Heated X-ray Examination Table

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Problem Statement

- Current X-ray examination tables are uncomfortable
- Discomfort may cause patient movement
  - Poor image quality
  - Increased possibility of misdiagnosis
- No solutions available commercially

Motivation

- Minimum number of X-ray tables required per registered hospital = 1 (American Hospital Association, 2009)
- Number of registered hospitals (not including clinics) in the U.S. = 5,815 (American Hospital Association, 2009)
- Number of X-ray procedures performed in the U.S. in 2001 = 90.6 million (Census, 2001 and Bhargavan, 2005)

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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”

http://www.advanceimaging.net/

Design Specifications

- Materials/design must be radiolucent
- No anatomical distortion
- Must incorporate patient control
- Must not obstruct tech's workspace
- Patient safety
- Low-cost

Testing


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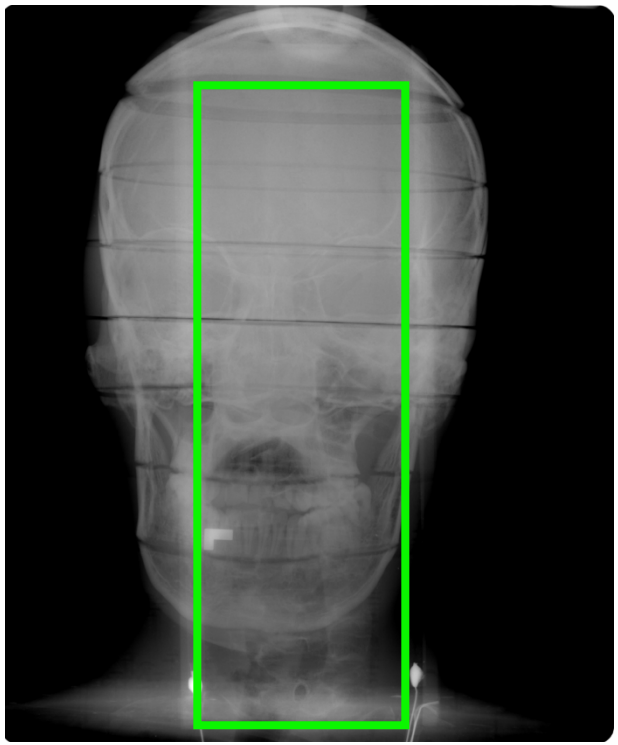
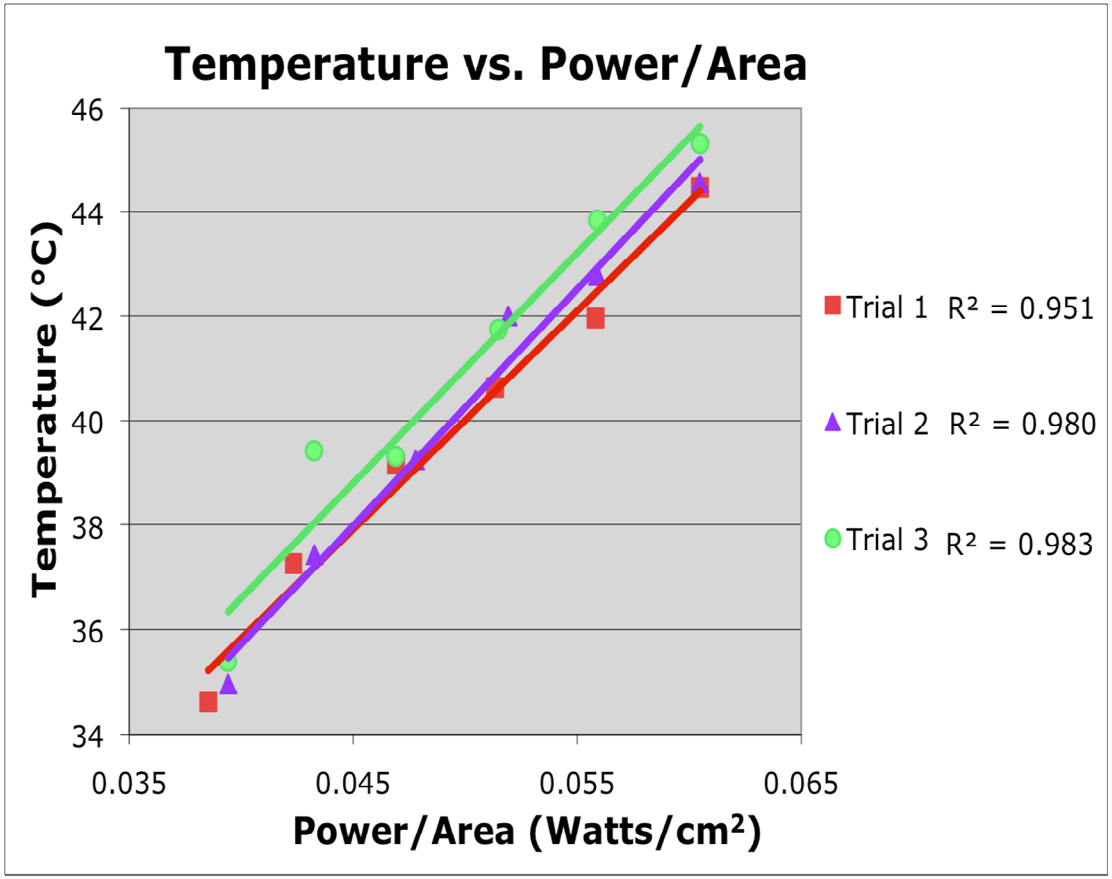
Radiolucency



• Image with head phantom overlaying.

• Image with no phantom. Image analysis software calculated less than 3.9% attenuation. (Peppler, 2009)

Power Demand



Results

- Target temperature = 35° C
- Full scale power demand ≈ 660 Watts (I ≈ 5.5 amps, V ≈ 120 volts)
- Temperature allowed to equilibrate for 1 min. after voltage increase
- 1 data point is the average of 3 temp. measurements

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Design


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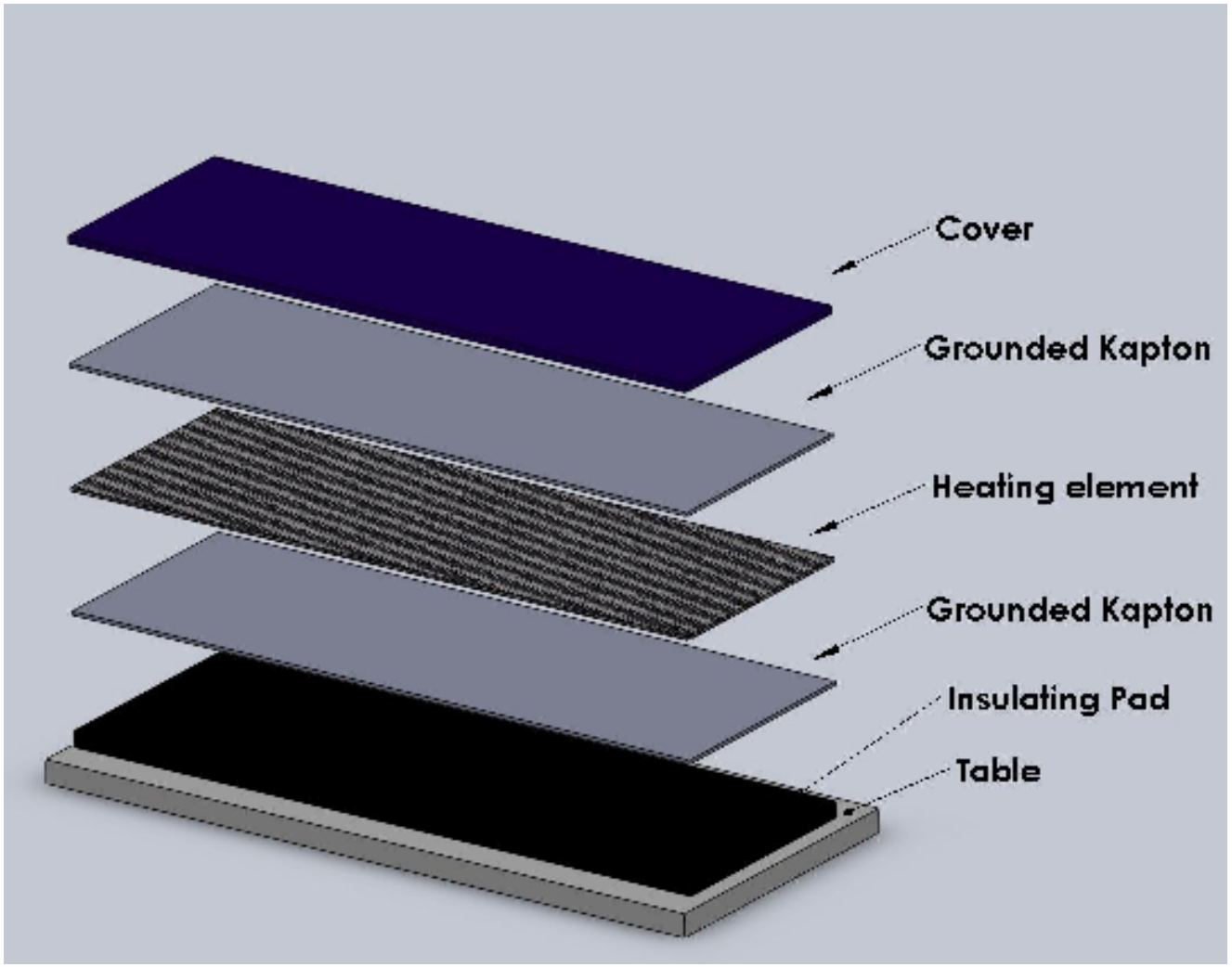
Heating Unit Design



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Cover Material Design Matrix

	Weight	High Density Polyethylene	Naugahyde (“Pleather”)
Impermeable	50	50	10
Sterilizable	30	30	25
Comfortable	15	7	14
Ease of manufacture	5	4	3
TOTAL	100	91	52

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Heating Element Materials

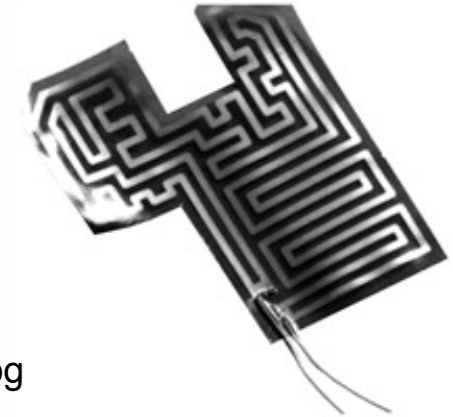
Indium Tin Oxide (ITO)

- Sputtered ITO layer
  - Poly(ethylene terephthalate) substrate
  - Ω=62.5/sq.
- Imperfections can cause hot spots

http://image.ecplaza.com/offer/k/kintechk/4397300_s.jpg

Kapton 200RS100

- Two-layer film
  - Dielectric layer up to 50 kV
  - Conductive layer Ω=100/sq.
- Homogeneous throughout



http://www.instrumart.com/Product.aspx?ProductID=22023

Heating Element Design Matrix

	Weight	Kapton	ITO Film
Uniformity	30	30	22
Heating	20	15	17
Radiolucency	15	15	15
Degradation	15	12	10
Flexibility	10	9	5
Cost	10	10	7
TOTAL	100	91	79

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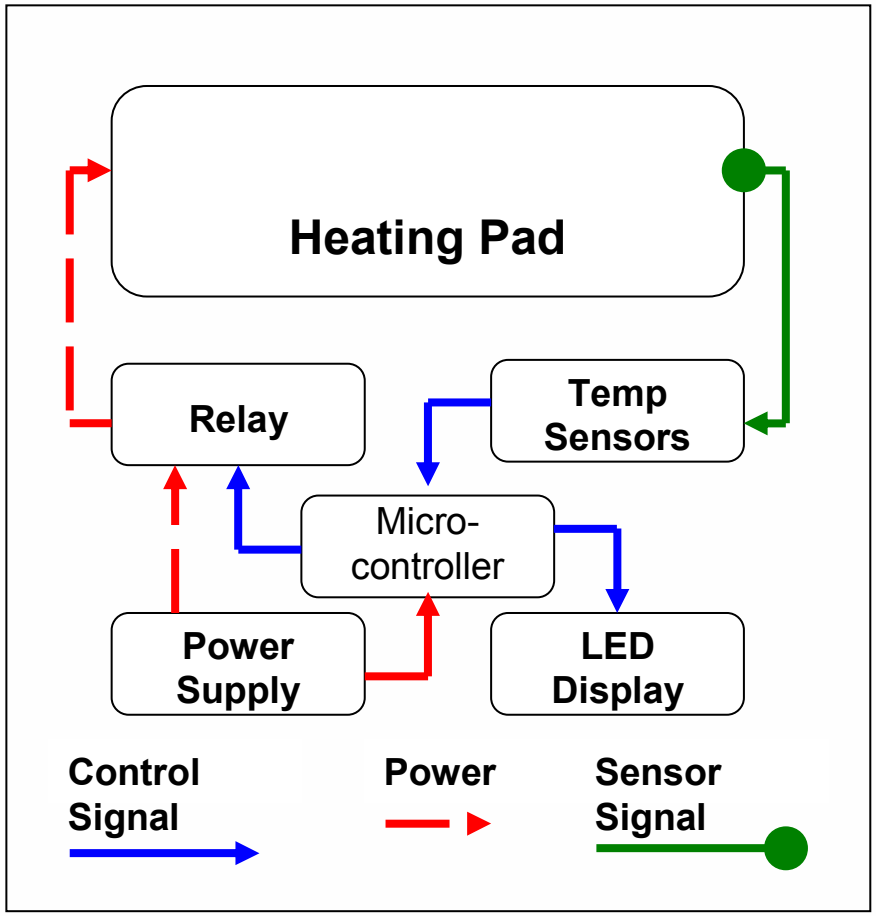
Control Circuit



- Temp monitoring
  - Three temp sensors
- Control
  - Microcontroller
  - Relays
- User Feedback
  - 4 digit LED display
  - Push switches

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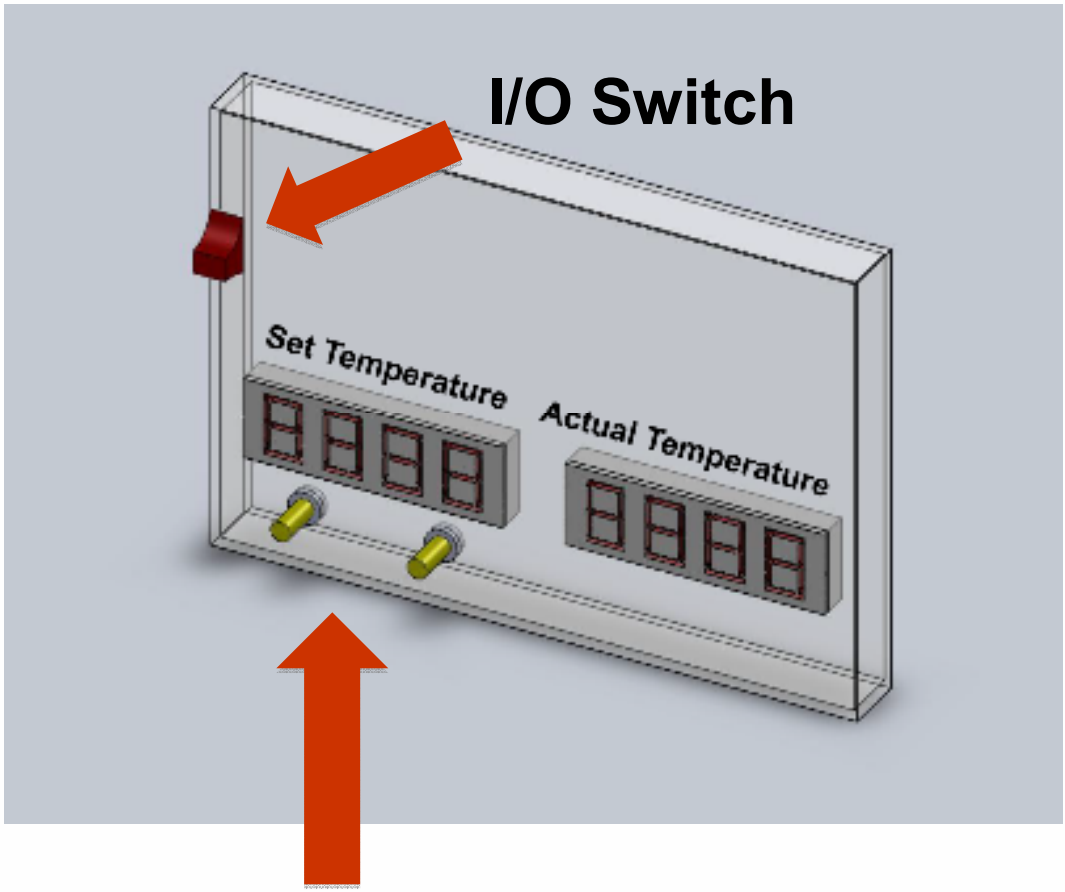
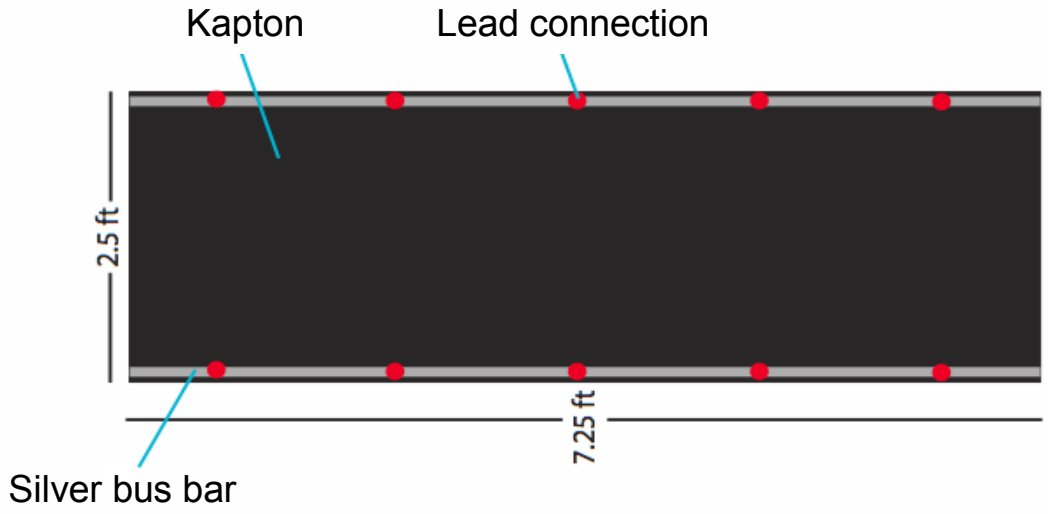
Control Interface



Connection Design Matrix

	Weight	Epoxy	Solder	Clamp
Contact	30	24	28	19
Security	25	20	23	16
Resistivity	25	15	22	25
Temperatur	20	20	6	20
TOTAL	100	79	79	80



Safety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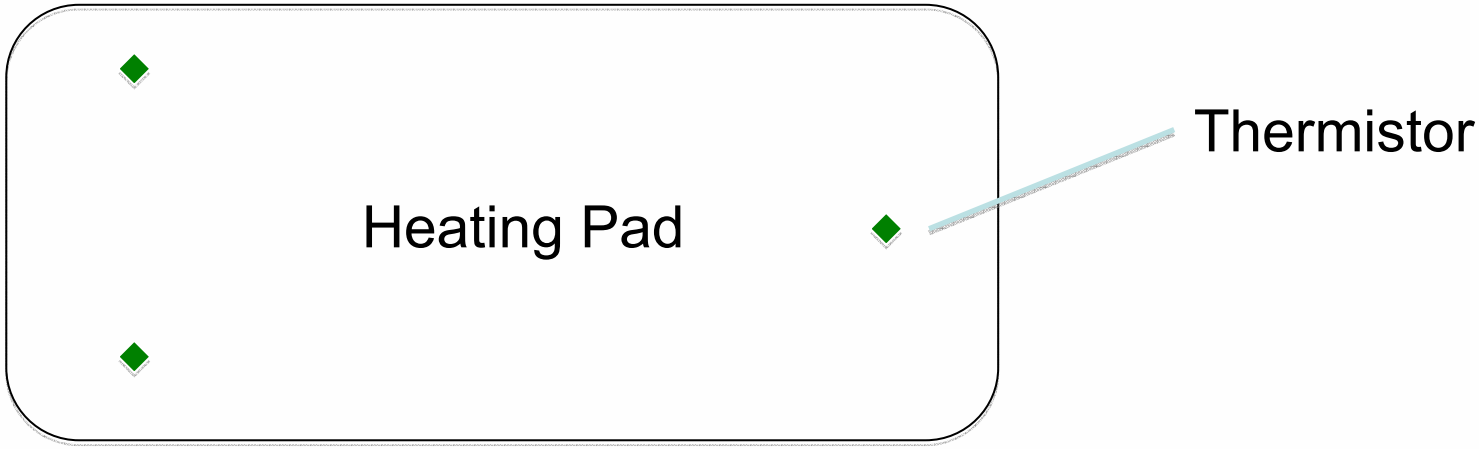
Preventing Burns

- 3 thermistor system
  - Any one can trigger shut-off
- Necrosis begins at 44 °C (Exponent, Inc., 2010)



Preventing Electrocution

- Cover Isolation
- Kapton dielectric layer
- Kapton conductive layer
- GFI

Future Work

- Finalize bus bar specs
- Prototype fabrication
- Heating testing
- Safety validation

References

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Questions?


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