Pitch
The mean of Pitch in CT?
Pitch = \frac{\text{table travel} / \text{rotation}}{\text{X-ray beam width}}
Pitch for Single-Slice CT

- Image and beam width are same for conventional CT

- Pitch = table travel ÷ beam width

- Typical pitch values are 0.7 to 1.5
Conventional Helical CT Detectors

Image width determined by beam thickness

Pitch = table mm / beam mm
Beam Collimation

- Pre-patient collimators define width of beam in z (all systems)

- “Detector” collimators reduce scatter at detectors (some CTs)
Over beaming caused by wider collimator settings to avoid penumbral effects;
Pitch redefined for MDCT

Beam Pitch = \frac{I}{W}

Detector Pitch = \frac{I}{T}

Beam Pitch = \frac{Detector Pitch}{N} = \frac{I}{N*T} = \text{Pitch}

I - Table feed (mm/rotation)  \quad T - Single DAS channel width (mm)
W - Beam width (mm)  \quad N - Number of active DAS channels
Pitch factor

- Inter-slice distance is defined as the couch increment minus nominal slice thickness. In helical CT the pitch factor is the ratio of the couch increment per rotation to the nominal slice thickness at the axis of rotation. In clinical practice the inter-slice distance generally lies in the range between 0 and 10mm, and the pitch factor between 1 and 2.

- The inter-slice distance can be negative for overlapping scans which in helical CT means a pitch < 1.
Data Acquisition

- Continuous Spiral – Pitch = 1 (10mm/10mm)
- Extended Spiral – Pitch = 2 (20mm / 10mm)
- Overlapping Spiral – Pitch = ½ (5mm/10mm)

\[
Pitch = \frac{Table\ Movement}{Collimation}
\]
Pitch=1; Contiguous Spiral

- Width of Spiral Path (From Collimation)
- Center of Spiral Path
- Direction of Continuous Patient Transport

AAPM Refresher Course Nashville, TN July 28, 1999
Pitch=2; Extended Spiral

Width of Spiral Path (From Collimation)

Center of Spiral Path

Direction of Continuous Patient Transport

z, mm

0

t, sec

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Helical (spiral) scanning - pitch

**pitch 2**
- Table travel/rot = 80 mm
- Beam width = 40 mm

**pitch 1**

**pitch 0.5**
Pitch

Pitch = 1
Table Travel = Paint Width
Uniform Paint

Pitch < 1
Table Travel < Paint Width
Uniform + Overlapped Paint

Pitch > 1
Table Travel > Paint Width
Candy Cane Stripes
# Table Speed & Pitch

**Table Speed** is defined as distance traveled in mm per 360° rotation.

**Pitch** => **Table Feed per rotation**

<table>
<thead>
<tr>
<th>Table Feed</th>
<th>Collimation</th>
<th>Pitch</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 mm/rot</td>
<td>10 mm</td>
<td>1.0</td>
</tr>
<tr>
<td>15 mm/rot</td>
<td>10 mm</td>
<td>1.5</td>
</tr>
<tr>
<td>20 mm/rot</td>
<td>10 mm</td>
<td>2.0</td>
</tr>
</tbody>
</table>
Pitch 2 covers 2x distance as Pitch 1

More Coverage in the same time with extended Pitch!!
Scan Range = **300 mm**

10mm P1
10 mm/s

10mm P2
20 mm/s

Cover the same volume in shorter time with extended Pitch
Pitch
ratio of the distance the table travels per rotation to the x-ray beam width

<table>
<thead>
<tr>
<th></th>
<th>Number rotations</th>
<th>Slice thickness</th>
<th>Table movement per rotation</th>
<th>Pitch</th>
<th>Dose</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>1.5</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>10</td>
<td>20</td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>2.5</td>
<td>10</td>
<td>30</td>
<td>3</td>
<td>3.33</td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>10</td>
<td>40</td>
<td>4</td>
<td>2.5</td>
</tr>
</tbody>
</table>

Dose

<table>
<thead>
<tr>
<th></th>
<th>10</th>
<th>7.5</th>
<th>5</th>
<th>3.33</th>
<th>2.5</th>
</tr>
</thead>
</table>

Number of rotations: 10, 5, 2.5
Slice thickness: 10
Table movement per rotation: 10, 15, 20, 30, 40
Pitch: 1, 1.5, 2, 3, 4
Dose: 10, 7.5, 5, 3.33, 2.5
Helical Single-Section Mode

Interpolation using samples from single row detector ring
Conventional
SSP

conventional
MSCT
To reduce artifacts due to table motion during spiral scanning, we use a special reconstruction process called *INTERPOLATION*.
Helical Interpolation

Collect data (black dots)

Rebin to estimate the $180^\circ$ data (blue squares)

Interpolate to estimate image between collected and rebinned data

Helical CT needs fast computers
Wide algorithm produces a broader image thickness
Wide algorithm uses more raw data => less image noise
Pitch 2 scanning produces a broader image thickness.
Pitch 2 scanning does not increase image noise.

30% increase in image thickness with Pitch 2.
Slice Sensitivity Profile (SSP)

SSP describes the **effective slice thickness** of an image and to what extent anatomy within that slice contribute to the signal.

**RESOLUTION**

- **SSP**
  - All points within the slice contribute equally & points outside of the slice do not contribute to the image at all.

**Image signal**

- **Ideal SSP**
  - Collimation = width of x-ray beam = slice profile

**Z-axis (mm)**
Slice Profile (SP)

- Effective slice thickness of an image

Factors influencing Slice Profile

- Collimation
- Pitch
- Interpolation algorithm (360° or 180°)
Factors influencing SSP

• Collimator width

Spiral CT

• Table speed or Pitch

• Interpolation Algorithm

=> mathematical process required to reconstruct axial images from the spiral volume data set
SSP
Spatial resolution

Smaller image

SSP
Spatial resolution

Noisier image
Effect of Pitch on Dose and Image Quality

P = 0.64
CTDI = 47.8 mGy
30% higher

P = 0.83
CTDI = 37 mGy

P = 1.48
CTDI = 20.6 mGy
45% lower
Thank you for your attention!