MEDICAL RADIOISOTOPE PRODUCTION PLATFORM

Supplying the fight against cancer

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No patient should be denied the cancer care they need simply because some options are in **short supply** or **unavailable.**

Breakthrough, patented ion source capable of producing a wide range of **DIAGNOSTIC** and **THERAPEUTIC** radioisotopes.

Supplying the fight against cancer by:

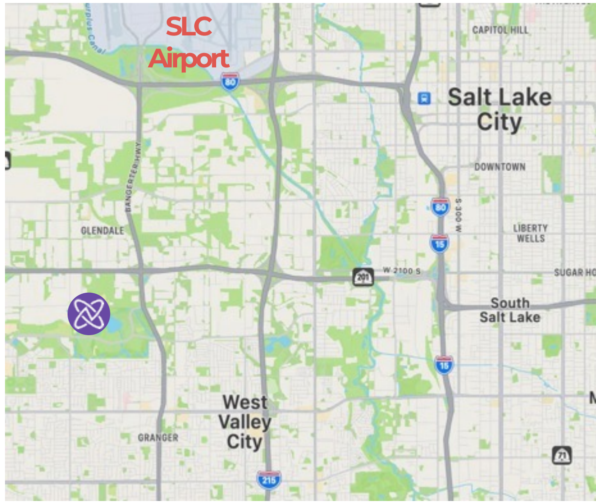
- Stabilizing supply chains
- Enabling innovation
- Providing unprecedented flexibility
- Increasing manufacturing capacity

Location:

- Production facility opening Q1 2025 in West Valley City, Utah (Salt Lake City)

Production plant sited & progressing ahead of schedule

West Valley City, UT



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Nusano’s proprietary, high-current ion source technology:

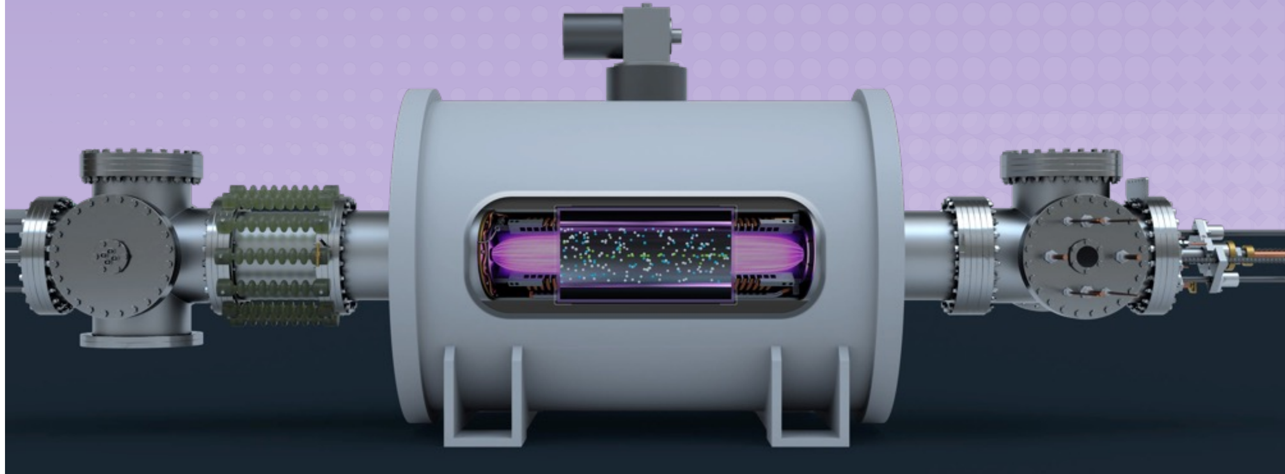
- Generates heavy ions, He^{++} & $^{2}H^{+}$, to greatly increase yield & efficiency
- Beam enables production of broad array of radioisotopes
- Annual preventive maintenance vs. monthly downtime

36mA
ALPHA BEAM CURRENT

≥36mA
DEUTERIUM BEAM CURRENT

288 – 720x
GREATER ALPHA PRODUCTION
than existing alpha ion beams

10,000+
HOURS RUNTIME



Performance

Particles

$^{2}H^{+}$

$^{3}He^{2+}$

$^{4}He^{2+}$

$^{7}Li^{3+}$

3-5

MILLIAMP

AVERAGE CURRENT ON TARGET*

Particle Energy

25 MeV

37.5 MeV

50 MeV

87.5 MeV

* Li beam ~1 mA

Production Capabilities

- **18 F** — DIAGNOSTIC — *Positron*
- **67 Ga** — DIAGNOSTIC — Thera. potential — *Gamma, Auger*
- **123 I** — DIAGNOSTIC — Thera. potential — *Gamma, Auger*
- **124 I** — DIAGNOSTIC — *Positron, Gamma*
- **111 In** — DIAGNOSTIC — Thera. potential — *Gamma, Auger*
- **203 Pb** — DIAGNOSTIC — Thera. potential — *Gamma, Auger*
- **89 Zr** — DIAGNOSTIC — *Positron*

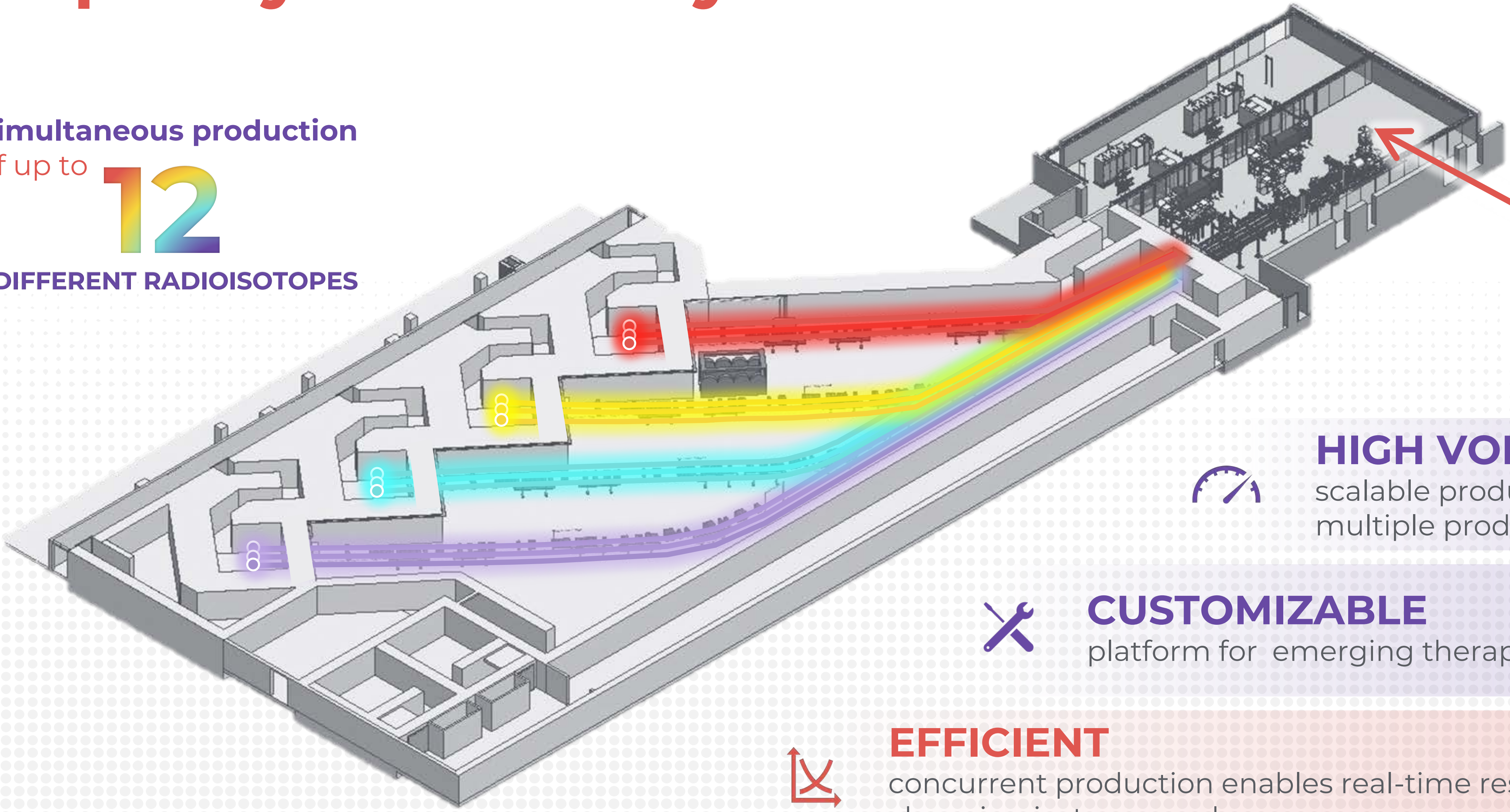
- **225 Ac** — THERAPEUTIC — *Alpha, Beta*
- **211 At** — THERAPEUTIC — *Alpha*
- **131 Cs** — THERAPEUTIC (brachytherapy) — *X-ray*
- **67 Cu** — THERAPEUTIC — *Beta*
- **131 I** — THERAPEUTIC — *Beta*
- **192 Ir** — THERAPEUTIC (brachytherapy) — *Gamma, Beta*
- **177 Lu** — THERAPEUTIC — *Beta*
- **103 Pd** — THERAPEUTIC (brachytherapy or Auger) — X-rays, Auger, IC electrons
- **186 Re** — THERAPEUTIC — *Beta*
- **47 Sc** — THERAPEUTIC — *Beta*
- **89 Sr** — THERAPEUTIC — *Beta*

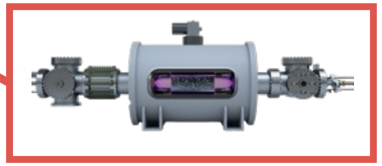
- **64 Cu** — DIAG. & THERA. — *Beta, Positron*
- **117m Sn** — DIAG. & THERA. — *Gamma, IC electrons*
- **131 Ba** — GENERATOR
- **68 Ge** — GENERATOR
- **99 Mo** — GENERATOR
- **211 Rn** — GENERATOR
- **82 Sr** — GENERATOR
- **227 Th** — GEN. / THERA. — *N/A. Alpha*
- **60 Co** — INDUSTRIAL or EXT. THERAPY — *Gamma*

KEY: Diagnostic | Therapeutic | Diagnostic & Therapeutic | Generator | Other

Unprecedented production capacity & flexibility

Simultaneous production
of up to **12**
DIFFERENT RADIOISOTOPES





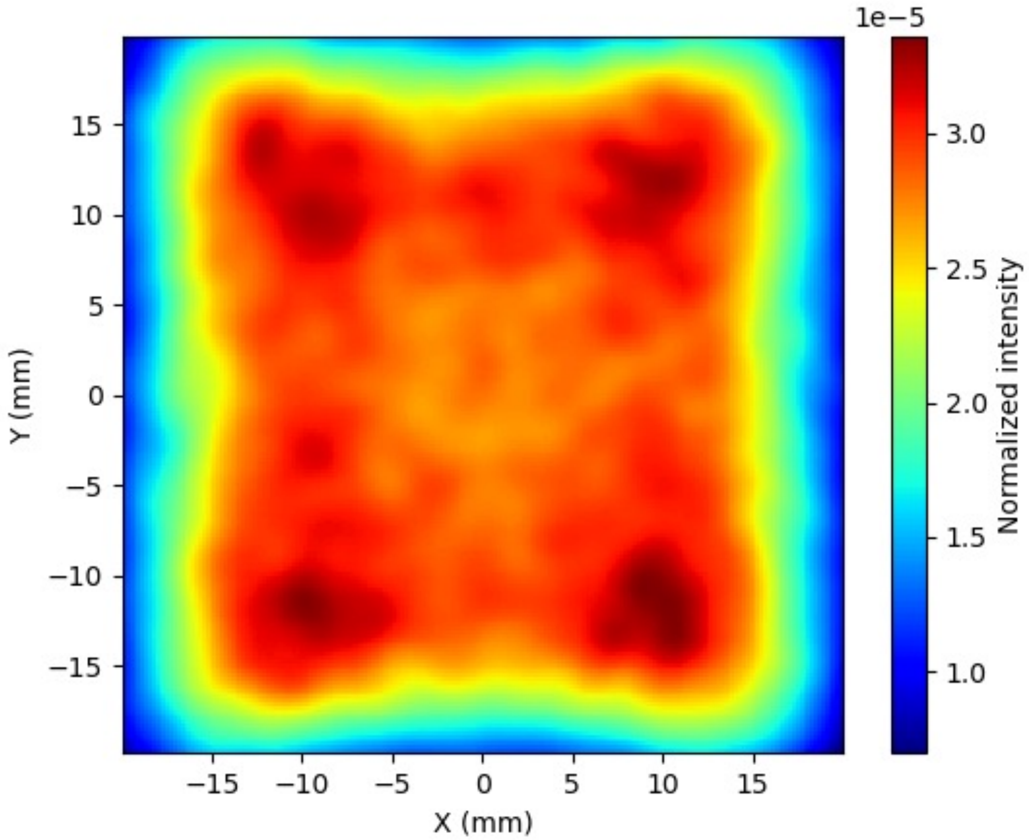
HIGH VOLUME
scalable production supporting multiple product lines at launch

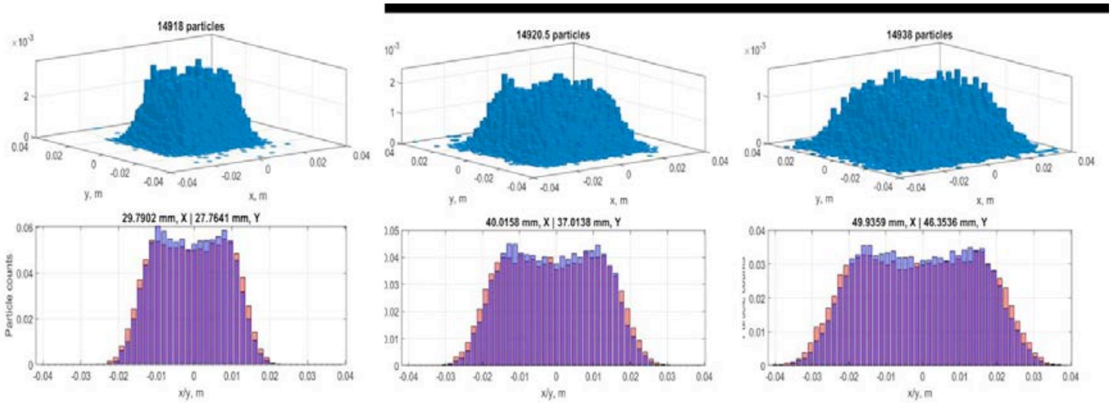
CUSTOMIZABLE
platform for emerging therapeutics needs

EFFICIENT
concurrent production enables real-time response to changing isotope needs

The Octupole Transformation

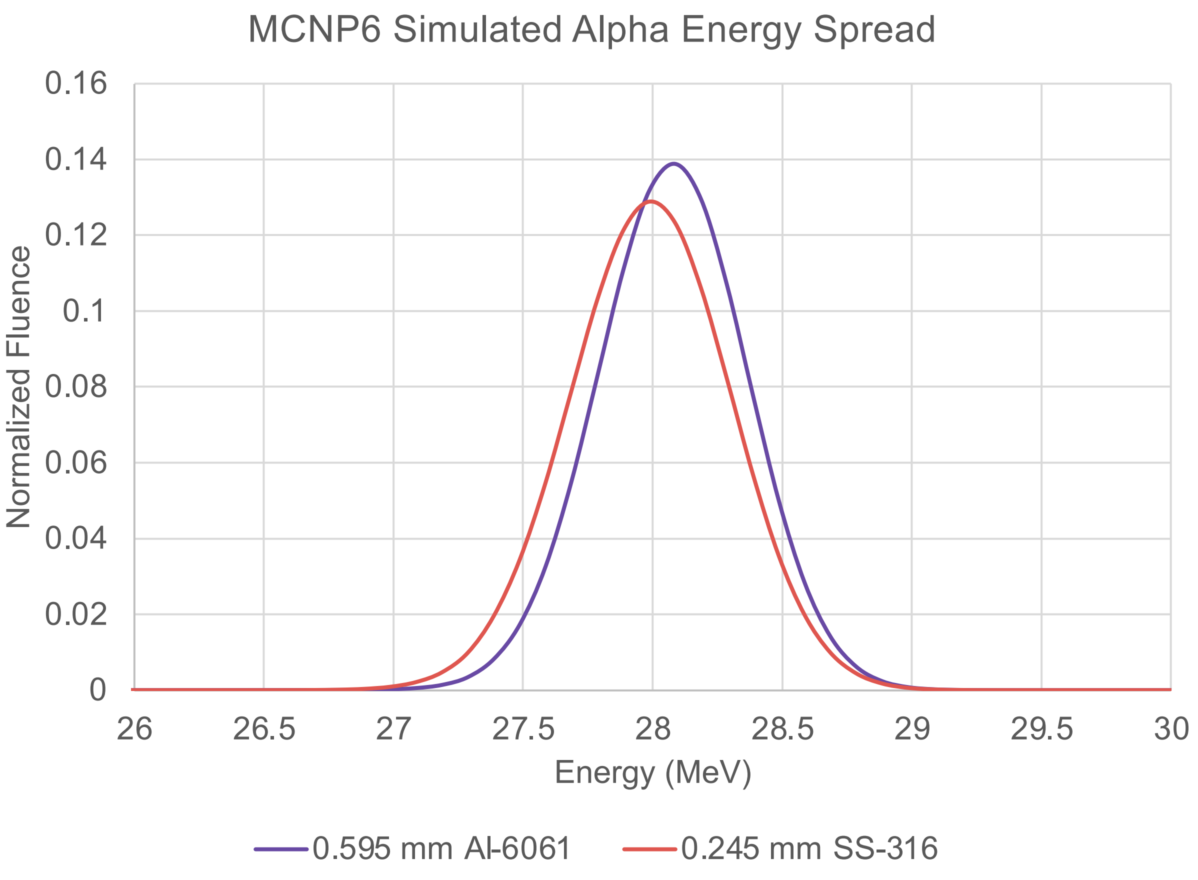
- The transformation takes the outer edges of the beam and folds them back on the body of the beam.
- Nominal beam distribution is gaussian. With the transformation there is a homogenous distribution uniform over the square target area.
- Octupoles modify the distribution slightly so the effect appears 20m later.





^{211}At Targetry

- Vertical, windowed design to moderate beam to <29 MeV
- 4 cm x 4 cm (16 cm^2) or 5 cm x 5 cm (25 cm^2) spot size
  - 12.0 cm x 1.8 cm (21.6 cm^2) target at U. of Washington external target[1] – gaussian, less distributed beam
- ^{209}Bi thickness: 0.1 mm
- Bismuth melted in place with similar methods to Gagnon *et al* 2012[1]
- Water cooling with option for cryogenic cooling



*0.03% of alpha fluence with energy >29 MeV in each case

[1]Source: Gagnon et al. (2012). Design and evaluation of an external high-current target for production of 211At. *J. Labelled Compounds and Radiopharmaceuticals, Volume 55*, Pages 436-440. DOI: 10.1002/jlcr.2968

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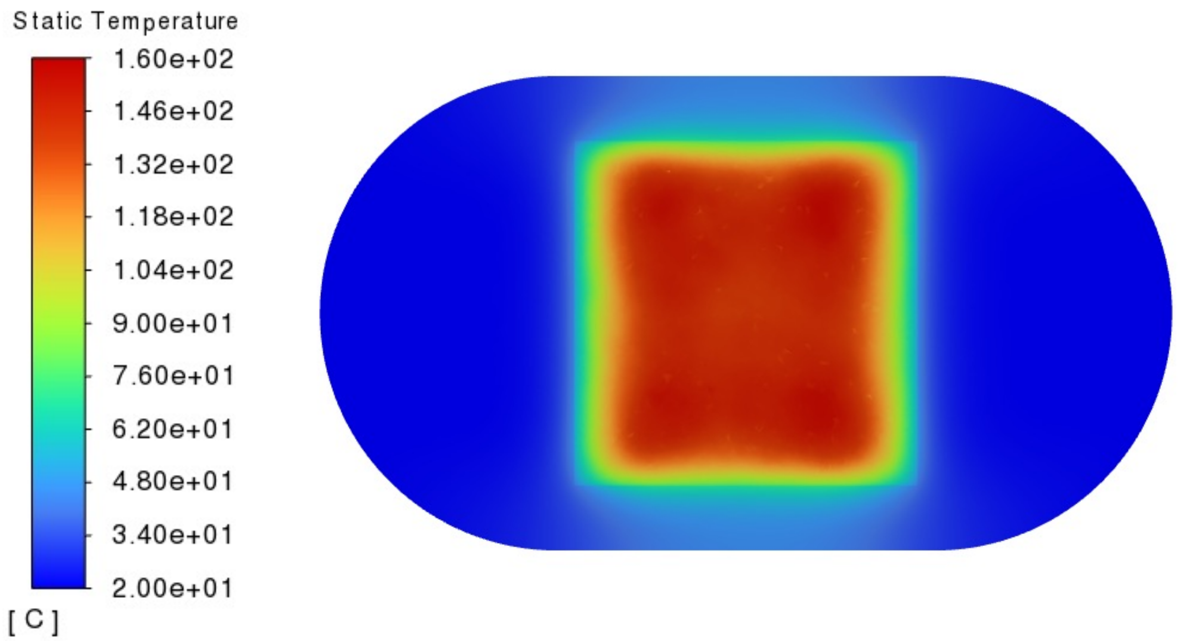
^{211}At Targetry – ANSYS Thermal Modeling

- Temperature distributions simulated in target using ANSYS
  - 0.595 mm Al6061 (or 0.245 mm SS316, 0.1 mm ^{209}Bi layer, and Al6061 backing
  - Steady-state conditions – 250 µA
  - 56 lpm cooling water flow
  - Thermal contact resistance between window and Bi set to 1×10^{-4} m^2K/W
- Max temperature in Bi <160 °C for 4 cm x 4 cm spot size



Bismuth max temperature remains well below the melting temperature

^{211}At: Worldwide Production

Table 1
Current ^{211}At production sites. Facilities that have reported production of ^{211}At during the last 5 years.

Location		Facility	Cyclotron manufacturer	Model and target	Production parameters	Current production status
North America	Durham, USA	Duke University Medical Center	CTI	CS-30 cyclotron, Internal target system	28 MeV, 100 μA	Max 9.3 GBq in 4-h
	Seattle, USA	University of Washington Medical Center	Scanditronix	MP-50, External target system	29.0 MeV, 58 μA	Max 4.3 GBq in 4-h
	Philadelphia, USA	University of Pennsylvania	Japan Steel Works (JSW)	BC3015, External Target	28.4 MeV, 10 μA	Max 395 MBq in 5-h
	Bethesda, USA	National Institutes of Health	CTI	CS-30 cyclotron, Internal target system	29.8 MeV, 43 μA	Max 1.71 GBq in 1-h
	College Station, USA	Texas A&M University	In house	K150 variable energy cyclotron	28.8 MeV, 7 μA	1.5 GBq in 9-h
Europe	Copenhagen, Denmark	Copenhagen University Hospital	Scanditronix	MC-32, Internal target system	29 MeV, 20 μA	Max 3–4 GBq in 4-h
	Nantes, France	Arronax	IBA	Cyclone 70	28 MeV, 15 μA	Production since 2020, 0.5–1 GBq capacity
Asia	Osaka, Japan	RCNP-Osaka University	In house	K140 AVF cyclotron	28.2 MeV	3 GBq expected after upgrade
	Chengdu, China	Sichuan University	CTI	CS-30	28 MeV, 15–20 μA	Max 200 MBq in 2-h
	Takasaki, Japan	QST-Takasaki, (TIARA)	In house	AVF (K110)	28.1 MeV, 4.5 μA	300 MBq in 3 h
	Chiba	QST-NIRS	In house	AVF-930	28.5 MeV, 10–13 μA	0.74–1.11GBq in 5-h
	Wako Saitama, Japan	IPCR Riken	In house	AVF	29 MeV, 40 μA	1.3 GBq in 1-h
	Fukushima City, Japan	Fukushima Medical University	Sumitomo	CYPRIS MP-30, External target system	29 MeV, 20 μA	Max 2 GBq in 4-h

Source: Yutian Feng, Michael R. Zalutsky. (2021). Production, purification and availability of 211At: Near term steps towards global access. *Nuclear Medicine and Biology, Volumes 100–101*, Pages 12-23. https://doi.org/10.1016/j.nucmedbio.2021.05.007.

~350 μA

combined worldwide alpha current being used to produce ^{211}At **in the last 5 years**

Nusano's single facility will have an **ORDER of MAGNITUDE greater current than current worldwide capacity**

^{211}At Production

211

At

DIRECT

^{211}At yields: 0.44-1.1 mCi/µAhr[1]

Average current 250 µA per target with up to 12 simultaneously running targets

Annual production capacity of ^{211}At up to 27000 Ci at EOB

With co-location and/or vertical integration, single facility able to serve entire U.S. market for R&D/early phase trials

Future: ~3 production sites in U.S. and 1-2 in EU to fulfill market needs when multiple approved therapeutics on market

[1]Source: Yutian Feng, Michael R. Zalutsky. (2021). Production, purification and availability of 211At: Near term steps towards global access. *Nuclear Medicine and Biology, Volumes 100–101*, Pages 12-23. https://doi.org/10.1016/j.nucmedbio.2021.05.007.

^{211}At Production

211

Rn

INDIRECT

FUTURE CAPABILITY

Nusano's $^{7}Li^{+++}$ source capability untested, though we are highly confident we could do >1 mA of average current

^{211}Rn generator for ^{211}At - expand our service region

Calculated yearly production capacity ^{211}Rn at EOB: 400-600 Ci

Special consideration to avoid/limit co-production of ^{210}Rn

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[1]Source: Yutian Feng, Michael R. Zalutsky. (2021). Production, purification and availability of 211At: Near term steps towards global access. *Nuclear Medicine and Biology, Volumes 100–101*, Pages 12-23. https://doi.org/10.1016/j.nucmedbio.2021.05.007.

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No patient should be denied the cancer care they need simply because some options are in **short supply** or **unavailable.**

THE NUSANO PLATFORM WILL:

211 At

Generate **significant quantities** of ^{211}At

Provide **flexibility** and **scalability** to support global demand

Help **supply** the fight against cancer

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