

Laser Tracker-Based Geodetic Alignment Assessment and Realignment of Operational Beamlines at RAON

Jaehyun Cho*, Jongdae Joo, Changseog Seo, Sukjin Choi
Institute for Rare Isotope Science, Institute for Basic Science, Daejeon, Republic of Korea • *jhcho@ibs.re.kr



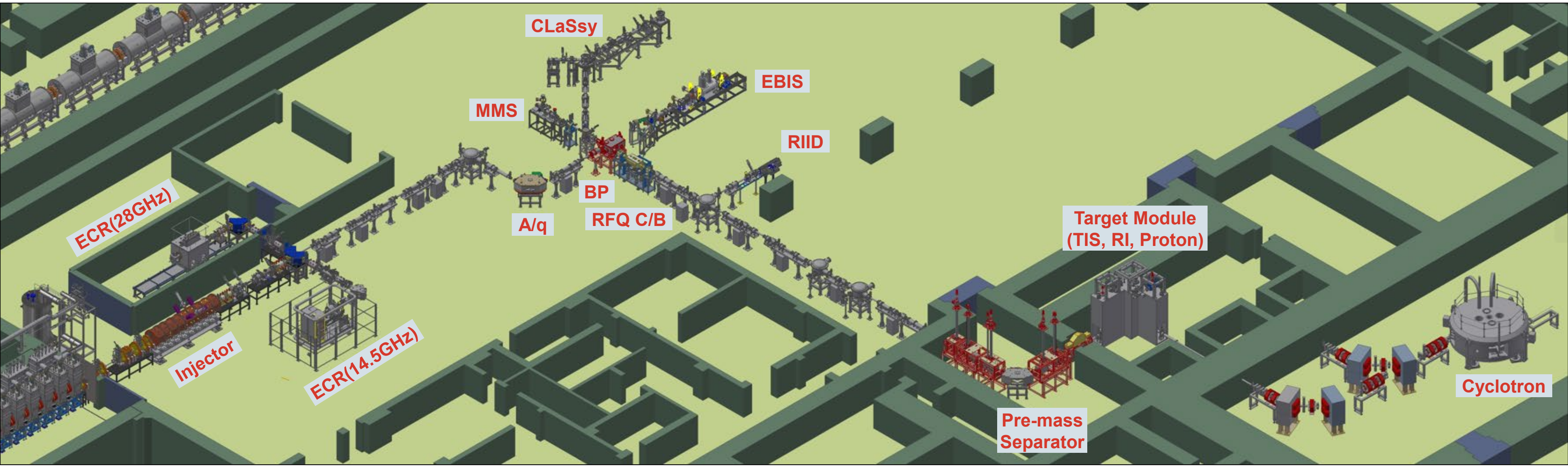
Scope This poster presents the component-level alignment assessment and realignment of the operational beamlines at RAON, carried out with respect to the facility survey control network. The establishment, periodic monitoring and current status of that network are presented in a companion poster (WEP04).

1 Abstract

The low-energy accelerator and the experimental facilities at RAON are in operation, with installation and initial alignment complete. Stable beam delivery requires the geometry of the operational beamlines to be checked periodically against the facility survey control network (WEP04). This poster reports such a check for the ISOL system, covering the cyclotron, the target module and the CLaSsy beamline, based on laser tracker coordinate measurements.

Component positions were measured and compared with their nominal or reference coordinates, and the sections found outside tolerance were realigned. Contributing to the realignment, beam transmission through the CLaSsy section increased from 19.80 % to 65.78 %. For components that carry no manufacturer alignment reference, and for those installed by the stretched-wire method, reference coordinates are now being established from laser tracker multi-point measurements.

2 ISOL System Layout



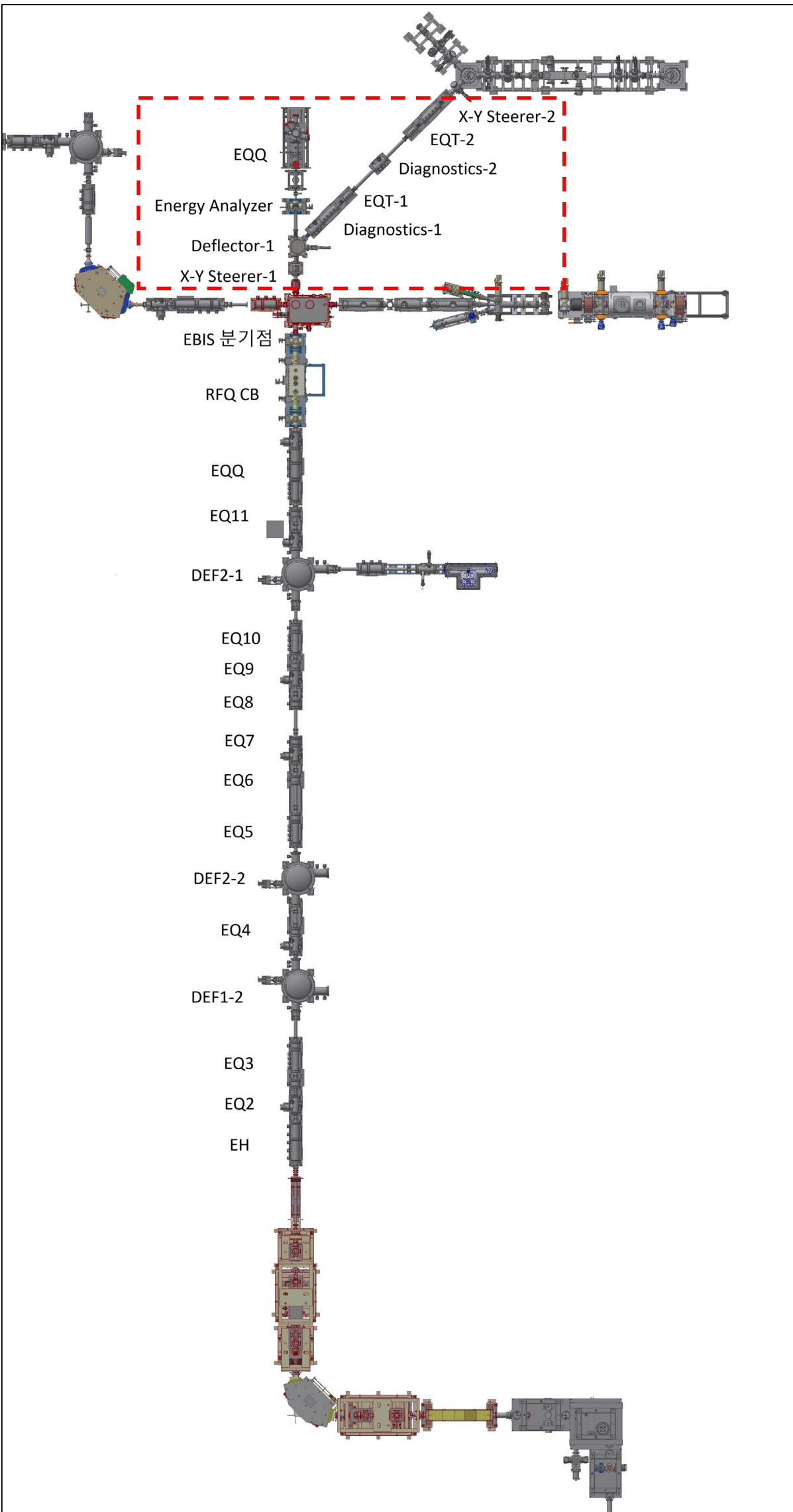
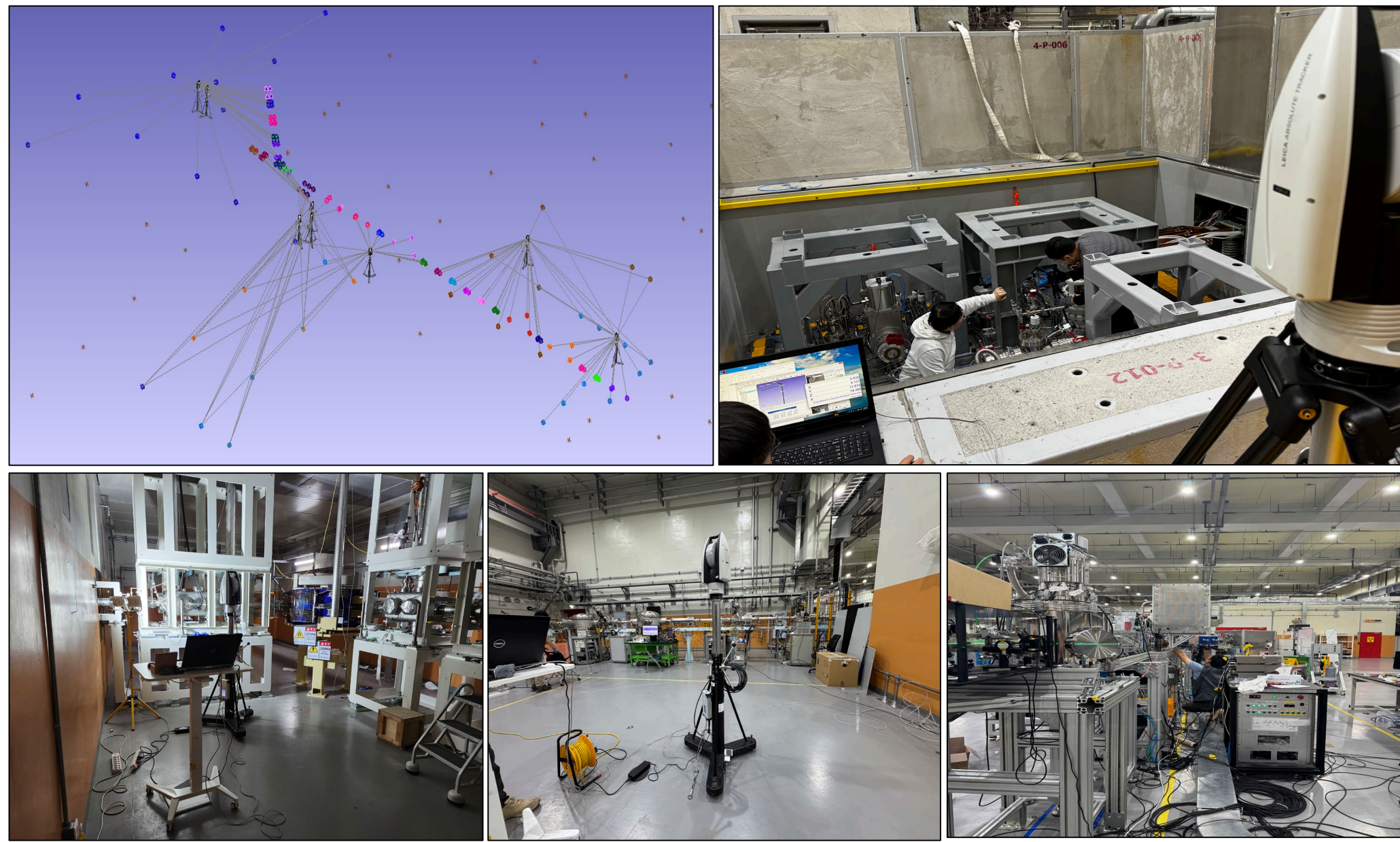
ISOL system

Isotope Separation On-Line. A 70 MeV proton beam from the cyclotron is driven into a thick target of heavy elements. The fragments produced there are ionized, extracted and mass-separated, so that rare isotope beams become available while the target is still under irradiation.

- Cyclotron — circular accelerator delivering the proton beam to the ISOL target. Design values: 70 MeV beam energy, up to 750 μ A beam current.
- Target module (TIS) — produces the rare isotopes and ionizes them for extraction. Design values: 10 kW-class target, beam delivered at 10 keV/u.
- Pre-mass separator, RFQ cooler-buncher, EBIS charge breeder, A/q separator — cool, bunch, charge-breed and separate the extracted beam before it reaches the experimental devices or the post-accelerator.
- MMS — Mass Measurement System, for precision mass measurement of rare isotope nuclei.
- CLaSsy — Collinear Laser Spectroscopy system, formerly CLS, measuring the hyperfine structure of rare isotopes by laser spectroscopy.

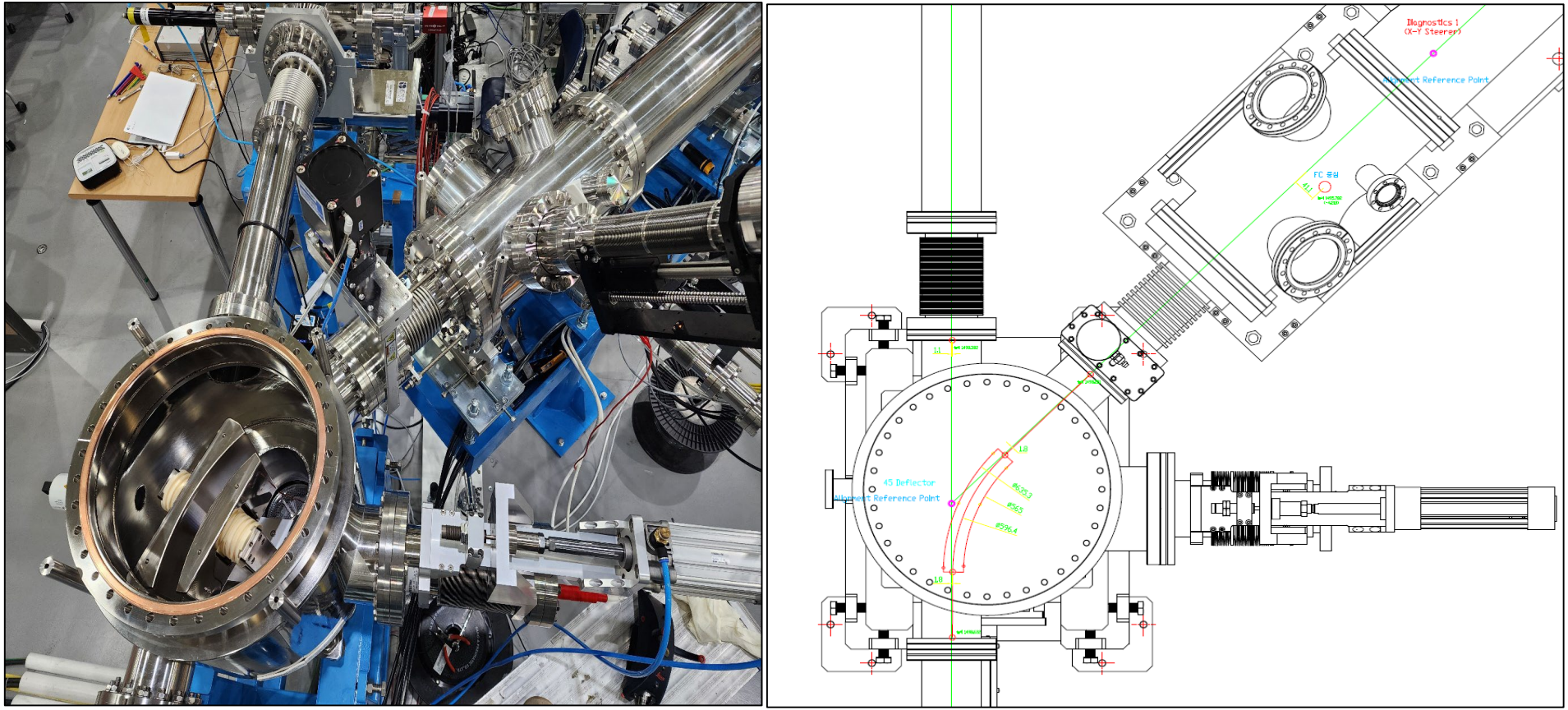
3 Precision Alignment Assessment and Realignment

- Alignment conditions throughout the ISOL area were assessed by measuring alignment fiducials and surveying the geometry of the beamline components.
- At the request of the responsible beamline group, a geometric survey and realignment were performed from the EBIS branch point to the CLS beamline.
- Contributed to improving beam transmission efficiency through equipment optimization following the successful realignment of the CLaSsy beamline.
- Alignment Accuracy : Magnets(Quadrupole, Sextupole) : $\pm 100 \mu\text{m}$, Dipole Magnets: $\pm 150 \mu\text{m}$, Others: $\pm 150 \mu\text{m}$.



Device	Pre-alignment Deviations (mm)			Post-alignment Deviations (mm)		
	X	Y	Z	X	Y	Z
Diagnostics-1	0.095	-0.958	-1.420	-0.182	-0.233 *	-0.001
EQT-1	1.162	0.229	-1.426	0.013	0.062	-0.014
Diagnostics-2	0.896	-0.684	-1.084	-0.059	-0.118	-0.038
EQT-2	1.061	0.904	-0.396	0.006	-0.003	-0.025
X-Y Steerer-2	1.280	0.671	-1.040	0.108	0.121	-0.040
MMS EQQ	0.870	-3.250	-0.926	-0.028	-3.541 *	0.006
Energy Analyzer	-8.029	-6.168	2.420	-0.032	-4.870 *	0.051

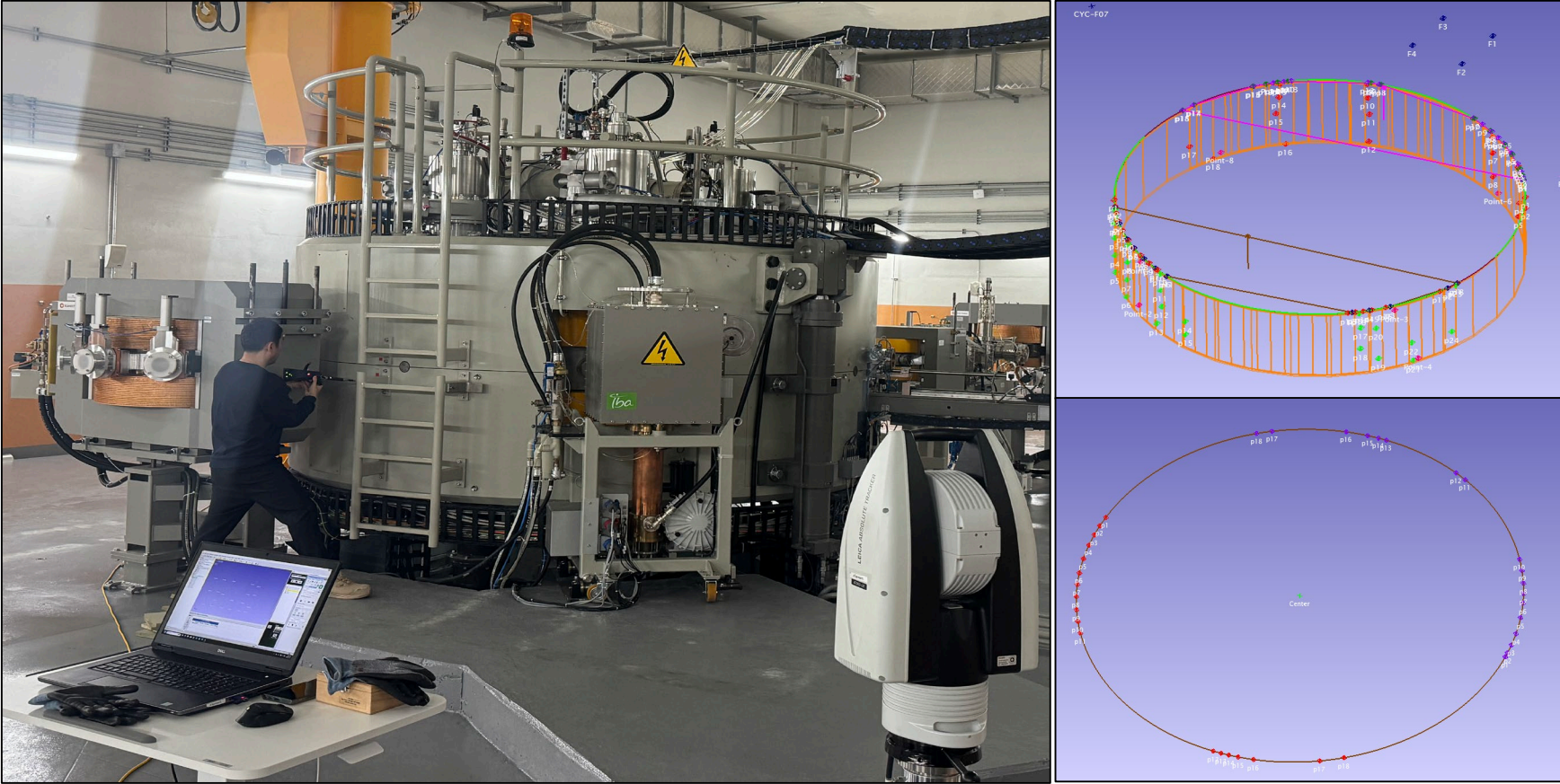
* Y adjustment of the present girder had reached its limit. A modification of the girder is planned, after which these components will be realigned.



Corrective Action Following the Y-Bender Geometry Survey

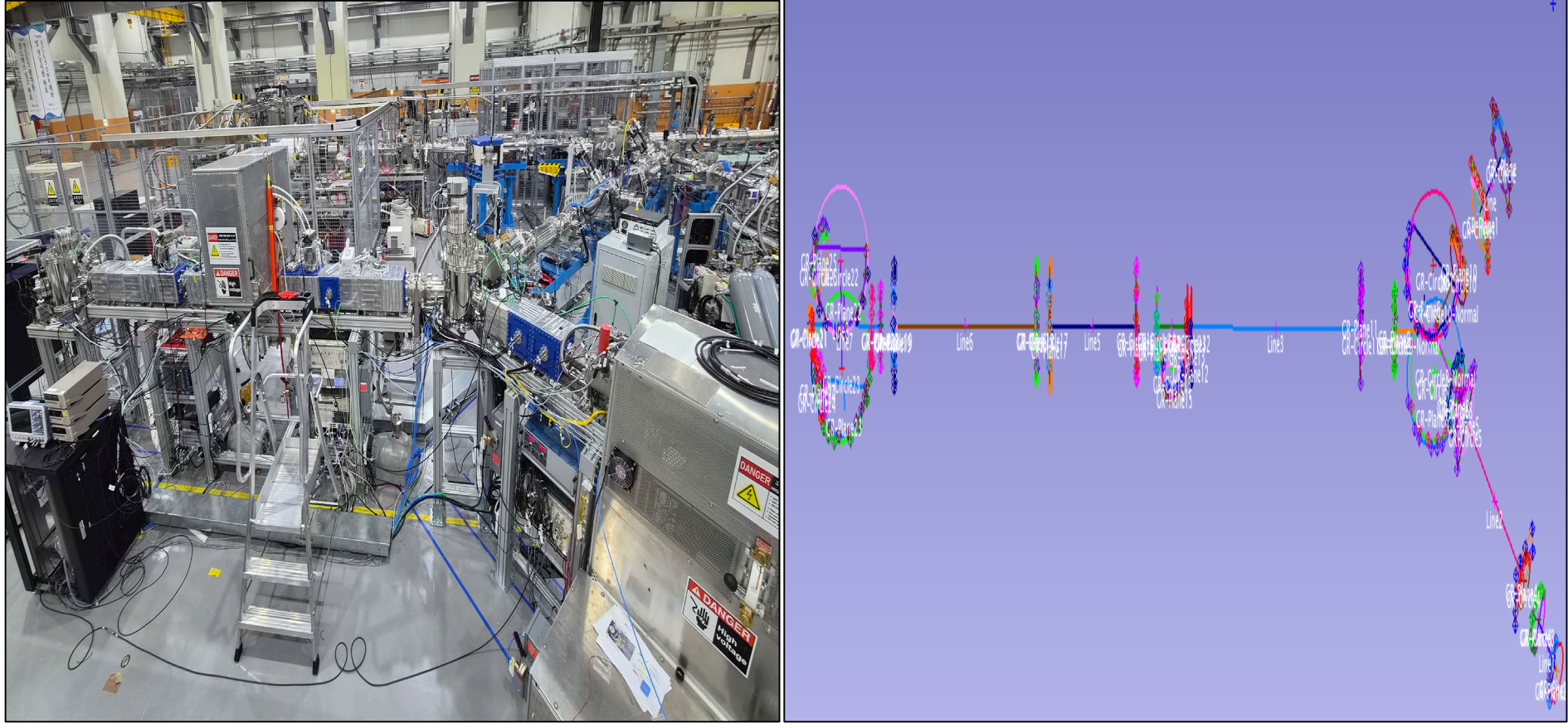
- A horizontal offset of 41.1 mm and a vertical offset of 4.2 mm were identified between the center of the diagnostic Faraday cup and the beamline axis.
- The travel-limit setting of the actuator cylinder was subsequently readjusted.

4 Fiducialization and Reference Establishment



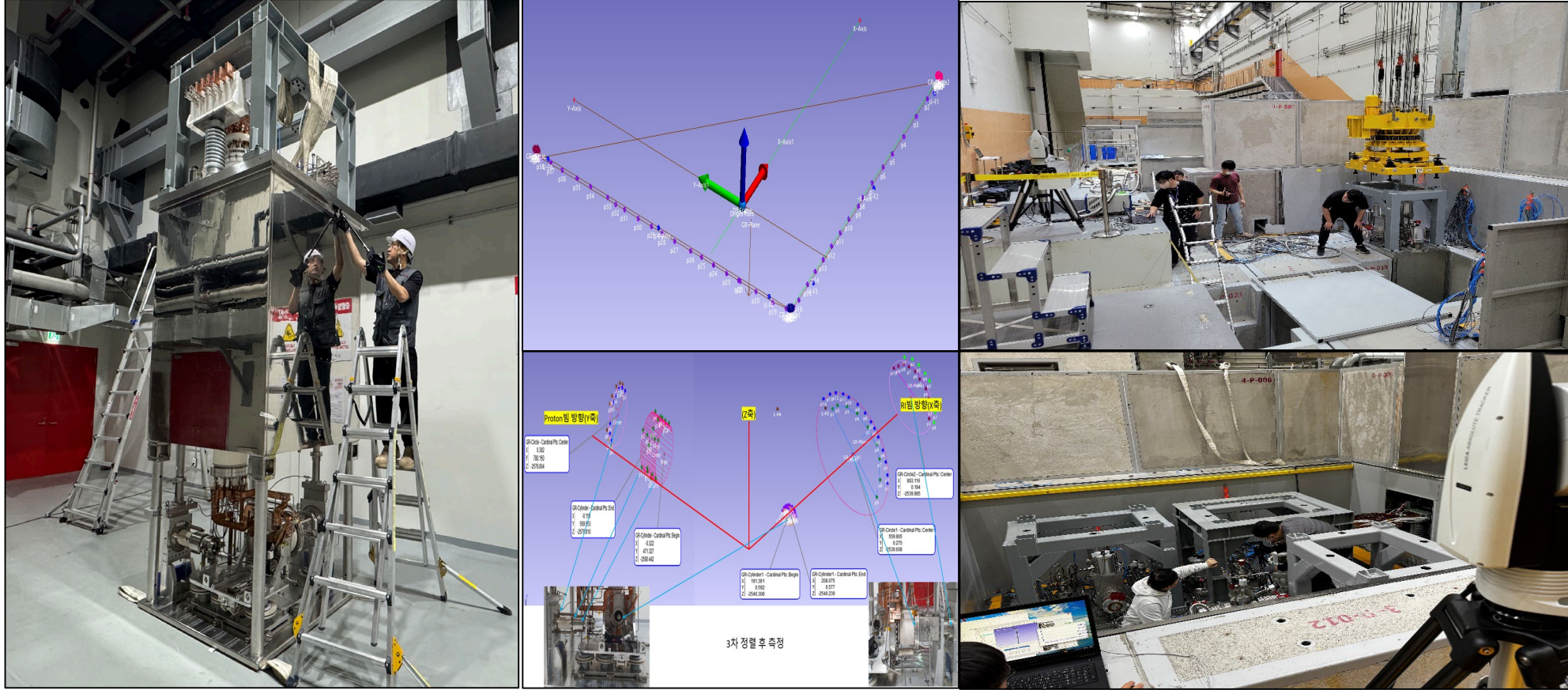
Cyclotron

- The cyclotron body's external geometry was measured using a laser tracker-based multi-point capture method.
- Reference coordinates were compared with two Spatial Analyzer (SA) workflows: plane and circle fit & cylinder fit.
- The cylinder-based solution showed smaller center-coordinate deviations across tracker stations and was selected as the alignment reference, despite its larger fit residual.
- Circle based ΔR : 0.219-0.438, Cylinder based ΔR : 0.189-0.296



CLaSsy

- The components were installed using the stretched-wire method and were not equipped with individual fiducial nests.
- Their external geometry was measured in the as-installed condition using a laser tracker-based multi-point capture method.
- The resulting geometric reference data were used to assess the current alignment accuracy of each component.
- Realignment will be performed after modifying the existing girder to provide X-Y adjustment capability.



ISOL TIS Module

- The geometry of the large, 4 m-high structure, which was difficult to measure using a conventional CMM, was characterized using a laser tracker-based multi-point capture method.
- Because the beam path becomes inaccessible after installation of the TIS module, the beam-axis reference was transferred to fiducial nests mounted on the top cover, enabling alignment verification after installation.

5 Conclusion

- During scheduled maintenance, the alignment of beamline components throughout the operational ISOL system was measured and assessed.
- Components found outside the alignment tolerance were realigned. Beam transmission through the CLaSsy section rose from 19.80 % to 65.78 %.
- A Y-bender survey revealed a 41.1 mm horizontal and 4.2 mm vertical offset between the diagnostic Faraday cup and the beam axis, and the actuator travel limit was readjusted.
- For the TIS module, whose beam path is inaccessible once installed, the beam-axis reference was transferred to fiducial nests on the top cover.
- Reference coordinates are being established by laser tracker multi-point measurement for components without a manufacturer reference and for those installed by the stretched-wire method.