The Alignment of BEPCII RING

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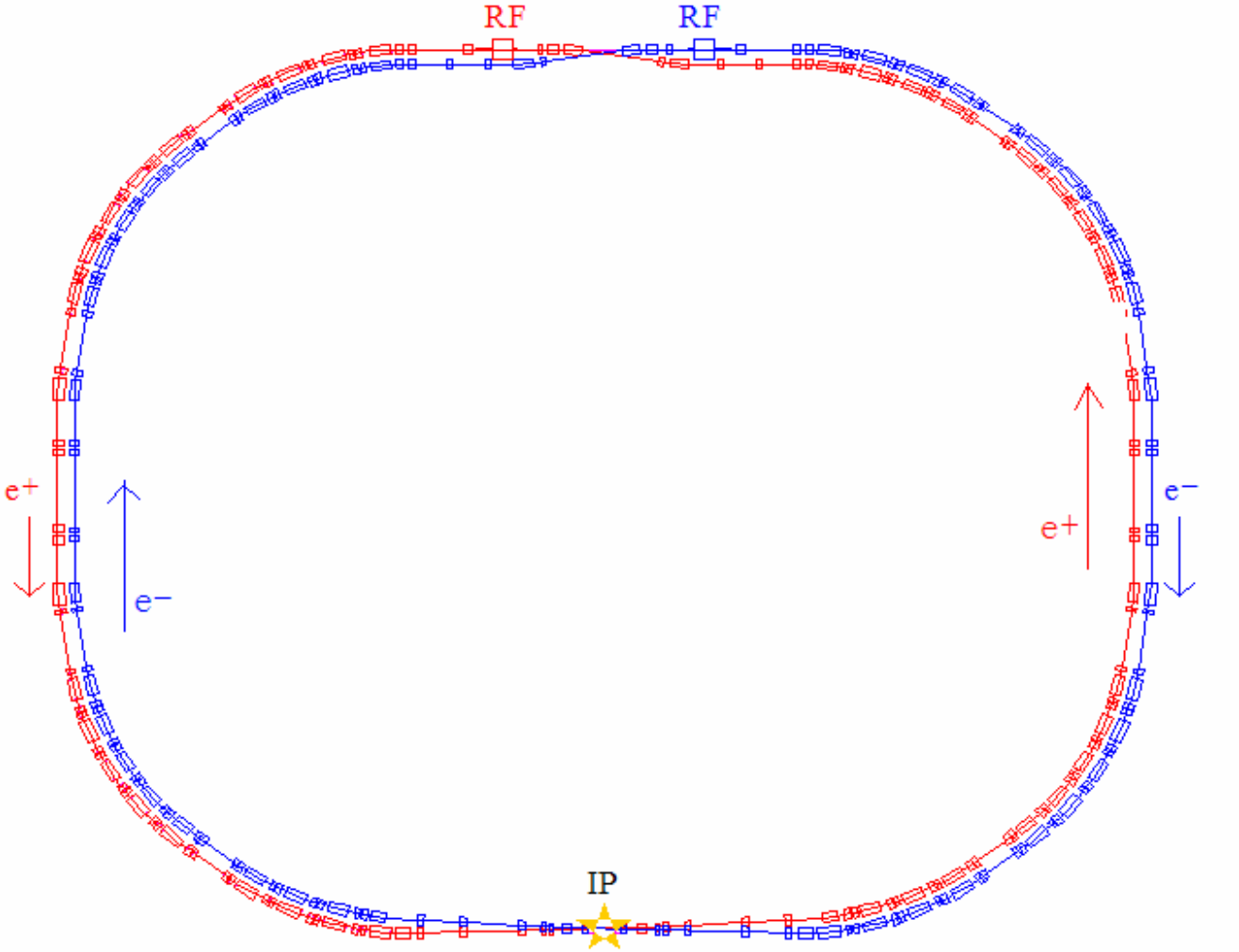
- Brief introduction of BEPCII ring
- The survey of BEPCII ring
- The installment and alignment of BEPCII ring

I. Brief introduction of BEPCII ring

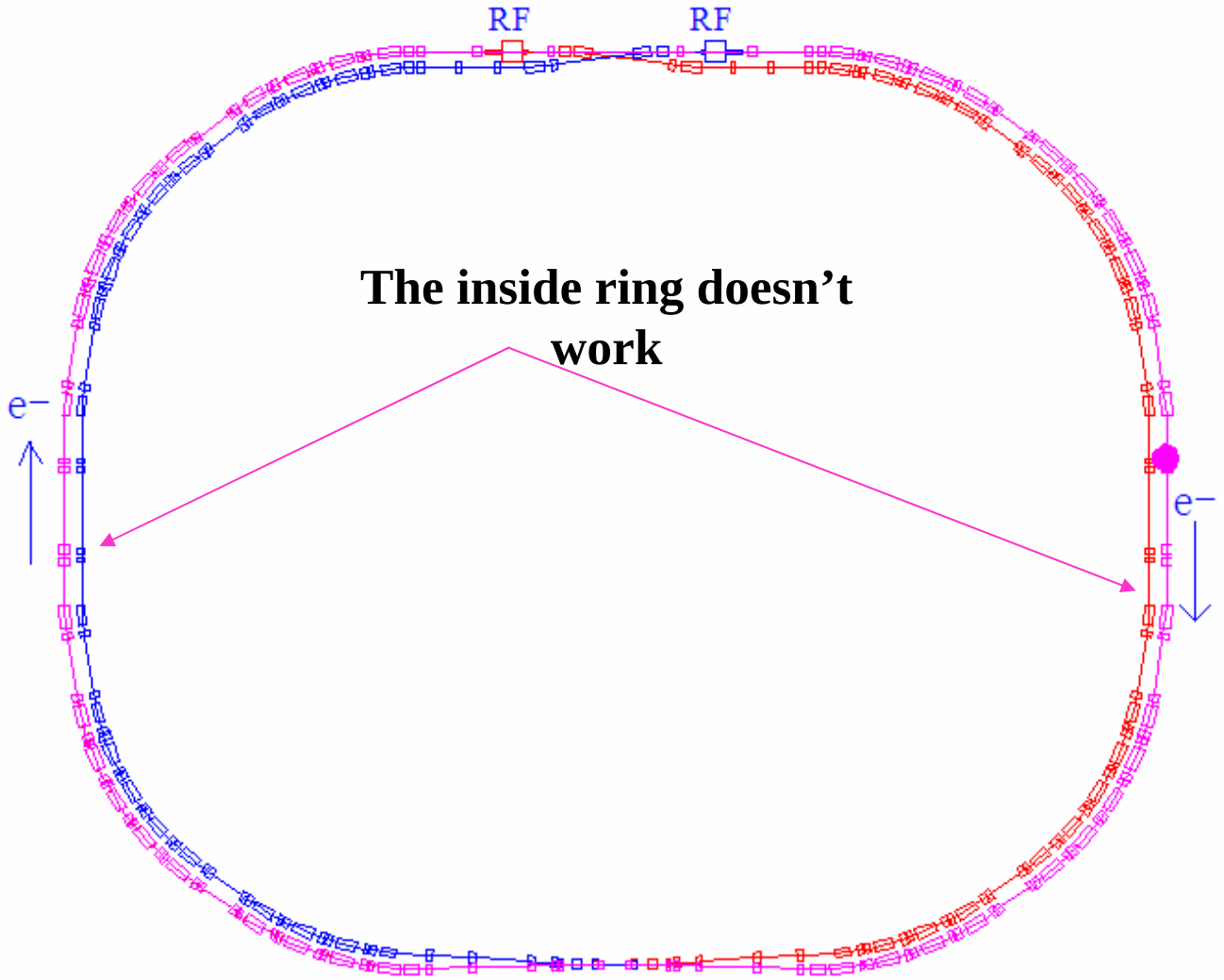
Bireview of BEPCII

- 3 parts: linac, transport lines, storage rings
- Linac,2004
- Transport lines, no change
- Rings,2005-2006
- Now, 3 rings

BEPCII in Collision Mode

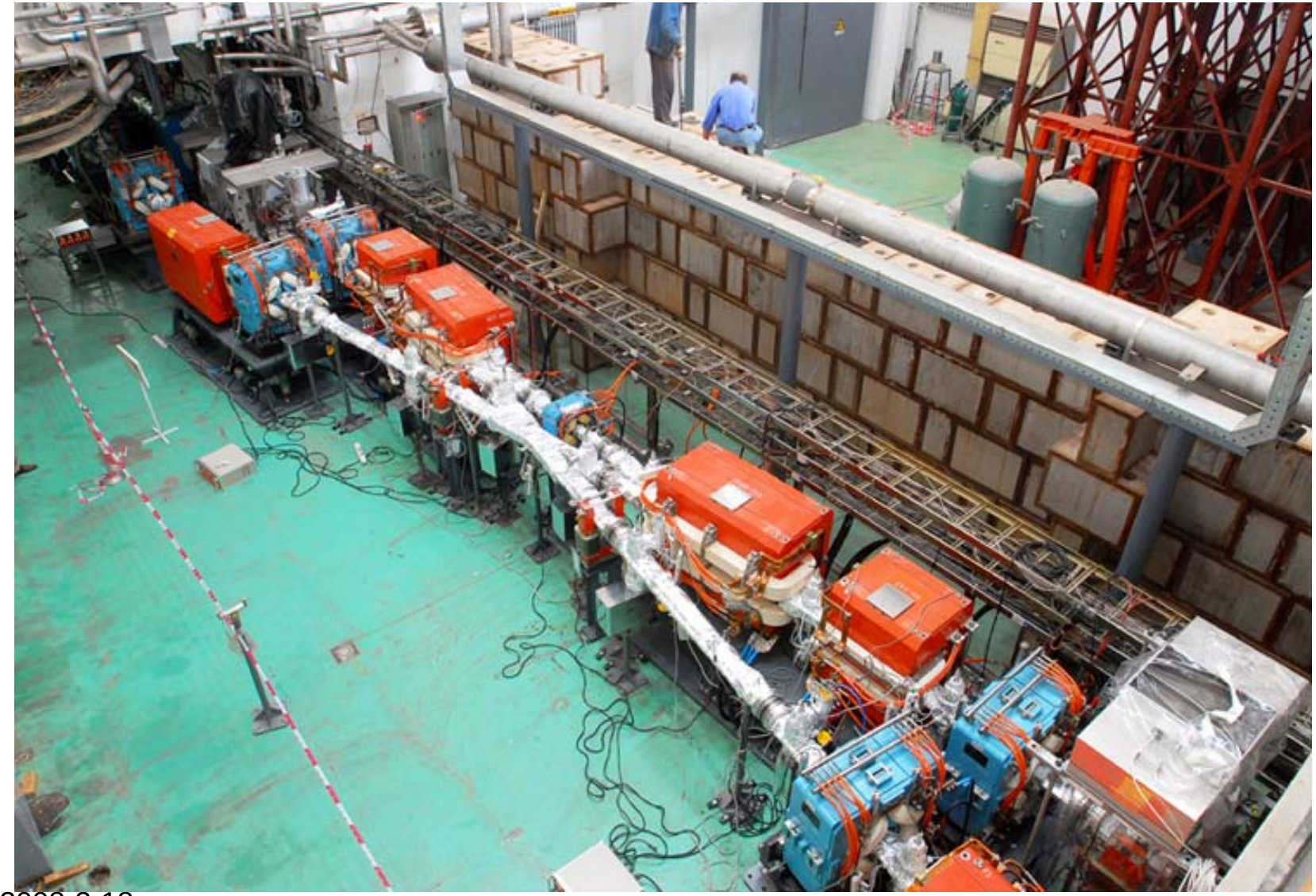


BEPCII in Synchrotron Radiation Mode



The tunnel of the BII Ring

RF region of the BII Ring

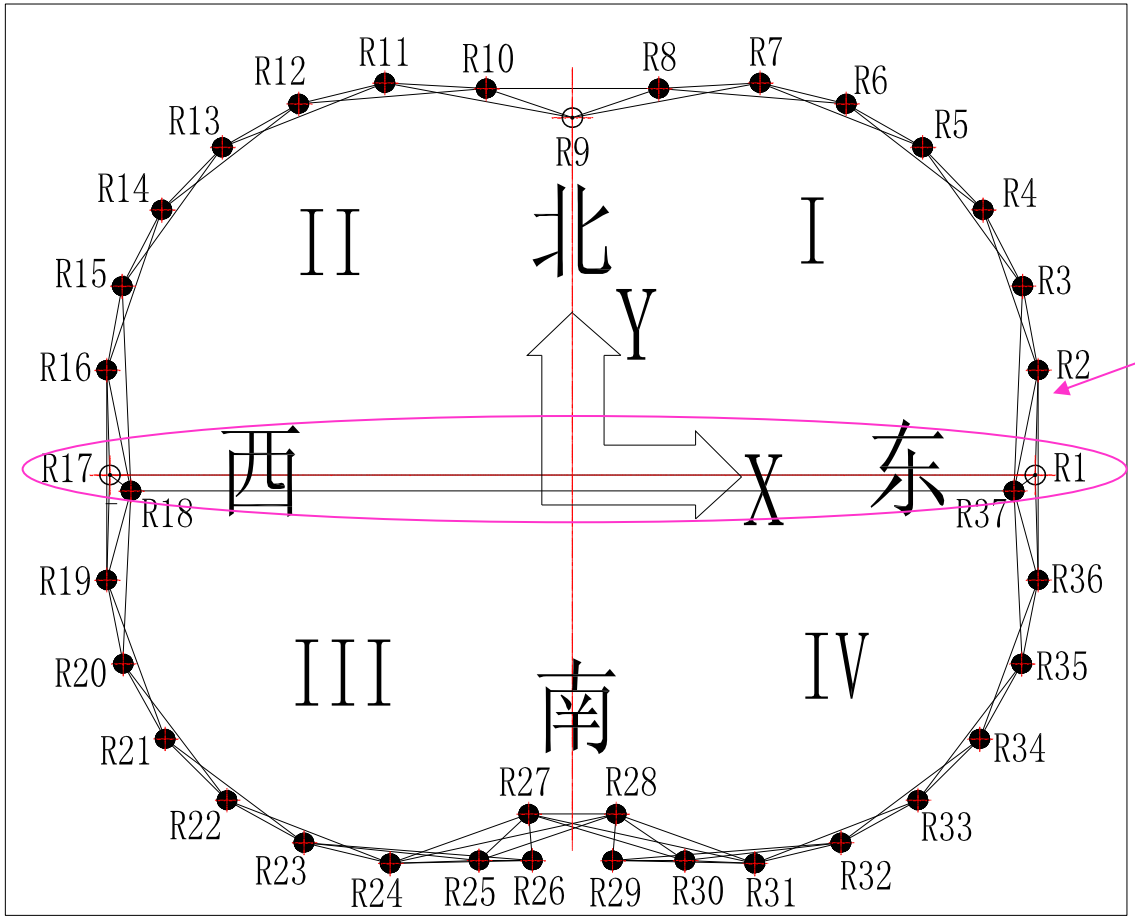


The IR region of BII Ring

II. The survey of BEPCII ring

- We layout a three dimensional control network in storage ring tunnel, measure its horizontal coordinate with total station and laser tracker, and measure its vertical coordinate with level.

2.1 survey the supporting framework of the control network



A channel in the storage ring

Fig. The tunnel network of the BEPCII storage rings

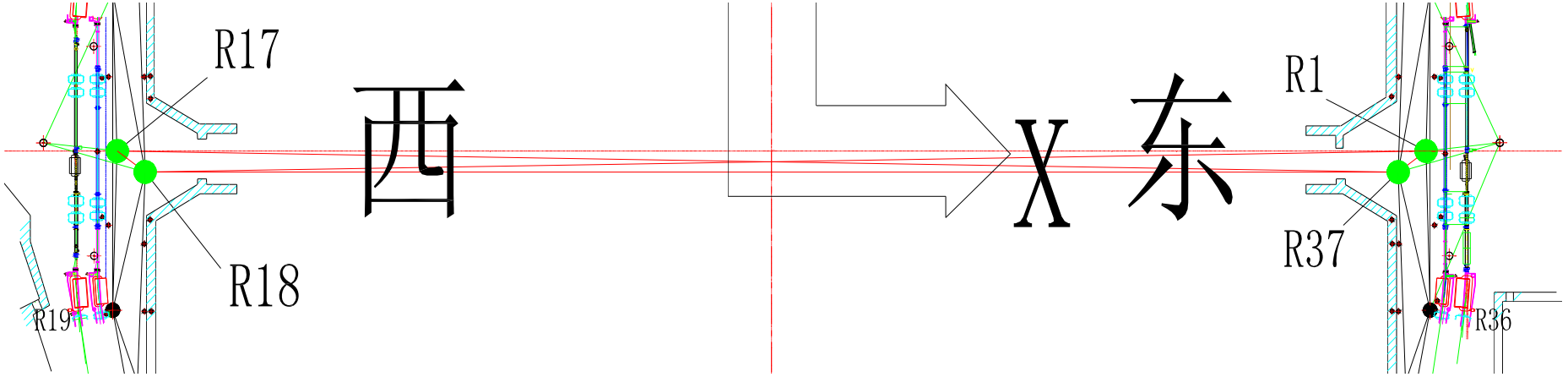


Fig.The supporting framework of the control network

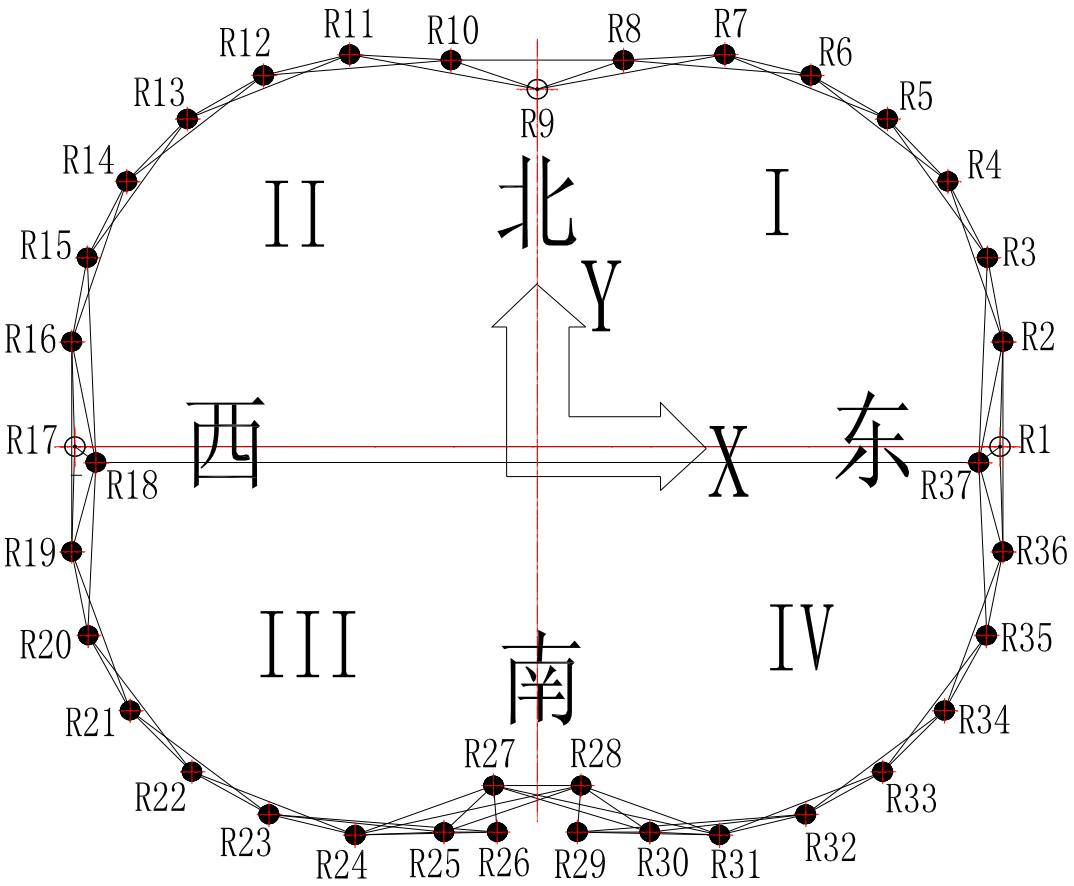
- We layout the supporting framework of the control network in the channel. The supporting framework of network consists of R1、R17、R18 and R37.
- We use the total station of Leica TDA5005 in

forced centering mode to measure the supporting framework. The total station was centered on each of the 4 monuments to measure 3 directions and distances of the other monuments.

- The triangulation measurement accuracy of the total station is 2.2 seconds.
- The distance measurement accuracy of the total station 0.17mm.

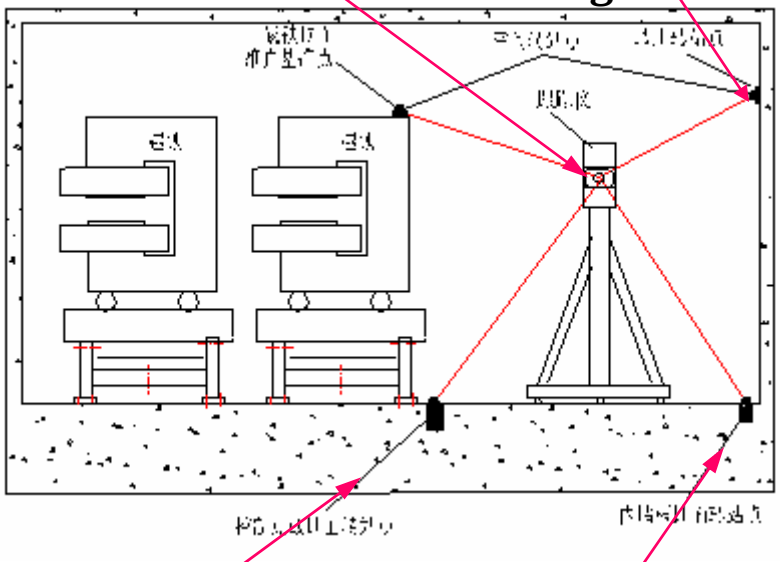
2.2 survey the horizontal network

- The 3 dimensional tunnel network consist of 268 control points.
- The floor and wall of the storage ring tunnel was populated with 3 dimensional monuments.

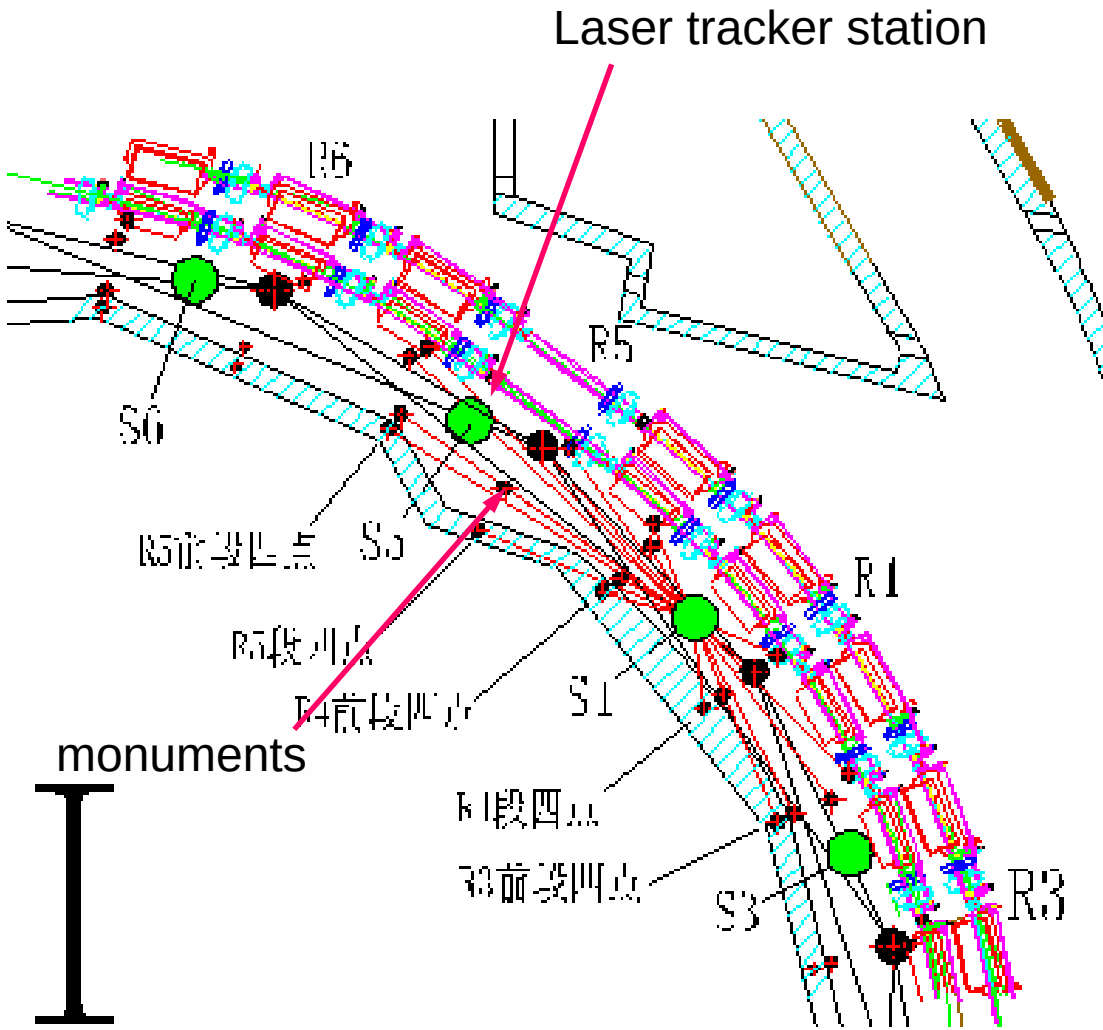


The tunnel network of the BEPCII storage rings

- We use laser tracker to measure the tunnel network in horizontal.



- Each station, laser tracker measures two sections forward and three backward. In one station 20 monuments can be measured.



- The absolute horizontal coordinate error is 0.15mm(rms).
- The relative horizontal coordinate error between adjacent control points is 0.08mm(rms).

2.3 survey the vertical coordinate

- We use level of Leica NA2 to measure the vertical coordinate of the tunnel network.
- The level is setup along tunnel at intervals of 7 meters to measure the height of every monument in direct and reversed observation mode.

Optical tooling scale for measuring height of wall monument

The leveling staff for measuring the height of floor monument

- The closing error of height in direct and reversed observation is 0.18mm.
- The absolute vertical coordinate error is 0.11mm(rms).
- The relative vertical coordinate error between adjacent control points is 0.06mm(rms).

III. The installment and alignment of BEPCII ring

- The circumference of storage rings cannot deviate from its design value by more than 5mm
- The difference between two rings has to be set within 4mm.

3.1 install and adjust

- Before installed in tunnel, the magnets that belong to the same cell are fixed on the girder.
- After fixed on the girder, the cell is pre-aligned in the local frame.
- Before adjust a module, we first check the position correlation of the magnets on the girder. If their correlation occurs to change and don’t satisfied with the requirement, we will readjust them.

- When adjusting the position of a component, we first use the laser tracker to measure monuments populated in 3 dimensions adjacent to the component, and best-fit the actual coordinates of these monuments to their nominal coordinates of the network, the standard deviation of the best-fit should be less than 0.07mm.

- After the best-fit of coordinates, the offset between nominal position and actual position of the component can be displayed by laser tracker.
- Adjust the component until the offsets within required installation precision(0.05mm).

Fig. using the laser tracker to adjust the magnet

Tolerable displacements for storage ring magnets (components) defined by the accelerator physics

	Horizontal ΔX (mm)	Vertical ΔY(mm)	Beam Direction ΔZ (mm)	Pitch $\Delta\theta x$(mrad)	Yaw $\Delta\theta y$(mrad)	Roll $\Delta\theta z$(mrad)
SC magnet	0.15	0.15	0.2	0.1	0.1	0.1
B	0.2	0.2	0.2	0.2	0.2	0.1
Q	0.15	0.15	0.5	0.5	0.5	0.2
S	0.15	0.15	0.5	0.5	0.5	0.5
BV, BH	0.5	0.5	1.0	1.0	1.0	0.5
RF	0.15	0.15	0.5			
Kicker	0.3	0.3	1.0	1.0	1.0	0.5
Lambertson	0.3	0.3	1.0	1.0	1.0	0.5

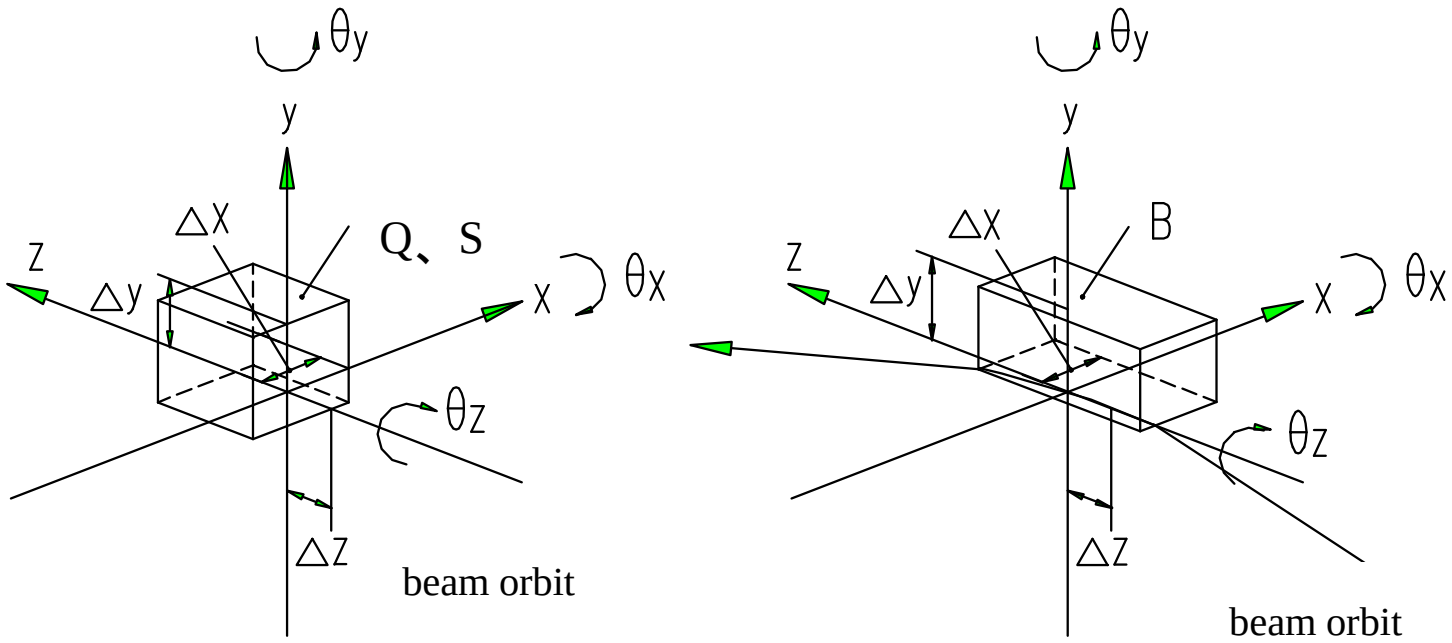


Fig. The magnet frame

3.2 smooth and the circumference

- After all components had been installed and adjusted, we measured the tunnel network and components again, then smoothed all the components.
- We calculate the deviation between the measurement and the theory value of each component in x and y direction in the local frame. Then we calculate the

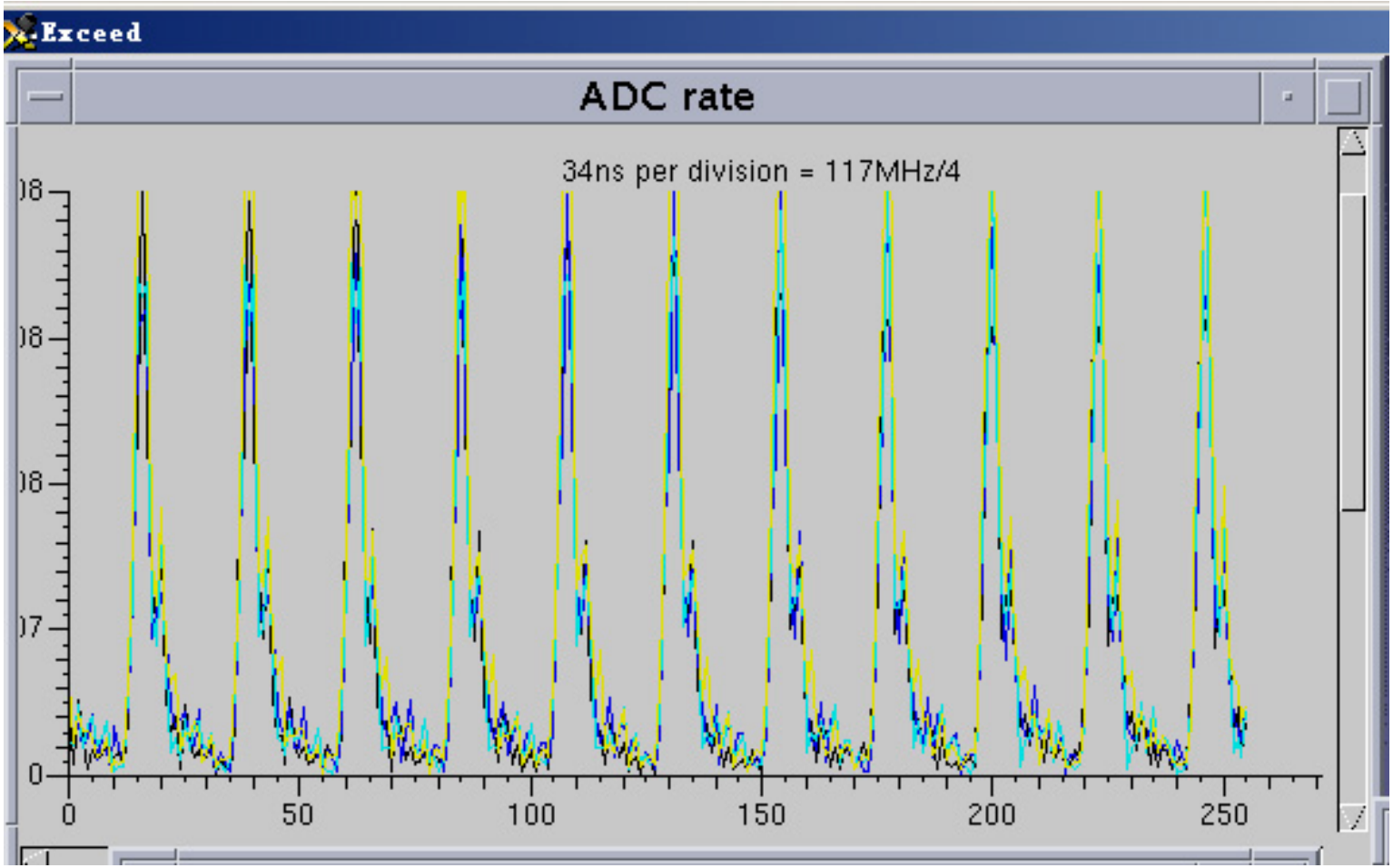
difference between the deviation of every two adjacent components. If the difference is more than 0.15mm,then we adjust one of these two components or both of them. And the accelerator physics group will check whether the orbit through the smoothed components is closed or not.

- The circumference of the storage rings mainly depends on the position of the dipoles and the quadruples.
- We calculate the length of the straight lines between them and the length of the curve inside them, then we add these lengths to get the circumference of the storage ring.

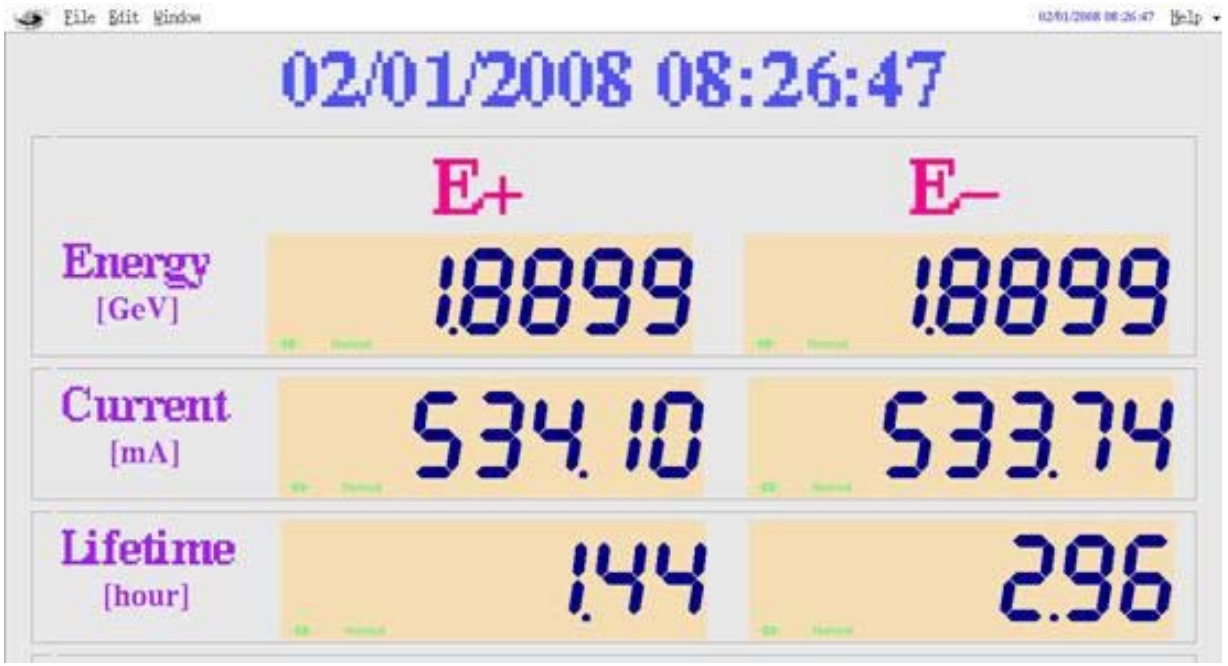
- We calculate the value of the electron ring is 237.52527m, the deviation from its design value(237.53m) is -4.73mm,this is less than the requirement given by accelerator physics(5mm).
- We calculate the value of the positron ring is 237.52634m, the deviation from its design value(237.53m) is -3.66mm,this is less than the requirement given by accelerator physics(5mm).

- The difference between two rings is 1.068mm,less than the requirement given by accelerator physics(4mm).
- These results are within the requirement given by accelerator physics. The BEPCII rings work well under the design energy, no need to shift the frequency of the RF.

First beam:2006-10-25



- On February 1, 2008, before the completion of the second phase commissioning of the BEPCII, the collision of the electron and positron beams of 530mA by 530mA was realized.



The end, thank you!