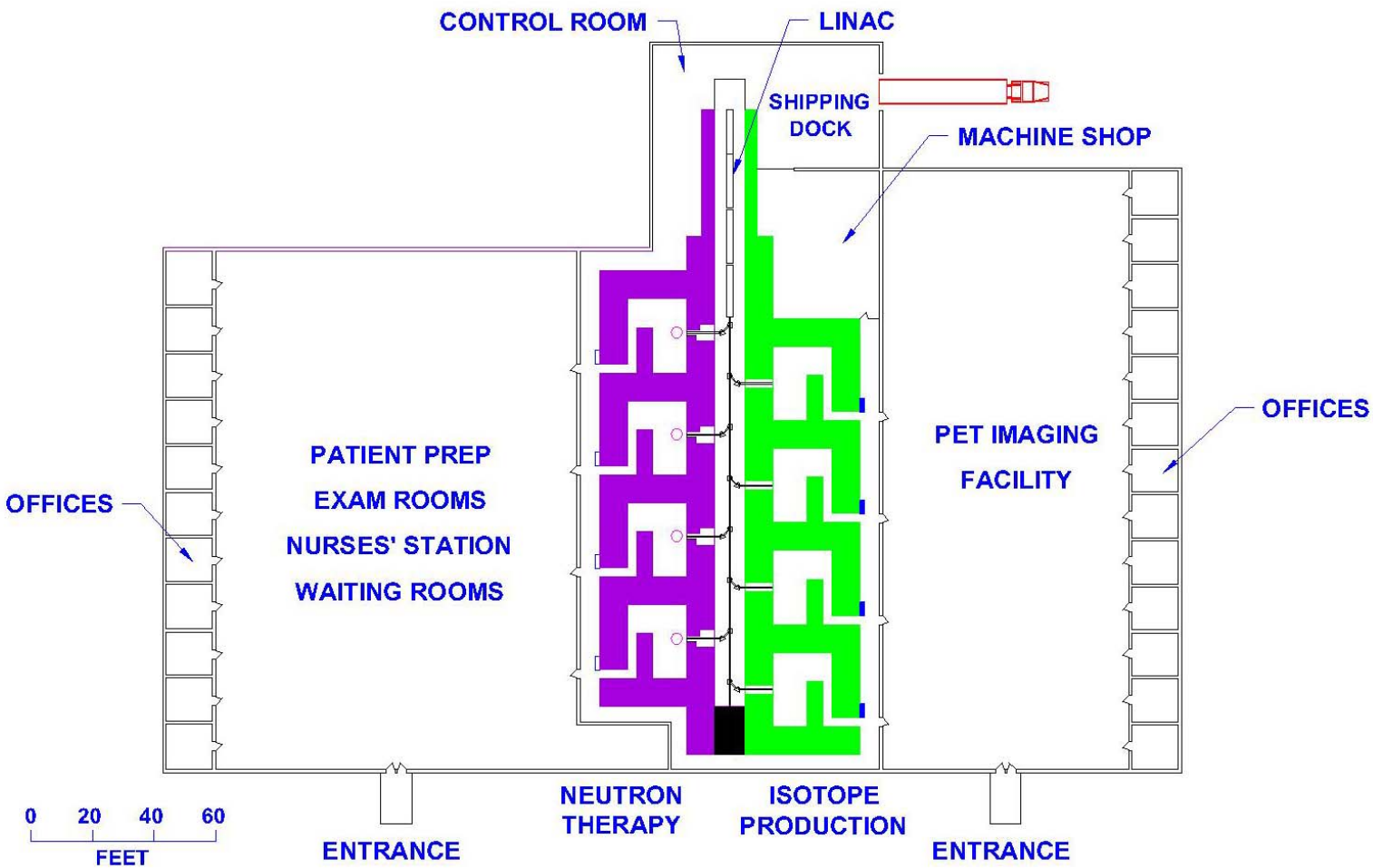
Institute for Hadron Therapy

A Multidisciplinary Program

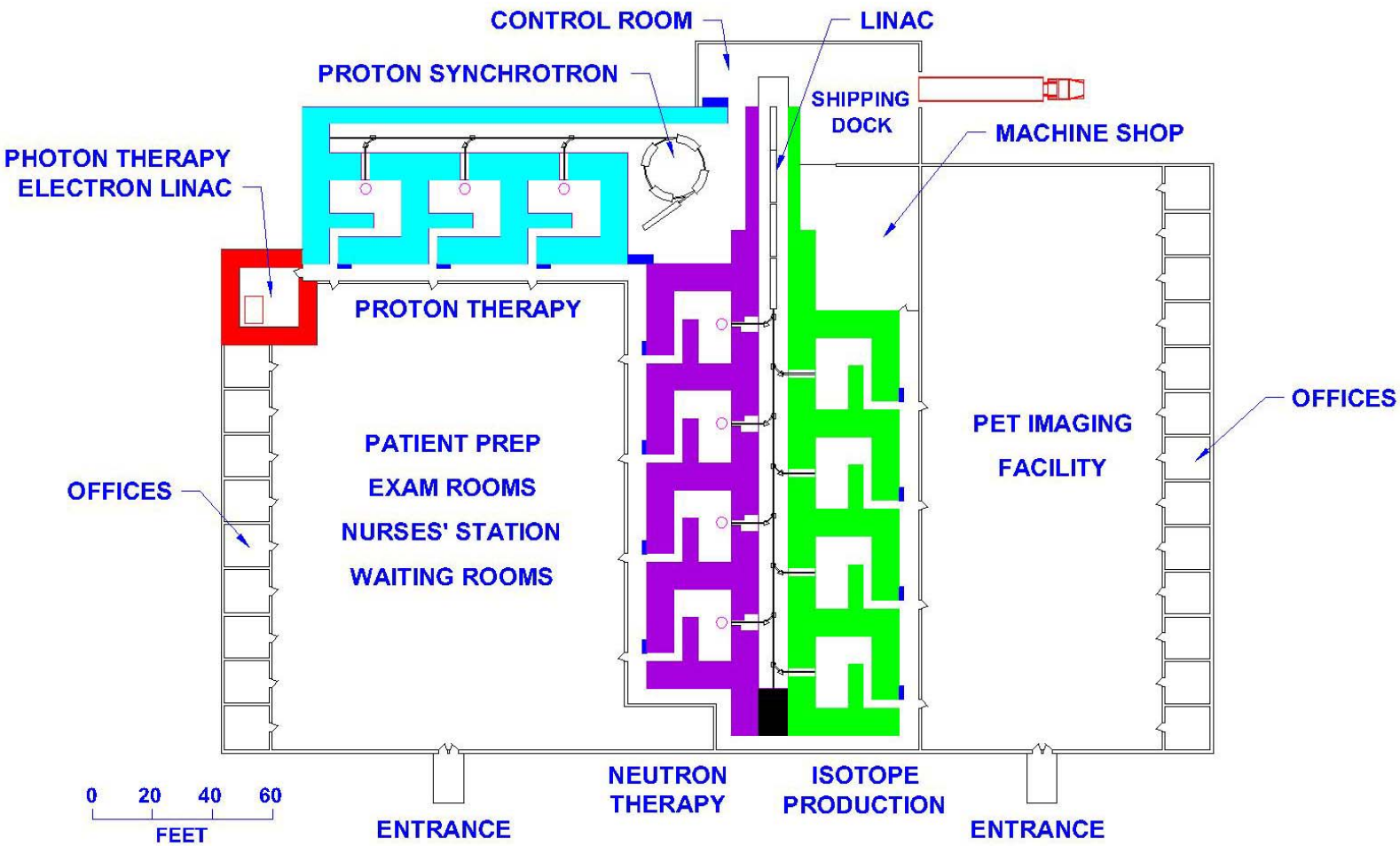
- ***Physicians treat up to 1500 patients per year***
- ***Specialists work to make hadron therapy more cost effective and accessible***
  - Accelerator, mechanical, electrical engineers
  - Accelerator and medical physicists
  - Software and controls specialists
- ***Radiobiologists study biological effectiveness***
- ***Pharmaceutical specialists develop radiosensitizers***
- ***Isotope specialists track changes in tumors***
- ***Basic scientists have access to research isotopes***

A Lennox 11/6/03

Neutron Therapy Facility
First Floor - Plan View



Hadron Therapy Facility
First Floor - Plan View



Institute for Hadron Therapy
Pre-construction R & D

- ***Physics/Engineering***
  - Accelerator Design -
    - 70 MeV, 200μA linac for neutron therapy/isotopes
    - 70 - 300 MeV 10 nA synchrotron for proton therapy
  - Beamline and Transfer Design
  - Remote Collimator Handling
  - Patient Manipulation
  - Shielding for neutron and proton rooms
- ***Chemistry/Biology/Physics***
  - Choice of isotopes
    - Basic Research
    - Clinical research and/or sales
  - Production rooms design and shielding

Engineering Challenges

Protons

Beam Scanning

Neutrons

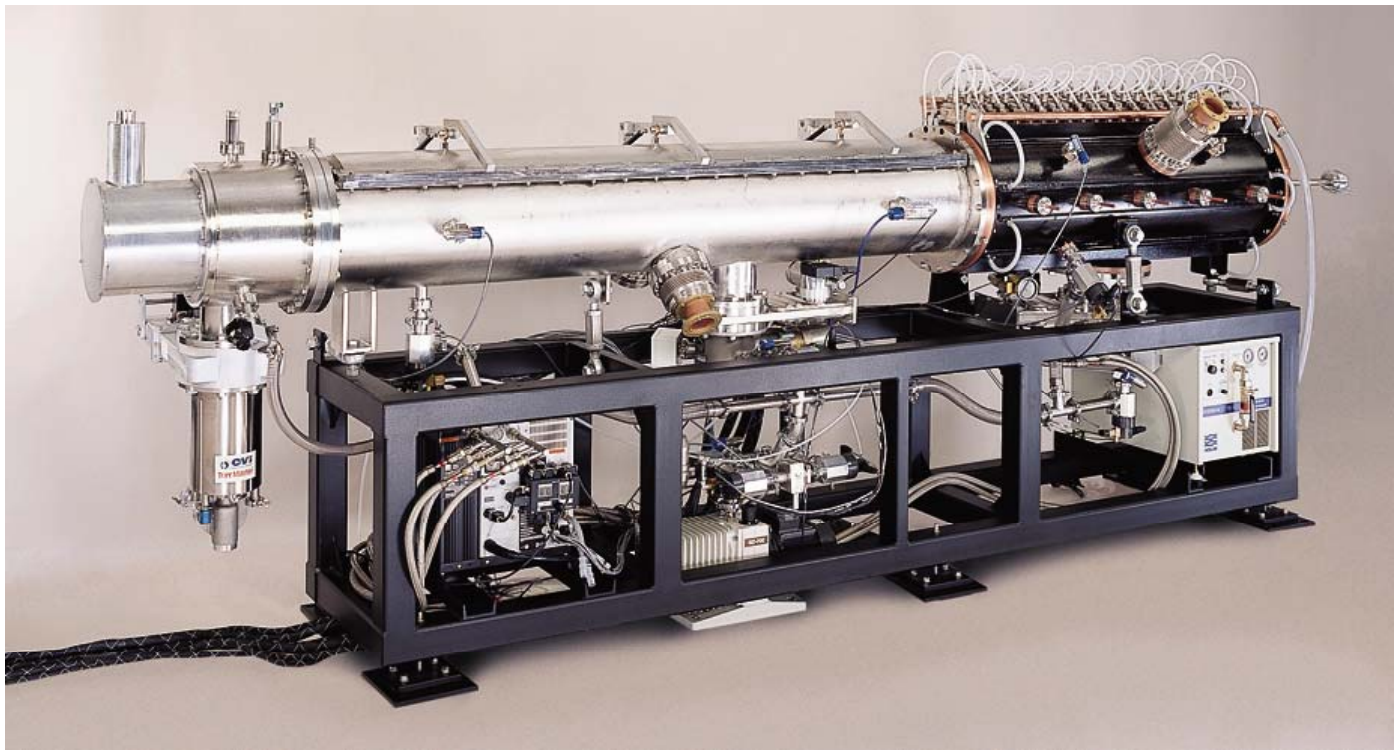
Remote handling of collimators

Neutrons and Protons

Patient Immobilization

Upright Imaging

INSTITUTE FOR HADRON THERAPY



7 MeV Injector from AccSys Technology/Hitachi

Isotopes Produced by 70 MeV Protons

Mausner et al - Brookhaven

Nuclide	Half-life	**Nuclide**	Half-life	**Nuclide**	Half-life
7Be	53.3 d	**77Br**	2.37 d	**122Xe**	20.1 h
22Na	2.6 y	**81Kr-m**	13.1 s	**127Xe**	36.4 d
28Mg	21 h	**82Sr**	25.4 d	**128Ba**	2.43 d
48V	16 d	**88Y**	106.6 d	**139Ce**	137.6 d
52Fe	8.3 h	**89Zr**	3.27 d	**179Ta**	1.8 y
55Fe	2.73 y	**95Tc-m**	61 d	**178W**	21.6 d
55Co	17.5 h	**96Tc**	3.4 d	**195Pt-m**	4.02 d
57Co	271 d	**97Ru**	2.89 d	**195Hg-m**	1.67 d
61Cu	3.35 h	**103Pd**	17.0 d	**203Pb**	2.2 d
64Cu	12.7 h	**109Cd**	462 d	**205Bi**	15.3 d
67Cu	2.58 d	**111In**	2.8 d	**206Bi**	6.2 d
68Ge	272 d	**117Sn-m**	14.0 d	**211At**	7.2 h
73As	80.3 d	**123I**	13.3 h	**237Pu**	
74As	17.8 d	**124I**	4.2 d		

Short-lived Isotopes with Medical Applications

Isotope	*Application*
52Fe(8.2hr)	Bone Marrow Scanning
62Zn(9.1hr)	Heart/brain Imaging
67Ga(78hr)	Tumor Localization
111In(67.2hr)	Label Leucocytes
123I(13.3hr)	Thyroid Scan
201Tl(74hr) Elute from 201Pb	Heart Imaging
11C(20.5min)	Metabolic Tracer

Long-lived Isotopes with Medical Applications

Isotope	*Application*
68Ge(280d)➲ 68Ga(68min)	Calibrate PET imagers
82Sr(25d) ➲ 82Rb(1.5min)	Heart Imaging
103Pd(17d)	Prostate Seed Implants
127Xe(36.4d)	Lung Ventilation

Institute for Hadron Therapy

References

Streaming video:
vmsstreamer1.fnal.gov/VMS_Site_02/Lectures/Colloquium/Lennox/index.htm

Proceedings of Third International Topical Meeting on Nuclear Applications of Accelerator Technology: Long Beach California, American Nuclear Society, Nov 1999.

Lennox and Hamm, "A Compact Proton Linac for Fast Neutron Cancer Therapy", pp 33 - 35.

Coutrakon, "Proton Synchrotrons for Cancer Therapy," pp 36 - 42.

Mausner and Srivistava, "Current Status and Future Directions of Production of Radioisotopes with High Energy Accelerators," pp13-19.

Future Talk: Hadron Therapy for Cancer Treatment, Fermilab Lecture Series, Friday, Nov 21, 2003.