Heated X-ray Examination Table

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Overview

- Background Information
- Problem Statement
- Design Specifications
- X-ray attenuation
- Component Alternatives
  - Padding
  - Tubing
  - Heating
- Proposed Design
- Future Work

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Background Information

- Diagnostic use of X-ray
  - Density of body structures
  - Skeletal pathologies, some soft tissue applications
  - Anatomy vs physiology
- Duration of procedure
- Current exam table
  - Hard laminate surface
  - Dimensions 87” X 31-3/4”

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Problem Statement

- Current X-ray examination tables are uncomfortable
  - Hard
  - Cold
- Discomfort may cause patient movement
- Long examination duration
- Not available commercially

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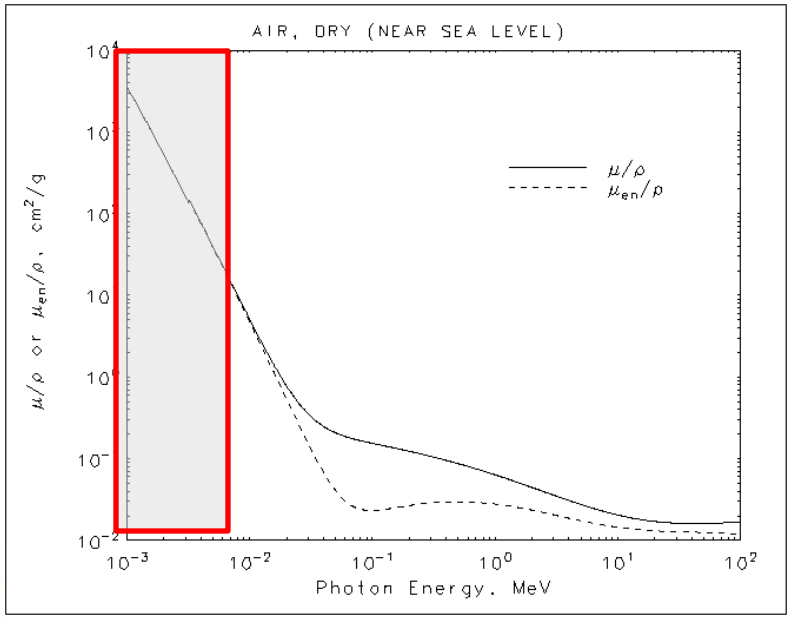
Design Specifications

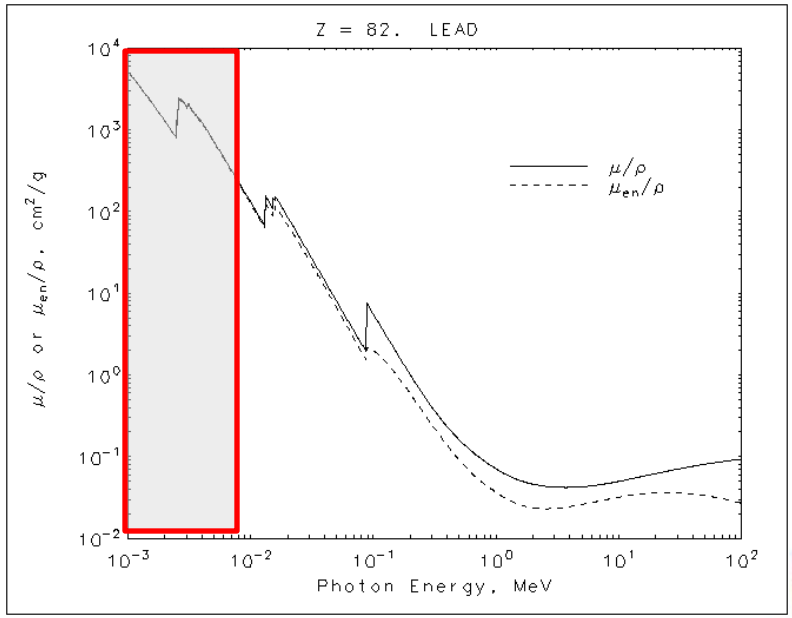
- Materials/design must be radiolucent
- No anatomical distortion
- Must incorporate patient control
- Must not obstruct the technician's workspace
- Patient safety
- Budget ~ $200

Radiolucency of Materials

- Mass Attenuation Coefficient (μ/ρ)
- Dependent on Photon Energy (12.4-124 keV for Diagnostic X-rays)
- K/Absorption edge - Photoelectric absorption of photons

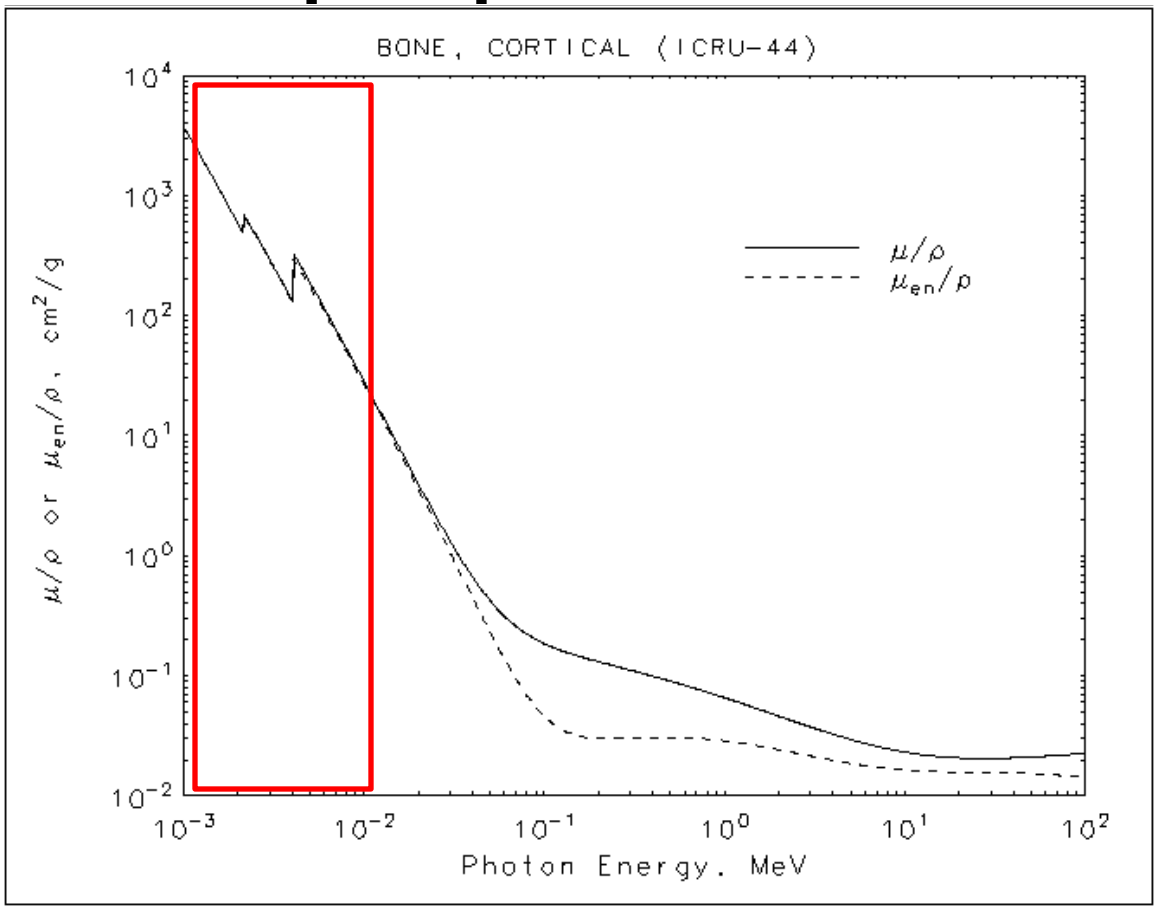


Air



Lead

Radiopaque Materials



Cortical Bone

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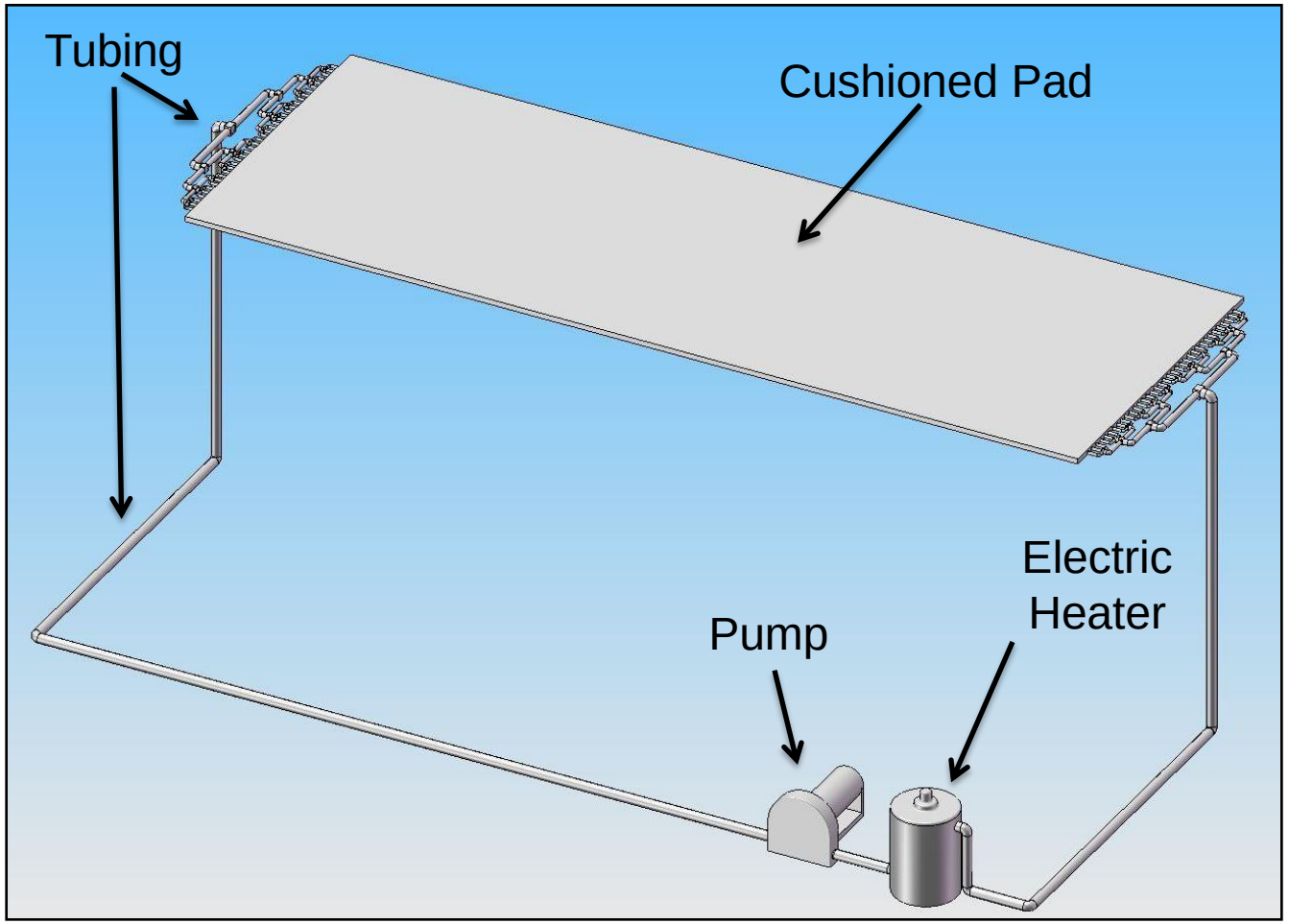
Proposed Design



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Padding

Category	Weight	PETa	PETb	PVR
Radiolucency	50	47	40	34
Cost	20	10	14	10
Firmness	20	14	16	10
Sterilization	10	9	4	7
Total	100	80	74	61

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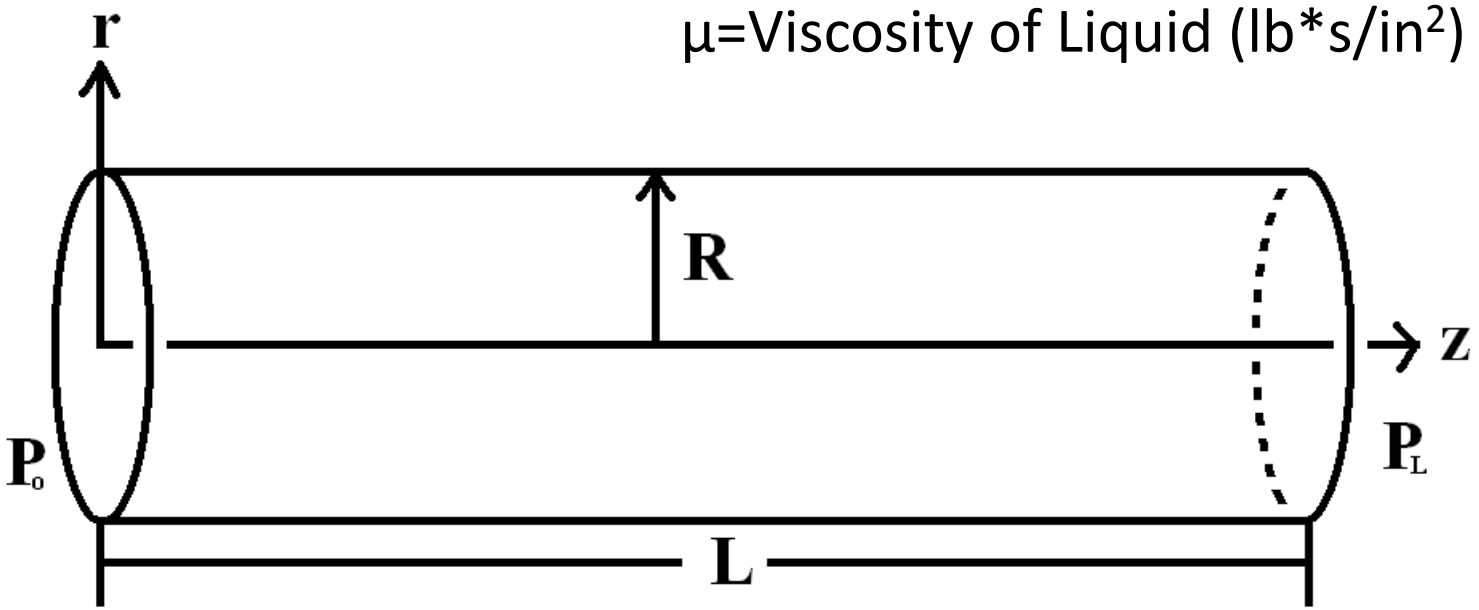
Tubing

$$Q = \frac{\Pi(P_o - P_L)R^4}{8\mu L}$$

Q=Volumetric Flow Rate (gal/min)
P_o=Initial Pressure (PSI)
P_L=Final Pressure (PSI)
R=Inside Diameter (in)
L=Length of Tube (in)
μ=Viscosity of Liquid ($lb*s/in^2$)



Tubing

Category	Weight	PET	Vinyl	Nylon	PVC
Radiolucency	50	Test	Test	Test	Test
Thermal Conductivity	30	24	12	12	9
Cost	10	9	9	9	9
Strength	10	10	10	10	10
Total	100	43+?	31+?	31+?	28+?

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Heating

- Materials thermal conductivity
- Determine Q_{tube} through testing
- Calculate temperature drop across tube wall
- Methods for heating fluid
  - Water heater element in tank
  - Heated wire in tubing
  - Commercial water heater

$$\frac{Q_{tube}}{A_{tube}} = \frac{k_{tube} \cdot \triangle \cdot T}{2 \cdot R_{tube}}$$

Q = Heat rate across tube

T = Temperature (kelvin)

A = Cross-sectional area of tube

k = Thermal conductivity of tube

R = Radius of tube

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Heating

Category	Weight	Coiled wire	Heater element	Commercial heater
Cost	70	56	56	14
Control	30	18	12	30
TOTAL	100	74	68	44

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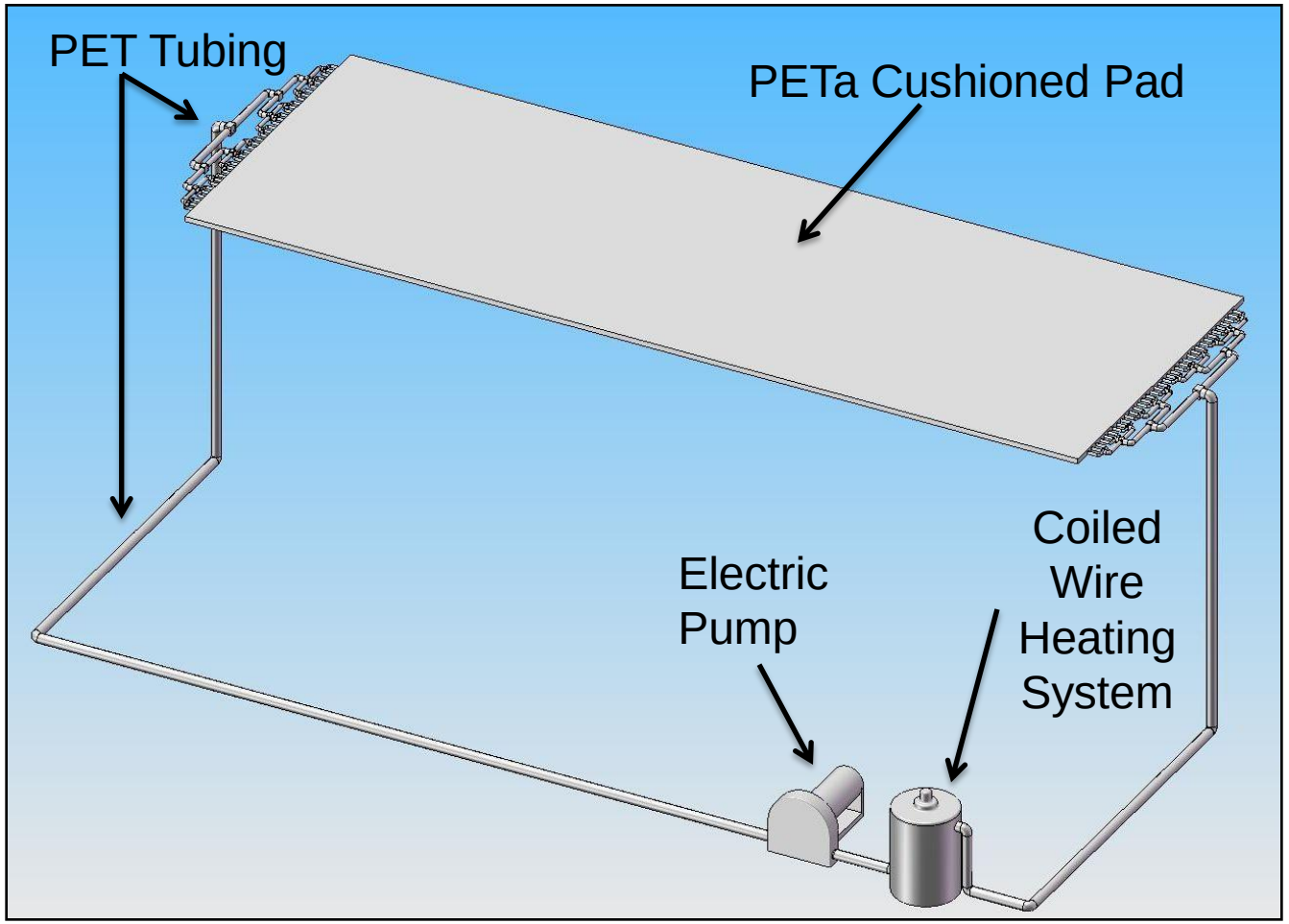
Proposed Design



Future Work

- Further testing of tube materials
- Purchase all necessary materials
- Fabrication of inlaid tubing system
- Fabrication of heating conduit

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References

Bird, B., Lightfoot, E., Stewart, W., *Transport Phenomena*. New York: Wiley and Sons. 2007.

Links, J. M., Links, J., Prince, J., *Medical Imaging Signals and Systems.* Prentice Hall, 2005.

http://www.advanceimaging.net/

http://www.mcmaster.com/

http://physics.nist.gov/

Personal Interview with Dr. John Vetter

Personal Interview with Prof. John Yin

Testing with Lanee MacLean

Questions?


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