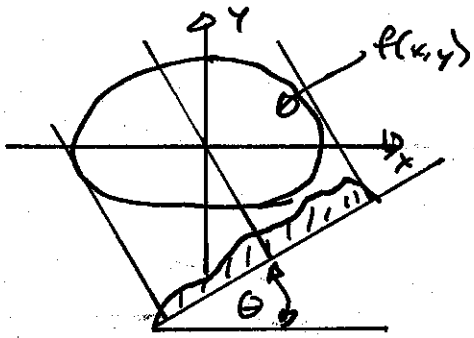
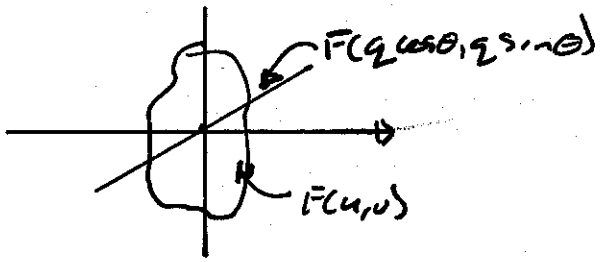
LECTURE 10 FAN BEAM RECONSTRUCTION

SO FAR WE'VE STUDIED PARALLEL BEAM CASE



SPACE

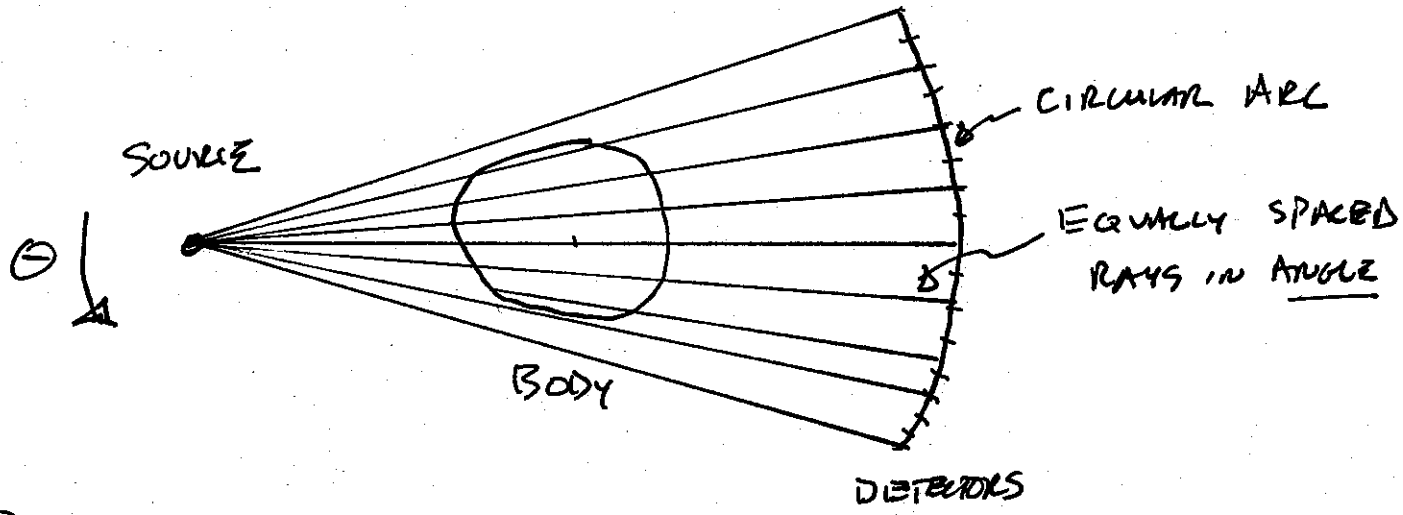


SPATIAL FREQUENCY

ACTUALLY USED IN EARLY CT. STILL USED IN INDUSTRIAL CT SYSTEMS (SCANNING ROCKET MOTORS, SHIPPING CONTAINERS)

PET AND SPECT ARE PARALLEL BEAM RECONSTRUCTIONS

MOST CT SYSTEMS USE <u>FAN BEAM</u> GEOMETRY



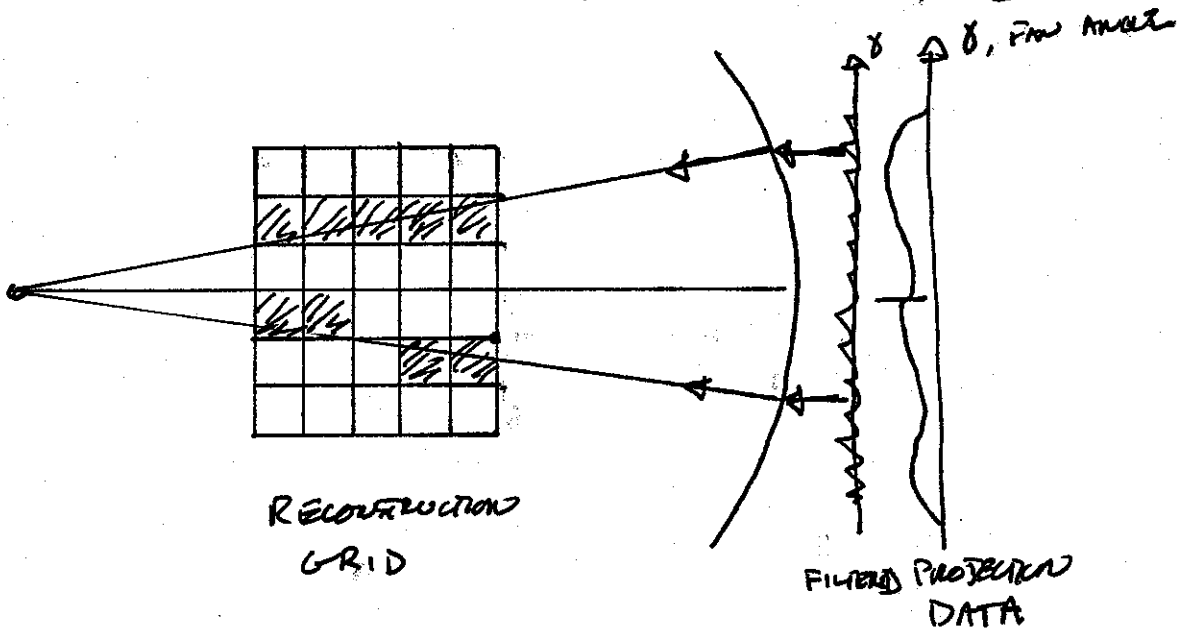
PARALLEL BEAM ALGORITHM DOESN'T WORK DIRECTLY

TWO APPROACHES

1) FIX UP BACKPROJECTION: FAN BEAM FILTERED BACKPROJECTION
2) RESORT DATA INTO PARALLEL BEAM DATA: REBINNING

FAN BEAM FILTERED BACKPROJECTION

BASICALLY SAME IDEA AS FILTERED BACKPROJECTION



1) FILTER PROJECTION DATA WITH "RHO" FILTER

2) BACKPROJECT ALONG FAN RAYS

SEVERAL ISSUES

1) RHO FILTER SHOULD BE DIFFERENT AT DIFFERENT DEPTHS

2) THE RAYS ARE NOT UNIFORMLY DISTRIBUTED
   DENSITY CORRECTION

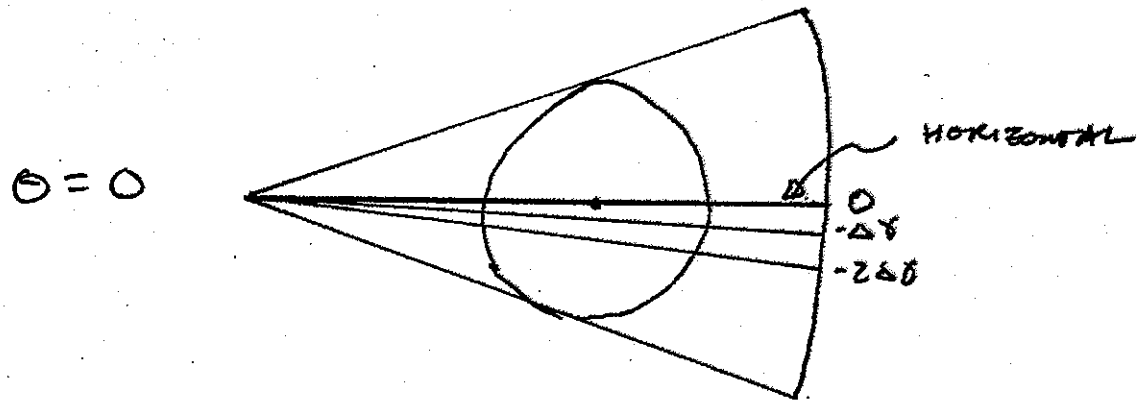
THE BOOK TALKS ABOUT THIS APPROACH

REBINNING

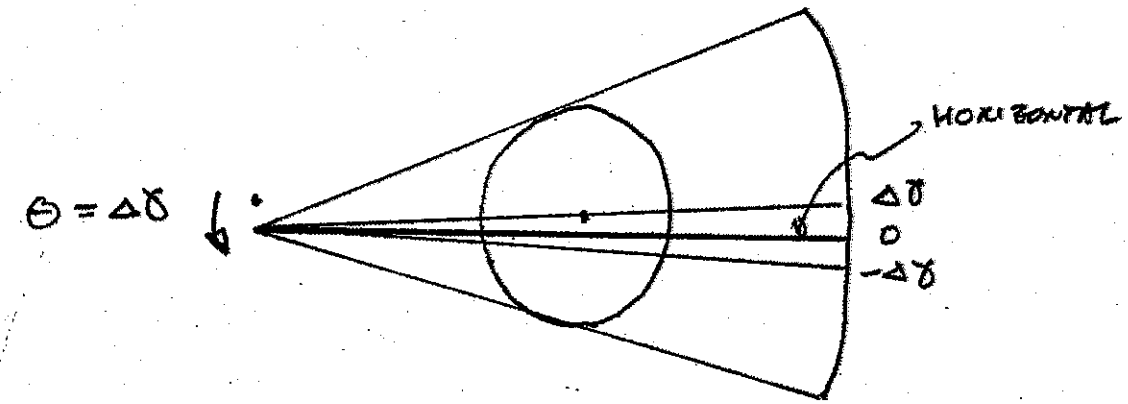
CONVERT THE PROBLEM TO A PARALLEL BEAM PROBLEM

BASIC REBINNING IDEA

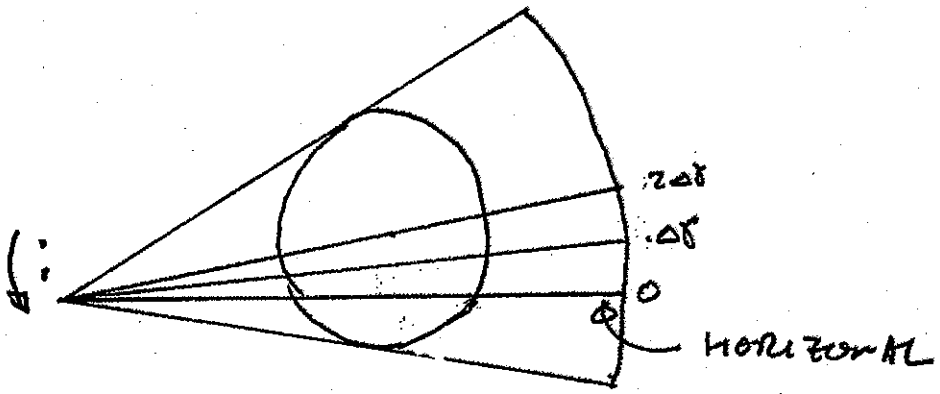
ASSUME BEAMS SPACED BY $\Delta\delta$, AND THAT WE ROTATE BY $\Delta\gamma$ STEPS



AFTER INCREASING Θ BY $\Delta\delta$

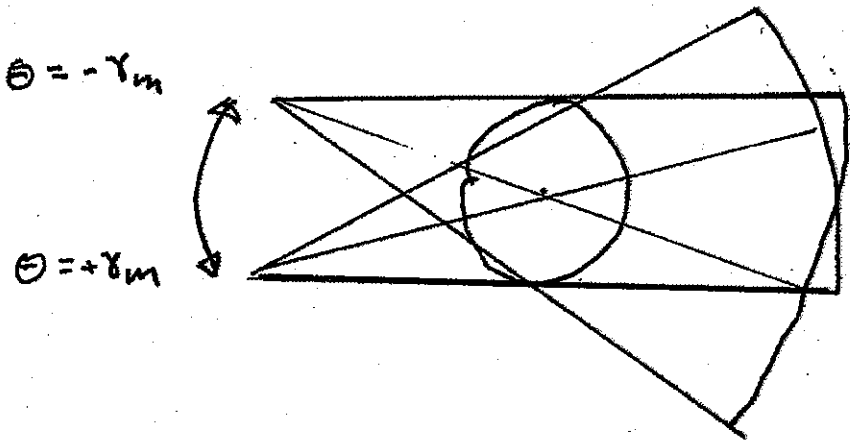


$\Theta = 2\Delta\gamma$



WE CAN COLLECT ALL THESE PARALLEL BEAMS INTO ONE PARALLEL PROJECTION

THE EDGE RAYS ARE;



ONE PROJECTION REQUIRES $2\gamma_m$, WHERE THE FAN BEAM GOES FROM $\pm\gamma_m$

TOTAL ANGLE REQUIRED FOR RECONSTRUCTION IS

$$\pi + 2\gamma_m$$

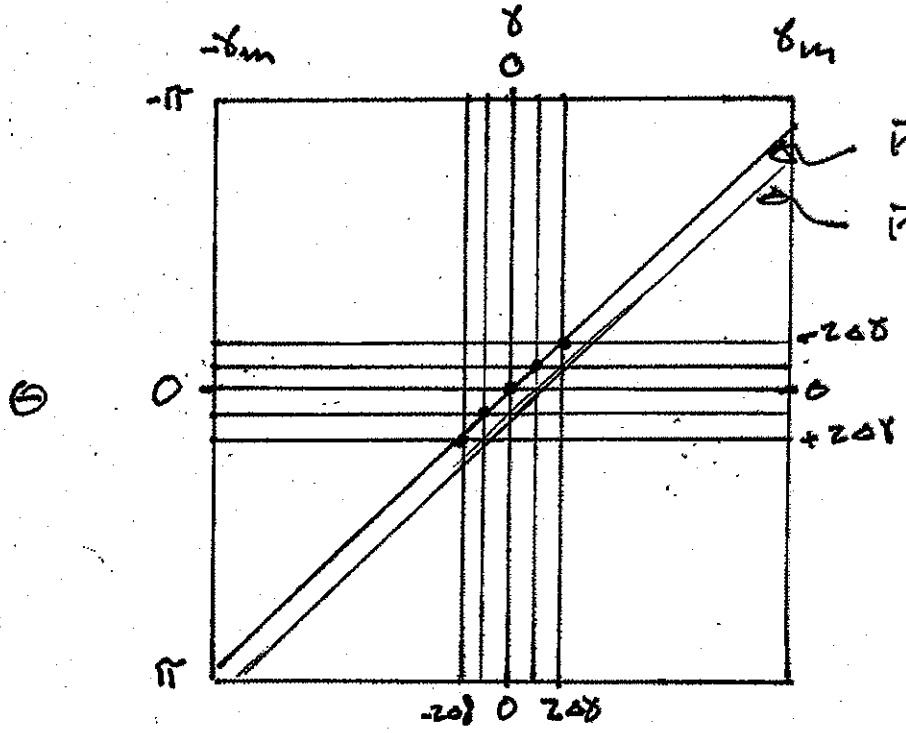
TOTAL NUMBER OF PROJECTIONS

$$N = \frac{\pi + 2\gamma_m}{\Delta\theta}$$

FOR EVERY $\Delta\theta$ FROM $-\gamma_m$ TO γ_m, ANOTHER RAY BECOMES PARALLEL TO THE $\theta=0$, $\gamma=0$ RAY

WE CAN PLOT THIS ON A SINOGRAM

ASSUME $\Delta\theta=\Delta\gamma$



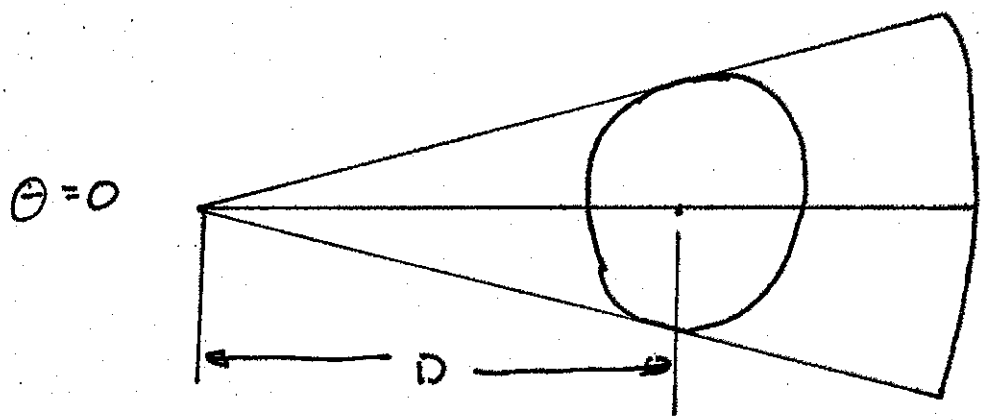
WE CAN CREATE PARALLEL PROJECTIONS BY SAMPLING THE SINOGRAM ALONG DIAGONAL LINES

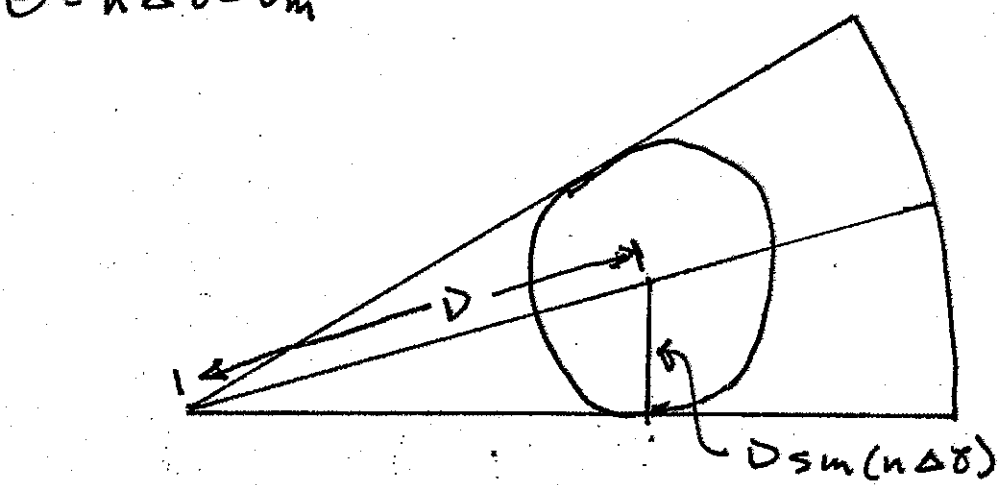
EASY IF $\Delta\theta=\Delta\gamma$, OR MULTIPLES

REQUIRES 2D INTERPOLATION IN GENERAL.

PROBLEM

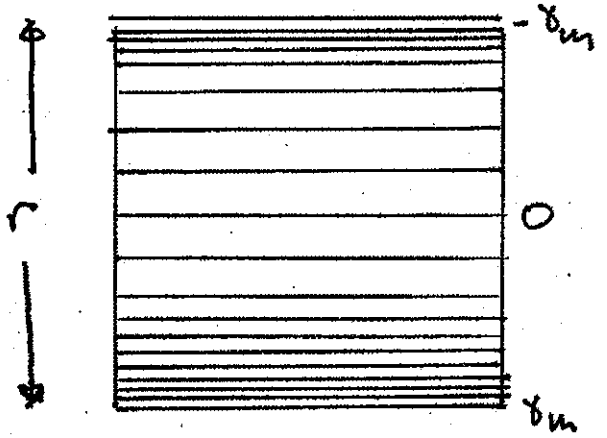
ALTHOUGH THE REBINNED DATA IS PARALLEL, IT IS NOT UNIFORMLY SPACED!





$$\sin(n\Delta\gamma) < n\Delta\gamma$$

PROJECTIONS GET CLOSER AS ANGLE INCREASES



RAY SPACING FOR $\theta = 0$

$$r_n = D\sin(\gamma_n) = D\sin(n\Delta\gamma)$$

RESAMPLE TO GET UNIFORM SPACING

ALSO A DENSITY CORRECTION ISSUE, IMPORTANT FOR FAN BEAM FILTERED BACKPROJECTION

SUMMARY OF REBINNING

1) RESAMPLE SINOGRAM ALONG DIAGONAL LINES TO GENERATE PARALLEL BEAM DATA
2) RESAMPLE PARALLEL PROJECTIONS TO GET UNIFORMLY SAMPLED DATA
3) RHO FILTER
4) BACKPROJECT

COMPARISON

FAN BEAM FILTERED BACKPROJECTION

ADAPTS TO NON-EQUAL-ANGLE DATA, OTHER SCANNER GEOMETRIES

ONLY INTERPOLATION IS BACKPROJECTION

SUBTLETIES IN RHO FILTER, DENSITY

REBINNING

MULTIPLE INTERPOLATIONS

SINOGRAM RESAMPLING

DENSITY RESAMPLING

BACKPROJECTION

CONCEPTUALLY MORE STRAIGHTFORWARD