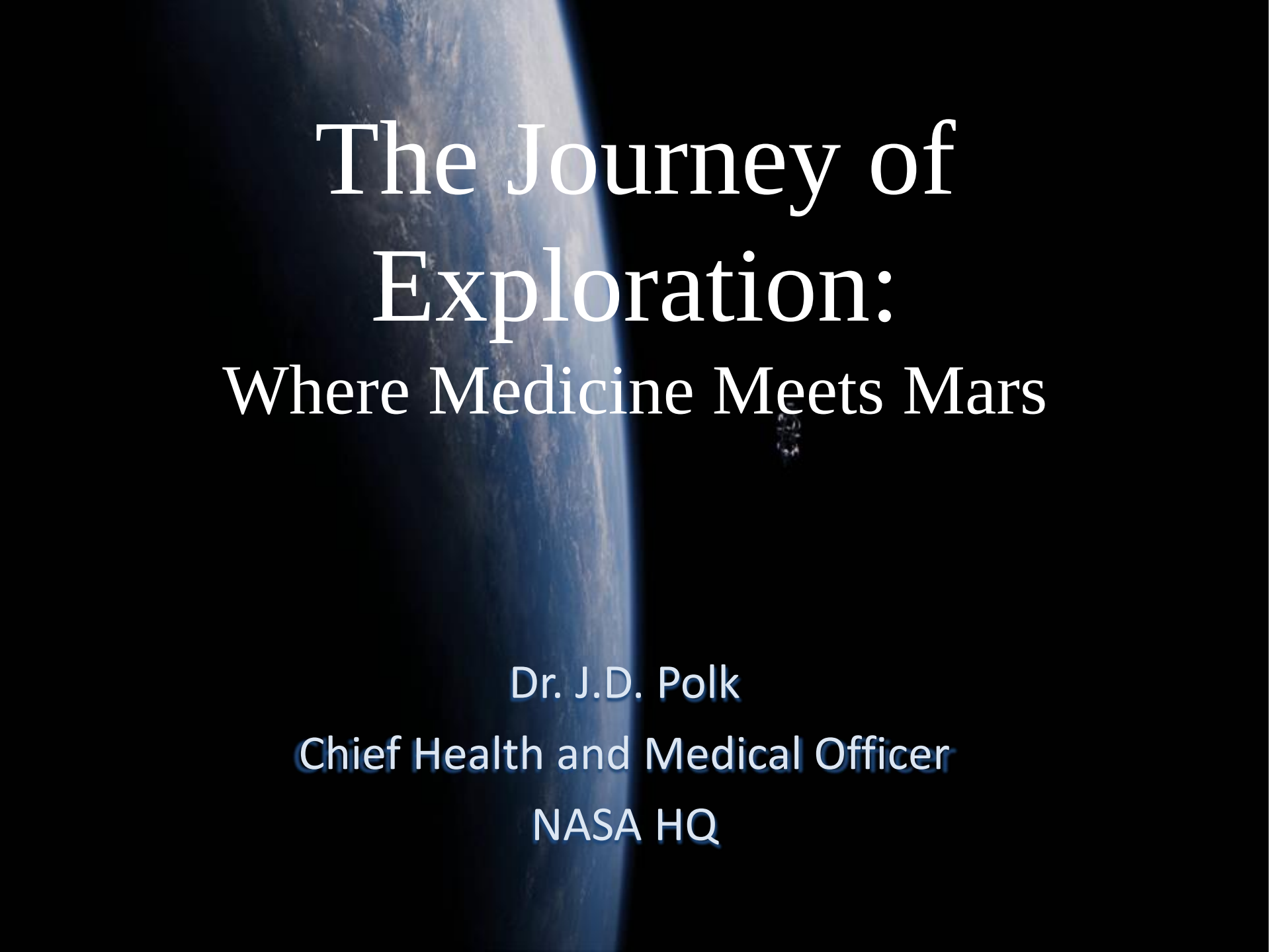
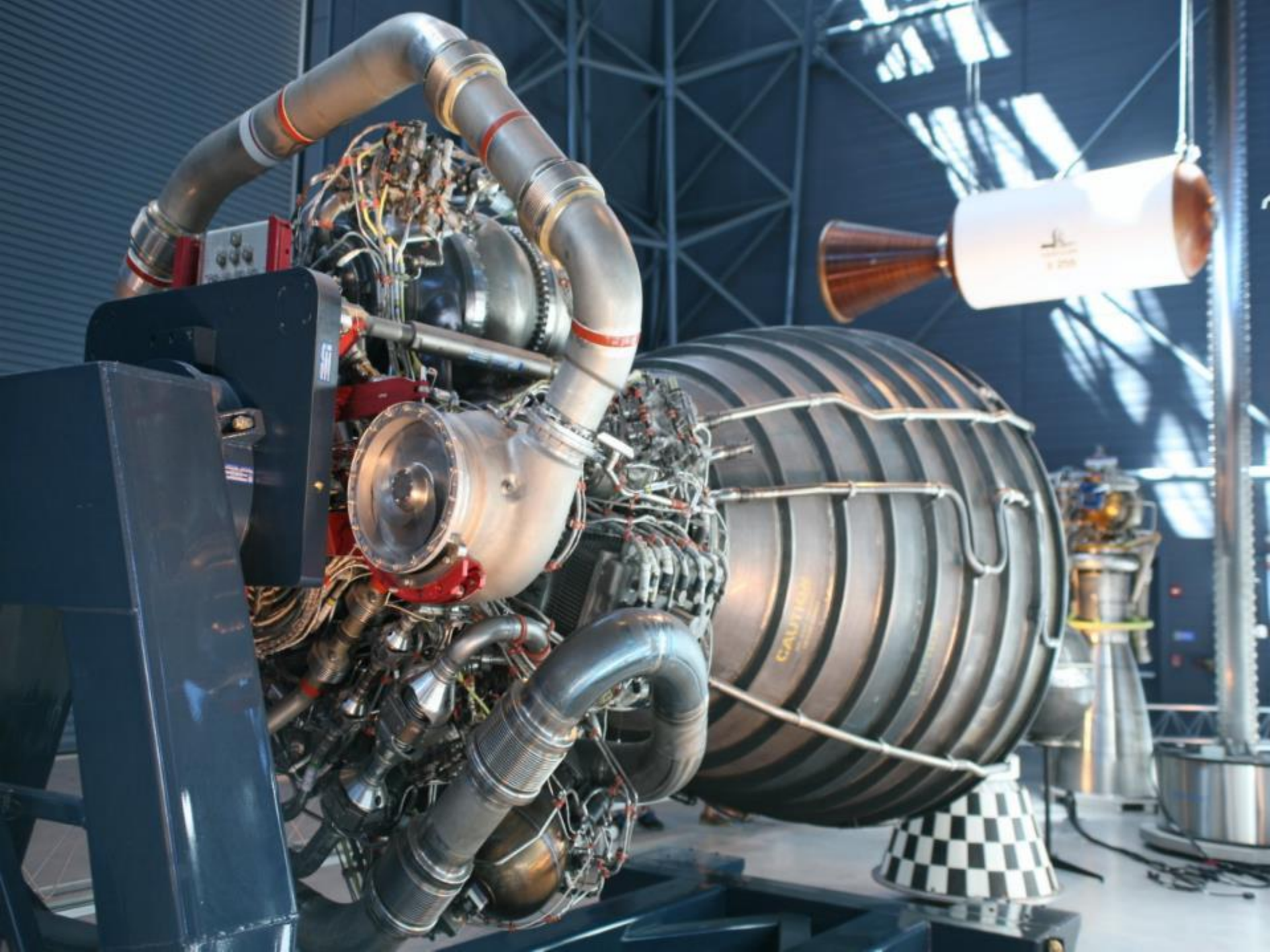
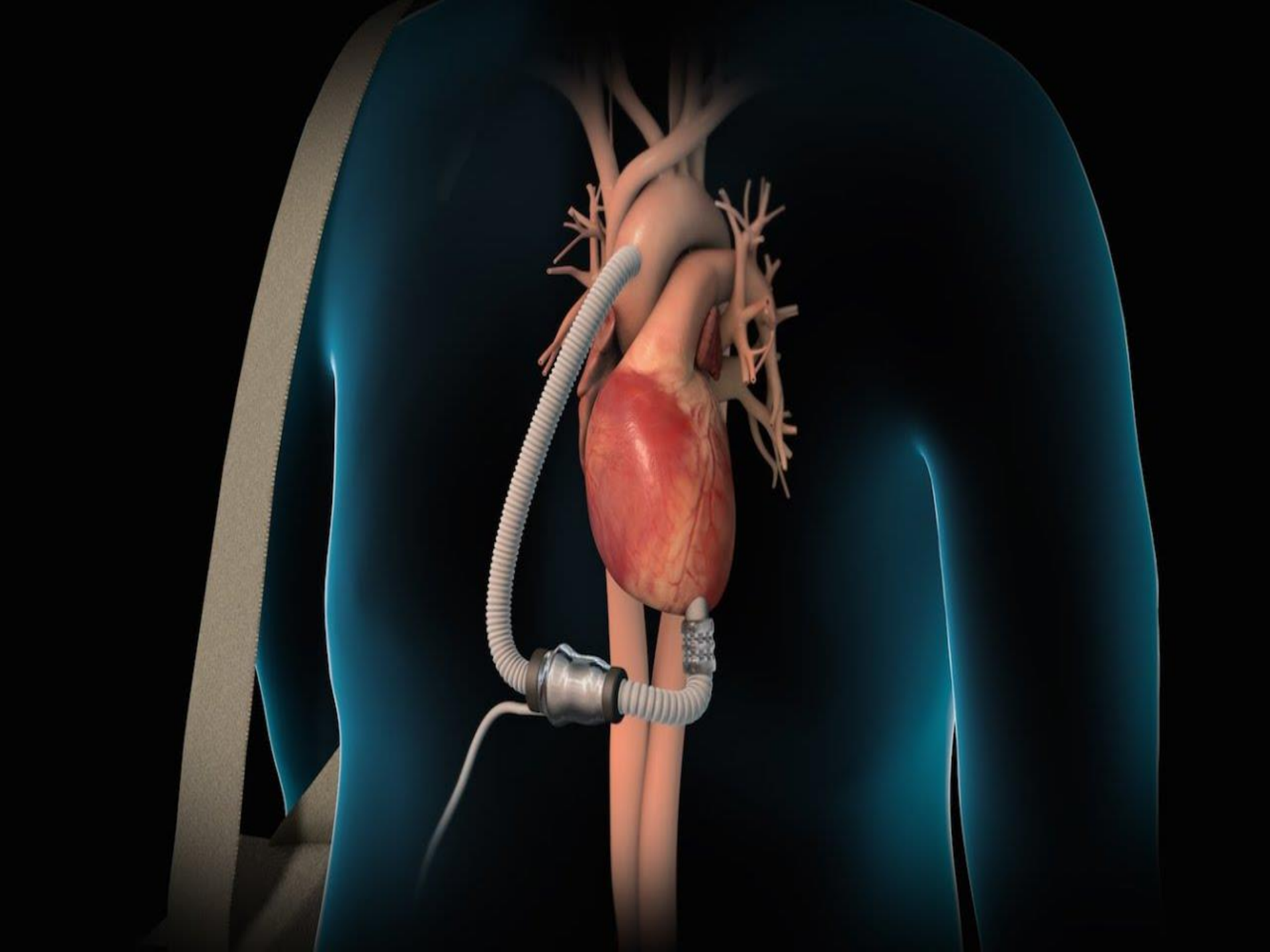


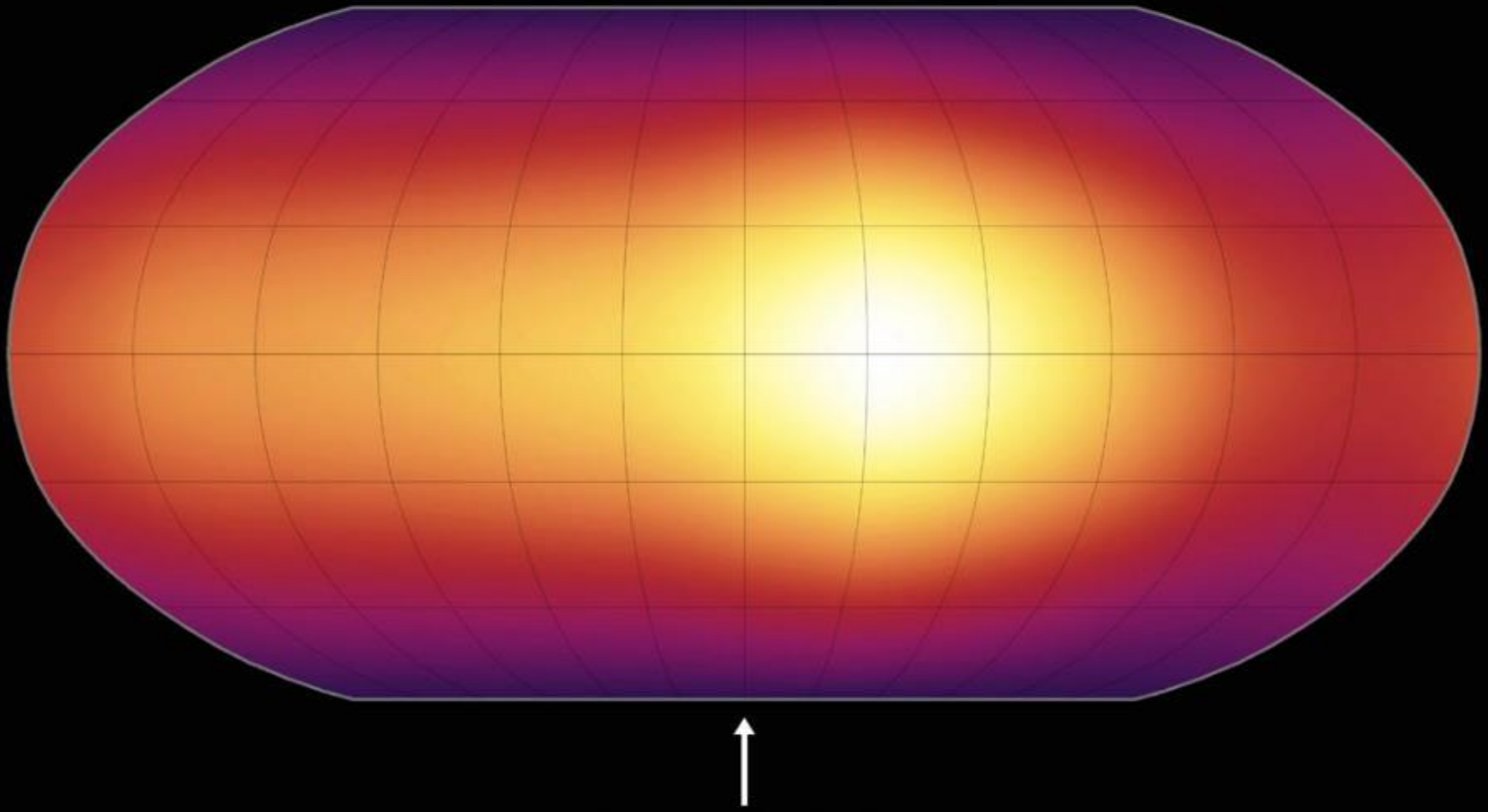
The Journey of Exploration:
Where Medicine Meets Mars

Dr. J.D. Polk
Chief Health and Medical Officer
NASA HQ






M&D
Surgery



Sun-Facing Longitude

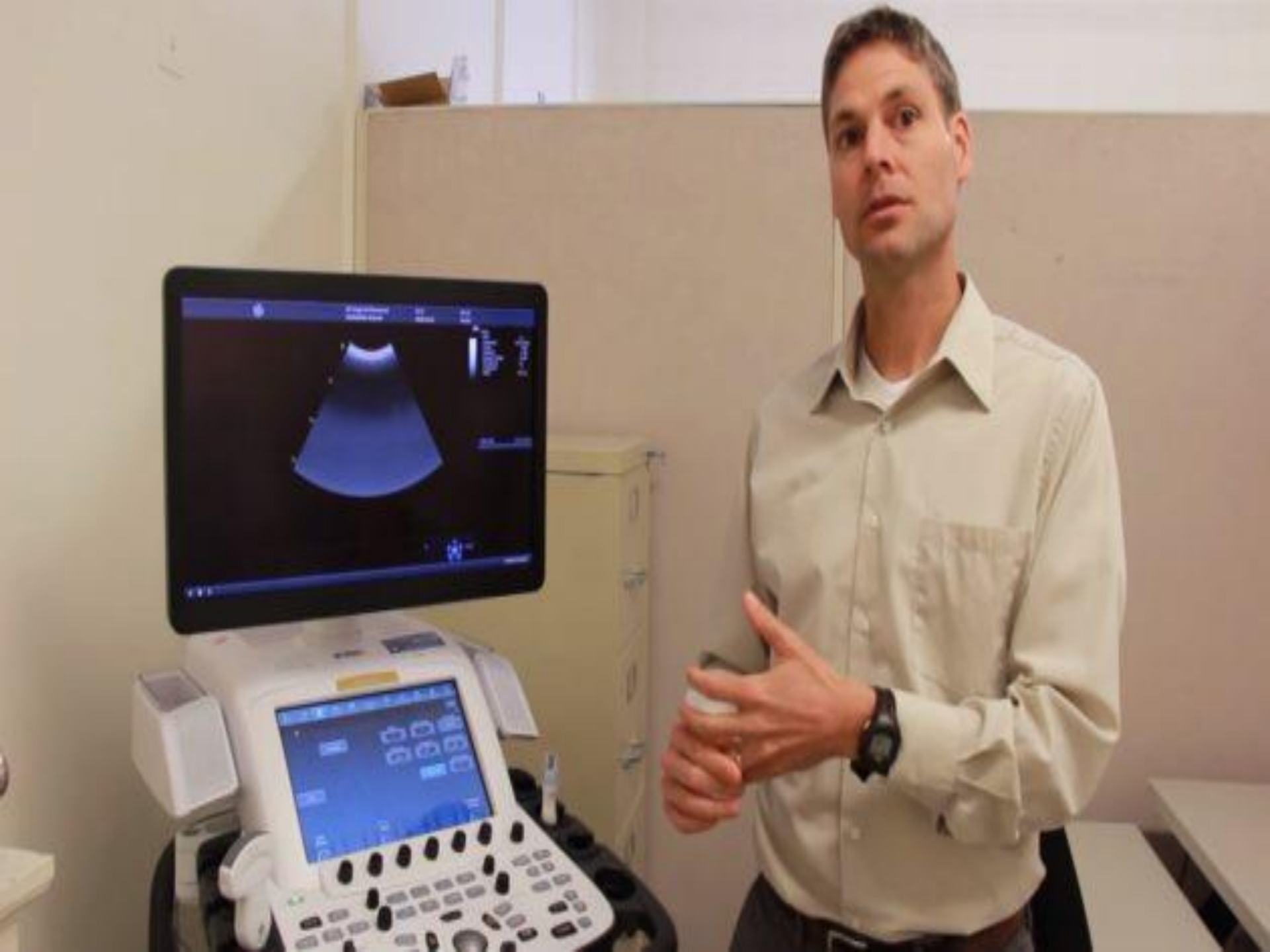
(Grid Spacing: 30°)

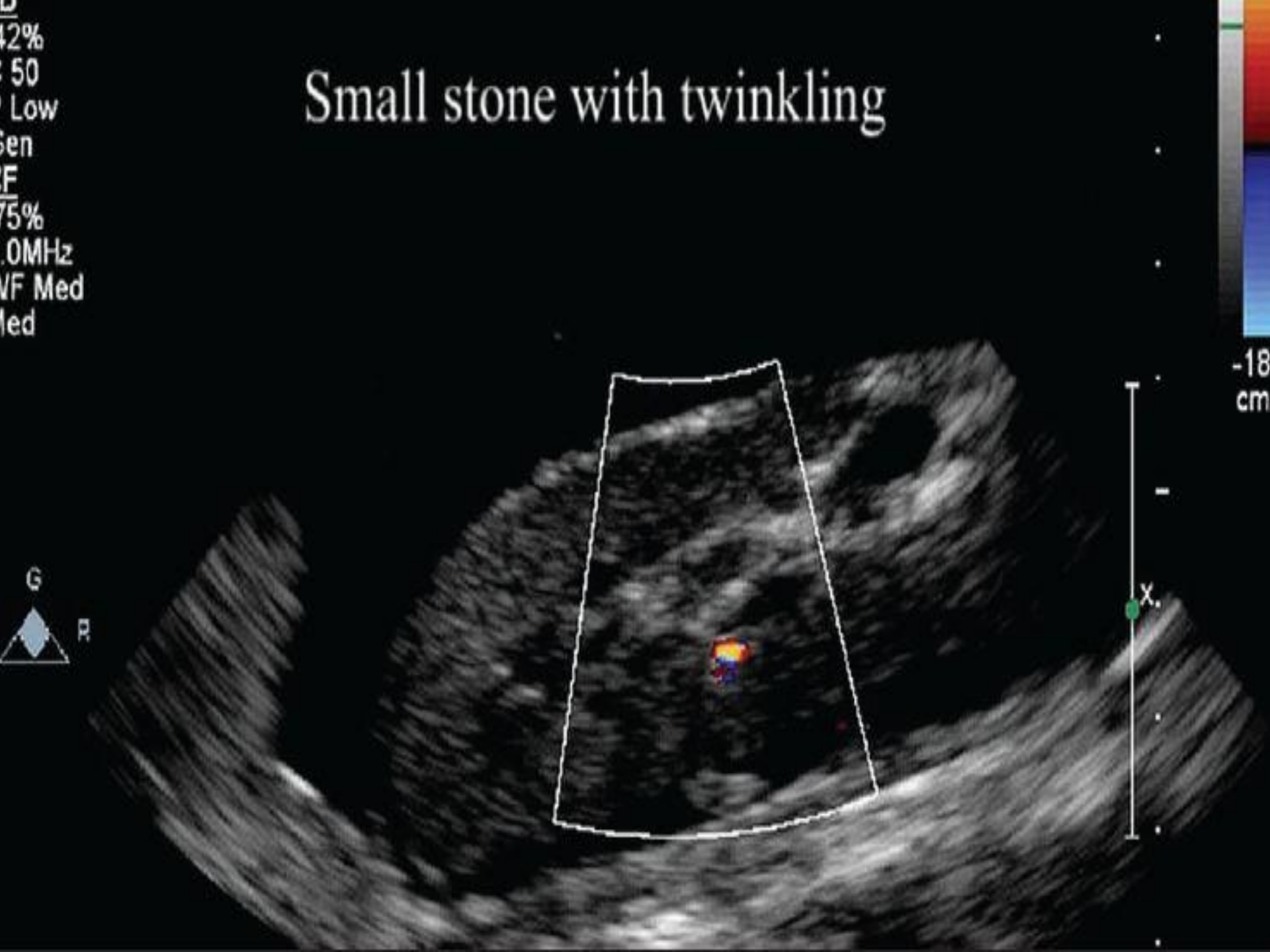
Global Temperature Map for Exoplanet HD189733b

NASA / JPL-Caltech / H. Knutson (Harvard-Smithsonian CfA)

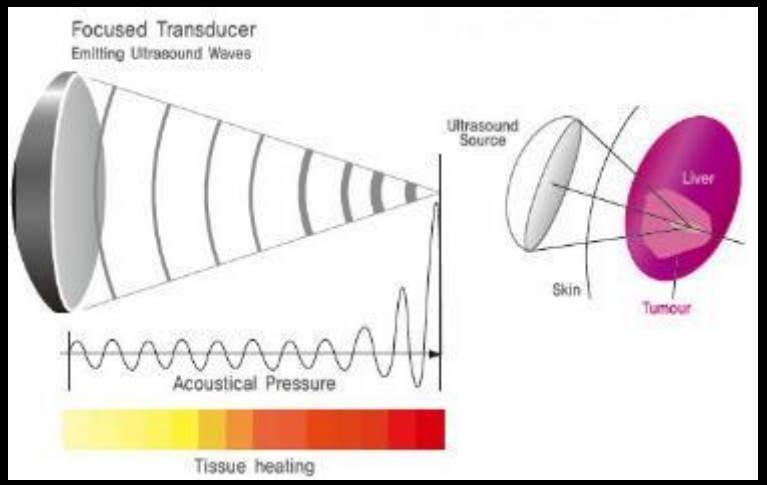
Spitzer Space Telescope • IRAC

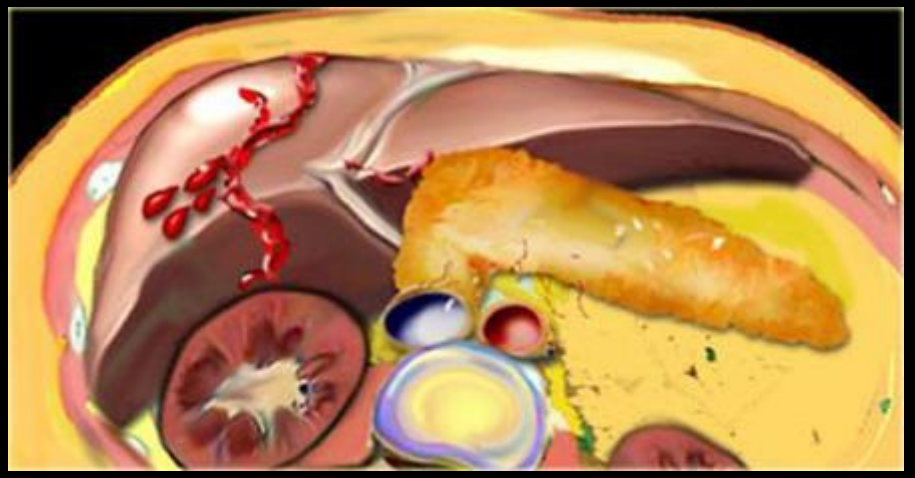
ssc2007-09a

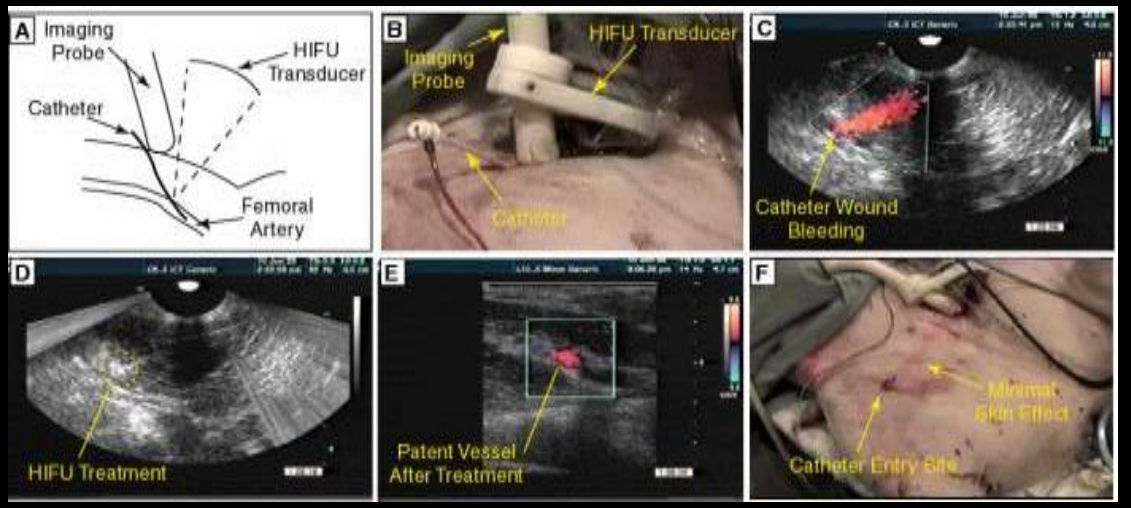


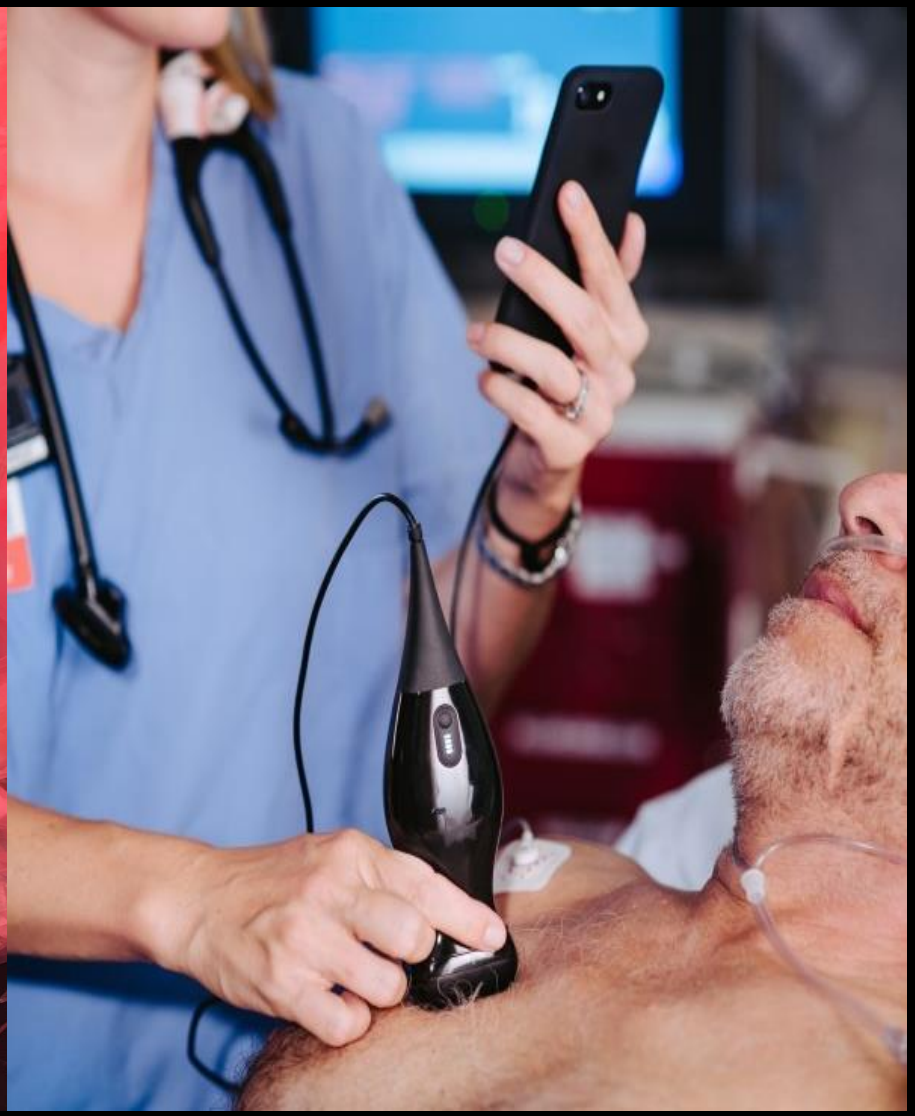

Small stone with twinkling

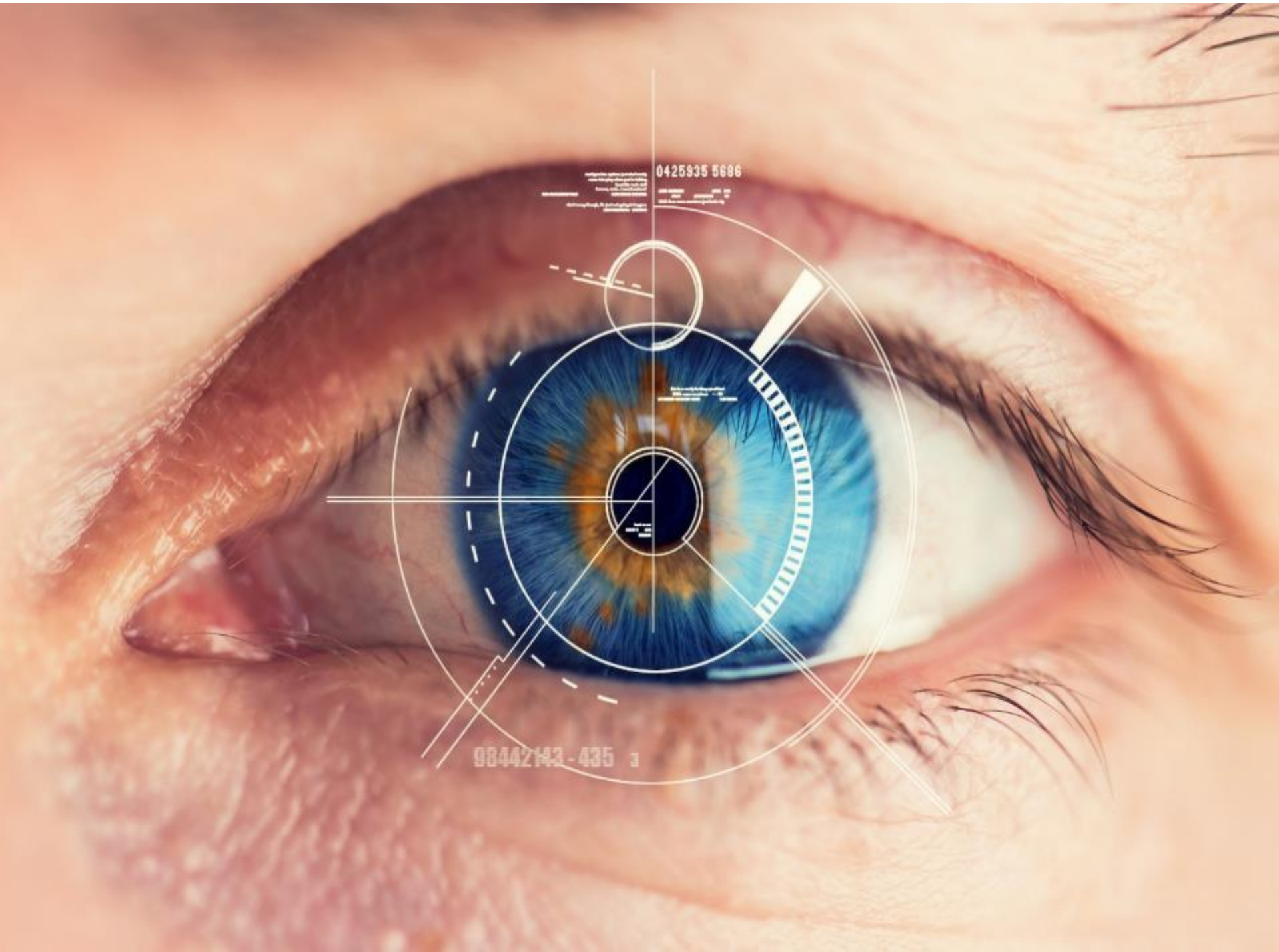
High Intensity Focused Ultrasound







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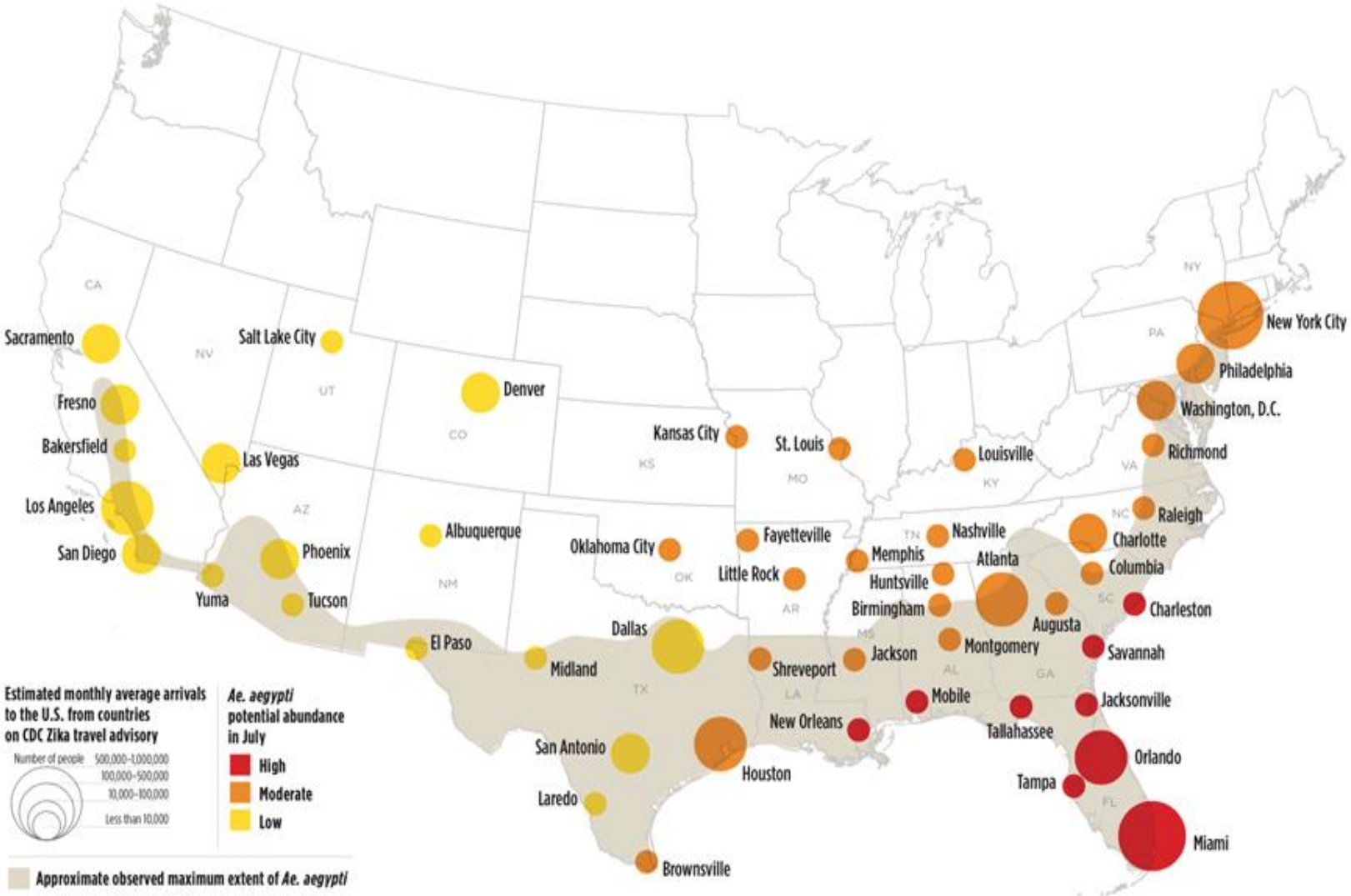
Sacramento
Salt Lake City
Denver
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Bakersfield
Las Vegas
Los Angeles
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Phoenix
Albuquerque
Yuma
Tucson
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Fayetteville
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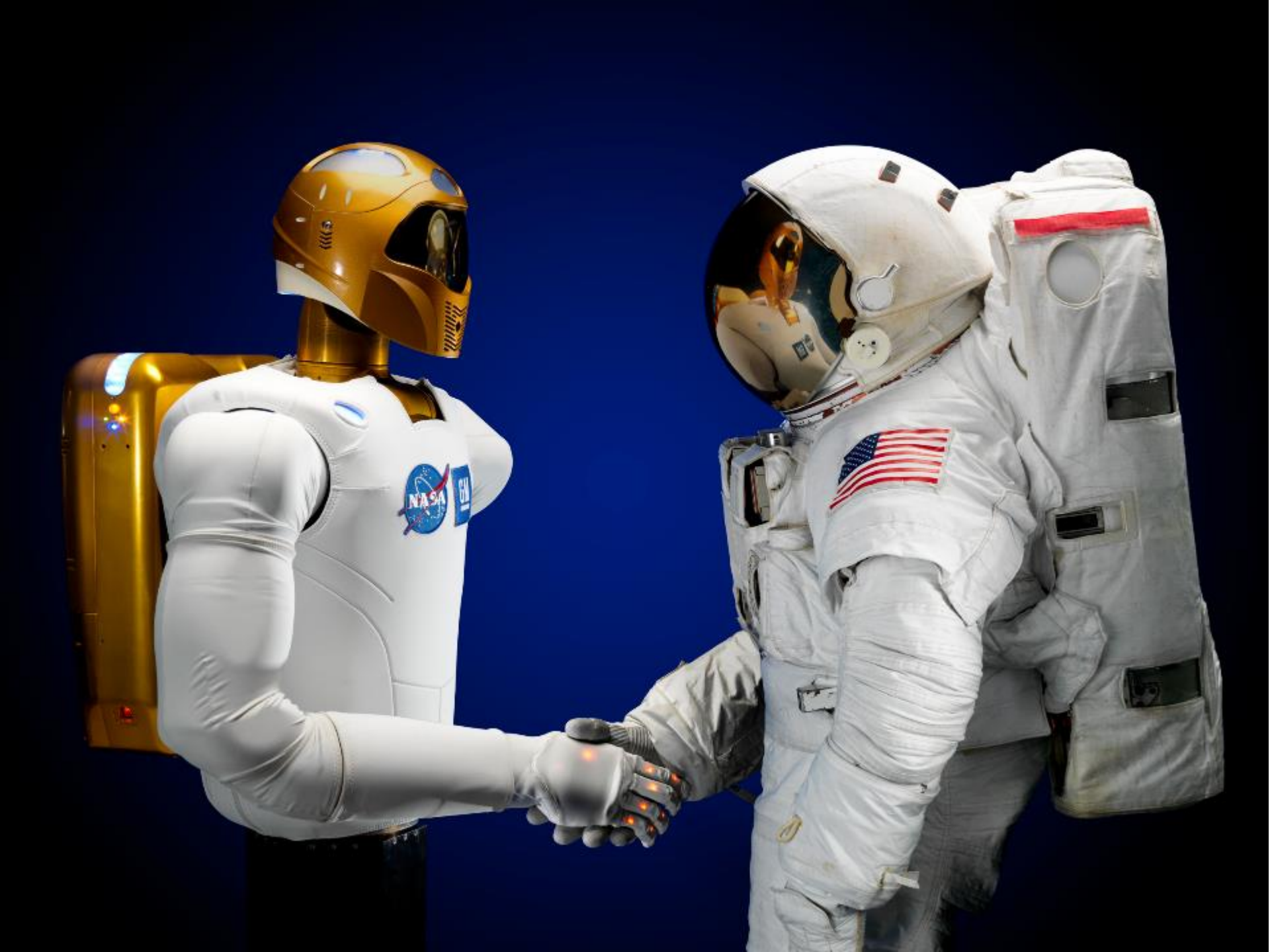
St. Louis
Louisville
Nashville
Memphis
Atlanta
Huntsville
Birmingham
Augusta
Charlotte
Columbia
Charleston
Raleigh
Richmond
Washington, D.C.
Philadelphia
New York City
Dallas
El Paso
Midland
Shreveport
Jackson
Montgomery
Savannah
Mobile
Jacksonville
New Orleans
Tallahassee
San Antonio
Houston
Orlando
Tampa
Laredo
Miami
Brownsville
CA
NV
UT
CO
AZ
NM
KS
OK
TX
MO
AR
LA
TN
MS
AL
GA
KY
VA
NC
SC
PA
NY
FL
Estimated monthly average arrivals to the U.S. from countries on CDC Zika travel advisory
Number of people
500,000–1,000,000
100,000–500,000
10,000–100,000
Less than 10,000
Ae. aegypti potential abundance in July
High
Moderate
Low
Approximate observed maximum extent of Ae. aegypti


NASA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E3


www.nasa.gov

Galileo - Smart Prosthetics Control App
Orthocare Innovations LLC, Galileo Prosthetics Control Support LLC.

NASA Valkyrie
Robot

Ford, O. *Robotic Exoskeleton. The Future is Now.* Medical Device Daily, Aug 24, 2014.

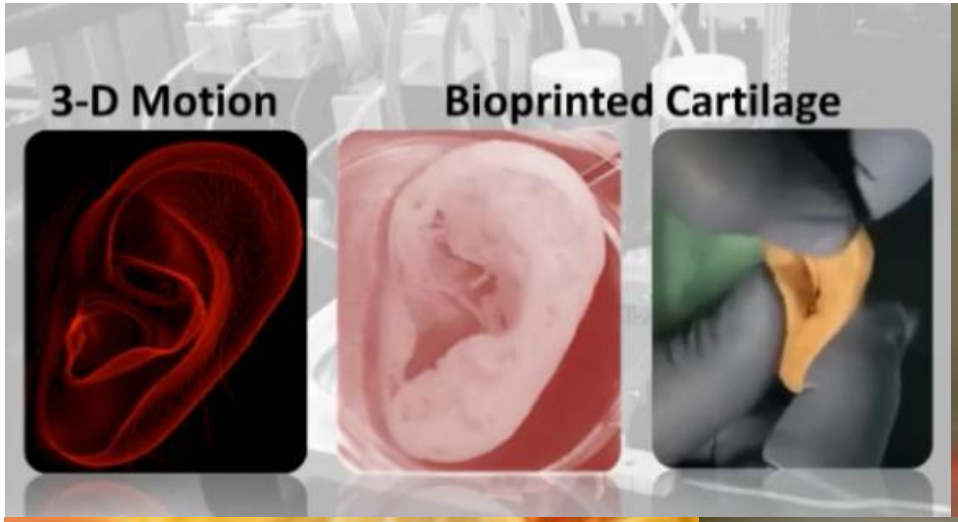
3D Printing for skin and flesh tones

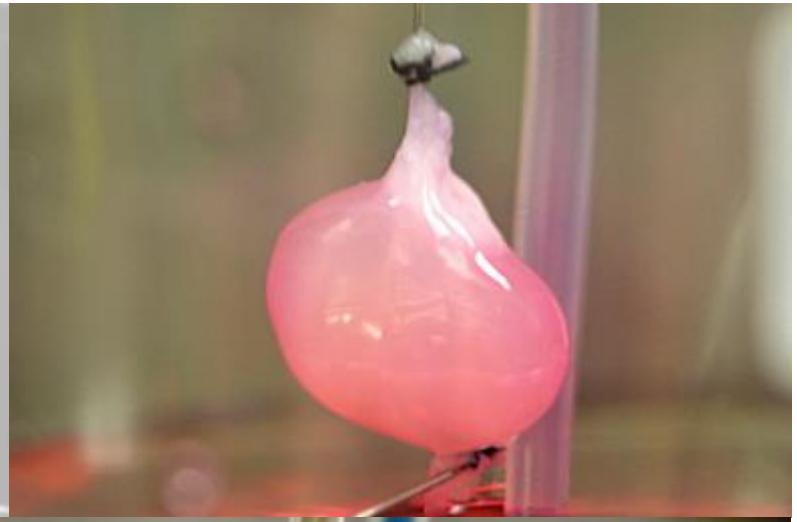
Scan of remaining eye to create exact duplicate eye with 3-D printer

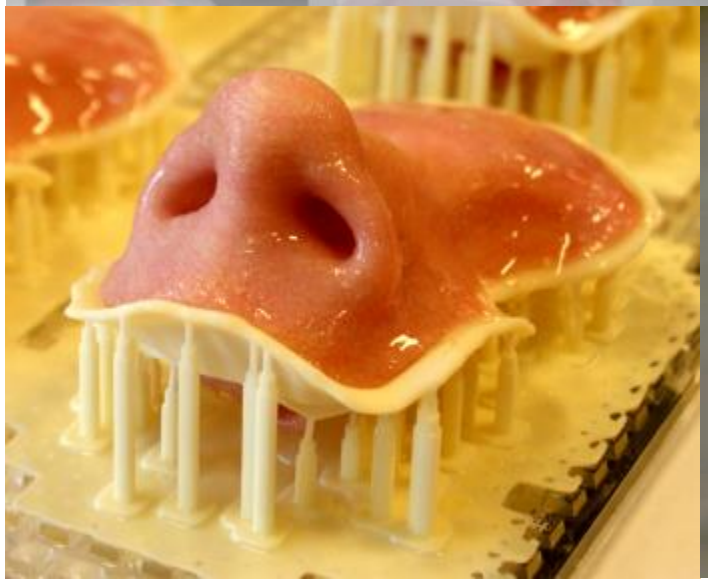
Computer scanned, then flipped images of remaining limb to create “3-d duplicate”

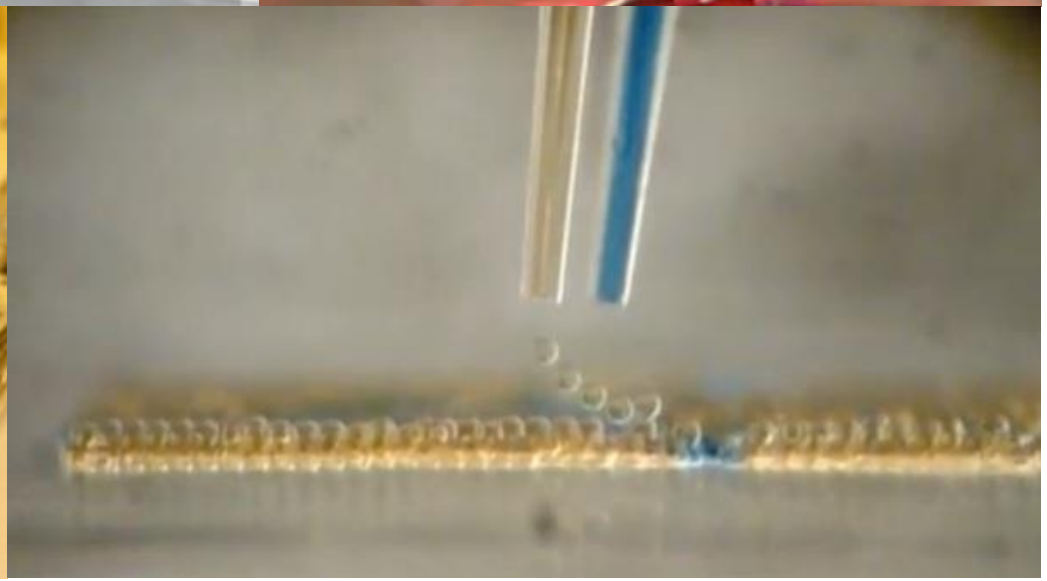
Wake Forest University: Printing skin directly onto the burned limb.

3D Printers and Human Tissue

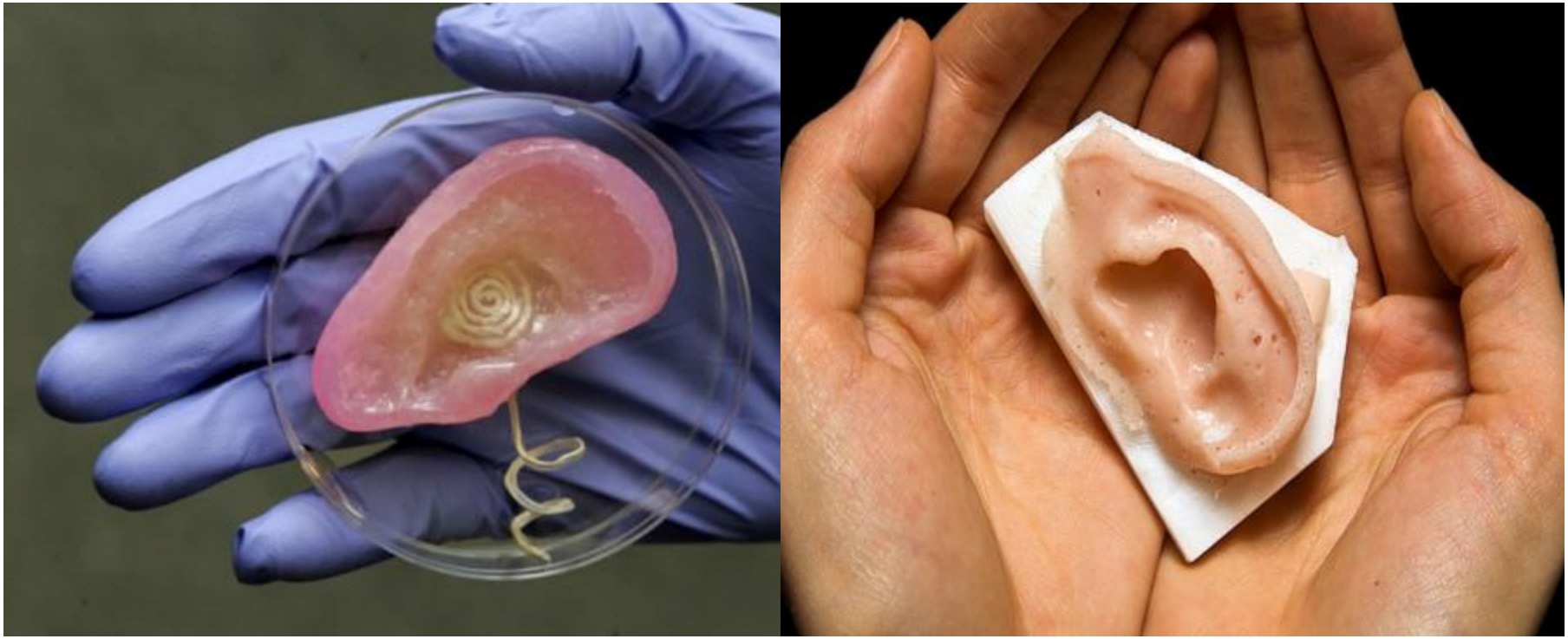






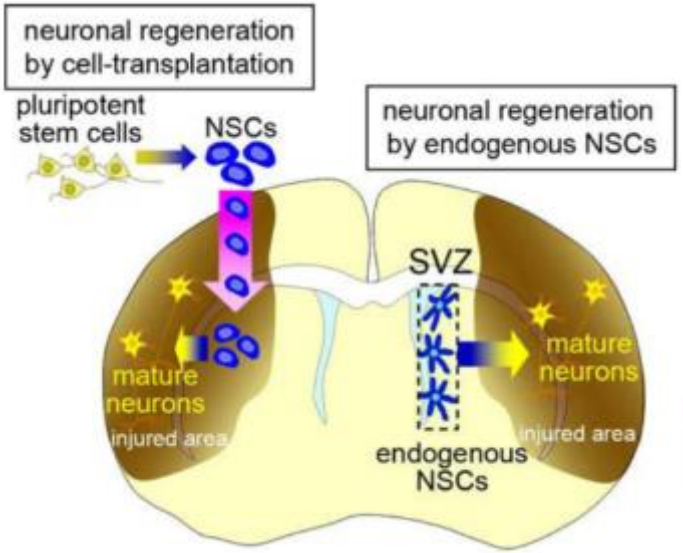


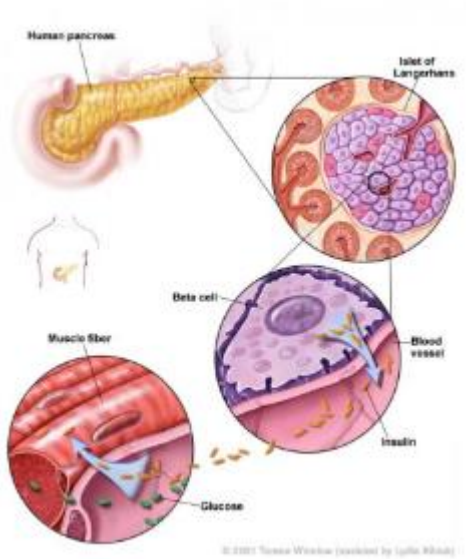
3-D printed ears that can hear…

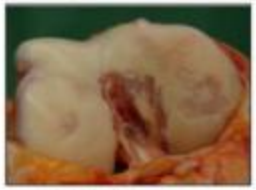


- Princeton 3-D printed ear with acoustic ear coil transmission.

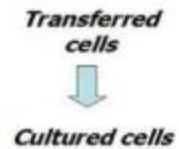
Insertion of Progenitor Cell Lines







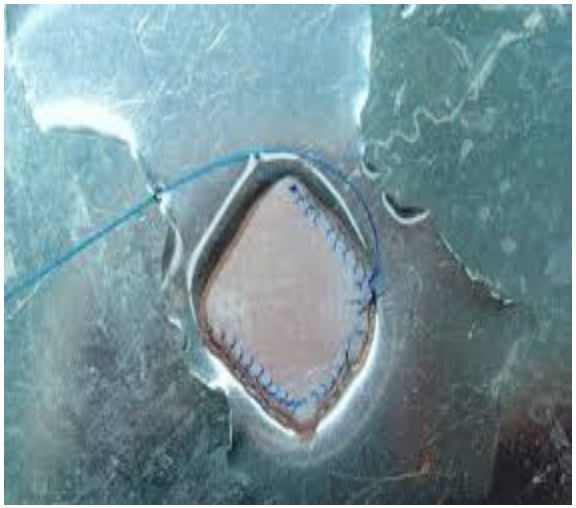
Cartilage lesions



Strategies for cartilage repair.

Autologous chondrocyte transplantation (ACT). Stage 1.

Autologous chondrocyte transplantation (ACT). Stage 2.

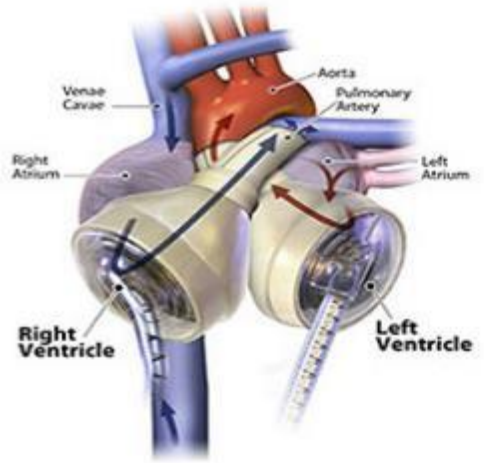


First Use of 3D printed tissue to make Trachea

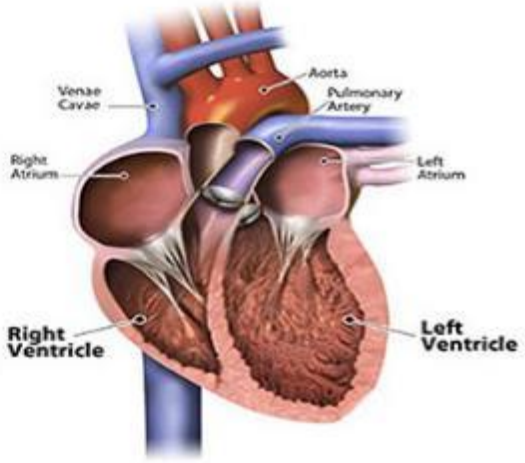
University of Michigan implants first 3-D printed tissue into infant

http://www.uofmhealth.org/news/archive/201403/babys-life-saved-after-3d-printed-devices-were-implanted-u

Artificial Heart

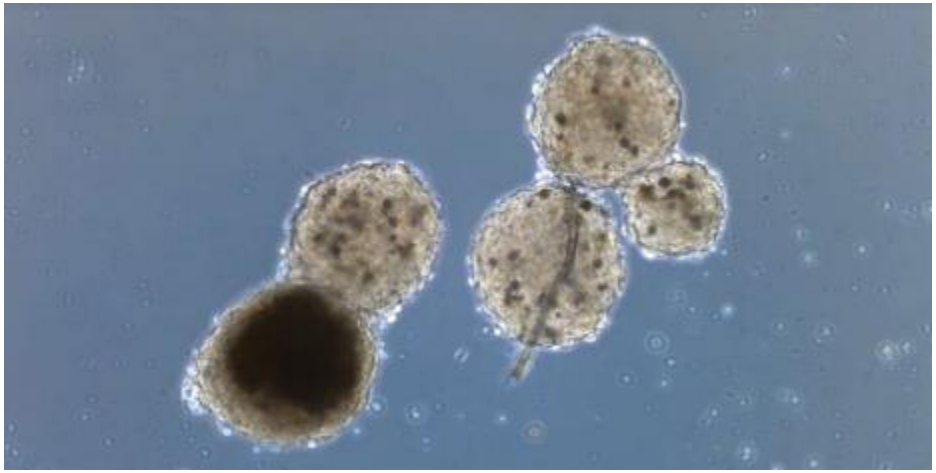


Total Artificial Heart



Human Heart

Wake Forest Institute for Regenerative Medicine, 3-D printed beating cardiac cells



But could you make a cell like a cardiac cell, neuron, or insulin secreting cell?

Dr. Kate Rubins sequences DNA and grows cardiac cells on orbit.

Vaccine and Pathogen Research in Microgravity on the Shuttle and ISS

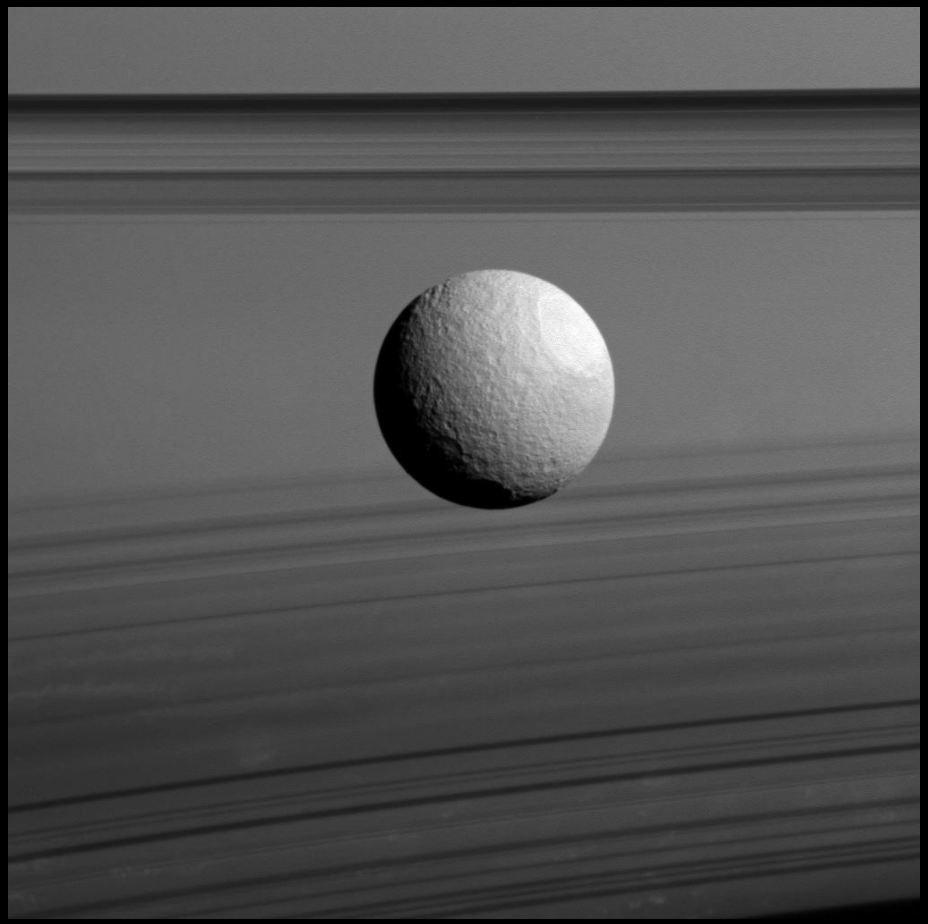
Dr. Cheryl Nickerson of the Biodesign Institute at Arizona State University works on NASA granted research.

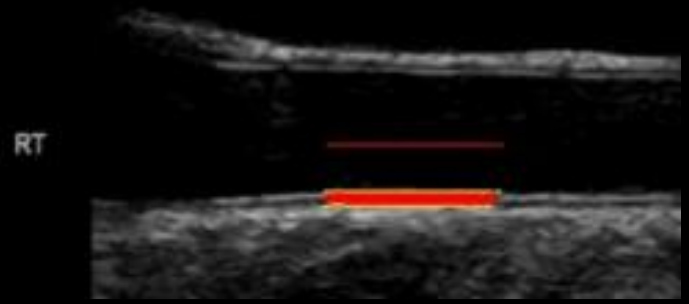
Salmonella

Microgravity Vaccine Research (NLP-Vaccine-Salmonella)

Parkinson's Disease

Microgravity LRRK2 Protein Research (CASIS PCG 7)





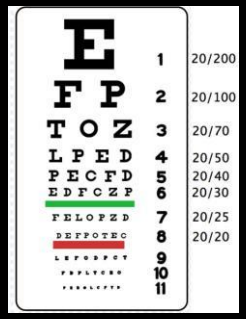
www.nasa.gov

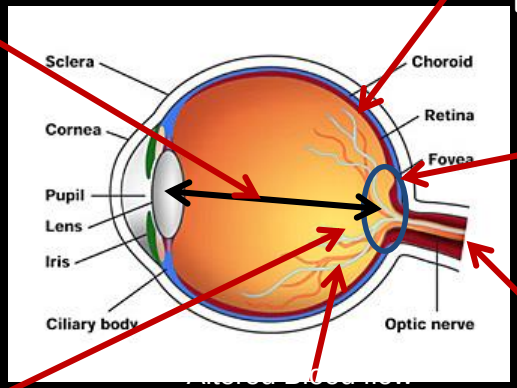
The Case for Intracranial Hypertension

www.nasa.gov

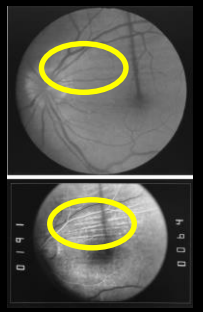
- Several known cases predominantly in long duration crew members
  - Each with different degrees of symptoms
  - Elevated measures of Intracranial Pressure (ICP) post flight
  - Evaluation of shuttle fliers showed mild changes in the optic nerve diameter, even in 14 day missions.

•Hyperopic Shifts
-Up to +1.75 diopters



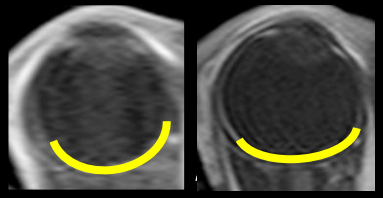


•Choroidal Folds - parallel grooves in the posterior pole



•Optic Disc Edema (swelling)

•Globe Flattening

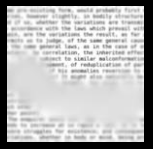


Normal Globe Flatten Globe

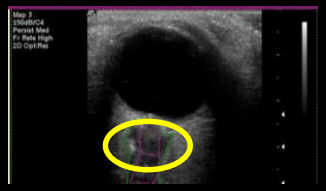
MRI Orbital Image showing globe flattening

•"cotton wool" spots

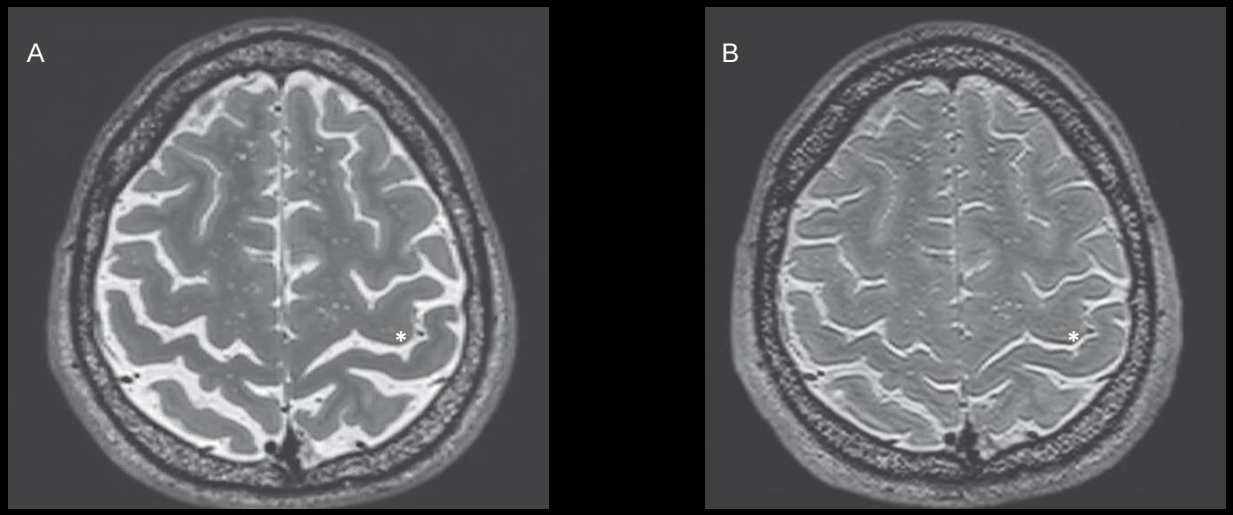
Scotoma



•Increased Optic Nerve Sheath Diameter



Narrowing of the CSF Spaces Within the Brain Sulci



Axial T2-weighted images of the brain obtained before (Panel A) and after (Panel B) this astronaut had long-duration spaceflight on the International Space Station. The astronaut presented with optic-disk edema syndrome after spaceflight. **Crowding of the sulci can be seen at the vertex**. The gyrus* is the precentral gyrus (primary motor cortex).

Cerebral edema present. Clearly not solely an eye issue.

www.nasa.gov

From Donna Roberts' Study,

Impacts to Design

Questions?

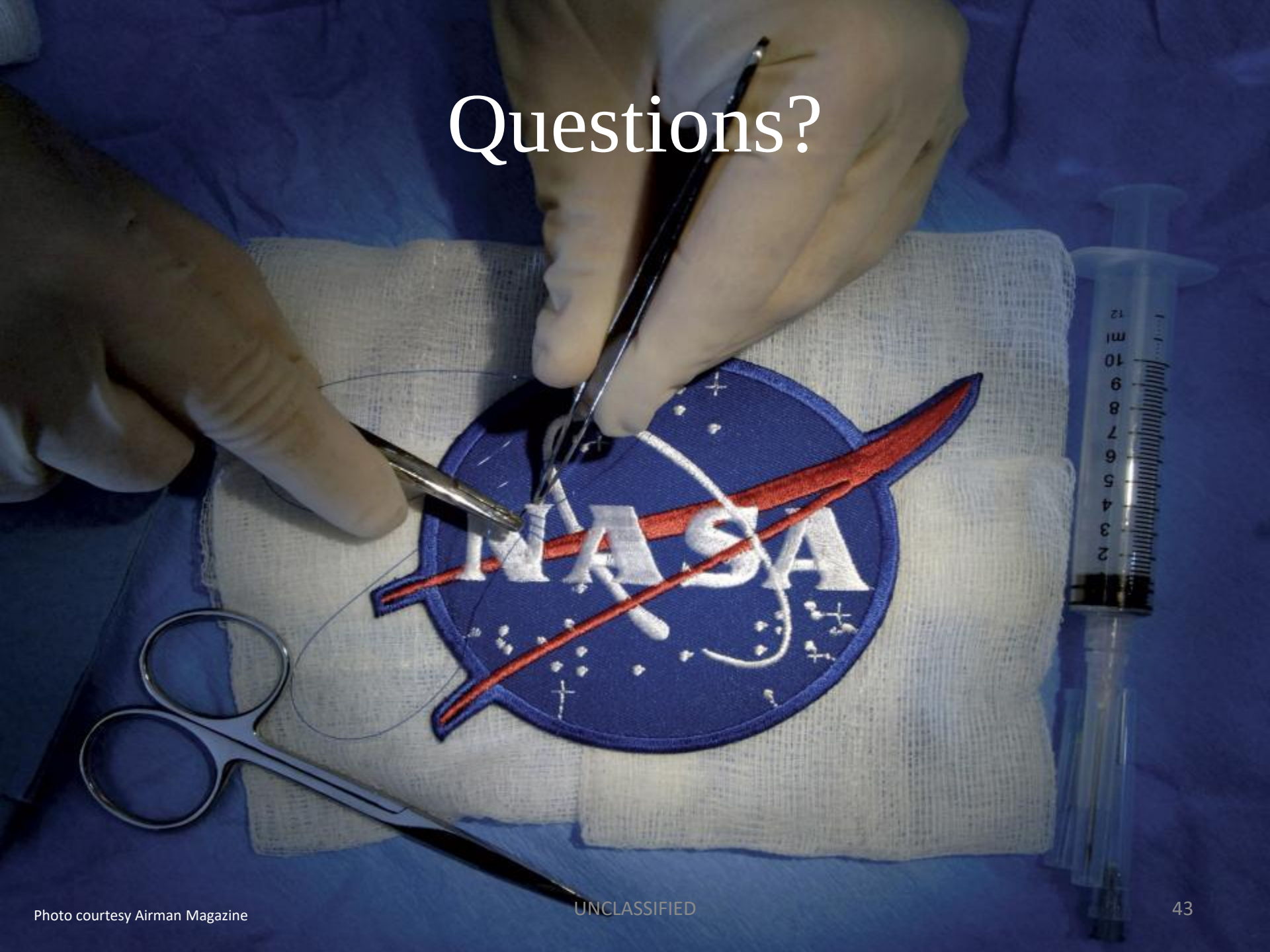


Photo courtesy Airman Magazine