Several Recent Monitoring Efforts of NSLS-II

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1. Introduction
2. Truck tunnel monitoring
3. SR Circumference measurement
4. Summary

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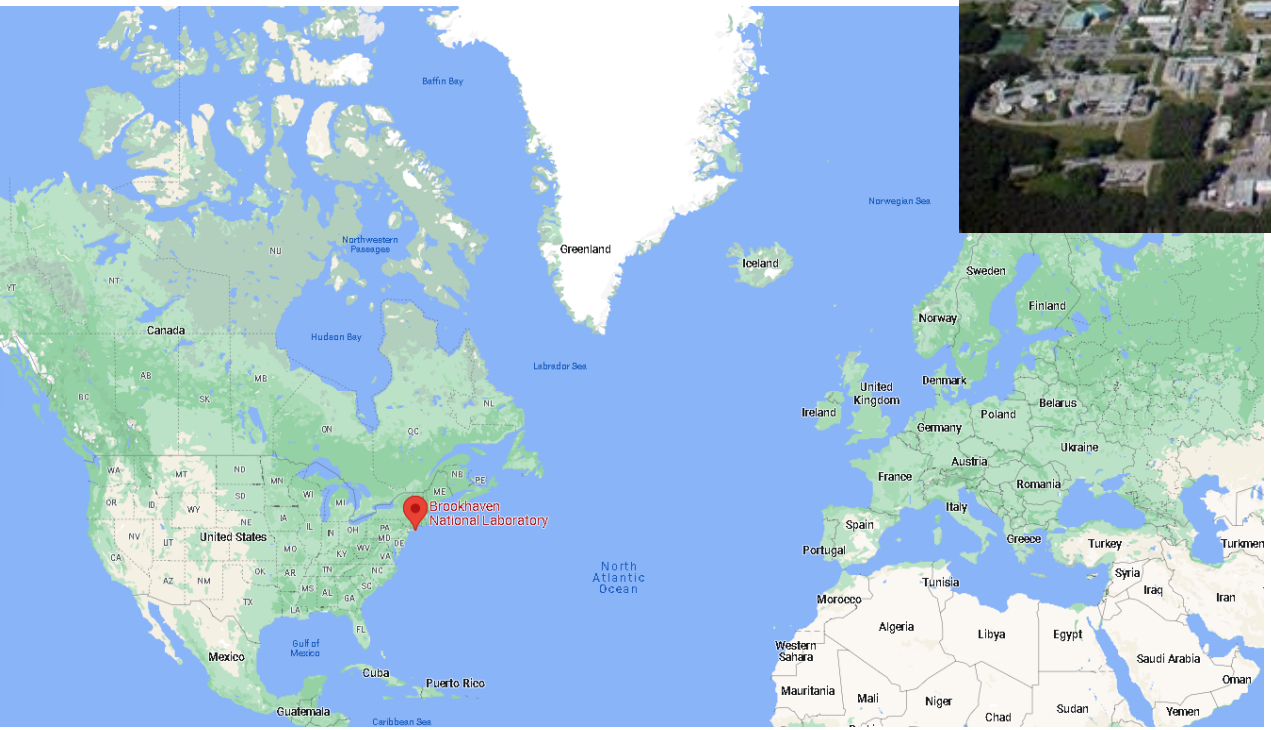
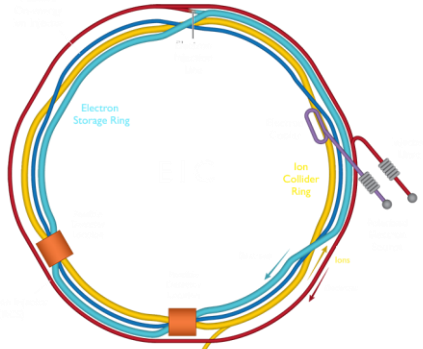
1. Introduction (NSLS-II)

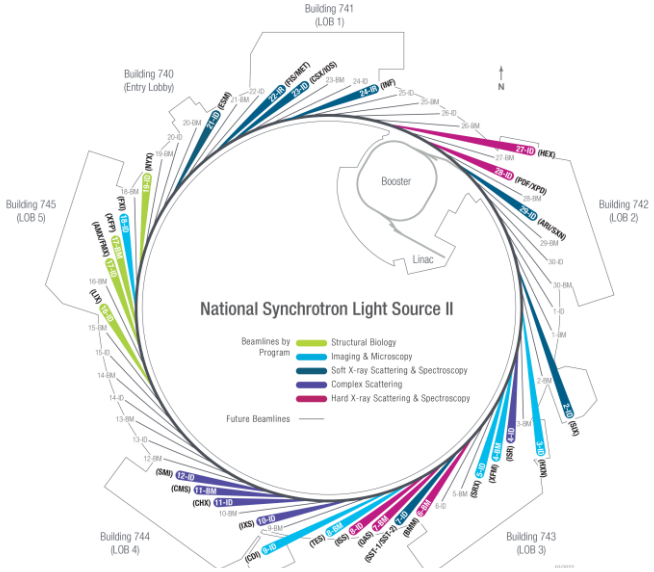
- East Coast of US
- EIC project (In the near future)

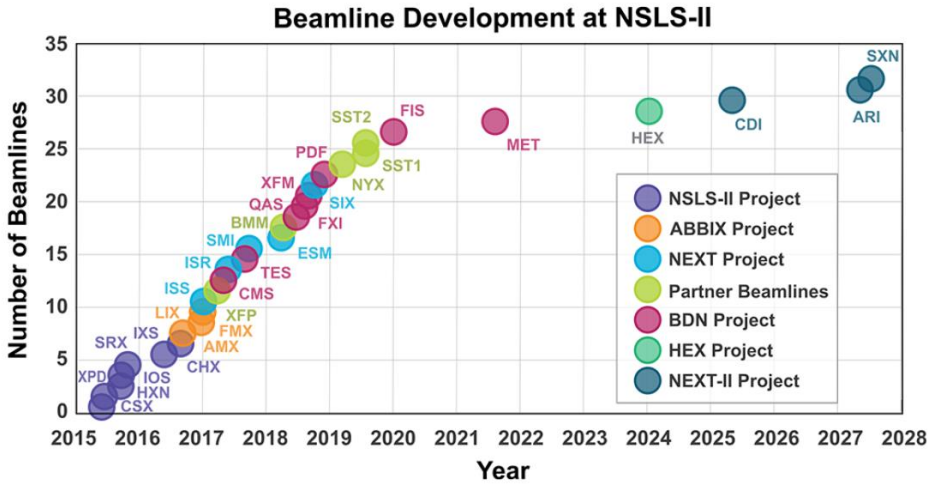




1. Introduction (NSLS-II)

- 29 running beam lines
- 4 beam lines under construction
- Future update TBD





1. Introduction (Monitoring)

General activities

- New installation
- New R&D
- Maintenance
- Monitoring

Monitoring

- Truck tunnel long term monitoring
- WPS
- SR Circumference measurement

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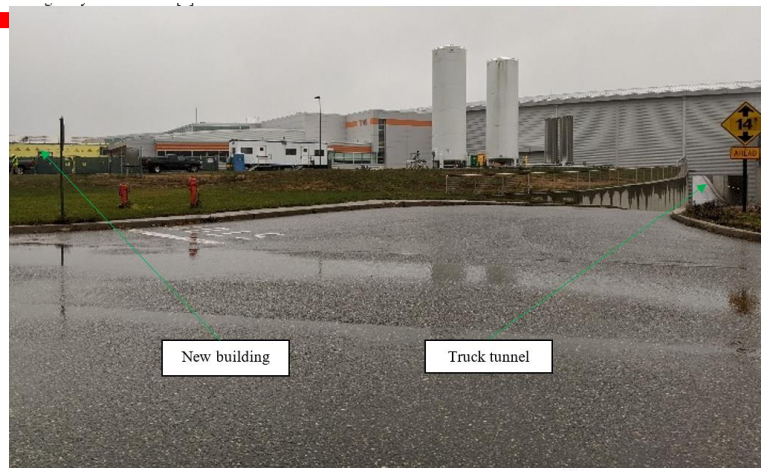
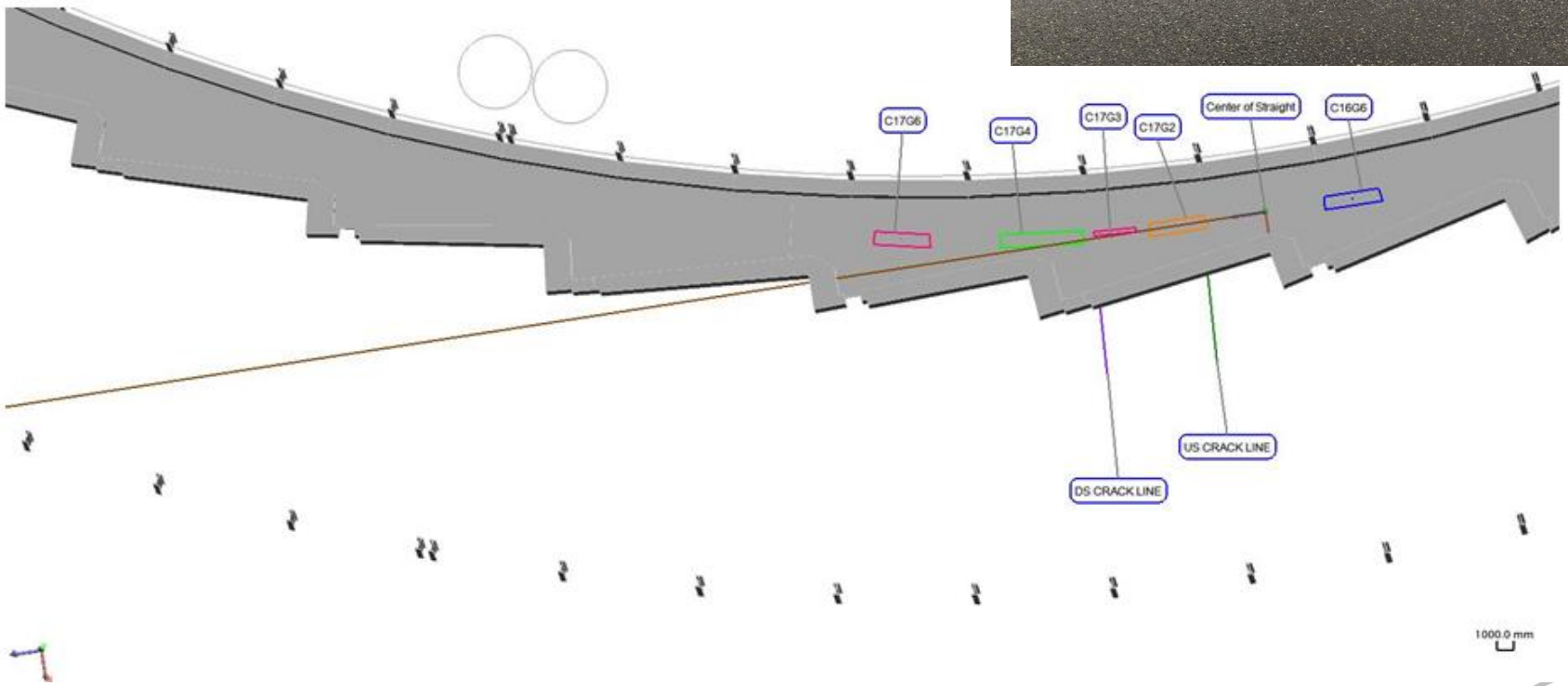
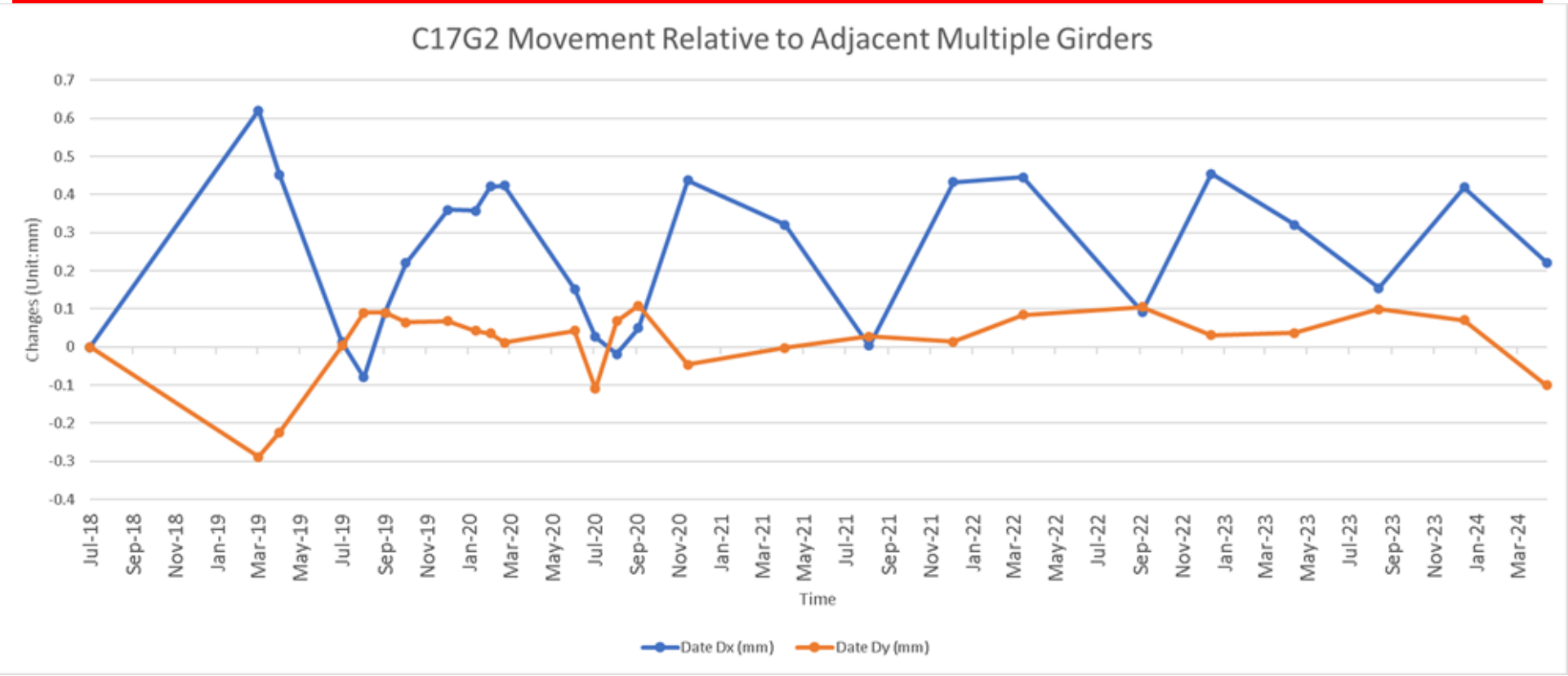
Status of truck tunnel





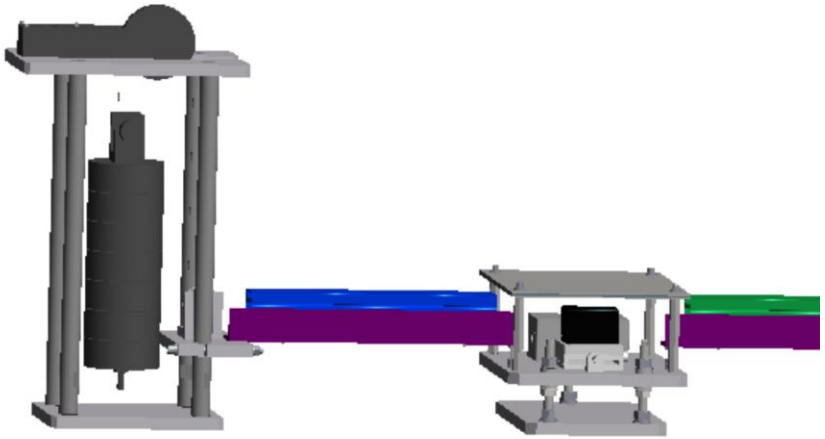
Long term trend in tunnel area



- The unit of the vertical axis is millimeter.
- It assumes that girder C16G6 and C17G4 doesn't move.
- The changing magnitude is 0.7 mm horizontally and 0.4 mm vertically.

WPS design

- Close to the floor
- Wire is protected



WPS Installation

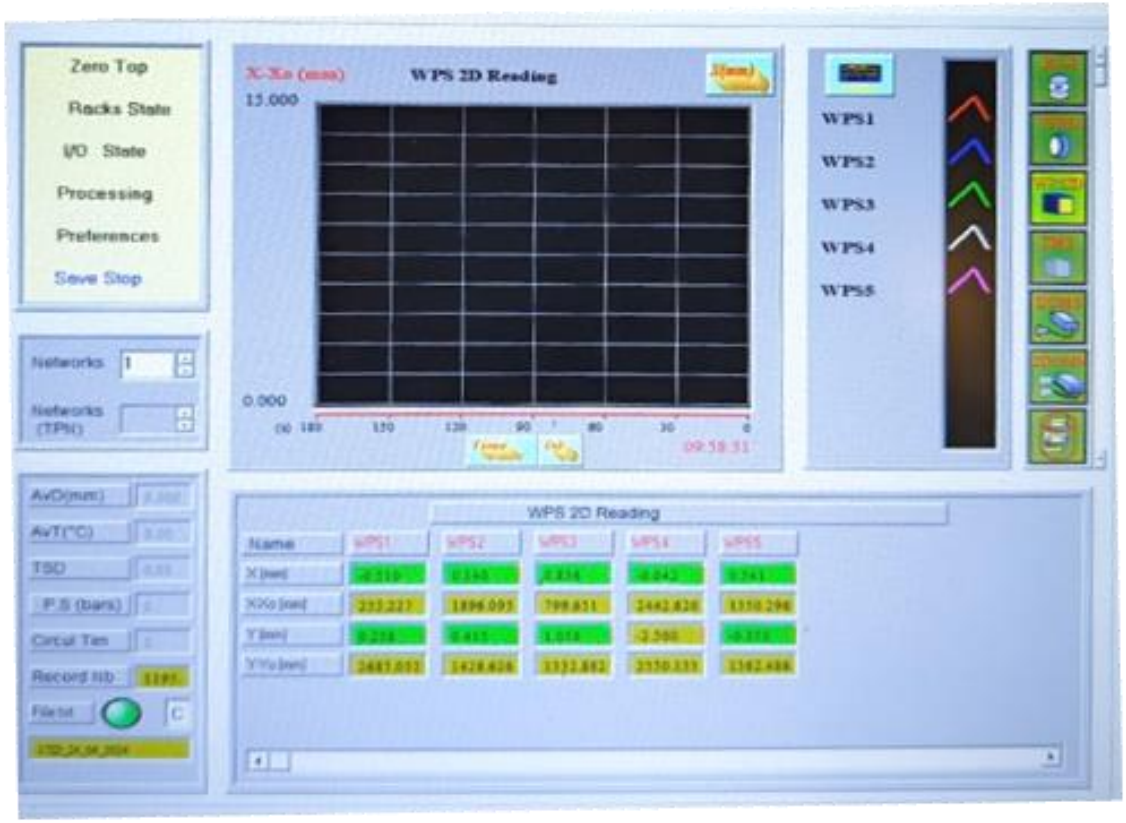
- Epoxied on the floor
- Sensors are Leveled

Lessons learned

- The sensor should be insulated with ground

Data acquisition interface

- The raw data was collected with the software provided by the vendor.
- 5 channels
- Data can be gathered in short interval .
- The system is up and running since May 2024.

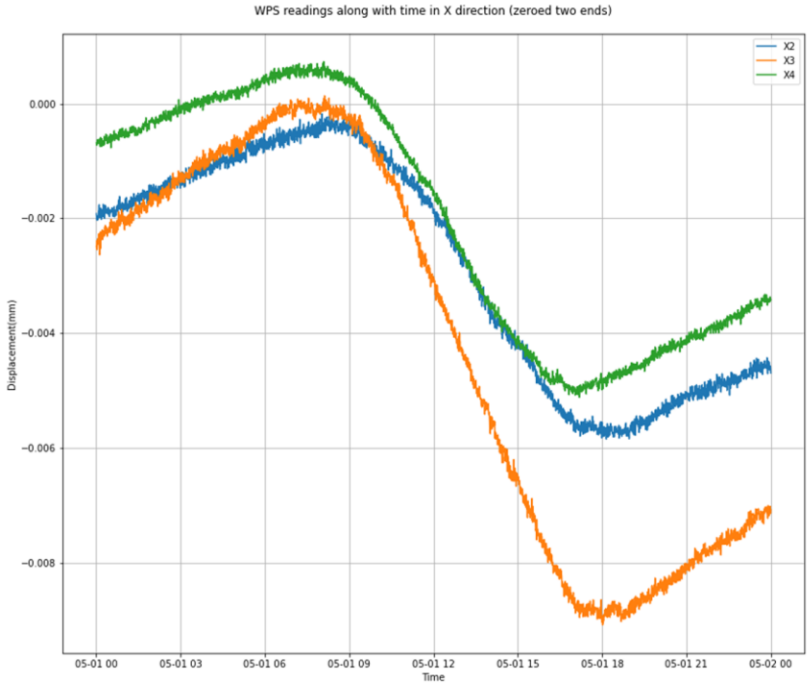


Post processing

- Scripts were created to connect the data together. For each set of measurements, a line will be established with two ends as datum. Then the data was shown as a graph.
- The scripts were written with Python and the Measurement Plan of Spatial Analyzer.

Trend

- The change in about two months is about 0.17 mm.
- In one day, the changes are in the order of 10 micron (much smaller than the data in experimental area).



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SR CIRCUMFERENCE MEASUREMENT

- Accelerator Physicists observed large long-term variations of the measured amplitude-dependent tune shifts and suspect that seasonal variations of the storage ring circumference and energy could be the culprit. Therefore, the circumference changes monitoring work is scheduled.
- Circumference changes have been observed in several facilities, such as like SSRF and ALBA etc. However, there is little direct measurement examples of the circumference by survey techniques recently.
- We performed two kinds of circumference measurements since May 2022.

Two approaches

Due to inaccessibility, no direct measurement can be done in the tunnel directly.

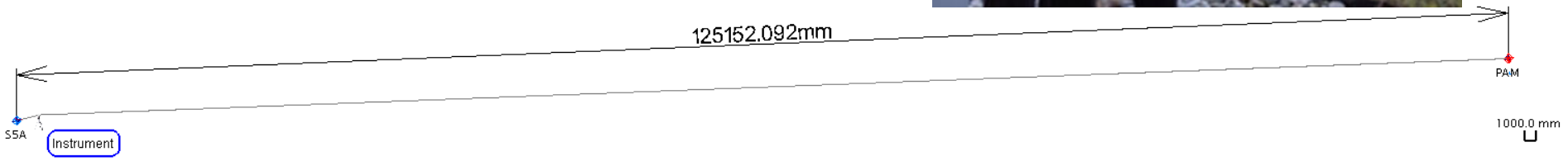
- Measure radius (unsuccessful)
- Measure arc

Radius Measurement Approach

During the construction of NSLS-II, several primary monuments were set to establish the relative location of different accelerator tunnels.

Radius Measurement

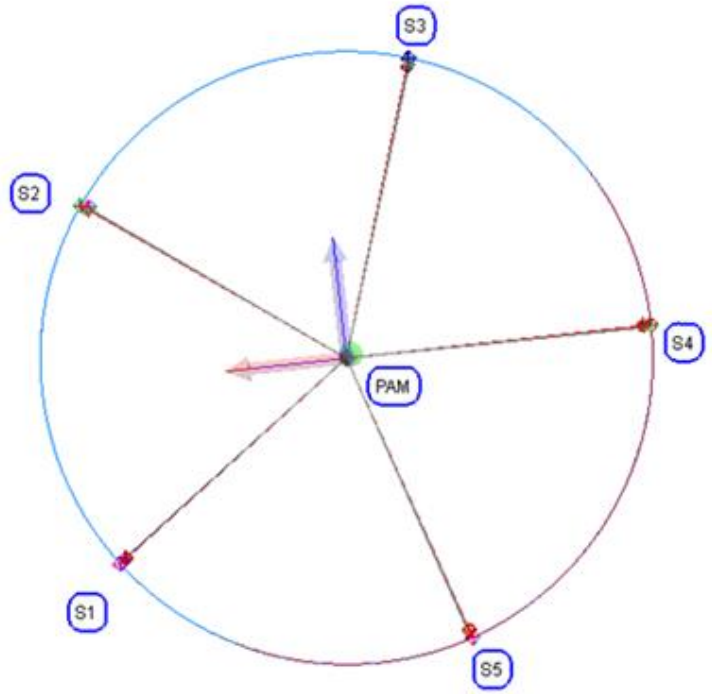
- R=125m.
- Difficult to measure directly.
- Instrument is set up on the mezzanine and in-between PAM and each monitoring point. The distance is calculated based on the angular and distance measurement.



Pros and Cons

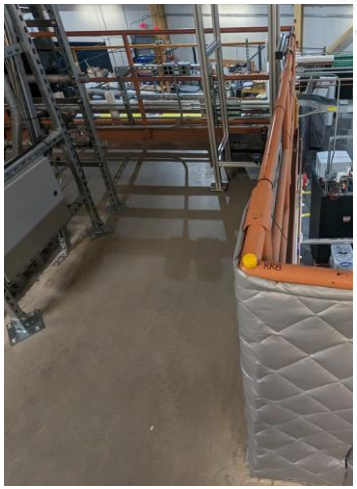
- Pros: It's convenient to use those monuments to take radius measurements and calculate the circumference with C=2*R*pi.
- Cons: temperature has large impact to distance measurement, especially in winter

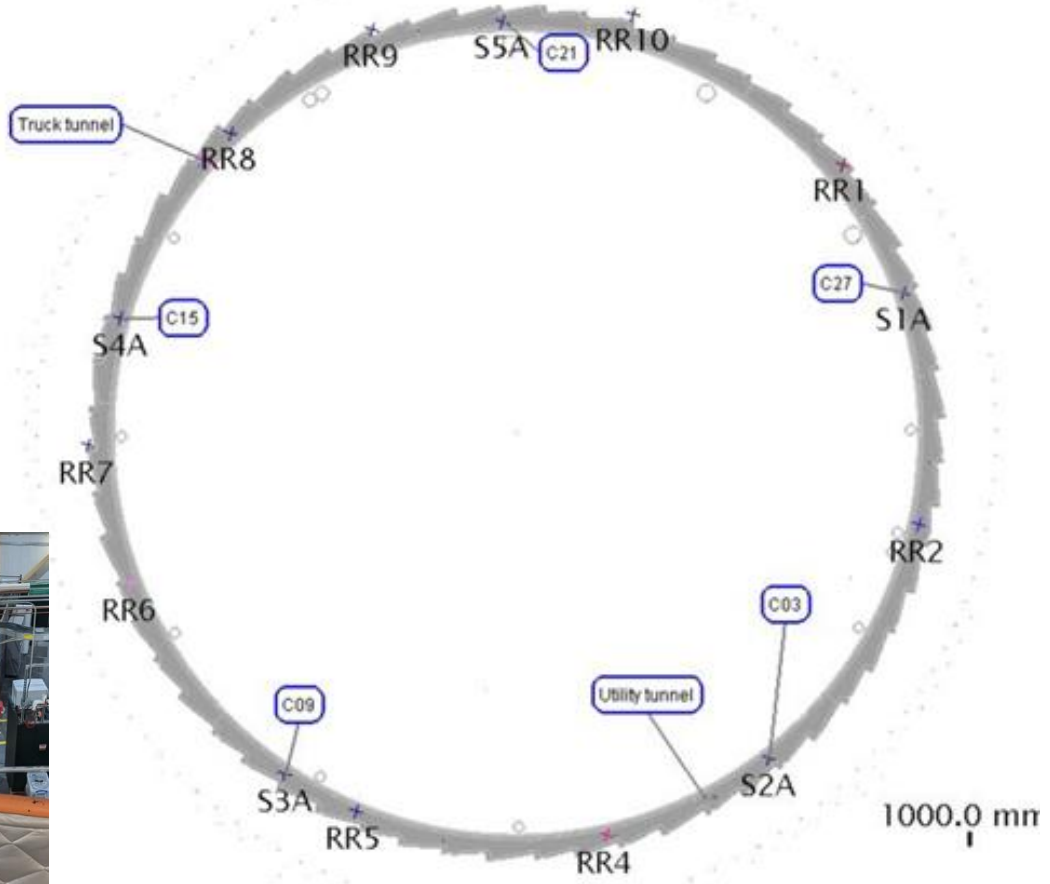
After several rounds of measurements, this approach is abandoned.



Arc Measurement Approach

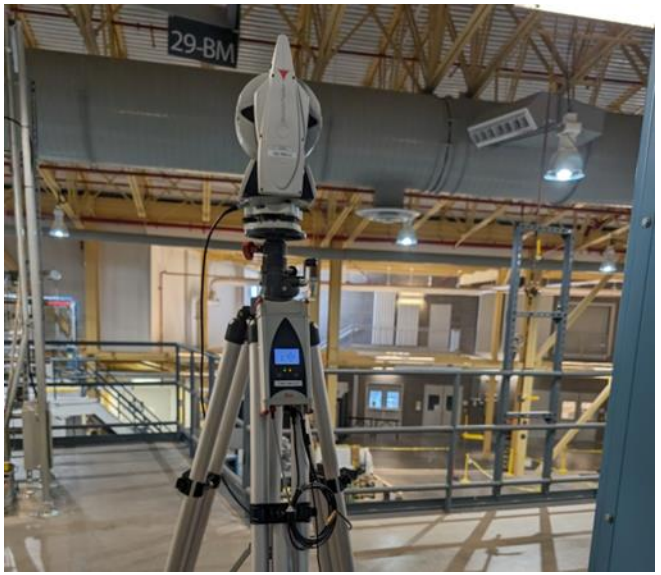
- New monuments are set up along the beam path
- On the mezzanine
- Temperature is well controlled





At401 specification and error estimate

- A Leica AT401 laser tracker
- Each monument will be measured three times
- In 2023–2024, a total of 16 sets of data had been collected.



Typical distance repeatability

39661.478 6_1_2023 RR1-S1A

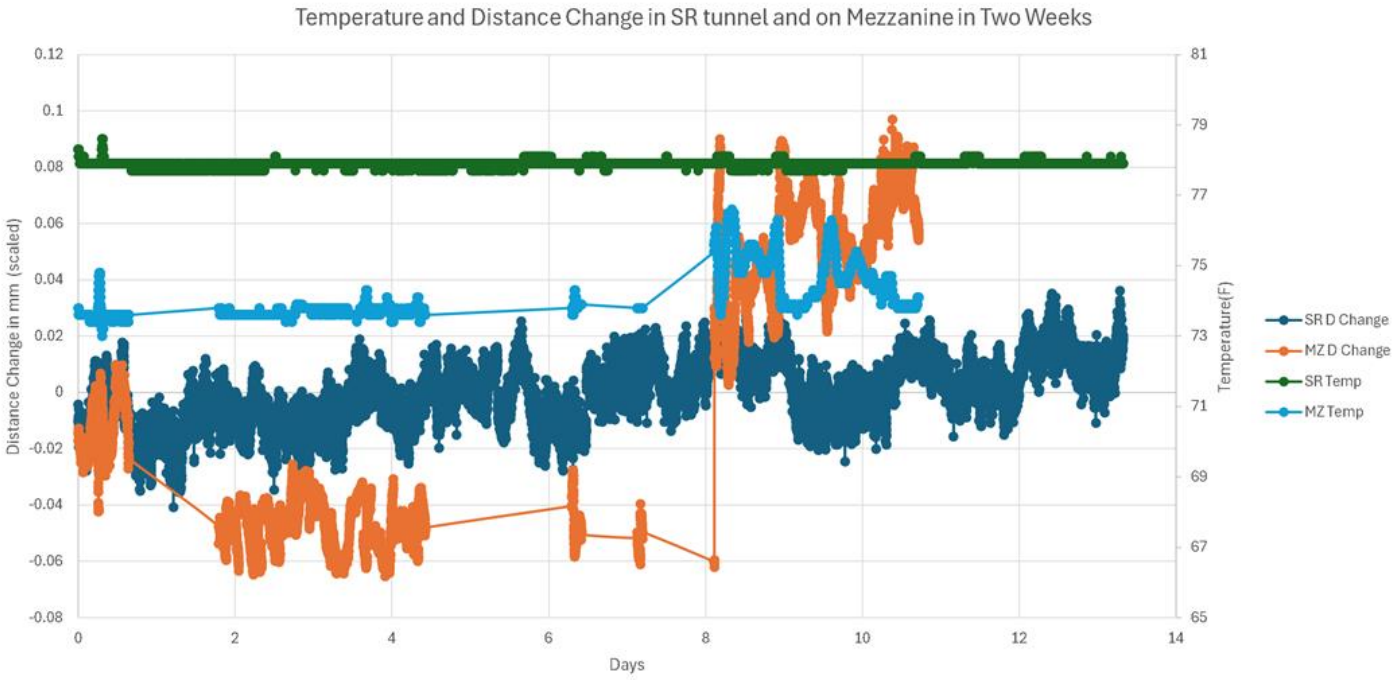
39661.486 6_1_2023

39661.489 6_1_2023 Unit:mm

- Specifications of AT401, distance error 0.010mm(2 sigma),1 arcsecond angular error (2 sigma).
- The error of distance between two monuments is about 0.07mm (2 sigma).
- The error of the circumference is about square root (15) *0.072=0.28mm(2 sigma).

Distance measurement comparison between mezzanine and storage ring tunnel

Two laser trackers were set up and took measurement simultaneously for two weeks.
In storage ring, the distance between two measured points is 34346mm.
On mezzanine, the distance between two points is 53256mm.



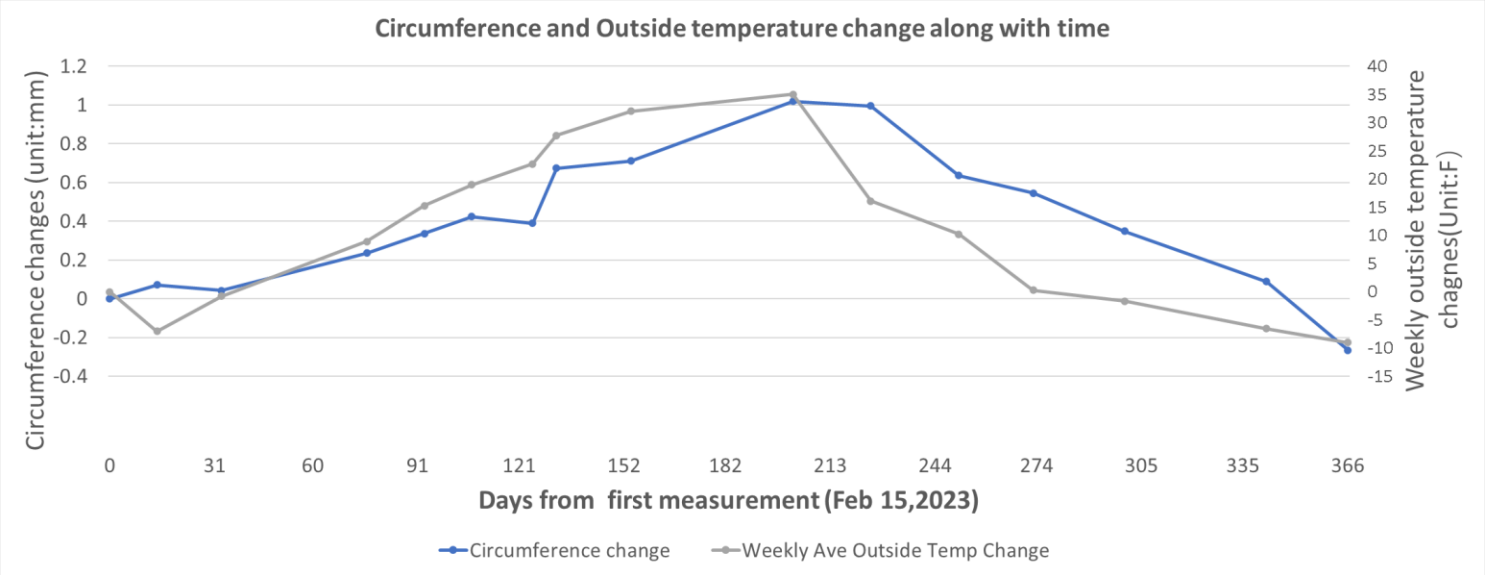
Temperature change in the storage ring and on the mezzanine is 0.9 °F and 3.6 °F respectively.

Distance change range in the storage ring and on the mezzanine is 0.07 mm and 0.16 mm (scaled to 34.3 meter) respectively.

This corresponds a scale factor of 0.44

Storage ring circumference and outside temperature changes

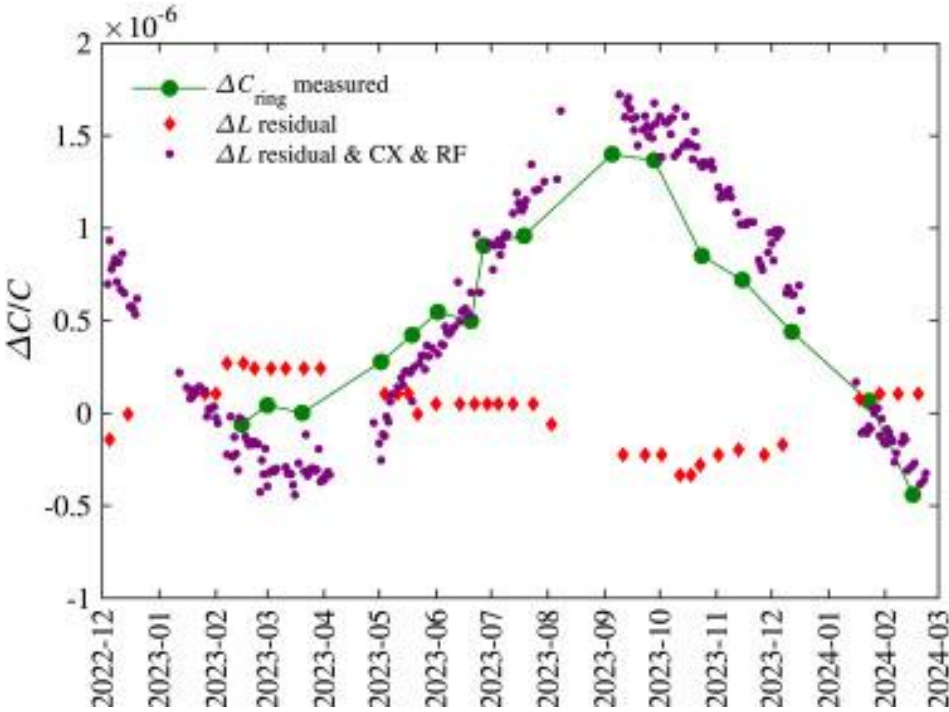
Circumference follows the temperature with a significant time lag



Estimated yearly peak-to-peak circumference change is about 1.5 mm.

Storage ring circumference and energy

- V. Smaluk et al. Measurement of seasonal variations of the NSLS-II circumference and energy. Nuclear Inst. and Methods in Physics Research, A. 1069 (2024) 169858.
- It summarizes the circumference measurement along with other data including RF frequency changes, sum current of power supplies feeding quadrupole magnets, IVU gap changes, and energy changes.
- The conclusion is that the seasonal variations of the ring circumference and energy seem to be the main reason for the lattice reproducibility issues observed at NSLS-II.



Summary

- The seasonally monitoring survey of the changes above truck tunnel shows that the changing trend is like previous years and has **a downward trend**. Nothing is to be alarmed.
- The newly installed **WPS** can provide real time data. It agrees with the trend from regular survey and could provide much more detailed information.
- The storage ring circumference measurement campaign is not ideal since it's not measured in the tunnel directly. However, with careful designed plan and corrections, the **estimated 1.5mm peak** to perk yearly change is reliable.
- NSLS II has been running for about 10 years. Although the machine is running well, potentially more problems will occur along with equipment get old. Monitoring the changes of equipment could be helpful. **Monitoring survey will continue.**

Thanks for your attention!

- Acknowledgement

The author would like to thank all the staff who involved in the NSLS-II alignment activities.

- Questions?