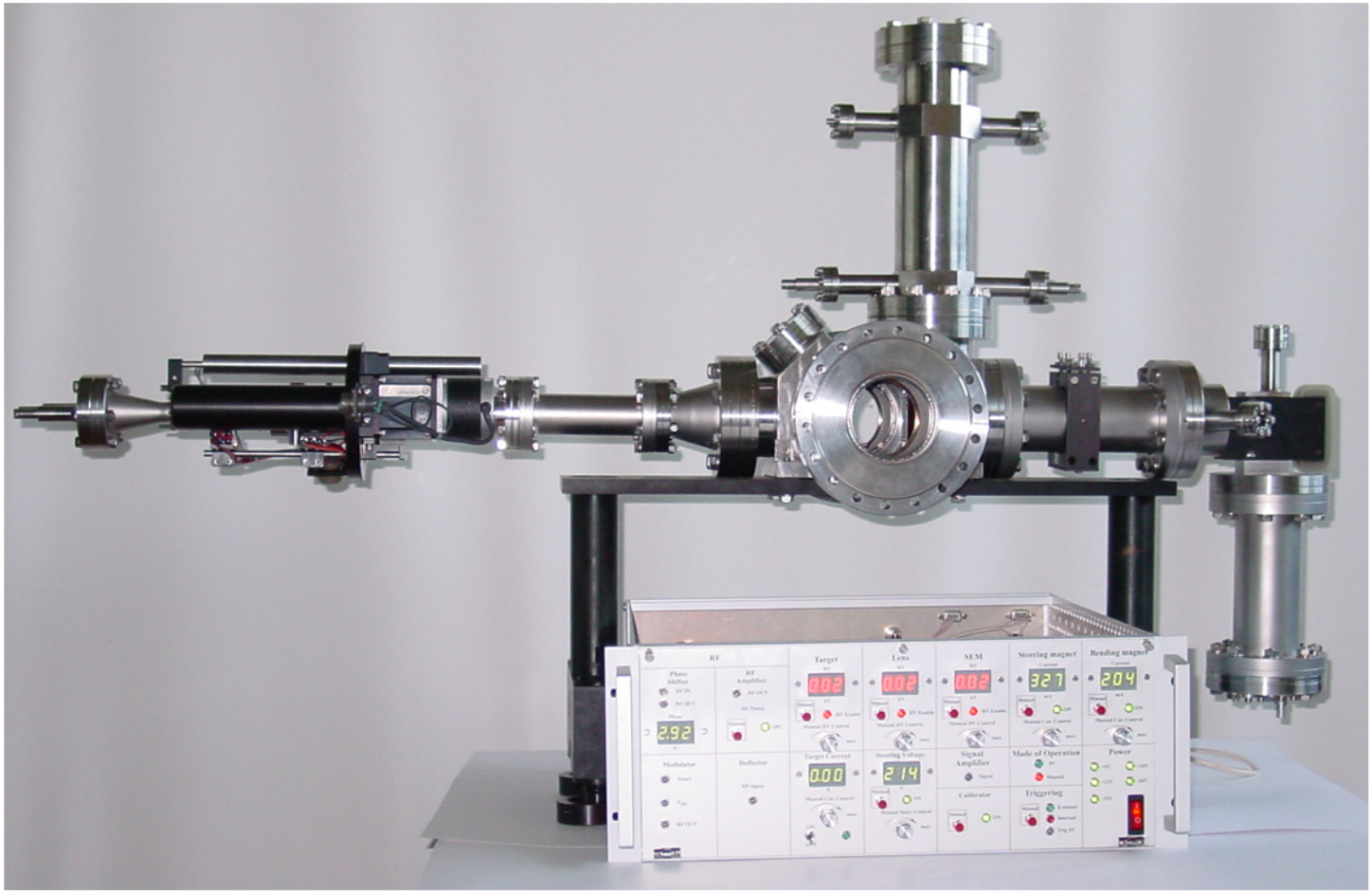
BUNCH SHAPE MONITOR (BSM)

L. Kravchuk and A Menshov for BSMs team

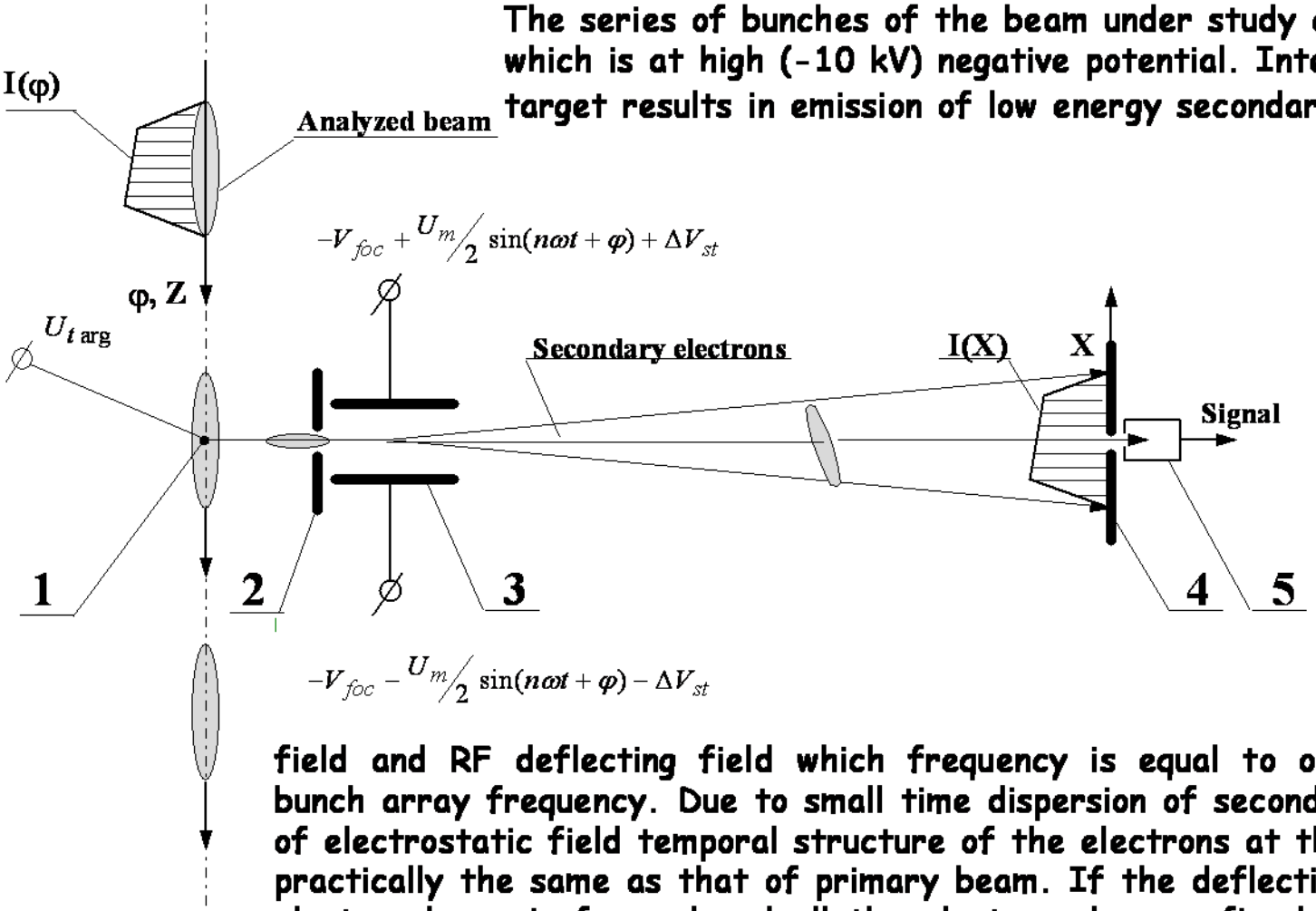


INTRODUCTION

The longitudinal distribution of charge in bunches (a bunch shape) is one of the most important parameters of the beam in linear ion accelerator. This characteristic can be used both to study beam dynamics and to tune precisely an accelerator. Information about a bunch shape enables to improve quality of the accelerated beam and is of extreme importance for the future linac upgrade. The design of the BSMs was based on the long-term experience of our team.

The principle of BSM operation is based on the coherent transformation of longitudinal distribution of the analyzed beam charge into spatial distribution of low energy secondary electrons through transverse RF modulation. Though this principle was directly used in the BSMs for the ORNL, much work has been done to satisfy mechanical requirements which resulting in rather intricate and precise design of the detectors.

PRINCIPLE OF BSM OPERATION

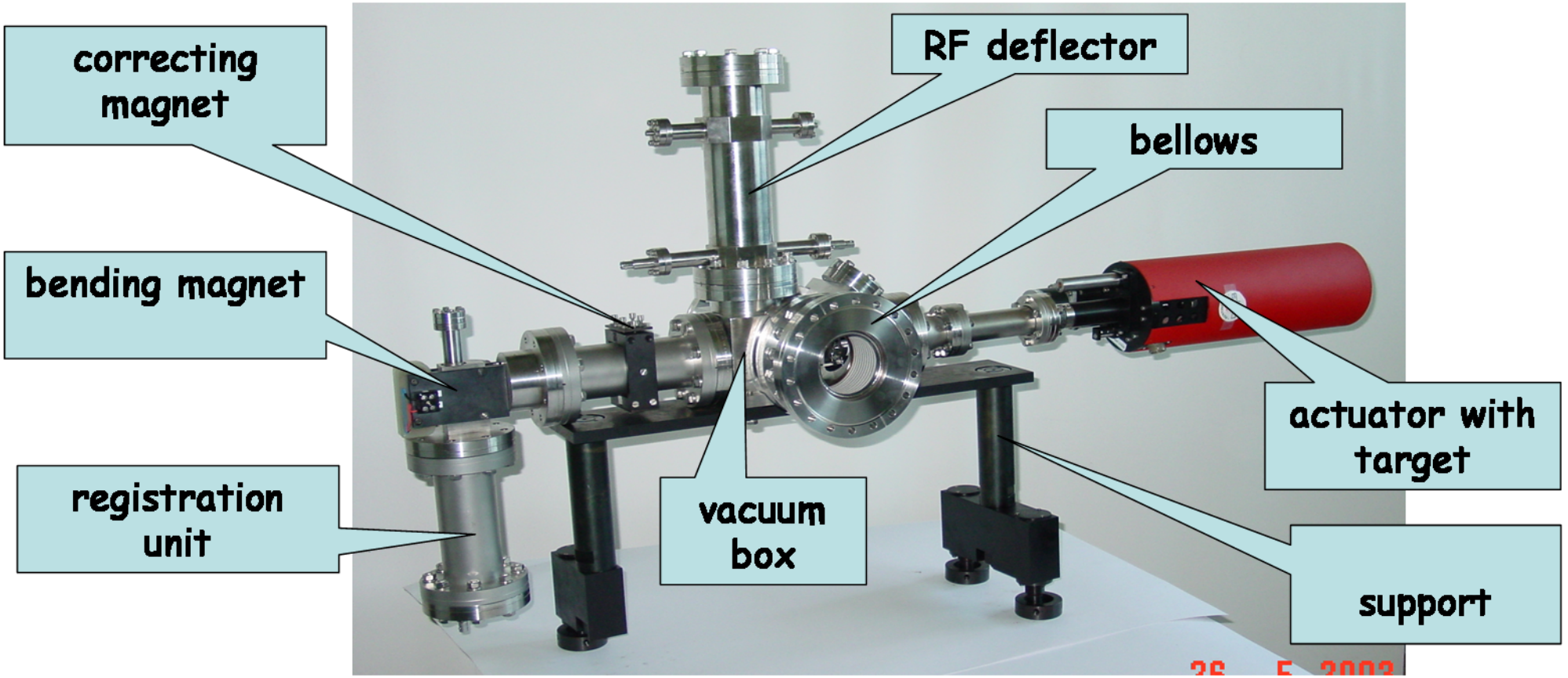


The series of bunches of the beam under study crosses the wire target (1) which is at high (-10 kV) negative potential. Interaction of ions with the target results in emission of low energy secondary electrons.

The electrons are accelerated by electrostatic field and move radially away from the target. Fraction of the electrons passes through the input collimator (2) and enters the RF deflector (3) combined with the electrostatic lens. Electric field in the deflector is a superposition of electrostatic focusing field and RF deflecting field which frequency is equal to or multiple of the fundamental bunch array frequency. Due to small time dispersion of secondary emission and high strength of electrostatic field temporal structure of the electrons at the entrance of the deflector is practically the same as that of primary beam. If the deflecting field is turned off then the electron beam is focused and all the electrons have a fixed coordinate X_0 at the plane of the output collimator (4). Longitudinal structure of the primary beam is coherently transformed into a spatial distribution of secondary electrons.

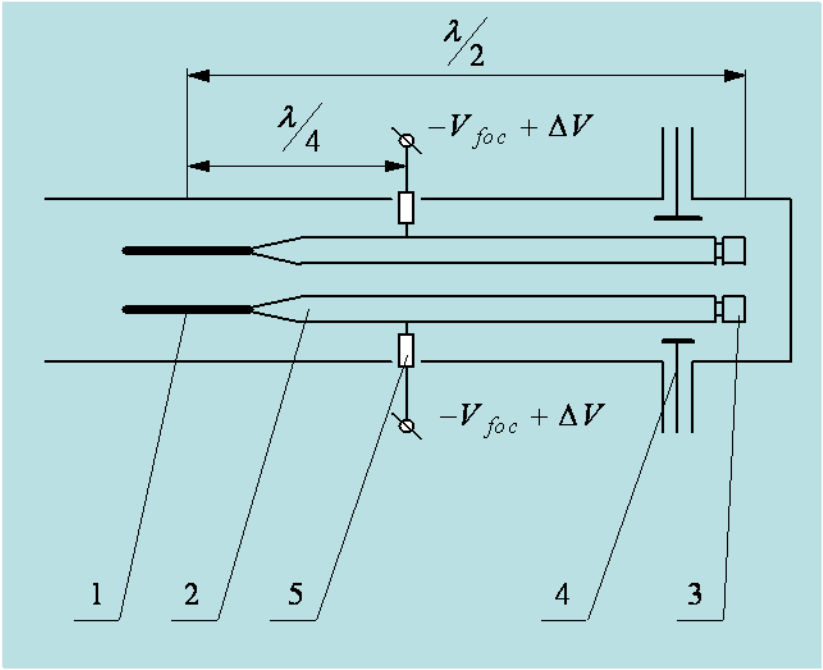
DESIGN OF THE BSM FOR D - PLATE

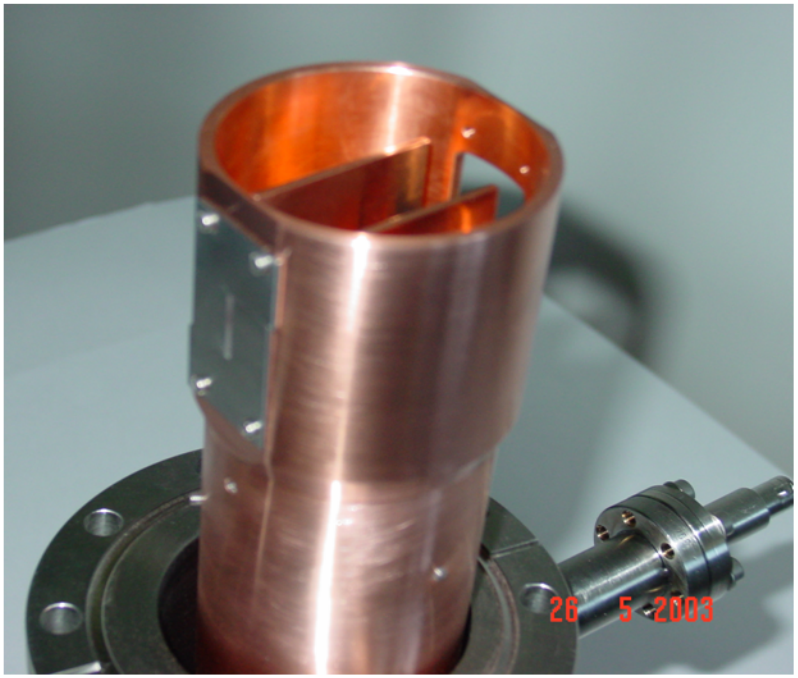
The BSM consists of the next main parts: vacuum box, the actuator with target unit, RF deflector combined with electrostatic lens, the registration unit combined with bending magnet, permanent correcting magnet to steer the electrons vertically, bellows and support with legs.



DESIGN OF THE BSM FOR D - PLATE - continued

RF deflector

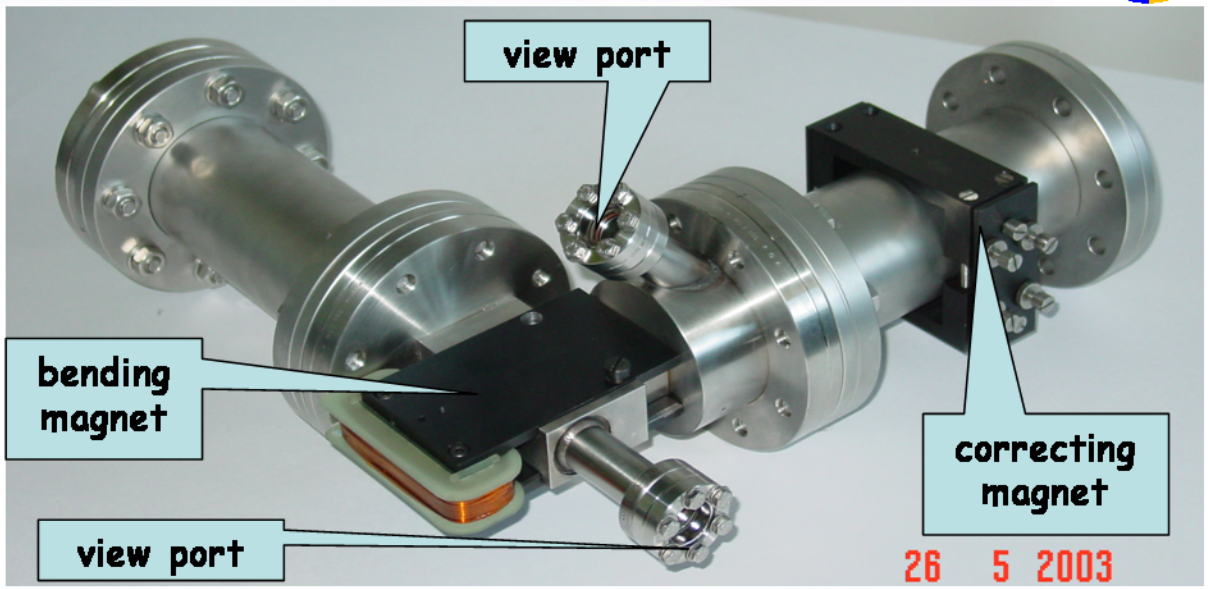




This unit is the most important element of the BSM. The deflector includes a parallel wire line. Two electrodes (2) are supported by two insulators from MACOR®-type ceramics. The electrodes are connected with the deflecting plates (1). The screws (3) are intended to tune a resonant frequency of the deflector cavity. Two coaxial feedthroughs are used to supply rf power and to pick up the rf signal. Capacitive buttons (4) are used as coupling elements. To adjust coupling, the distance from the coaxial line may be changed. HV potentials are applied via the feedthroughs, wire springs and resistors (5). The contacts to the central electrodes are located at the points of zero RF field thus avoiding any essential loading of the cavity even if the resistors are not used.

DESIGN OF THE BSM FOR D – PLATE – continued

Vacuum box

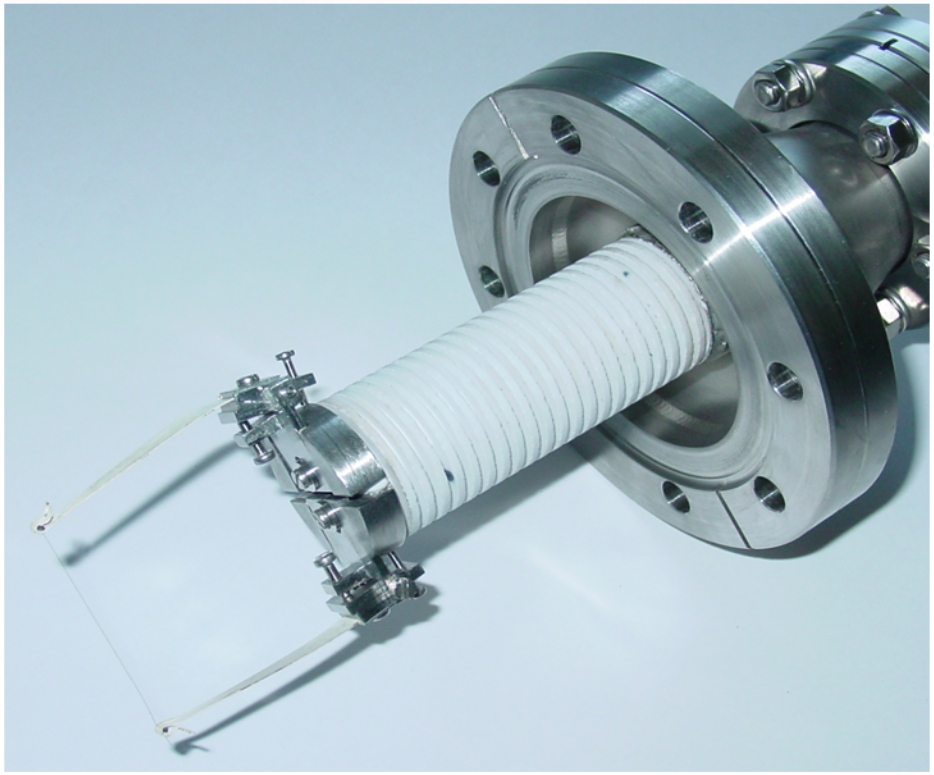


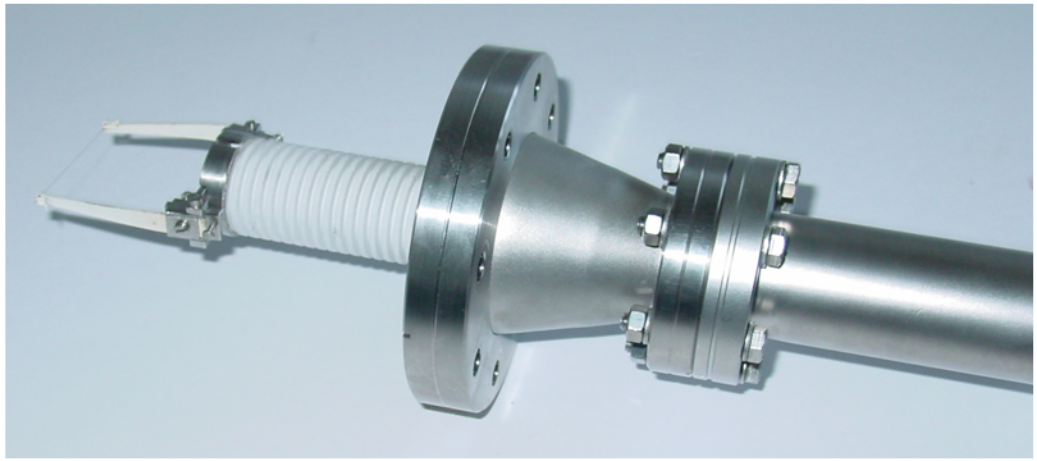
Registration unit combined with correcting and bending magnet

The secondary electrons are detected using the Secondary Electron Multiplier Hamamatsu R596. This device is installed in ceramic socket. Feedthroughs (not shown here) are used to supply HV to SEM device and to pick up the multiplied secondary electron signal. To provide the tuning of electron optics with thermal electrons plates of the collimators are covered by scintillator. The focused electrons can be visually observed through two view ports. The registration unit is connected with the vacuum box of BSM via extending stub tube.

The correcting magnet is fixed around the stub tube. It creates a horizontal magnetic field to correct the trajectories of the electrons in the vertical direction. This is a permanent magnet with an adjustable field. Barium ferrite rectangular bar is used as an active magnetic element. The aluminum spacer is located symmetrically. Adjustment of the magnetic field is made by varying the width of the gaps and between the joke and the shunting plates.

DESIGN OF THE BSM FOR D – PLATE – continued





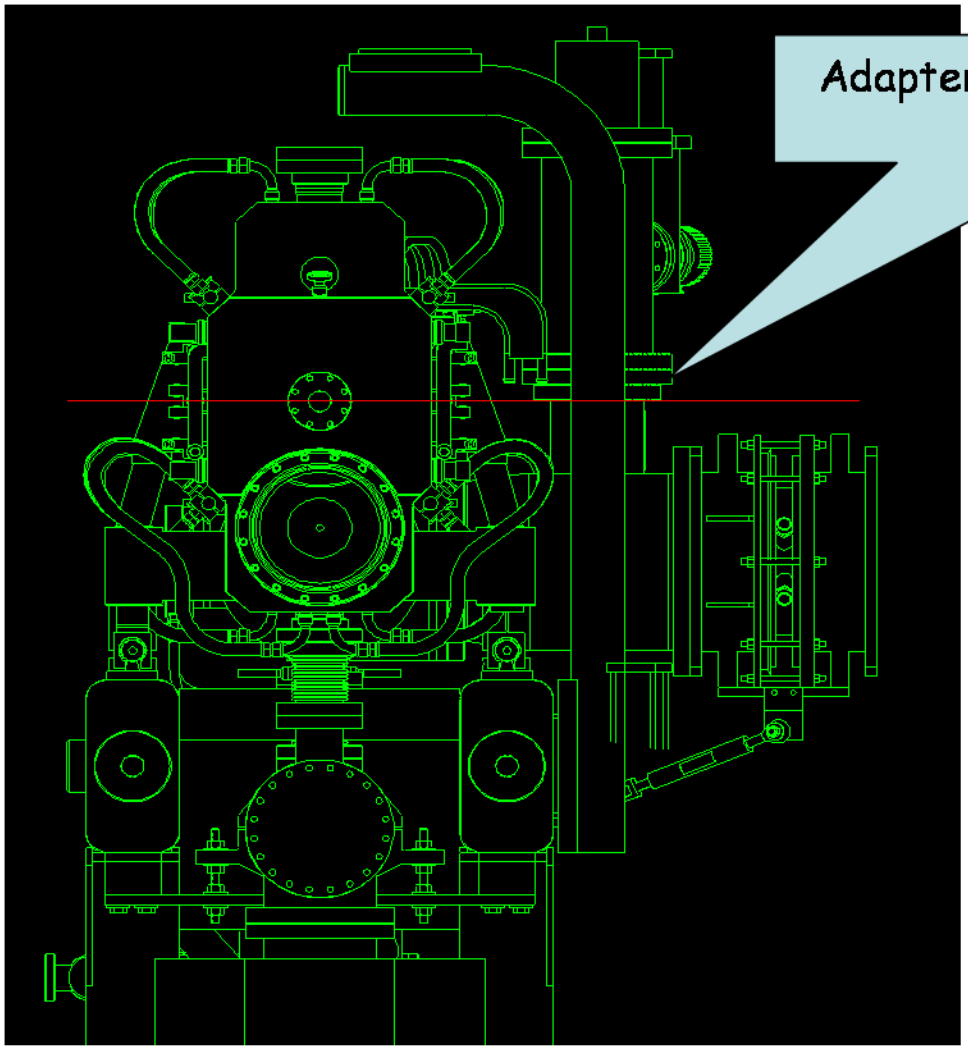
Actuator with target unit

The target actuator for the BSM uses the Huntington's actuator with stepper motor. The bellow is used to transmit the translation into the vacuum. The multiturn potentiometer is installed on the body of actuator and it used to control the position of the target. The target, 0.1 mm diameter tungsten wire, is installed on the spring pillars. The tension of the wire is adjusted by two mechanisms, installed on the HV ceramic insulator.

THE PROBLEM

THE PROBLEM

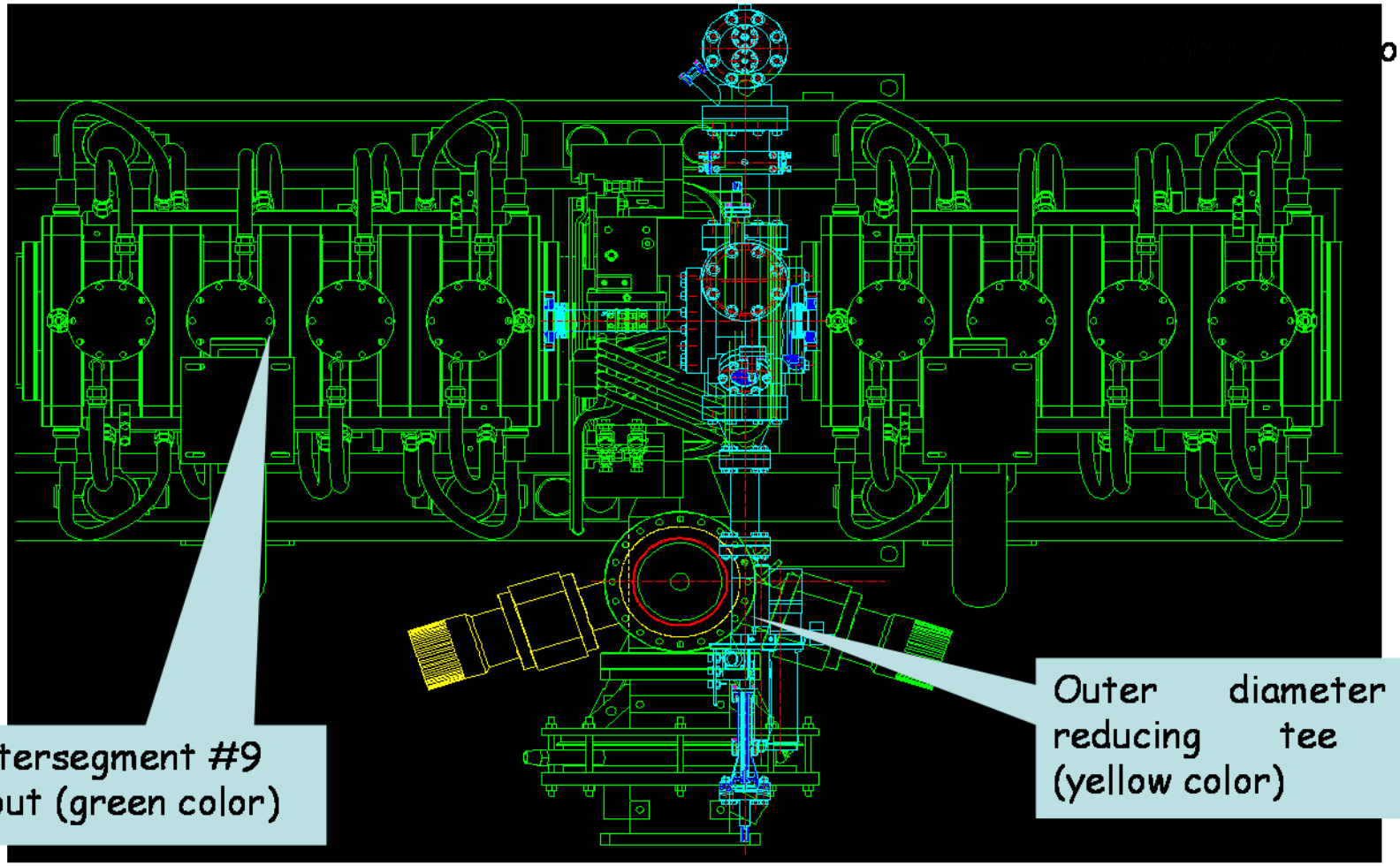
Pre-history of the problem



Unfortunately, we had not complete set of the LANL drawings and, respectively, had not the information about this adapter up to the middle of January, 2003.

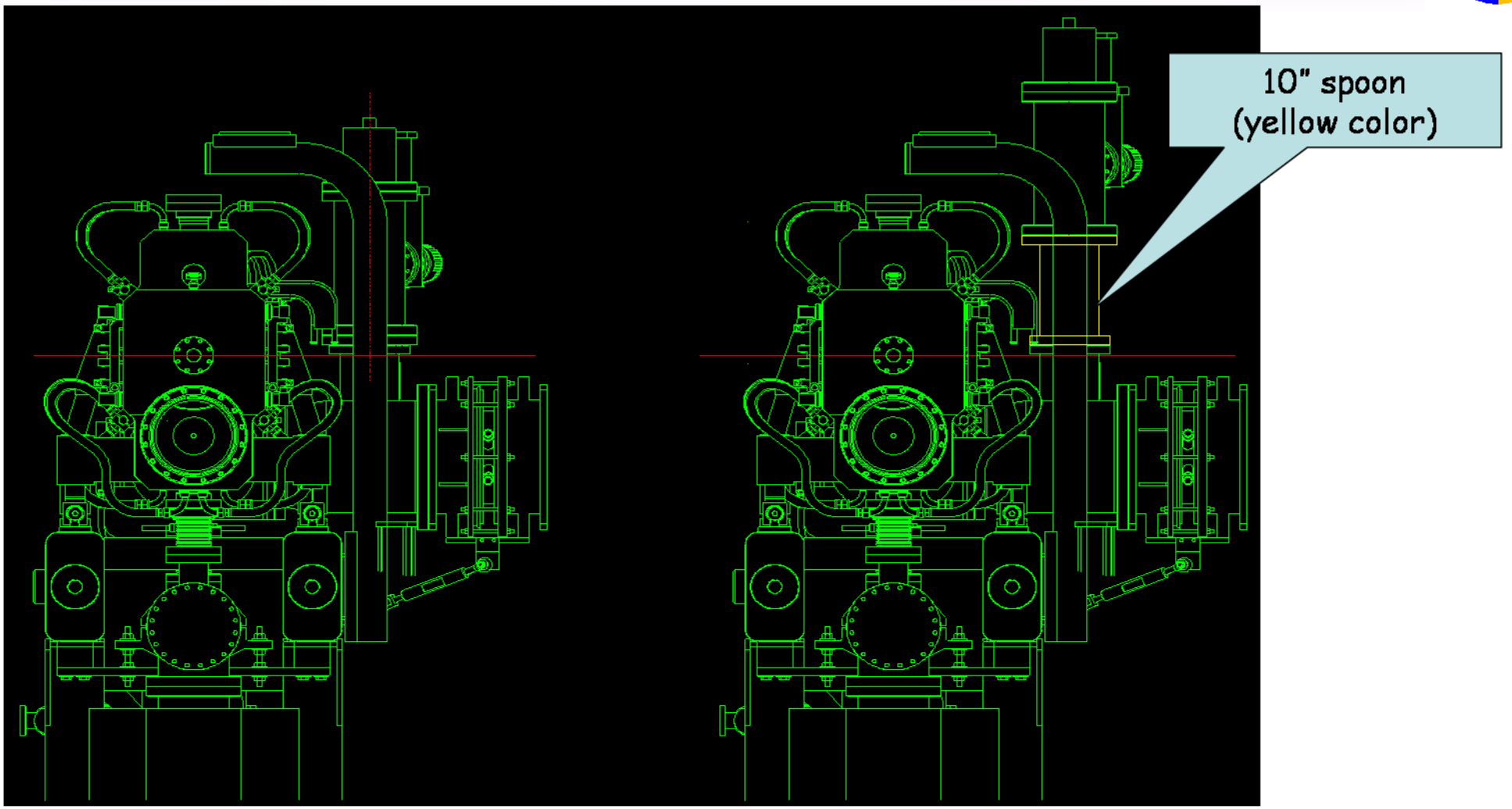
THE PROBLEM-continued

BSM superimposed on the intersegment # 9 layout



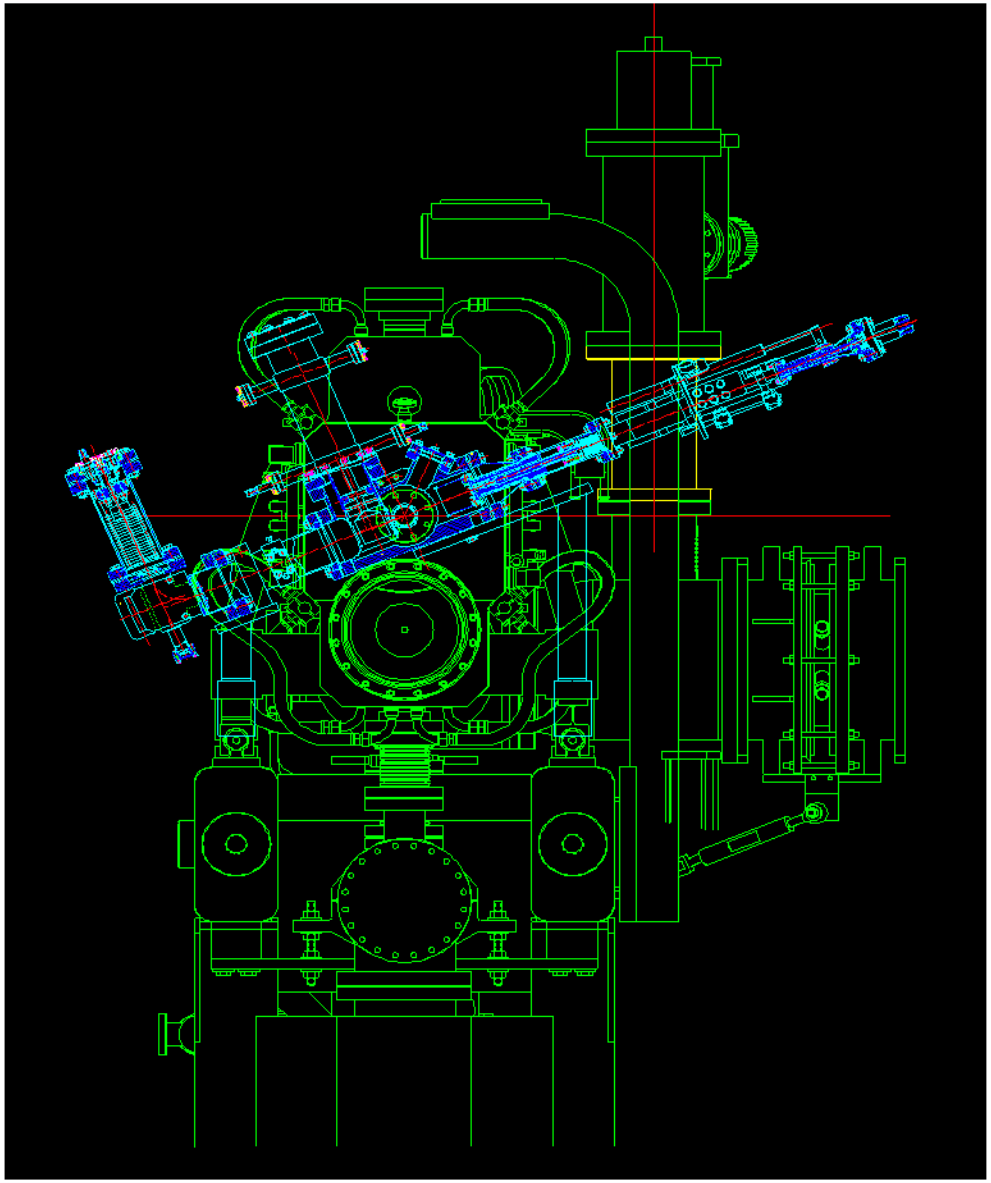
When we received the drawings from LANL, the interference between BSM and 8" CF flange was found.

THE PROBLEM-continued



We suggested to lift the pump, using 10" spoon with the same outer diameter. After that we could inscribe our BSM as shown below:

THE PROBLEM-continued

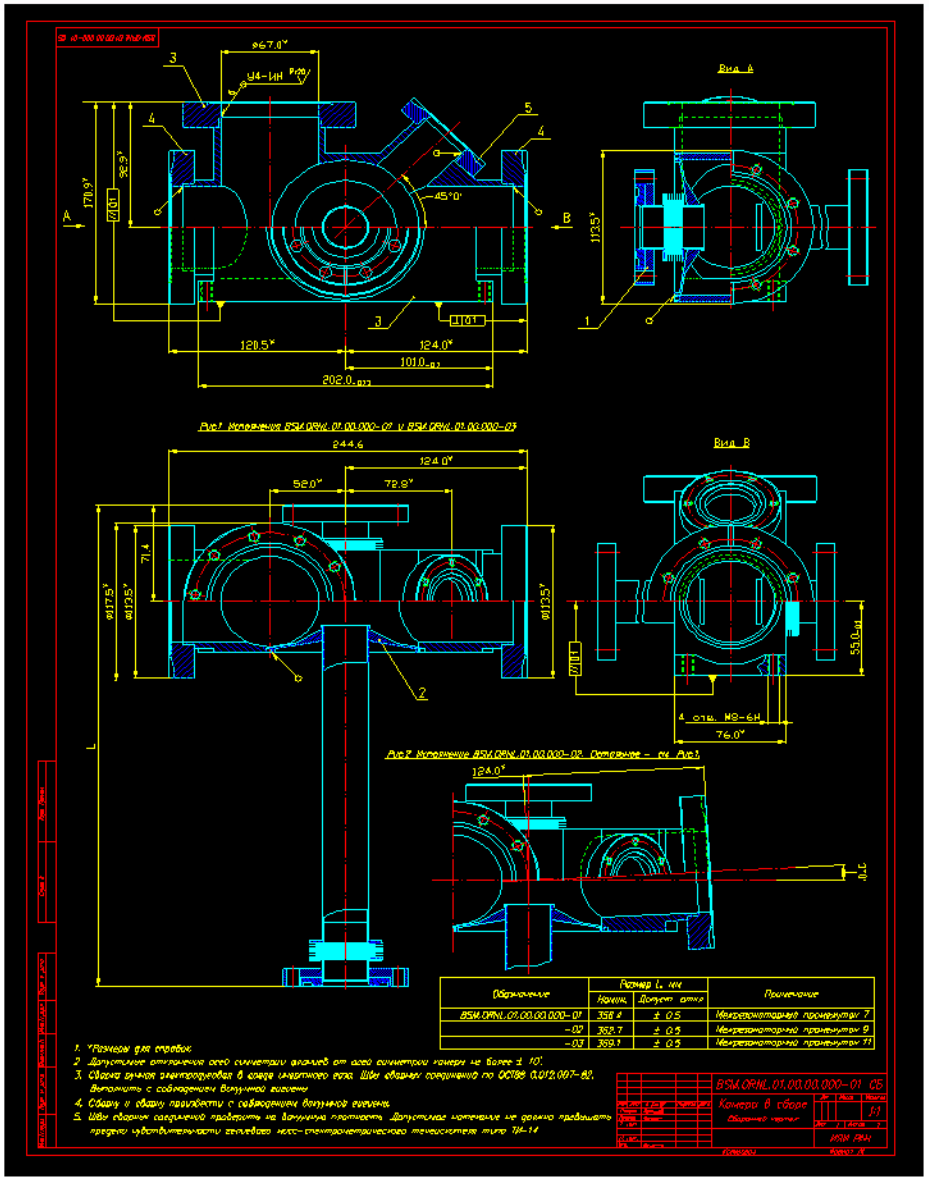


Unfortunately we have not an answer from LANL up to now.

To solve the problem mentioned above, we decided to change previous design completely.

THE NEW DESIGN

THE NEW DESIGN



THE GOALS AND OBJECTIVES OF NEW DESIGN

i. Remove the interference between the BSM and vacuum reducing tee

ii. Keep the design of separate parts as full as possible.

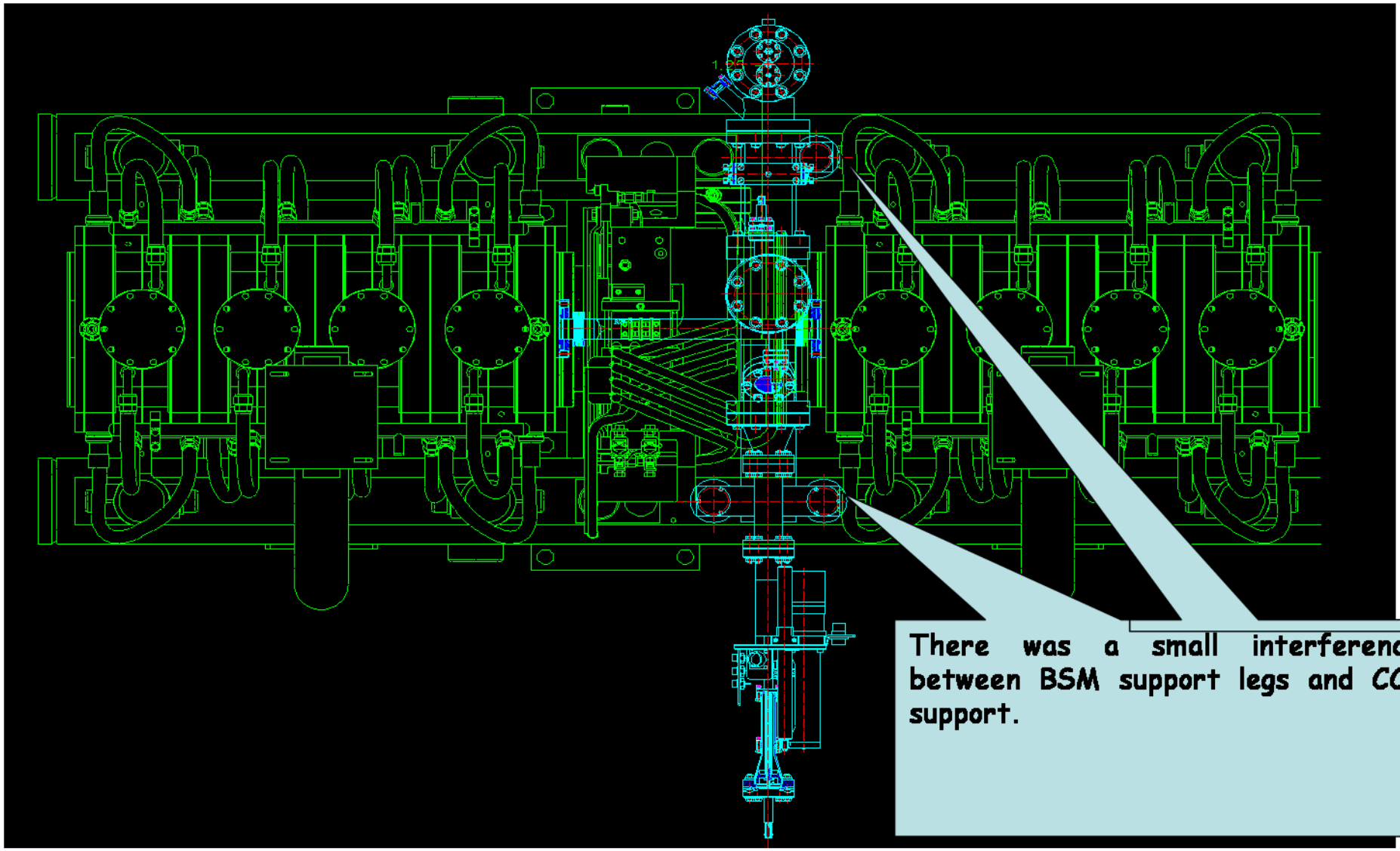
iii. Remove the eccentricity of RF deflector

For this goals we plan:

- Remove the connection flanges of vacuum box
- Use the weld connection of beam pipe and vacuum box

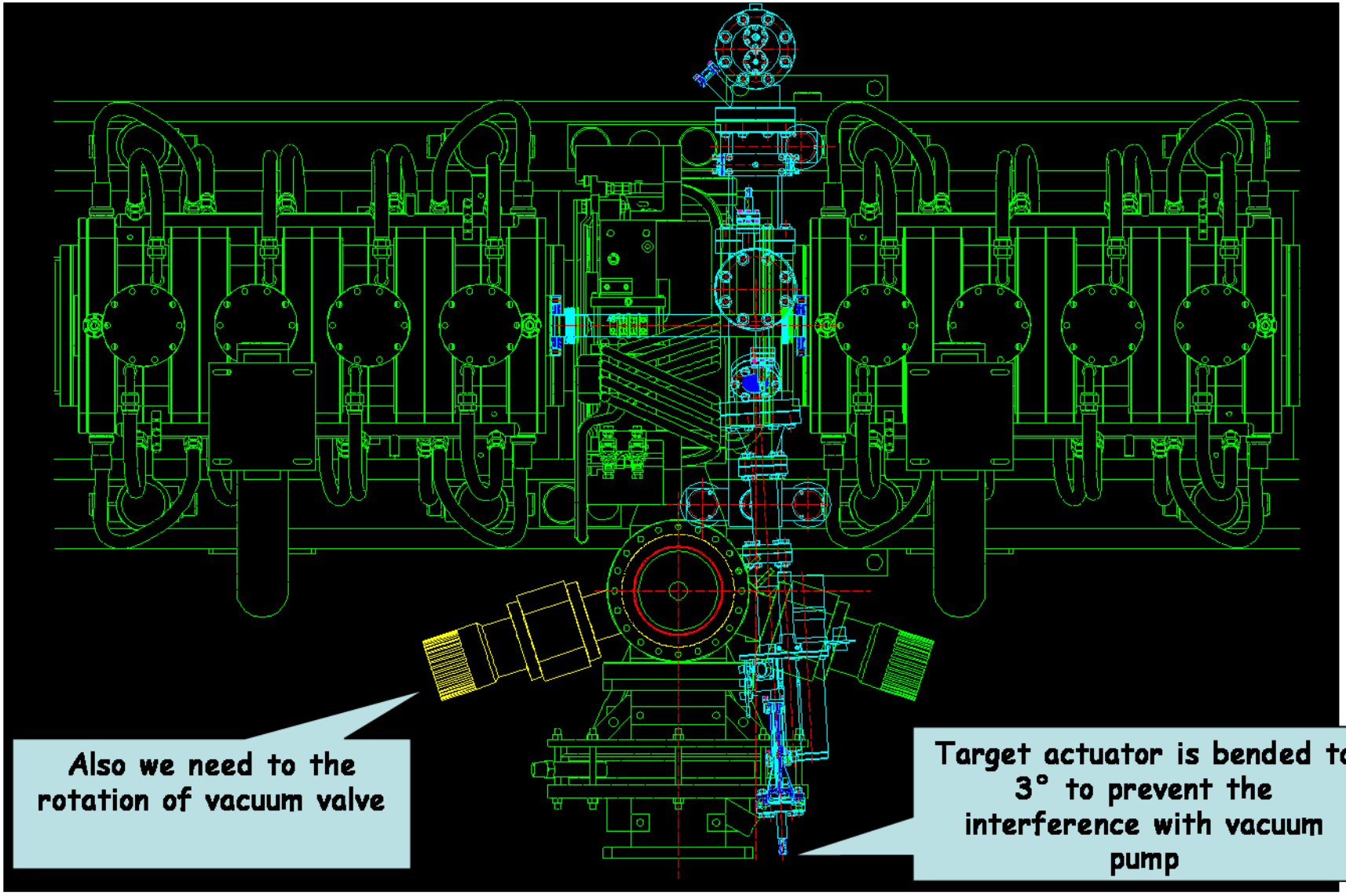
THE NEW DESIGN-continued

BSM-7 superimposed on the intersegment # 7 layout



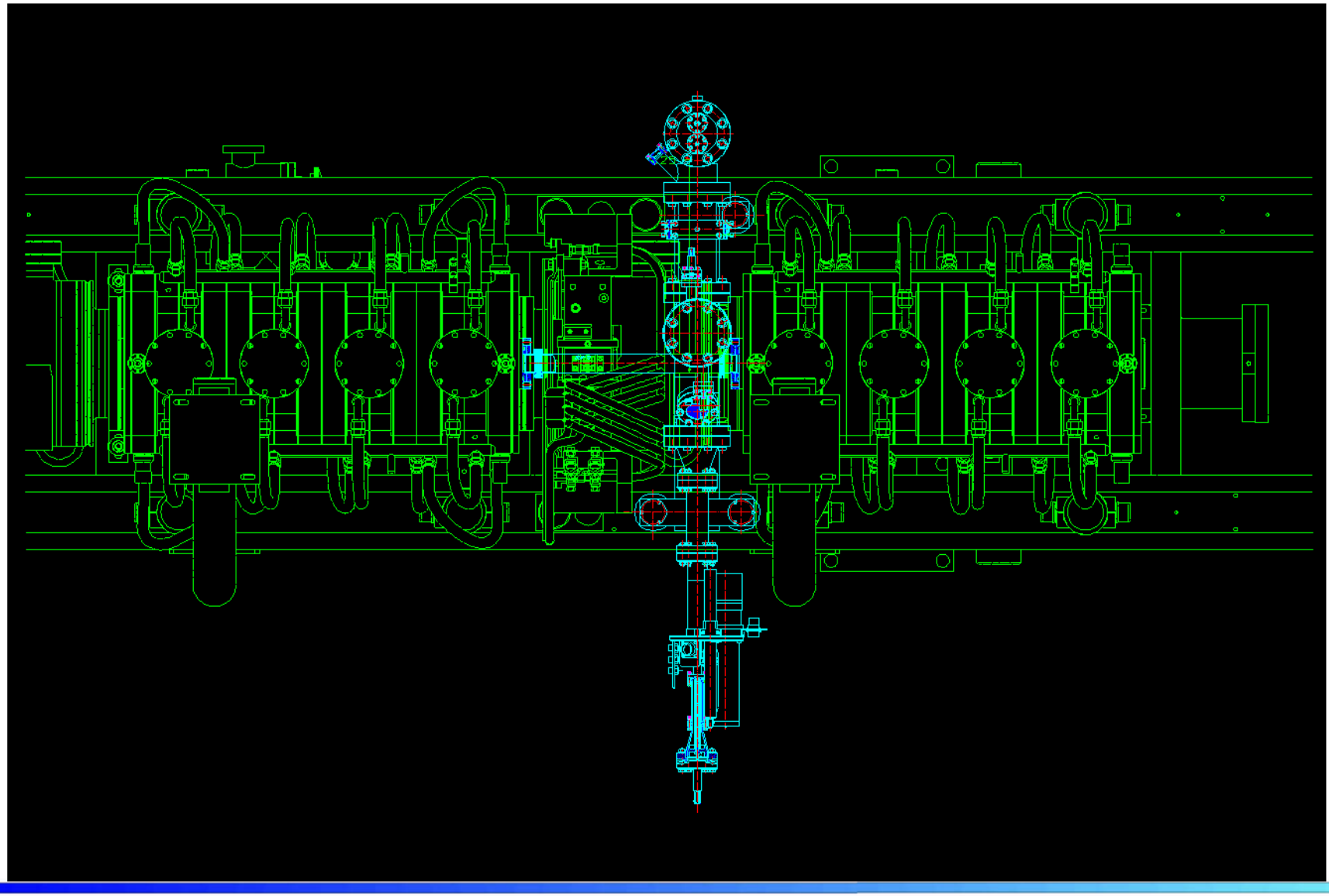
THE NEW DESIGN-continued

BSM-9 superimposed on the intersegment # 9 layout

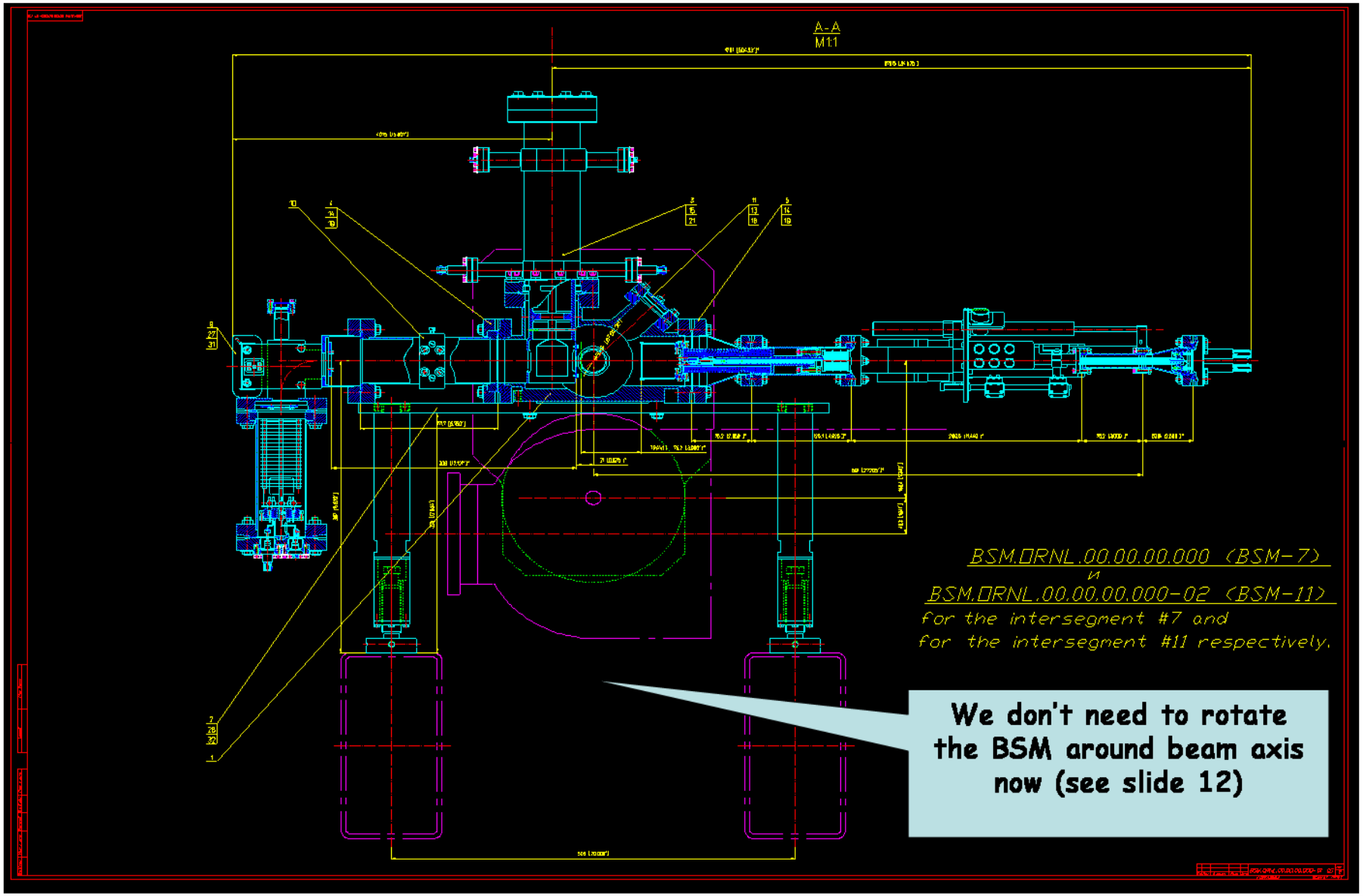


THE NEW DESIGN-continued

BSM-11 superimposed on the intersegment # 11 layout

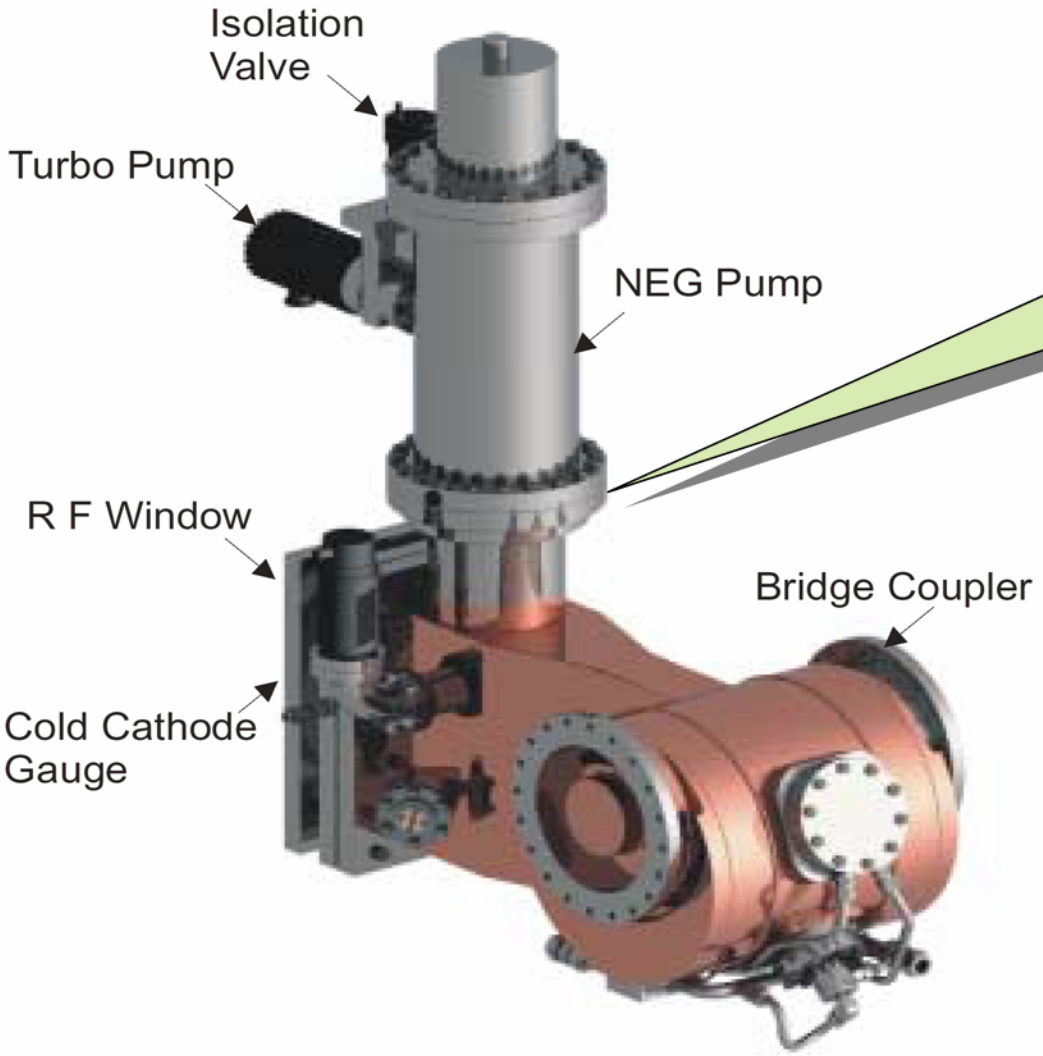


THE NEW DESIGN-continued



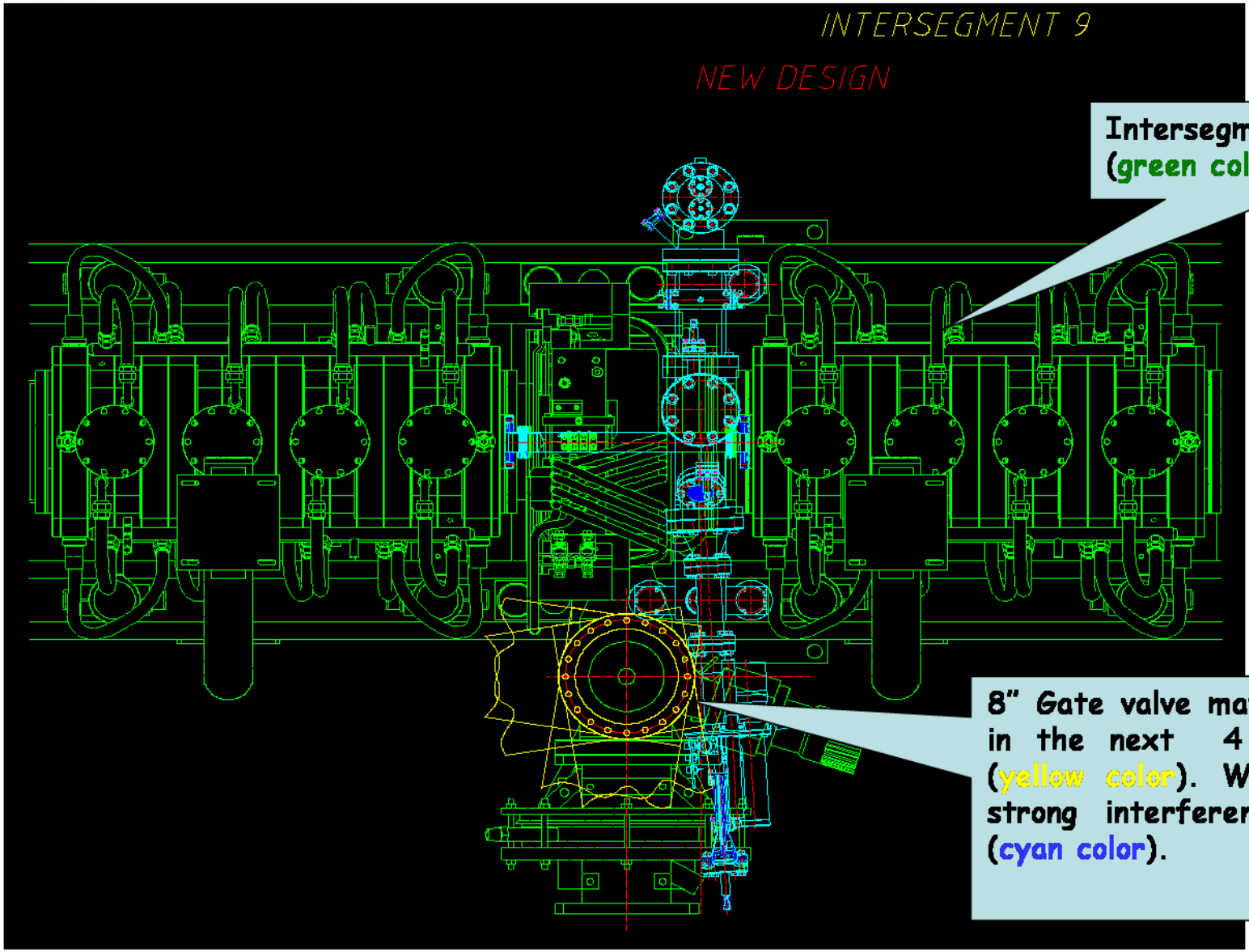
BUT…

NEWEST PROBLEM IN INTERSEGMENT # 9



Peter Ladd informed us that 8" Gate valve should be installed between the 8" CF flange of reducing tee and 8"/6.75" zero-length reducer.

INTERFERENCE THE 8" GATE VALVE WITH BSM



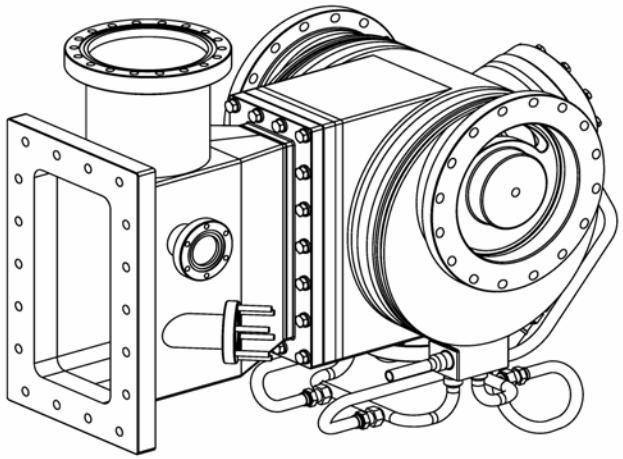
Intersegment # 9 layout (green color).

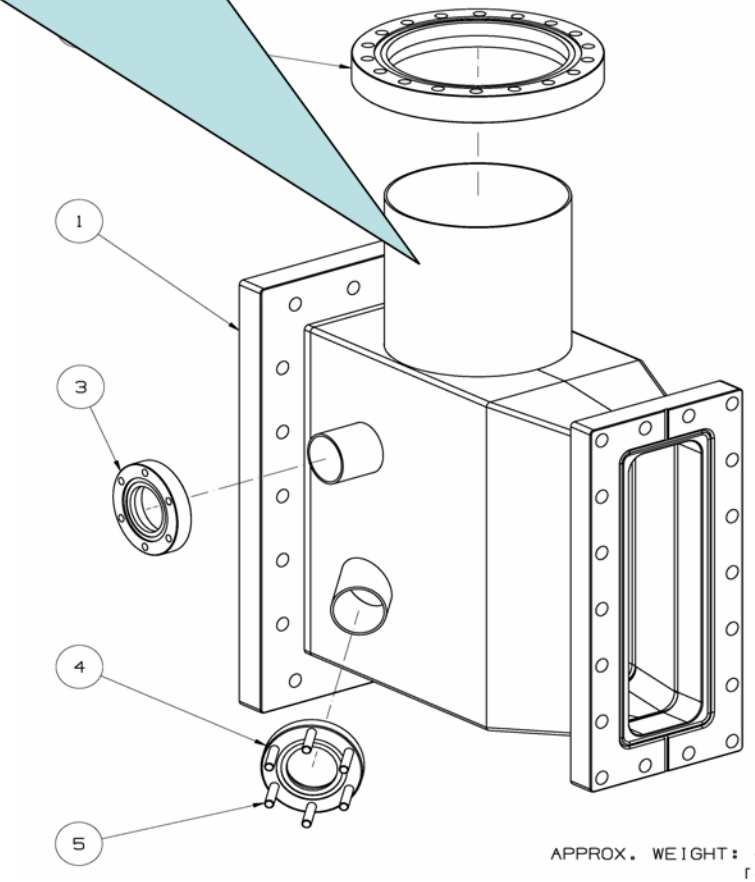
8" Gate valve may be installed in the next 4 positions only (yellow color). We can observe strong interference with BSM (cyan color).

TWO WAYS TO SOLVE THIS PROBLEM

Solution 1. This stainless steel tube is made longer on 2…4 inches. This work can be done for the waveguide transition of one of the last CCL modules. Then the assembly replace with the same unit of CCL Module 1.

Solution 2. The reducing nipple 6.75"/8" and 4" high can be used for the solution of this problem.



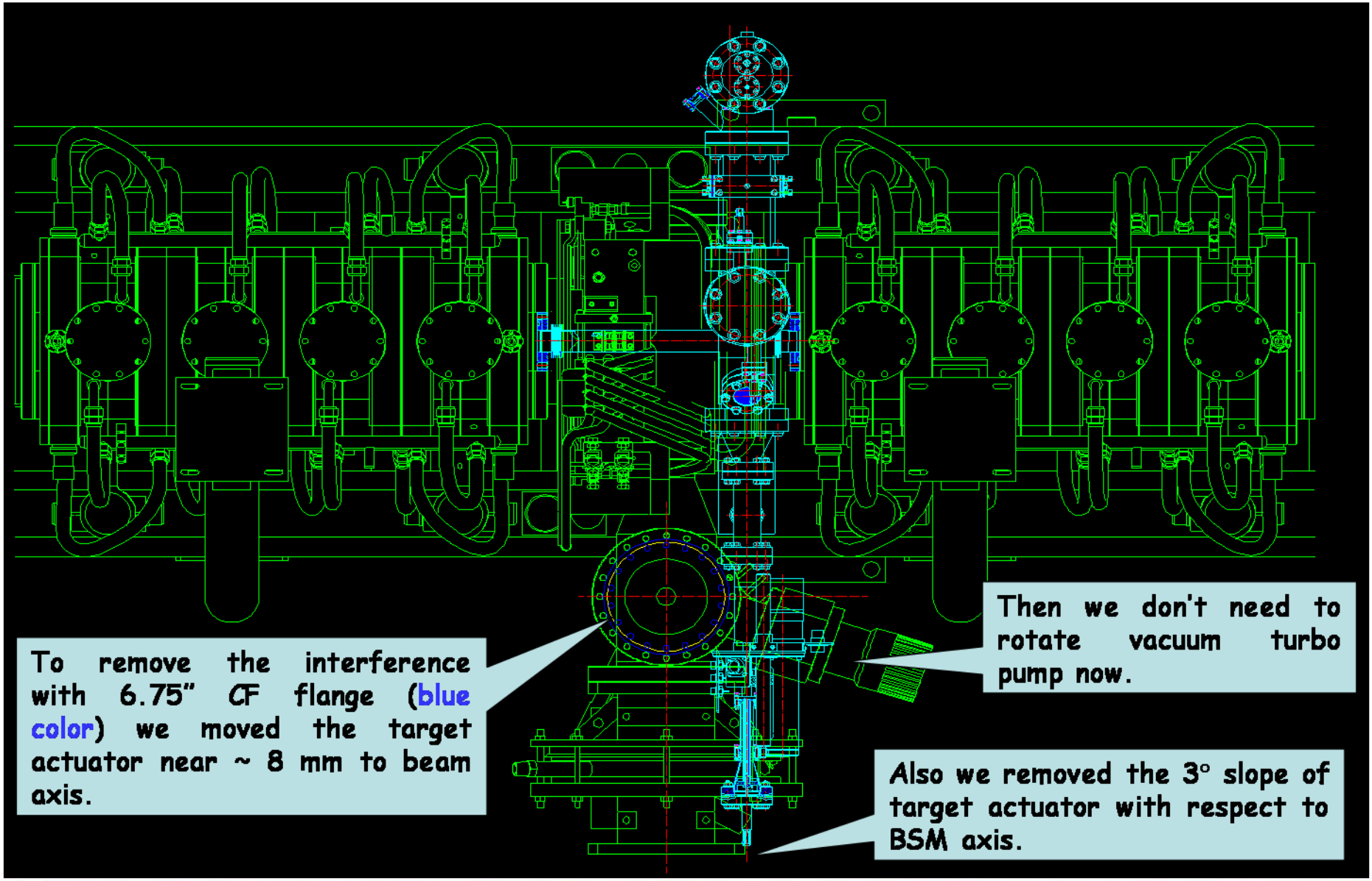


BUT…

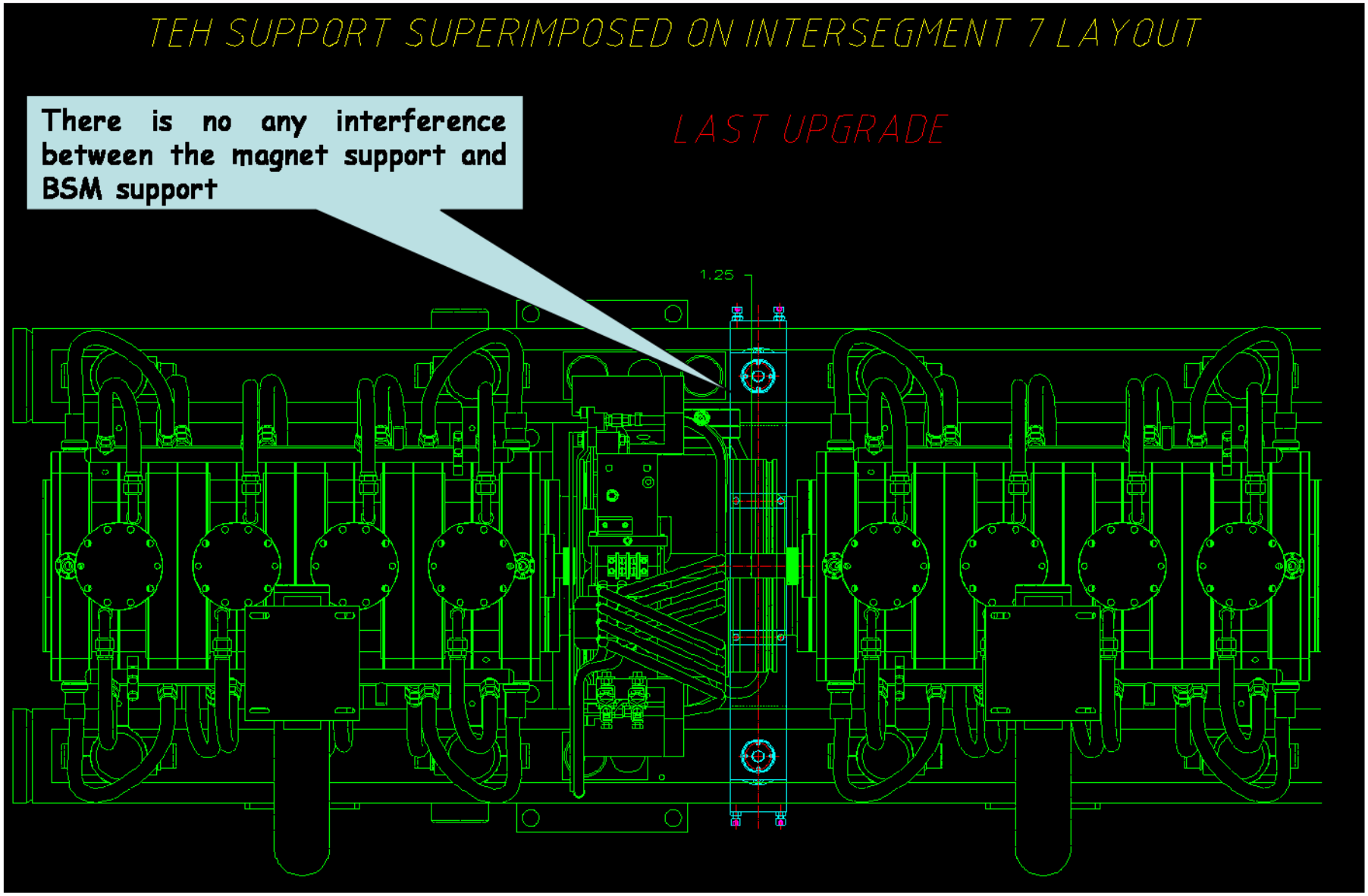
NEXT UPGRADE WAS NEED.

WHY?

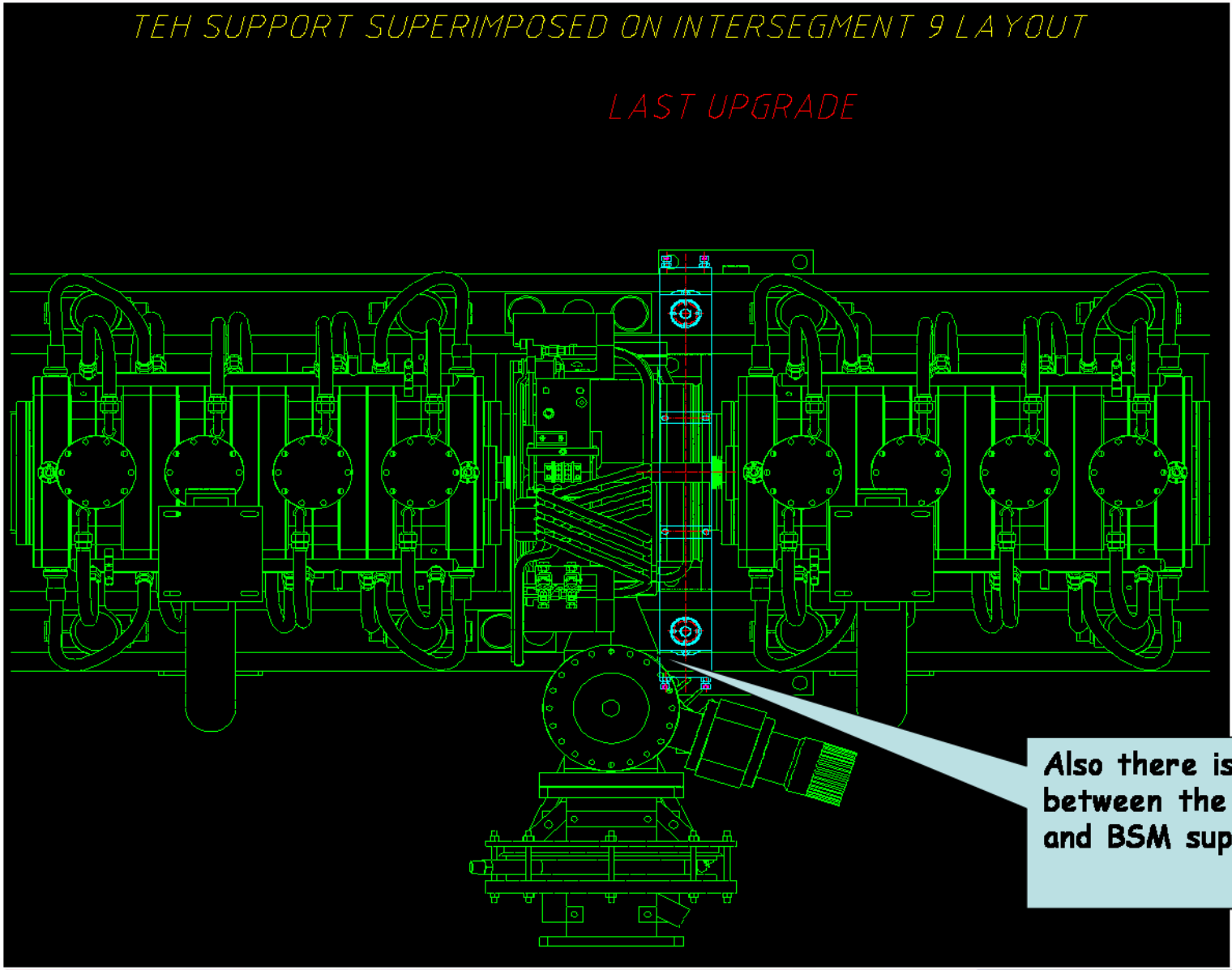
LAST UPGRADE - ADVANTAGES



LAST UPGRADE - ADVANTAGES - continued



LAST UPGRADE - ADVANTAGES - continued



Also there is no any interference between the waveguide transition and BSM support

CONCLUSION AND FUTURE WORK

CONCLUSION AND FUTURE WORK

WHAT WE NEED NOW ?

1. We have to have APPROVAL of new BSM design with last upgrade to continue the fabrication process.

2. Till now we have not the connection flanges and bellows:

Dr. # 155Y513773 CCL Delta Flange 3.38" Rotatable Outer Detail - 6 pieces + 1 spare
Dr. # 155Y513774 CCL Delta Flange 3.38" Rotatable Inner Detail - 6 pieces + 2 spare
Dr. # 155Y513776 CCL Welded Bellows Detail - 6 pieces + 1 spare
These parts are not the standard parts, and we can not order them without SNS and LANL.

3. The BSM installed on D-Plate now'll be reconstructed for the CCL Module 1. We would like to return all idle parts (such as the beam-box, the bellows, the RF deflector and the support) after the device commissioning to INR.

4. We suggest to divide the commissioning procedure for the next three BSMs on two stages:
   i. Mechanical assembly, vacuum test and installation at the CCL Module 1 intersegments.
   ii. Fine tuning, remote control and tuning with beam/commissioning.

5. We have to provide 3 groups of 4 threaded holes in the CCL Module 1 frame. The best way is to do it on place during the installation process. Is it OK?

THANKS FOR YOUR ATTENTION