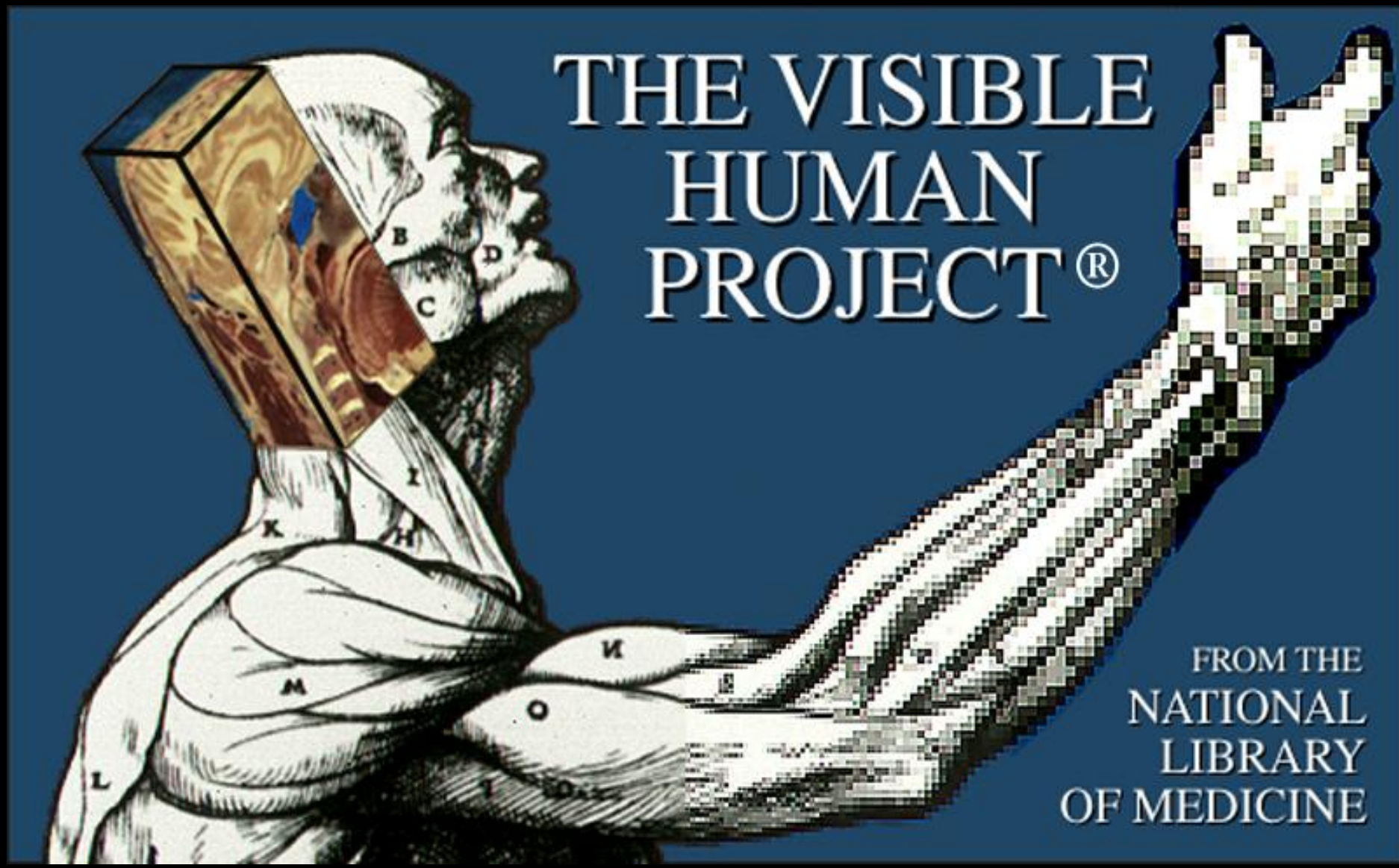


Lessons in Sharing

The NLM Board of Regents Recommended That the NLM Should:

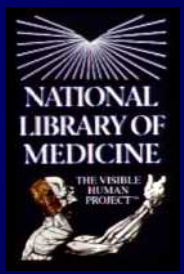
" . . . thoroughly and systematically investigate the technical requirements for and feasibility of instituting a biomedical images library."

1986 Long Range Plan

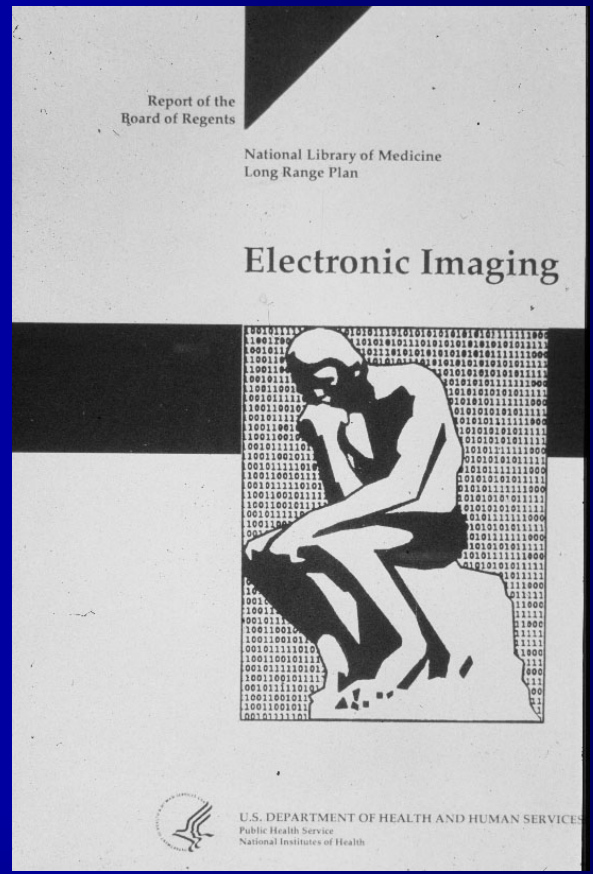
NATIONAL LIBRARY OF MEDICINE
THE VISIBLE HUMAN PROJECT

Background

- Knowledge in pictures
- New Technologies
  - Computers
  - Video displays
  - Storage media
  - Networks
- NLM as Picture Archive



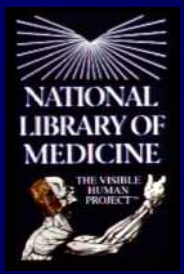
"The NLM should undertake a first project, building a digital image library of volumetric data representing a complete normal adult human male and female. This Visible Human Project would include digitized photographic images from cryosectioning, digital images derived from computerized tomography, and digital magnetic resonance images of cadavers."



1989 Board of Regents Planning Panel on Electronic Imaging

Cadaver Specifications

- Size:
  - H < 72 in. W < 20 in. D < 14 in.
  - Weight appropriate for height
- Medical History:
  - No dangerous infections diseases, no major surgery, no metastatic cancer, no transplants, implants or major prosthesis
- Survey X-ray:
  - No evidence of major pathologies, deformities or implants

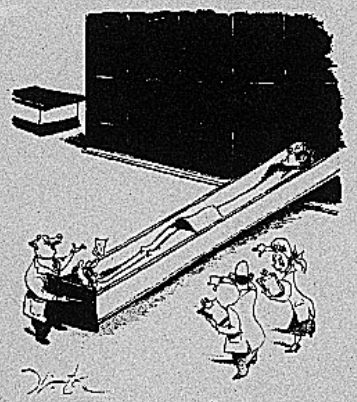


Rest in Pieces

BY JEFFREY KLUGER

THERE ARE A LOT OF REASONS I'M NOT A DOCTOR today. For one thing, I'm just the tiniest bit squeamish. The sight of anything even remotely illness-related—needles, bandages, rice pudding with raisins—makes me instantly weak-kneed. For another thing, some of the routine parts of a doctor's job have always struck me as rather unattractive. I'm pretty sure I could go through my entire life without ever speaking the words, "Turn your head and cough," or, "Now, let's have a look at that polyp, shall we?" • More important, however, the science of anatomy has always left me baffled. From grammar school on, I've had only the roughest idea of how the human body is put together, even when that body is my own. I'm pretty certain I've got the standard heart, lungs, and kidneys; pretty sure I don't have a crop, gizzard, or brood pouch; and as for my gallbladder, pineal gland, and jejunum, I'll take it as an article of faith that they're where they ought to be, but I couldn't find them with a copy of *Gray's Anatomy* and a sextant.

In fairness, my anatomical illiteracy is not entirely my fault. My first exposure to the mysteries of the human innards was an "educational toy" (translation: no batteries, decals, or suction-cup darts) I acquired in childhood, called The Visible Man. The Visible Man was a tiny model of a human being with snap-in and snap-out organs that was supposed to show you precisely how the average person is put together. By and large, the little model did a pretty good job—provided, of course, that the average person is 11 inches tall, completely transparent, and able to accept an organ donation from a Lego set. In my house, The Visible Man lasted only a week or so before becoming The Visible Man Minus Key Organs, and it was eventually taken away from my brothers and me altogether after tiny plastic glands started turning up in the Chex mix.



For even the most anatomically unschooled, however, all this confusion may soon come to an end. Recently the U.S. Department of Health and Human Services went The Visible Man of my childhood one better, announcing the creation of the intriguingly named—and now gender-neutral—Visible Human Project, a government program designed to simplify and standardize the study of human anatomy once and for all. The Visible Human Project is sort of the medical equivalent of the Miss America contest, in which one man and one woman will be selected from the general population to serve as science's archetypes of the human form. These two perfect specimens will be scanned, photographed, and data-based and then used as anatomy models in classrooms and laboratories across the country.

At the National Institutes of Health, organ donors meet organ grinders.

For anyone looking for a line of work that doesn't exactly require four years of graduate school, the two openings sound promising. But before typing up a résumé and submitting Polaroids of your pancreas, be aware of the fine print in the employment contract. The perfect pair chosen for the project will be X-rayed from head to toe, spend hours lying still in a magnetic resonance imaging machine for soft-tissue pictures, and later spend at least half a day submitting to a series of full-body CT scans. Finally (and here's the part that some fussier applicants might object to), both lucky winners will be steadily ground to dust by a planing machine and photographed as different parts of their bodies are exposed. Not

ILLUSTRATIONS BY MICHAEL WITTE

chemicals he and Whitlock use—sort of the mortician's equivalent of a delicate balsamic vinaigrette—are able to maintain the shape and appearance of flesh and organs while at the same time slowing their decomposition.

After being chemically treated, the body is taken for the battery of full-body X-rays, MRIs, and CT scans. The X-rays and MRIs can be conducted pretty quickly since the necessary machines are usually readily available in any good hospital or research facility. CT scans, however, can be a problem.

The hardest part, the researchers knew, would be finding just the right ex-people for the two job openings.

"CT scan machines are in enormous demand and are thus not always available when you need them," Spitzer says. "Sometimes it can take days before a machine is freed up, and you can't just leave a body lying around that long."

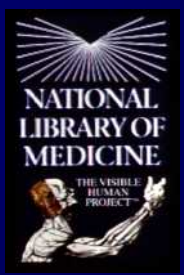
To preserve their perished perishables for extended periods, Spitzer and Whitlock must freeze them. The job of making a six-foot Ben & Jerry's out of an ordinary Ben or Jerri is relatively easy and involves little more than suspending the bodies vertically in a freezing chamber with cables supporting the head, chest, and hips ("No wire hangers, ever!"), packing the chamber with dry ice, and allowing the temperature of the tissue to drop to –70 degrees. When the CT machine becomes available, the bodies are simply rolled into place and scanned.

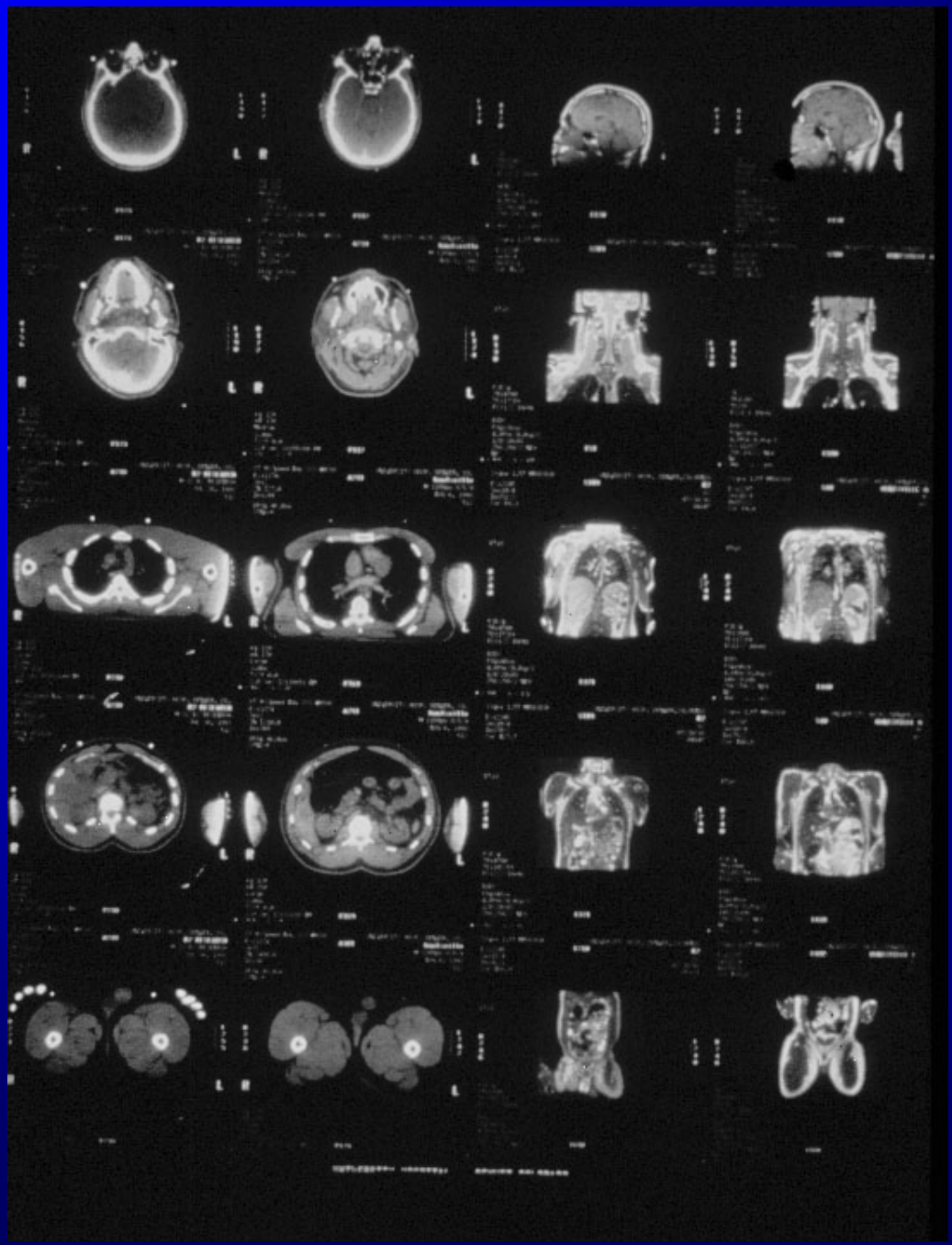
From this point on, though, things get a little messy. The most difficult part of the Visible Human work—the part that separates the men from the boys (not to mention the cadavers from their limbs)—involves the body grinding techniques. The first step in cutting the frozen remains down to size involves using a surgical saw to slice them horizontally into four sections, none taller than a foot and a half. These four sections are then immersed in separate blocks of gelatin, each measuring 14 inches by 18 inches by 18 inches. The gelatin itself is then frozen, helping to keep the tissue cold and stable throughout the upcoming slicing. (Evidently, in some cases there's not just always room *for* Jell-O, but always room *in* Jell-O.)

Once the quiescently frozen human cubes have solidified, they are inserted in a machine that uses a blade to shave a one-millimeter layer off the top of the block in much the way a carpenter planes wood. Spitzer and Whitlock then photograph and videotape that newly exposed surface. Next another millimeter is planed off, and the new surface duly photographed and videotaped; then another, and another. It takes up to 1,800 planings to complete a photo album of the frozen innards, and when the last layer of erstwhile person has been

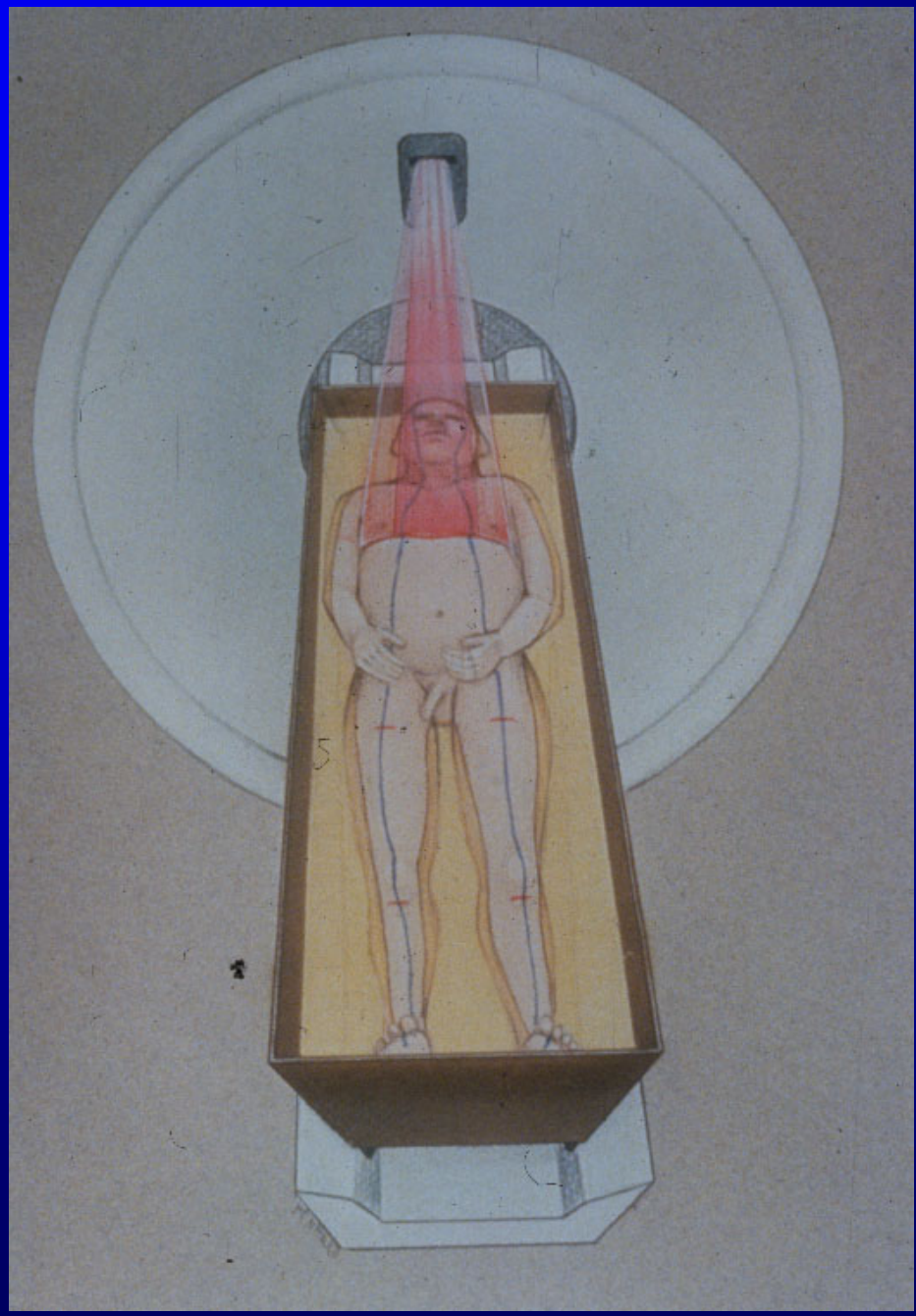
Discover Magazine

October 1993

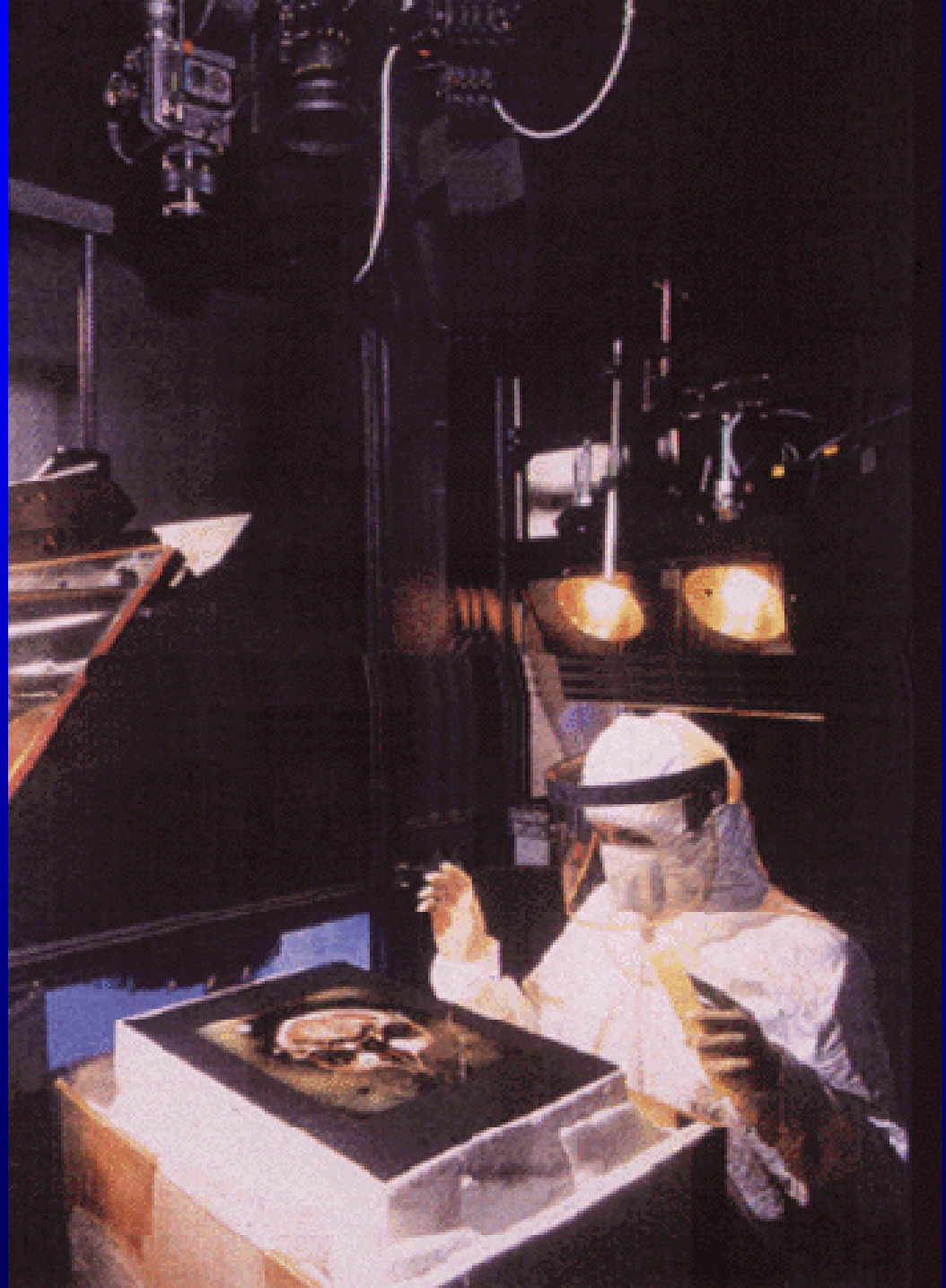




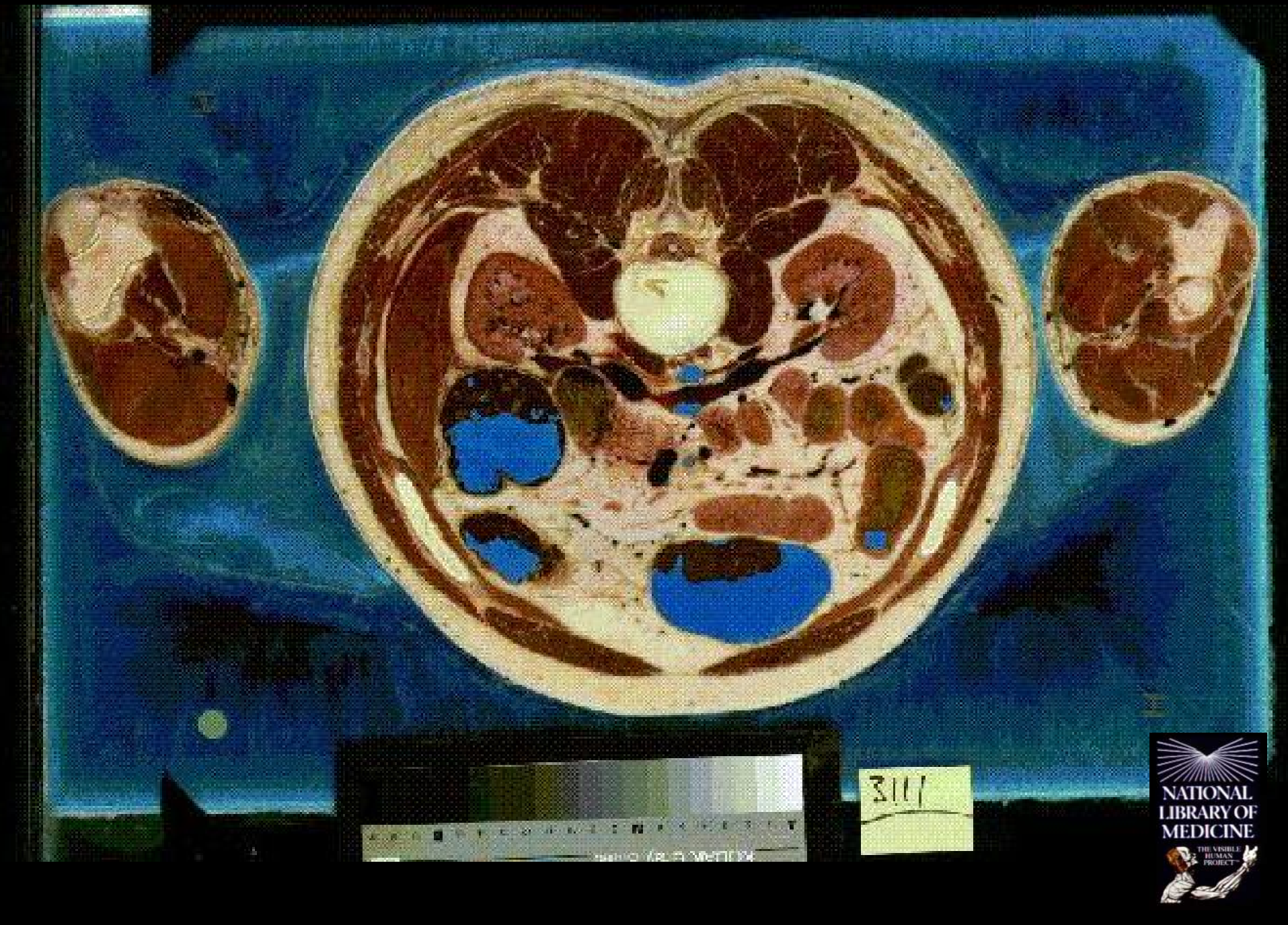
NATIONAL LIBRARY OF MEDICINE
THE VISIBLE HUMAN PROJECT

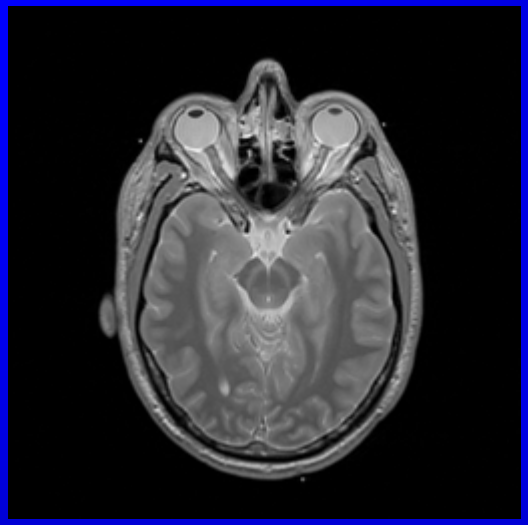


NATIONAL LIBRARY OF MEDICINE
THE VISIBLE HUMAN PROJECT

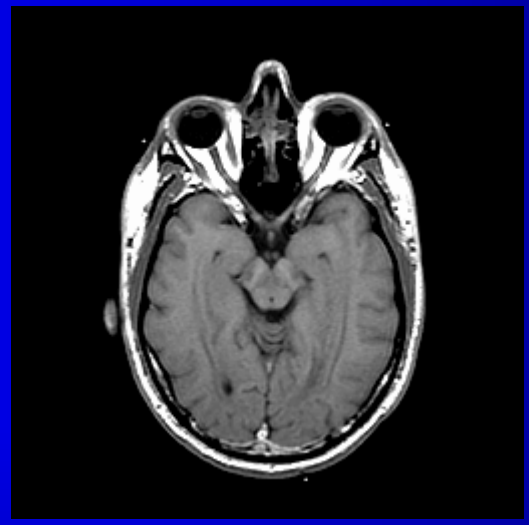


NATIONAL LIBRARY OF MEDICINE
THE VISIBLE HUMAN PROJECT

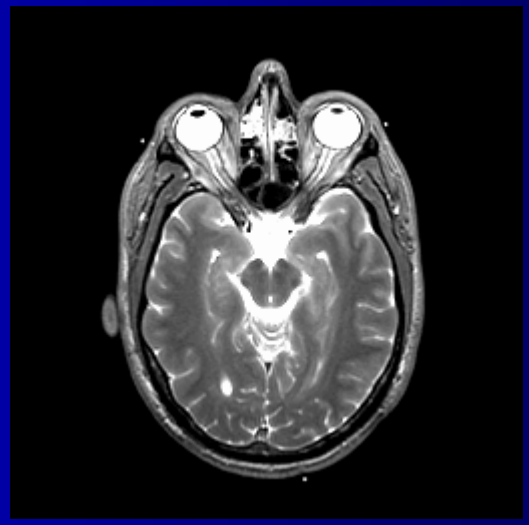

3117
NATIONAL
LIBRARY OF
MEDICINE
THE VISIBLE
HUMAN
PROJECT



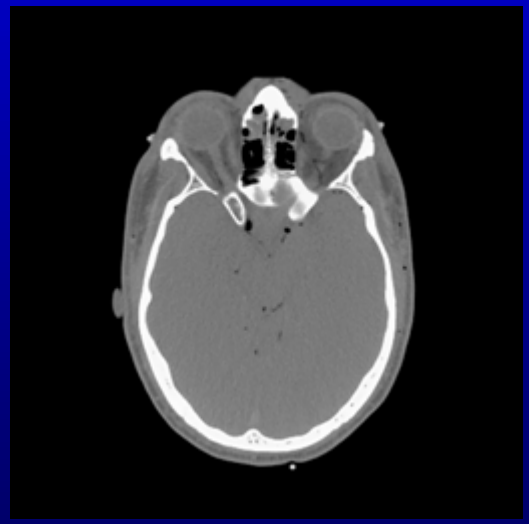
MRI - Proton Density



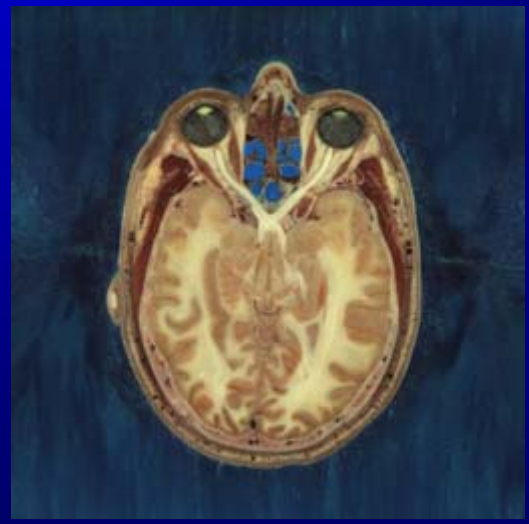
MRI - T1



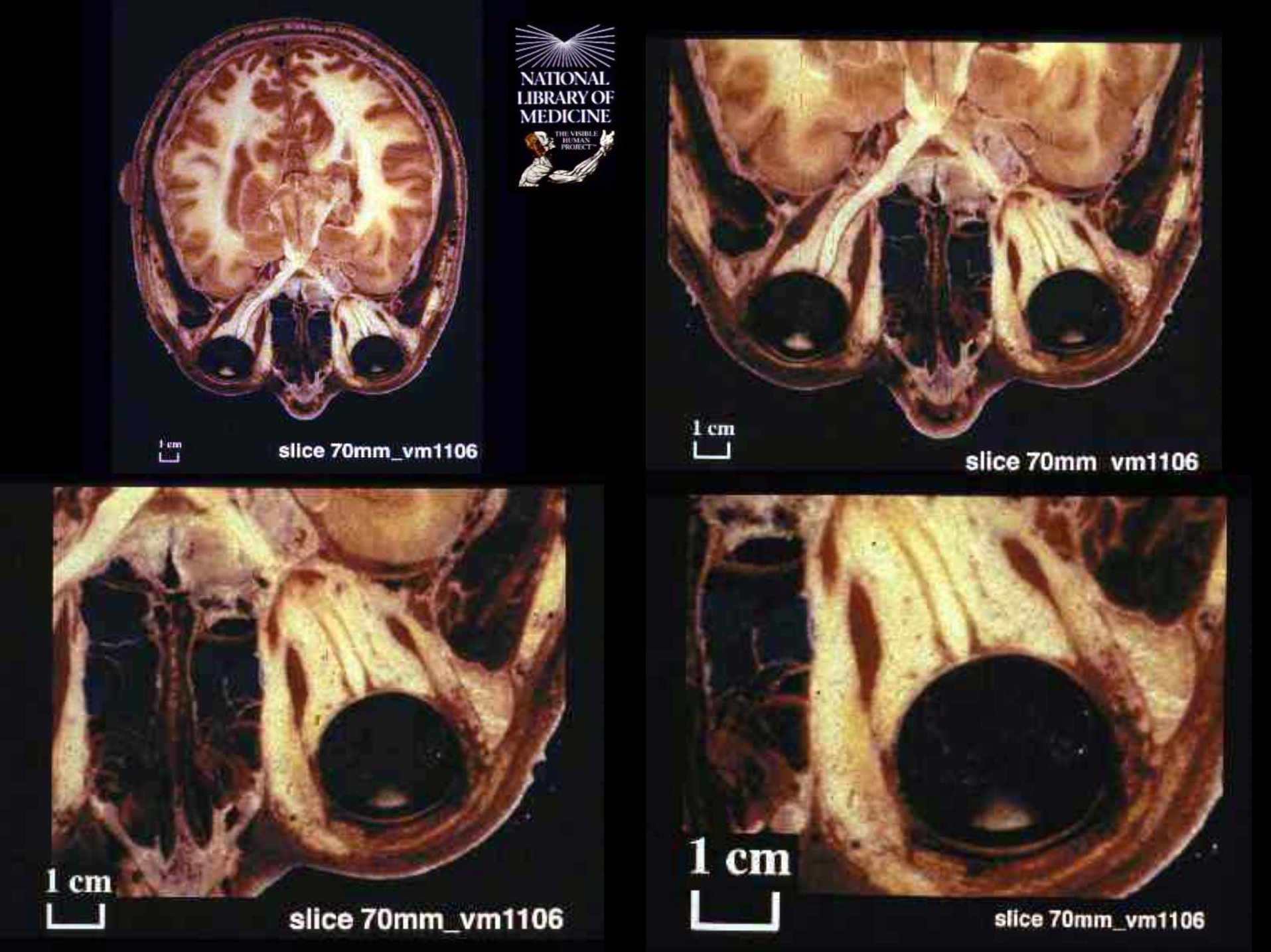
MRI - T2



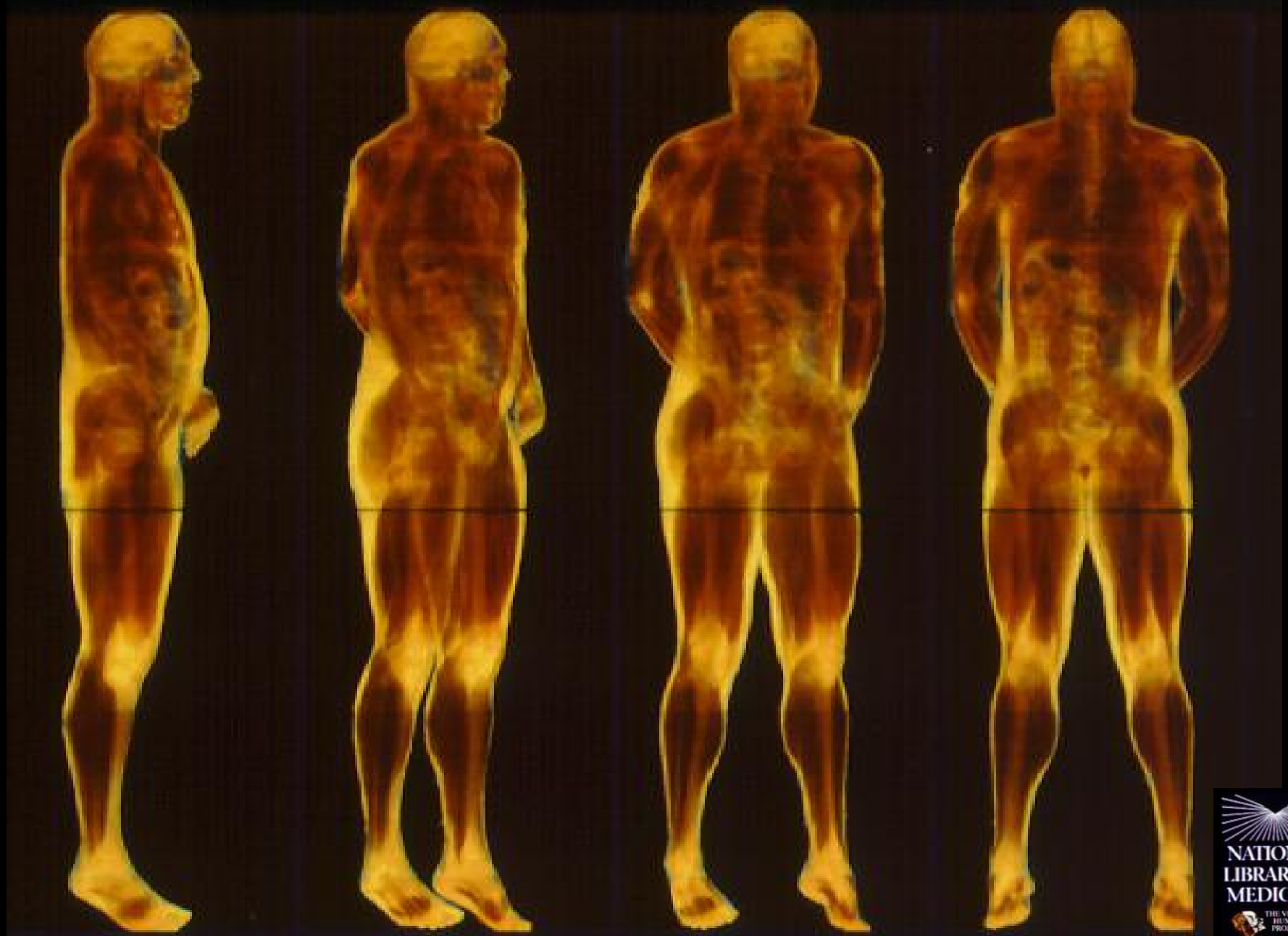
CT



Cryosection

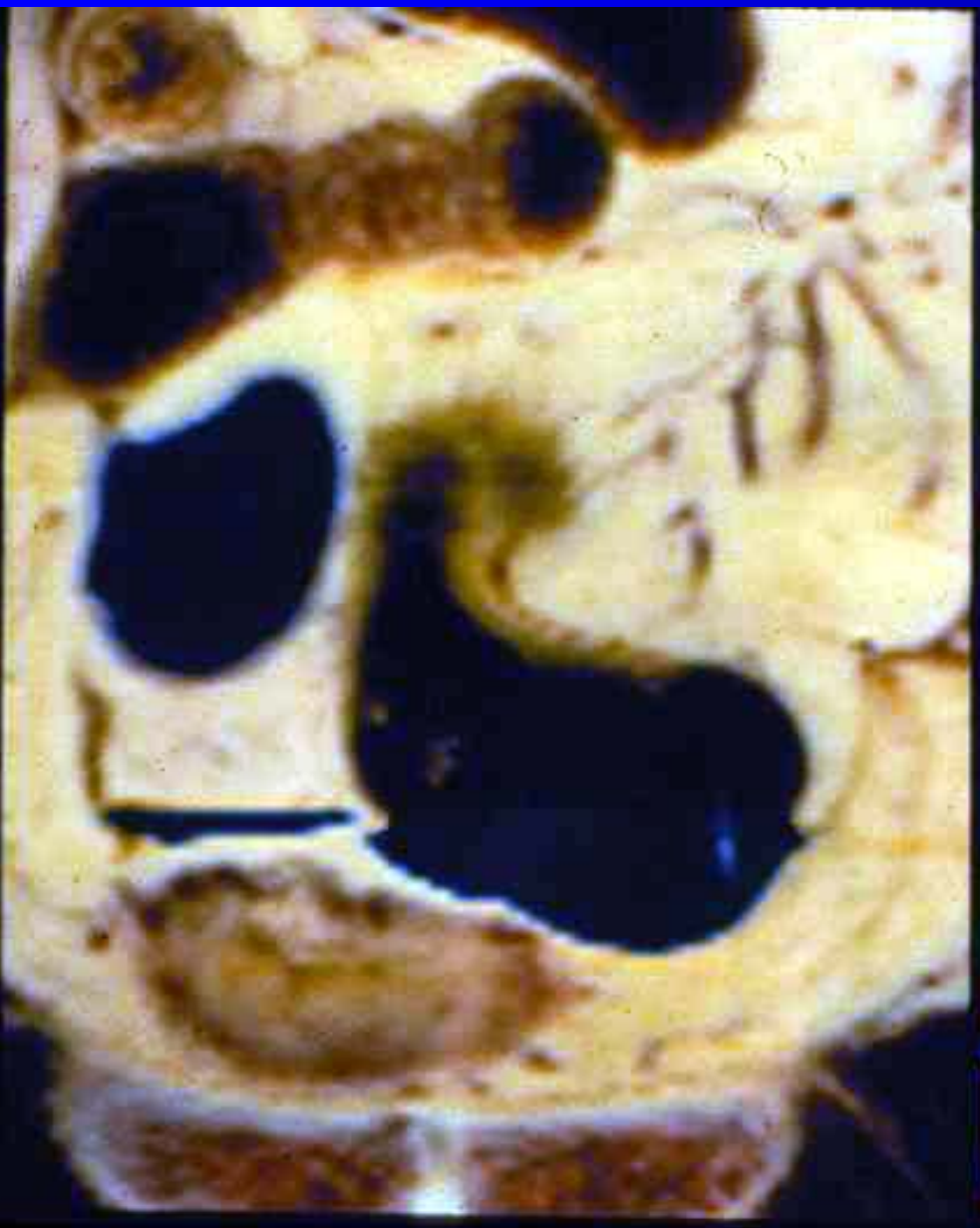

NATIONAL
LIBRARY OF
MEDICINE
THE VISIBLE
HUMAN
PROJECT
1 cm
slice 70mm_vm1106
1 cm
slice 70mm vm1106
1 cm
slice 70mm_vm1106
1 cm
slice 70mm_vm1106


NATIONAL
LIBRARY OF
MEDICINE
THE VISIBLE
HUMAN
PROJECT


NATIONAL
LIBRARY OF
MEDICINE
THE VISIBLE
HUMAN
PROJECT

NATIONAL LIBRARY OF MEDICINE

THE VISIBLE HUMAN PROJECT



Male 1.00mm data

Female 0.33mm data

NATIONAL LIBRARY OF MEDICINE

THE VISIBLE HUMAN PROJECT™

Projects Based on the Visible Human Data Set

Products

- Beyond Vesalius: download free software or purchase it on CD-ROM, from Wright State University.
- The Visible Human Male CD-ROM, videodisc, poster, and library of 3D models from Visible Productions.
- Visual Human product offerings distributed by Expomed:
    1. Visual Man and Visual Man Lite CD-ROMs from Data Express.
    2. Visible Human Male CD-ROM from Research Systems, Inc.
    3. Visible Human Female CD-ROM from Research Systems, Inc.
- The Dissectable Human CD-ROM from Engineering Animation, Inc. and MediaTech USA.
- Visible Human Product offerings from Springer Verlag, Electronic Media:
    1. VOXEL-MAN interactive 3D atlas on CD-ROM for Unix workstations (Institute of Mathematics and Computer Science in Medicine, University of Hamburg),

Marching Through the Visible Man

The National Library of Medicine is creating a digital atlas of the human body. This project, called the Visible Human, has already produced computed tomography, magnetic resonance imaging and physical cross-sections of a human male cadaver. This paper describes a methodology and results for extracting surfaces from the Visible Male's CT data. We use surface connectivity and isosurface extraction techniques to create polygonal models of the skin, bone, muscle and bowels. Early experiments with the physical cross-sections are also reported. There is a companion paper on the Visible Woman.

Make Your Own Visible Woman shows how to use the Visualization Toolkit to make and render surface models of the Visible Woman.

Welcome to NCAR

The National Center for Atmospheric Research, NCAR, was established in 1960 to serve as a focus for research on atmospheric and related science problems.

More About NCAR

What's New at NCAR

FY 2000 Annual Scientific Report now available

more news

ACD
atmospheric chemical, geochemical, and biogeochemical cycles

ASP
postdoctoral appointments, summer colloquia, NCAR's geophysical turbulence program

ATD
observing systems and platforms, field program support, instrument development, data management

CGD
models of climate system components; atmosphere, oceans, land, and ice; global dynamics

ESIG
societal impacts and policy issues related to climate and weather

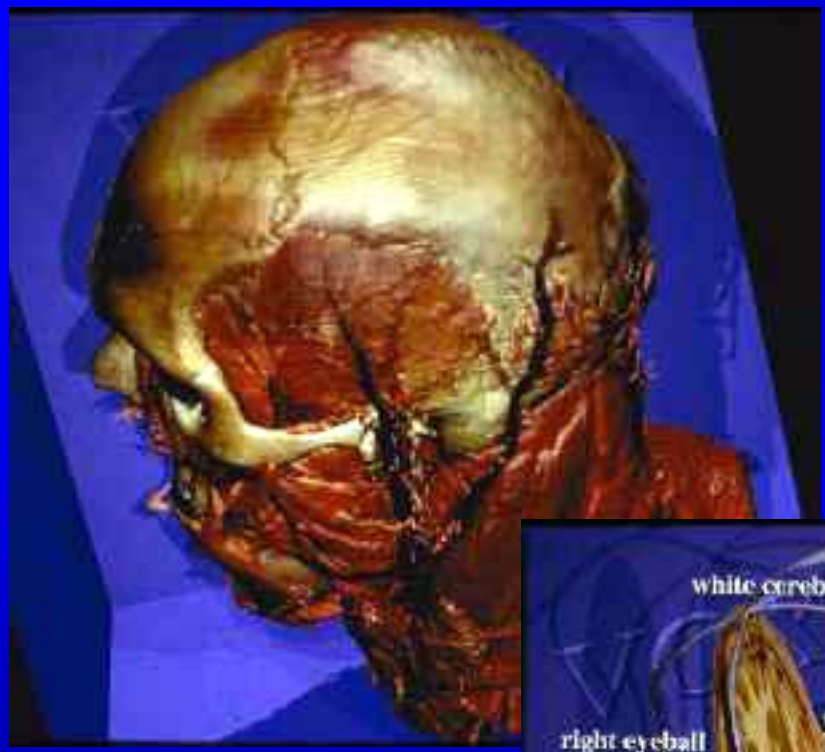
HAO
solar variability, solar magnetism, solar-earth interactions

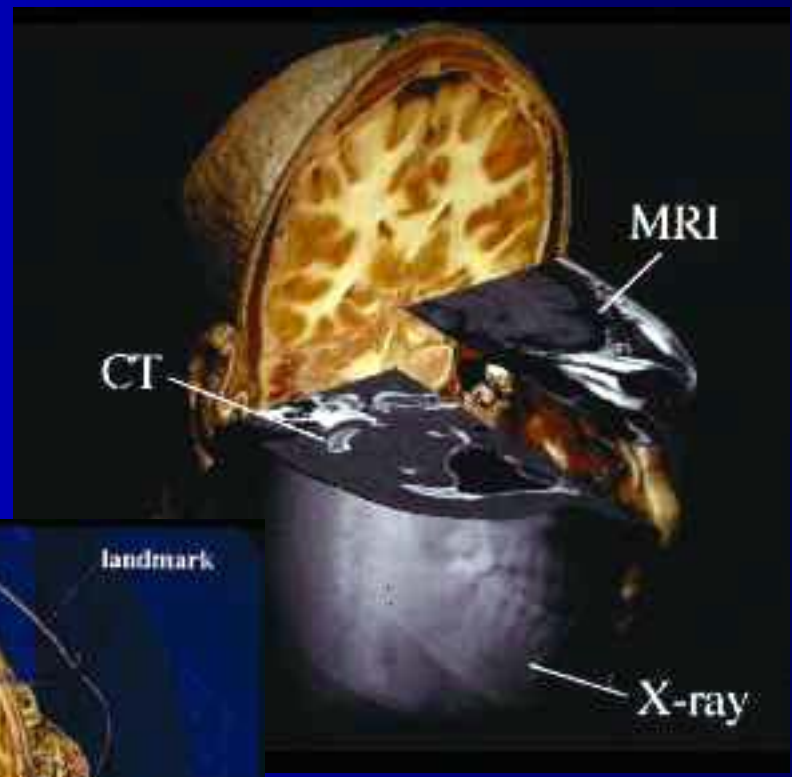
MMM
numerical weather prediction and simulation, cloud/climate interactions, weather processes

RAP
aviation weather detection and forecasting systems, technology transfer to public and private sectors

SCD
supercomputing, high-speed networks, visualization, data analysis and archiving, user support

QUICK LINKS





Voxelman - University of Hamburg

NATIONAL LIBRARY OF MEDICINE
THE VISIBLE HUMAN PROJECT

Visible Human Animations

We present here animations created at Vizlab with the Visible Human dataset and motion capture data.

Please follow a link from the table of contents to the left.

Contact Information

Web / E-mail address

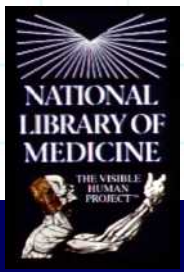
Dr Deborah Silver: silver@caip.rutegrs.edu

Nikhil Gagvani: Gagvani@caip.rutgers.edu

Kundan Sen: ksen@caip.rutgers.edu

Arindam Bhattacharya : arindamb@caip.rutgers.edu

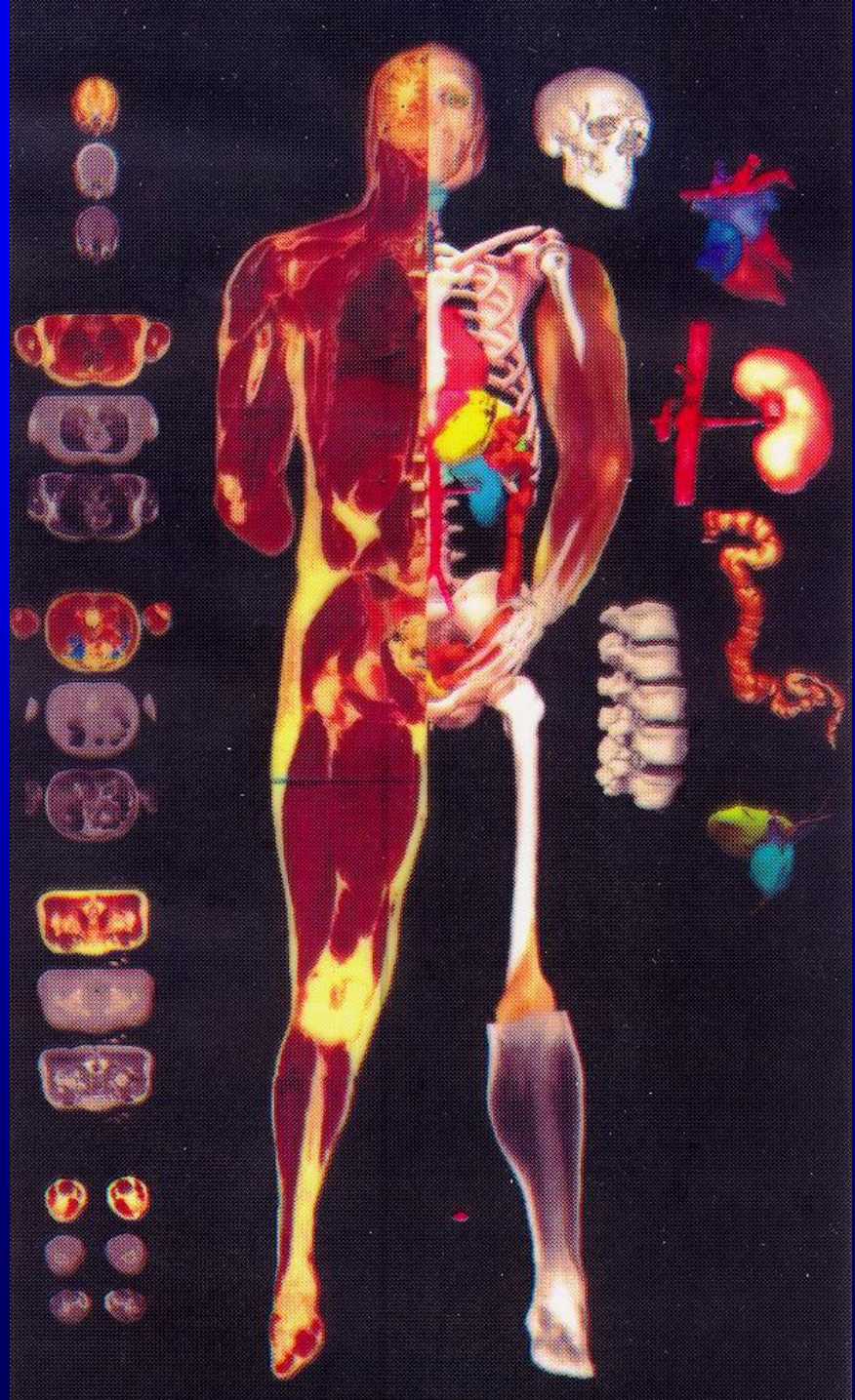
Andrez Martinez : amart@caip.rutgers.edu



Virtual Reality - Haptics

NATIONAL LIBRARY OF MEDICINE
THE VISIBLE HUMAN PROJECT

Cross Sectional Bit Maps



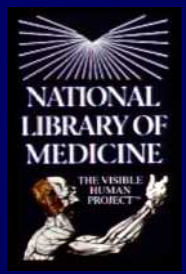
3 Dimensional Objects

NATIONAL LIBRARY OF MEDICINE
THE VISIBLE HUMAN PROJECT™

Insight Tool Kit - ITK

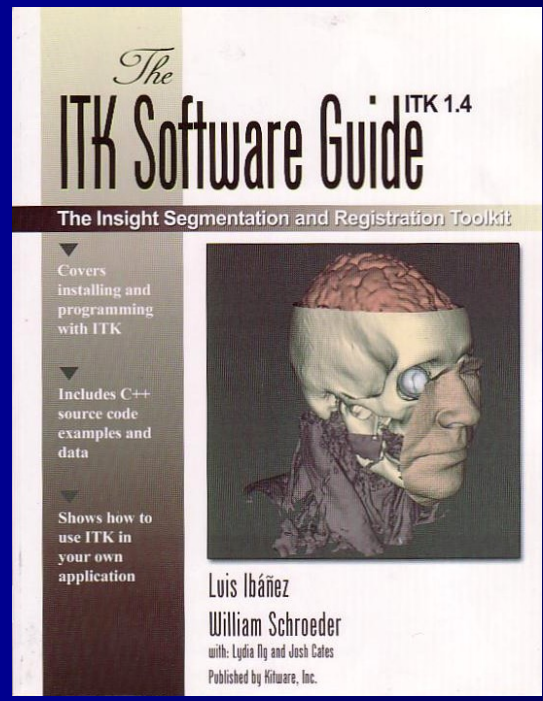
Segmentation & Registration

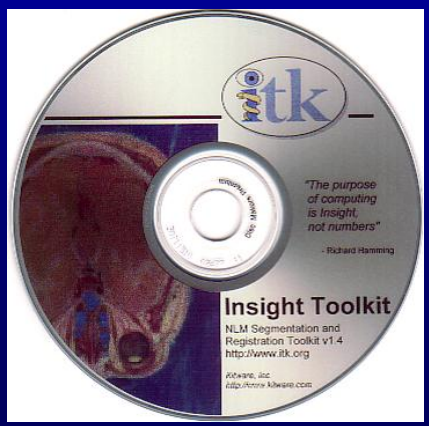
- Open Source
- Image Segmentation
  - Multi-valued (multimodal) data
- Image Registration
  - Rigid and deformable registration



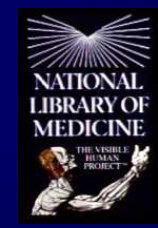
Insight Toolkit – ITK Release 2.4

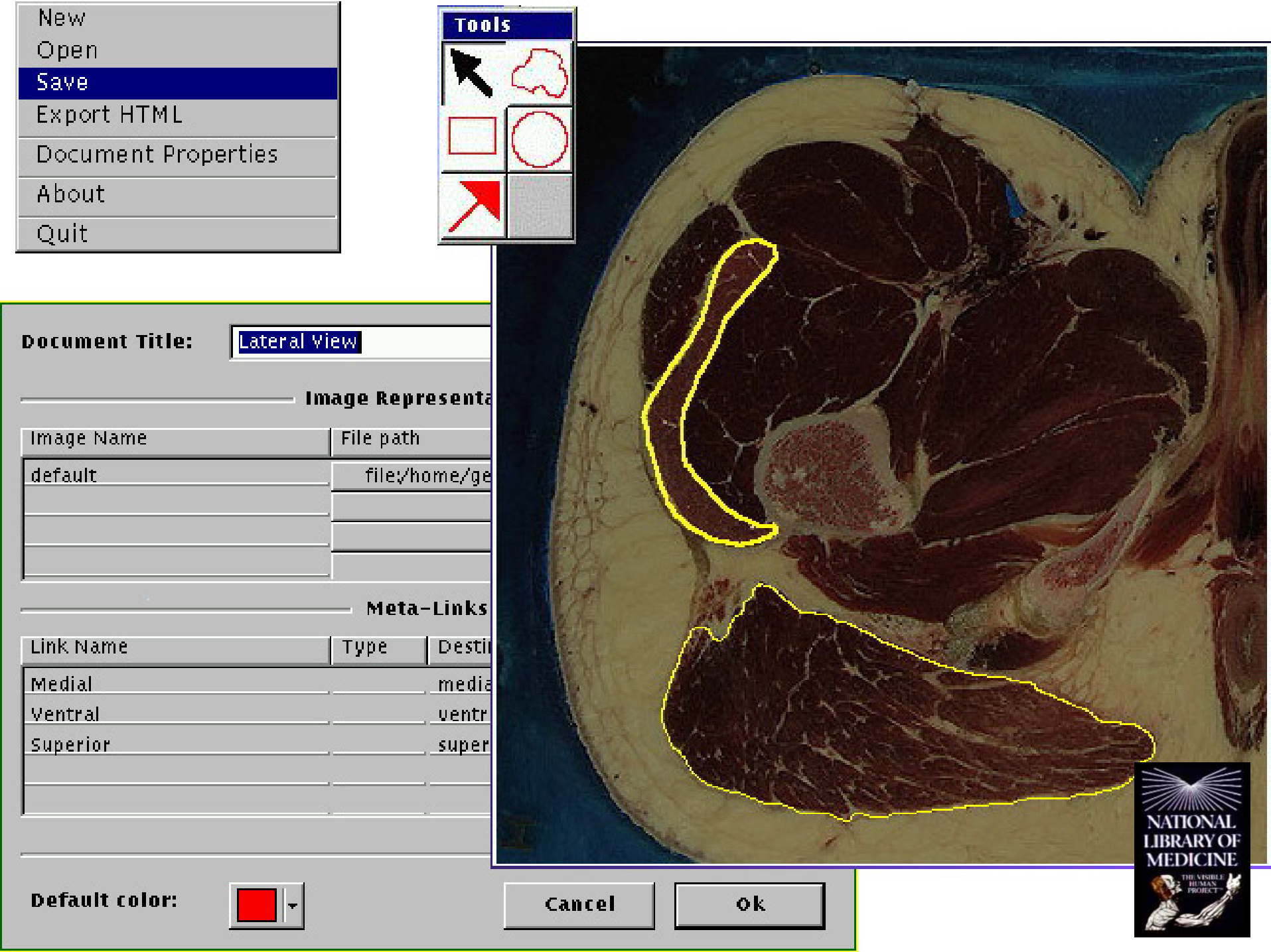
- About 400 C++ classes
- About 300,000 lines of code
- 34,000 cvs comments by 36 developers
- Two mailing lists:
  - Insight-developers@public.kitware.com
  - 200 Insight-users@public.kitware.com

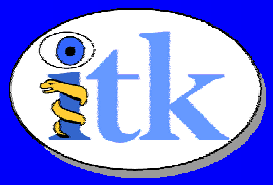




www.itk.org

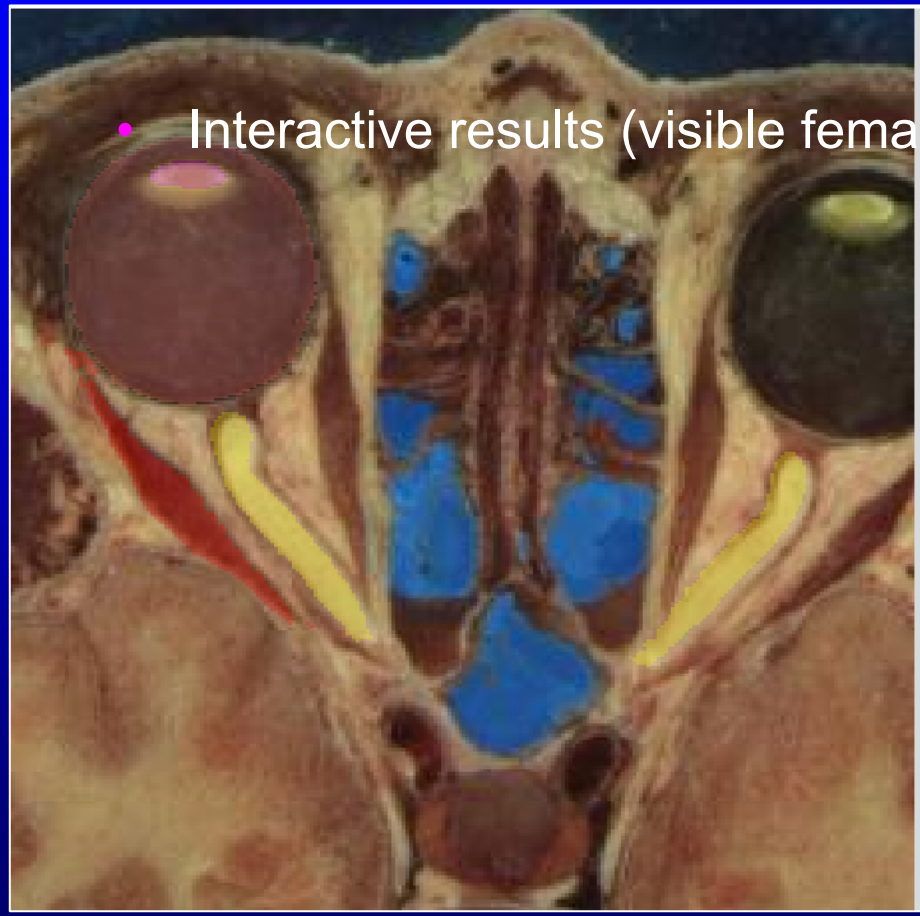


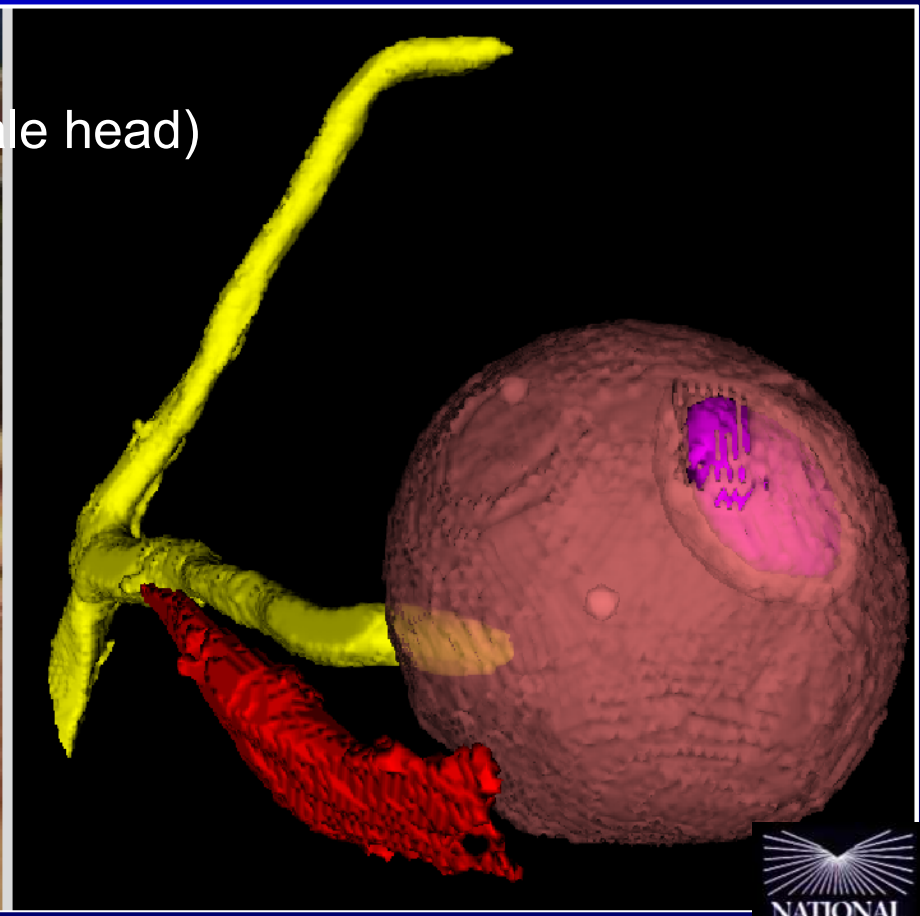

New
Open
Save
Export HTML
Document Properties
About
Quit
Tools
Document Title:
Lateral View
Image Representa
Image Name
File path
default
file:/home/ge
Meta-Links
Link Name
Type
Desti
Medial
media
Ventral
ventr
Superior
super
Default color:
Cancel
Ok
NATIONAL LIBRARY OF MEDICINE
THE VISIBLE HUMAN PROJECT

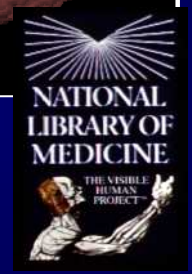


Visible Human Segmentation and Visualization

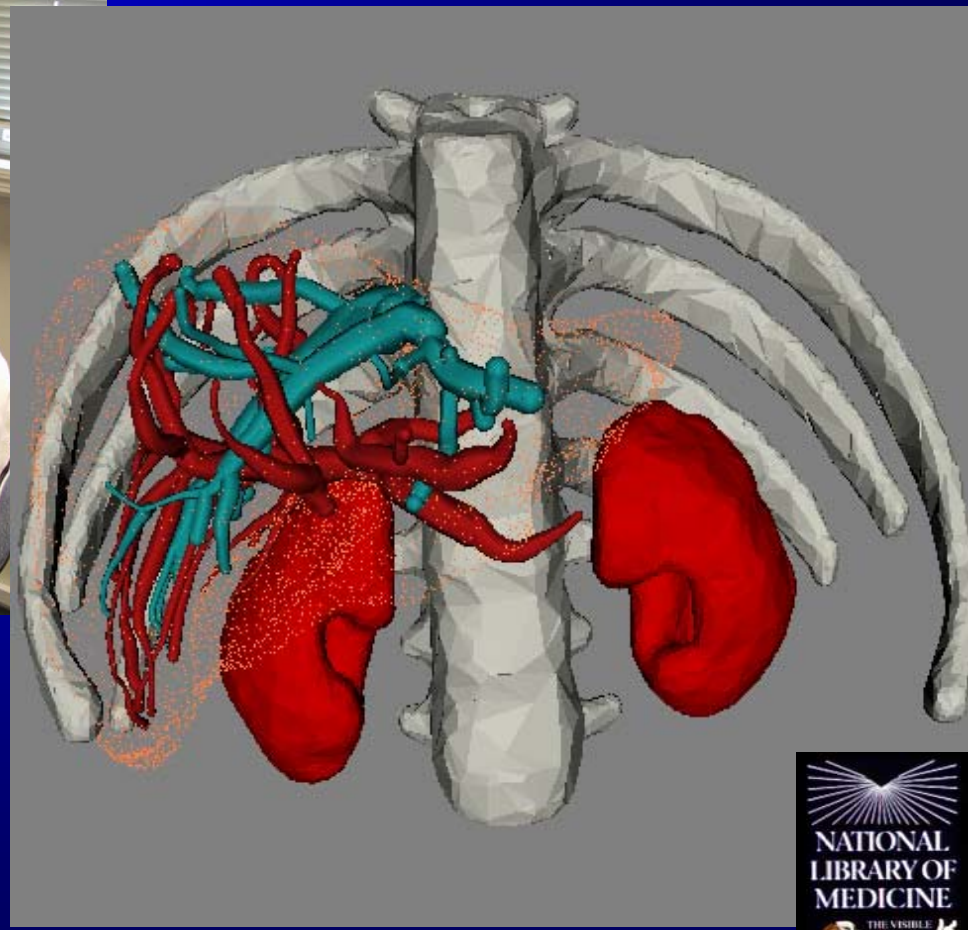
- Interactive results (visible female head)







Haptics for Surgical Training



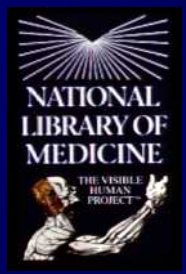
Scan to simulation : 1 hour

Anatomical Methods

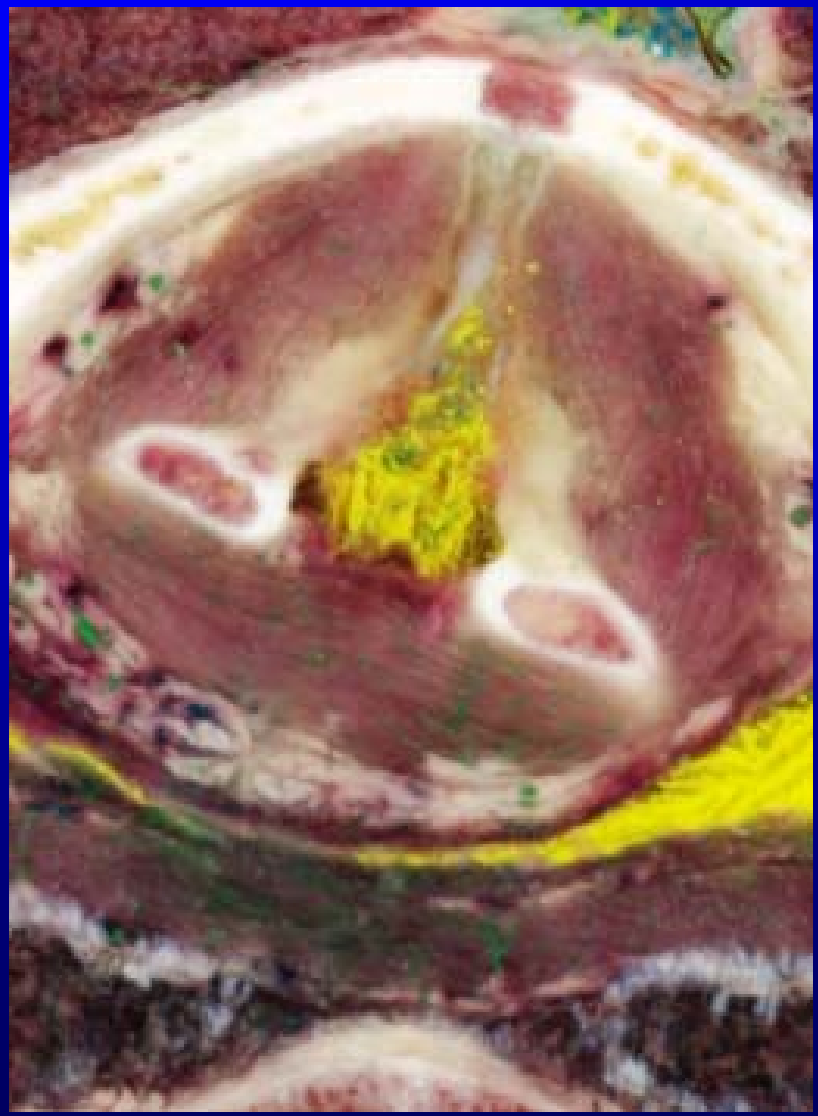
- Elimination of preservation artifacts
- Visual enhancement of neural and vascular structures
- Markers for correlation between imaging modalities

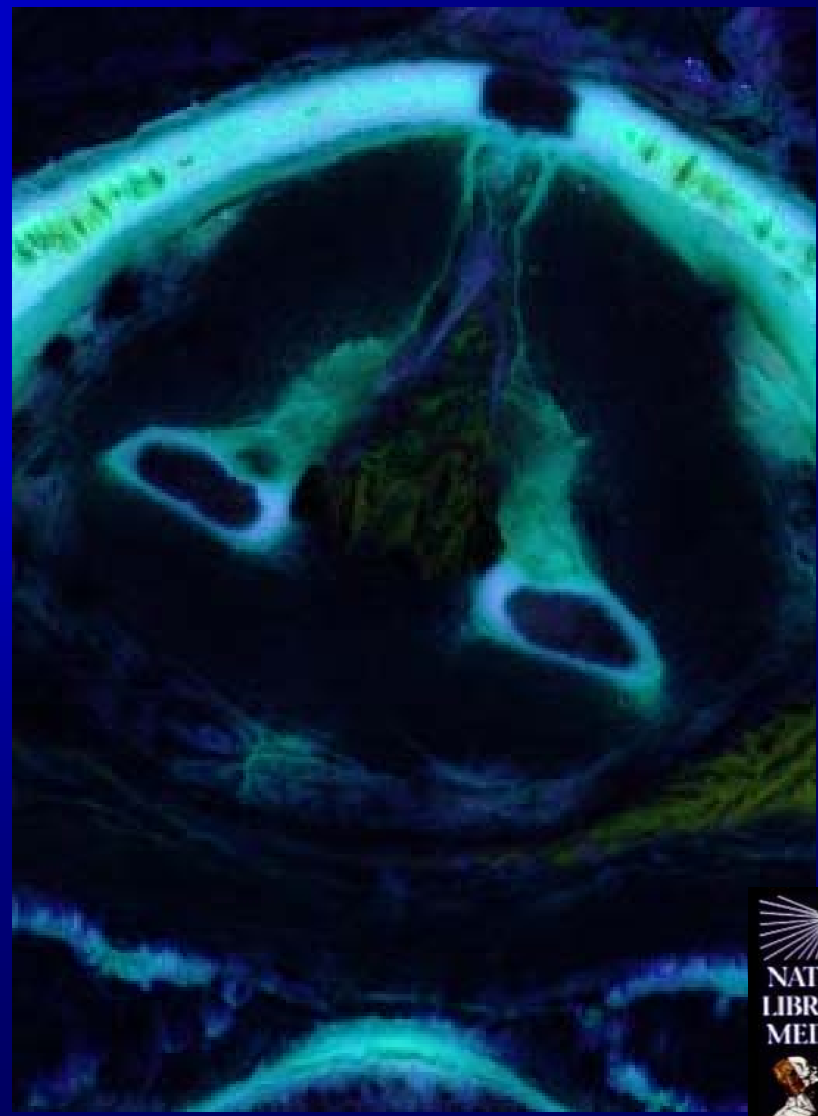
University of Colorado Health Sciences Center - V. Spitzer

Brigham and Womens Hospital - P. Ratiu



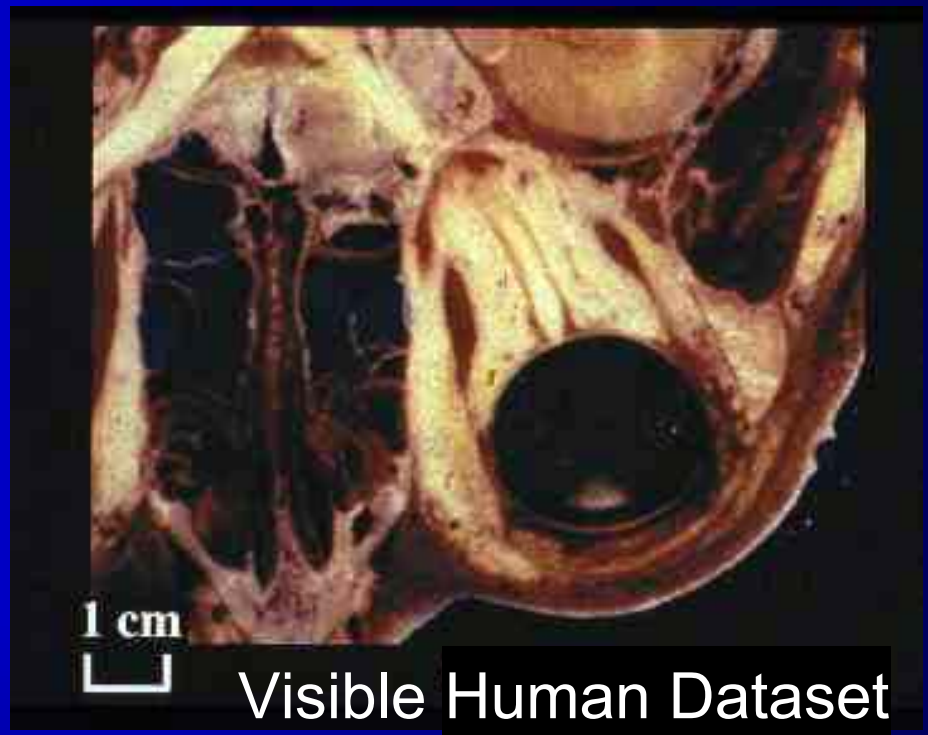
Visible and UV Photography





NATIONAL LIBRARY OF MEDICINE
THE VISIBLE HUMAN PROJECT

Anatomical Methods data

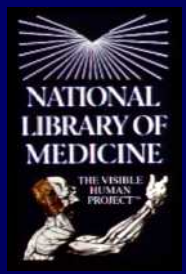


Visible Human Dataset

NATIONAL LIBRARY OF MEDICINE
THE VISIBLE HUMAN PROJECT

The long term goal of the Visible Human Project

To transparently link the print library of functional-physiological knowledge with the image library of structural-anatomical knowledge into one unified resource of medical information.



The only way to predict the future is to invent it.

Lister Hill Center
Visible Human Project

http://www.nlm.nih.gov

NATIONAL LIBRARY OF MEDICINE
THE VISIBLE HUMAN PROJECT