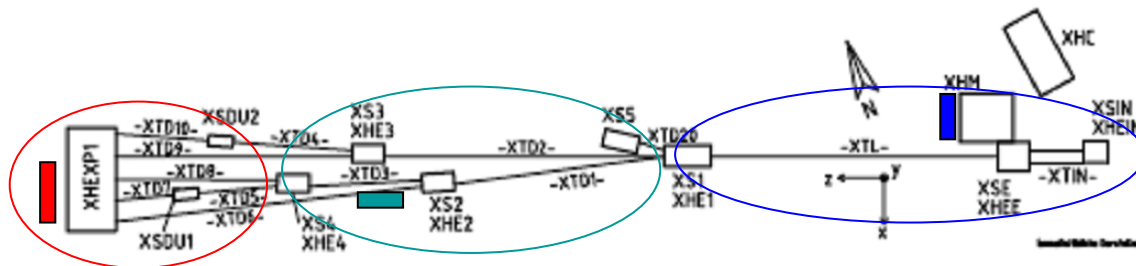


EIFast Workshop for the European X-FEL Project

Contribution 5 Water Cooling

Pump stations,	supplied sections	and	recooling power
➤ DESY	linac and injector tunnel		17 MW
➤ Distribution	undulator tunnel		2 MW
➤ Experiment	photon tunnel, dumps, hall..		8 MW



Main components of the cooling system

- ❖ Pipes
- ❖ re cooler
- ❖ chiller machines
- ❖ water treatment
- ❖ pumps

Main cooling water (30°C <-> 50°C)

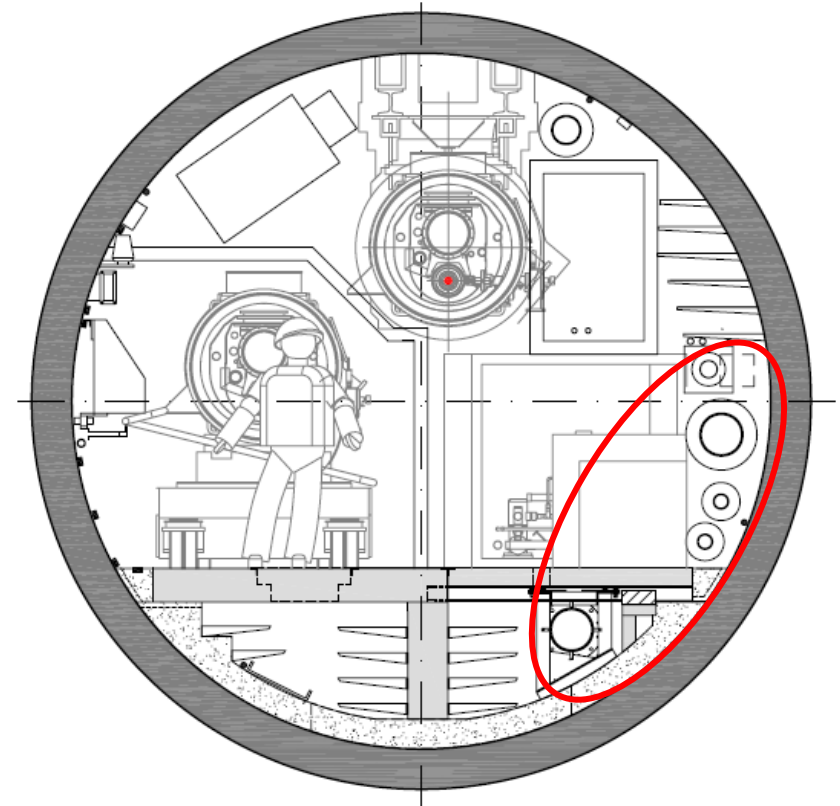
- low conductivity water ($S \leq 1 \mu S/cm$)
direct cooling from high-voltage-devices
- DN 300 PN 10 / 1.4541 (ASI 316 Ti)
return pipe insulated
- length over all 2 x 2100 m
- welded 6m or 12m pieces
- flanged axial compensators
- every 50m outlet DN 65 (valve)

Cold water (18°C <-> 25°C)

- not controlled LC-water
 - DN 125 PN 10 / 1.4541
 - every 50m outlet DN 25
 - length over all 2 x 2100 m
 - not insulated
dew point in the ambient air is lower
- Other points similar to the main cooling

Auxiliary Pipes

- water and gas
 - DN 125 - DN 15
 - 1.4541 or SF-Cu
- pressed air, nitrogen, drainage water, pure water to the recoler



Chilled water (6°C <-> 12°C)

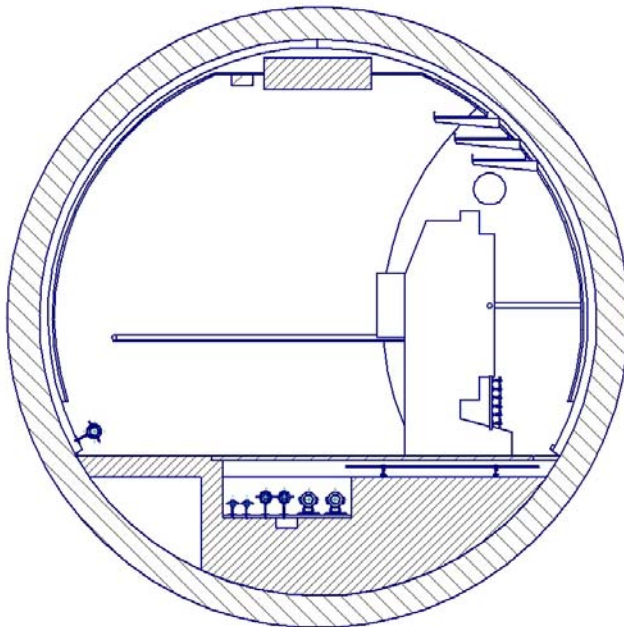
- not controlled LC-water
 - DN 250 - DN 25 PN 10
 - 1.4541 or SF-CU
- Supply pipes for air conditioning

Main cooling water / Cold water / Auxiliary pipes

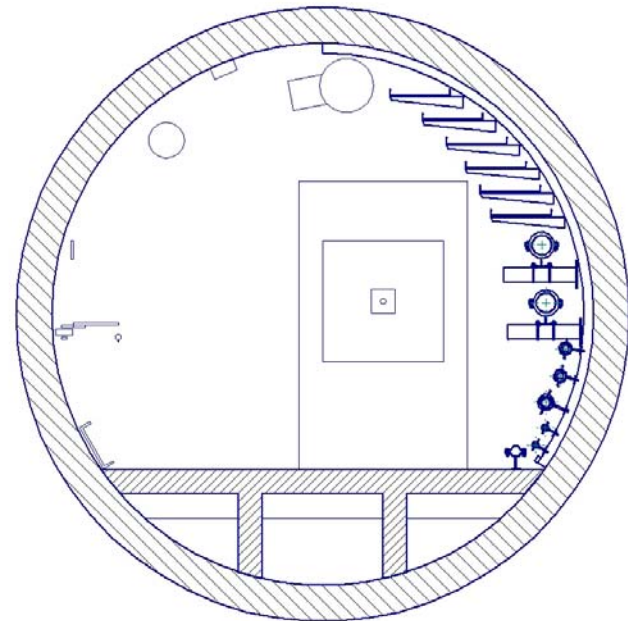
Fraction of the cost

Main Tunnel : Undulator tunnel : Photon tunnel

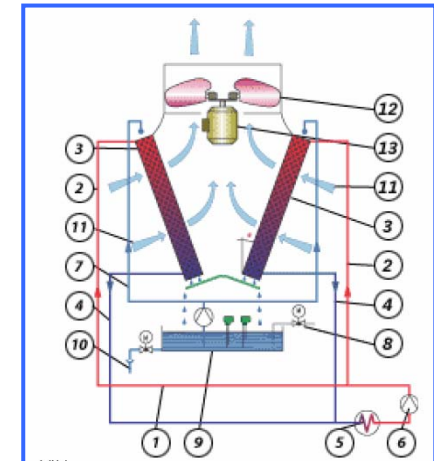
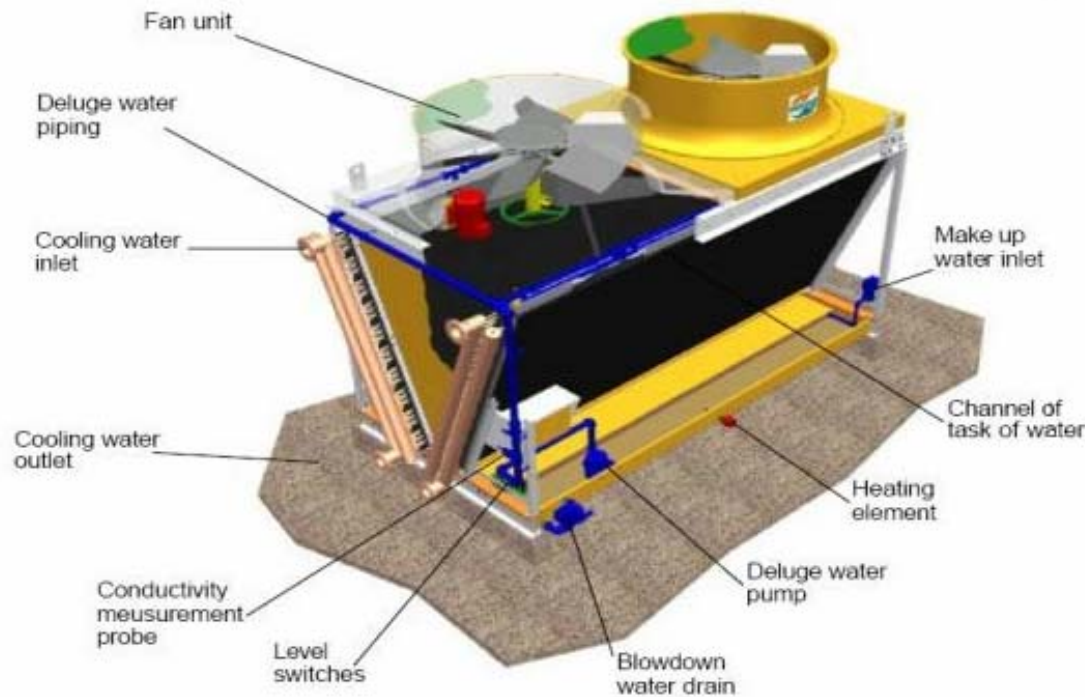
3 : 1 : 2



Undulator tunnel



Photon tunnel

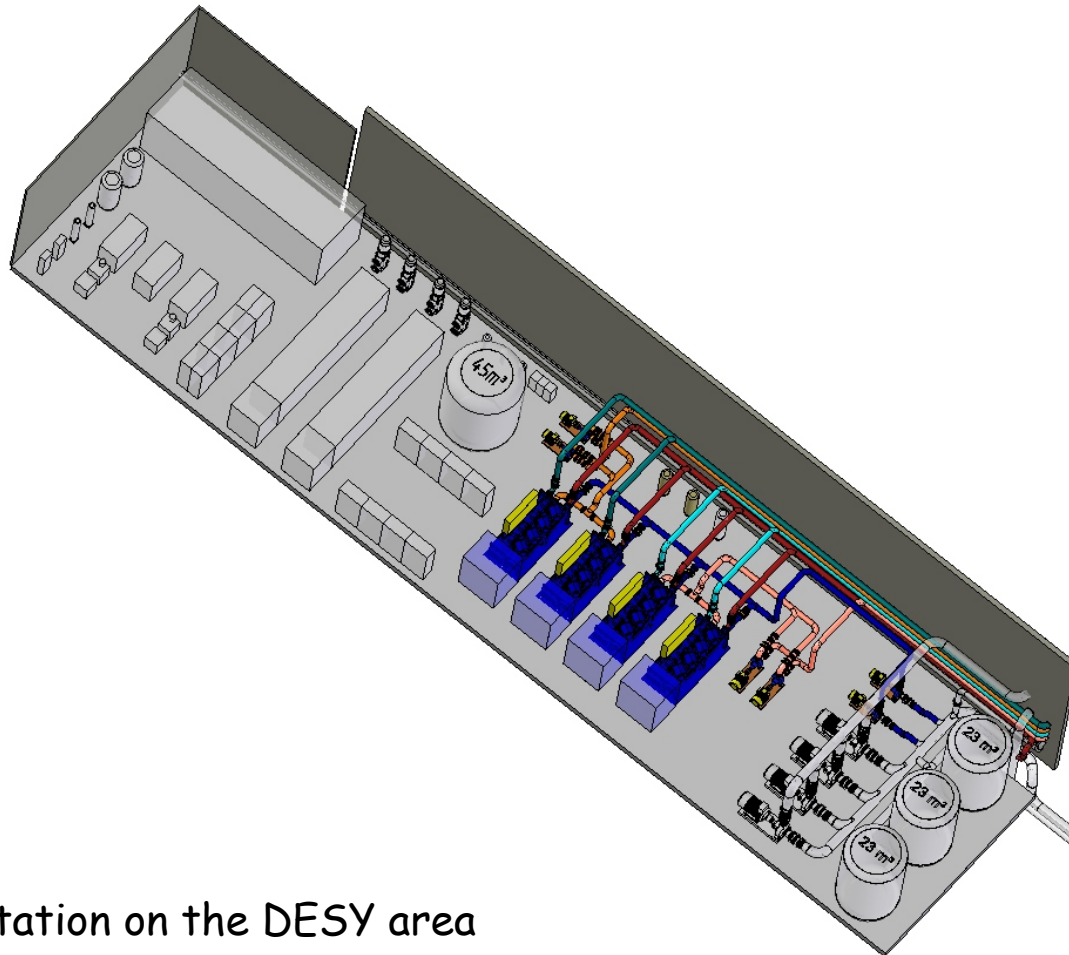


Hybrid cooler

- heat transfer: dry or evaporation
- ambient air temperature > threshold temperature : wetted finned tubes
- operating mode = f (head load, velocity of the fans, ambient air conditions)

Technical details and demands

- design point temperature : 35°C / 30% r.h.
- threshold temperature dry/wet of ≥ 15 °C
- no visible vapour plume
- low noise level ($< 50/35$ dB(A) at 80m)
- easy to maintain and to inspect
- finned tube has to be completely wetted
(only water drops in the air not sufficient)
- low space requirement
- drain system to prevent freezing
(no Glycol additives)
- wetted with make-up water ($S \leq 15$ $\mu\text{S}/\text{cm}$)
To avoid damage caused by calcification

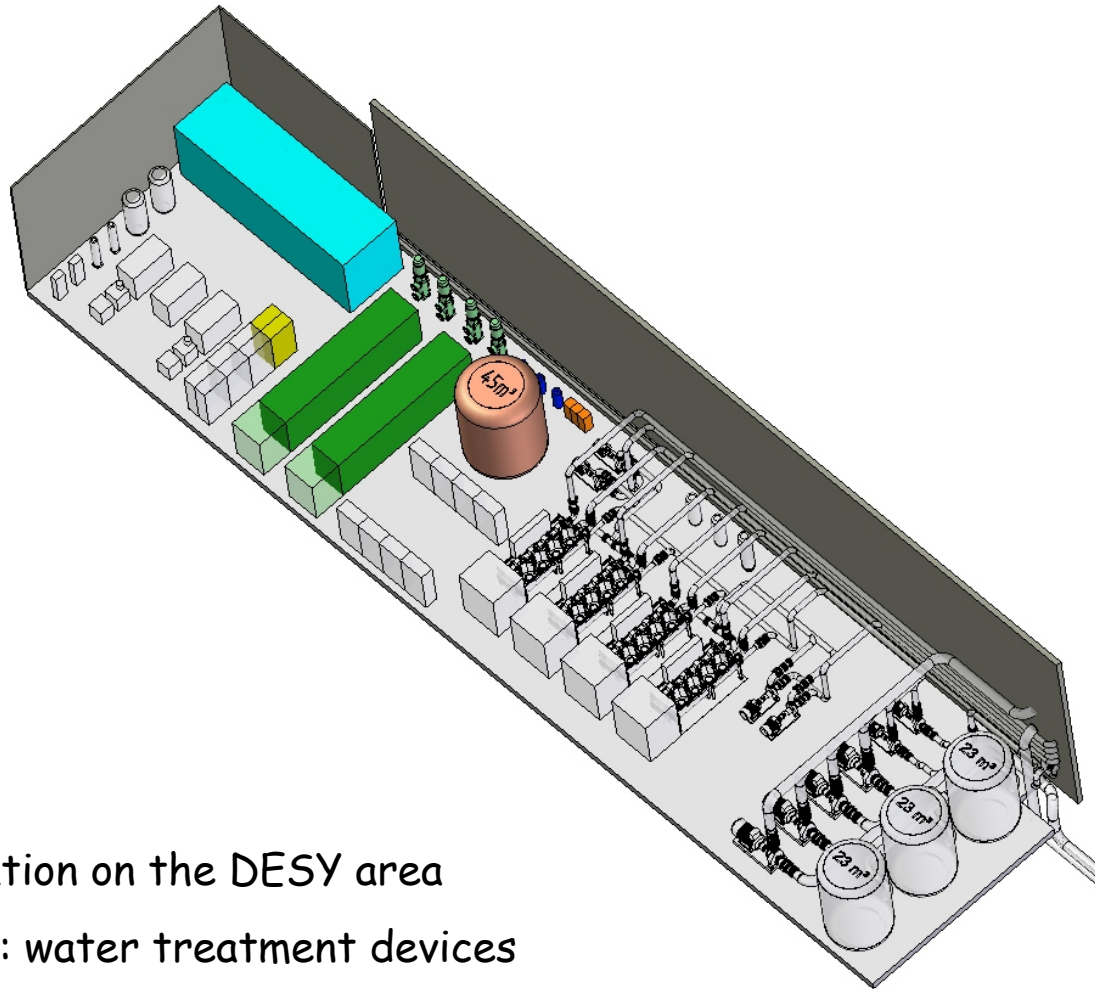


Pump station on the DESY area

Coloured: chiller machines and pipes

Technical details and demands

- Power: $\sim 3,7$ (6,2) MW
(in units from 200 kW to 1800 kW)
- number ~ 10 (16)
- Temperature 18°C or 6°C
- upgradeable machines
- regulation without steps
- operation range 20% ... 100%
- refrigerant R134a
- temperature at the re-cooling-side $> 45^{\circ}\text{C}$
e.g. flow-controlling to increase the temperature to the cooling tower in case of reduction of the chill power



Pump station on the DESY area

Coloured: water treatment devices

Well water after iron removal (750 $\mu\text{S}/\text{cm}$)

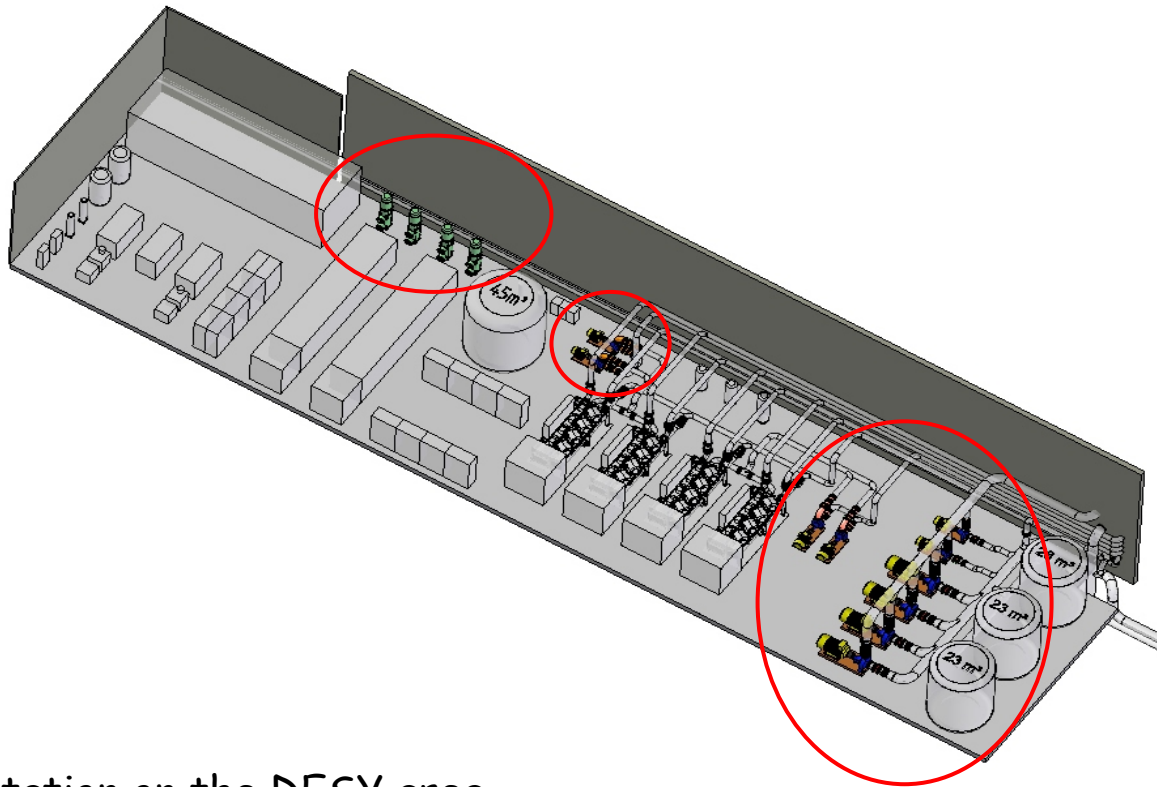
Water softening preferred by scale inhibition

Reverse osmosis (15 $\mu\text{S}/\text{cm}$) $\longrightarrow$ Hybrid cooler
only at DESY

Ion-exchanger cartridge (< 1 $\mu\text{S}/\text{cm}$) $\longrightarrow$ Cooling water
at every pump station for refilling and stabilization of the conductivity circuits

Technical details and demands

- treatment capacity ca. 45 (60) m^3/h
switched off during the winter and a fraction of this value during most of the time of the year
- stabilization 5 .. 10 m^3/h
- permeate buffer tanks for the peak demand of the hybrid cooler at hot days
- regeneration done by tender



Pump station on the DESY area

Coloured: pumps

Technical details and demands

- power 132 kW ... < 1,5 kW
 - cast-bronze or stainless steel
 - number > 100 pieces
 - sound pressure level < 75 dB(A) $f(\# \text{ pole pairs, power})$
 - vibration damping (> 90%)
 - frequency controlled electro motors
- pressure = speed set point

• Pipes, main tunnel	<= 3 contract lots	DN300,... CU-DN25
• Pipes, distrib. tun	> = 8 contract lots	XTD.. Pro tunnel and halls
• injector building	1 contract lot	one construction phase
• recooler	1 contract lot	maintenance, stock keeping
• chiller	<= 3 contract lots	per pump station
• water treatment	1 contract lot	only one big station
• pumps	<= 3 contract lots	per pump station, kind of water
• pump station	3 contract lots	pipes and assembling
• water connect.	> 20 contract lots	for every tunnel, halls,...
• air compressors	<= 3 contract lots	per pump station
• auxiliaries	> 20 contract lots	measurement devices, valves,...

Call for tender

2007/2008	main tunnel
2008	Pump station (Desy)
2009	injector, distribution tunnel I
2010	Pump station (Distr. Tunnel)
2010/2011	distribution tunnel II, Experiment
2012/2013	Water connections

Milestones will be provided by the Surface-Building-group

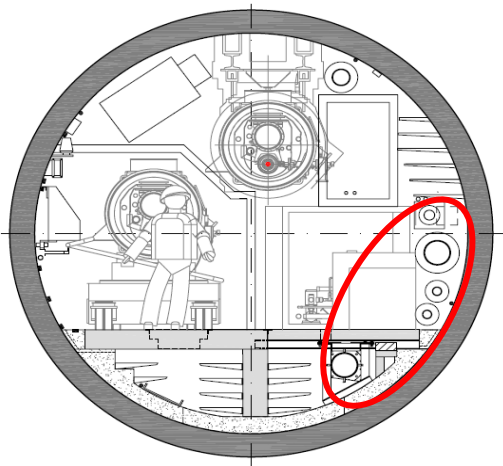
By DESY

- Basic design
- calculation of the hydraulic system
- Simulation of the control system and the heat transfer elements
- Basic planning
- design proposal of pipe support and fixed points etc.

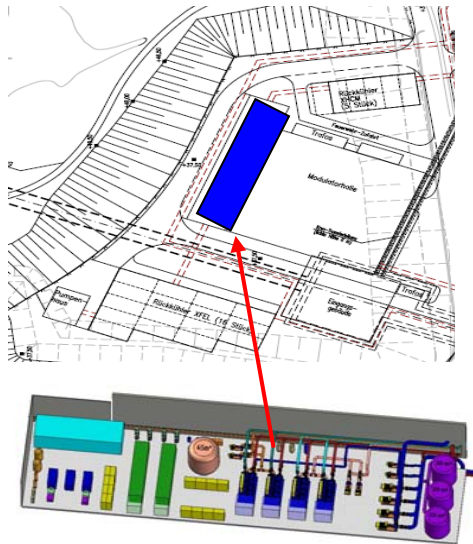
By industry

- delivery of all devices, equipments and pipes
- assembling of all pipes
- design, calculation, certification (if demand) and delivery of all pipe supports and fixed points
- installation of all components (pumps, recoler,...)
- design and installation of small pump stations (Dump, Gun,...)
- ordering of valves, compensators, etc (if/as ordered from DESY)
- maintenance of the water treatment equipment

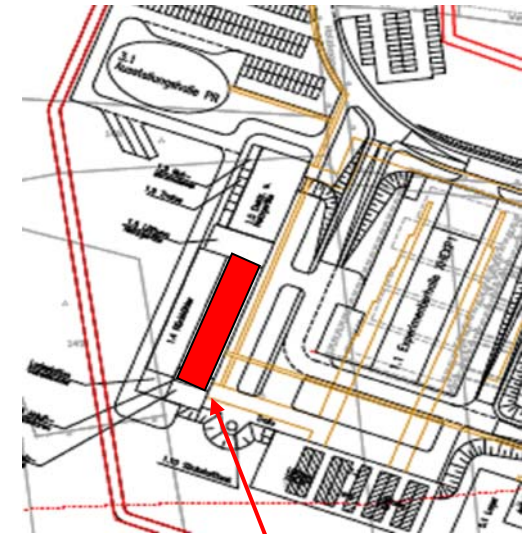
The water cooling system is planned by DESY as later operator and designed in the fundamental parameters. The delivery and assembly will be carried out almost exclusively (according to DESY default) by the industry. During XFEL operation the largest part is taken over again by DESY, however some services will be covered by the industry.



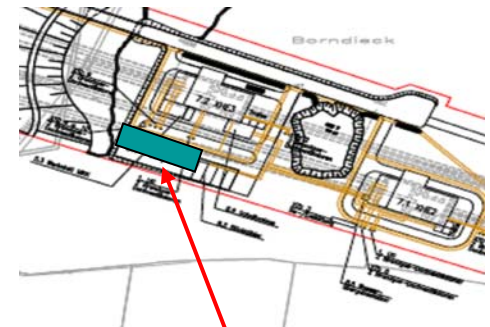
Pipes in the main tunnel



Pump station DESY



Pump station
Experiment Hall



Pump station
Distribution Tunnel