MIDEFACE:
Minimally Invasive Defacing

Medical Image De-Identification (MIDI), May 23, 2023

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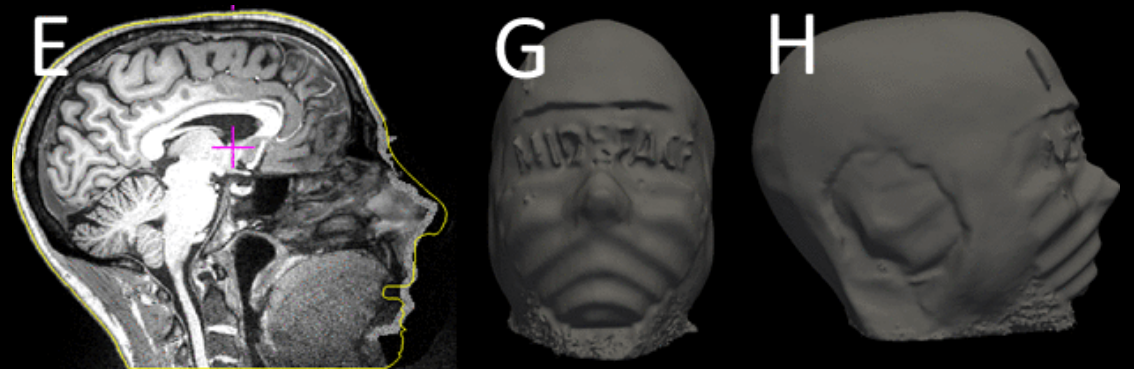


MASSACHUSETTS GENERAL HOSPITAL

Framingham Heart Study
Three Generations of Dedication

Motivation

- Balance Privacy and Utility
- Don’t remove enough – compromise privacy
- Remove too much – make data unusable
  - Now or in the future

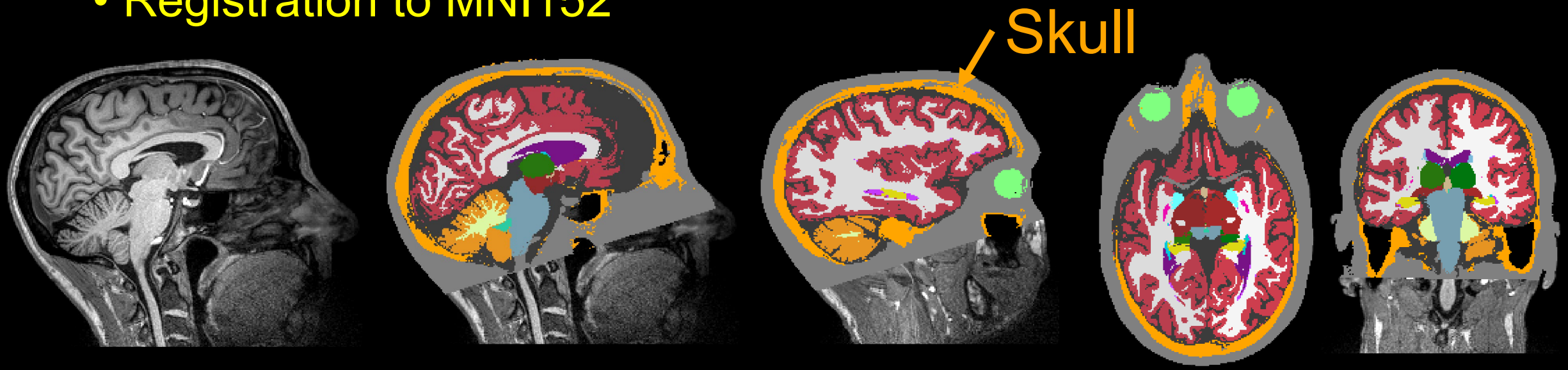
Mideface Strategy

- Segment brain and head (skull, eyeballs)
  - Make sure that important things are not removed
- Isolate and remove critical identifying facial features
  - Eyes, nose, mouth, cheeks, chin, ears, wrap-around
  - Minimally remove them in a way that is hard to reverse
  - Surface-based (because, FreeSurfer)

https://surfer.nmr.mgh.harvard.edu/fswiki/MiDeFace

Segmentation

- Sequence Adaptive Multimodal Segmentation (SAMSEG)
- Whole head, including skull and eyeballs
- Fairly fast – 5min single threaded
- Intensity normalization
- Registration to MNI152



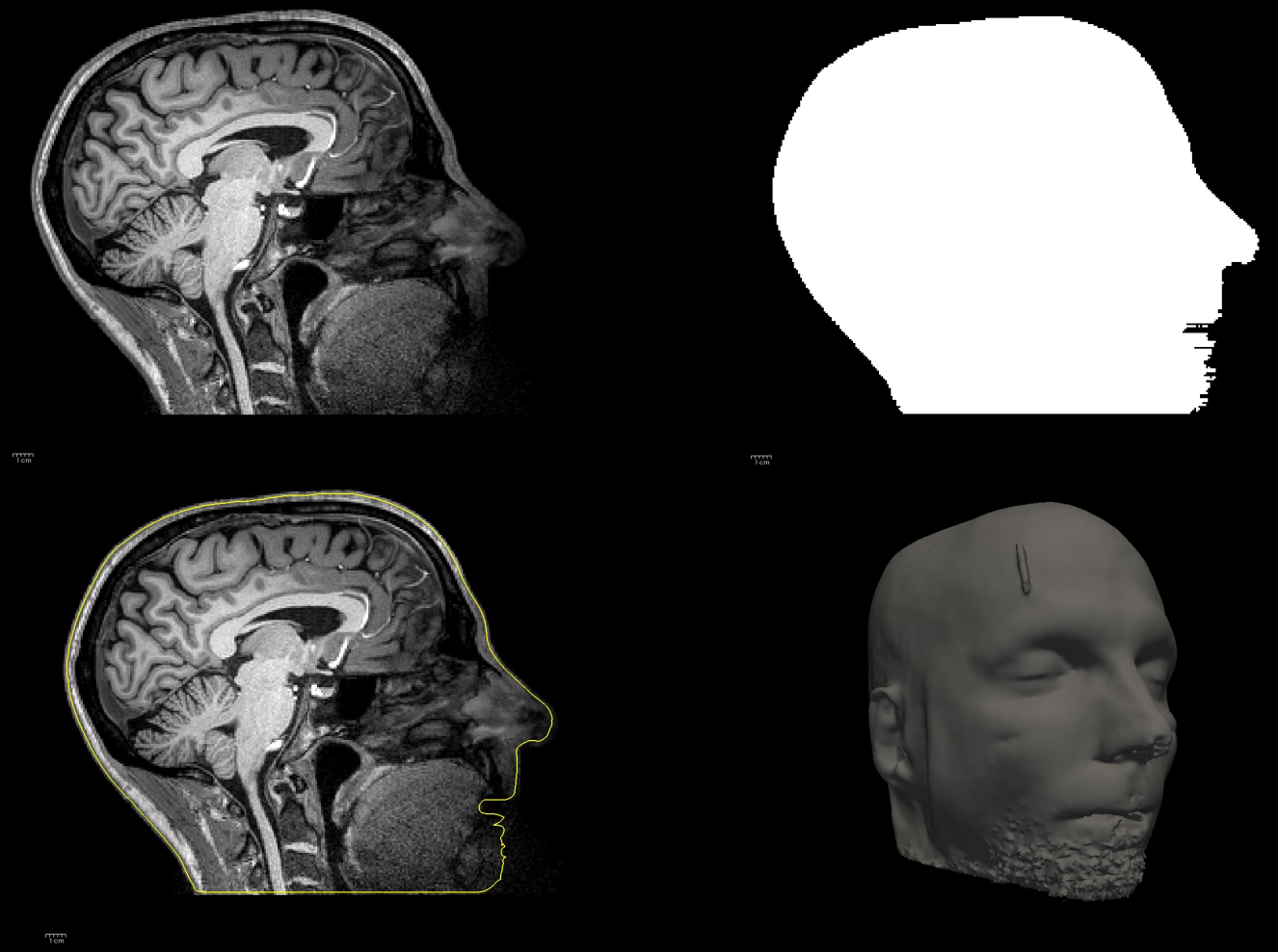
Puonti, Iglesias, van Leemput, 2016, Neuroimage. Fast and sequence-adaptive whole-brain segmentation using parametric Bayesian modeling

Surface-based Face Atlas

- Average head in MNI152 space
- Build a surface around it
- Manually label critical features
- “MIDEFACE” Watermark and Ripples

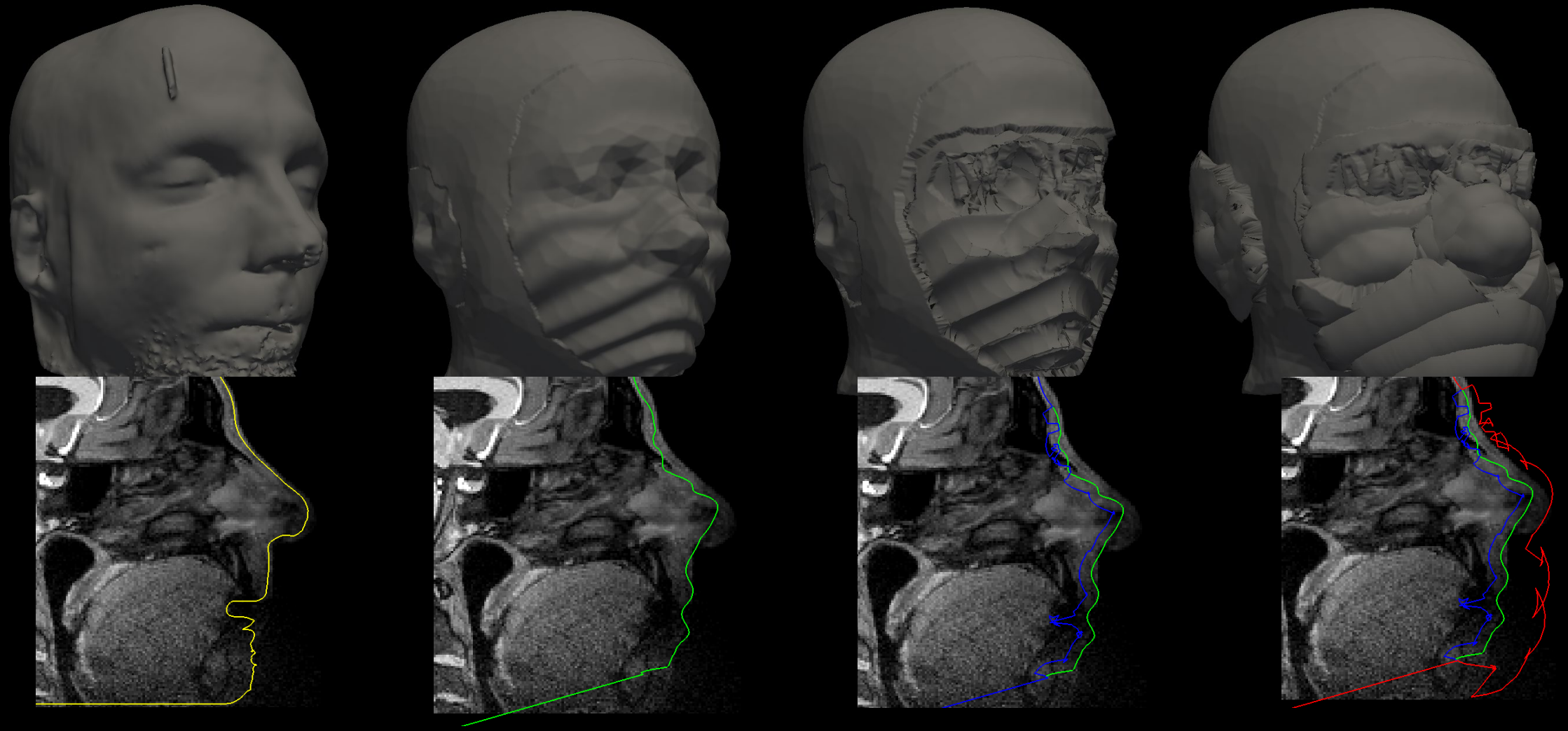
Head Segmentation and Surface Creation

- Head segmentation and true face creation

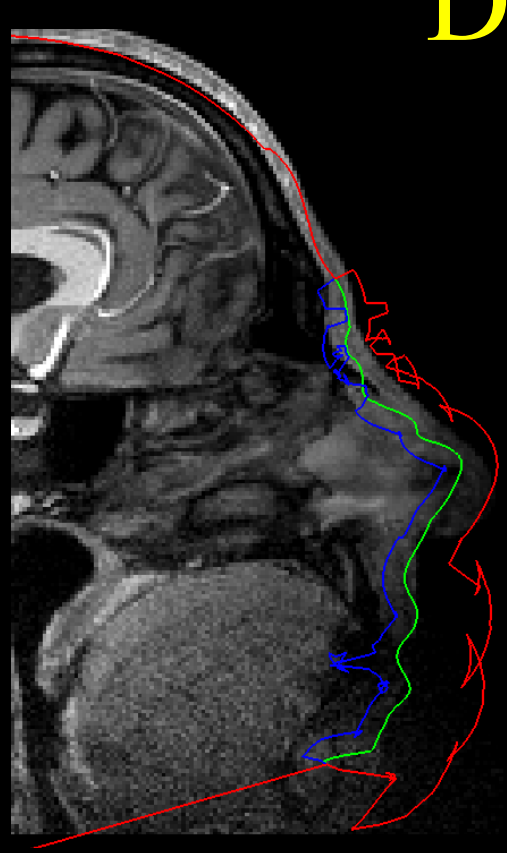


Face Bracketing

- Inward and outward projection of the atlas face
- Respect brain, skull, etc

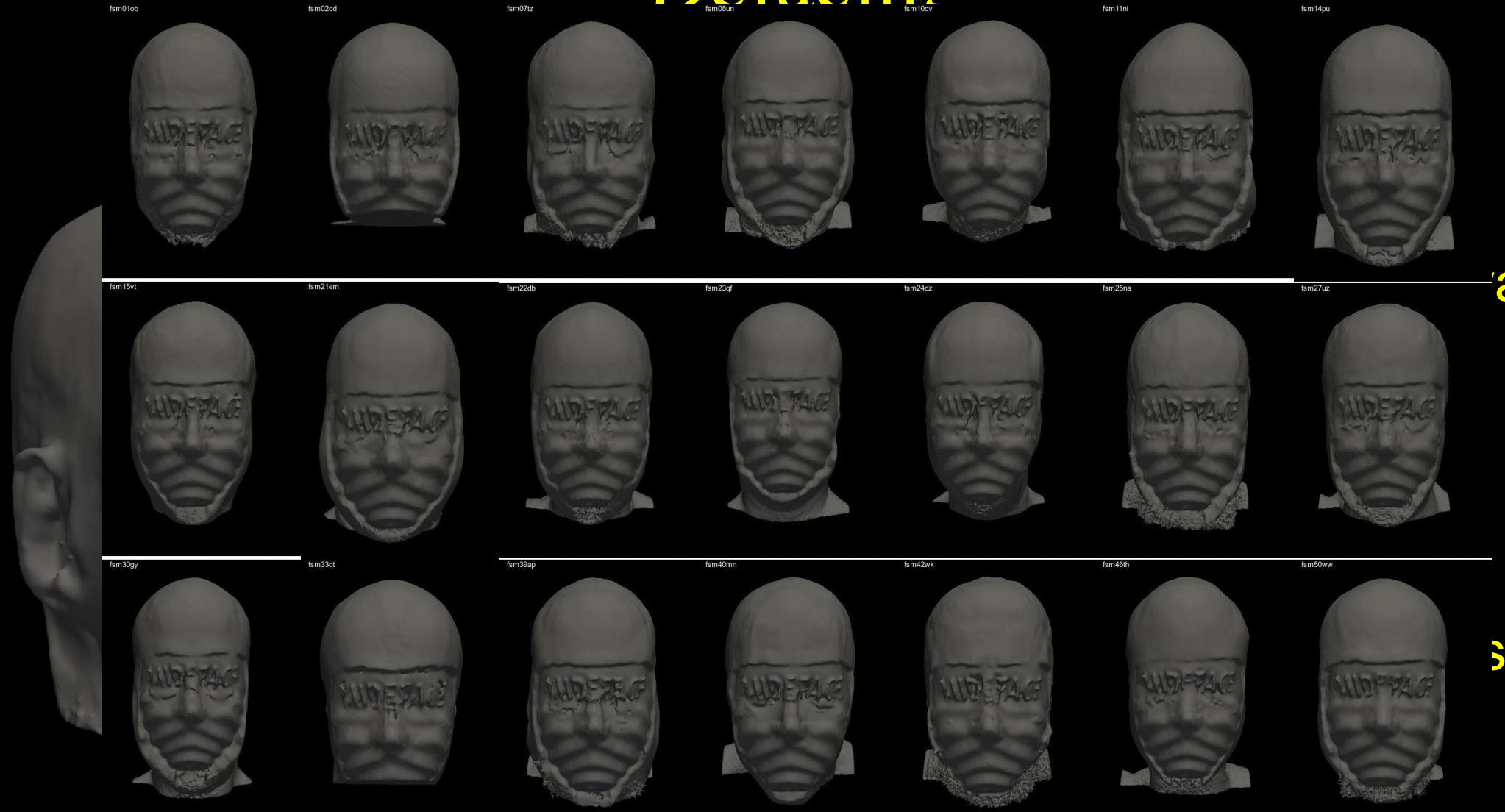


Defacing



- Random intensities at mean and std of the true data
  - Inside the average face (green-blue) – bright and random
  - Outside the average face (green-red) – dark and random
  - Statistically the same (mean, stddev)
  - The boundary of the true face is lost

Defacing



atermark

s

How Non-Invasive is Mideface?

- Study with 41 subjects
- Ran FreeSurfer with and without defacing
- Paired t-test on ROIs and exploratory
  - volume, thickness, area
  - Cortical and subcortical
- No situations in which there were significant differences …
- Except that estimated intracranial volume was 0.1% smaller (p=.001)
  - eICV in FreeSurfer estimated from registration with MNI305

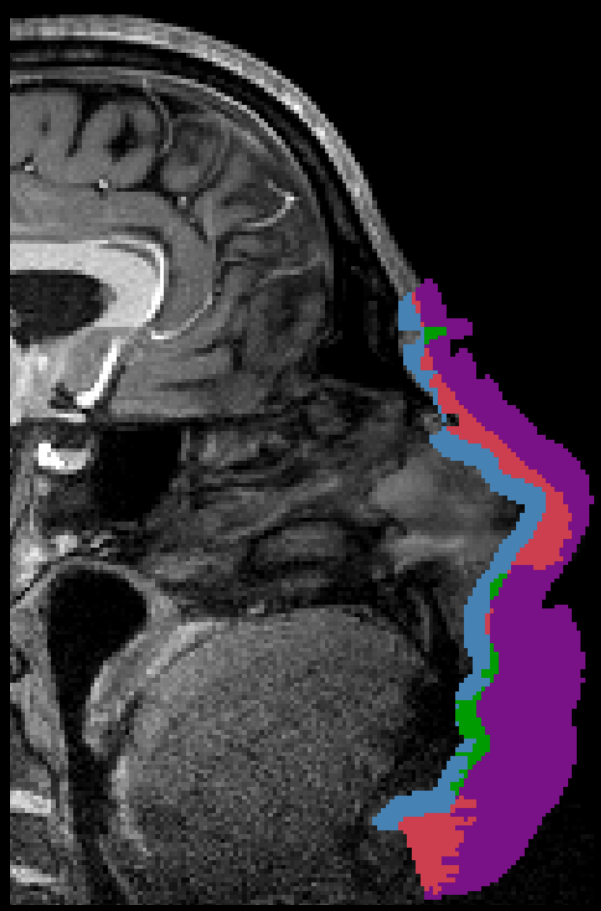
Summary

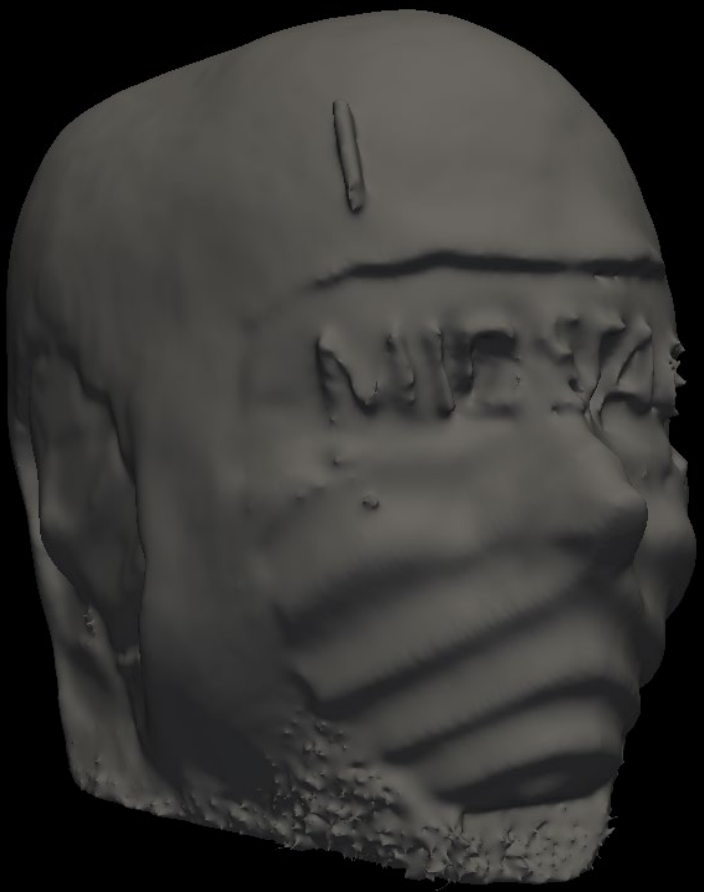
- Segmentation protects parts of the brain/head we want to keep
- Surfaced-based face bracketing/dithering/refacing
- mideface script in FreeSurfer
- https://surfer.nmr.mgh.harvard.edu/fswiki/MiDeFace
- Less than 8min
- Built-in QA visualization (FreeView, PNG pics)
- Can work on multiple modalities
- Can create mask from one volume, apply it to others

End of Presentation

Defacing

- Random intensities at mean and std of the true data

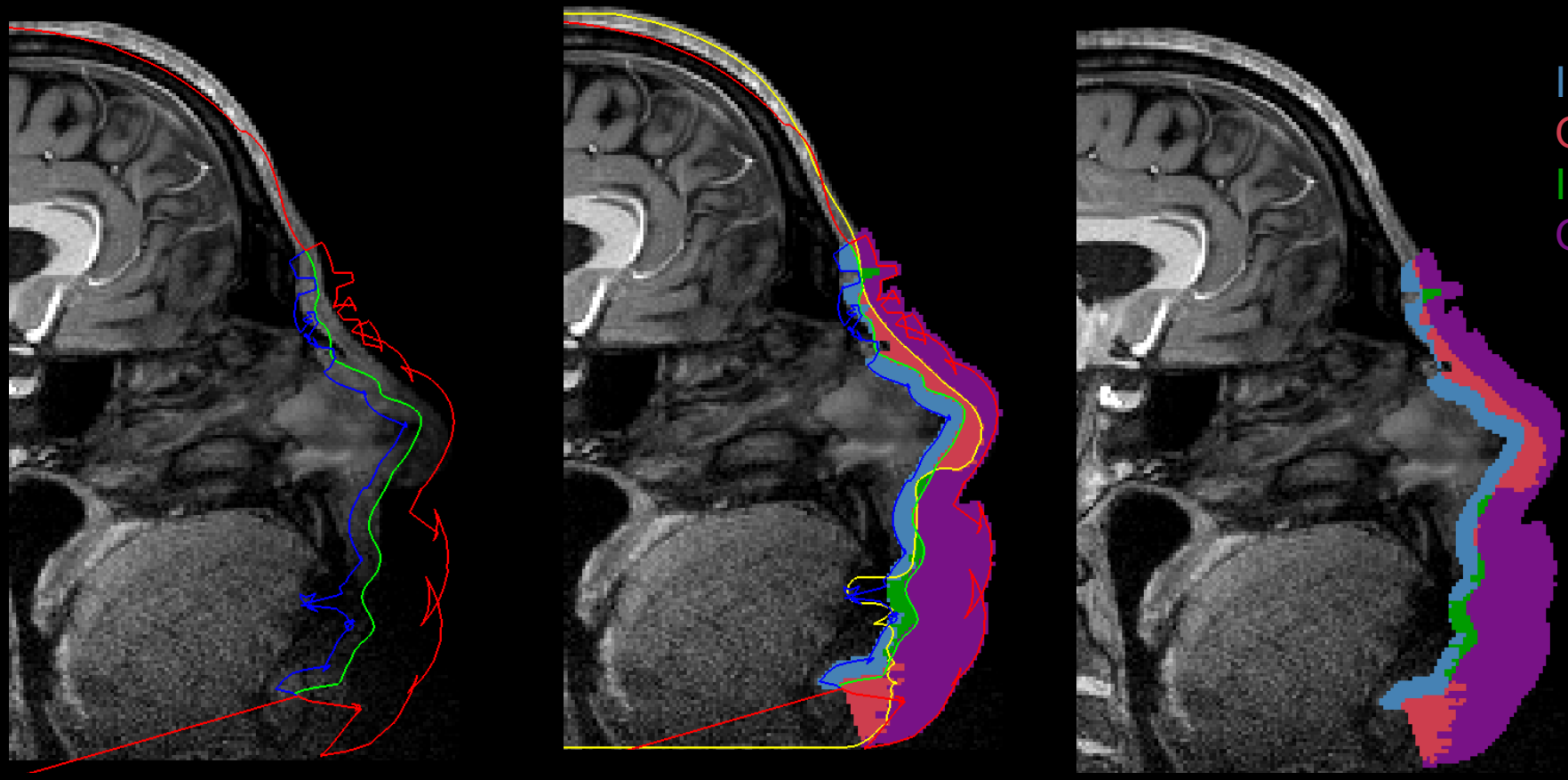




Inner Tissue+Inner Background = Mean/StdDev of true in-face
Outer Tissue+Outer Background = Mean/StdDev of true out-of-face

Face Segmentation

- Four Compartments



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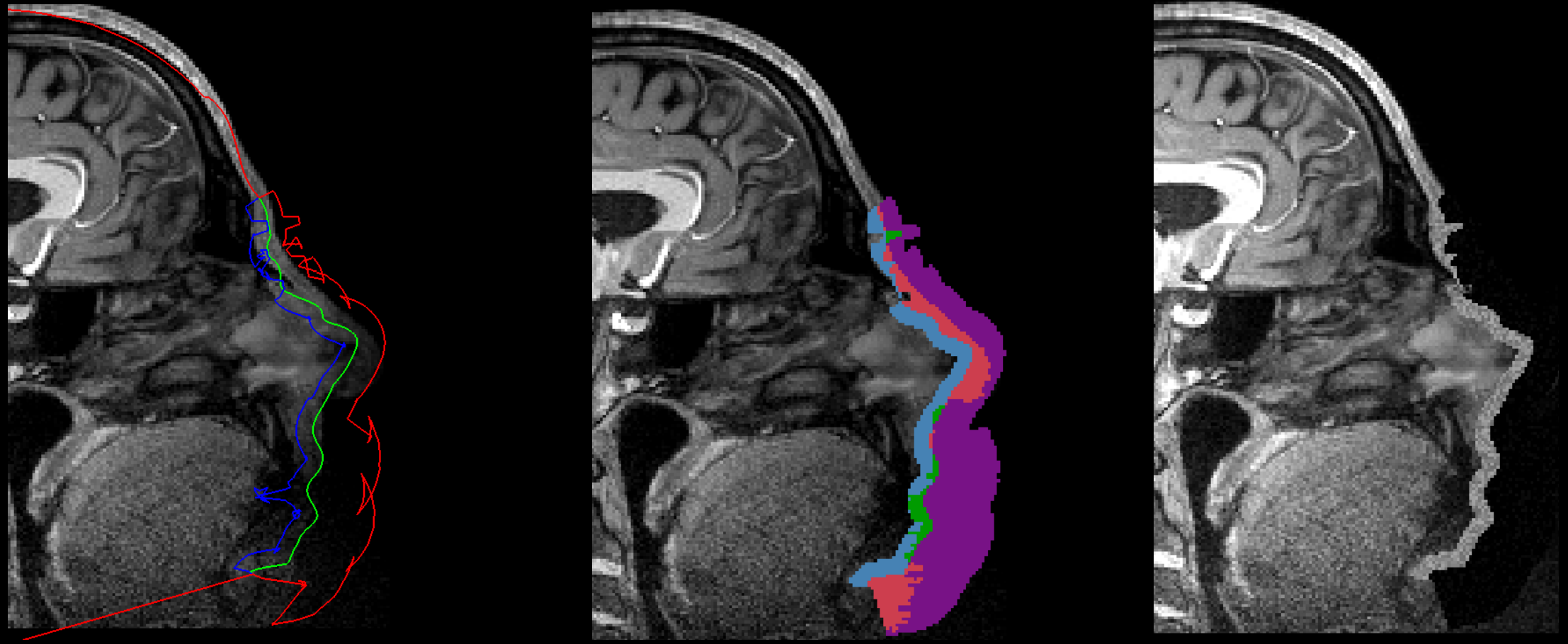

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