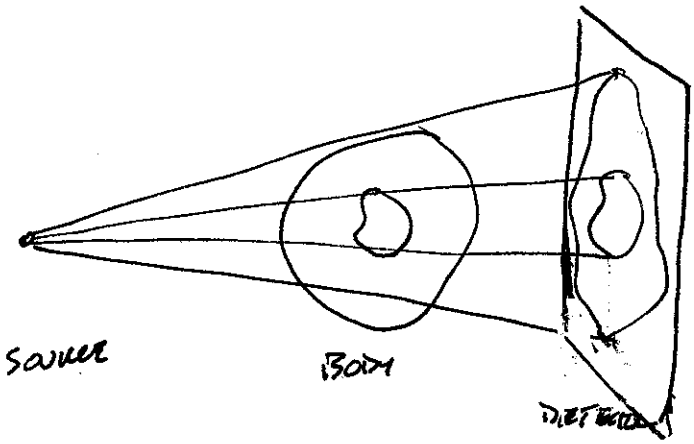
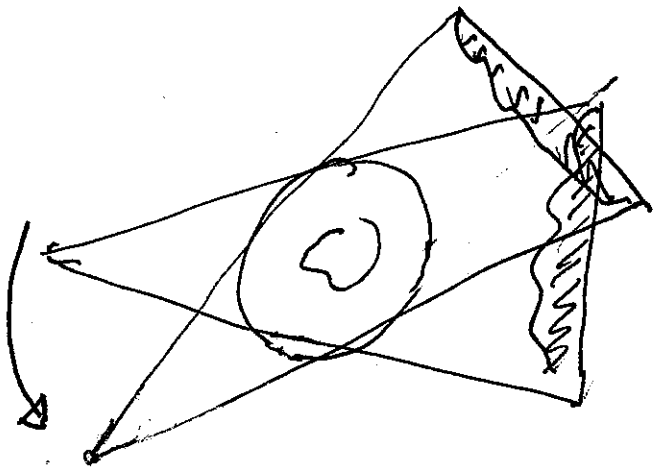
LECTURE 11 TOMOSYNTHESIS

SO FAR WE HAVE



PROJECTION X-RAY

+ SIMPLE SYSTEM
+ LOW DOSE
– STRUCTURES OVERLAP



COMPUTED TOMOGRAPHY

– COMPLEX SYSTEM
– HIGH DOSE
+ VOLUMETRIC RESOLUTION

ARE THERE OTHER WAYS TO RESOLVE IN DEPTH WITHOUT GOING TO A FULL CT SYSTEM?

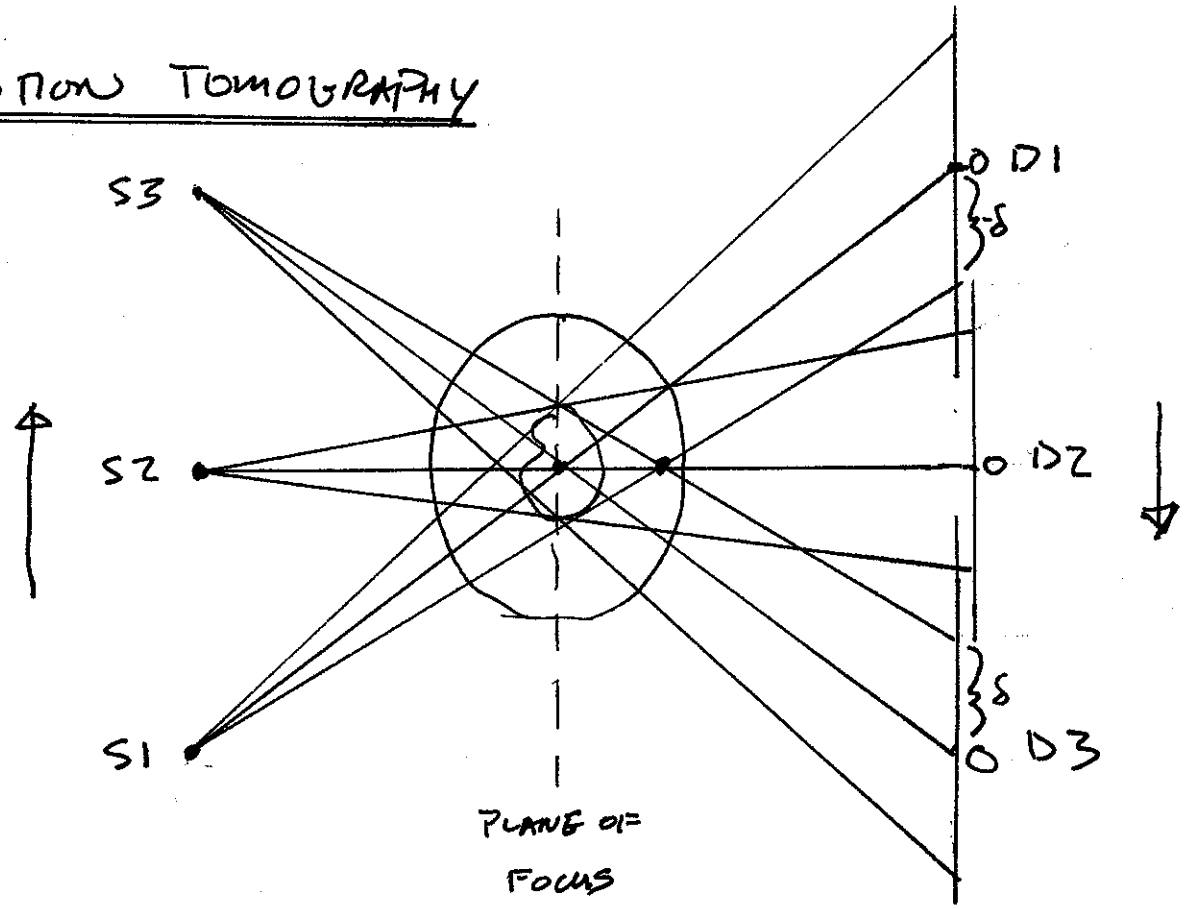
TOMOSYNTHESIS FILLS THIS GAP

EARLIEST FORM: MOTION TOMOGRAPHY

CURRENT FORM: DIGITAL TOMOSYNTHESIS

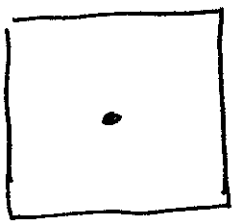
⇒ LIMITED ANGLE CT

MOTION TOMOGRAPHY

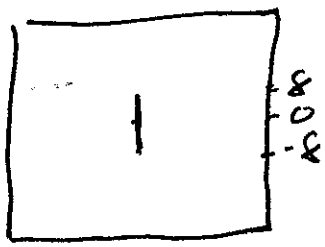


BASIC IDEA: MOVE SOURCE AND DETECTOR (FILM) TOGETHER IN OPPOSITE DIRECTIONS SO THAT ONLY ONE PLANE STAYS FIXED, ALL OTHERS BLUR

IMPULSE RESPONSE



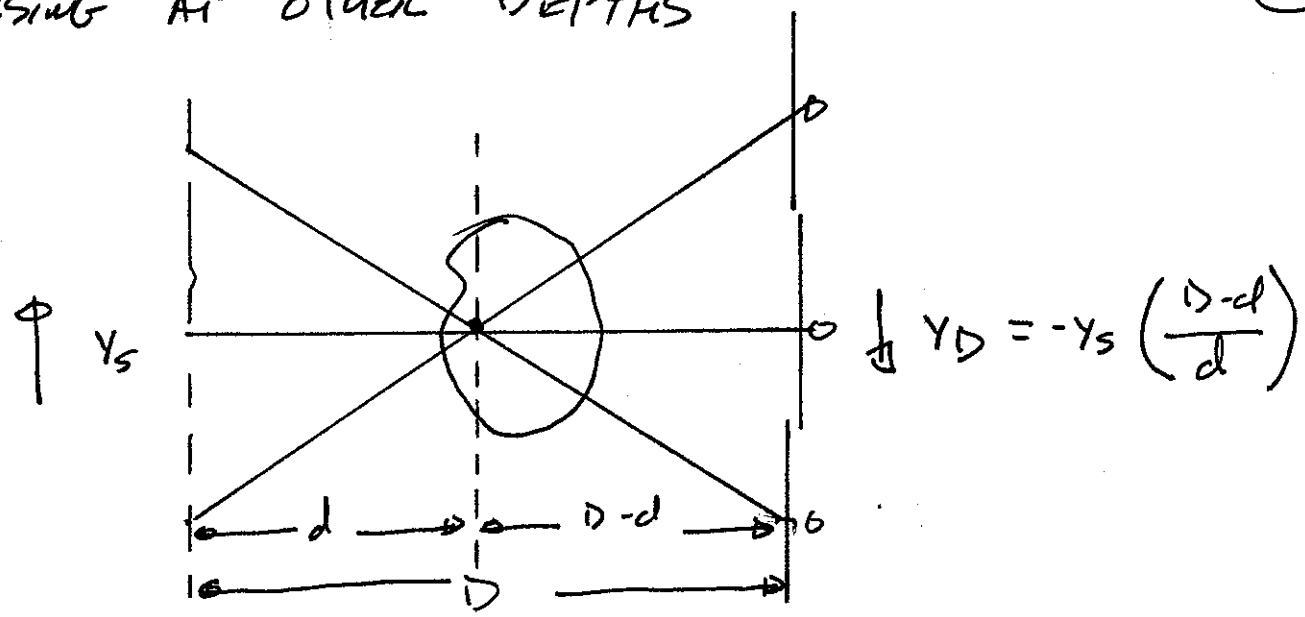
FOCUS PLANE IMPULSE



OTHER PLANE LINE

MORE BLURRING (BETTER LOCALIZATION) WITH DEPTH, AND ANGLE

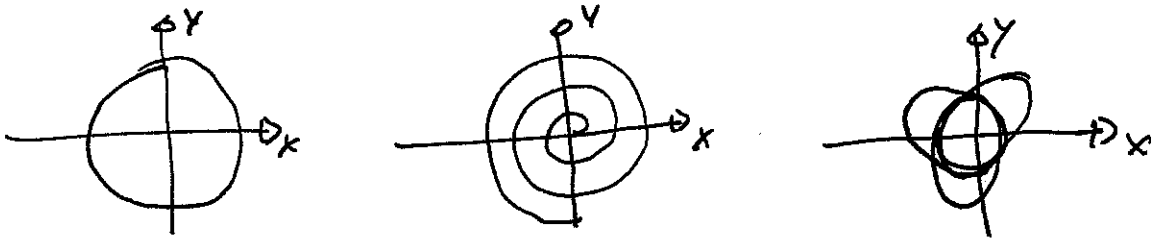
FOCUSING AT OTHER DEPTHS



WITH FILM, EACH DEPTH IS A SEPARATE EXPOSURE.

MOTION COULD ALSO BE IN 2 DIMENSIONS

COMMON EXAMPLES

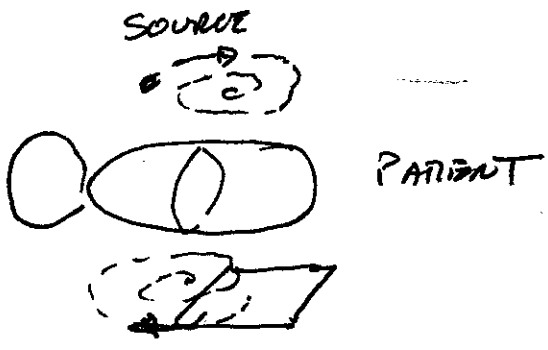


CIRCLE

SPIRAL

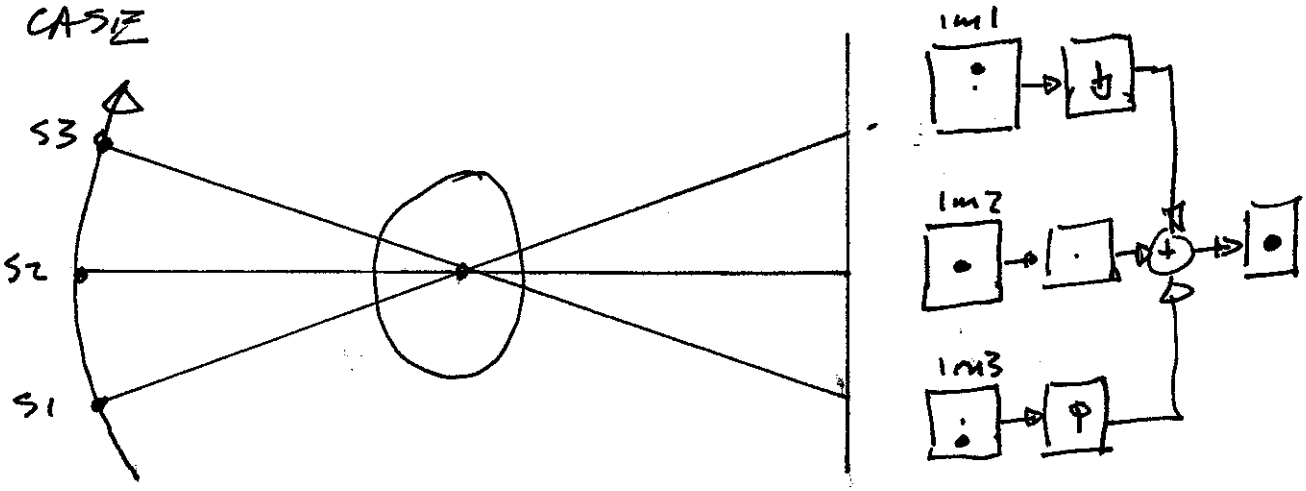
OTHER SPIROGRAPH FIGURES!

FILM MOVES IN OPPOSITE DIRECTION, SCALED BY DEPTH



DIGITAL TOMOSYNTHESIS

SIMPLE CASE



SOURCE MOVES ON ARC

FIXED DETECTOR

SAME EFFECT AS MOTION TOMOGRAPHY

- ONE FOCUS DEPTH
- BLURRING THAT INCREASES WITH DISTANCE FROM FOCUS.
  DEPTH AND ANGLE

DIFFERENCES

- WE CAN COMPUTE ANY FOCUS DEPTH FROM ONE DATA SET.
- WE CAN PROCESS DATA BEFORE COMBINING

SIMPLE SHIFT AND ADD ALGORITHM HAS LOTS OF LOW FREQUENCY BACKGROUNDS ⇒ BLURRED OUTER VOLUME

IF WE ASSUME PROJECTIONS ARE PARALLEL

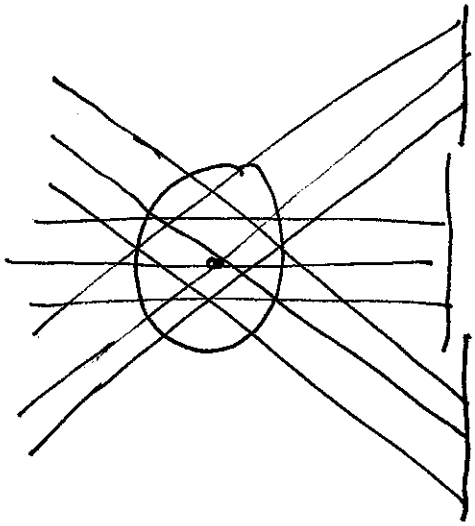
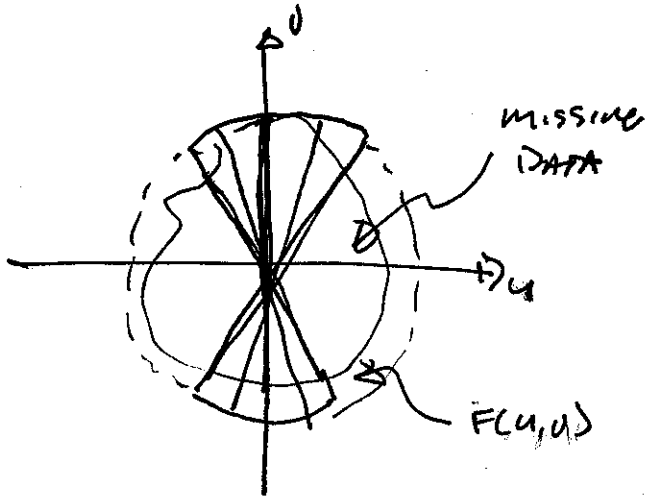


IMAGE DOMAIN



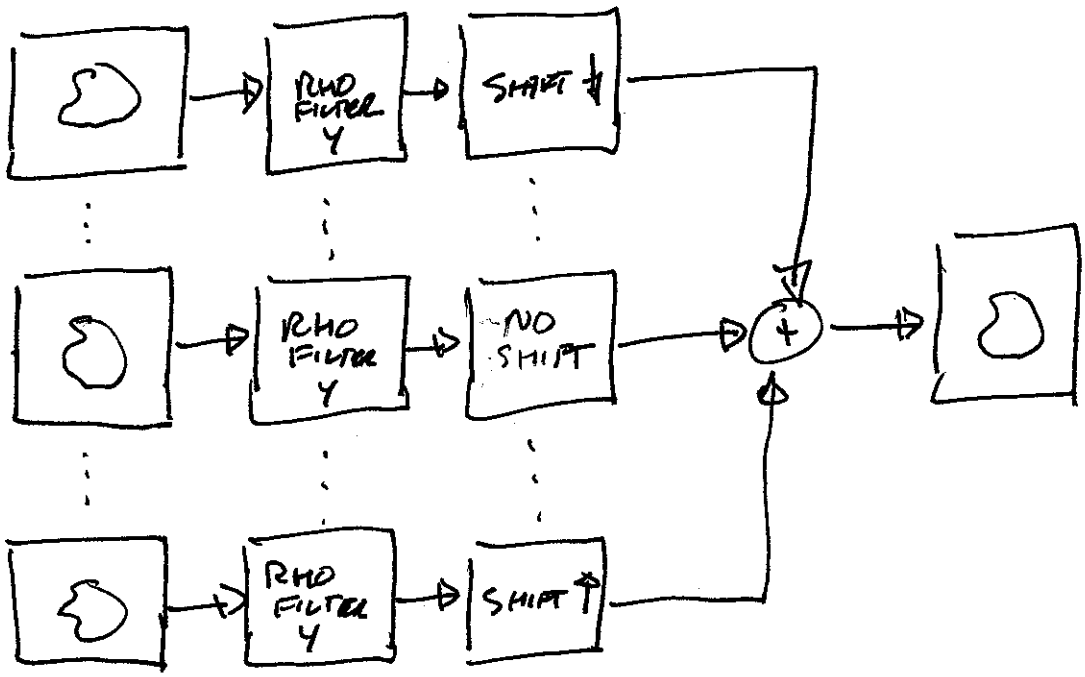
FREQUENCY DOMAIN

WE ARE MISSING A CONE OF DATA IN SPATIAL FREQUENCY, CAN'T UNIQUELY RECONSTRUCT

HOWEVER, DATA IS CLEARLY OVERWEIGHTED AT LOW SPATIAL FREQUENCIES.

CORRECT WITH RHO FILTER IN SWEEP DIRECTION

RECONSTRUCTION



SOURCE IMAGES

RHO FILTER

ALIGN (FOCUS)

FOCUSED IMAGE

REPEAT FOR EACH PLANE