

Status Report on CSR Survey and Alignment at IMP

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**1.GENERAL INSTRUCTIONS
Of HIRFL-CSR**

2.SURVEY AND ALIGNMENT WORK

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1.GENERAL INSTRUCTIONS

Of HIRFL-CSR

IMP-Institute Modern Physics, Chinese Academia Science,
LANZHOU, CHINA

The HIRFL-CSR project is upgrade project of the Heavy Ion Research Facility in Lanzhou (HIRFL). It will greatly enhance the performance of HIRFL for those researches by using Radioactive Ion Beams and high-Z heavy ion beams in the fields of nuclear physics and atomic physics. The CSR (Cooling Storage Ring) consist of main ring (CSRm) and experimental ring (CSRe). The circumference of CSRm and CSRe is 161m and 128.8m respectively. The max energy will be extracted from CSRm is 1100MeV/u (C6+) and from CSRe is 600MeV/u (C6+). The total cost of the project is about 43million of US dollars.

HIRFL-CSR Layout

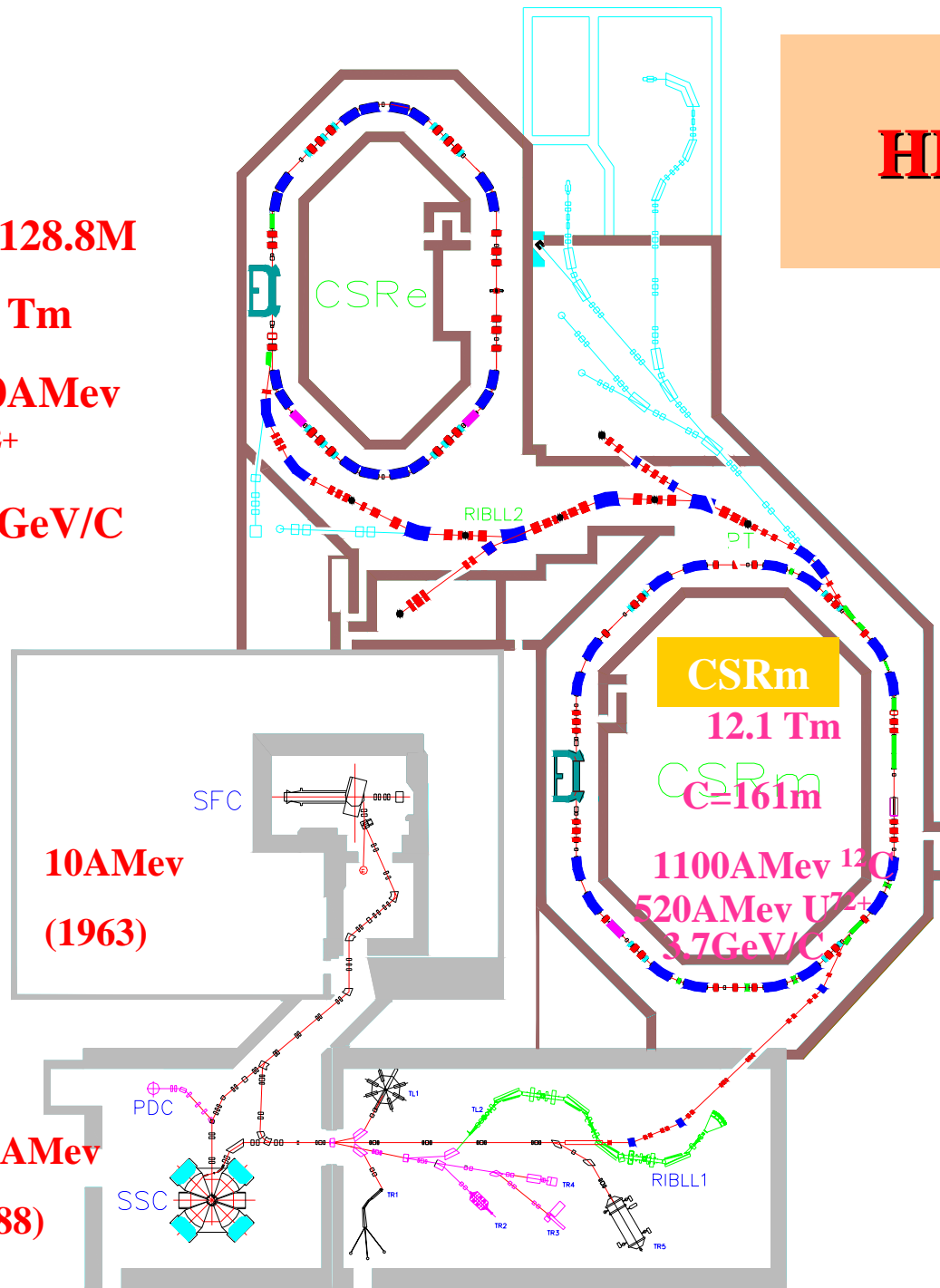
C=128.8M

9.4 Tm

500AMev

U⁹²⁺

2.8GeV/C



1. ECR Ion Source

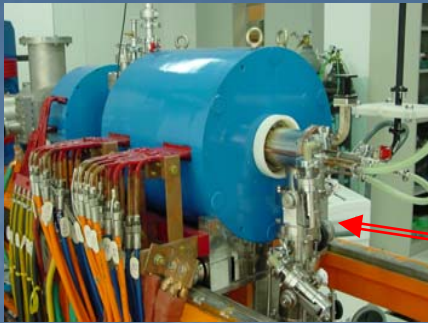
2. SFC K=69(72)-
10AMev

3. SSC K=450 –
100AMev

4. CSRm Cooler-
Synchrotron

5. CSRe: Accel. &
Deaccel. And High
Sensitive & Accuracy
Spectrometer

HIRFL operation & upgrade



ECR 14, 18GHz
H-U, $I_{\max} \sim 1\text{mA}$

Full ion: H--Xe→U

I_{\max} increase factor: 3~10



SSC K=69 (1963)

$E_{\max} = 10\text{AMeV}$

($Z < 30$, $E \sim 5\text{MeV/A}$)

$I: \sim 1 \times 10^{13}\text{pps (C—Ne)}$

$\sim 1 \times 10^{12}\text{pps (Ca—*Kr)}$

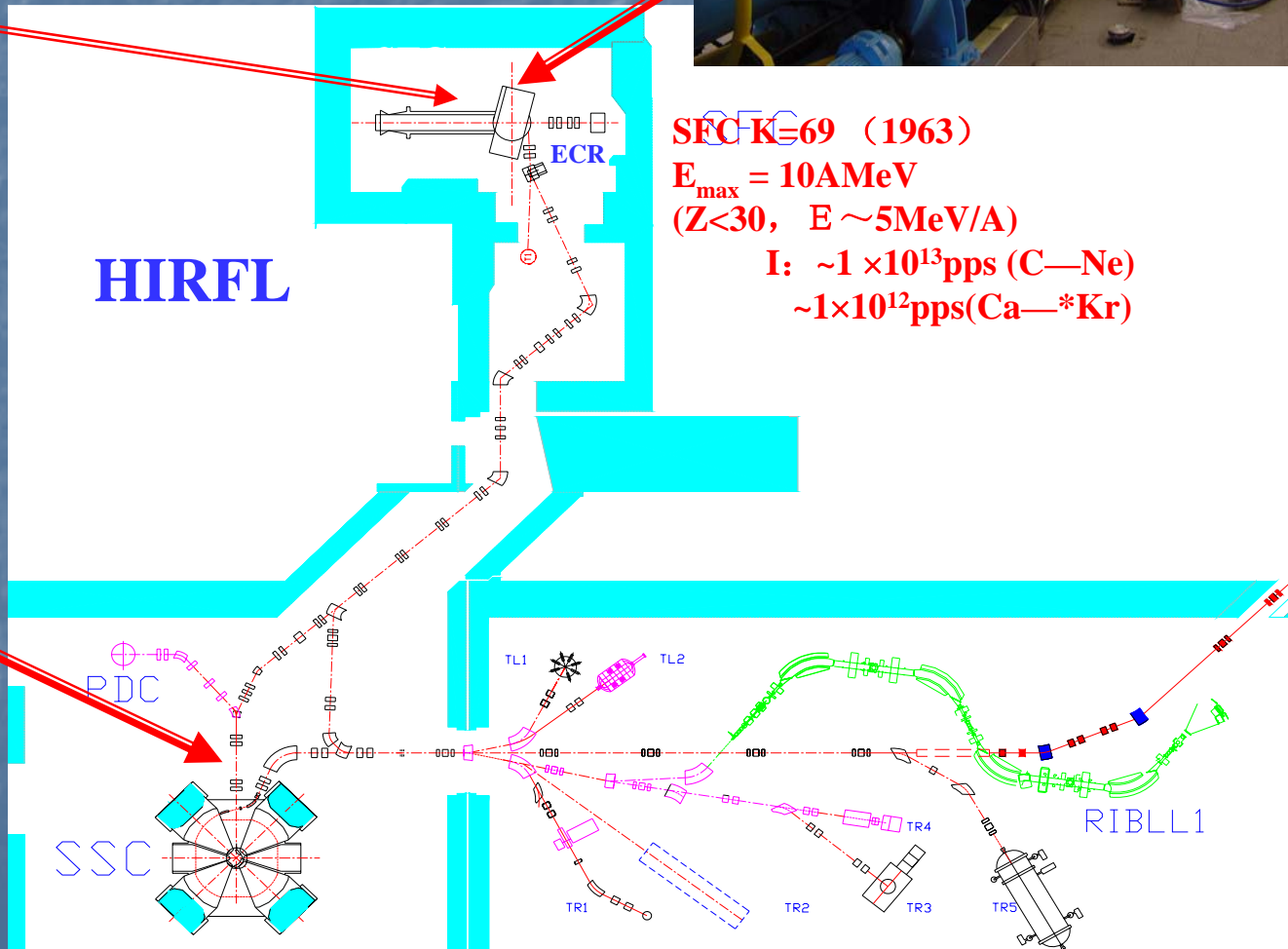


SSC k=450 (1988-)

$E_{\max} = 100\text{AMeV}$

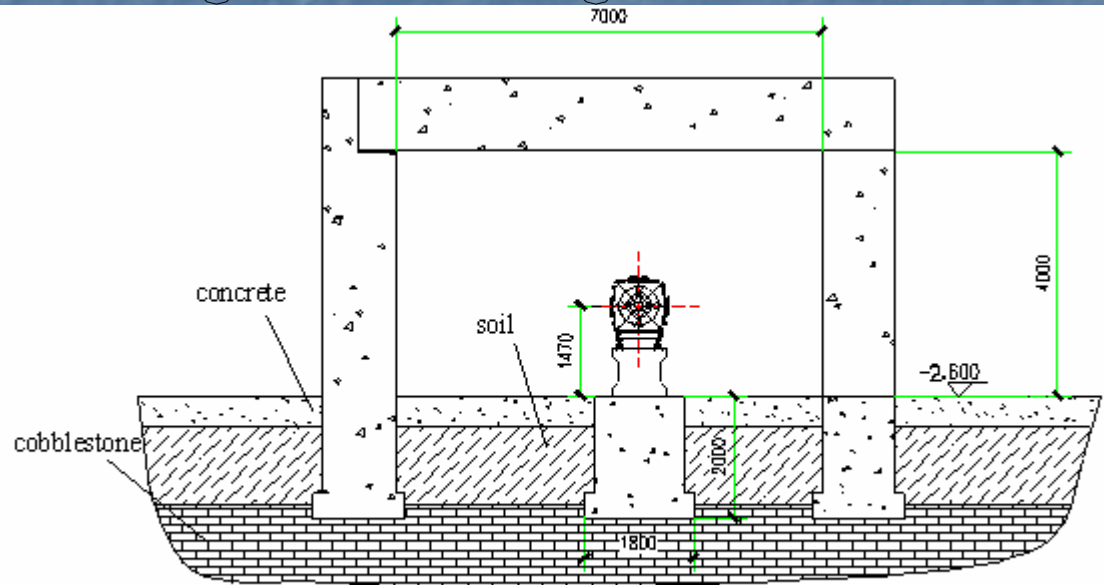
$I: 10^{10} \sim 10^{11}\text{pps}$

$6 \times 10^{11}\text{pps (Ar/25AMeV)}$



Experimental setup 8: nuclear & Atomic IS irradiation 2

Start in 2000, installation
finished in 2004, total cost
43M \$



Cross Section of CSR Tunnel

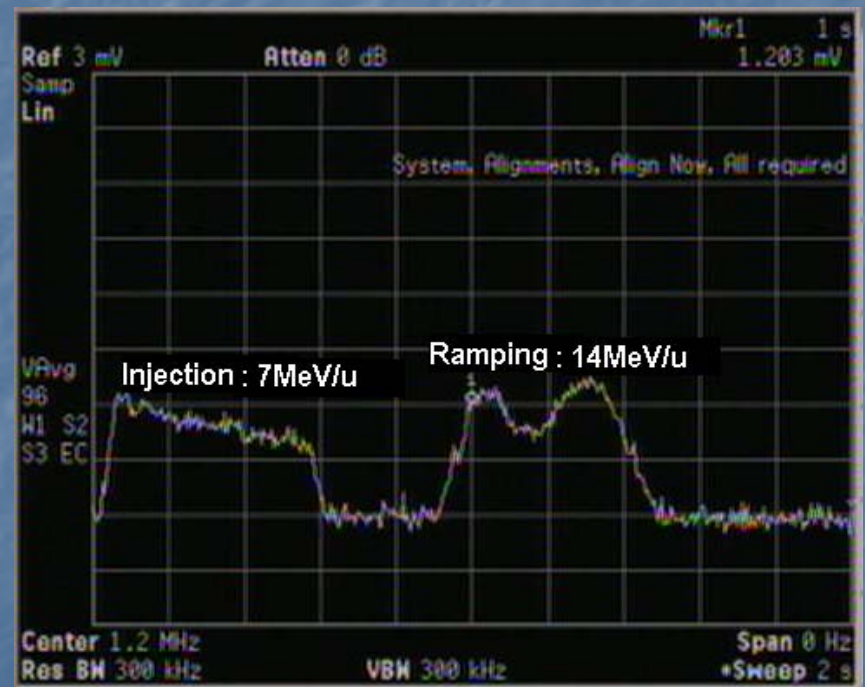
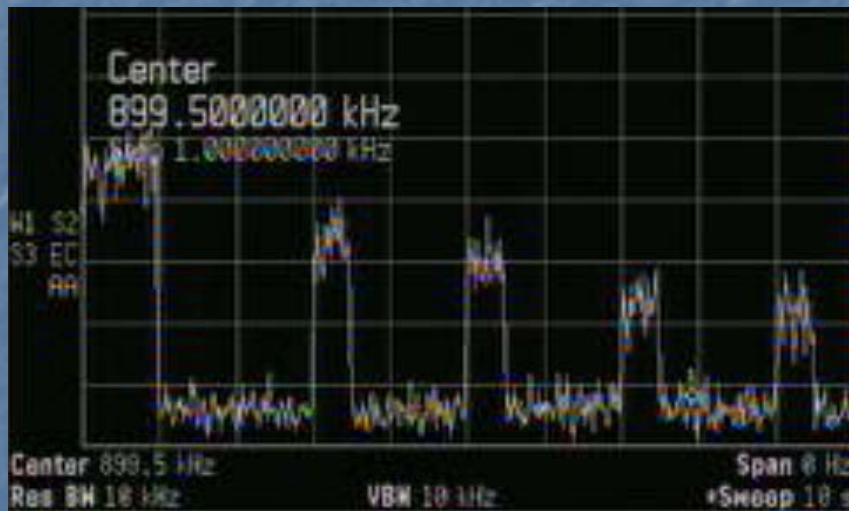


Under construction of CSRe in 2003



CSRm tunnel

The first stored beam in CSRm was observed on January 23, 2006 using 6.897 MeV/u C⁴⁺ as the injection beam, and the stripping injection mode was used. The stored beam with lifetime of more than 10 s was observed using Schottky spectroscopy. The stored beam was accelerated from 7 MeV/u to 14 MeV/u.

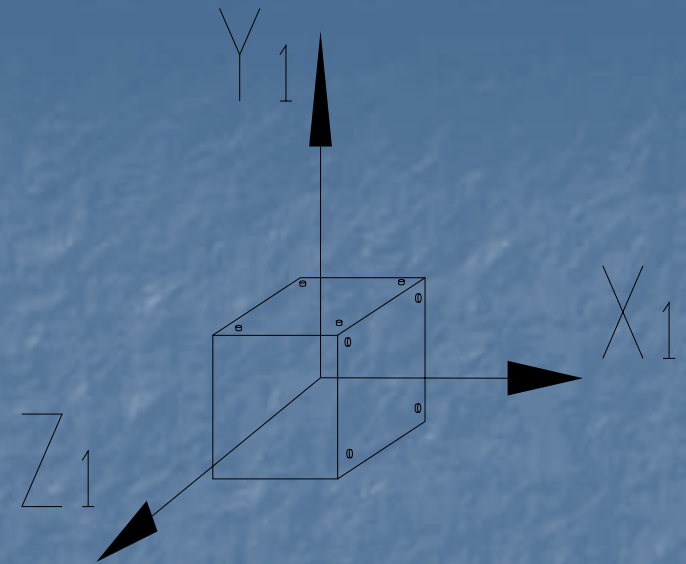


Alignment work

- 1. Fiducialization for magnets
- 2. Measuring the control network of CSR main ring
- 3. Align the magnets
- 4. Problems

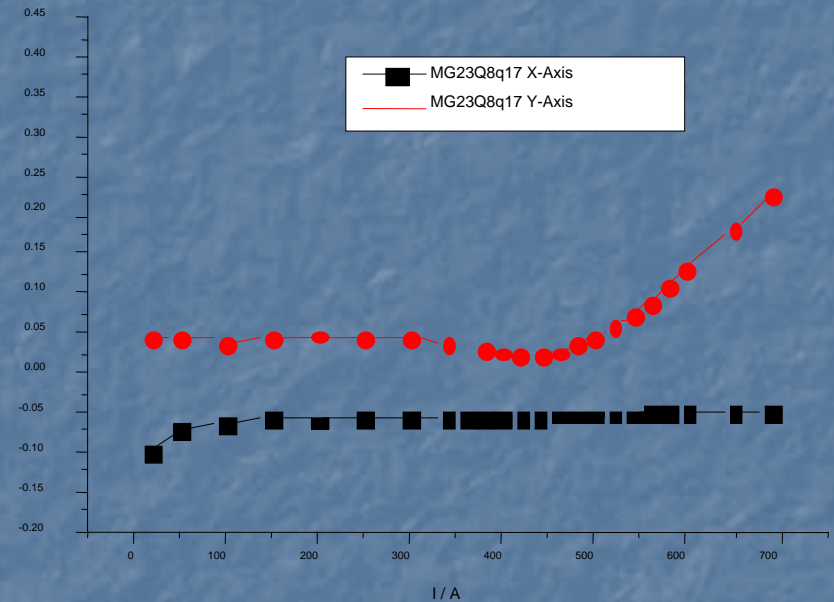
FIDUCIALIZATION FOR MAGNETS

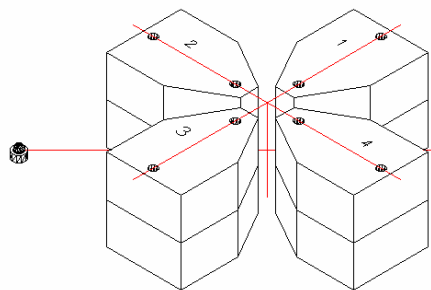




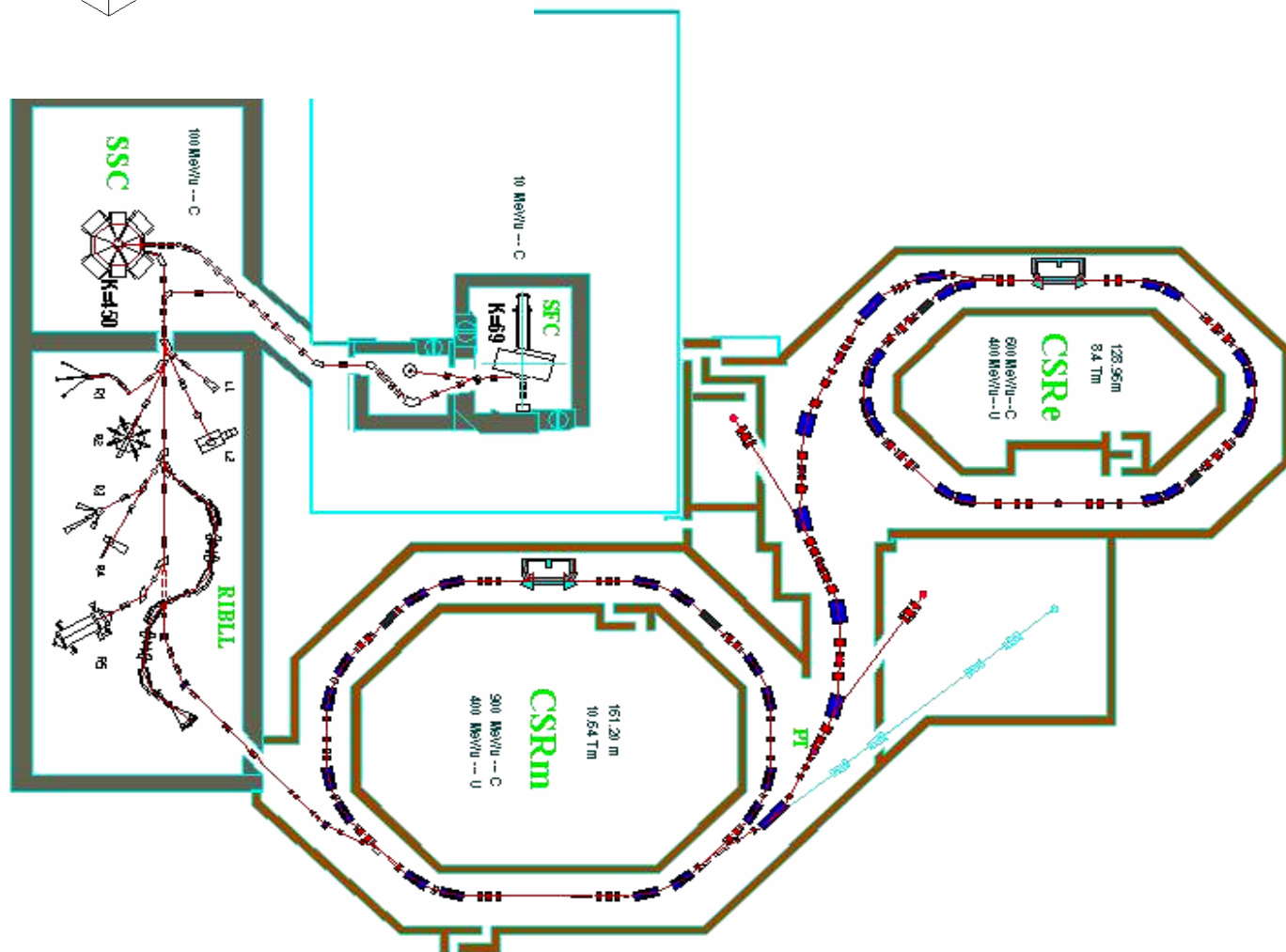
**FIDUCIALIZATION FOR
MAGNETS
ORIGIN OF PART FRAME IS ON
THE MECHANICAL CENTER**

Deviation between Magnetic Center and Mechanical Center





HIRFL-CSR GLOBLE NETWORK
ORIGIN IS ON THE CENTER OF SSC





CSRm center permanent
benchmark to monitor the tunnel
floor movement

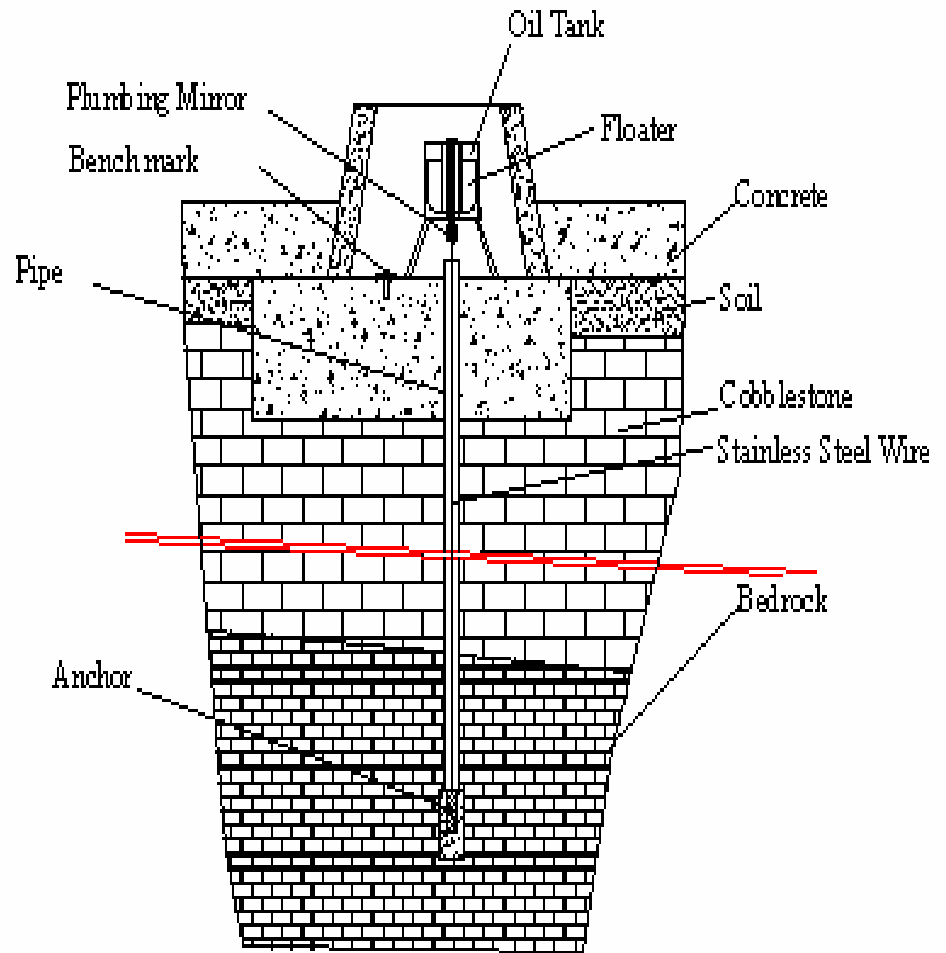
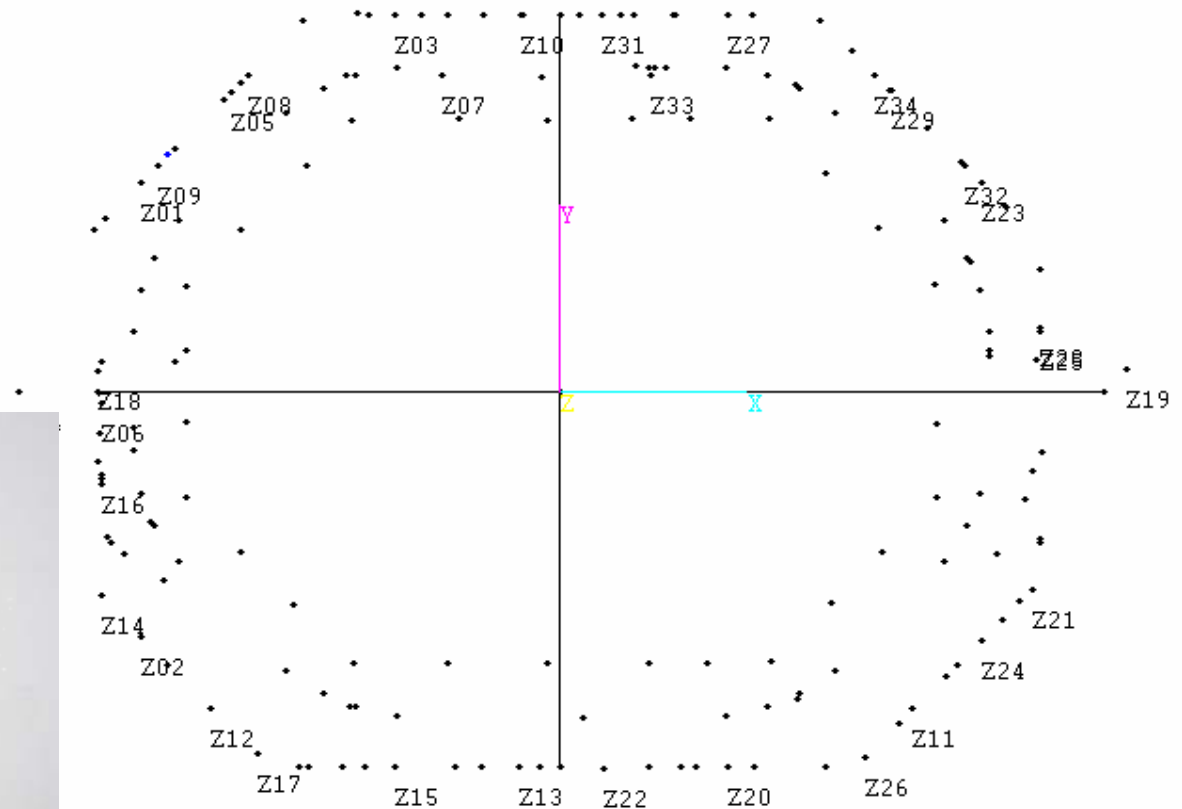


Fig.1 Construction of survey monument

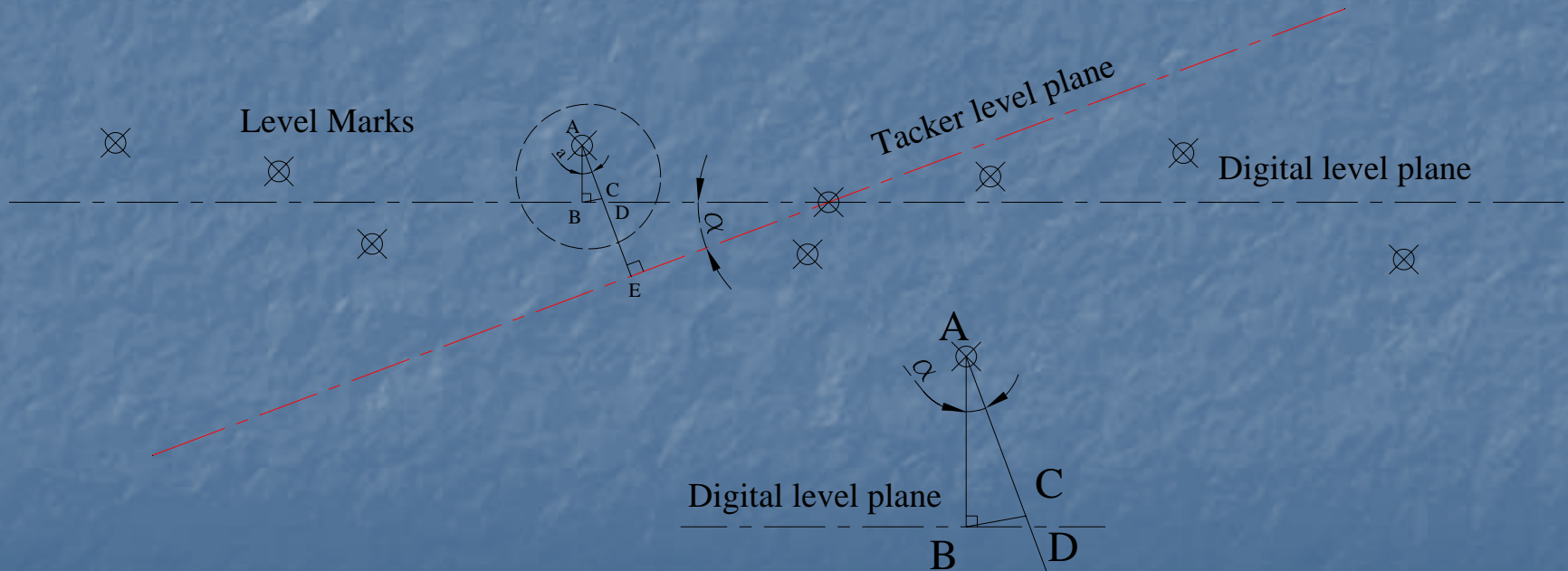


The control network of CSRm is defined by 134 monuments, 122 on the wall of tunnel, 10 on the floor surrounded the main ring as the level marks, another two are in the special pipe which is inserted deeply into the ground, those two control point generate a line as the long axis of CSRm.

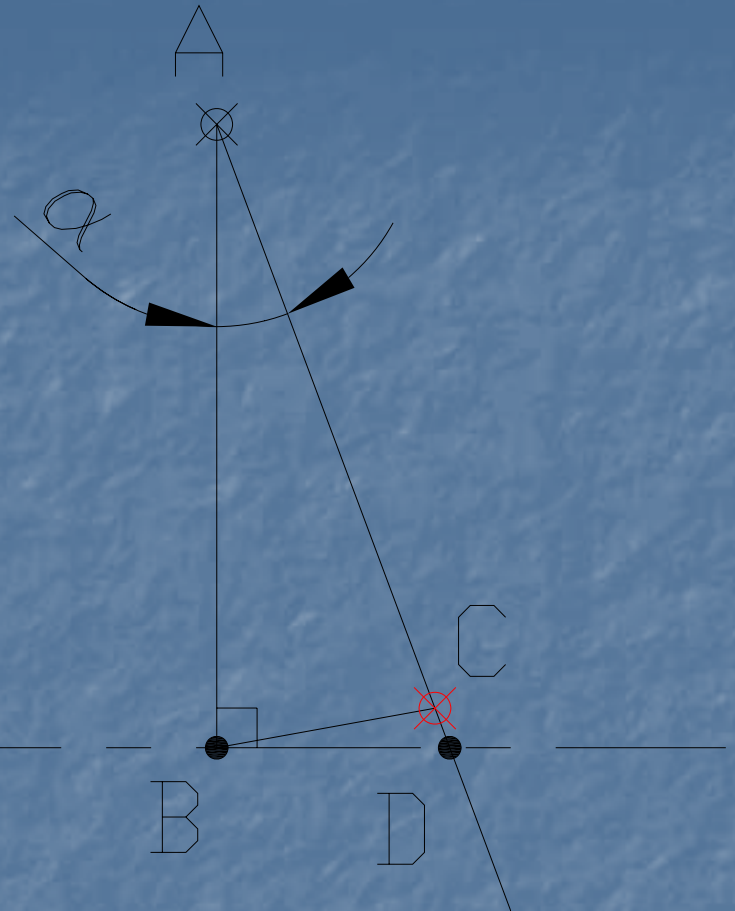


Generate Precise Level Plane

Measure Level Marks using DNA03 and Tracker. Get two Data of each Mark. Modify Tracker Data, Move A to C $AC=AB$; Generate a new Marks very close to digital level plane; Best fit to generate a new plane.



Digital level plane



$$AC=AB$$

$$CD=AD-AC=AD-AB=AB/\cos \alpha -AB$$

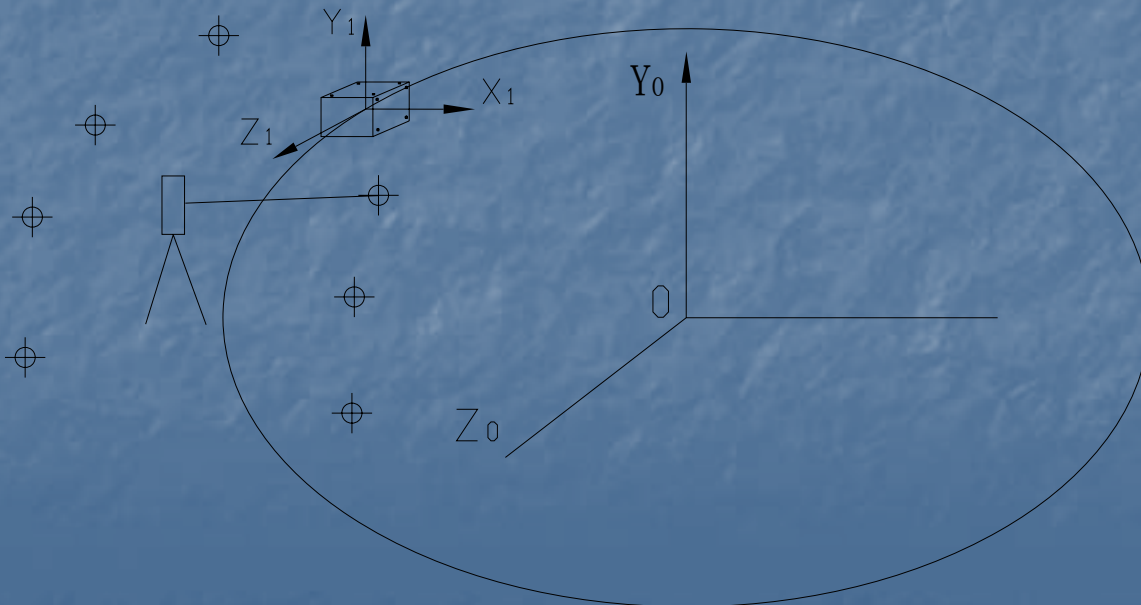
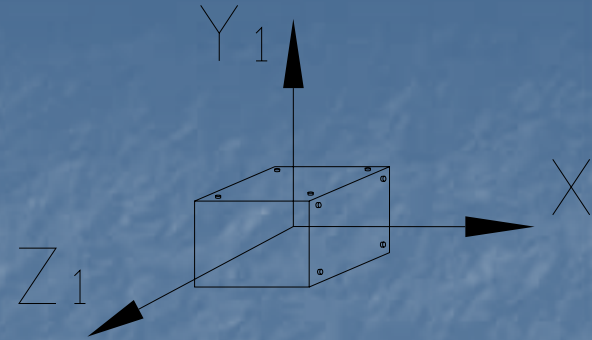
$$CD=AB*(1/\cos \alpha -1)$$

α is 2 arc second

$$CD=4.7e-11*AB \approx 0$$

ALIGN MAGNETS

1. measure net work points.
2. restore CSRm reference frame.
3. move the origin to the position magnet should be put on.
4. measure nests compare fiducial data, adjust the magnet, let two data as same as possible.
5. using a program to calculate the ΔX , ΔY , ΔZ , $\Delta \phi$, $\Delta \psi$, $\Delta \theta$.



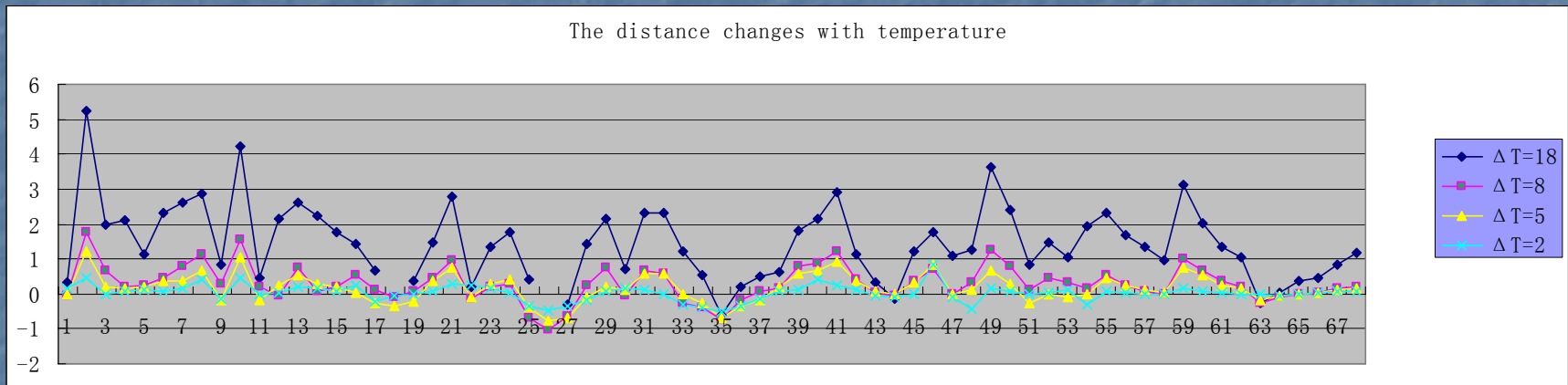
PART FRAME

RESULTS

- All the components of the CSR main ring have been carefully aligned and adjusted for several times, and the alignment errors are within 0.15mm and 0.3marc.

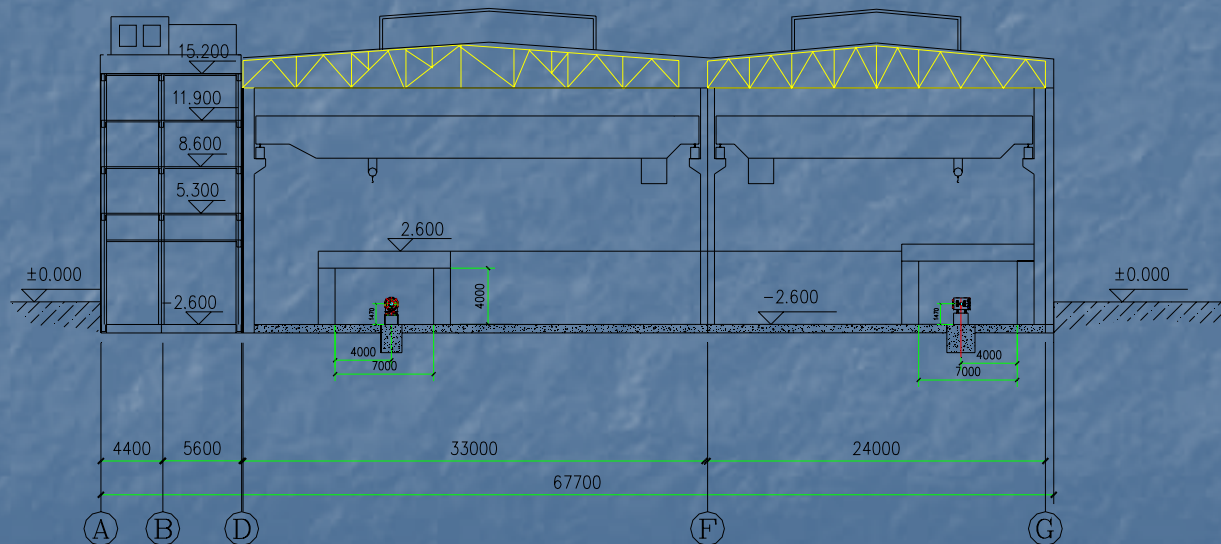
THE PROBLEMS

The scale of the CSR ring changed with the temperature. It follows the rule of hot expand and cold shrink. The maximum deference of temperature between summer and winter is 25°C . 70 distances between each two net points on the inner wall of tunnel are observed from February to August. The coefficient of thermal expansion is about $1 \times 10^{-6} \text{ m/m/}^{\circ}\text{C}$.



TO SOLVE THE PROBLEMS

1. To decrease the temperature in summer: a) ventilator; b) solar film
Experiment shows us that the solar film can reduce two degrees centigrade of temperature in the room.
 2. Using heater to increase the temperature in winter.
- We will observe the deformation continuously and to find the better method.



Thank You!
Welcome to Visit
in Lanzhou

