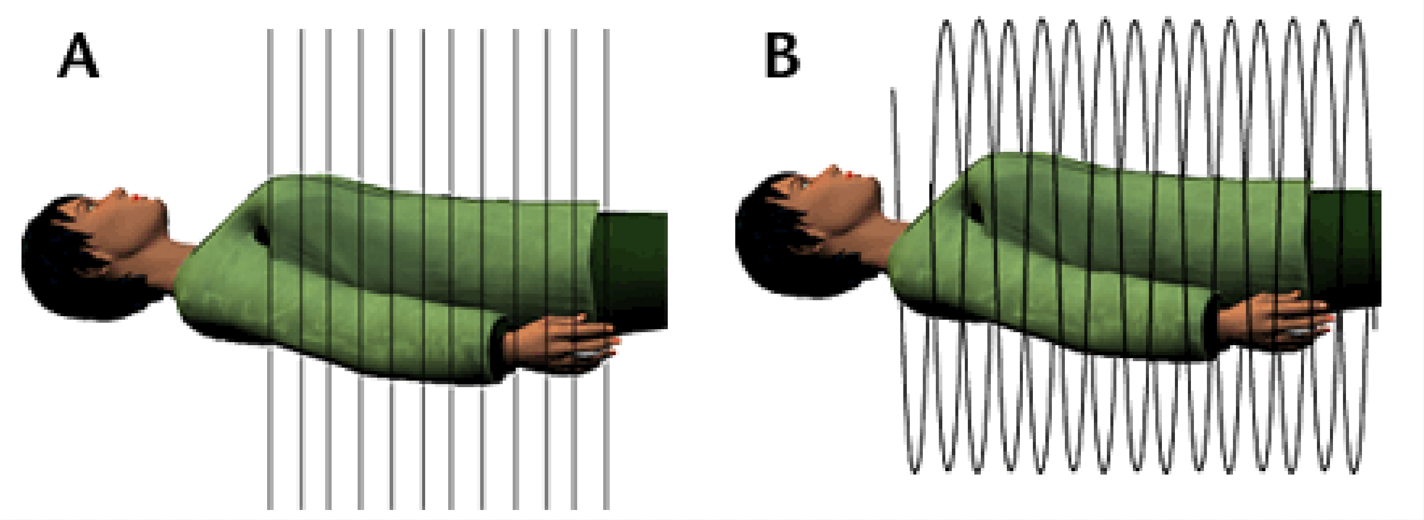
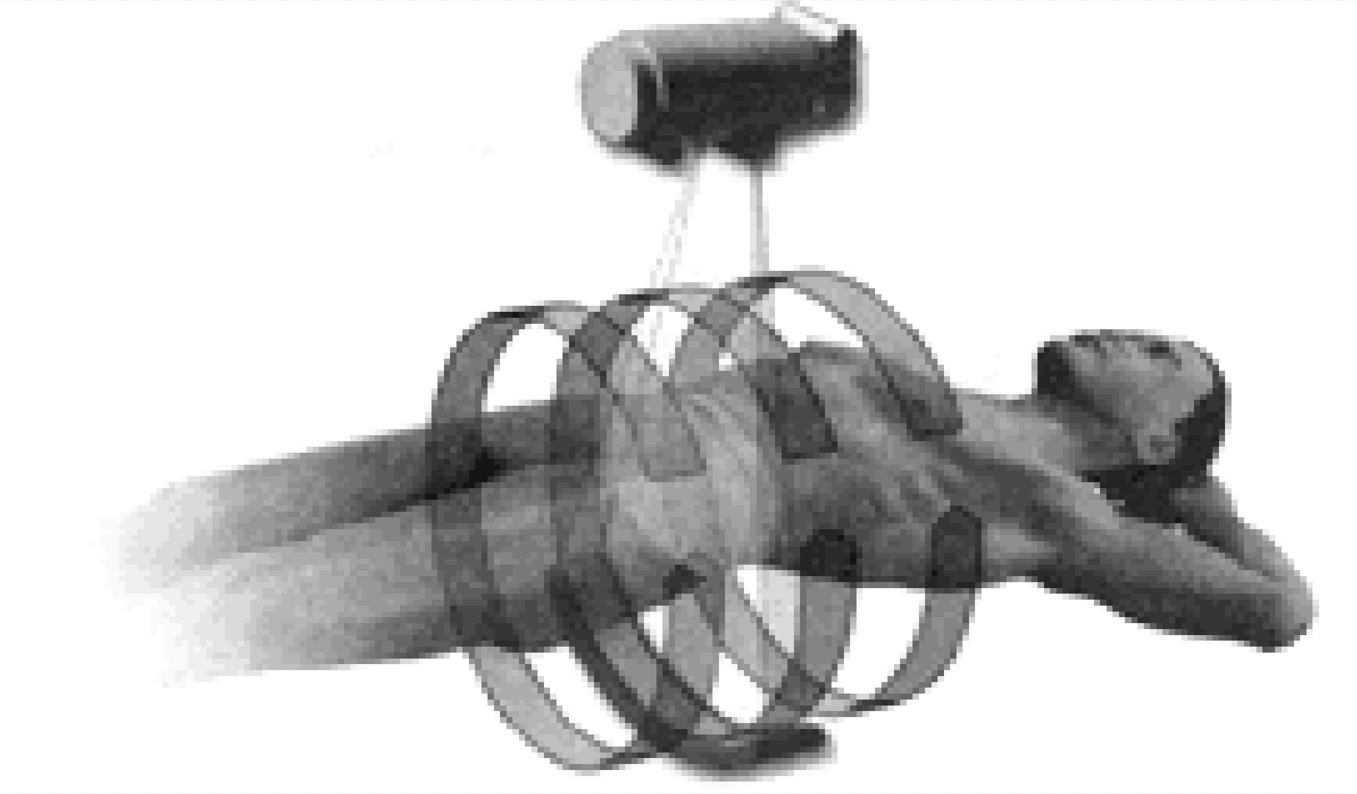
# CONVENTIONAL AND SPIRAL/HELICAL CT

سایت جامع رادیولوژی



# CONVENTIONAL SLICE-BY SLICE DATA ACQUSITION



# CONVENTIONAL CT

- **X-RAY TUBE ROTATES AROUND THE PATIENT TO COLLECT DATA FROM A SINGLE SLICE OF TISSUE-FOLLOWED BY TABLE INDEXING SO THE NEXT CONTIGUOUS SLICE CAN BE COLLECTED.**

# FOUR STEP PROCESS OF CONVENTIONAL CT

1

**START**

TUBE AND DETECTORS ARE ACCELERATED TO CONST. SPEED

2

X-RAYTUBE ENERGIZED
DATA COLLECTED
FOR 360DEG.

3

**STOP**

TUBE & DETECTORS SLOW DOWN & STOP

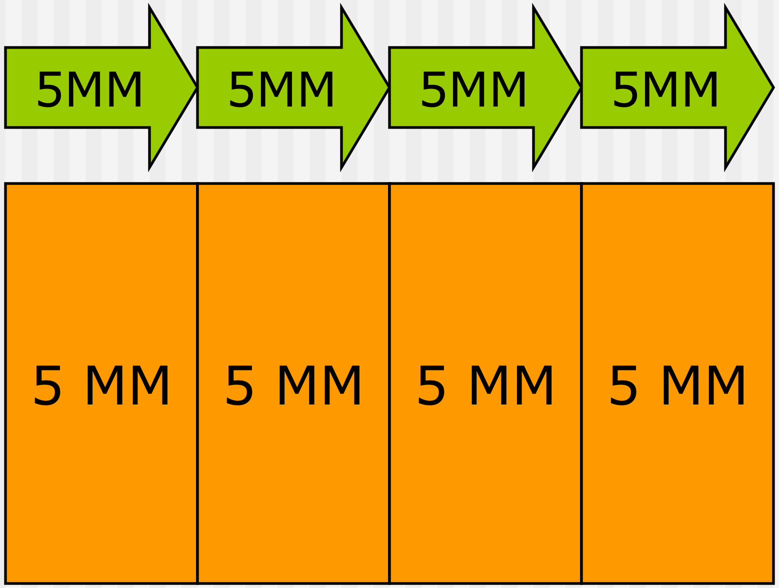
4

TABLE & PATIENT
INDEXED TO THE
NEXT SCANNING POSITION

# SECTION THICKNES vs INDEX

# INDEX vs SECTION THICKNESS-

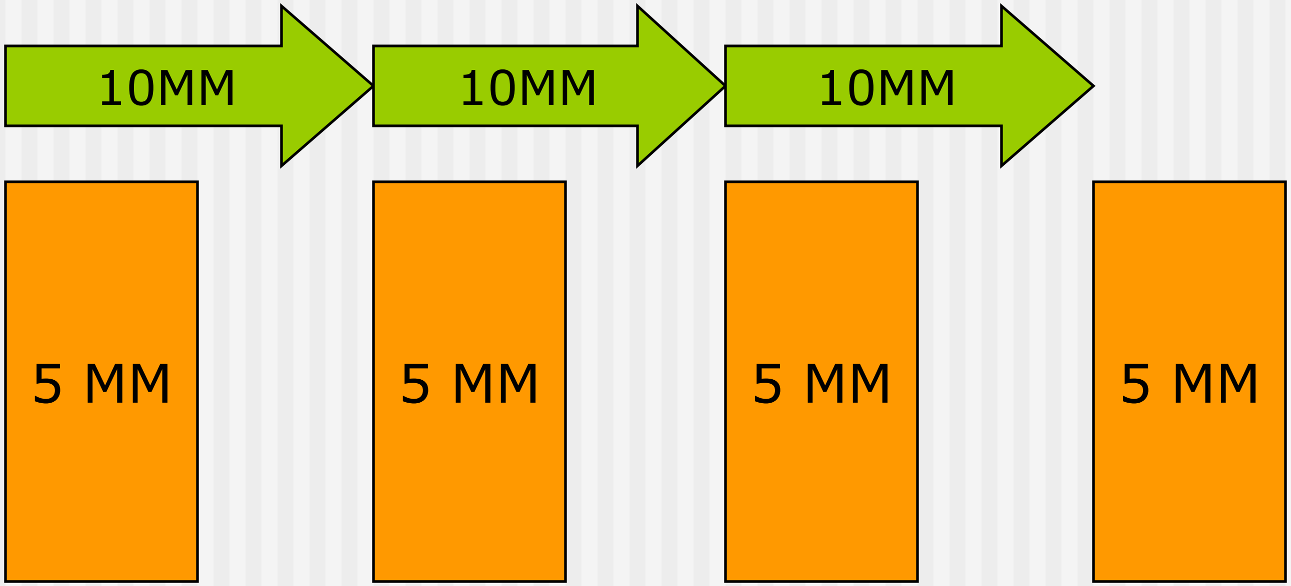
## CONTIGUOUS SLICES



# INDEX vs SECTION THICKNESS

## 100% GAP

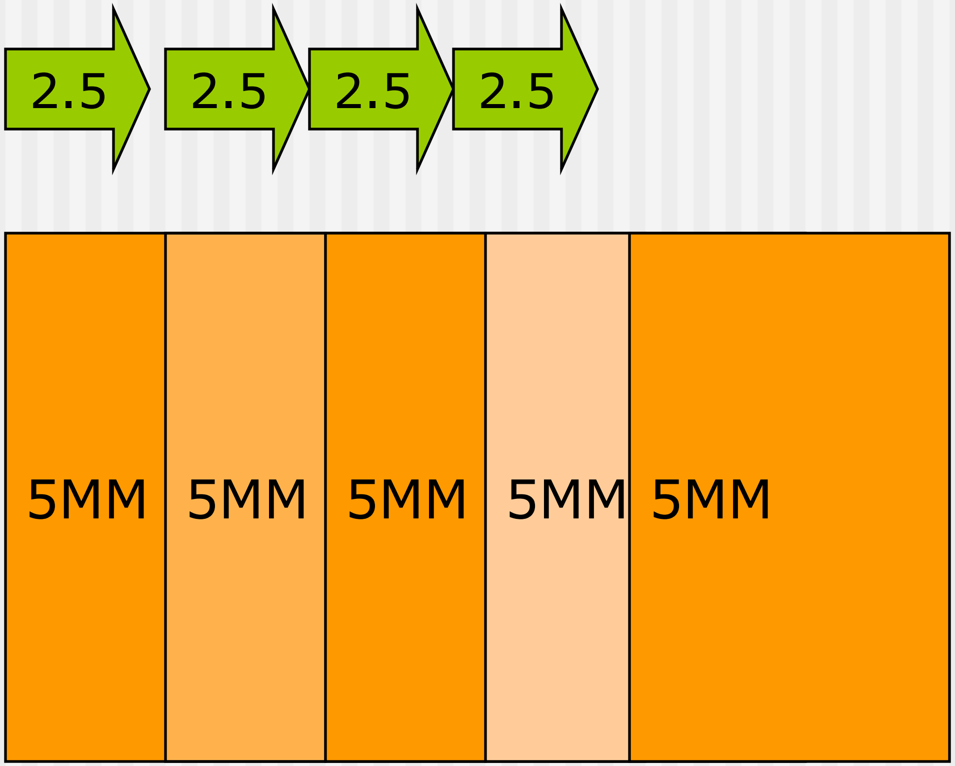
### 5MM SLICE –5MM GAP



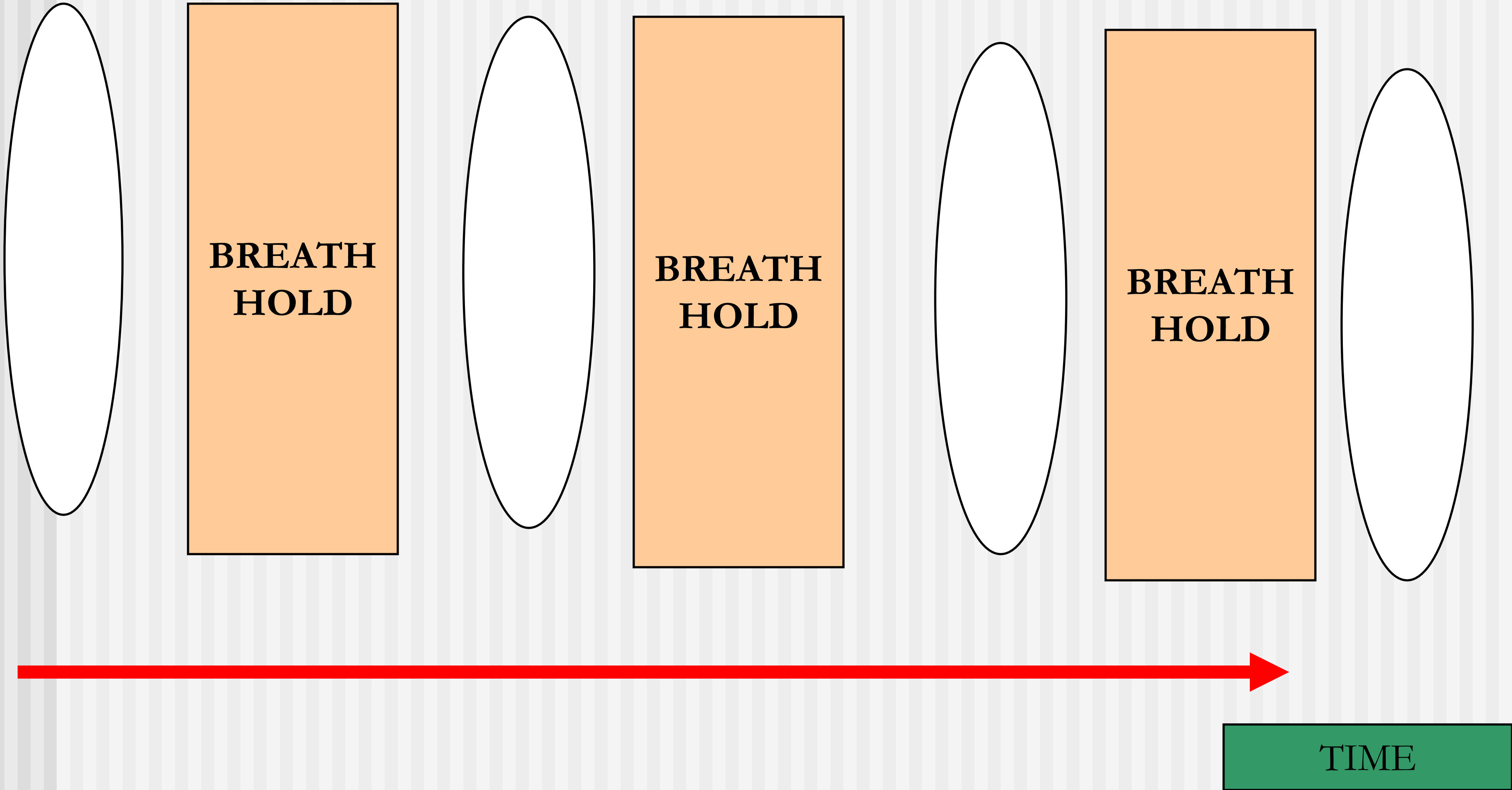
# INDEX vs SECTION THICKNESS

## 50% OVERLAP SLICES

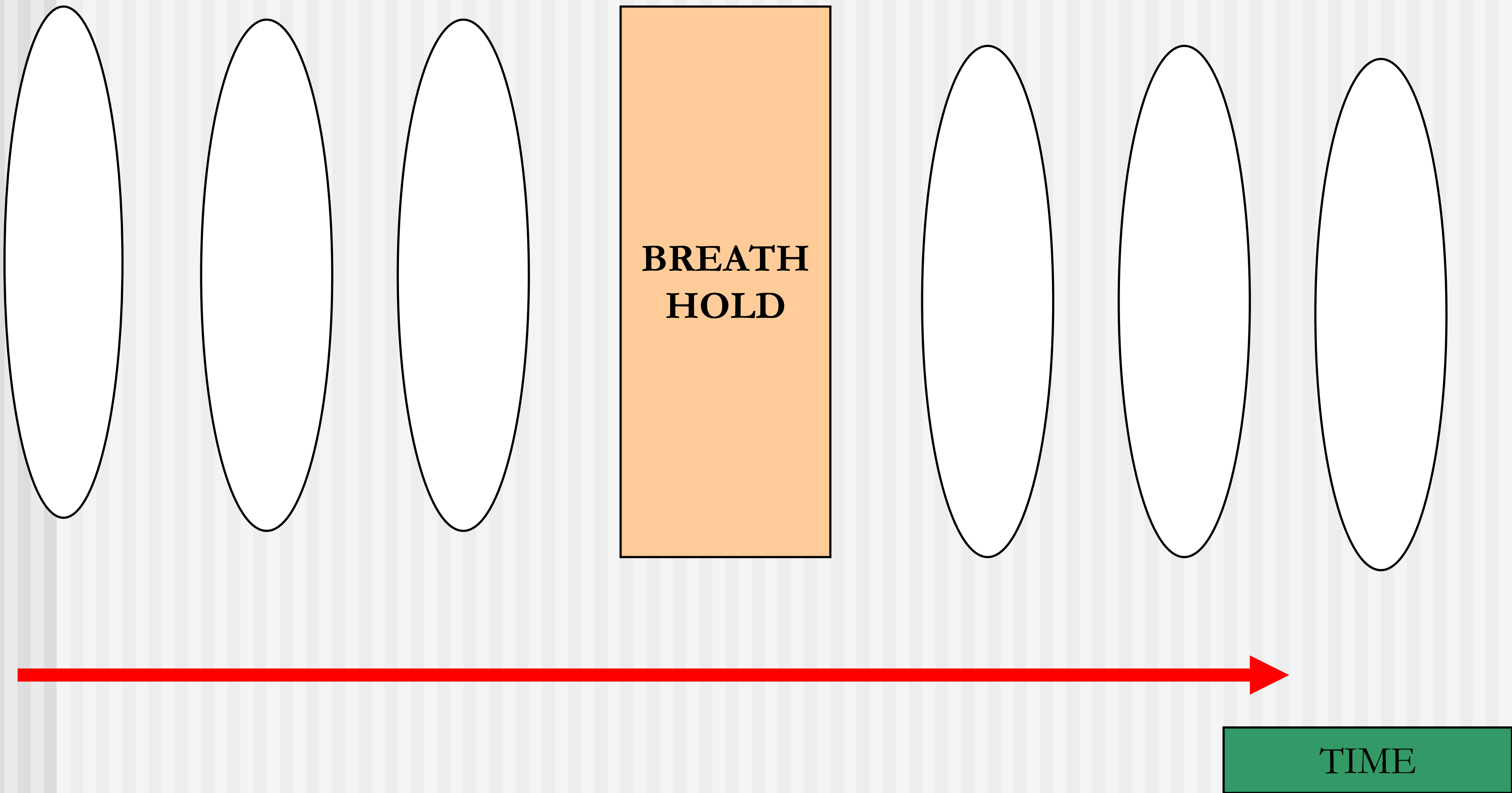
### 5MM SLICE 2.5 MM INDEX



# DATA ACQUSITION CONVENTIONAL CT

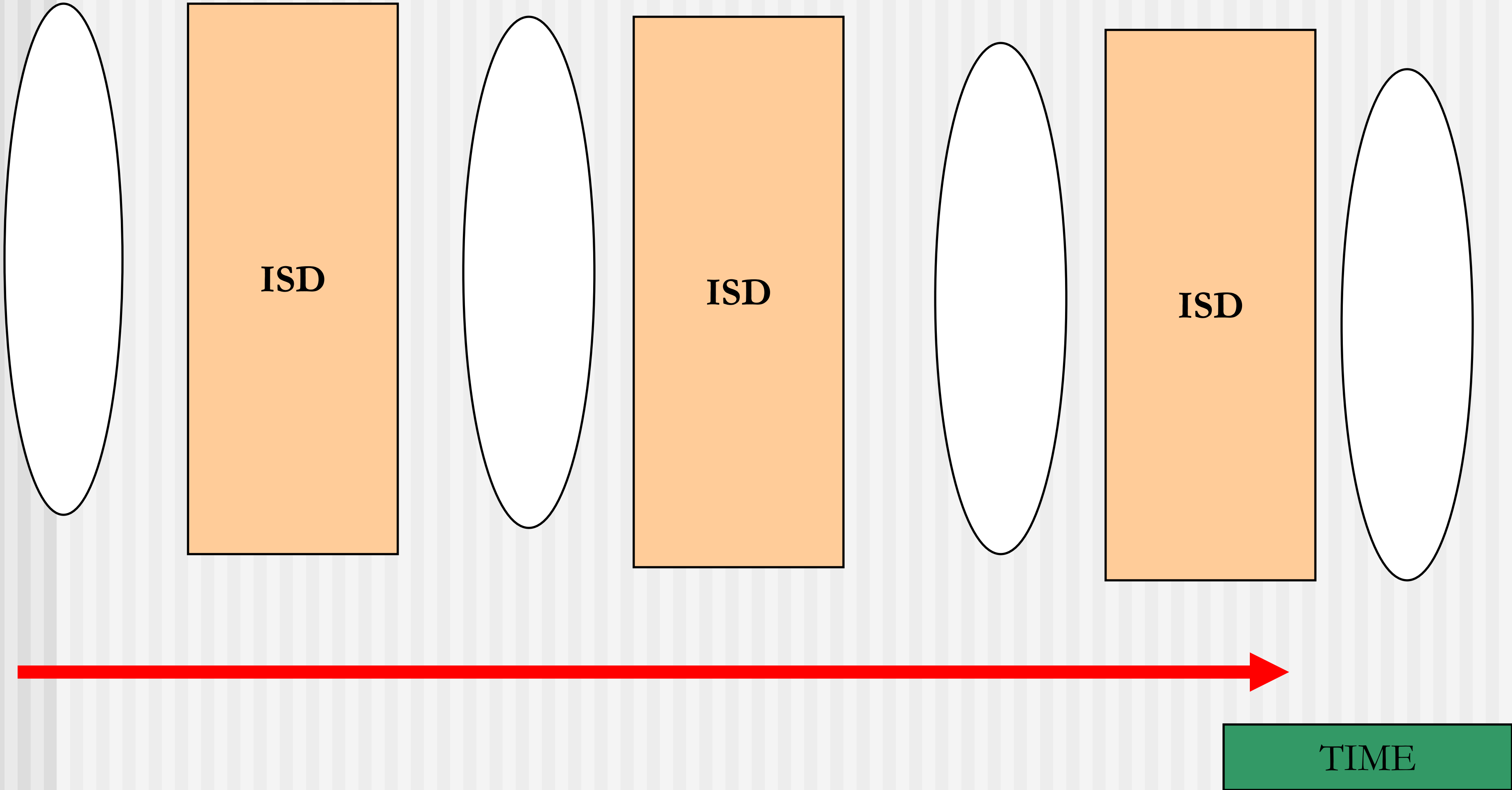


# DATA ACQUSITION CONVENTIONL CT CLUSTER METHOD



# CONVENTIONAL CT INTERSCAN DELAY

TUBE COOLS OFF

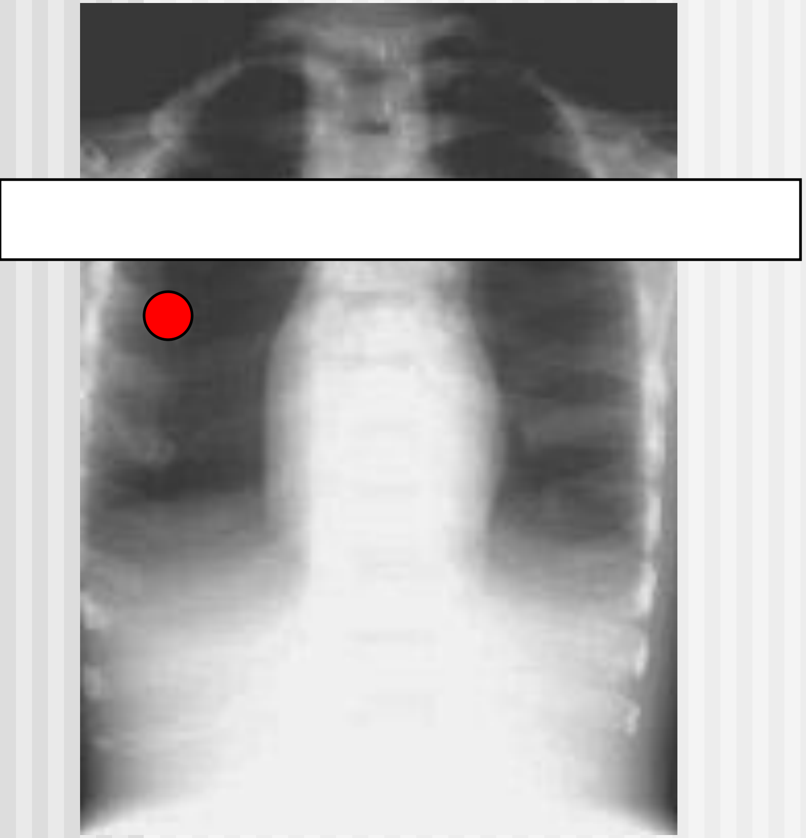


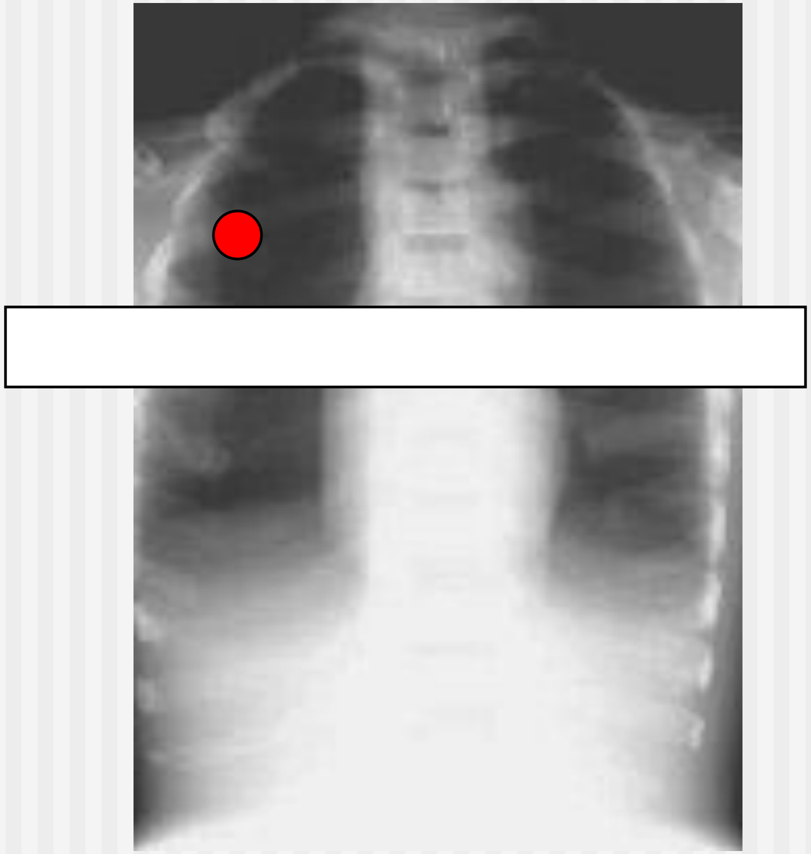
# LIMITATIONS OF CONVENTIONAL CT

- LONGER EXAM TIME
- PERTINENTANATOMY OMISSION

  **(MISREGISTRATION)**
- **INACCURATE GENERATIONOF 3-D IMAGES**
- **DIFFICULTY IN MAINTAINING HIGH CONTRAST ENHANCEMENT**

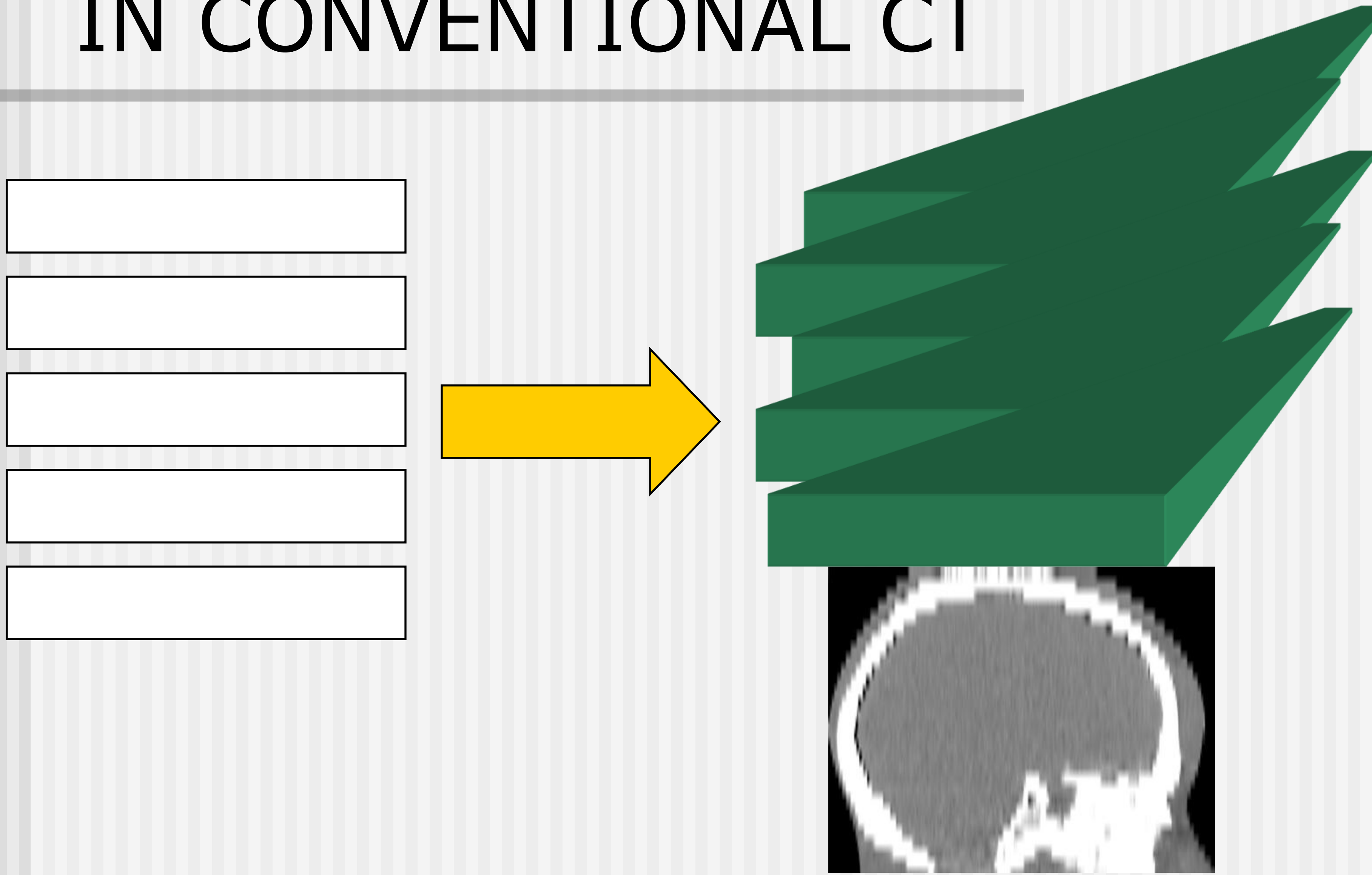
# MISREGISTRATION CONVENTIONAL CT



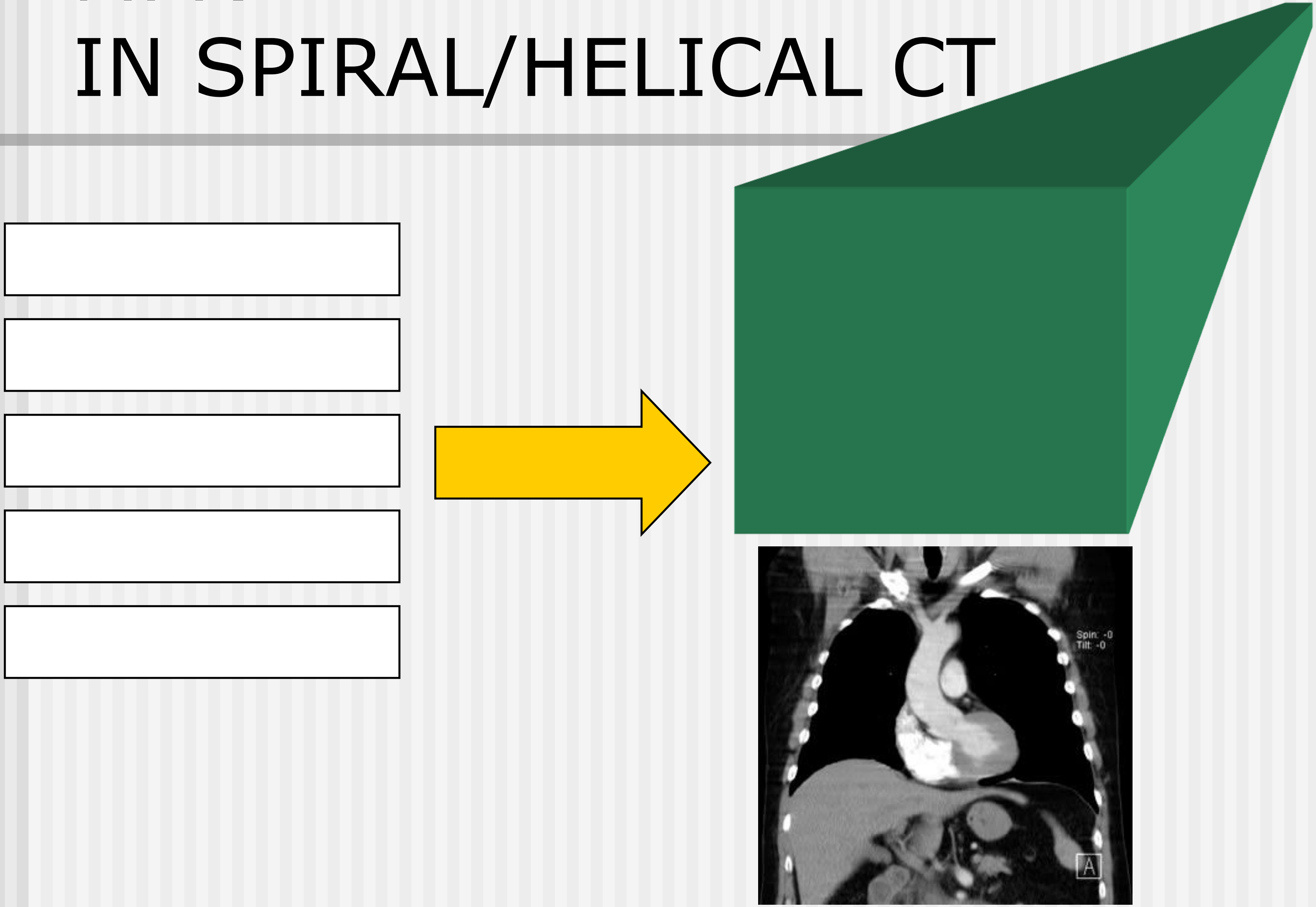


# SPIRAL CT

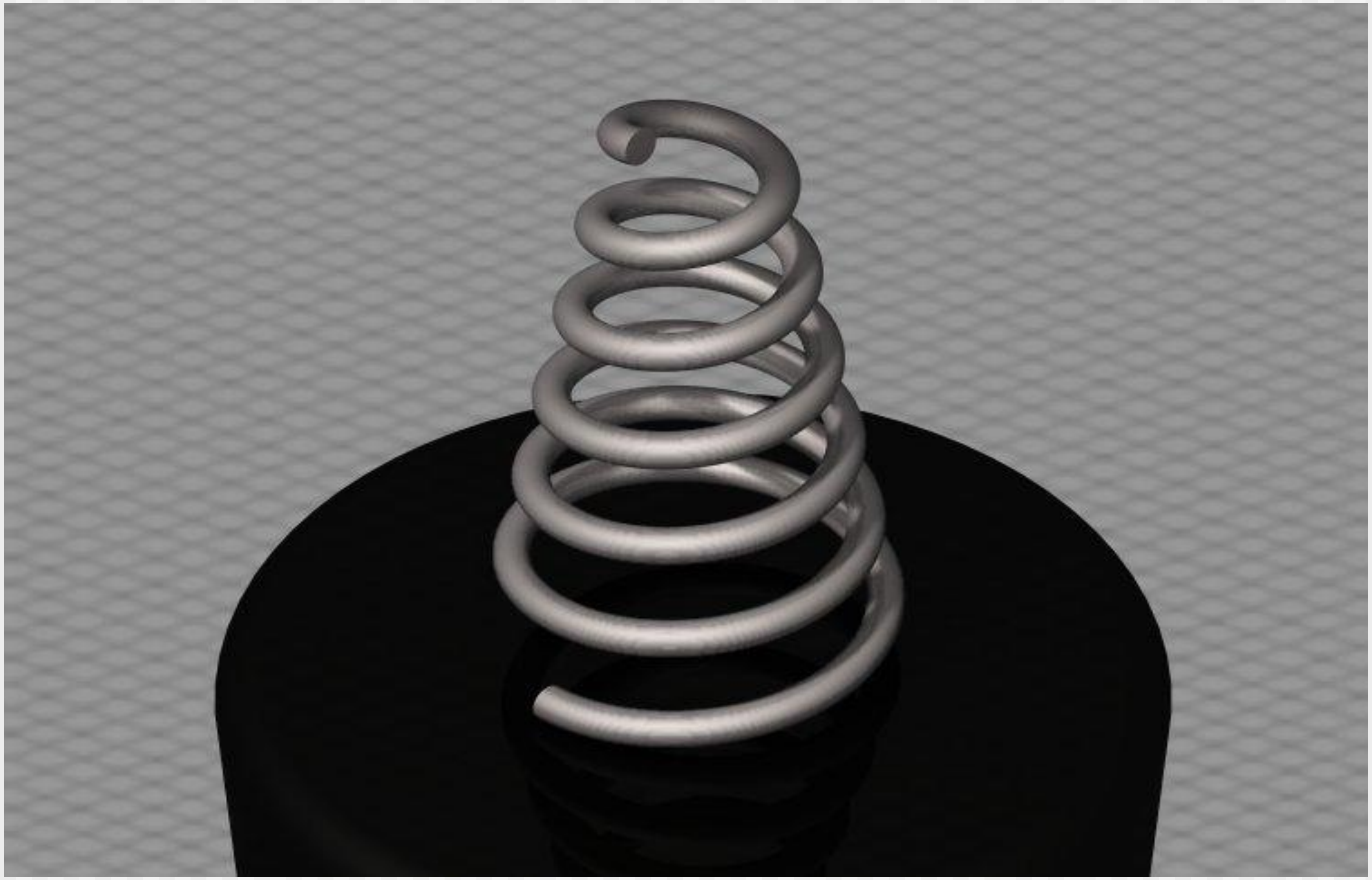
# MPR
# IN CONVENTIONAL CT



# MPR
# IN SPIRAL/HELICAL CT



# SPIRAL



# HISTORICAL BACKGROUND

- DR.KALENDER ( GERMAN SCIENTIST)

1988 STARTED WORKING ON SPIRAL CT WITH PETER VOCK FROM SWITZERLAND.

- 1989 DR. KALENDER DESCRIBED TECHNICAL DETAILS AND CLINICAL APPLICATIONS TO **RSNA**

SPIRAL

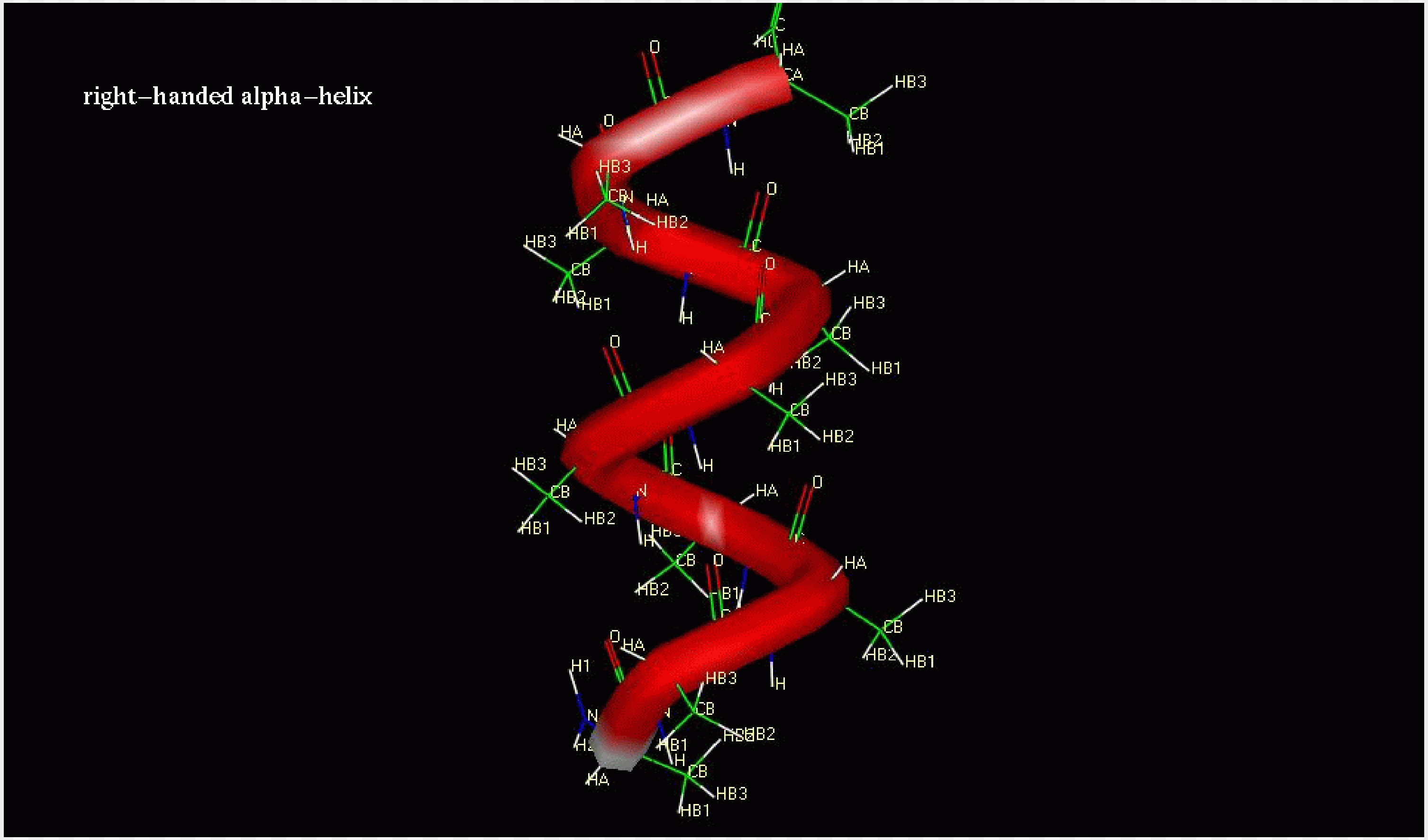
or

HELICAL

CT

?

# HELIX-TYPE OF SPIRAL!!



# SPIRAL ?
# HELIX ?

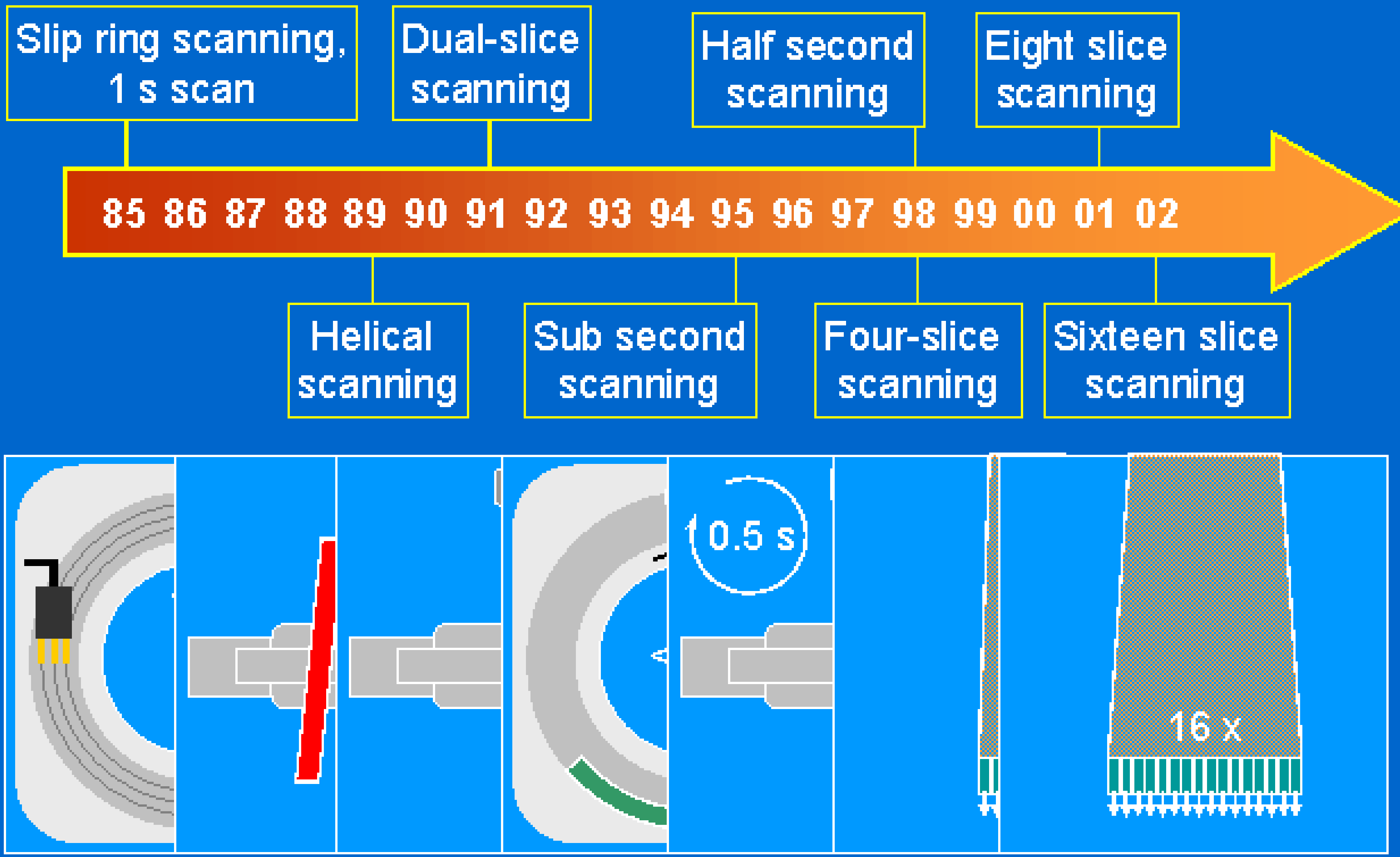
- SPIRAL - CURVE ON PLANE SURFACE

- HELIX – CURVE IN 3-D SPACE

# BOTH TERMS USED!!

DR.KALENDER SUPPORTS SPIRAL CT TERM

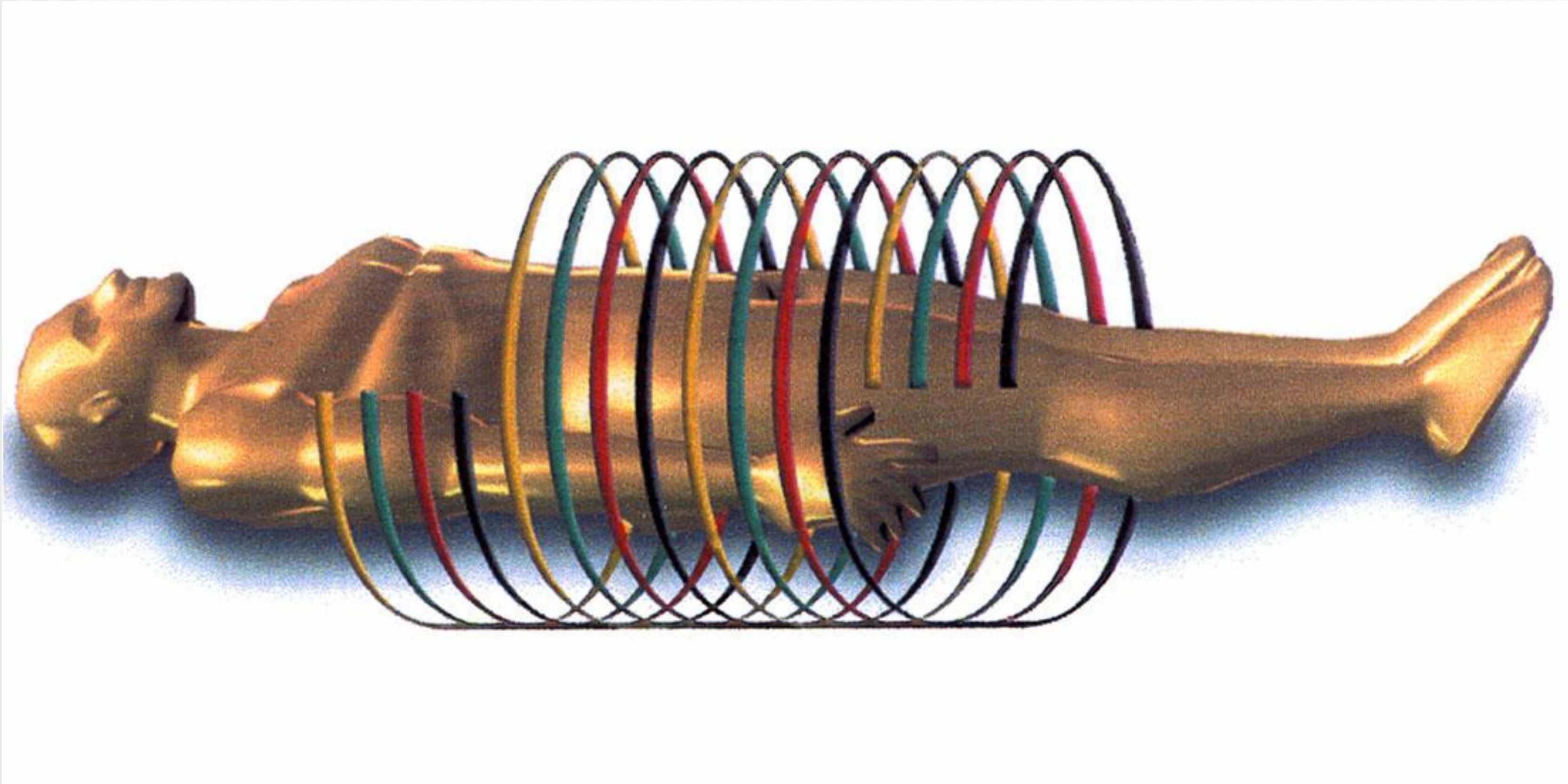
# Technological advances, 1985 - 2002



# SPIRAL/HELICAL SCANNI NG

- SPIRAL VOLUME CT
- HELICAL VOLUMETRIC CT

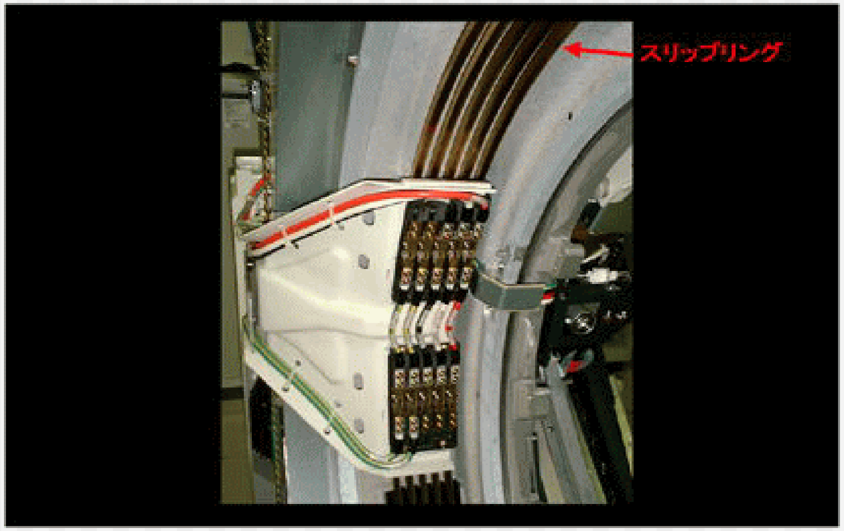
# SPIRAL/HELICAL CT

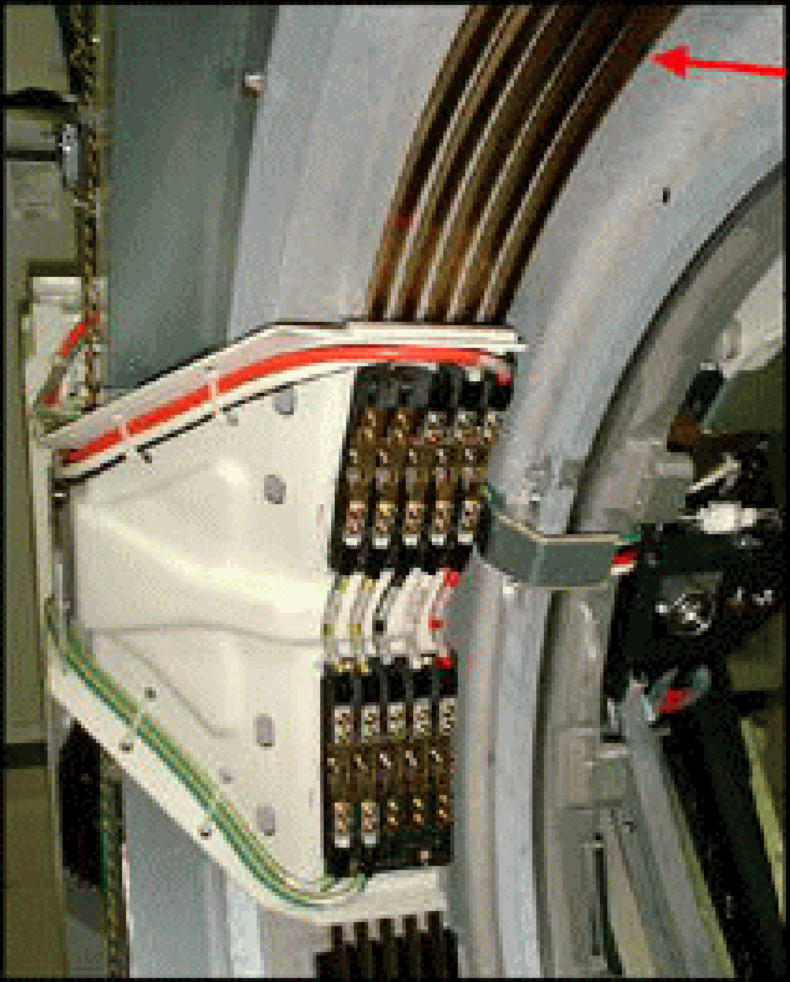


# REQUIREMENTS FOR VOLUME DATA ACQUSITION

- CONTINUOUSLY ROTATING SCANNER BASED ON SLIP RING TECHNOLOGY
- CONTINUOUS COUCH MOVEMENT
- INCREASE IN TUBE HEAT LOADABILITY
- INCREASED COOLING CAPACITY
- CAPABILITY TO STORE LARGE VOLUME OF DATA

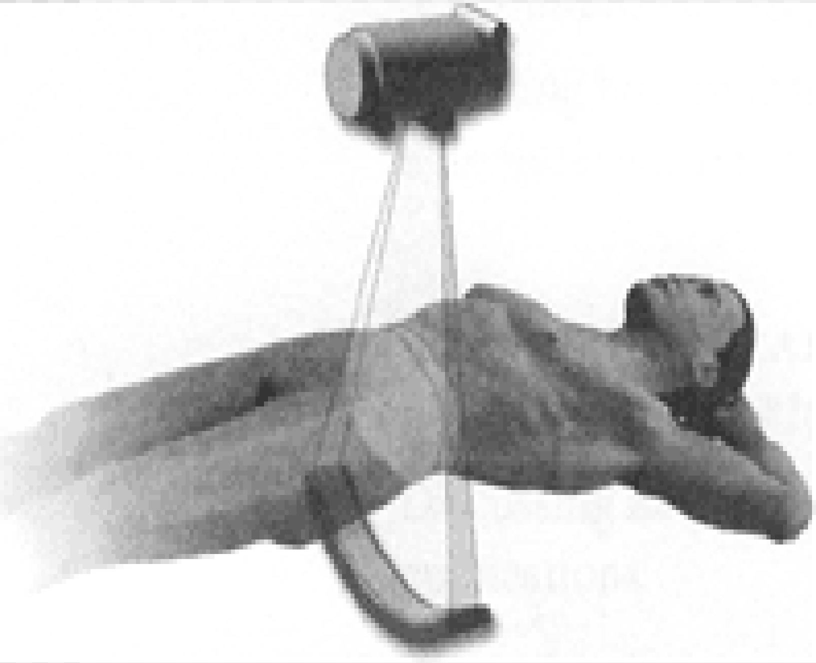
# CT SCANNING IN SPIRAL-HELICAL GEOMETRY BASED ON **SLIP RING** TECHNOLOGY

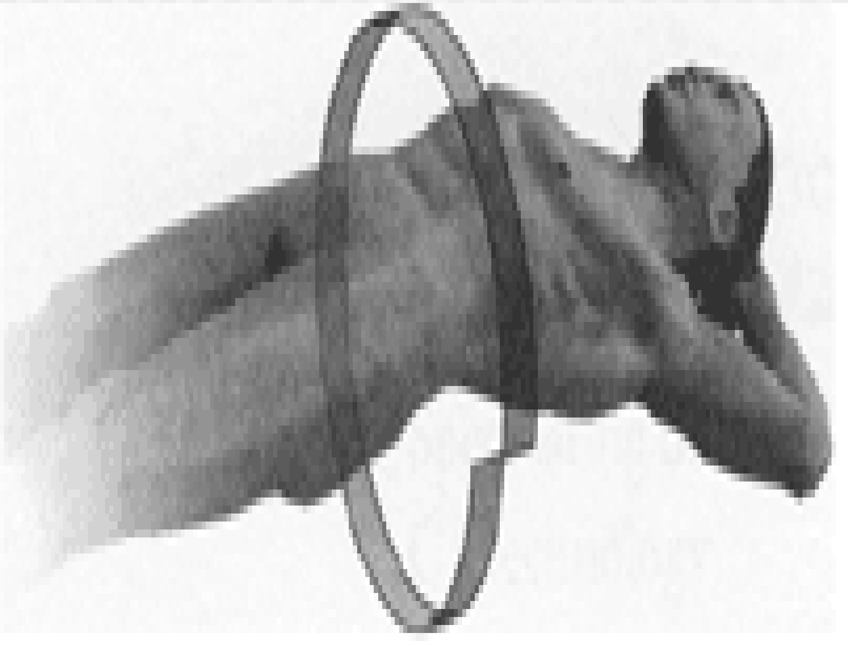



スリップリング

# SPIRAL CT MODES

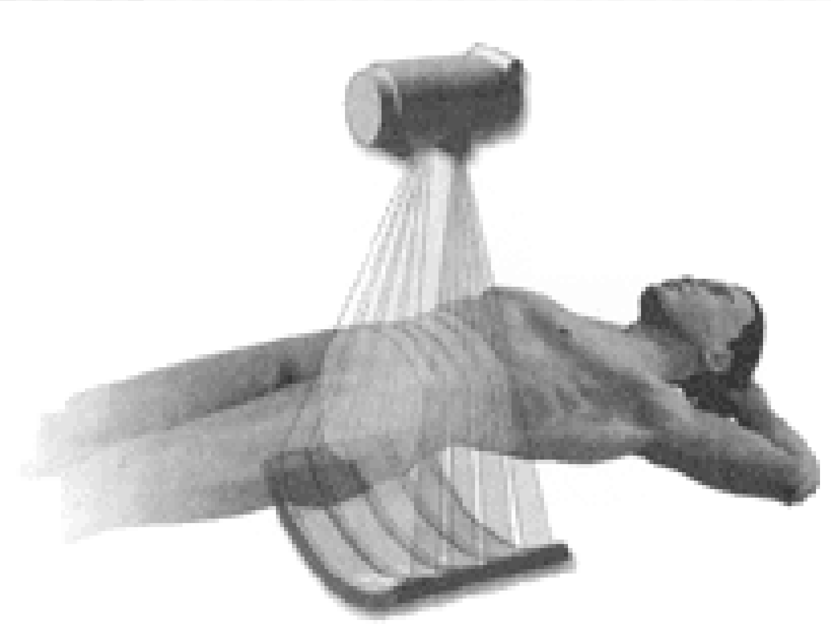
**SINGLE SLICE**

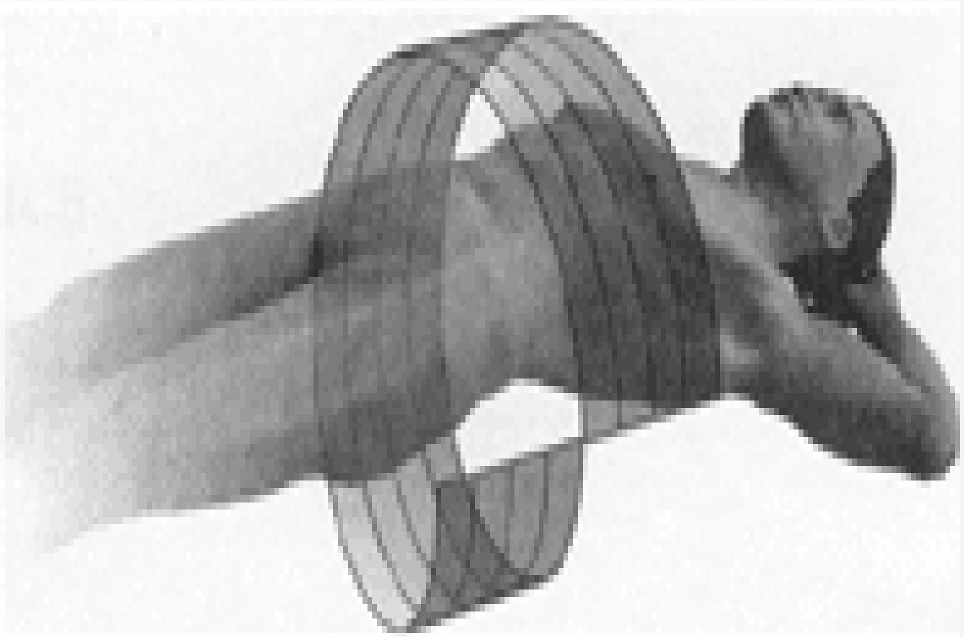




# SPIRAL CT MODES

**MULTI - SLICE**



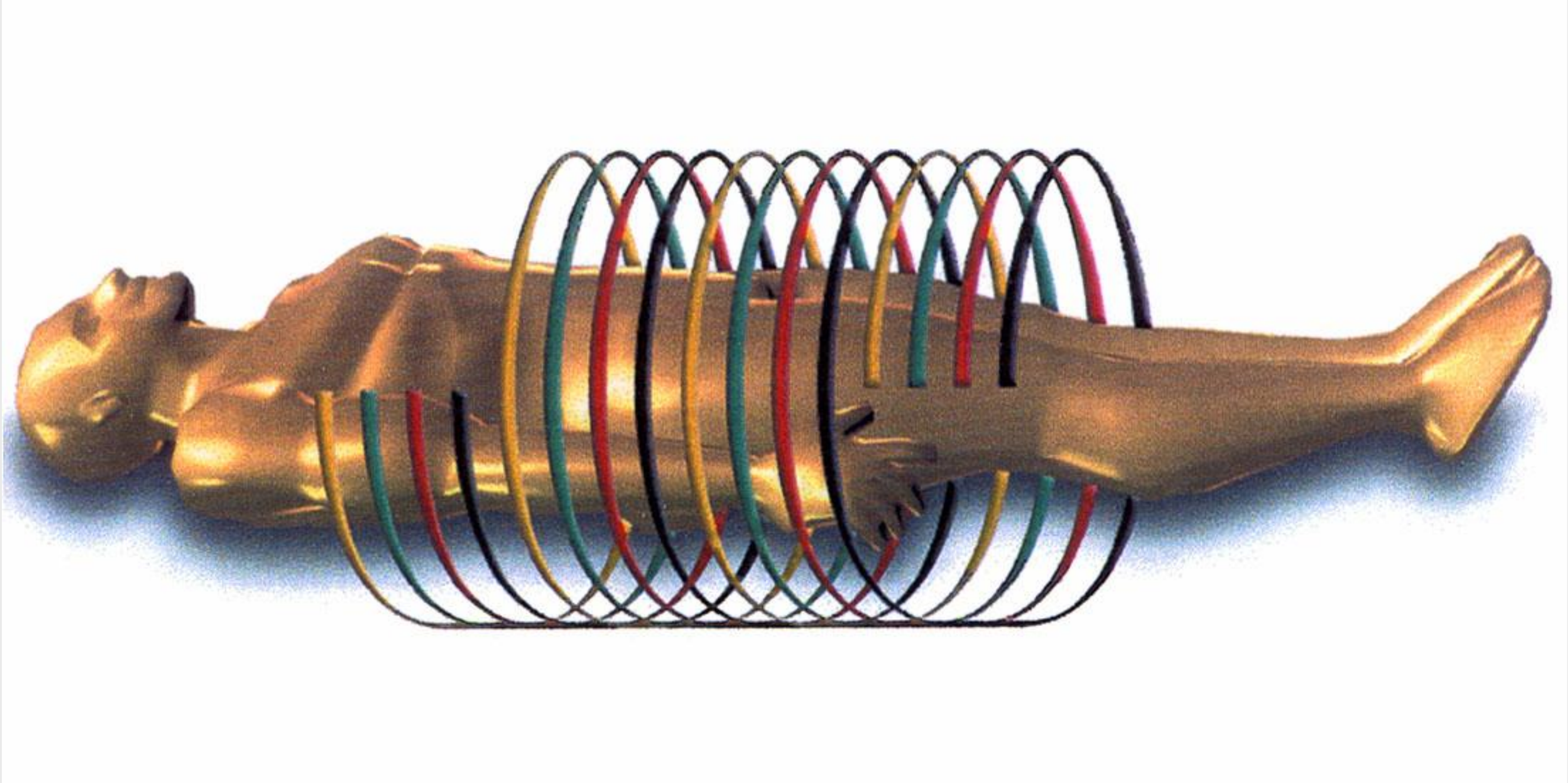


# SPIRAL CT MAJOR STEPS

- **DATA ACQUSITION-ENTIRE** TISSUE IS BEING SCANNED DURING ONE BREATH HOLD

- IMAGE RECONSTRUCTION-INTERPOLATION USED TO GENERATE SLICES. FILTERED BACK PROJECTION USED TO REDUCE BLURR.

# DATA ACQUSITION



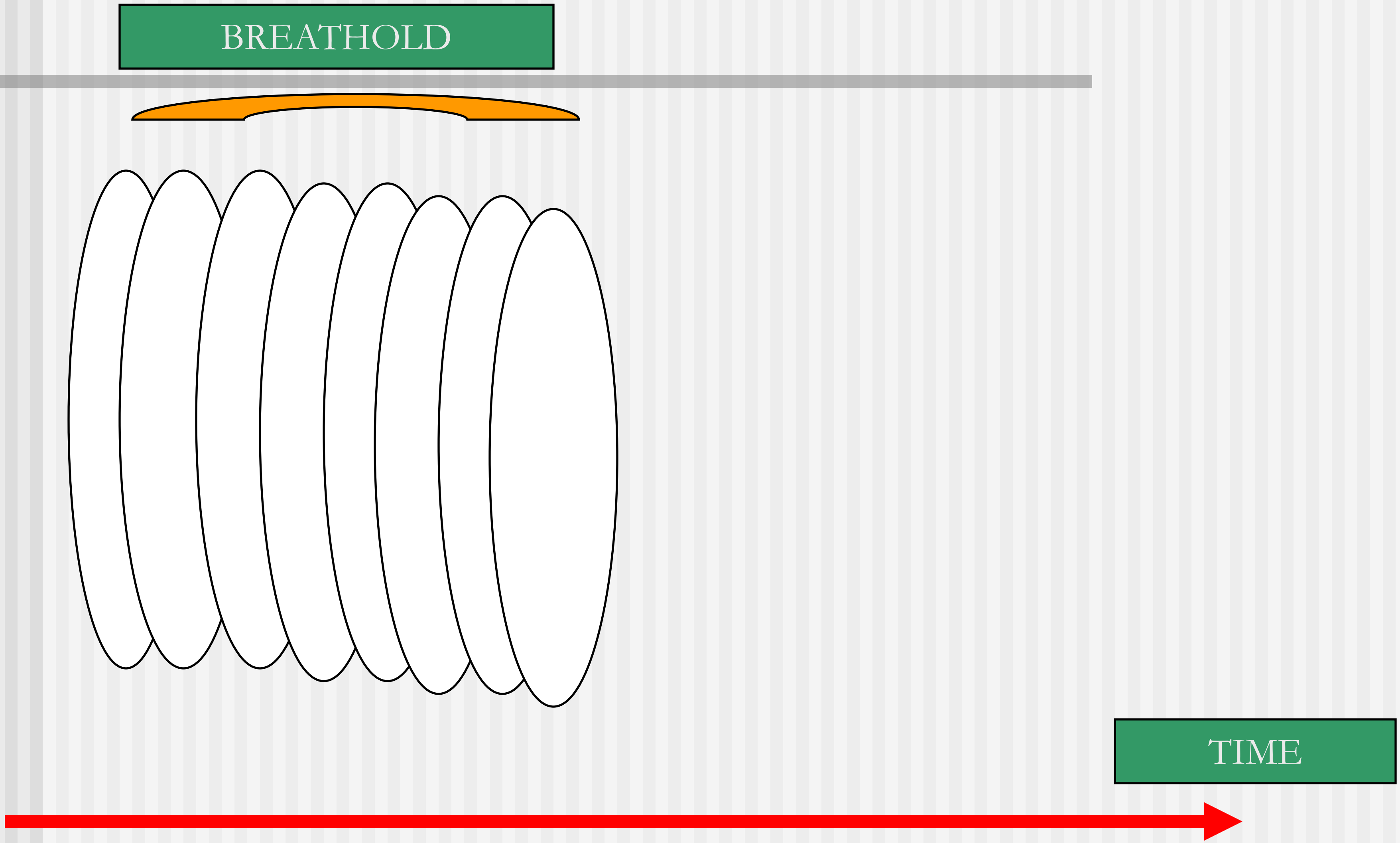
Z-AXIS

# SPIRAL CT

- CONTINUOUS SCANNING IN SHORT TIME
- IMAGE RECONSTRUCTION AT ANY POSITION ALONG Z-AXIS
- SLICES CAN OVERLAP OR BE SPACED AWAY

COUCH MUST MOVE WITH CONSTANT SPEED!

# DATA ACQUSITION SPIRAL CT

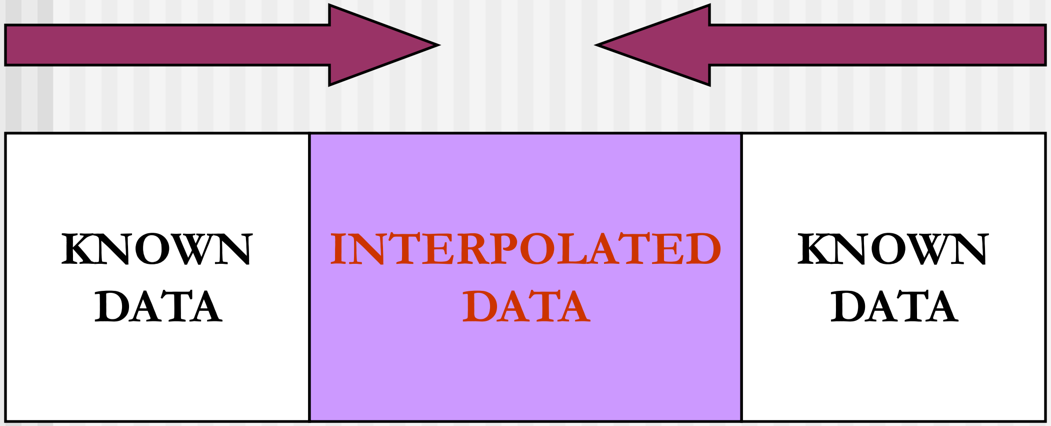


# SOLVING PROBLEMS IN SPIRAL CT

- SPECIAL POSTPROCESSING TECHNIQUES ( DEDICATED RECONSTRUCTION ALGORITHM)

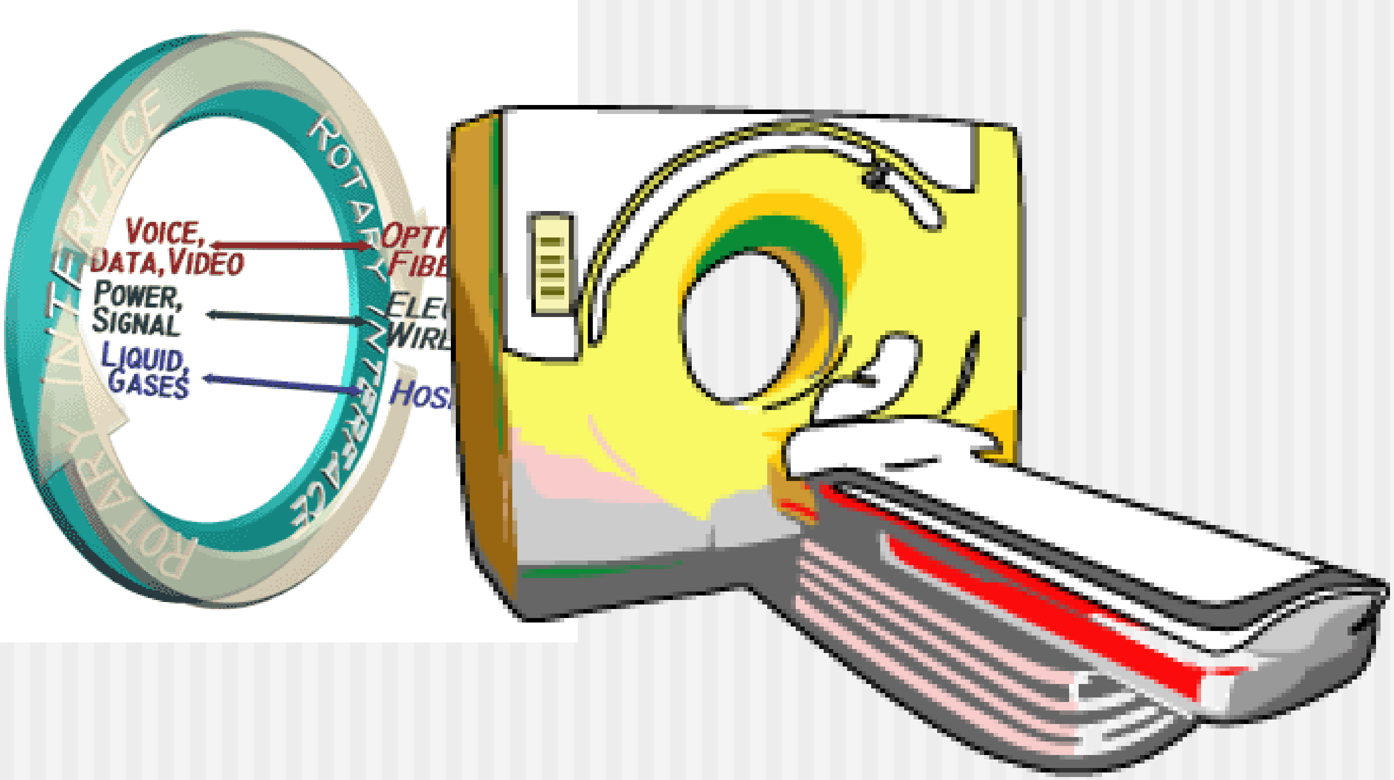
  **INTERPOLATION ALGORITHM**

# INTERPOLATION & EXTRAPOLATION

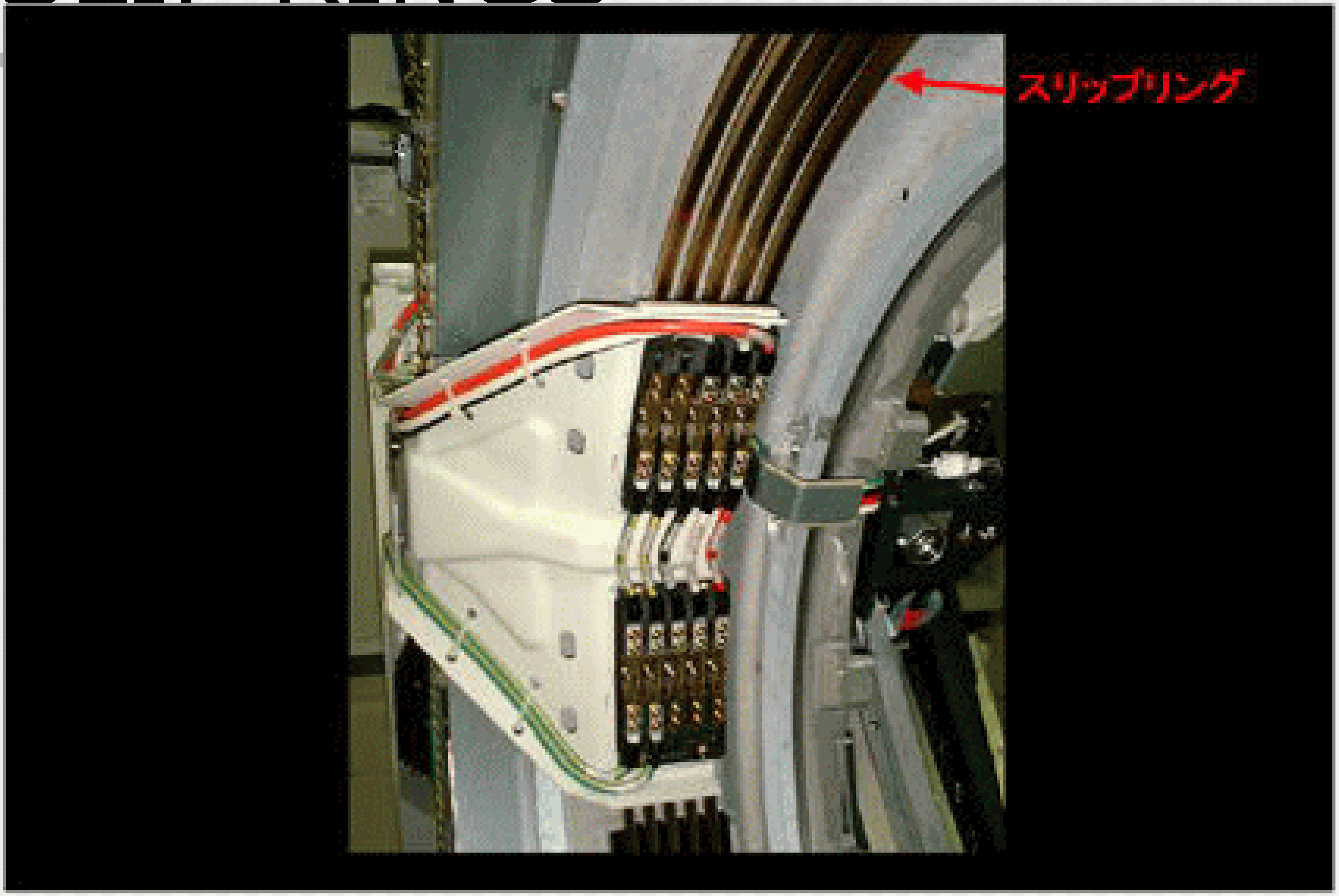


# INTERPOLATION

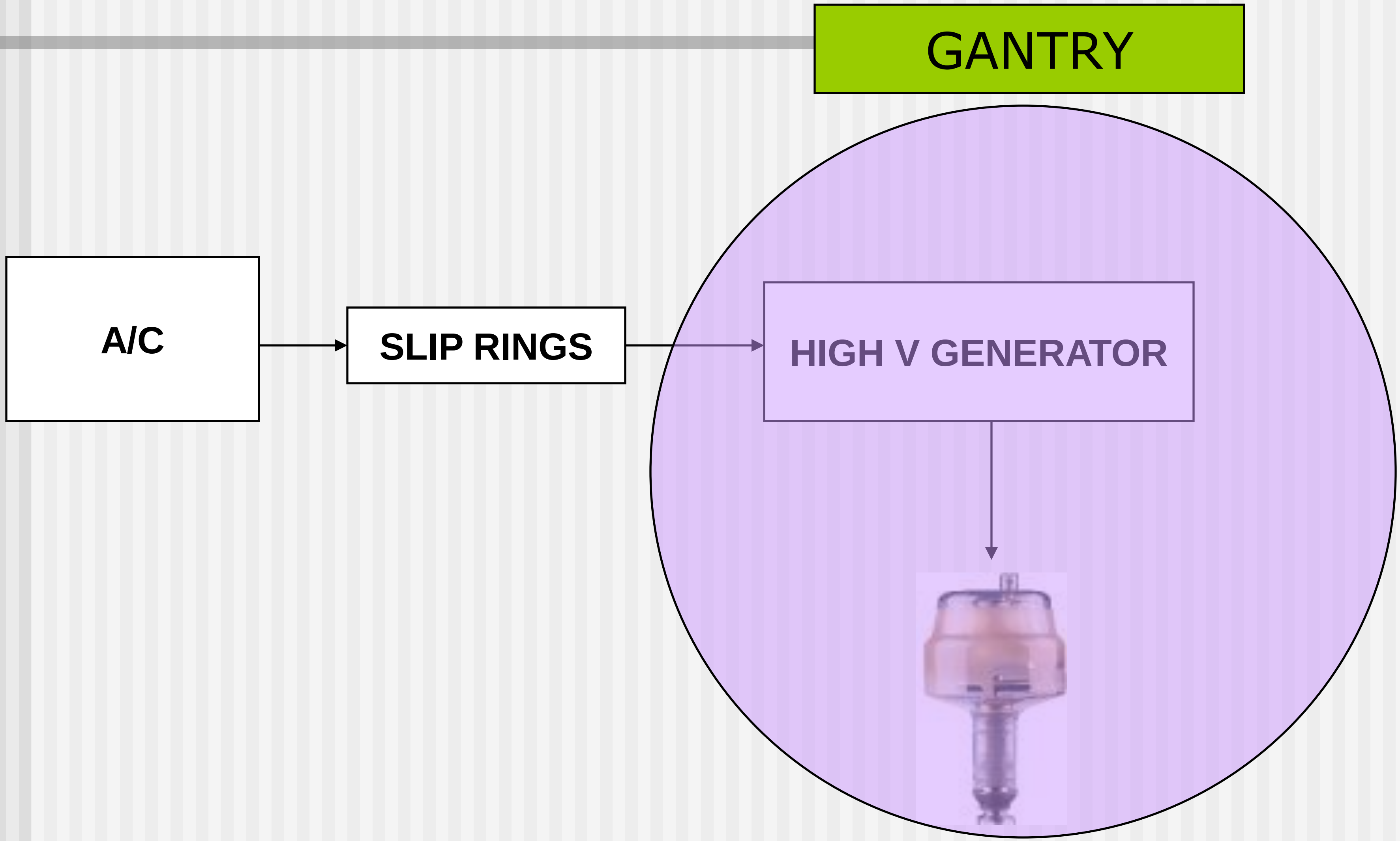
# SCANNER POWER SUPPLY- SLIP RINGS



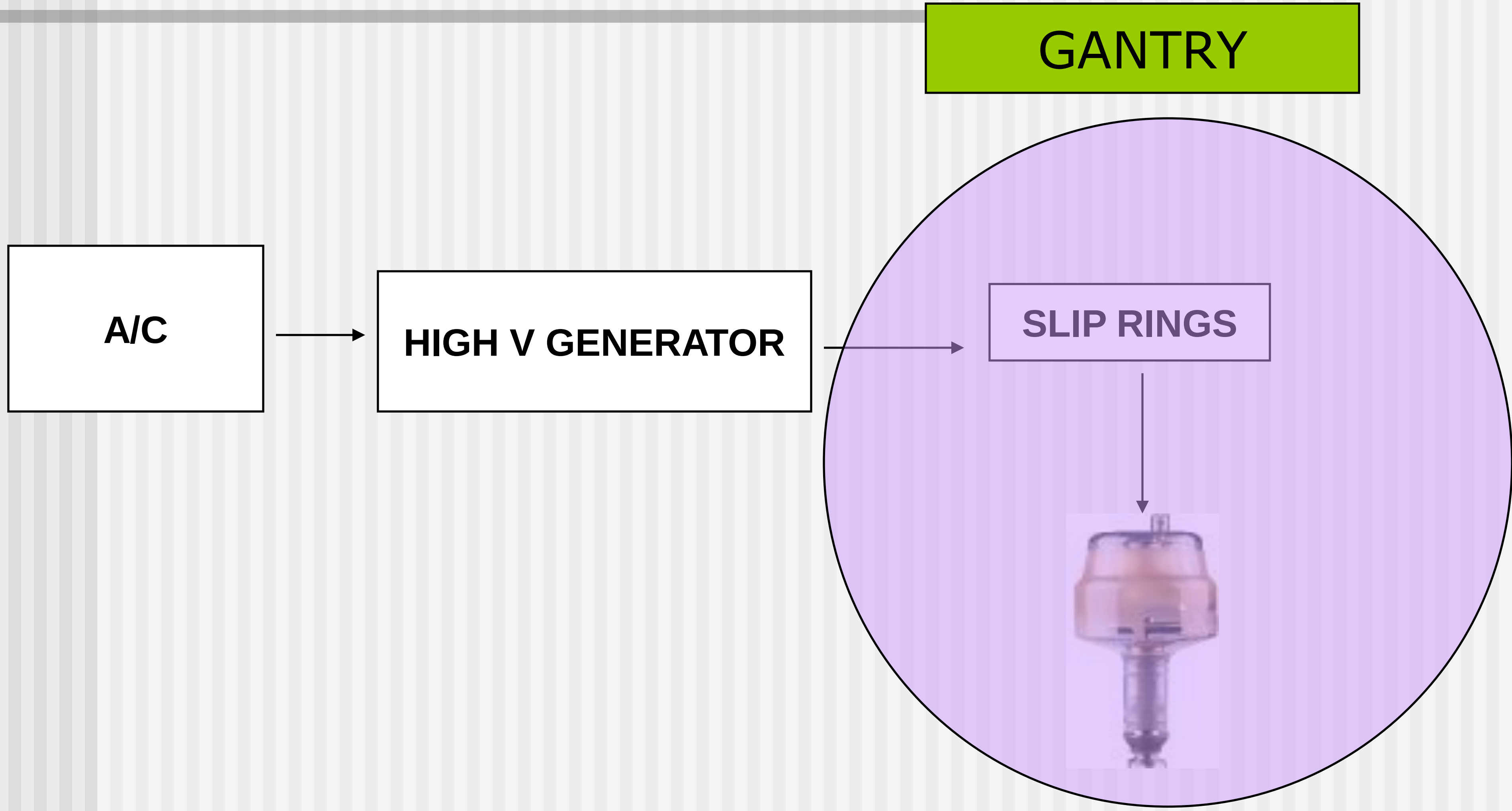
# SLIP RINGS



# LOW VOLTAGE



# HIGH VOLTAGE



# SPIRAL SCAN PARAMETERS

- **PITCH**
- **VOLUME COVERAGE**

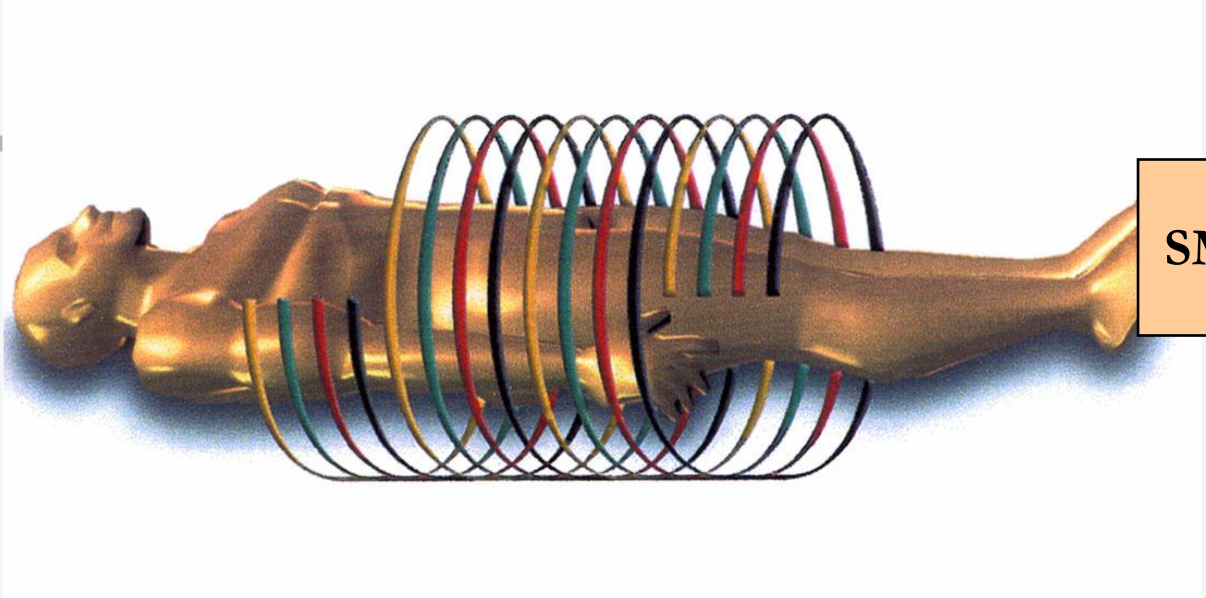
# PITCH

- DISTANCE IN mm THAT CT TABLE MOVES DURING ONE REVOLUTION OF THE X-RAY TUBE AROUND THE PATIENT

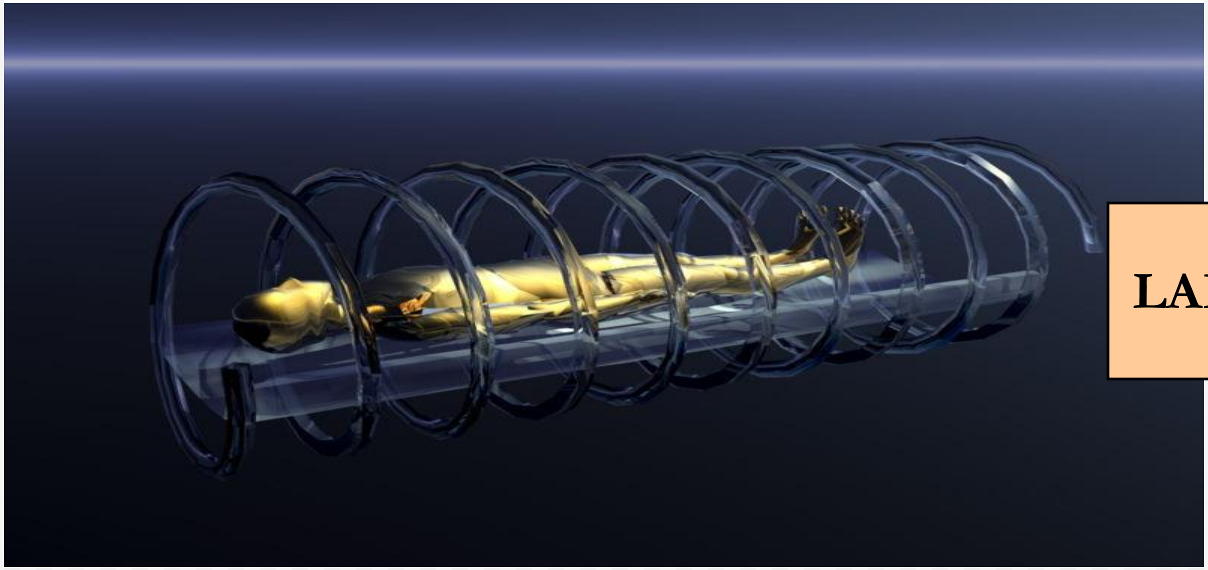
# PITCH

$$\text{PITCH} = \frac{\text{DISTANCE TABLE TRAVELS DURING ONE REV}}{\text{SLICE THICKNESS}}$$

# PITCH



SMALL PITCH



LARGE PITCH

# VOLUME COVERAGE

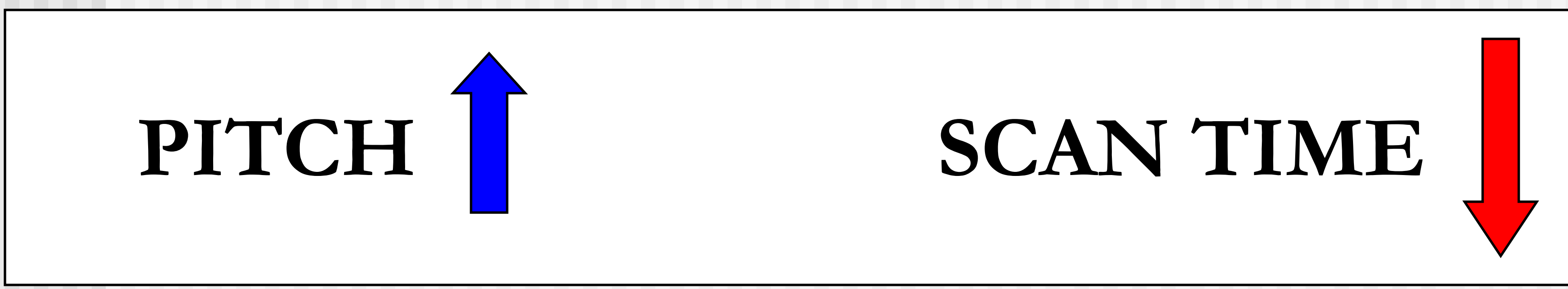
**VOL. COVERAGE =**

**PITCH x SLICETHICKNESS x SCAN TIME**

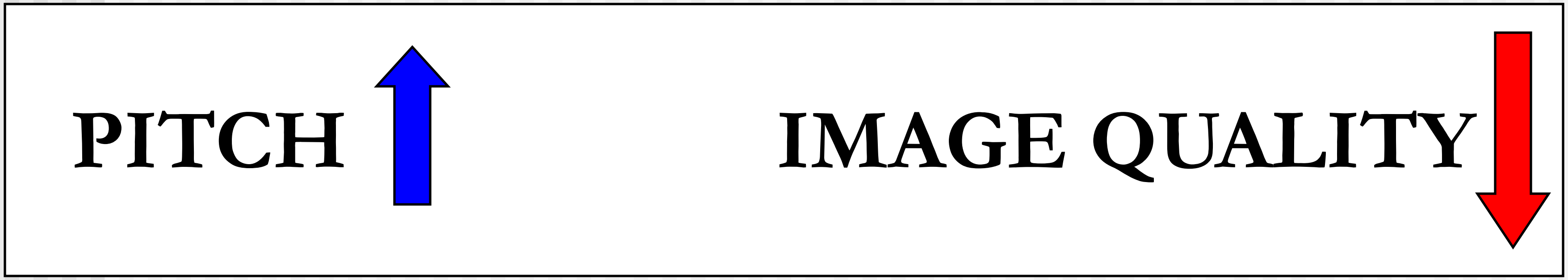
# RECONSTRUCTION INCREMENT

- DETERMINES THE DEGREE OF SECTIONAL OVERLAP TO IMPROVE IMAGE QUALITY

# PITCH



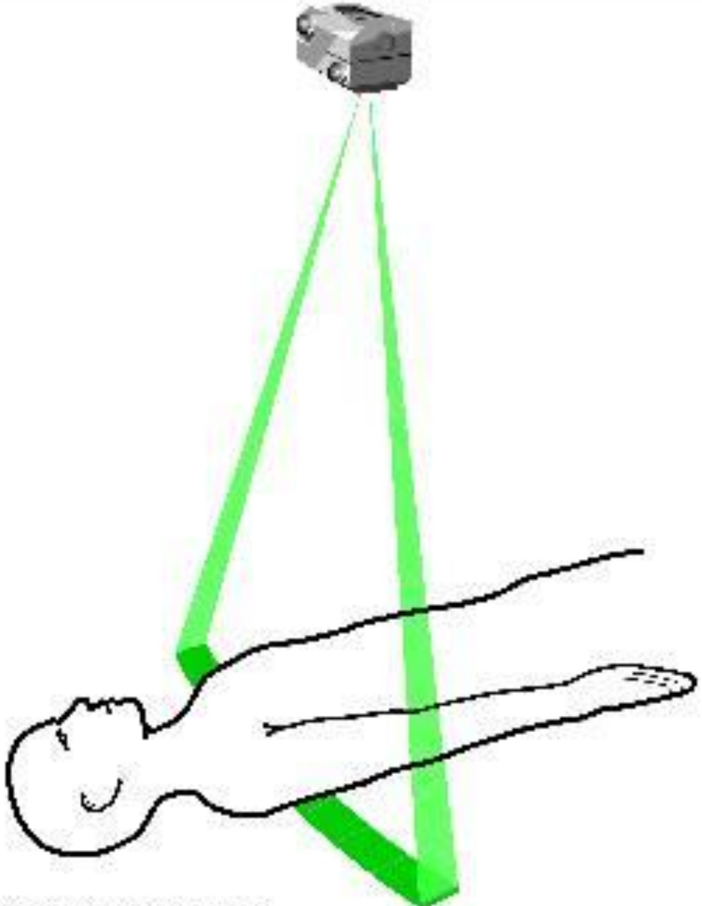
# PITCH



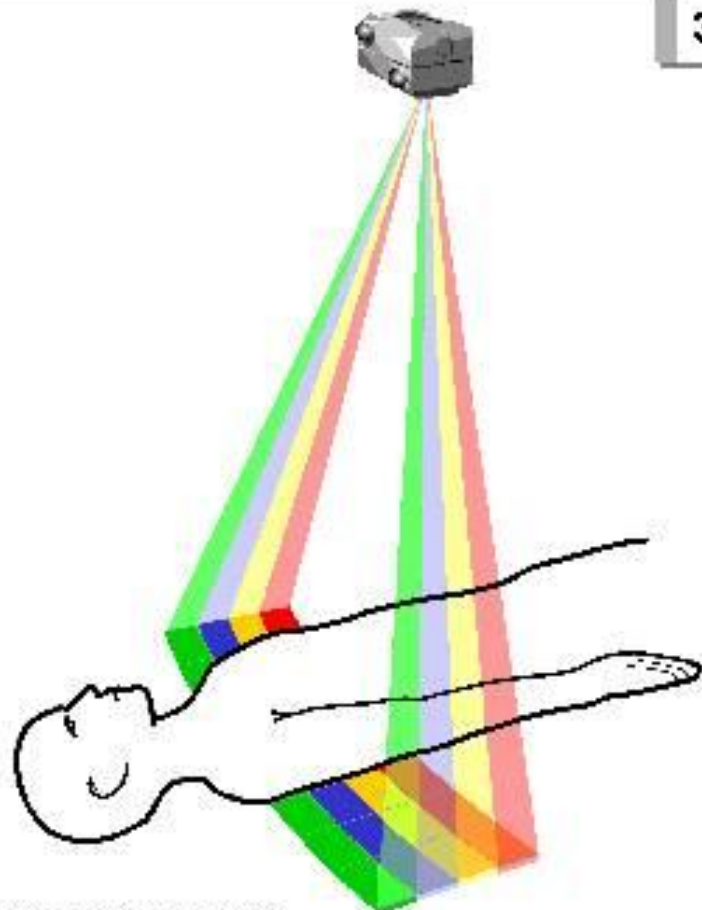
# MULTISLICE SPIRAL IMAGING

# Oblique view of gantry with X-ray tube, X-ray fan and detectors



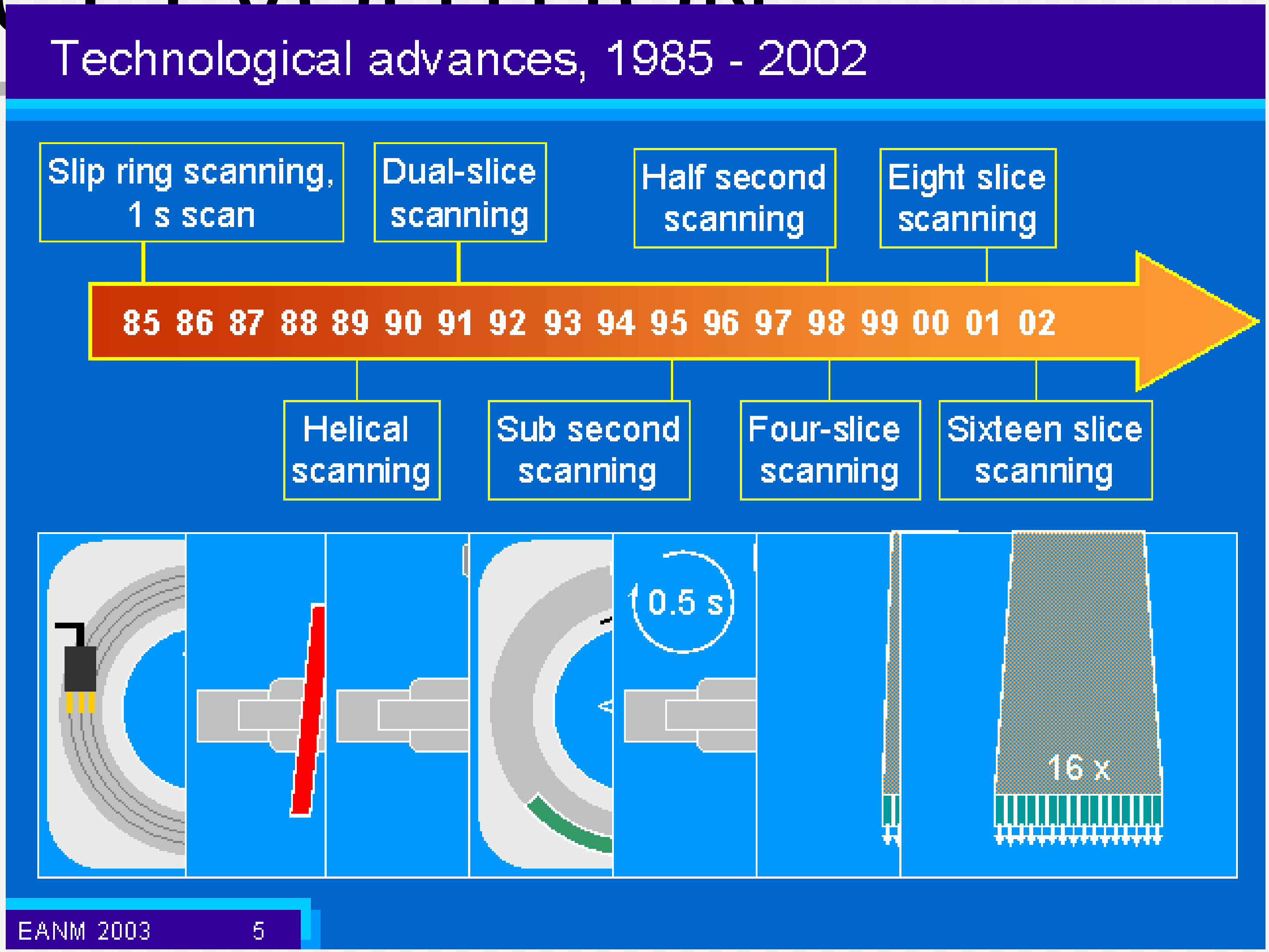


**Single-Slice CT**
One x-ray tube and one row of detectors provide *1 channel* of spatial data. 500-900 detectors in a single row(arc).



**Quad-Slice CT**
One x-ray tube and multiple rows of detectors provide *4 channels* of spatial data. Many thousands of detectors in a 2D array.

# CT EVOLUTION



# Multi-slice is 8 times faster than single slice

(4 slices at 2 rev/sec vs 1 slice at 1 rev/sec).

## Why is faster better?

- **Improved temporal resolution**
  - Because faster scanning results in fewer motion artifacts due to voluntary and involuntary (intestinal peristalsis, respirations, etc.) movement. Breath-holding is reduced.
- **Improved spatial resolution**
  - Because thinner slices improve resolution in the z-axis, reducing partial volume artifacts, and increasing diagnostic accuracy.
- **Increased concentration of intravascular contrast media**
  - Because scanning is completed more quickly, contrast media is administered at a faster rate, improving conspicuity of arteries, veins, and pathologic conditions rich in blood flow (aneurysms, hypervascular tumors, active bleeding, etc.).
  - Separation of arterial and venous phases is improved.
- **Decreased image noise**
  - Because imaging is completed rapidly, x-ray tube current (mA) may be increased, decreasing image noise and improving quality, especially important when using thin slices and/or imaging large patients.
- **Efficient x-ray tube utilization**
  - Because imaging is completed rapidly, x-ray tube heating is diminished, decreasing or eliminating the need to wait for tube cooling between scans.
  - 8 times more images are produced during the lifetime of a tube, decreasing cost.

# BEAM GEOMETRY

- SINGLE SLICE SPIRAL
- MULTISLICE
- FAN
- CONE

# BEAM GEOMETRY

- AS THE NUMBER OF DETECTORS IN A MULTIROW DETECTOR ARRAY INCREASES THE BEAM BECOMES WIDER TO COVER THE 2D DETECTOr ARRAY. LARGER # OF ROWS IN THE DETECTOR ARRAY WILL RESULT IN A WIDER BEAM IN Z-AXIS DIRECTION ( CONE BEAM)

# POST DETECTOR COLLIMATION IN MULTISLICE CT

- THE COLLIMATORS ARE POSITIONED BETWEEN DETECTOR COLUMNS.

# DAS

- ALMOST ALL MULTISLICE CT SCANNERS ARE BASED ON III GENERATION SYSTEM DESIGN

**ROTATE-ROTATE**

# Slice registration in unequal detector width scanners



The registration of a certain slice width depends on:

a/ selective activation and combination of detector signals into 4 channels.

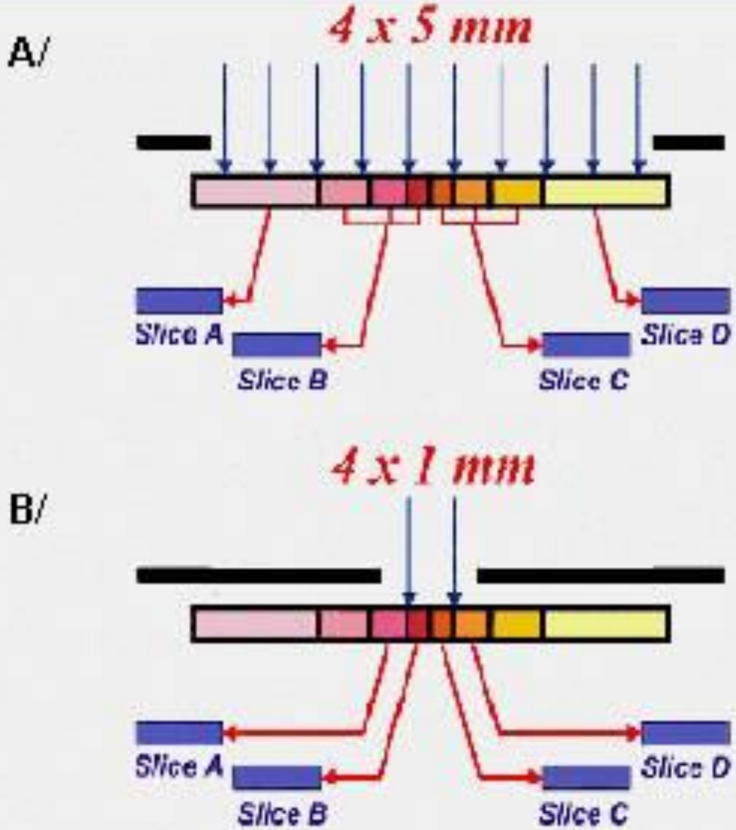
b/ precise collimation which sometimes covers *parts* of the detectors.

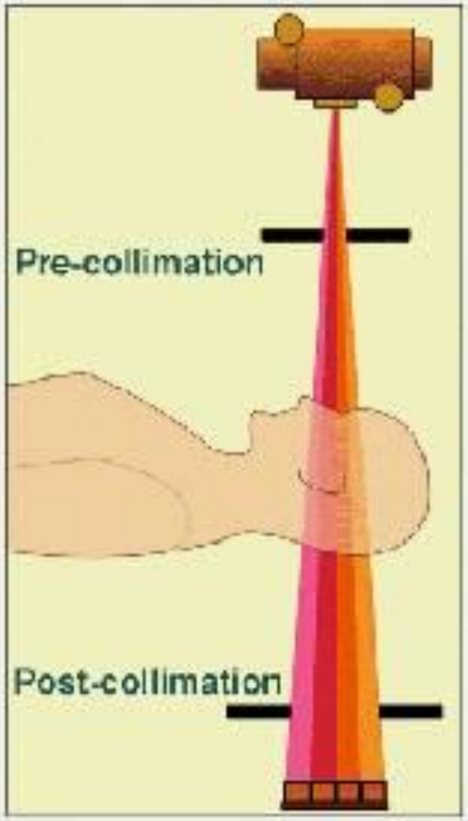
Example A/ For 4X5 mm collimation the incoming radiation from the three innermost detectors on each side are summed up into slice B and slice C.

Example B/ For 4X1 mm collimation the next but innermost detectors on each side are partially covered by the collimators thus allowing only a 1 mm wide x-ray beam to hit the 1.5 mm wide detectors.

Available detector widths in scanner exemplified:

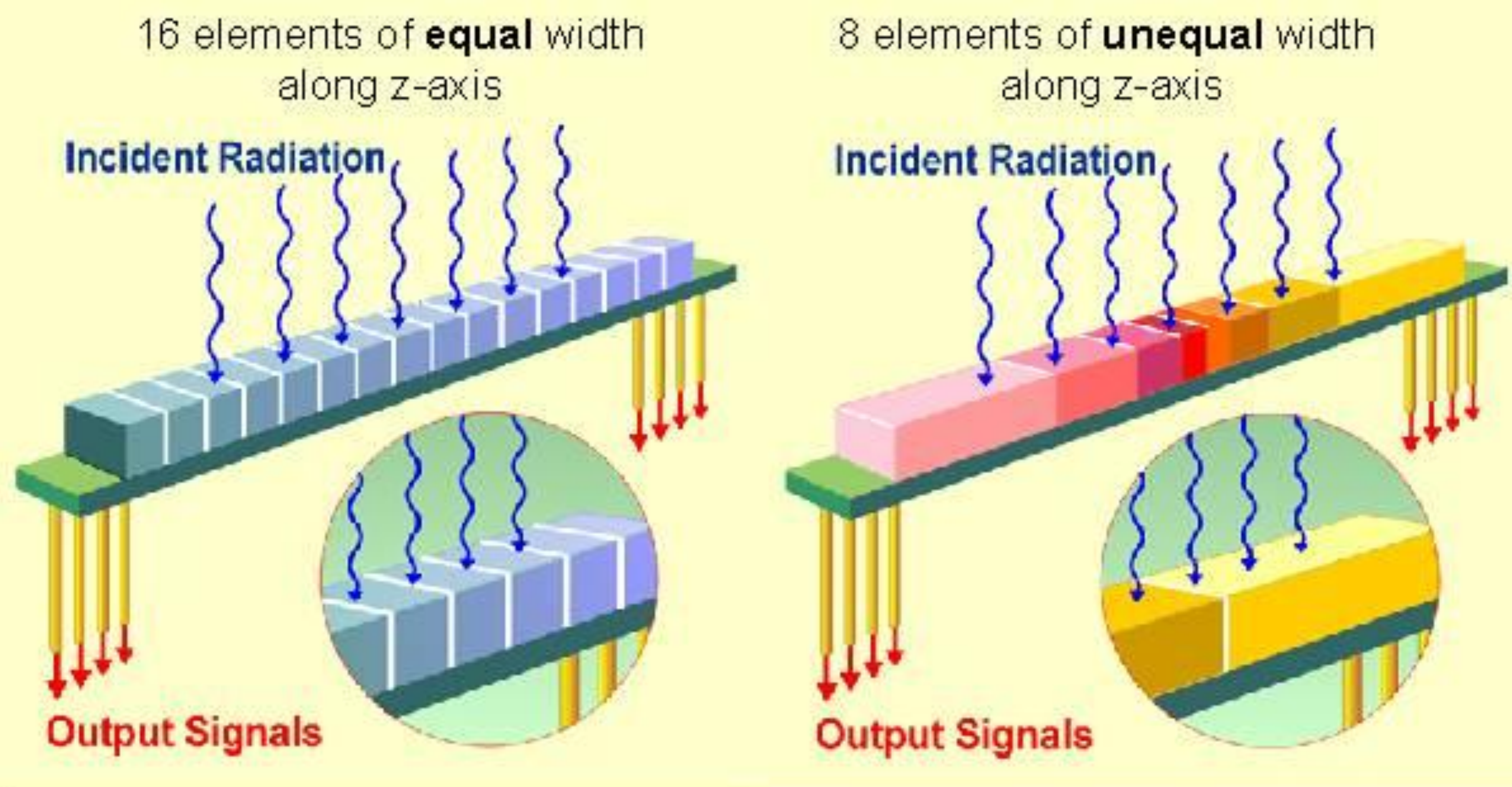
- 2 X 1.0 mm
- 2 X 1.5 mm
- 2 X 2.5 mm
- 2 X 5.0 mm



# Detector array designs: Equal and unequal width






Three different vendor approaches for detector design:

1. General Electric - <u>16 equal detectors</u>: 16 of 1.25 mm
2. Toshiba - <u>34 unequal detectors</u>: 4 of 0.5 mm and 30 of 1.0 mm
3. Picker/Siemens - <u>8 unequal detectors</u>: 2 of 1 mm, 2 of 1.5mm, 2 of 2.5 mm, 2 of 5.0 mm