Echospine

Lumbar puncture, visible

Team

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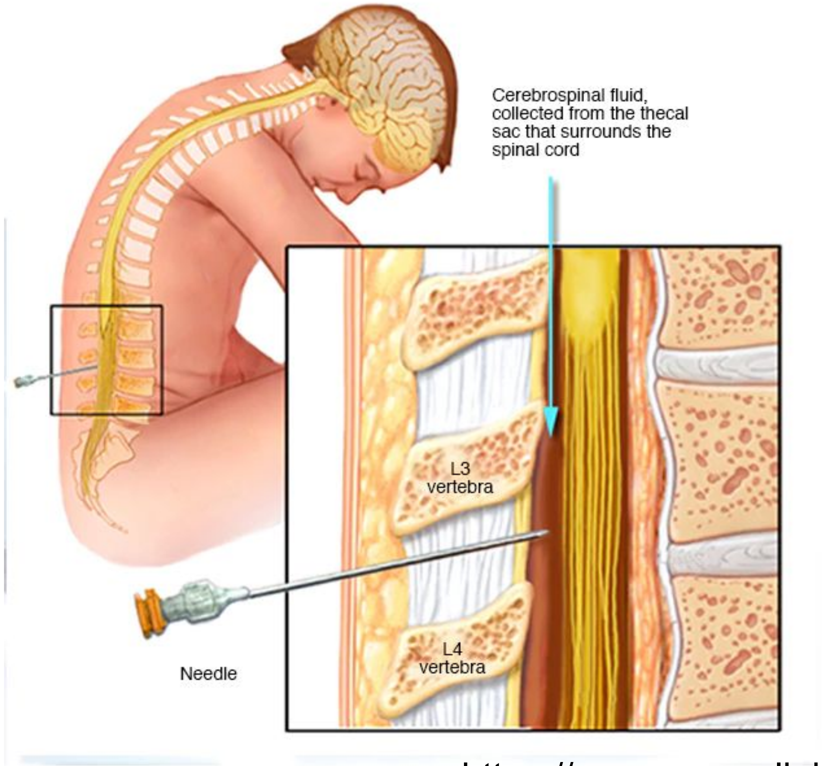
Lumbar puncture is useful



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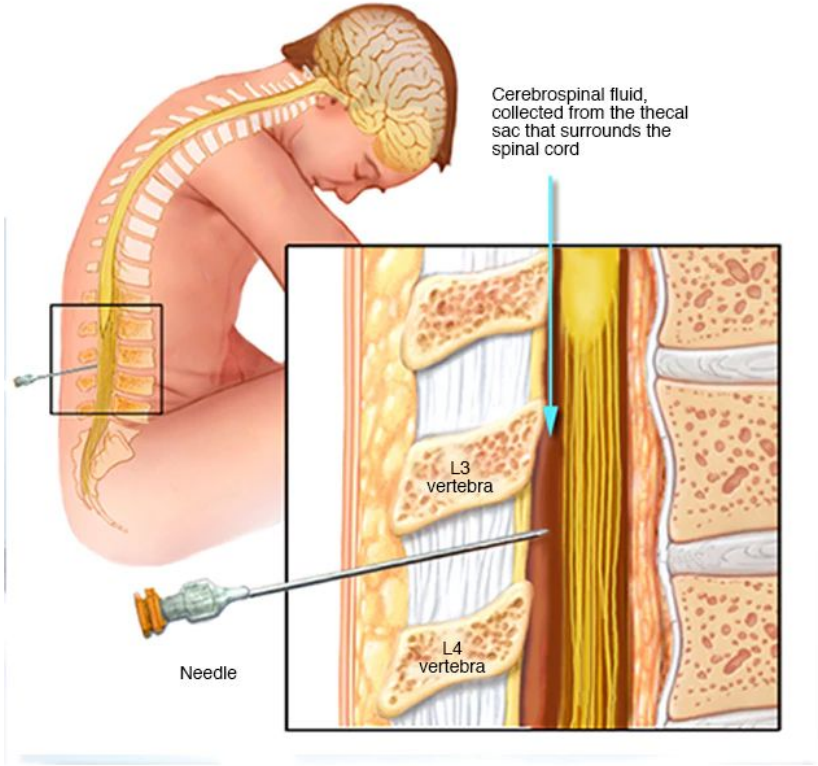
diagnose infections, cancer, bleeding, and inflammations

inject anesthetics and dye

https://www.mayoclinic.org/tests-procedures/lumbar-puncture/about/pac-20394631

Lumbar puncture is blind



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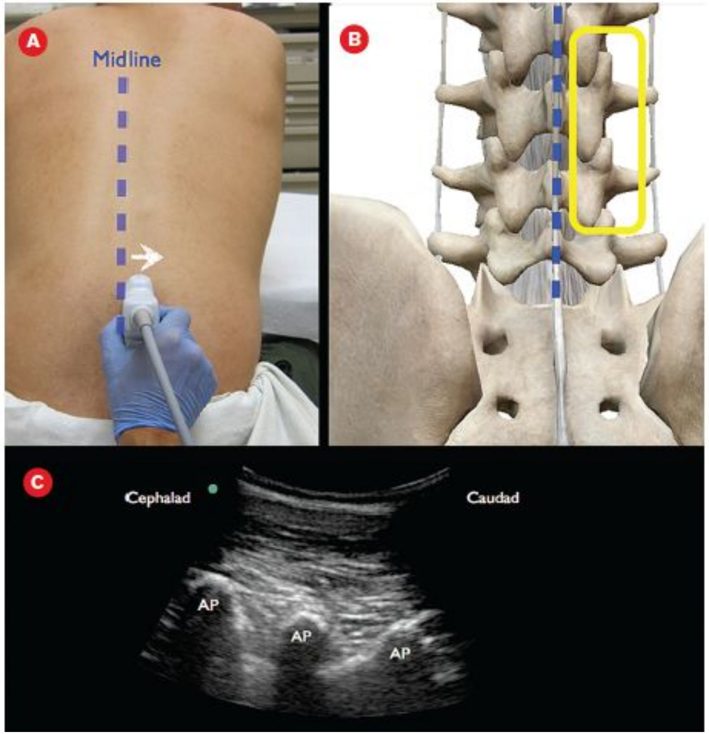
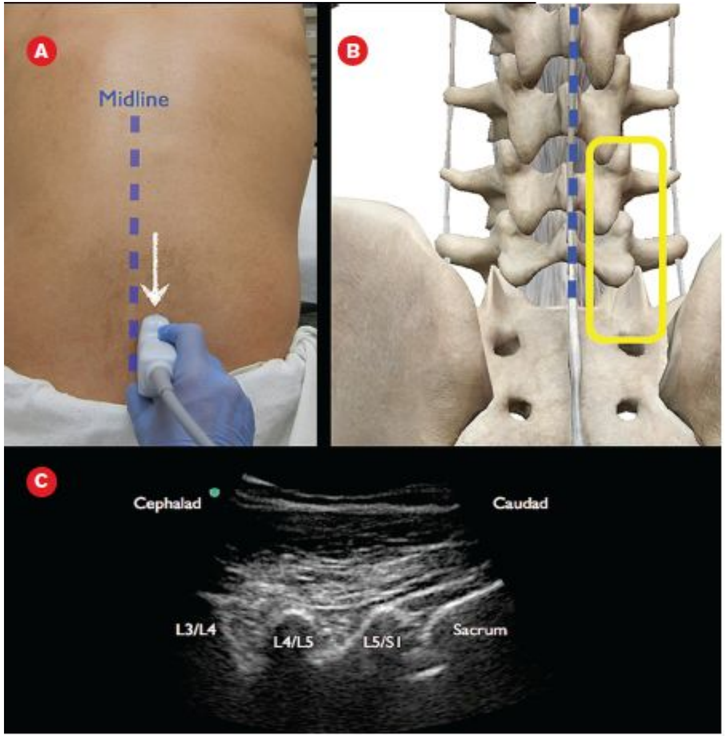
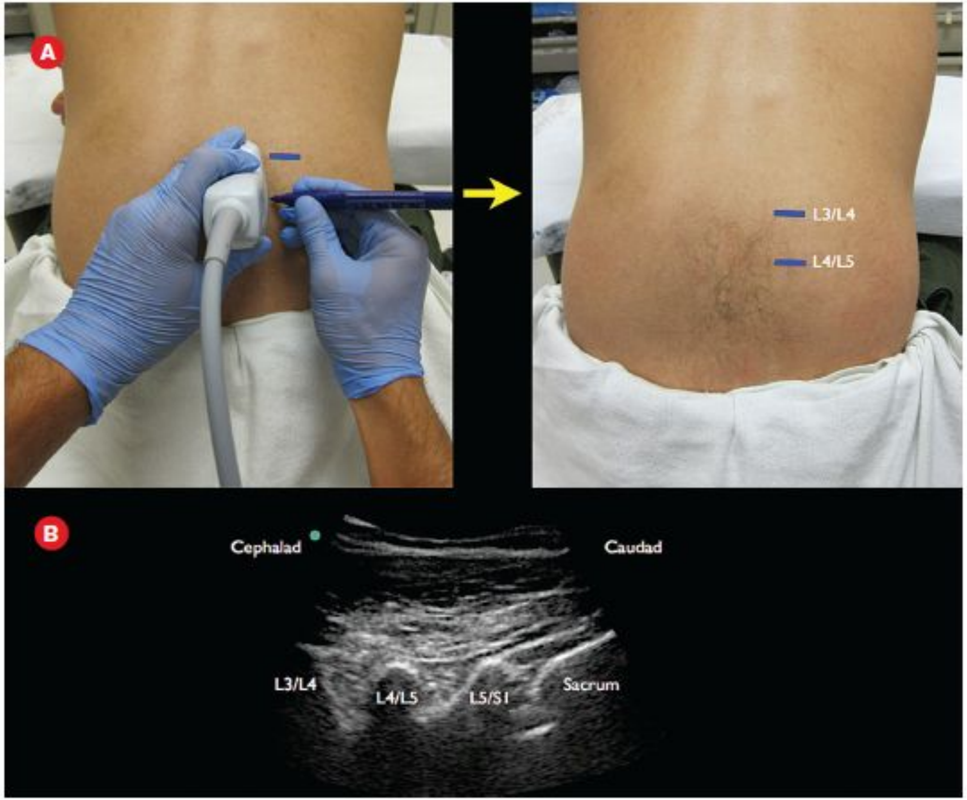
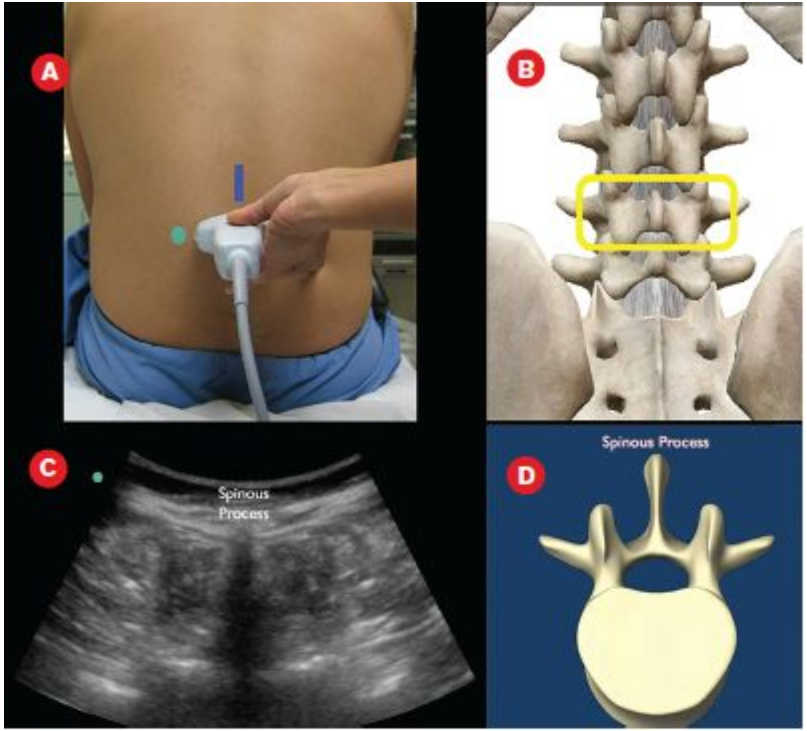
https://www.acepnow.com/article/perform-ultrasound-assisted-lumbar-puncture/

"Regular" ultrasound doesn't work because the probe is in the way






A
L3/L4
L4/L5
B
Cephalad
Caudad
L3/L4
L4/L5
L5/S1
Sacrum


A
B
C
Spinous
Process
D
Spinous Process

Goal

Build a tool to guide lumbar puncture with ultrasound imaging so the clinician can

- Find where and what angle to insert the needle

- See where the needle is as it goes in

- Easily afford the device

Approach

- Find where and what angle to insert the needle

    - **image the spine bones along the midline**

- See where the needle is as it goes in

    - **position the element to optimize needle visibility**

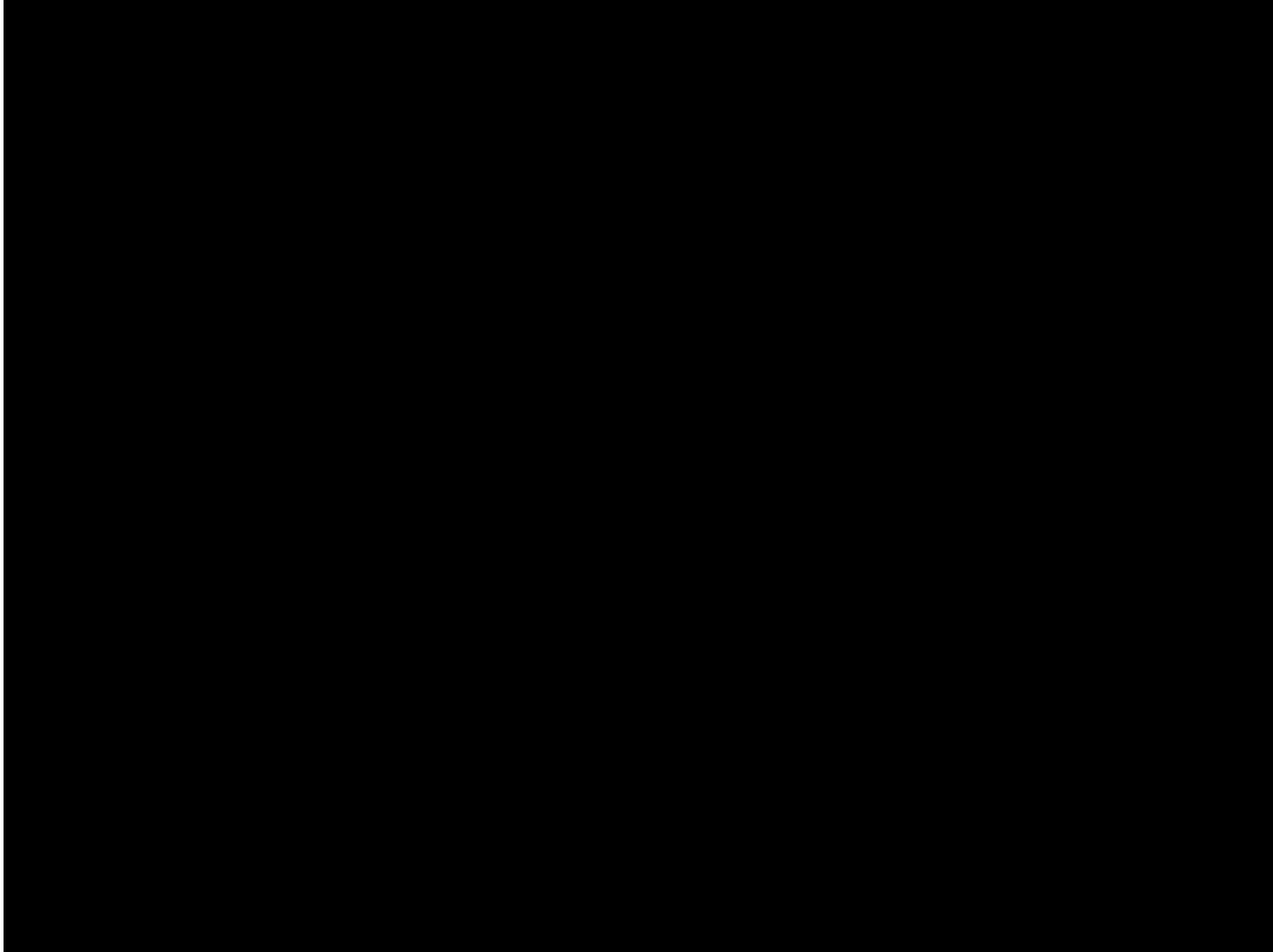
    - **active transmitter on the needle**

- Easily afford the device

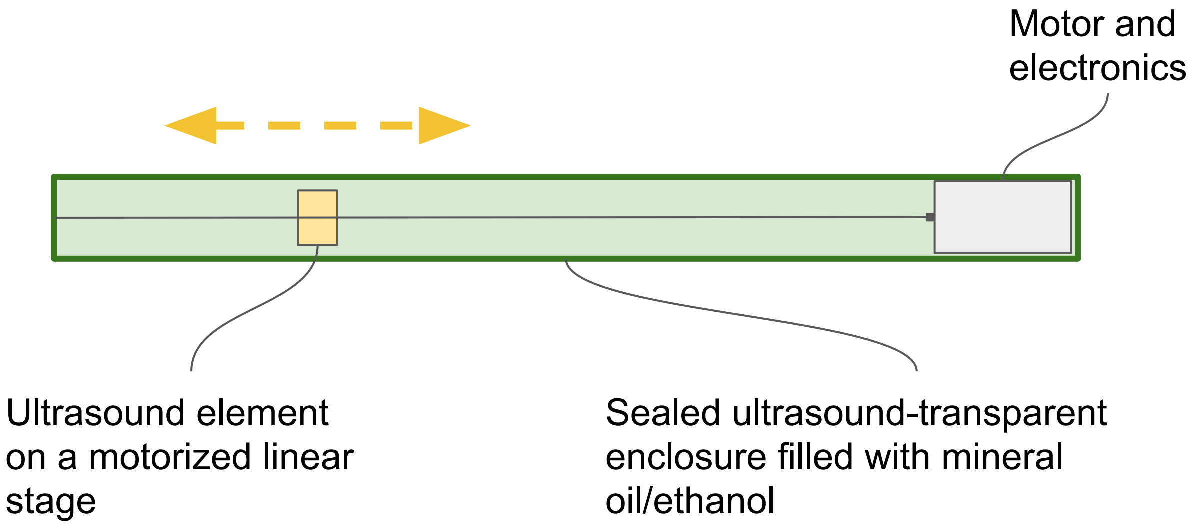
    - **move a few elements to fake a huge array**

    - **trade refresh rate for cost**

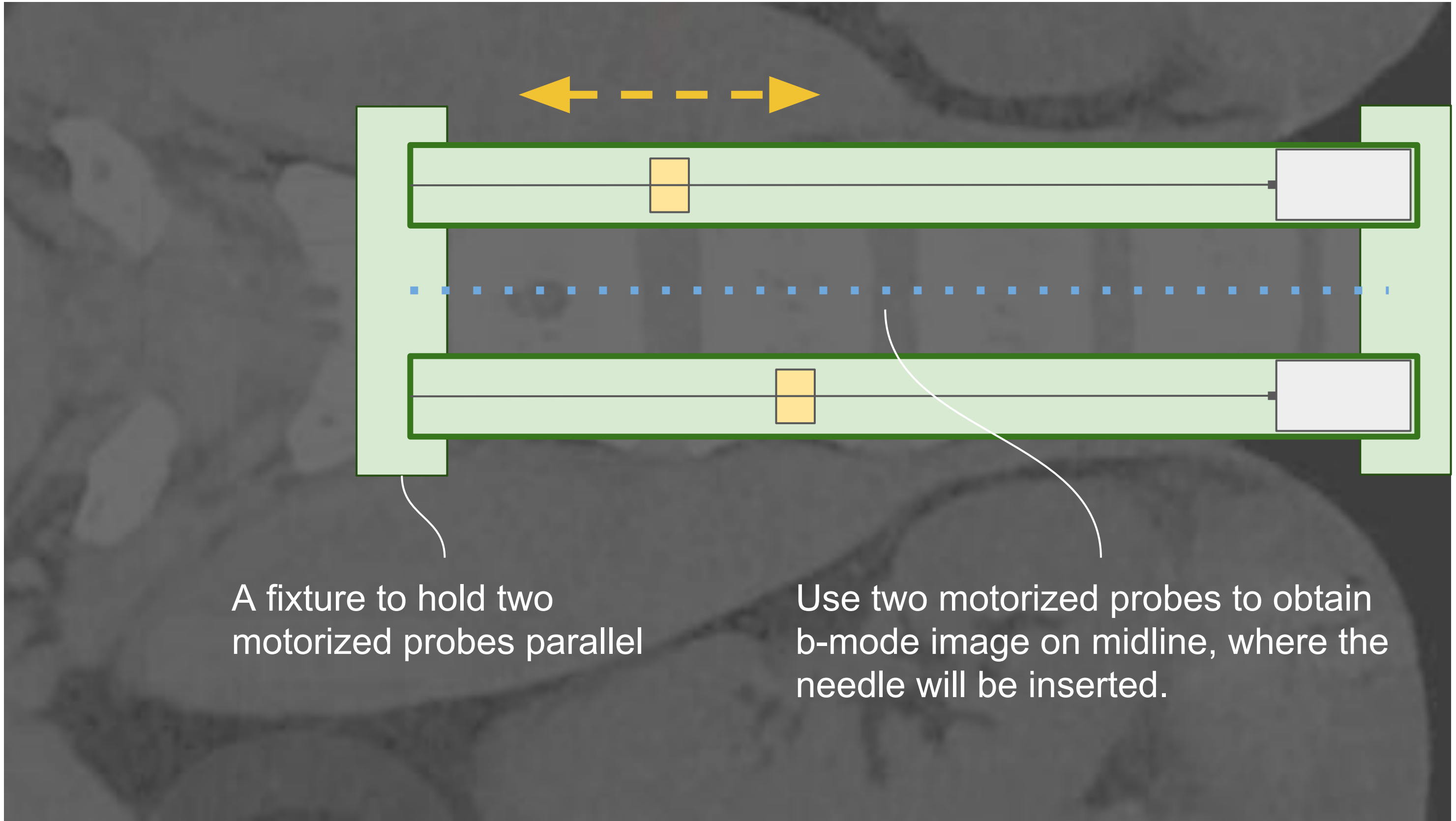
Prior work



Motorized probe



Midplane imaging

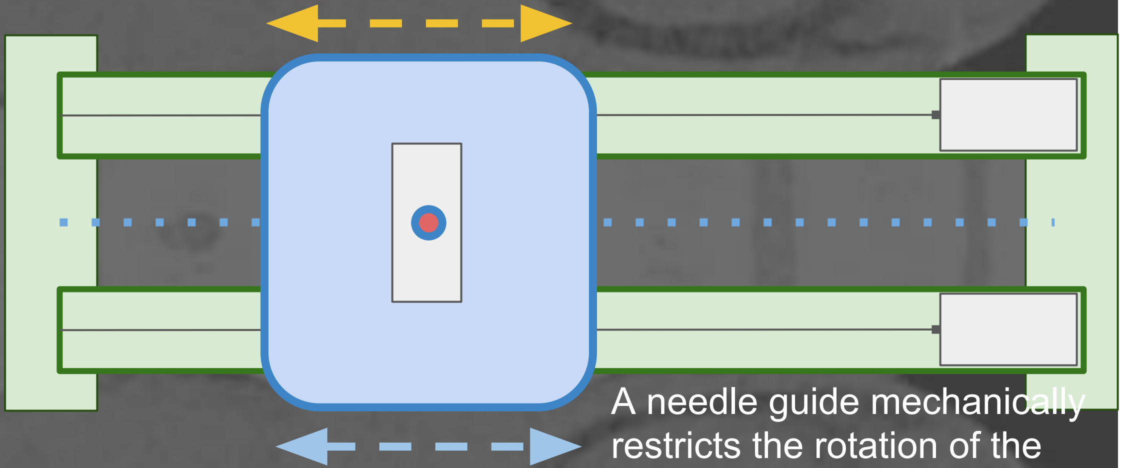


A fixture to hold two motorized probes parallel

Use two motorized probes to obtain b-mode image on midline, where the needle will be inserted.

Needle guide

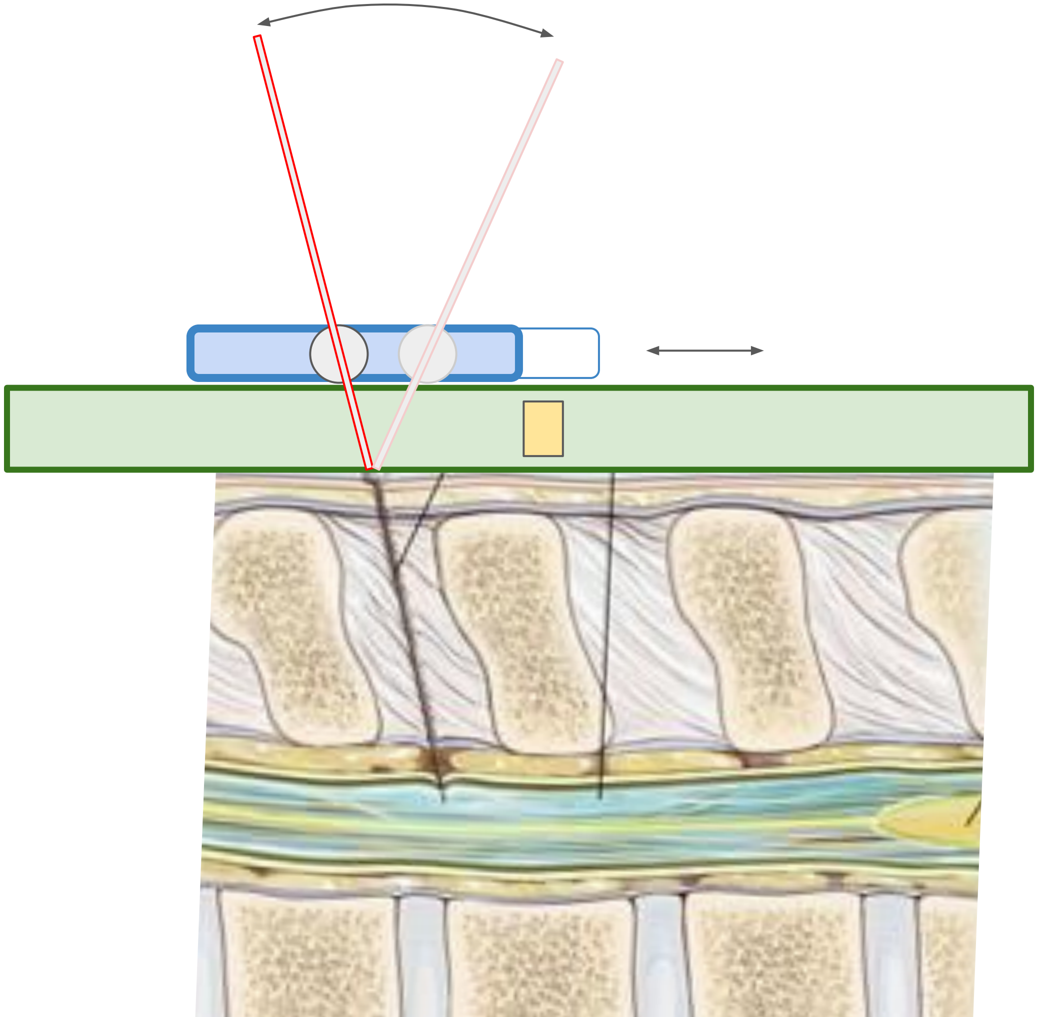
The ultrasound element follows the position of the platform and provide higher-update-rate local image



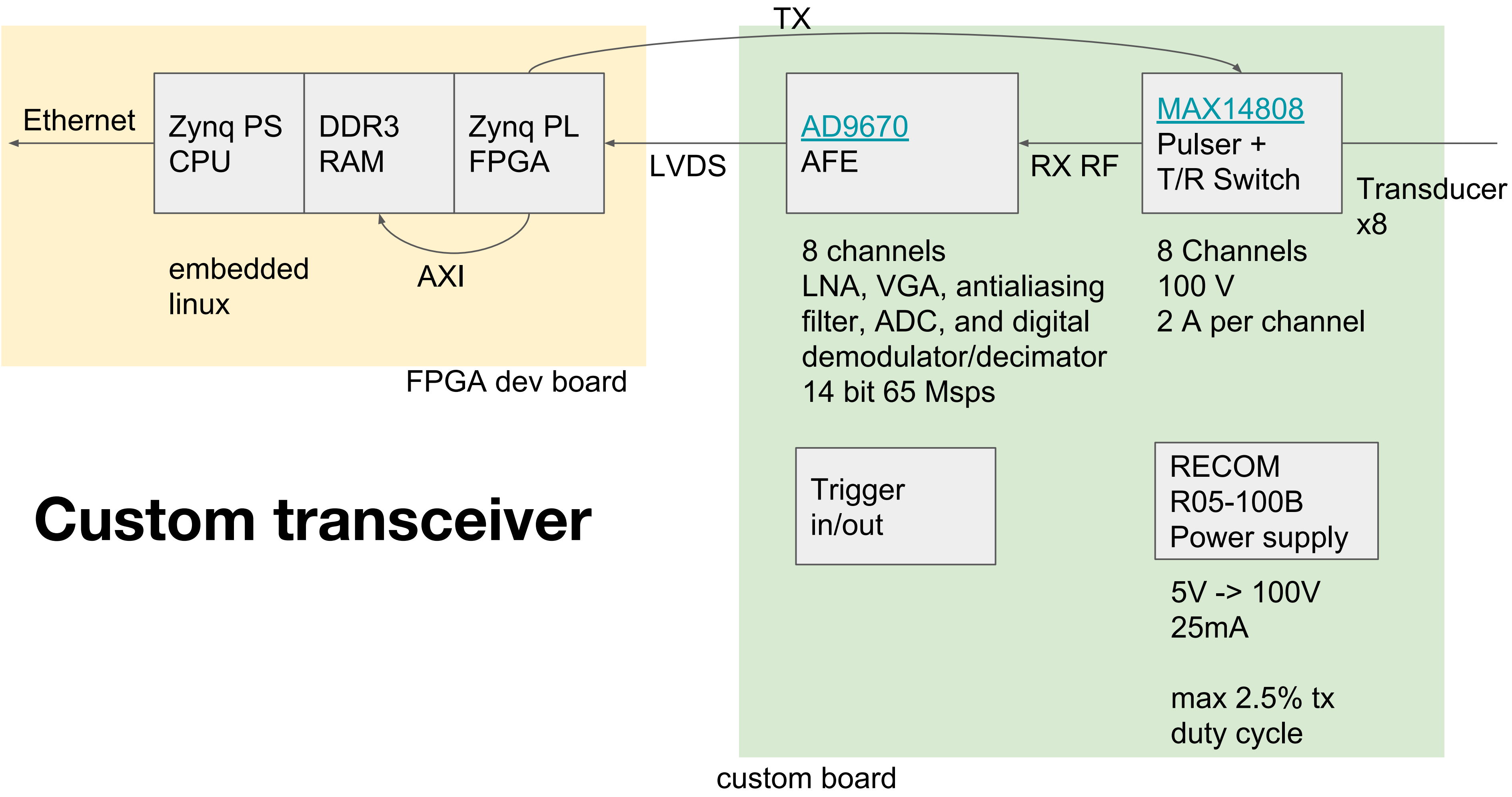
A platform attaches to the top surface of the motorized probes, and use them as rails to move. The platform can sense its position.

A needle guide mechanically restricts the rotation of the needle **in-plane** so the needle is visible in the image.
The needle guide can sense the rotation of the needle

Needle



Custom transceiver



CIS II Goals

minimum:

- design and fabricate the mechanical “ultrasound rails” and the needle guide prototype
- design and fabricate the electronics to drive the moving parts and sense their position
- acquire a image of a spine phantom with “ultrasound rails”

CIS II Goals

expected:

- animal experiment - demo imaging a spine phantom and inserting a needle
- expect the demo to be slow
    - limited by ultrasound equipment
    - see next slide for ambitious fix

CIS II Goals

maximum:

- design and fabricate a FPGA-based ultrasound transmit+receive interface for single-element ultrasound research
  - 50 Msps, 12 bit receive
  - 3-level transmit
  - 8 channels
  - **continuous acquisition and streaming** - high framerate
- use the custom ultrasound interface to demo for the impatient

Dependencies

$$$ - Emad

Find an animal for experiment - Emad

FPGA help - Ralph

Dates

Feb 15. Select ultrasound element, motors, linear motion parts, motor drivers, encoders.

Mar 8. Computer interface PCB sent to fab. Have 3d printed mechanical for the rail.

Mar 29. Read encoder positions. Drive motors. Read A-lines. **Minimum Goal.**

Dates

May 8 - Logic for the needle guide. Faster beamforming w/FPGA/GPU. Improve usability for animal experiment. Animal experiment. **Expected goal**

Parallel with everything - build the FPGA-based ultrasound transceiver.