

BEST 70P Cyclotron beam commissioning at LN Legnaro

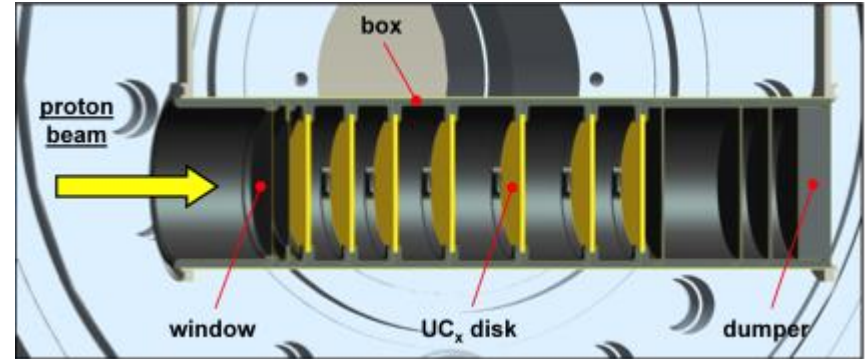
Vladimir Ryjkov,
Best Cyclotron Systems Inc.

Best Cyclotron

- Best Cyclotron Systems Inc – one of several companies worldwide offering cyclotrons for commercial medical isotope production.
- Line of cyclotrons includes 15MeV, 25MeV, 35MeV and 70MeV H- cyclotrons.

Commercial cyclotrons in nuclear science

- 70MeV H⁻ cyclotrons are also great option for online rare isotope production by fission in Uranium targets.
- Cost effective and power efficient.



Best 70P in LN Legnaro

- Best 70P cyclotron selected for Italian Istituto Nazionale di Fisica Nucleare (INFN) Laboratori Nazionali di Legnaro (LN Legnaro).
- Best 70P was also selected for RISP project underway here in Daejeon, South Korea.

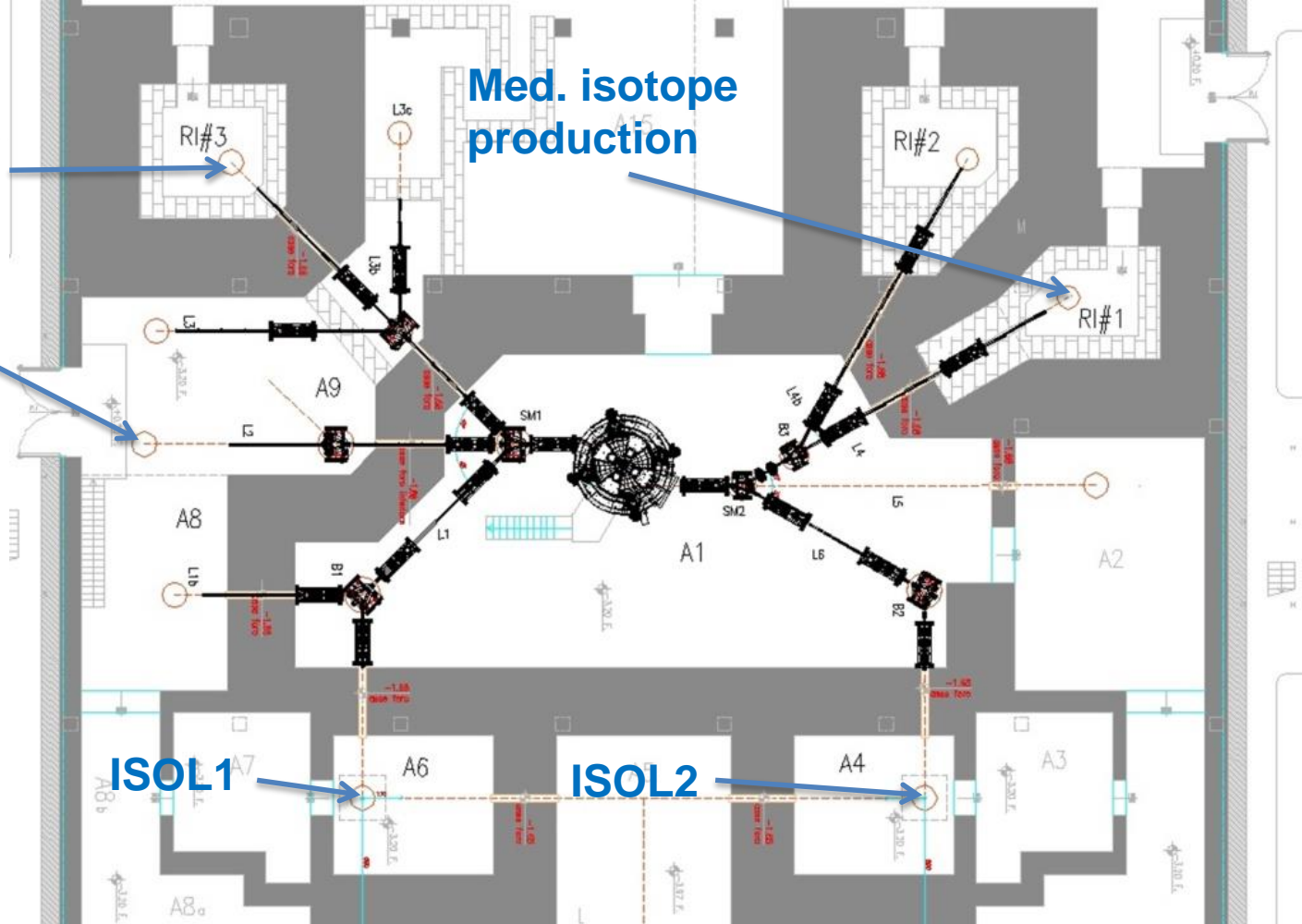


Best[®]
Theratronics
Med. isotope
research

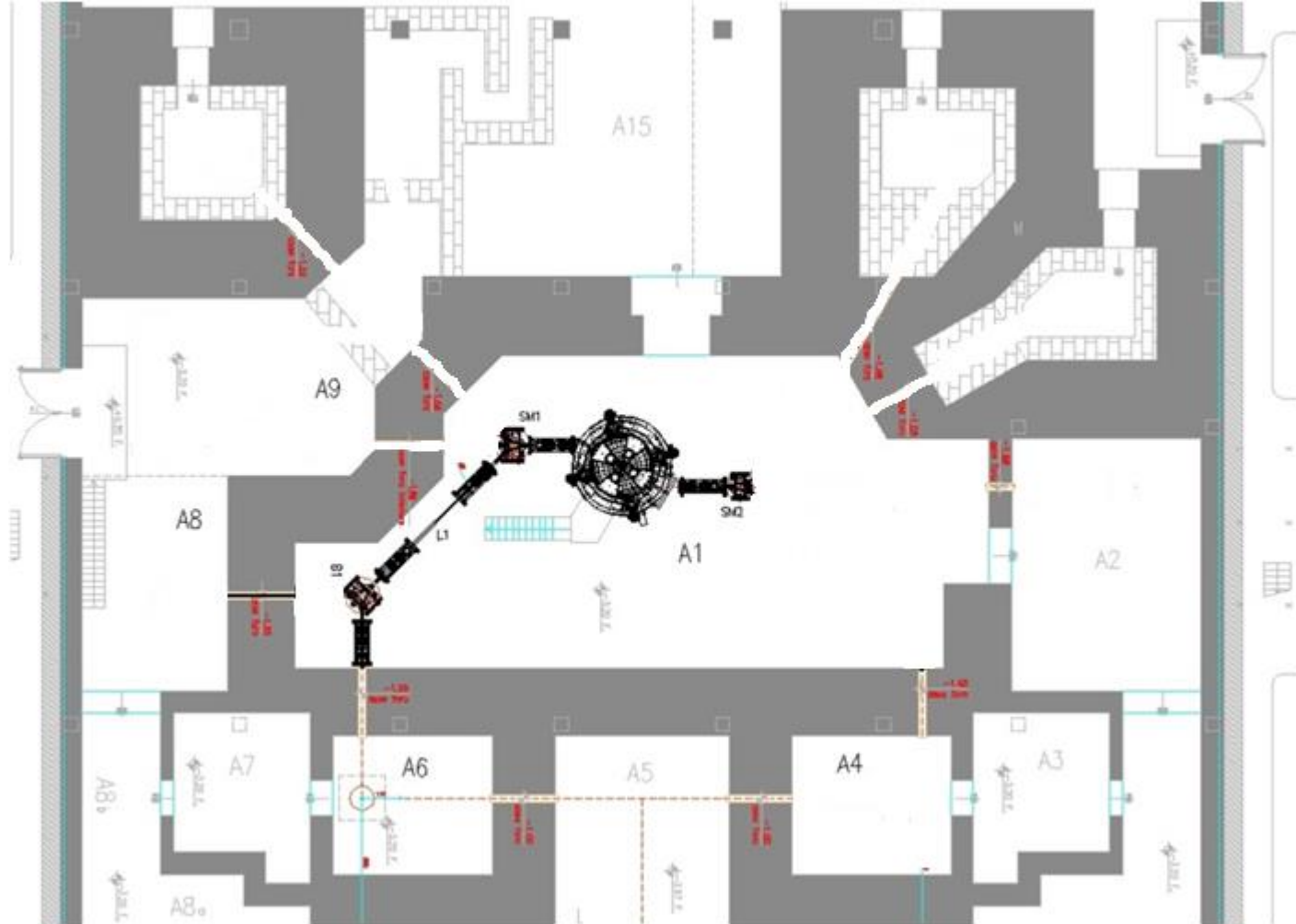
Neutron
studies

LN
Legnaro
facility

Med. isotope
production

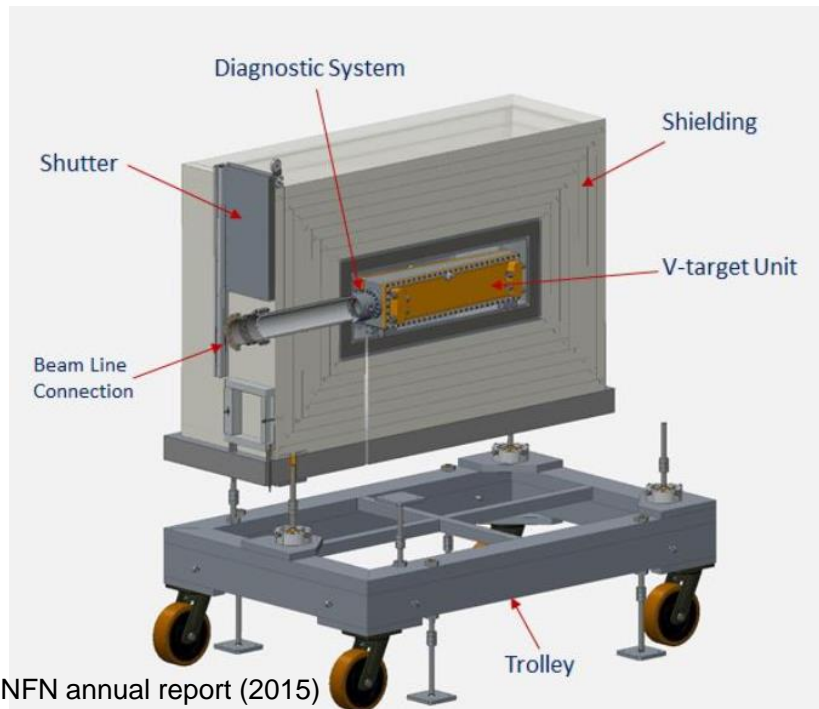


Best Cyclotron Delivery



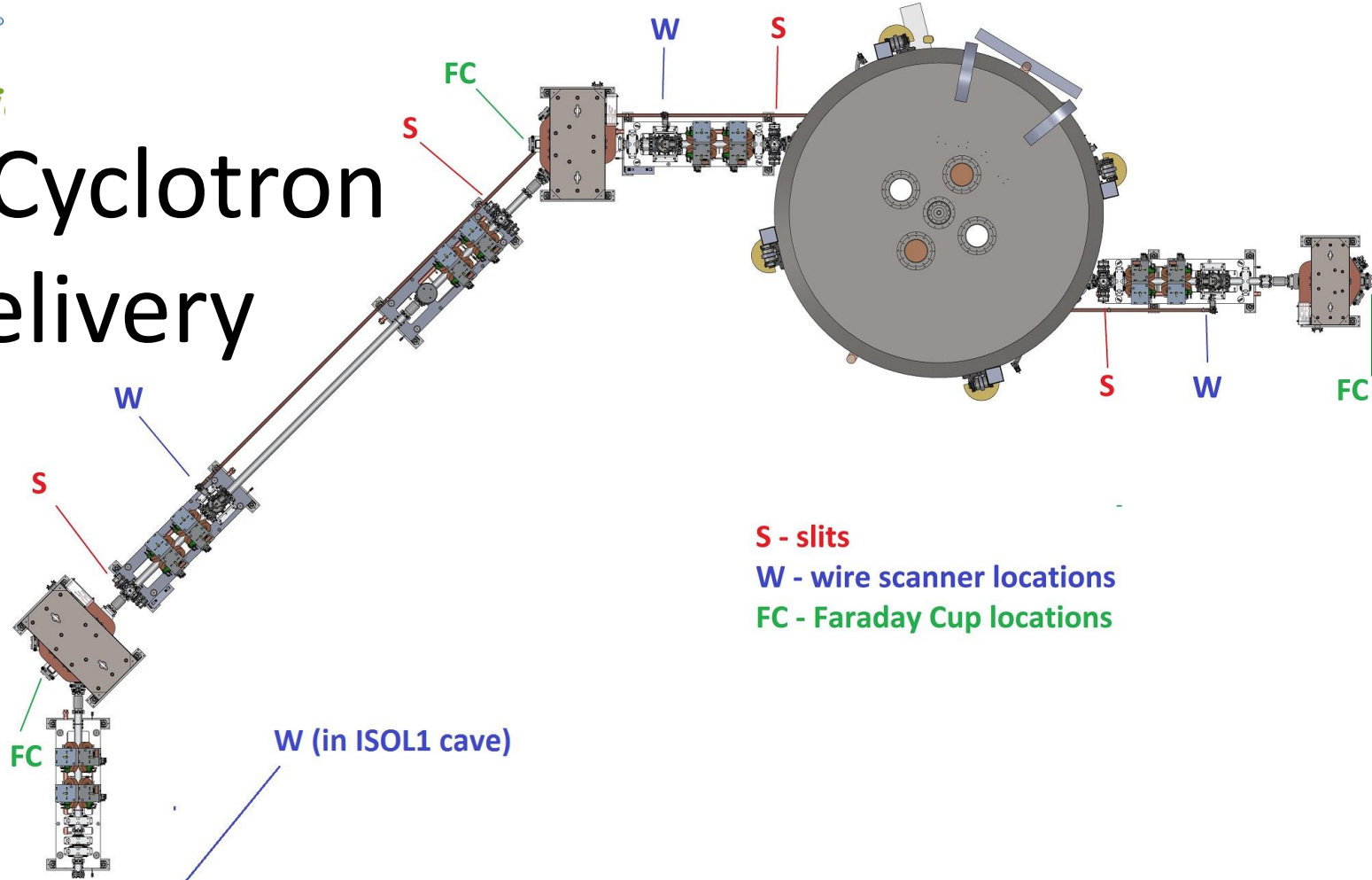
Beam dump (provided by LN Legnaro)

- Located in ISOL1 cave.
- 50kW capacity
- Locally shielded



from INFN annual report (2015)

Best Cyclotron Delivery





Best Cyclotron Delivery

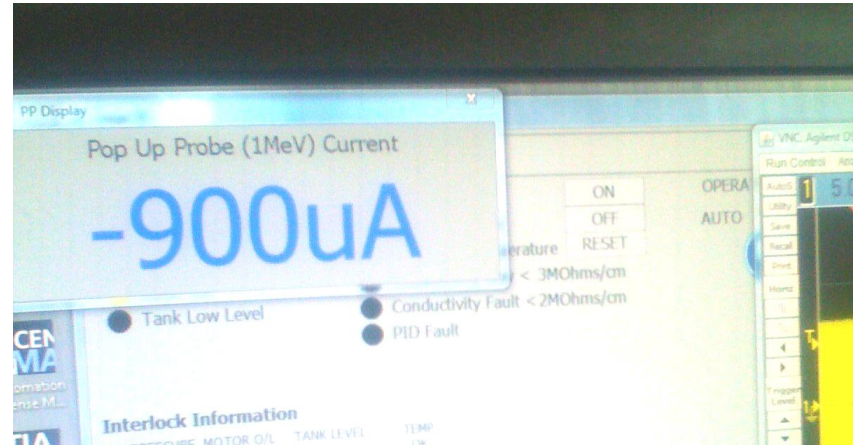
© Best Theratronics Ltd

Best 70P cyclotron specifications

- H- accelerator
- Variable energy 35MeV to 70MeV protons.
- Up to 700uA beam (49kW beam power).
- Two extraction ports, each with up to full current capability.

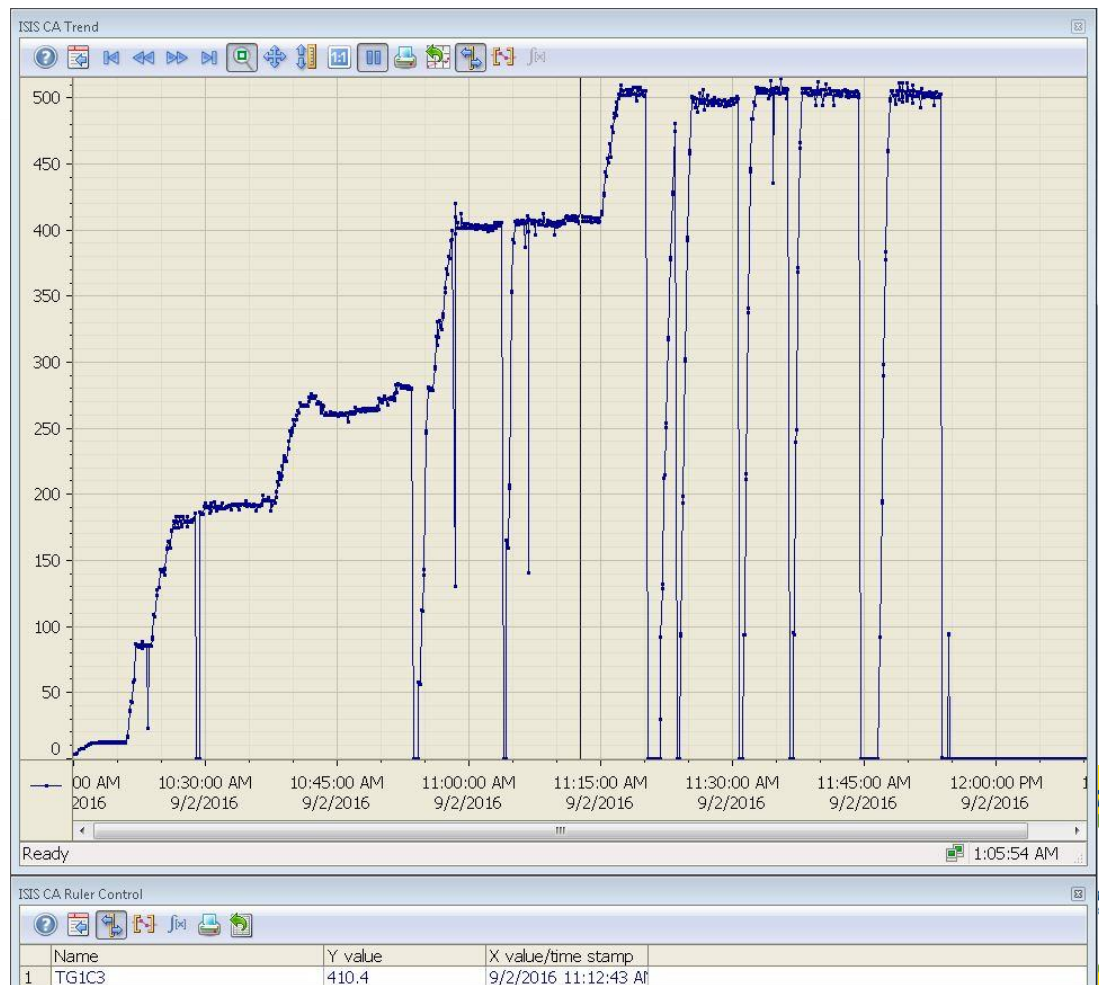
First step

- Accelerate a few turns to a beam stop “pop-up probe” located <1MeV.
- Ensured we have enough to extract full power (700uA)



First high power run

- Gradually increasing intensity up until 500uA
- Vacuum at the beam dump deteriorated and test stopped
- Operation above 200uA caused beam dump vacuum condition to permanently worsen.



Dual extraction

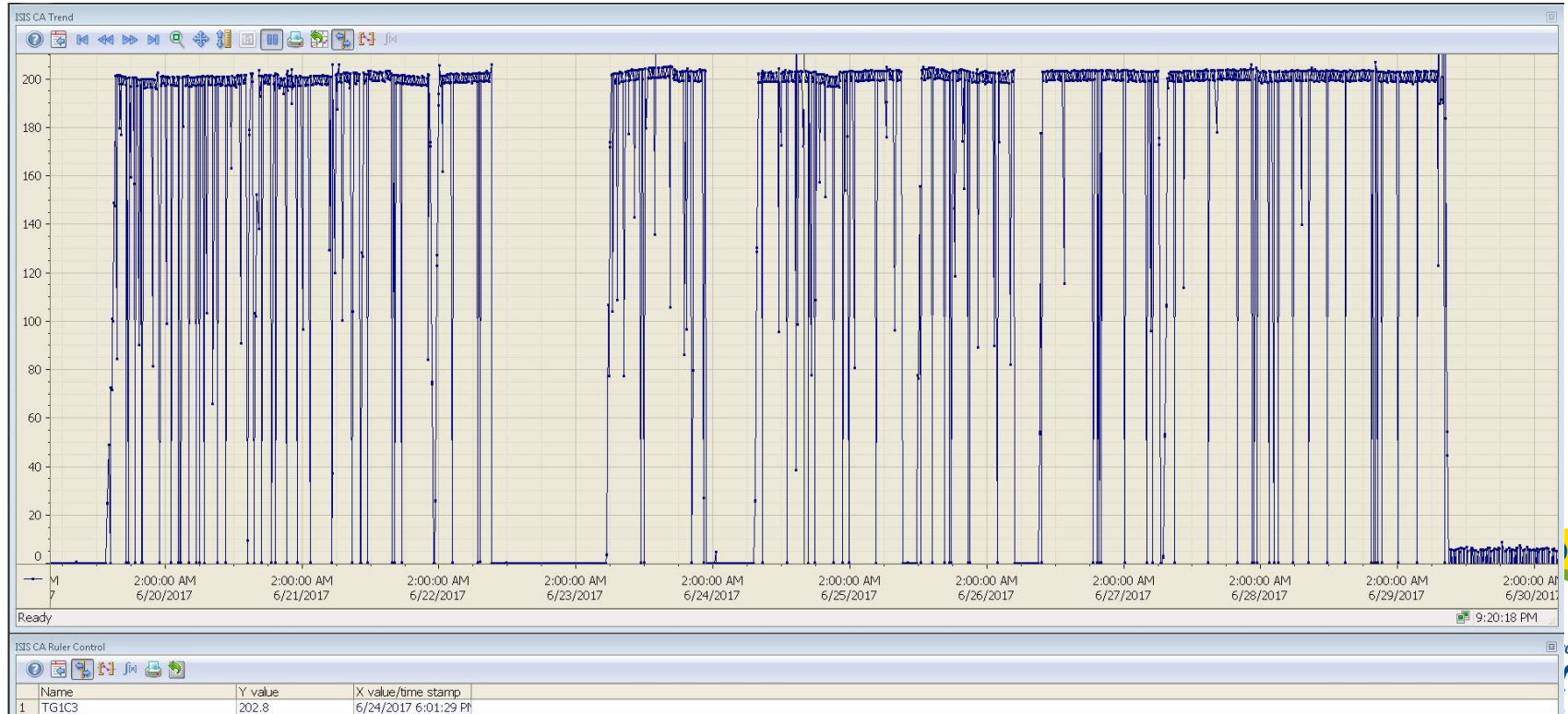
- Had to limit amount of beam extracted on port #2.
- Excludes more common and easier 1:1 or 1:5 intensity ratios.
- Shown is a test with 1:20 beam intensity ratio.



Endurance test

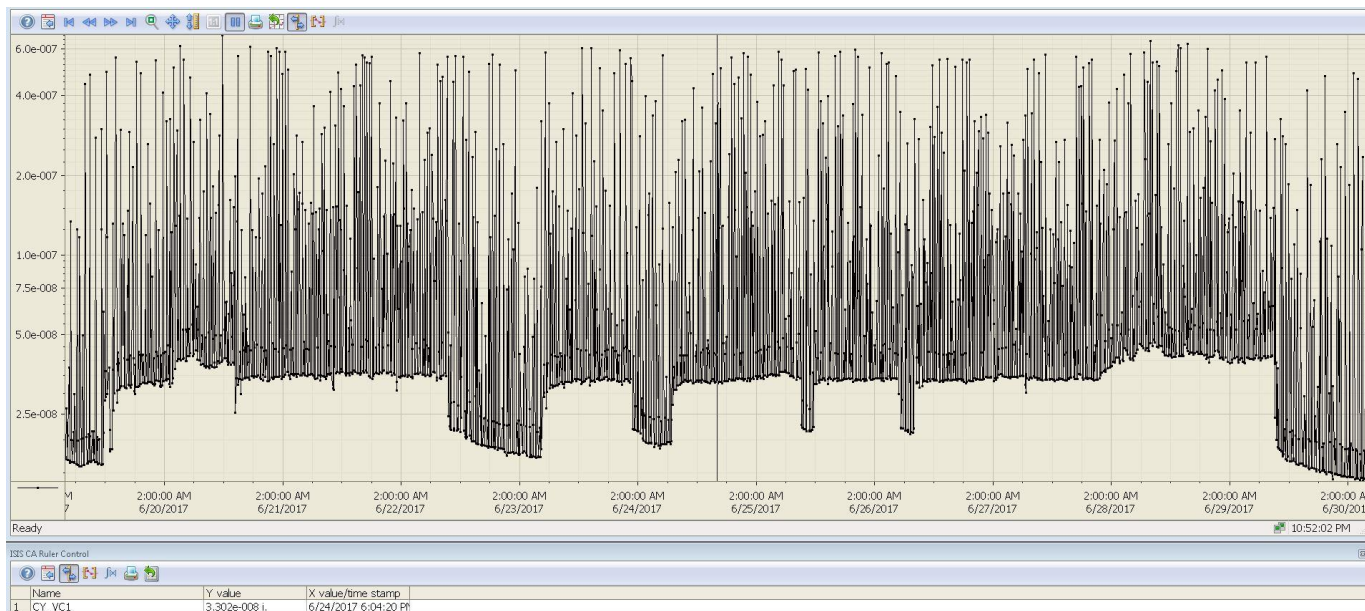
- 200uA, 40MeV
- Initially planned – 5 days
- Extended by mutual agreement due to irrelevant operation stoppages (4 building safety systems false positives, connector corrosion)

Endurance test



Endurance test vacuum trend

- Important (H- stripping)
- Ultimate vacuum level of $\sim 2 \times 10^{-8}$ Torr
- Operational (beam ON): $\sim 4 \times 10^{-8}$ Torr

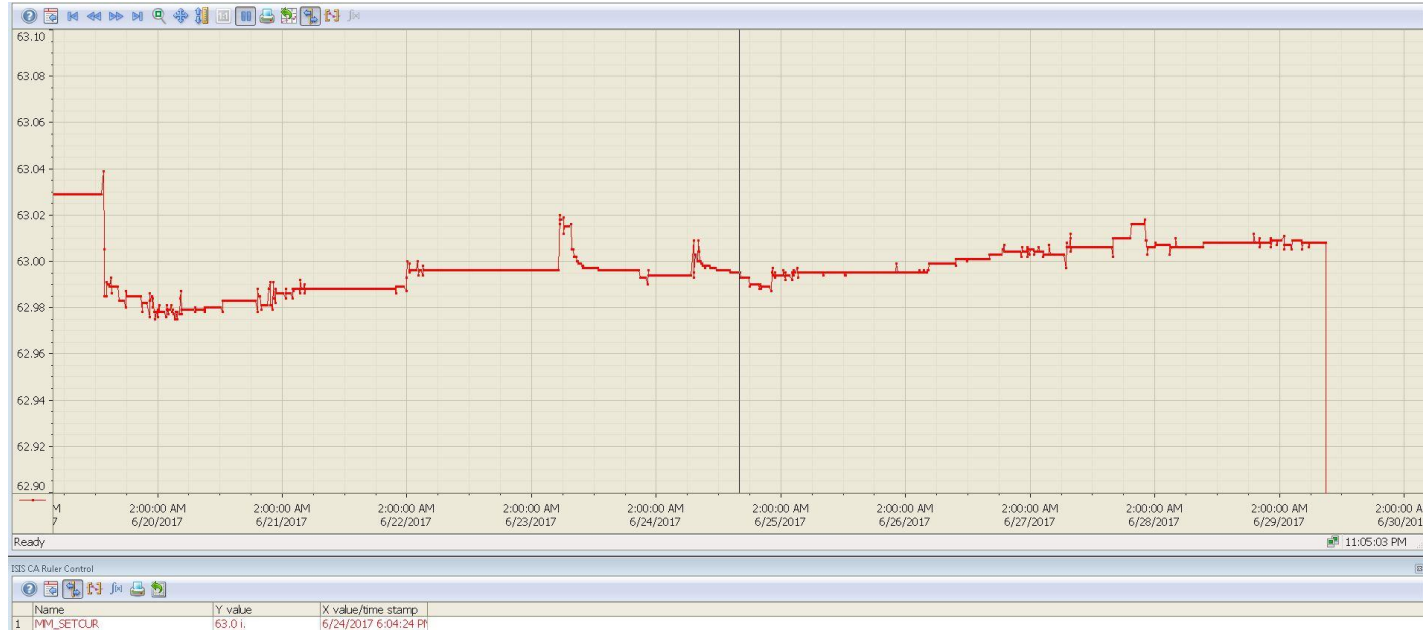


Endurance test tuning

- Injection line and beamline settings kept untouched
- Extractor tuning to compensate for foil deformation due to heat
- Main magnet tuning to compensate for thermal drift in PS
- Operated in very low collimator current mode (<1%), with fairly flat response, so most tuning was exploratory.

Endurance test MIM tuning

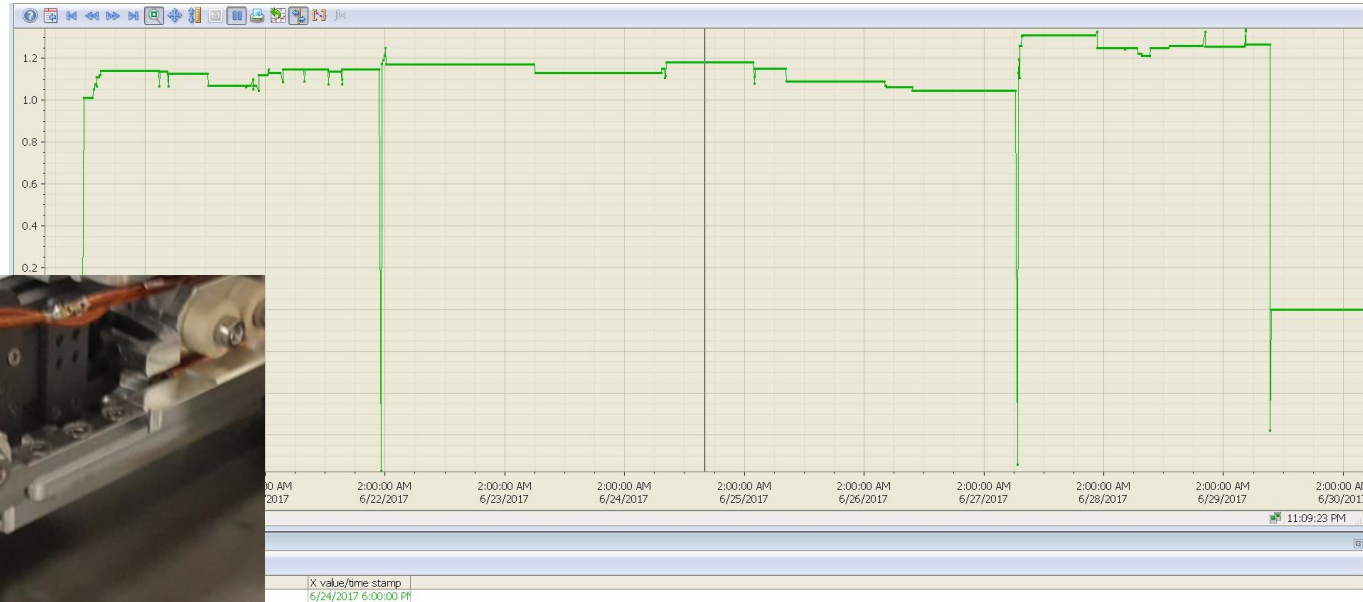
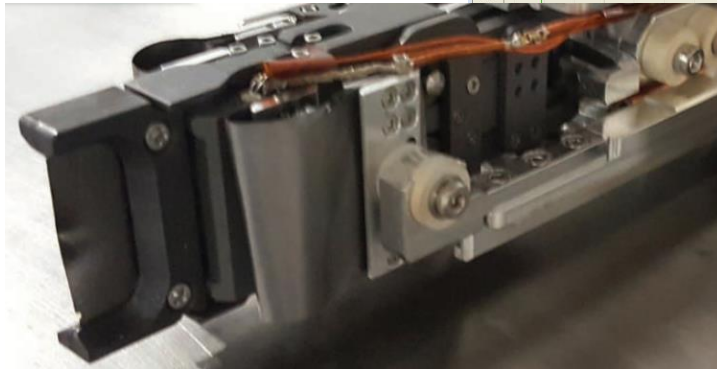
- 30mA (0.05%) change over 10 days.



ISIS CA Ruler Control		
Name	Y value	X value/time stamp
1 MIM_SETCLR	63.0 i	6/24/2017 6:04:24 PM

Endurance test extractor tuning

- 2 foil changes



Outlook

- Training of LN Legnaro personnel is complete.
- Operation up to 500uA in the last few month, constrained by radiation protection. Further increase planned.
- Cyclotron for RAON project is under construction.



Thank you

