BEST 70P Cyclotron beam commissioning at LN Legnaro

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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.

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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.
Legnaro facility

- Med. isotope research
- Neutron studies
- Med. isotope production
- ISOL1
- ISOL2

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Best Cyclotron Delivery
Beam dump (provided by LN Legnaro)

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

from INFN annual report (2015)

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Best Cyclotron Delivery

S - slits
W - wire scanner locations
FC - Faraday Cup locations

W (in ISOL1 cave)
Best Cyclotron Delivery
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

• 200\(\mu\)A, 40\(\text{MeV}\)

• 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 MM tuning

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