Operation Status of HLS system installed to Measure Ground Change of Large Scientific Equipment in Real Time

WEPH18

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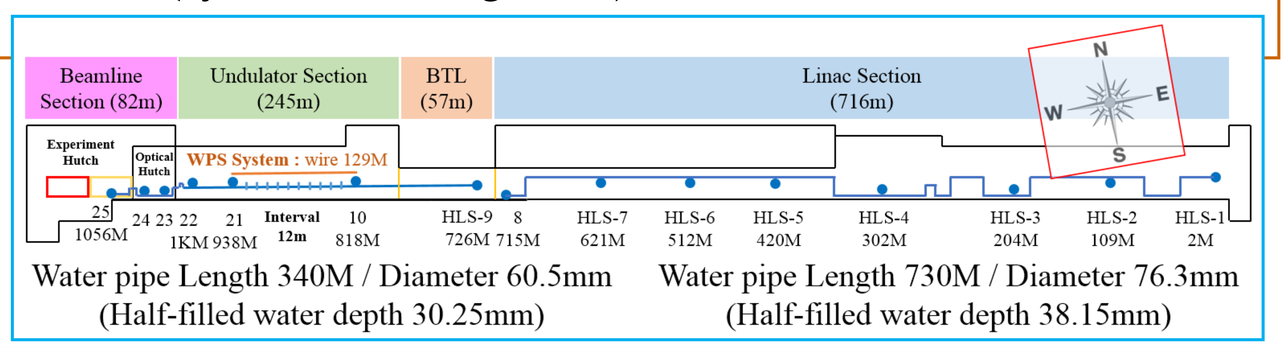
Several parts that comprise the large scientific equipment should be installed and operated at precise three-dimensional location coordinates X, Y, and Z through survey and alignment to ensure their optimal performance. As time goes by, however, the ground goes through uplift and subsidence, which consequently changes the coordinates of installed components and leads to alignment errors ΔX, ΔY, and ΔZ. As a result, the system parameters change, and the performance of the large scientific equipment deteriorates accordingly. Measuring the change in locations of systems comprising the large scientific equipment in real time would make it possible to predict alignment errors, locate any region with greater changes, realign components in the region fast, and shorten the time of survey and realignment. For this purpose, a HLS's (hydrostatic leveling sensor) with 0.2um of resolution are installed and operated in a water pipe of total length 1km in the PAL-XFEL building.

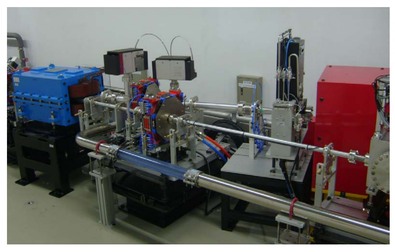
BC1	330MeV
BC2	2.52GeV
SX Branch	3GeV
BC3	3.45GeV
Linac End	10GeV

The position of HLS and WPS in PAL-XFEL



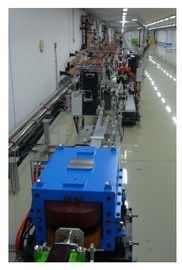
Laser Photocathode RF Gun

Beam Energy Analytical Station (BAS)



Bunch Compressor (BC)

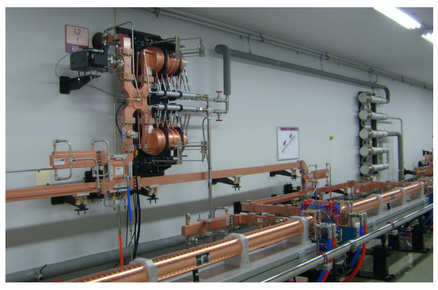
SX Branch



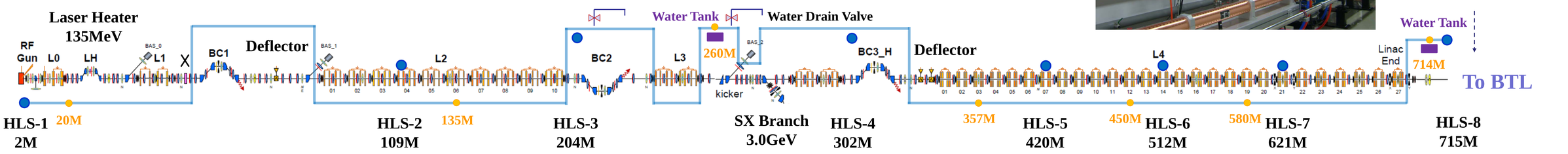
Water Drain Valve

200MW Pulse Modulator & S-band 80MW Klystron

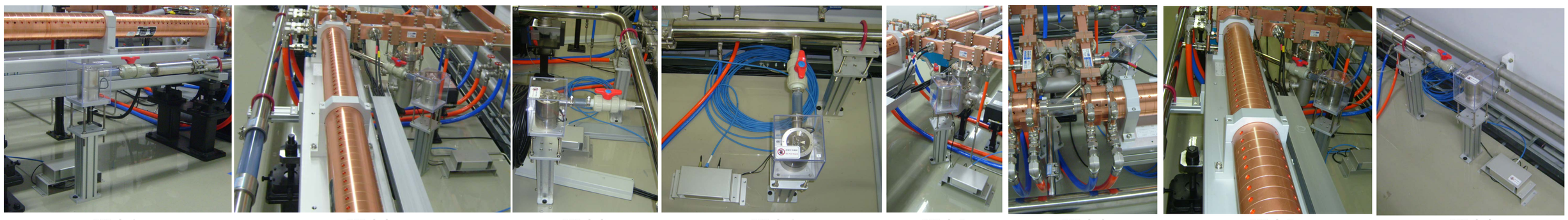
Stanford Linear Accelerator Energy Doubler (SLED) & Accelerator structures



Plastic air circulation barrier



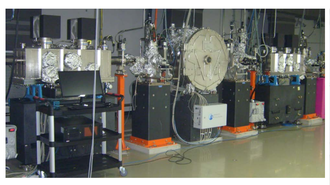
Linac Water-pipe Length: ~730m Pipe Diameter: 76.3mm BINP Untrasonic HLS Sensor Air Hole



HLS-1 HLS-2 HLS-3 HLS-4 HLS-5 HLS-6 HLS-7 HLS-8

Hard X-ray Experiment Hutch (HEH)

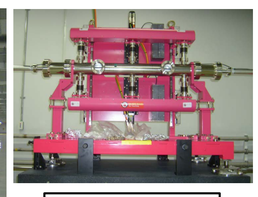
Mirror 1 DCM Mirror 2



E-Beam Dumper

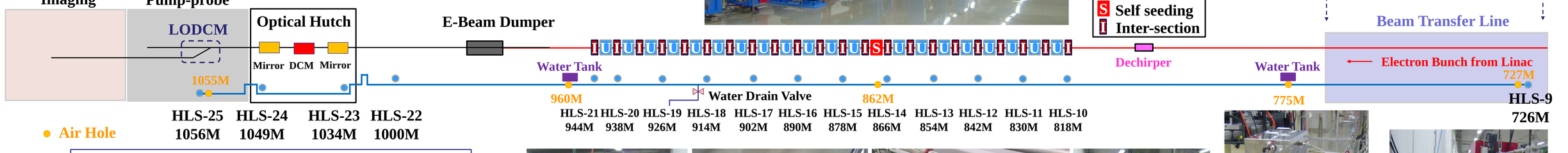
Hard X-ray Undulator

Dechirper



Plastic air circulation barrier

HEH-2 Imaging
HEH-1 Pump-probe
Optical Hutch



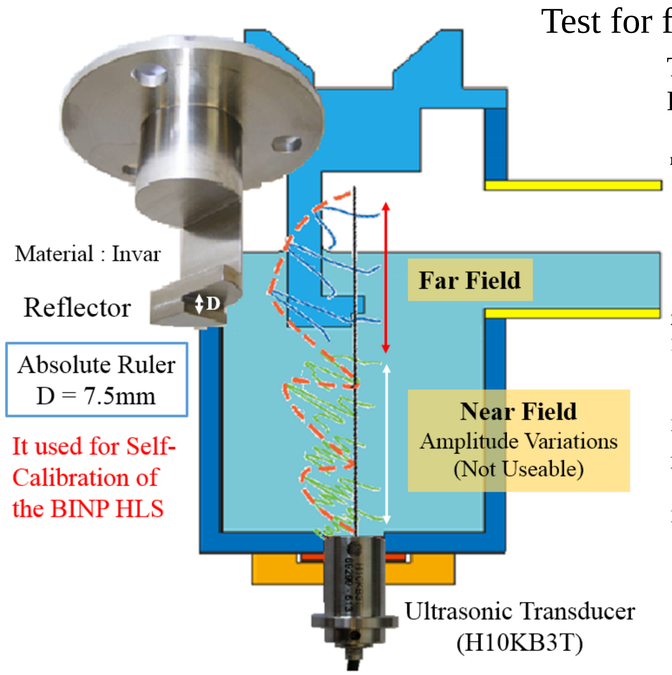
U Undulator
S Self seeding
I Inter-section

Air Hole

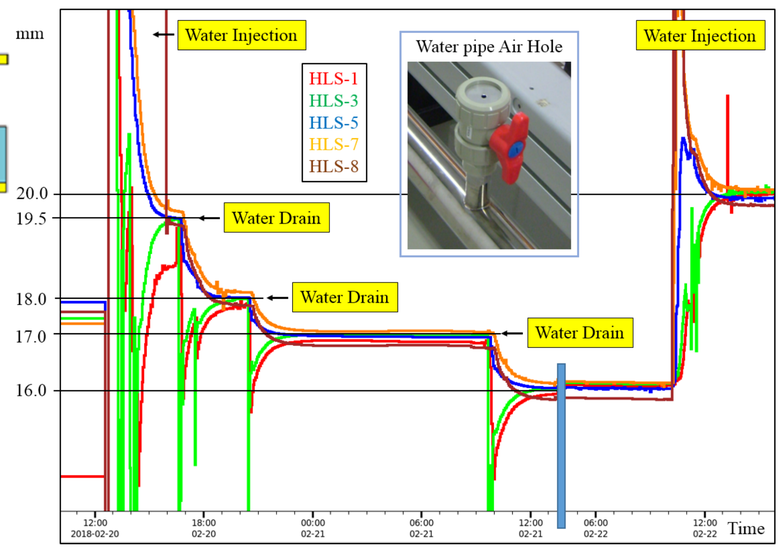
BTL & Undulator & Beamline Water-pipe Length: ~340m
Pipe Diameter: 63.5mm BINP Untrasonic Sensor

HLS-25 HLS-24 HLS-23 HLS-21 HLS & Electronics and PoE (Power of Ethernet) Cable HLS-10 Water Tank HLS-9

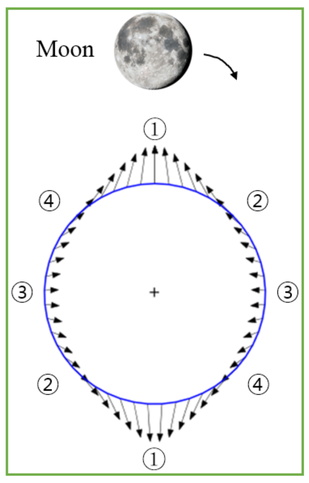
Test for flow of water in the water pipe on PAL-XFEL Linac section



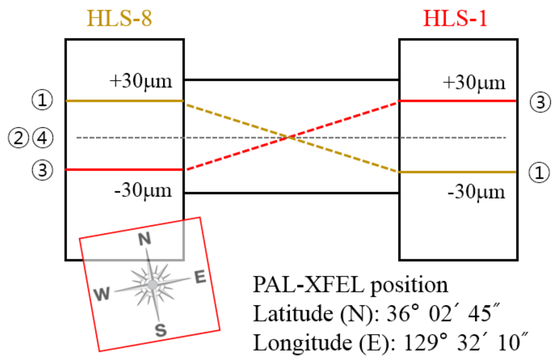
Time required to attain equilibrium of water after adding air holes :
LINAC Section 4 hours, Undulator Section 1.5 hours



HLS's measurement error by tides



Measure error by tide:
LINAC section < ±30μm
Undulator section < ±10μm



PAL-XFEL position
Latitude (N): 36° 02′ 45″
Longitude (E): 129° 32′ 10″