

RF Phase Reference Distribution System for RAON Heavy-ion Accelerator*

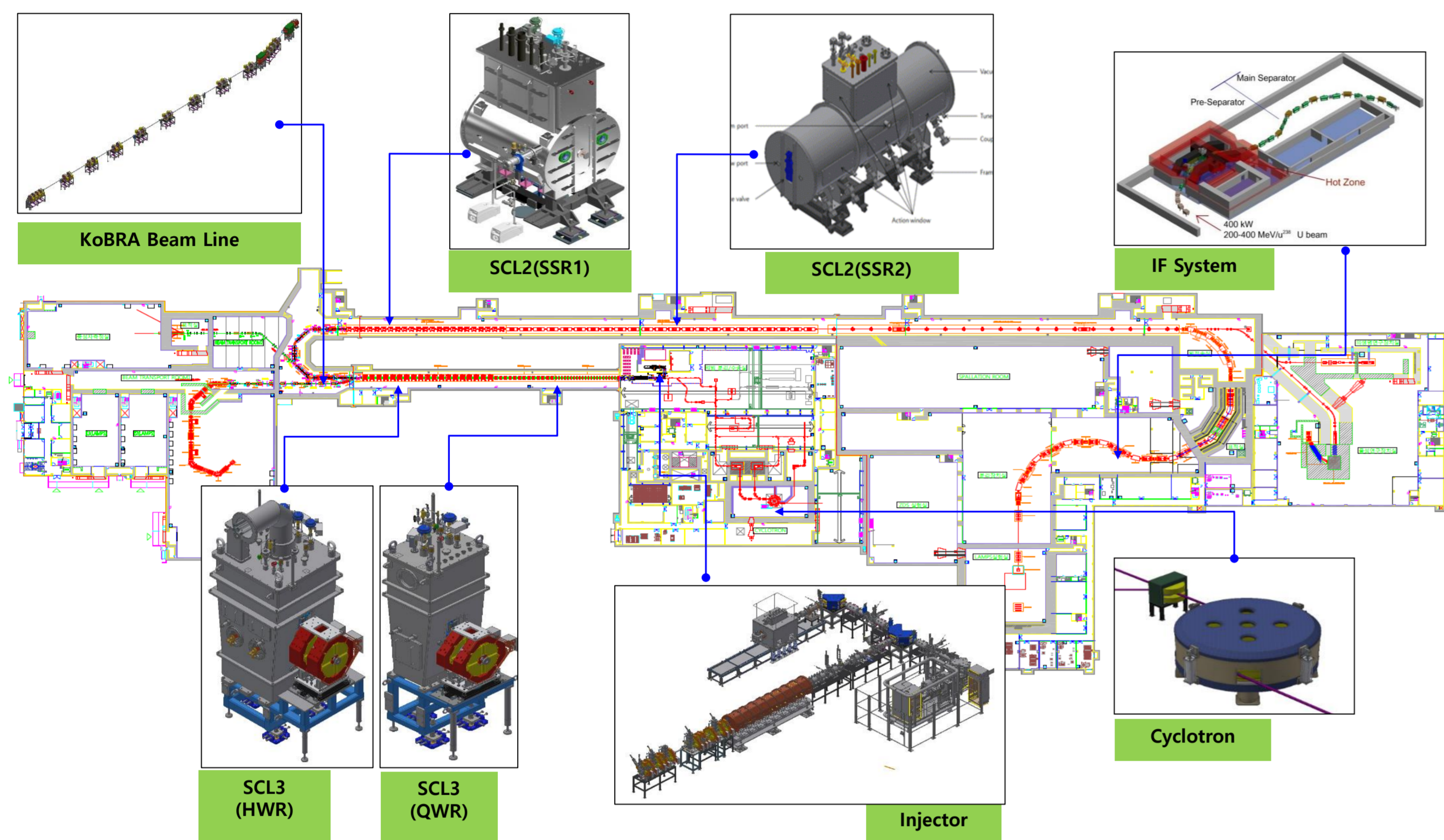


Kyung SEOL*, Doyoon LEE, Sangyoon BAE, Kitaek SON, Hyungjin KIM
Institute for Rare Isotope Science (IRIS) / Institute for Basic Science (IBS)

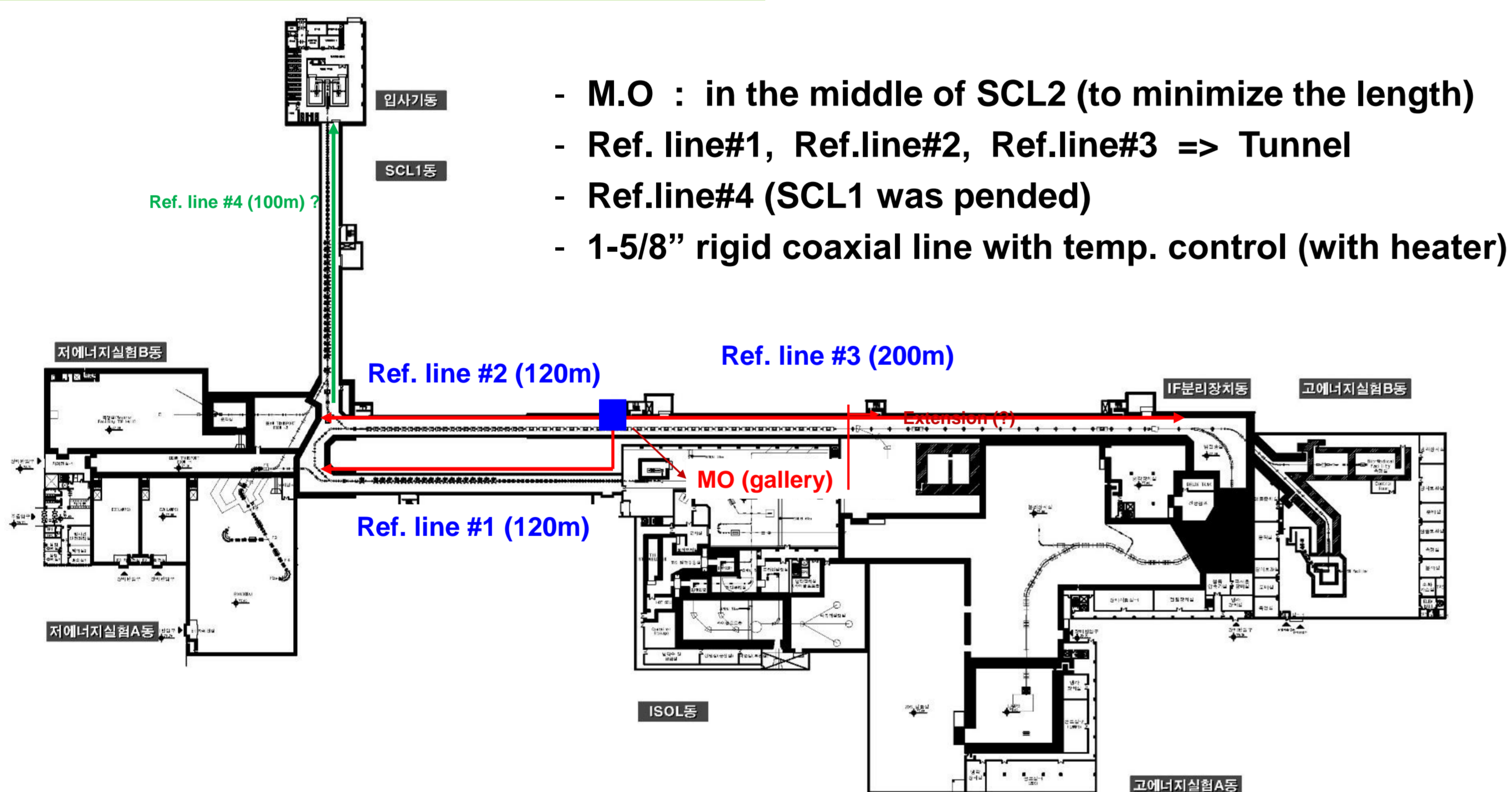
Abstract

The heavy-ion accelerator of the Institute for Rare Isotope Science (IRIS) has been developed and beam commissioning for the low energy superconducting linear accelerator has been performed. There are three types of SRF cavity, which are 81.25 MHz quarterwave resonator (QWR), 162.5 MHz half-wave resonator (HWR), 325 MHz single-spoke resonator (SSR). There are 22 QWRs and 102 HWRs in the low-energy superconducting linac (SCL3), and 69 SSR1s and 144 SSR2s in the high-energy superconducting linac (SCL2). The RF reference distribution system must deliver a phase reference signals to all low-level RF (LLRF) systems and BPM systems with low phase noise and low phase drift. The frequencies of RISP linac are 81.25MHz, 162.5MHz and 325MHz, and there are 130 LLRF systems and 60 BPMs respectively for SCL3, and 240 LLRF systems and 70 BPMs for SCL2. 81.25 MHz signal is chosen to the reference frequency, and 1-5/8" rigid coaxial line is installed with temperature control. This paper describes the design, test results and operation during the beam commissioning of the low-energy superconducting linac. .

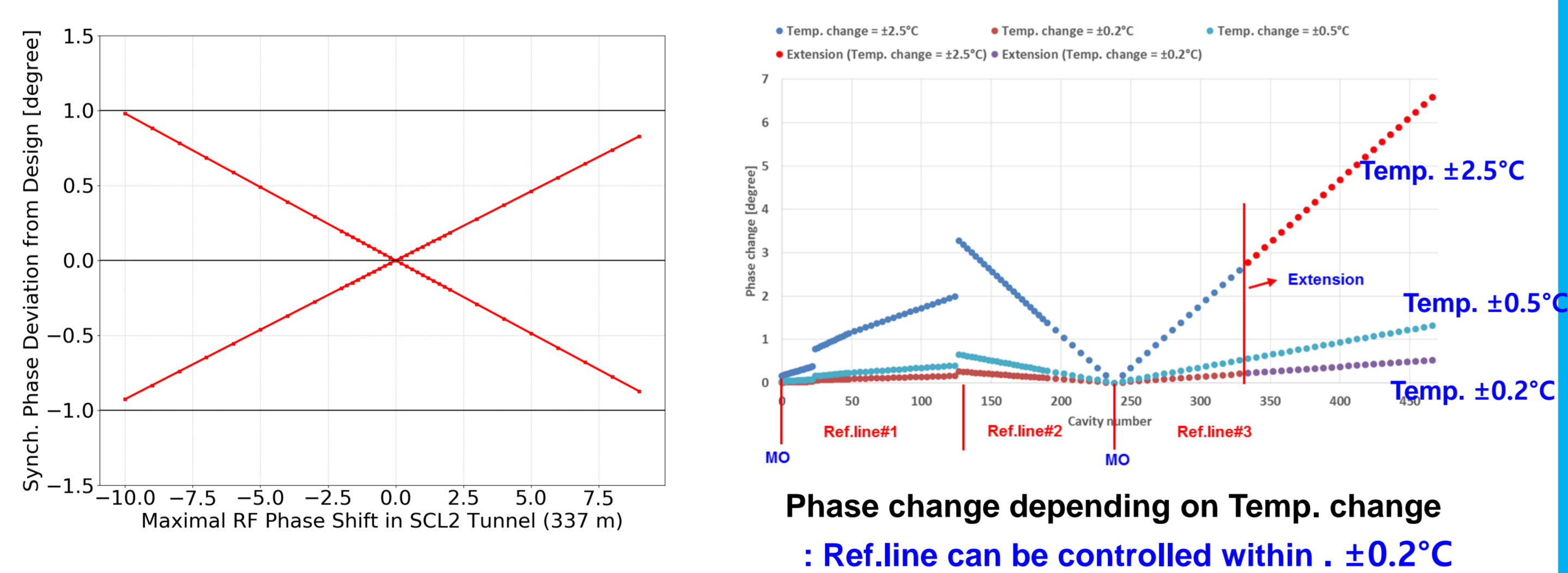
RAON Facility (SRF Linac)



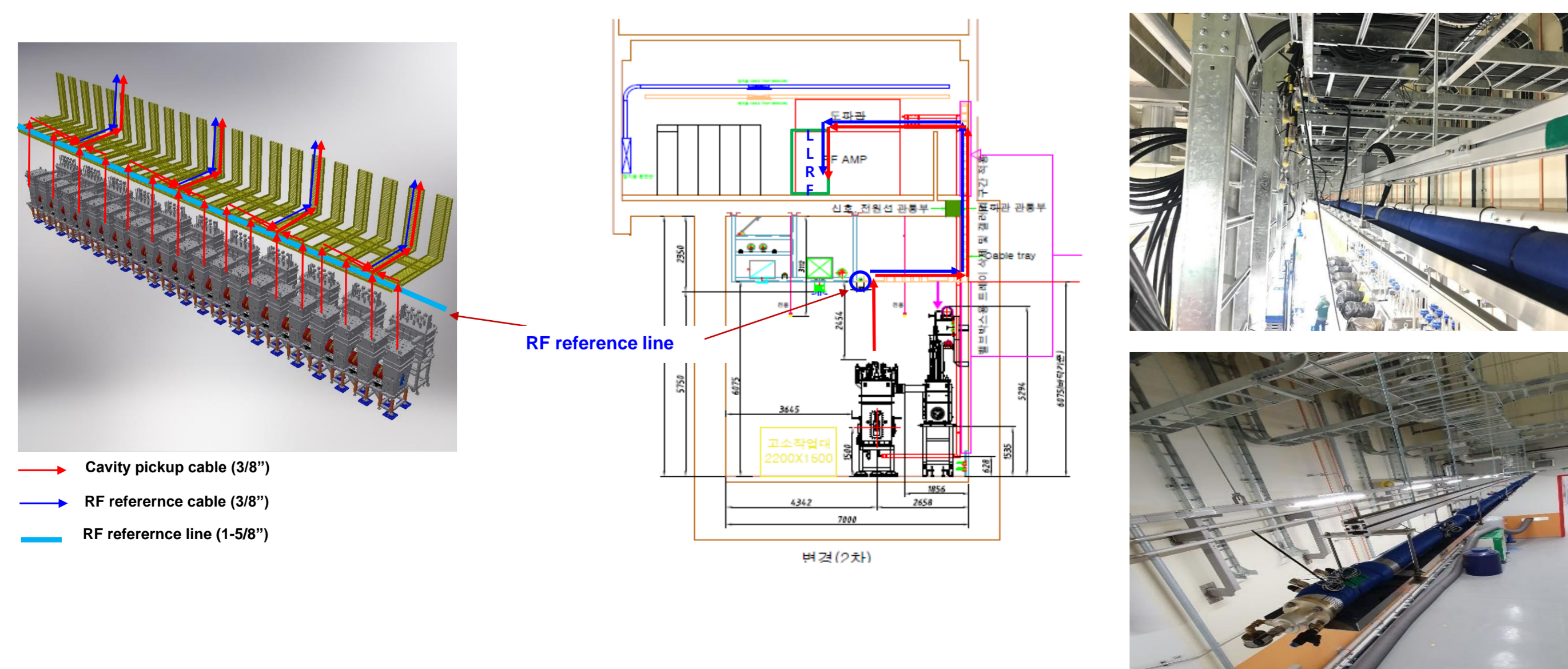
RF reference distribution



Phase stability requirement from beam dynamics



Installation for SCL3 RF reference line

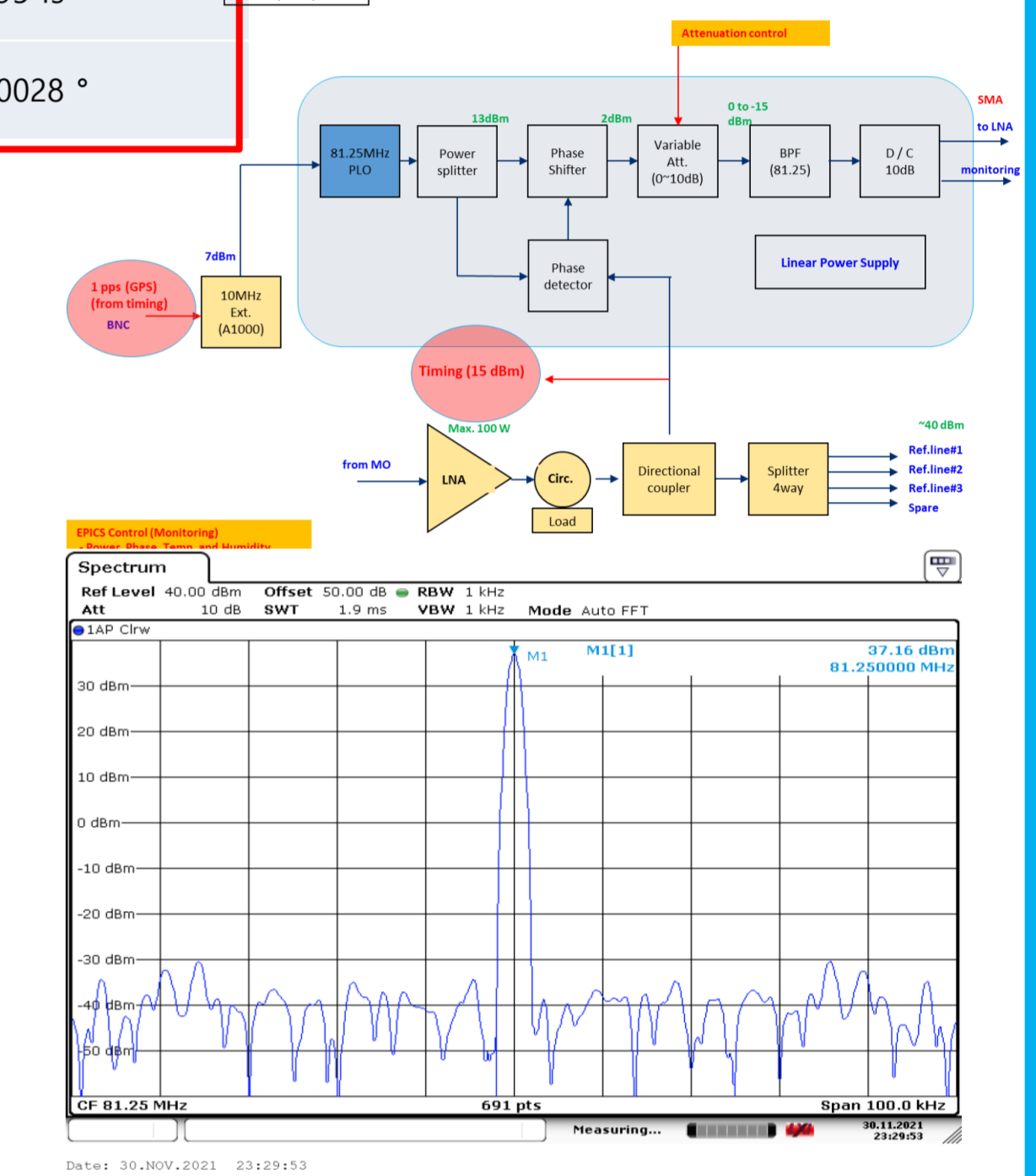
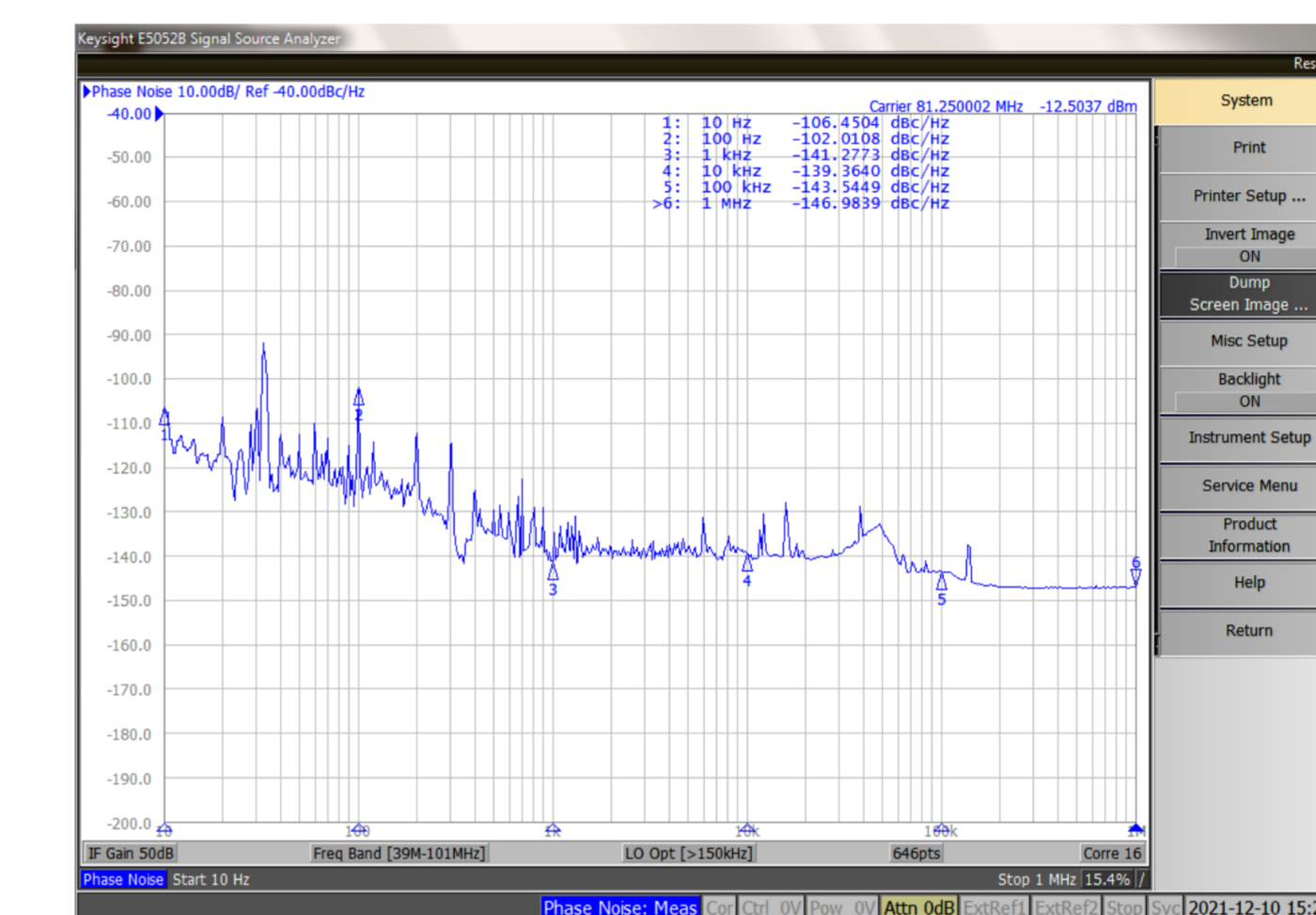


Test Results of the RF reference for SCL3

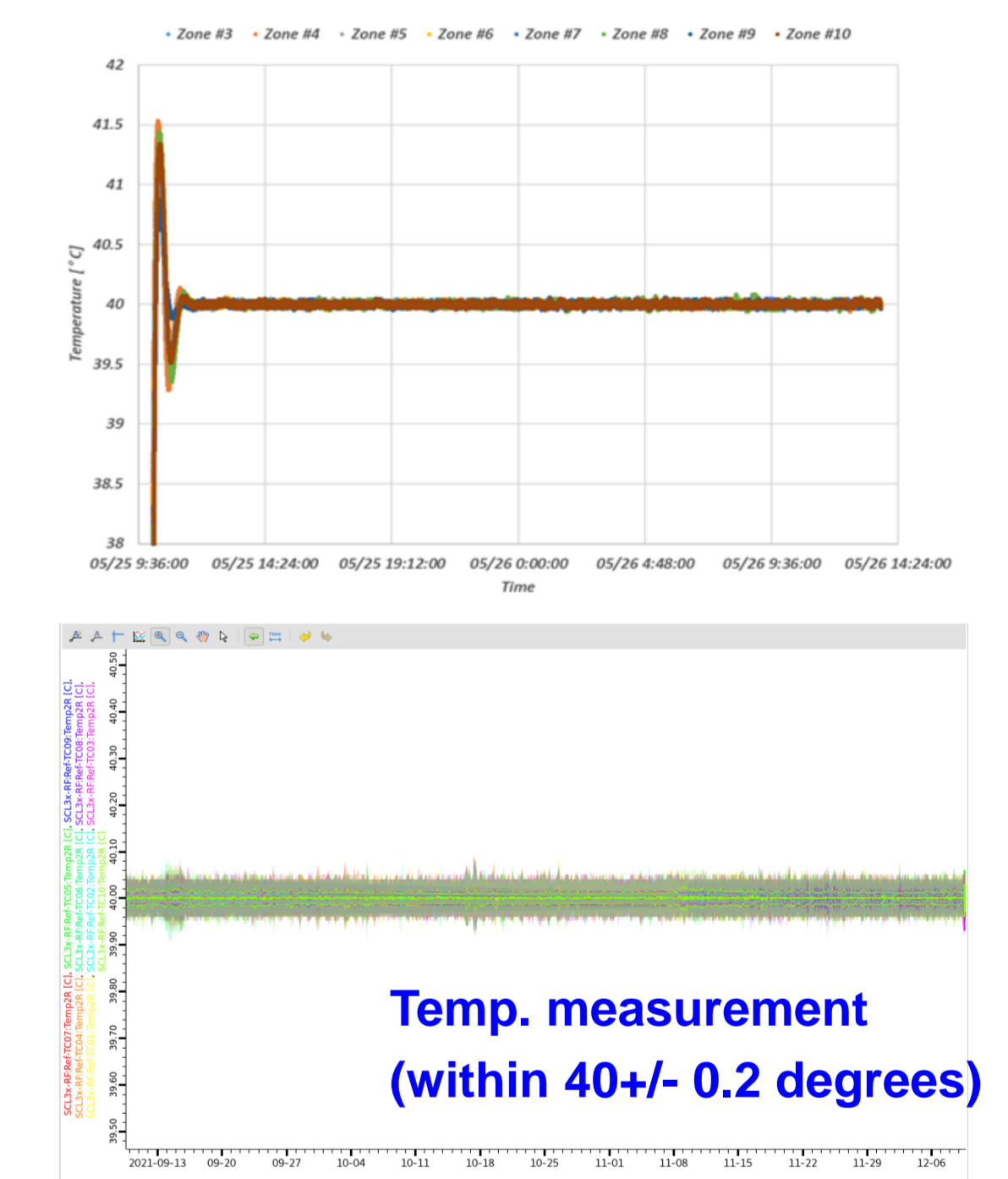
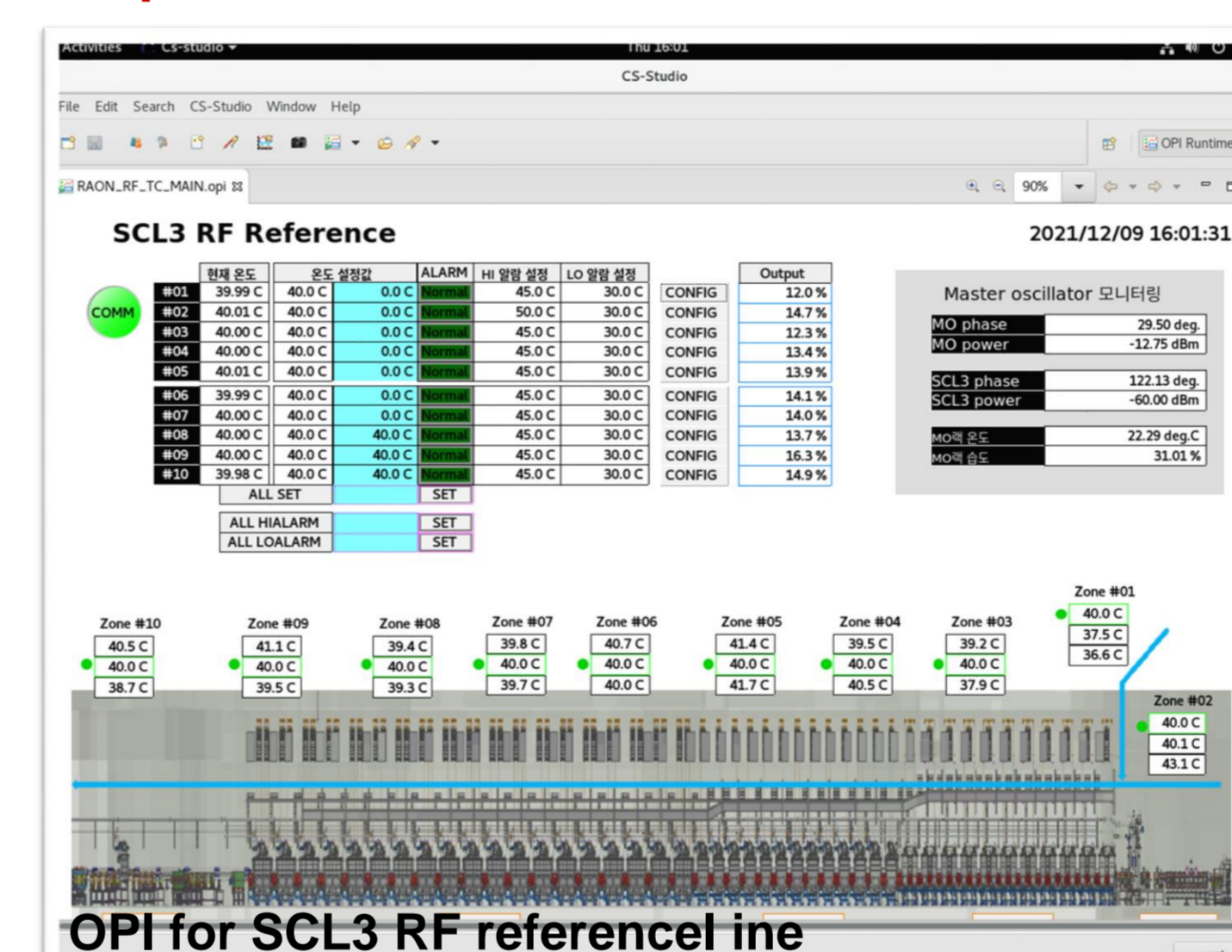
Phase noise and jitter of Master Oscillator

Frequency offset	10-MHz Rubidium Frequency (A 1000)	81.25-MHz PLO with A1000	81.25-MHz LNA with A1000 and PLO
1 Hz	-116 dBc/Hz	-	-102.3 dBc/Hz
10 Hz	-140 dBc/Hz	-101.9 dBc/Hz	-119.5 dBc/Hz
100 Hz	-158 dBc/Hz	-132.1 dBc/Hz	-131.9 dBc/Hz
1 kHz	-164 dBc/Hz	-157.1 dBc/Hz	-143.0 dBc/Hz
10 kHz	-170 dBc/Hz	-168.8 dBc/Hz	-148.5 dBc/Hz
100 kHz	-170 dBc/Hz	-174.5 dBc/Hz	-149.2.4 dBc/Hz
1 MHz	-	-174.8 dBc/Hz	-
Calculated jitter	47.2 fs	49.6 fs	95 fs
Calculated phase error	0.00017 °	0.0014 °	0.0028 °

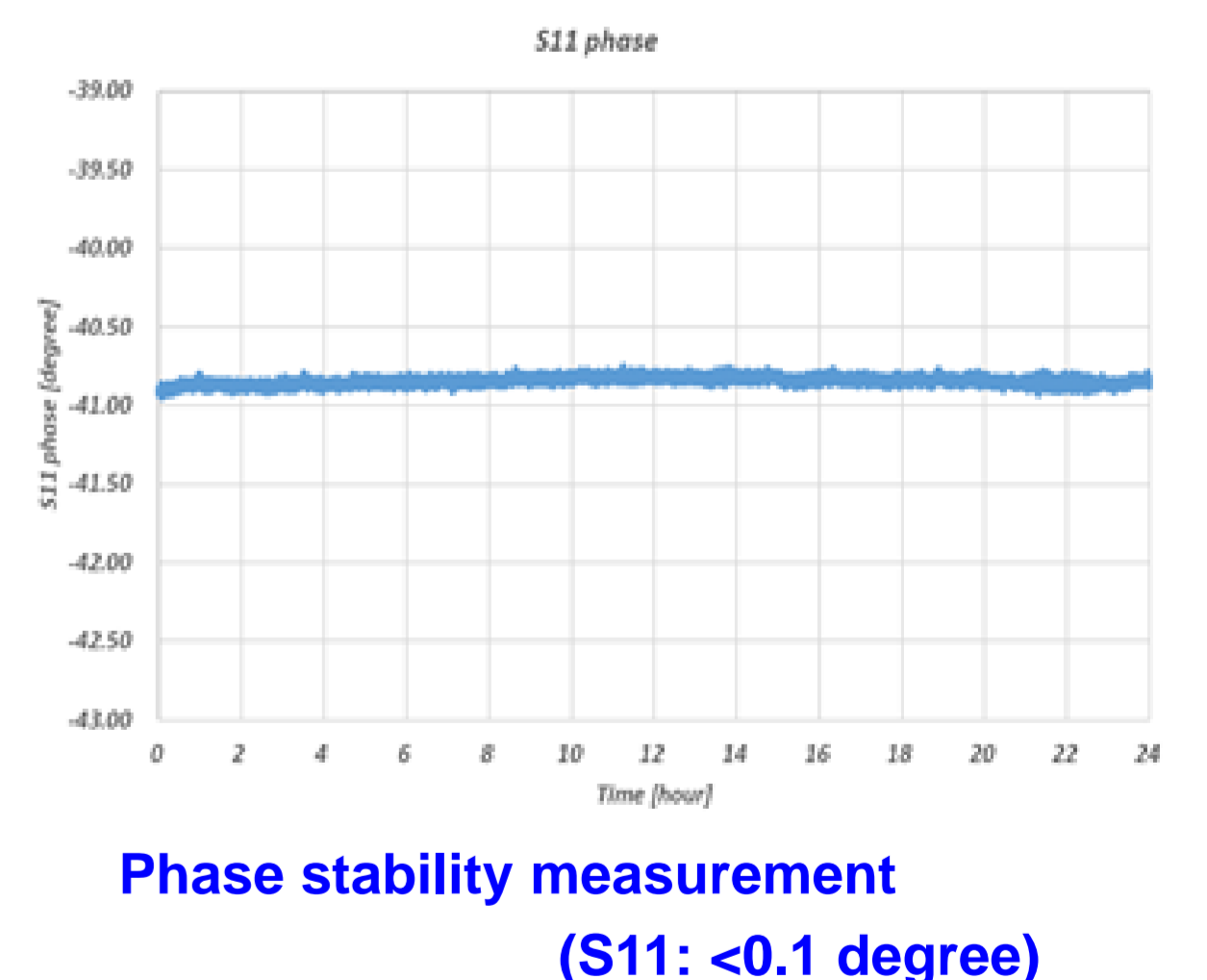
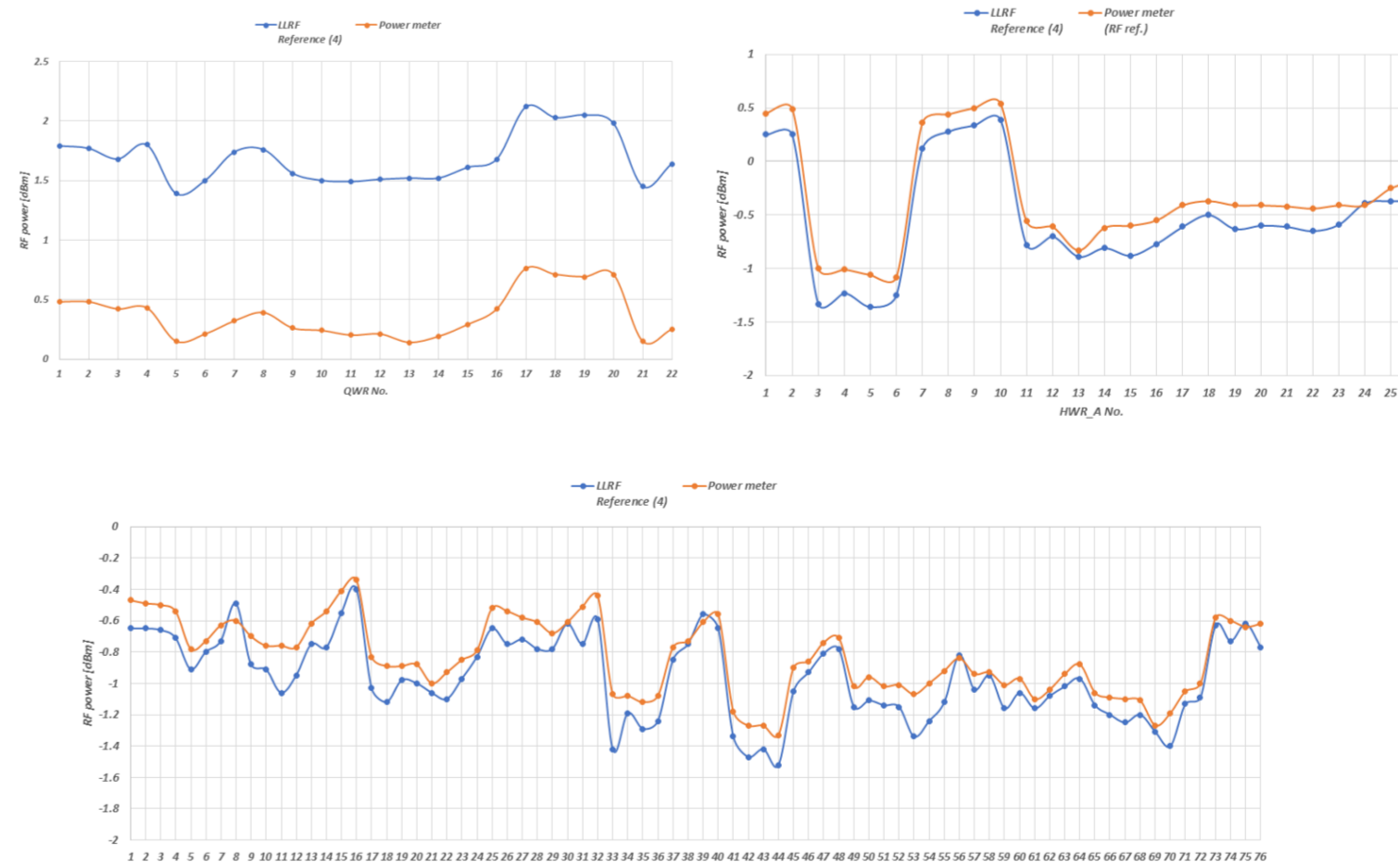
Constant temp. and humidity rack



Temperature Control at SCL3 RF reference line



RF reference signal level at each LLRF



Summary

- RF reference distribution system has been designed for the IRIS Linac (SCL3+injector, SCL2, EXT).
- SCL3 reference line (Ref.line#1) and Master oscillator have been installed and tested.
- RF reference system for SCL3 has been operated for SCL3 beam commissioning.
- RF reference lines for SCL2 (Ref.line#2, Ref.line#3) have been also installed in 2022

* ktseol@ibs.re.kr

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