DESIGN AND DISTRIBUTION OF HLS IN SSRF

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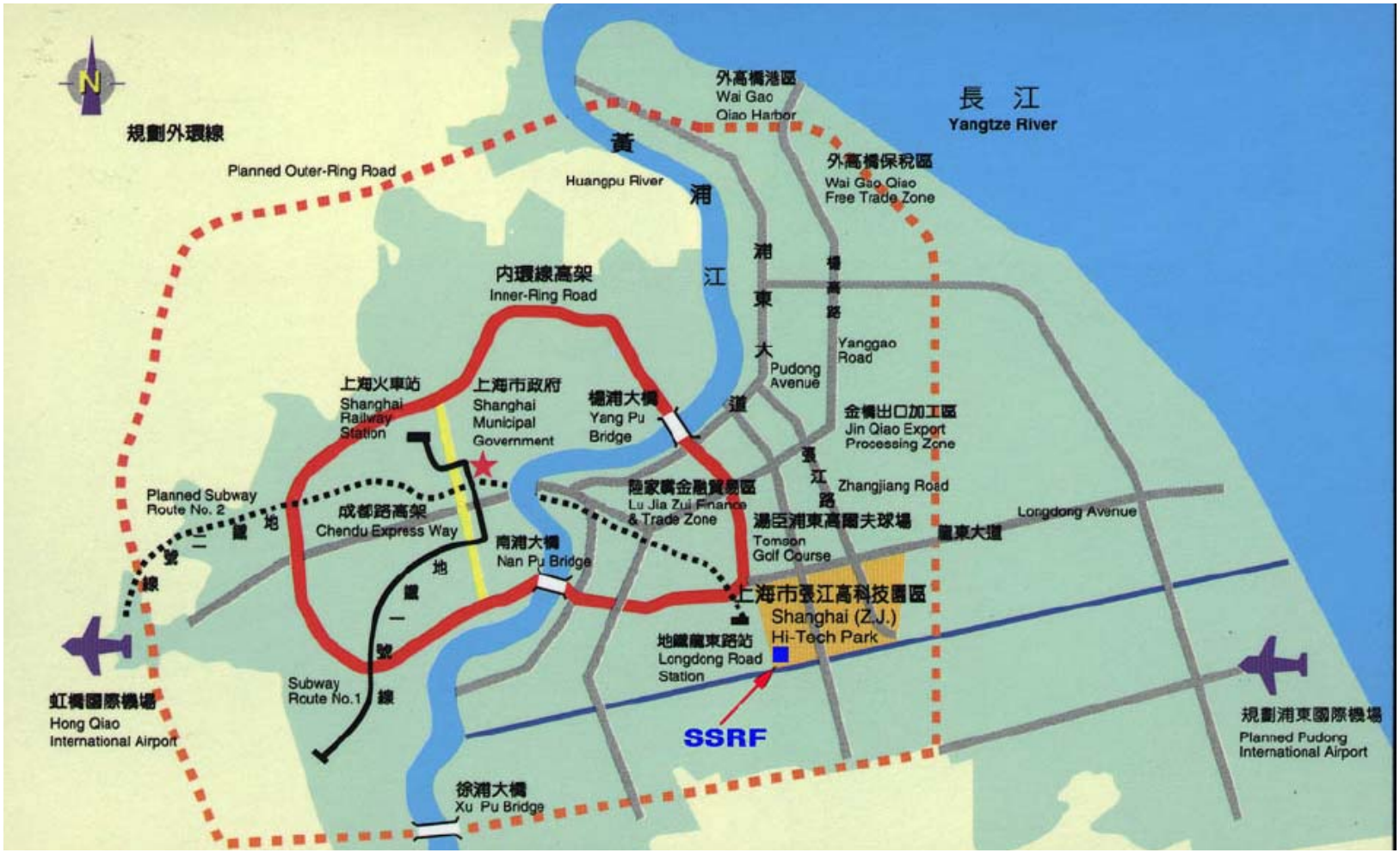
1 INSTRUCTION

★The Shanghai Synchrotron Radiation Facility (SSRF) is a low emittance third-generation light source, which is composed :

1. a 20m-long LINAC (100Mev),
2. 180m-circumference Booster (100Mev---3.5Gev),
3. 432m-circumference Storage Ring(3.5Gev),
4. the low-energy, high-energy beam transport lines
5. and the beam lines and stations.

★It is located at Pudong, Shanghai, where is at the confluence of more then two rivers and near the sea. The geological condition is complicated.

★It is necessary to establish a monitoring system to monitor the uneven subsides of foundation and key parts of the accelerator.



Location of SSRF at Pudong, Shanghai

★The alignment requirement of SSRF is to maintain the key magnetic elements at ±100 μm in relative position

★The HLS sensor's specifications should be as follows:

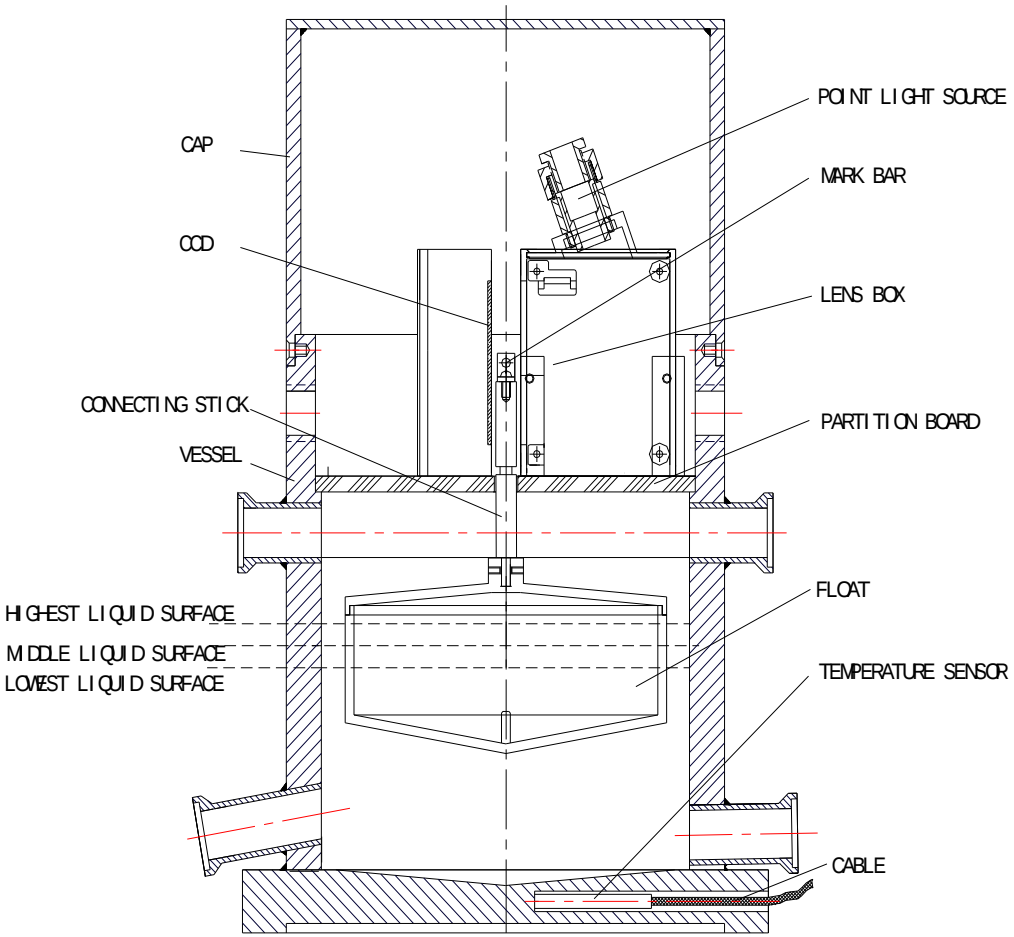
Resolution 1 μm,

Uncertainty 5 μm,

Vertical measuring rang 10 mm.

2 CCD HLS PROTOTYPES

★This type HLS sensor is developed based on the one that was developed for the BEPCII which I introduced at IWAA2004, CERN, Geneva, from October 4th to 7th, 2004.

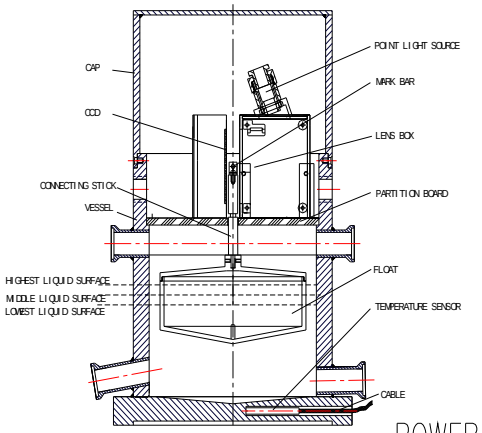


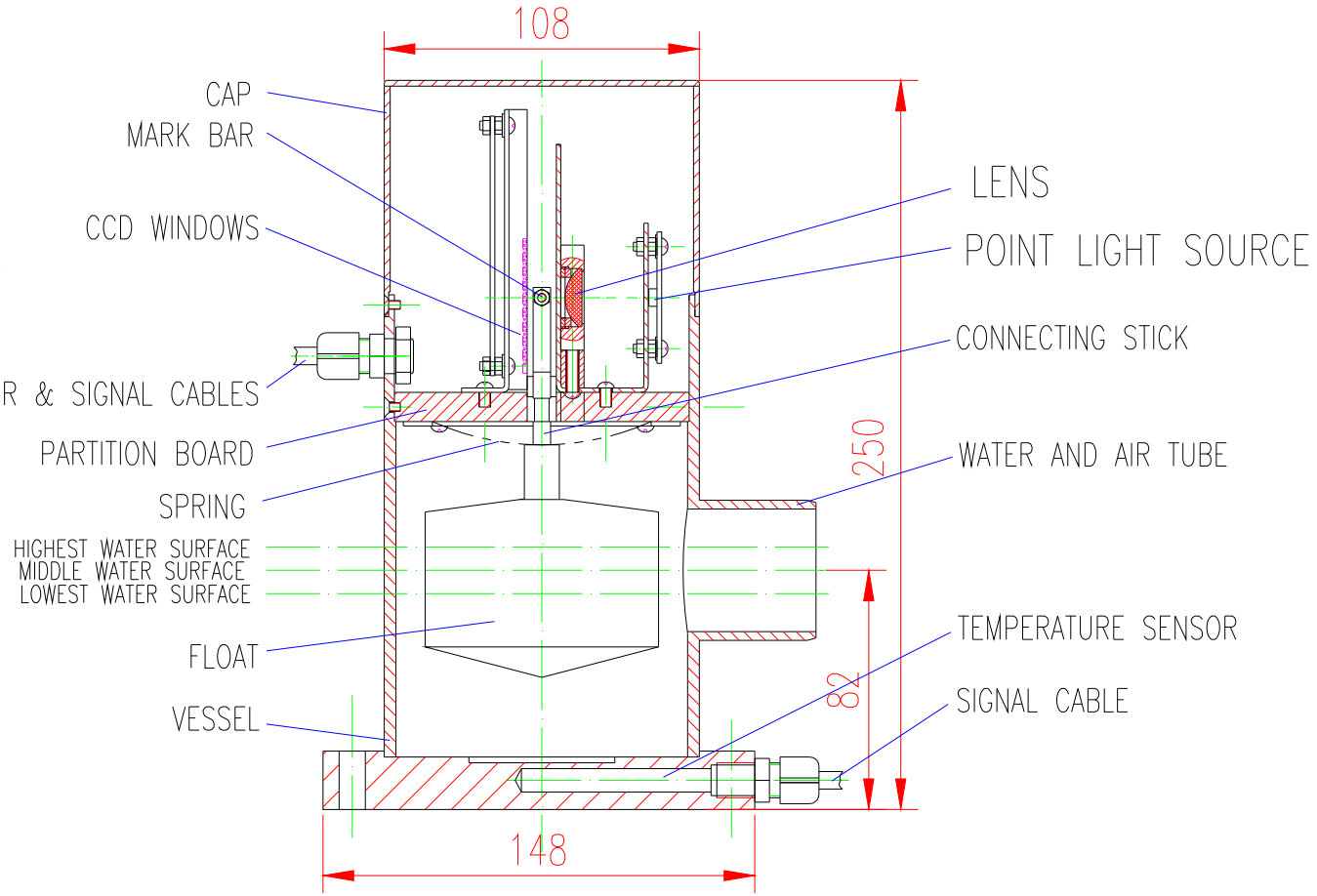
HLS sensor for the BEPCII, which I introduced at IWAA2004

★HLS has the same general principle of communicating vessels, but there are different kinds of methods to measure and record the changes of a liquid surface. `

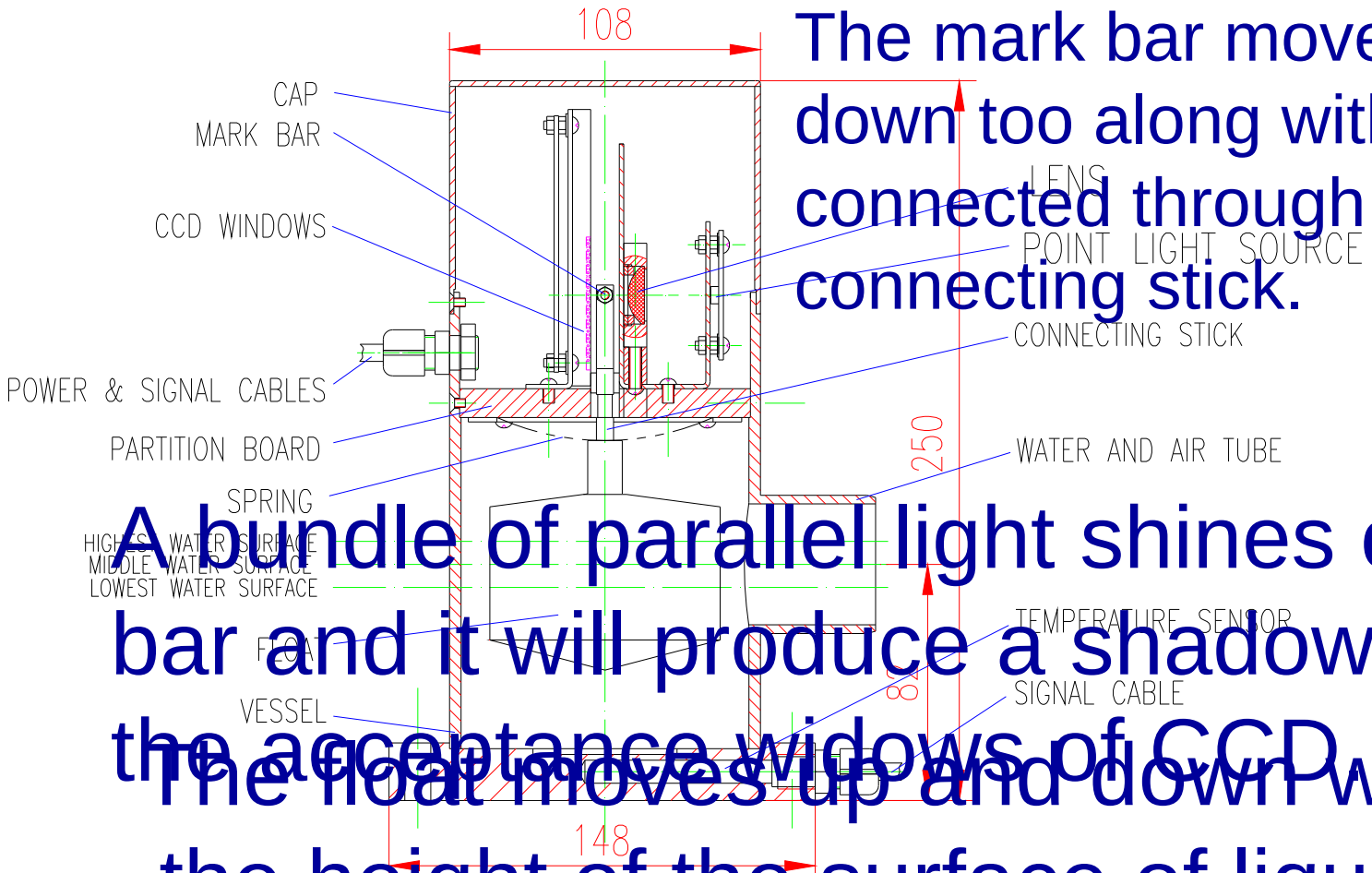
★In the Hydrostatic Levelling System developed for the SSRF, the charge couple devices (CCD) are also used to measure and record the upper surface of a liquid.

★The sensor developed for BEPCII was the kind of full-filled one, but the one for SSRF is a half-filled one. The basic principle is the same.





Cross section of the HLS vessel



The mark bar moves up and down too along with the float connected through connecting stick.

A bundle of parallel light shines on the bar and it will produce a shadow band on the acceptance widows of CCD.

The float moves up and down with the height of the surface of liquid.

★Because the geological condition of the SSRF site is more unstable than the BEPCII site, the HLS must have larger measuring range. Meanwhile, in order to get shorter time for HLS to stabilizing, the system uses circuit through stainless steel pipe with inner diameter 40 mm.

★vessel sensors are manufactured by a cooperating company, the Beijing Gekon Instrumentation Company.

Photo of the vessel sensor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3 DISTRIBUTION OF HLS

★In SSRF, although the level of the storage ring slab is at the same level as that of the booster and linac, they are on different foundations. It is important to monitor the relative altitude change between the level of SR slab and that of booster and linac.

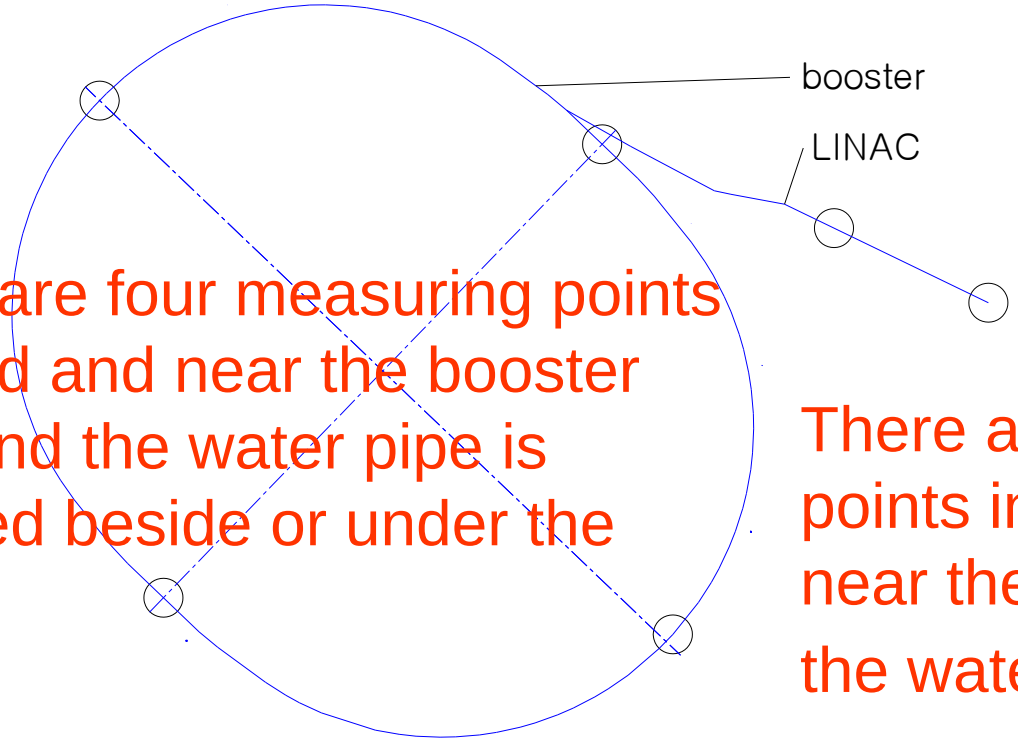
★In order to keep HLS work continually and reliably, and to keep the measurement continuance, and make it convenient to assemble and demount the vessel sensors, ball valves are assembled at every prospective measuring point.

★There are more than 200 prospective measuring points around the SSRF machine, but the vessel sensors will not be assembled at every of them.

★By using the valves, it is possible to change the sensors places to monitor different points at different parts of the machine during different periods, and during these changing courses it is not necessary to switch off the HLS, and it will not influence other sensors' working.

3.1 Topology of HLS in booster and linac

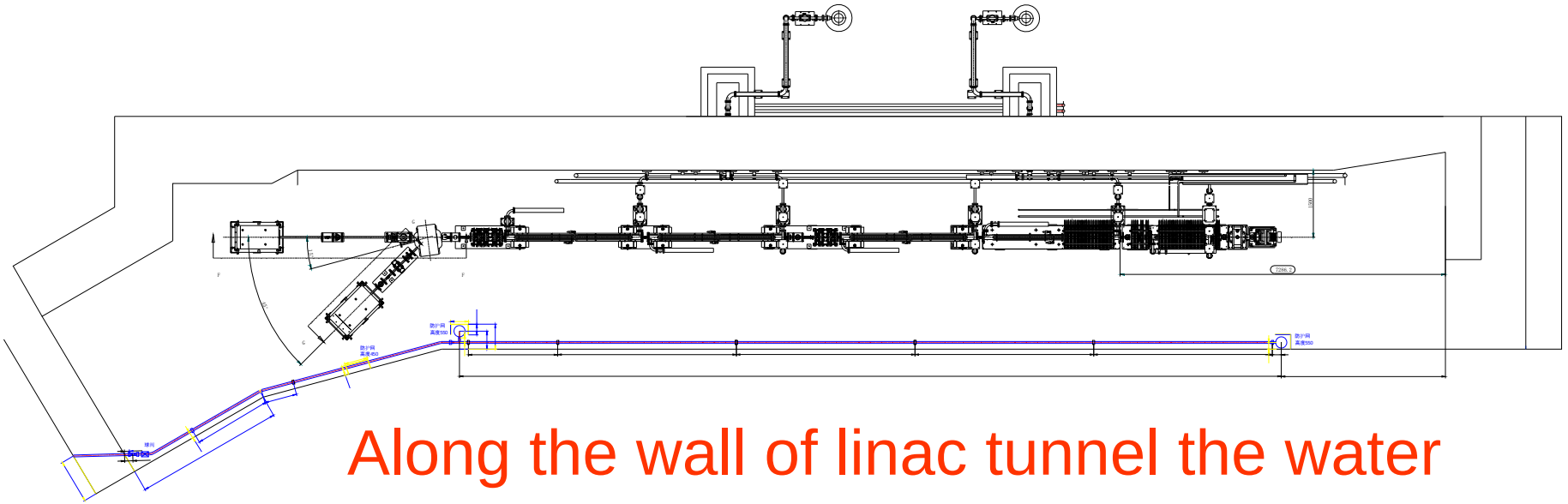
★ Sensors of HLS in booster and linac mainly monitor the vertical place changes of the points on the ground.



there are four measuring points around and near the booster gird and the water pipe is erected beside or under the girds.

There are two measuring points in the linac tunnel near the wall along which the water pipe is arranged

Layout of HLS in booster and LINAC



Along the wall of linac tunnel the water pipe is arranged

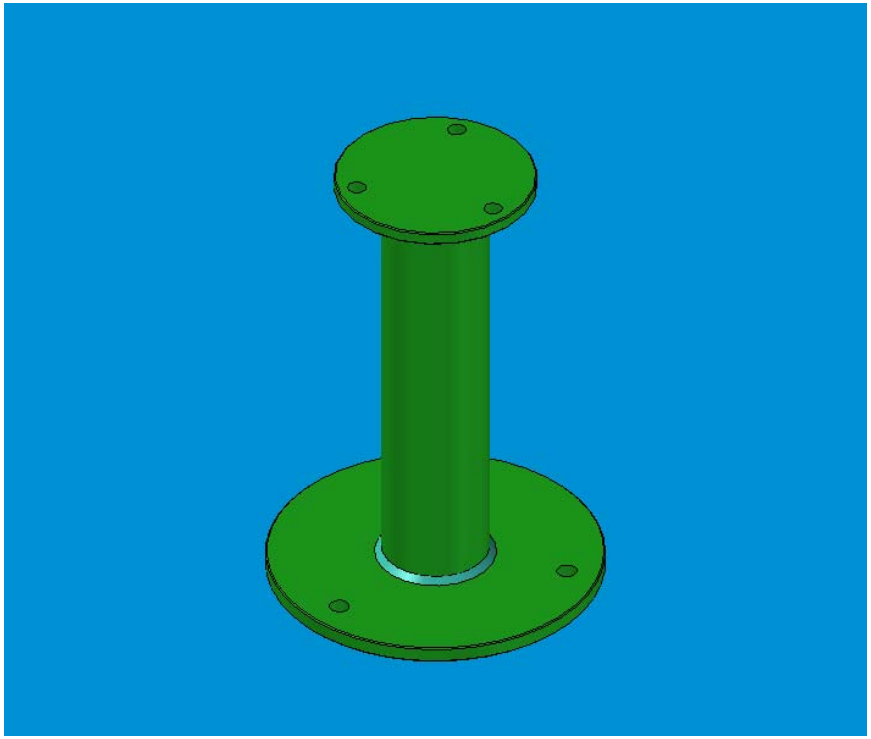
Layout of HLS in LINAC

Water pipe under the girds in booster

The place where a vessel sensor will be emplace

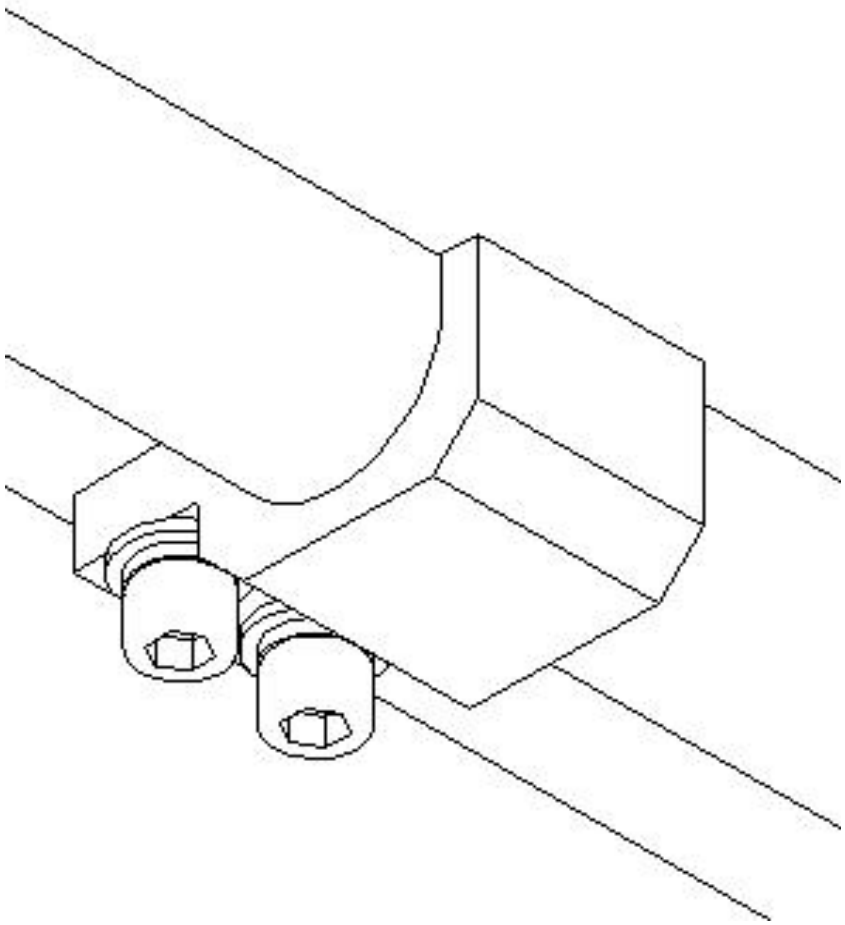
Water pipe along the inner wall of booster

★The vessel sensors are put on upholds which are specially designed to keep all vessel sensors in the system at the same level including those in the storage ring. The upholds are fixed on ground at one end and the upper end will be put sensors.



Picture of the uphold of vessel sensors

★The water pipe beside the gird is fixed on the side of gird using a special fixture which can slightly adjust the pipe height.



Fixture on gird side

★In order to keep different parts of water pipes stable and at the same level when the pipe passes an open area between girds, they must be fixed on the bolster which can adjust the pipe height too.

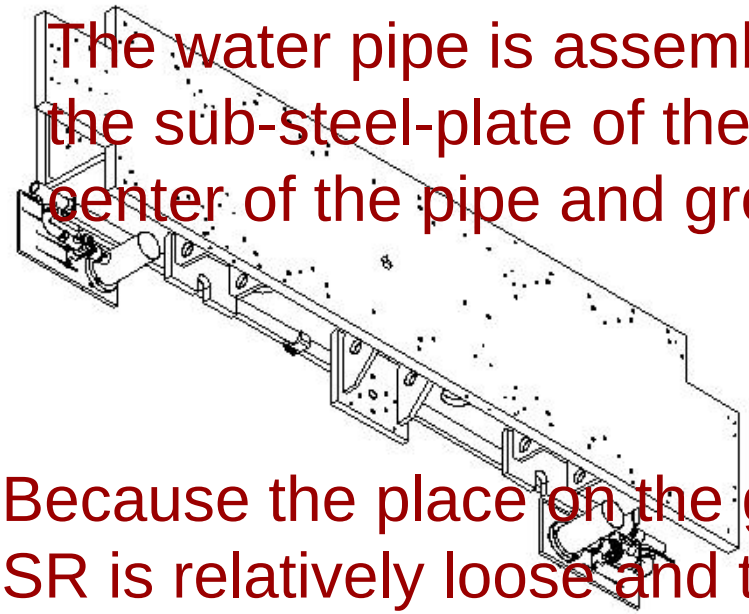
Picture of pipe and bolster

3.2 Layout of HLS in SR

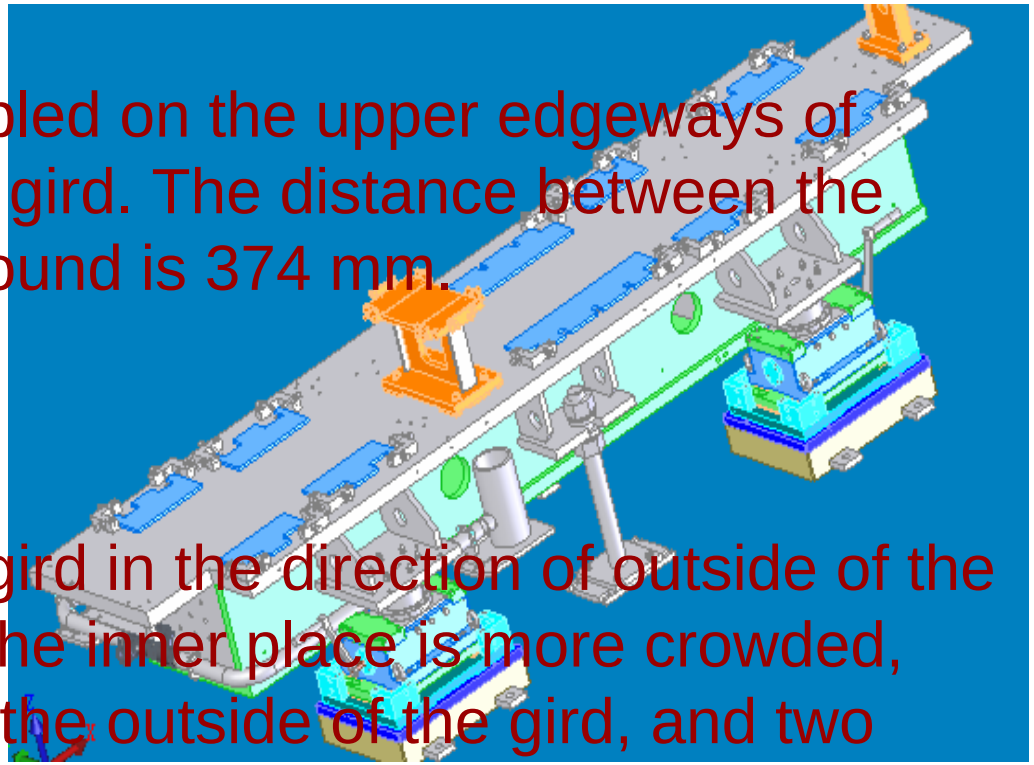
★As the first step of HLS project, vessel sensors are not assembled on every gird around the storage ring.

★Twenty typical girds are chosen to be monitored by HLS. But considering the connectivity of the water pipe and the amplification of the system in the future, the water pipe and location of vessel sensors are preset on almost all the girds in the SR.

★There are five kinds of archetypal girds in the SR. The layouts of the pipe and the location of vessel sensors on these girds are different, but the basic structures are the same.



The water pipe is assembled on the upper edgeways of the sub-steel-plate of the gird. The distance between the center of the pipe and ground is 374 mm.



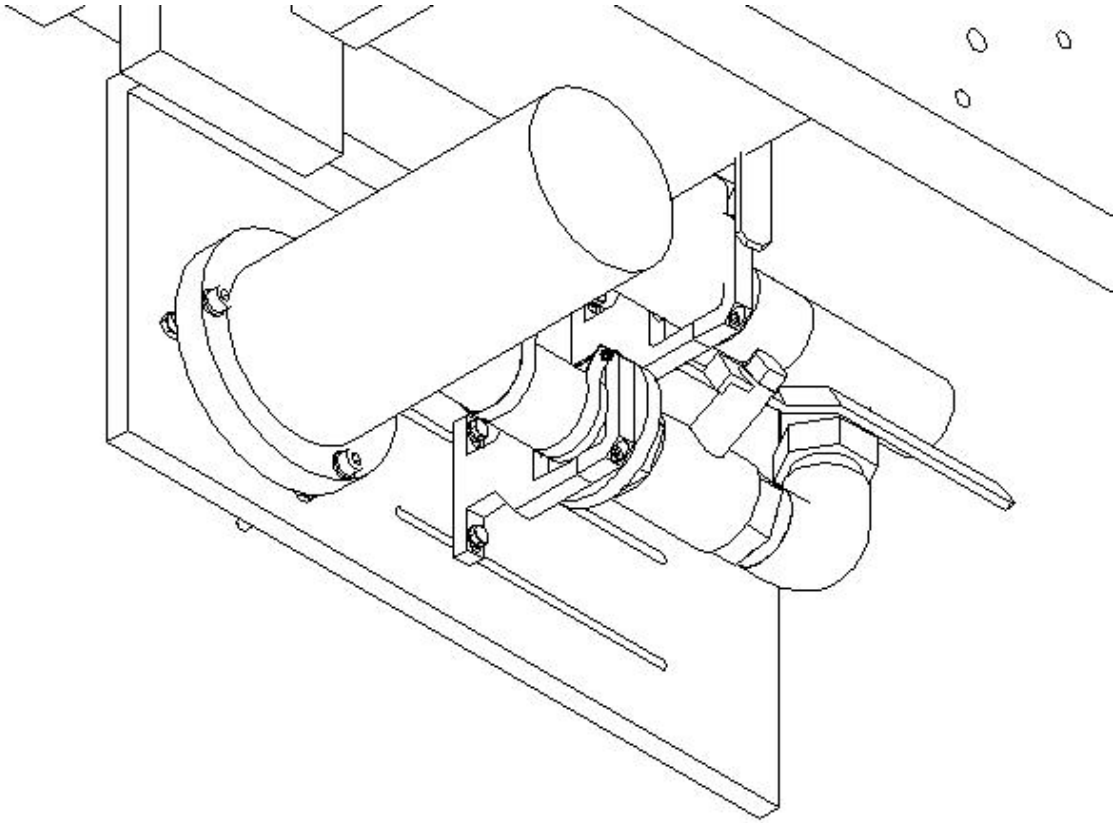
Because the place on the gird in the direction of outside of the SR is relatively loose and the inner place is more crowded, the pipe is arranged along the outside of the gird, and two sensor points are arranged on the outside and one is arranged on the inner side of the gird.

（a）on the outside　　（b）on the inner side

Arrangement of pipe and sensor points on a gird

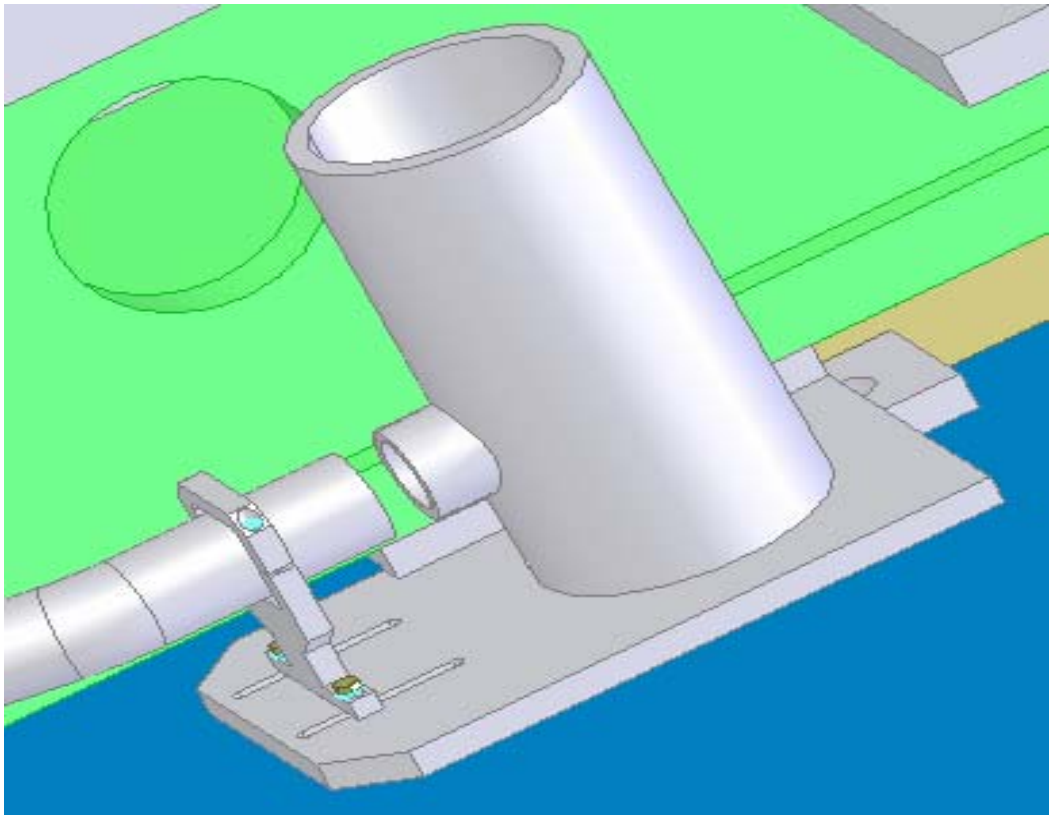
★For the convenience of mounting and operating of the system, a ball valve is emplaced ahead of every vessel sensor along the pipe. When closing a valve ahead of one sensor, it will not influence the work of the HLS. So it is convenient to replace or repair one or some sensors and it is not necessary to stop the work of all the HLS.

★The sensor and valve on the outside of gird are showed at.

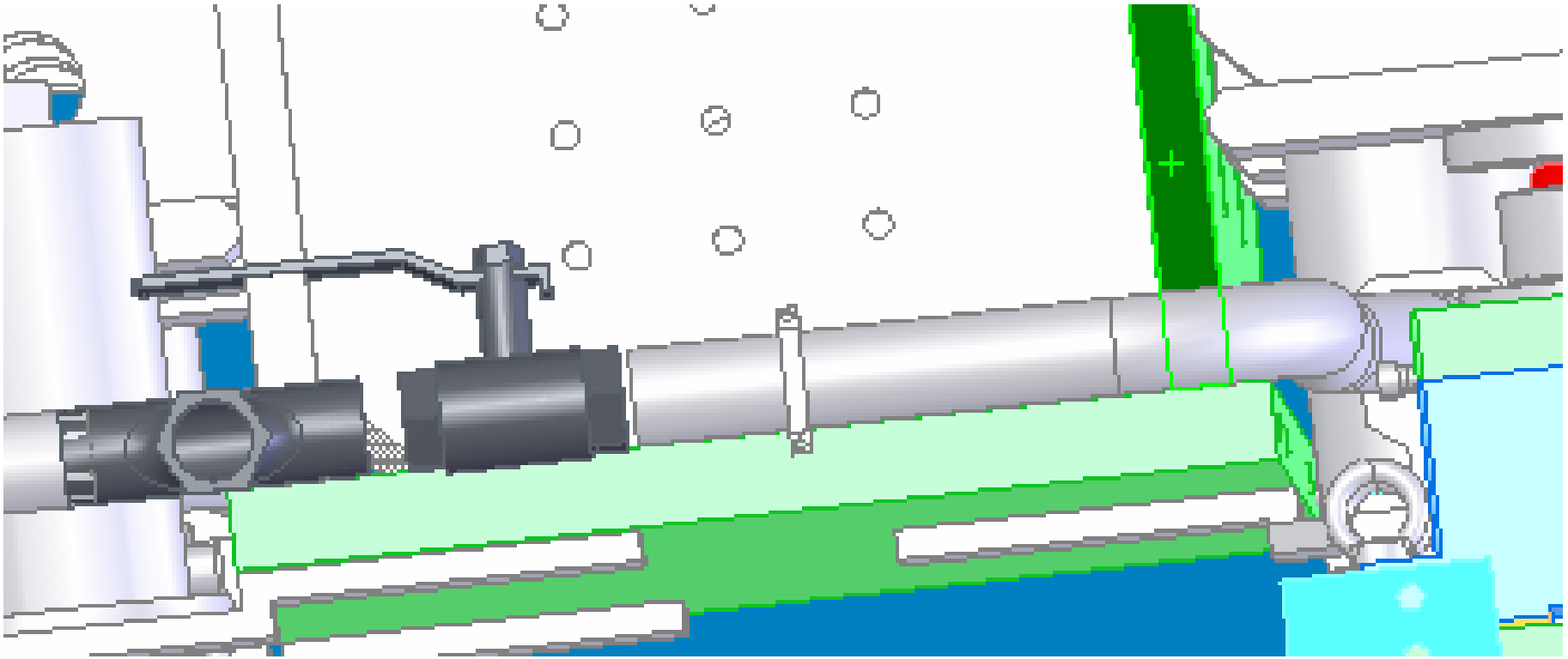


Sensor and valve on outside

★Because of the crowded place on inner side of the gird, the valve and sensor cannot be arranged nearly, and the valve is emplaced at a end of the gird along the beam direction.



Sensor on inner side



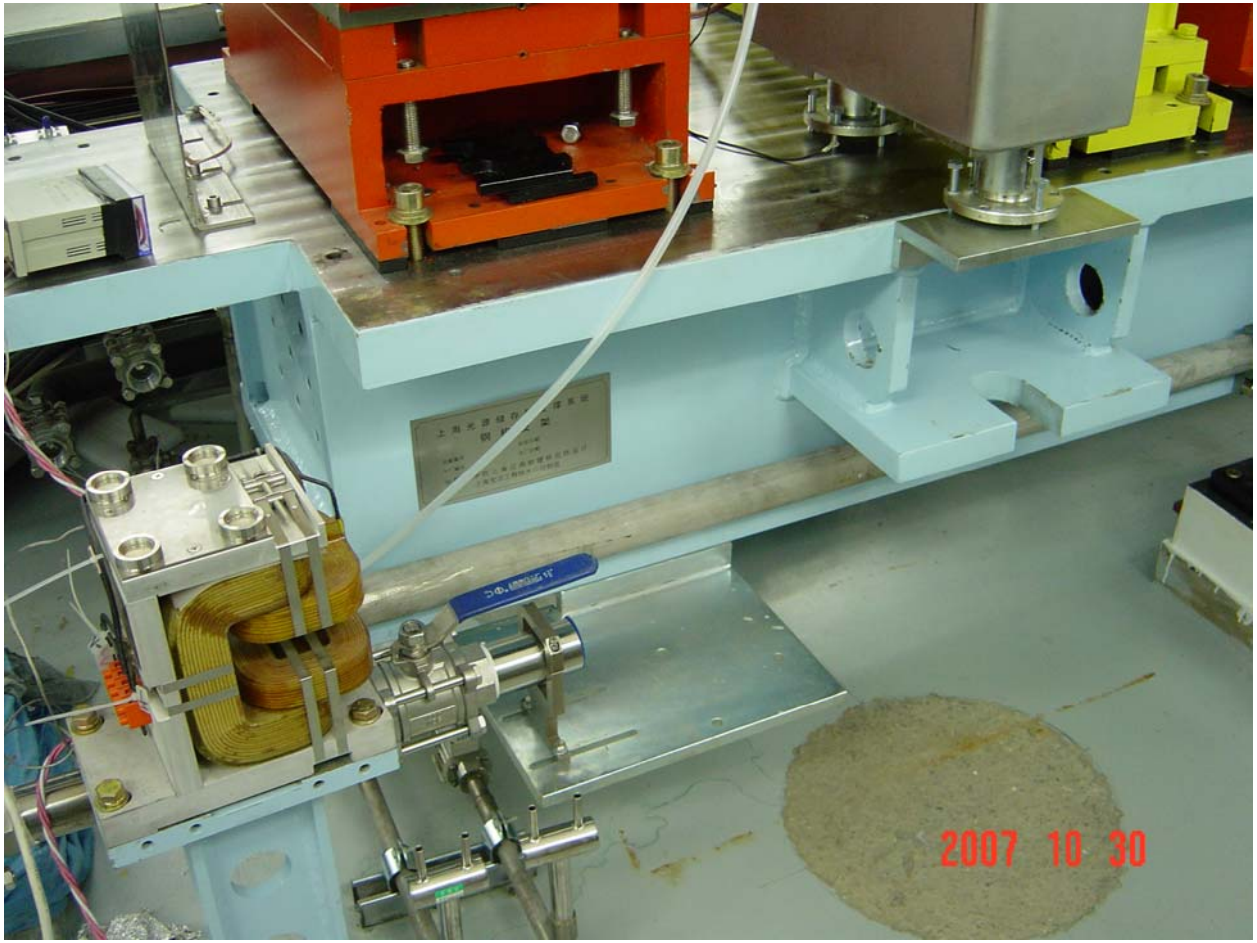
Place of valve for the sensor on inner side

★The water pipe passing the linear part of SR is arranged along the zigzag wall around the machine.

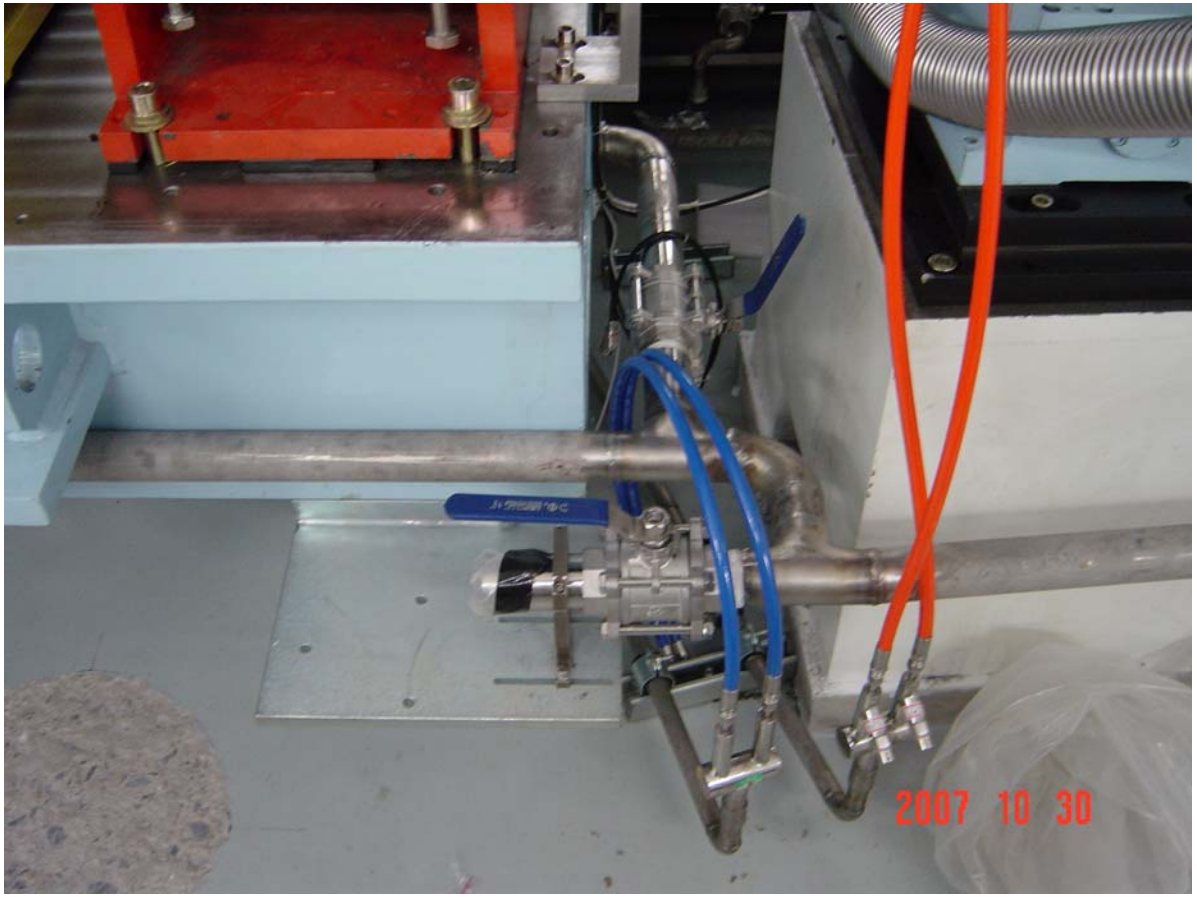
★The pipe is bended and welded in-the-spot according to the structure of the wall and gird in SR.

Water pipe is bended in-site

Water pipe in SR



Water pipe and valve on gird on outside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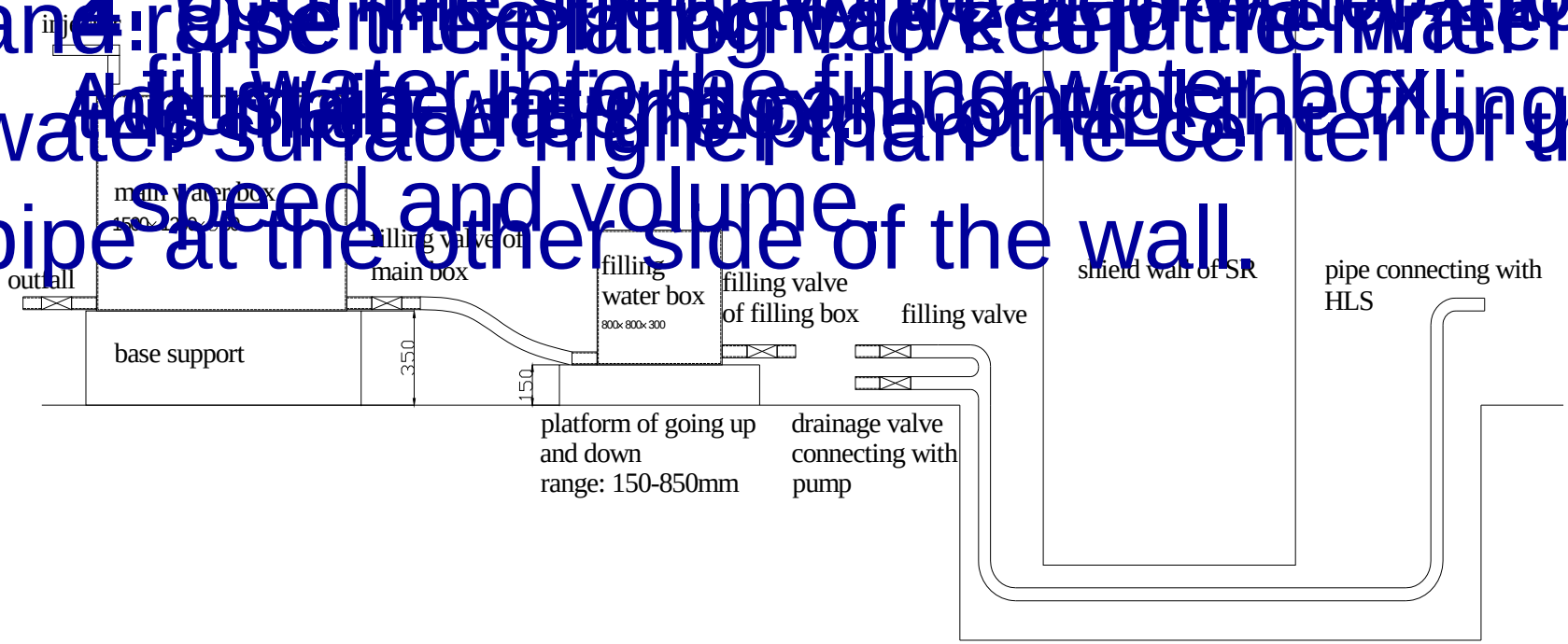
3.3 Design of filling and draining system

★The filling and draining system is arranged at outside of the shield wall of SR in order not to influence the operation of SR during the HLS filling or draining.

When filling the water into the HLS:

3. Close the filling valve of main water box and drainage valve connecting with pump.

4. Open the filling valve of main box to fill water into the filling water box until the water surface higher than the center of the pipe at the other side of the wall.



layout of filling and draining system

★During draining the water from the system, close the filling valve and open the draining valve, switch on the draining pump then water is drained from all the system.

4 Calibration of vessel sensor

★There are several methods for calibrating the units of vessel.

By controlling the elevation of one vessel in a system of two vessels, for example, and using Renishaw 10 Laser Measurement System to measure the change of the elevation, and comparing it with the output of the vessel sensor to calibrate it.

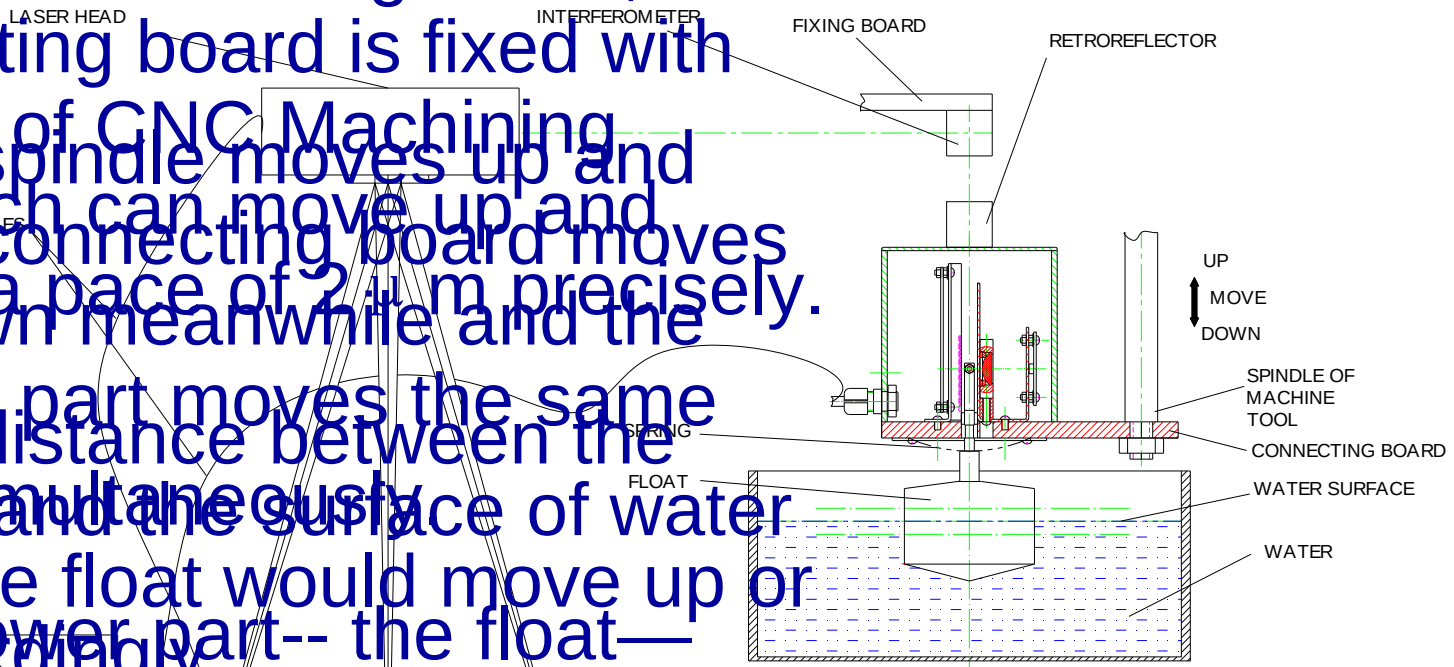
I introduced this method at IWAA2004

★But these methods always using two or more vessel sensors to establish a system, and the system factors often influence the calibration result.

★*How to calibrate a single vessel sensor?*

Here we designed a system which can calibrate just one vessel sensor by comparing the read of laser measurement system and the output of the sensor.

The upper part of the vessel sensor is fixed on a connecting board, and the connecting board is fixed with the spindle of CNC Machining Centre which can move up and down with a pace of 2 μm precisely. When the spindle moves up and down, the connecting board moves up and down meanwhile and the fixed upper part moves the same distance simultaneously. When the distance between the upper part and the surface of water changed the float would move up or down accordingly.



The lower part-- the float—freely float upon the surface of water with a fair depth in a container.

The method can actually reflect the real working state of the vessel sensor. On the top of the vessel a retroreflector of the laser measurement system is fixed. The interferometer is fixed on a fixing board, and use the laser measurement system to measure the moving distance of the vessel.

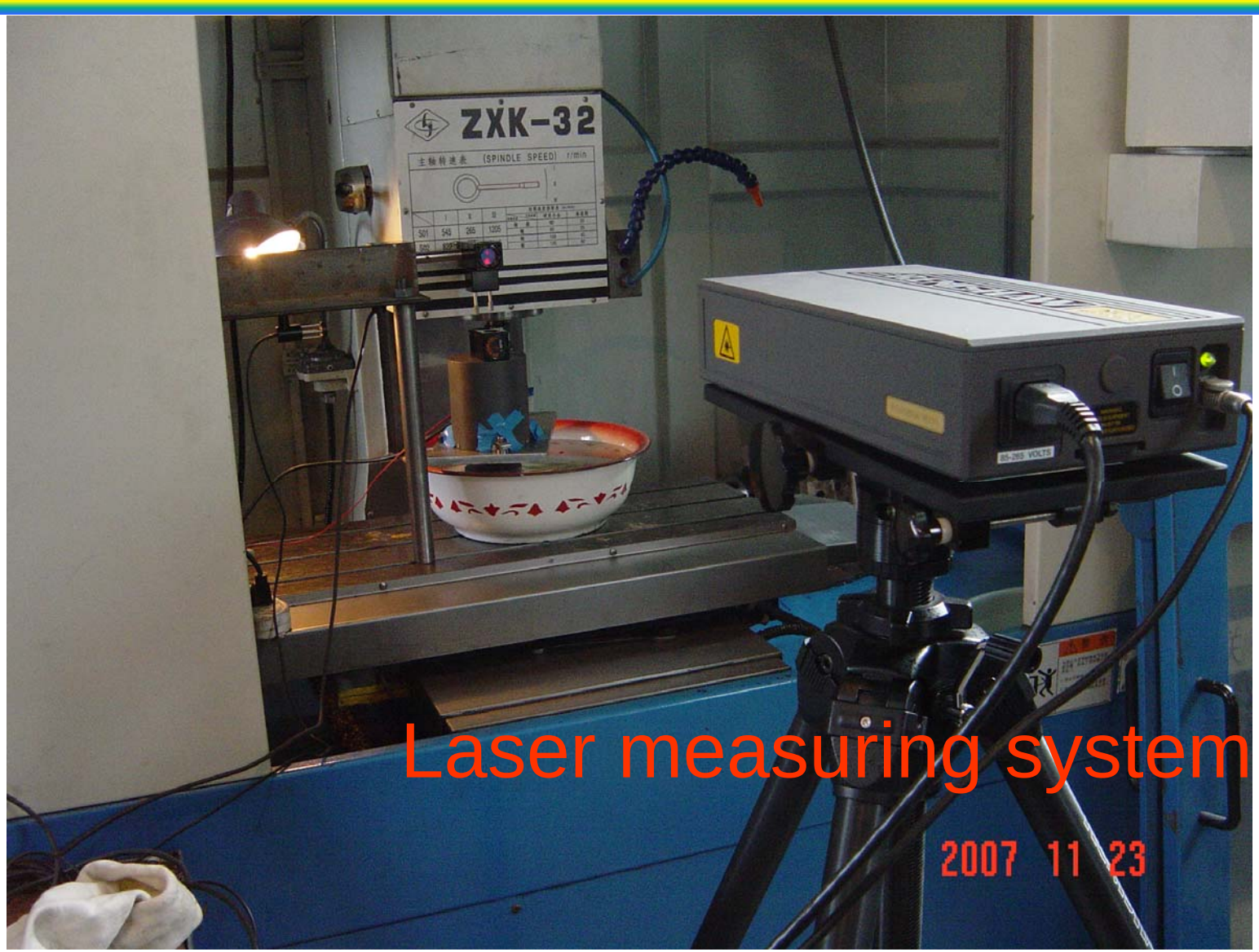
Calibration system for one vessel

★Using the laser system as the reference and by comparing the readings the laser system and the outputs of the vessel sensor, the vessel sensor is calibrated.

spindle

Used as water container

CNC machine center


ZXK-32
(SPINDLE SPEED) r/min
Laser measuring system
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6.49305
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5 CONCLUSIONS

★ The design plan of the HLS for SSRF has passed the assess of the experts who are invited by SSRF and has been sanctioned. All the water pipes have been mounted along the linac, the booster and the SR. The filling and draining system has been constructing.

★ The manufacture of the vessel sensors has been finished. In November the sample sensor passed the test and calibration.

★ As the schedule the vessel sensors will be emplaced on every monitoring point in-site in April, 2008. And the first survey data will be obtained in June, 2008. All the work progresses well now and we hope we could get an approving result.

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