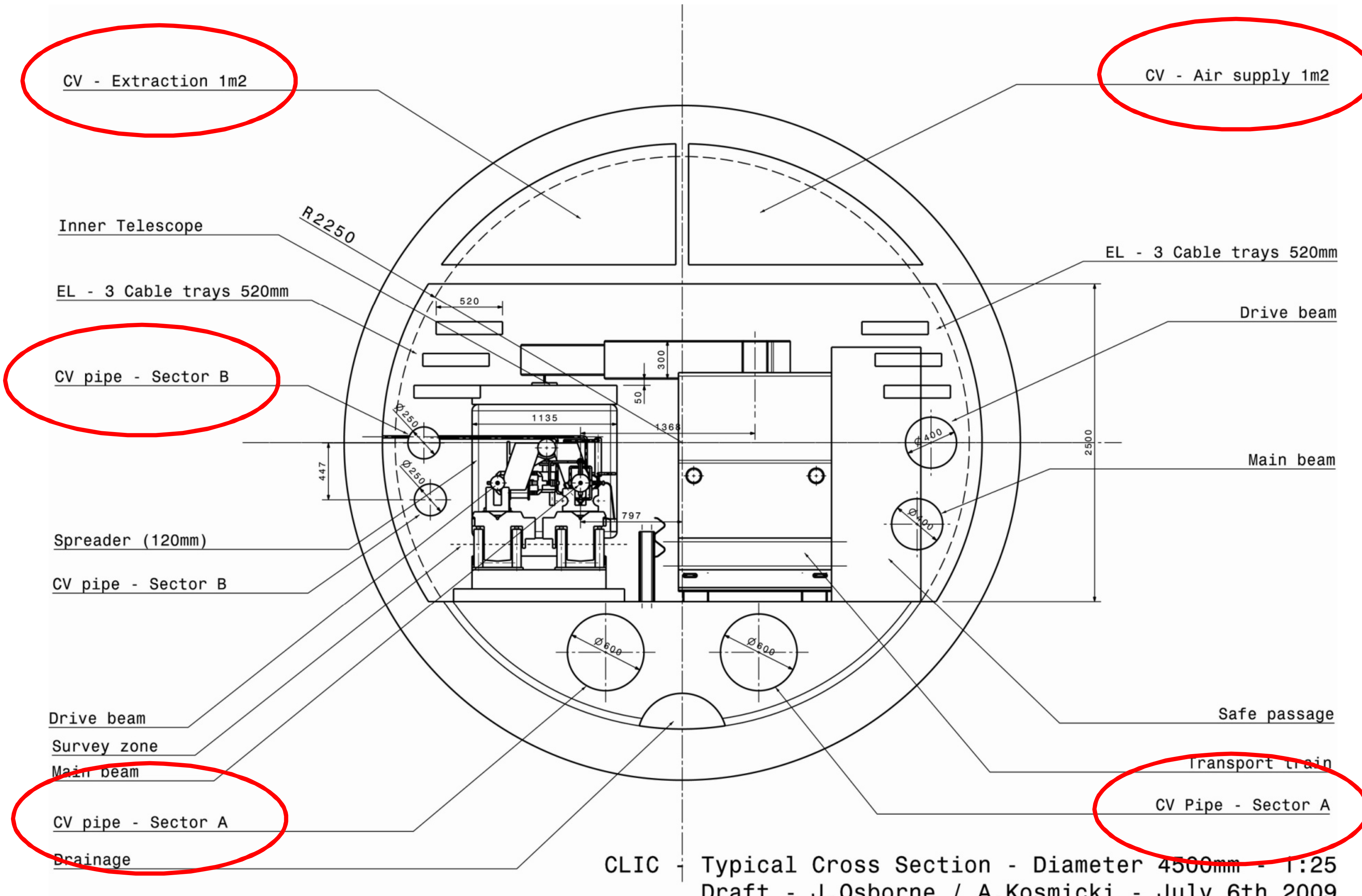
COOLING & VENTILATION FOR THE DRIVE BEAM TUNNEL

M Nonis – EN/CV – 16/9/2009

Agenda

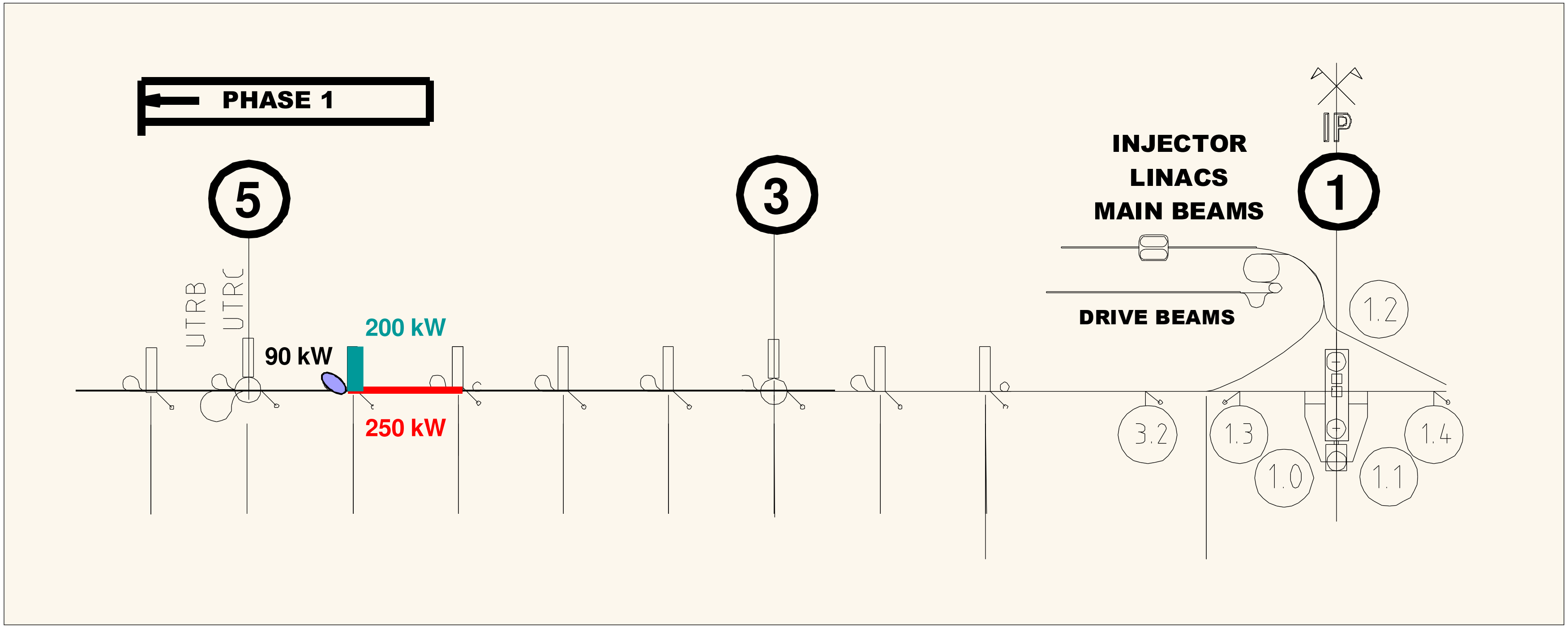
- Tunnel cross section
- Ventilation:
  - main parameters
  - improvements, pending issue
  - proposed solution
- Cooling:
  - main parameters
  - proposed solution
  - pending issues

Tunnel cross section



Ventilation main parameters: heat dissipation in the air

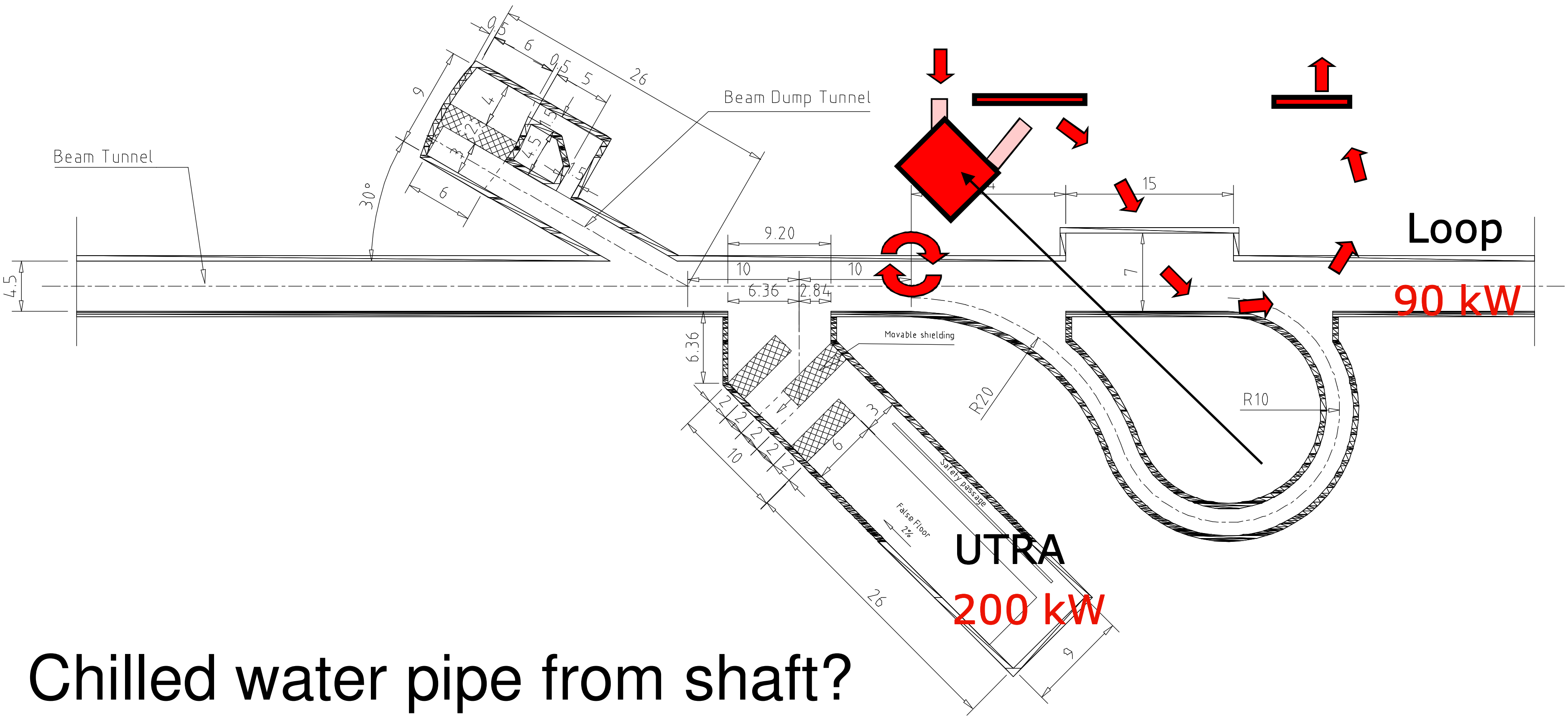
Drive Beam sector = 250 kW
UTRA cavern = 200 kW
Loop = 90 kW



Heat dissipation in the tunnel:
250 kW / DB sector
1250 kW between two shafts

Heat dissipation in the Loops & UTRA:
290 kW / DB sector
1450 kW between two shafts

Ventilation of UTRA and loop: local cooling solution



Chilled water pipe from shaft?

Ventilation working parameters:

Cooling power: 1250 kW
Delta T: 20 °C → 17-37 °C

Flow rate: 180’000 m3/h

- If v= 12 m/s → Cross section: 4.1 m^2
- If cross section 1.2 m^2 → v= 41 m/s

Possible improvements

a) Reduce the cooling power removed by air

- Cross section ducts: 1.2 m^2
- Flow rate: 52’000 m^3/h
- Cooling power:360 kW

b) Using pre-alignment shafts for ventilation shall allow a reduction in the dimensions of AHU on surface

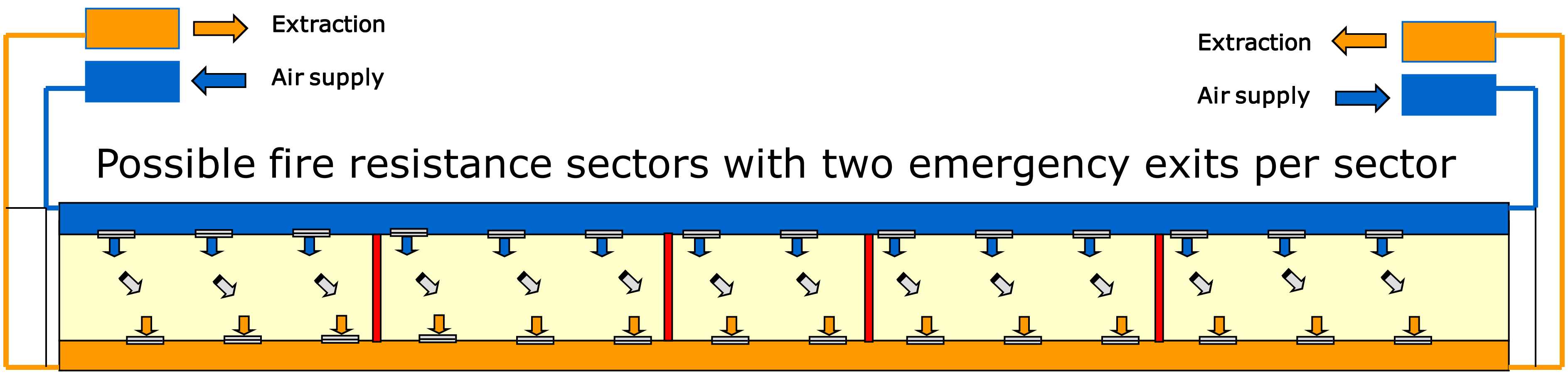
Pending issue

c) Validate the delta temperature

- Supply and extraction temperatures are average values at louvers position.
- Effective temperatures close to equipment are related to the heat load in each component and local air speed: HOT SPOTS
- Define the maximum acceptable temperature for equipment

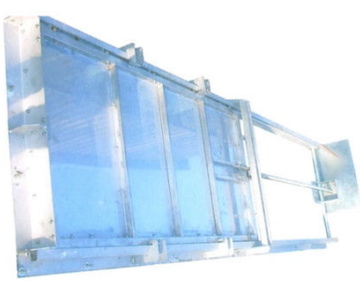
Proposed solution

Semi transversal principle



Optimisation of the air flow rate
Low air speed in the tunnel
Optimisation of the gradient temperature
Reversible and redundant operation possible
Energy recovery possible, recycling of air

SHAFT POINT



1 Smoke extraction trap per sector

NEXT SHAFT POINT

1 supply and extraction grille per 30 mtrs.

Water cooling main parameters

	User	Power [MW]	Delta T [°C]	Flow rate [m3/h]
Circuit A Demineralized water	Modules	70	27-45	3'350
Circuit B Demineralized water	UTRA, UTRC, loop, beam dump	15	27-52	516
Circuit C Raw water	Fire fighting	n.a.	n.a.	35
Circuit D Compressed air	Regulation	n.a.	n.a.	760
Drain system	Pumps in each UTRA; raised in each shaft			

Water cooling main parameters

WITH EXISTING CROSS SECTION

	Flow rate [m3/h]	**ND**	**Pressure loss [bars/km]**
Circuit A Demineralized water	3’350	600	~ 1.13
Circuit B Demineralized water	516	300	~ 0.8

Impossible to regulate the pressure at each delivery point for modules with such a pressure difference along the supply pipe

Possible solutions

- Use of booster pumps along the tunnel to have lower working pressure,
- Increase of pipes diameters:
  - ND600 → ND800
  - ND300 → ND400
- Use of cooling towers every 4.4 km,
- Doubling the circuits to reduce the flow rate and working pressures.

Pending issues

- Space needed in the cross section to pass from ND600 to delivery point (ND50? T.b.c.)
- Temperatures are at outlet of cooling station: stability in lenght still to be analysed
- Stability of temperature in time: local heating.
- Cooling with water from lake: reduce inlet temperature

Conclusions

AIR	- Thermal charges removed by air to be confirmed - Validate working temperatures for air
WATER	- Pressure loss on cooling circuit to be reduced; - Temperature stability in time and length - Study of connection between main collector and cooling pipe for module
	- Ratio air/water heat dissipation confirmed? - Evaluate the impact on tunnel cross section - All this figures require the use of non standard manifacturing, tooling and equipment: increase of costs.

Still to be discussed: heat dissipations in Exp. Caverns, LINACS etc.....