PURDUE UNIVERSITY

Hardwood Scanning Center

Forestry & Natural Resources

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# Innovations in Wood Processing

**Rado Gazo**

March 2013

San Jose, Costa Rica

# Indiana's Primary Industry
## (logging, sawmills, veneer, plywood, etc.)

- 601 firms in the primary industry of Indiana
- 21,692 individuals are employed by the primary industry
- $563 million dollars in wages were paid by the primary industry

# Indiana's Secondary Industry
## (furniture, fixtures, etc.)

- 509 firms comprise the secondary wood products manufacturing industry in Indiana
- 69 of the 300 largest U.S. furniture, cabinet, and millwork manufacturers have plants in Indiana
- 10 of the largest kitchen cabinet manufacturers have headquarters or plants in Indiana
- 26,150 individuals are employed by the secondary industry
- $666 million in wages were paid by the secondary industry

# Secondary Wood Processing

## Example: Cryogenic Treatment of Tools

# The Effect Cryogenic Treatment on Tool Wear in Machining

| | 70°F (21°C) | 40°F (4.4°C) | 20°F (-6.7°C) |
|---|---|---|---|
| Untreated | Control | +27% | +15% |
| Treated | +65% | +85% | +217% |

Estimated increase in tool life

# Primary Wood Processing

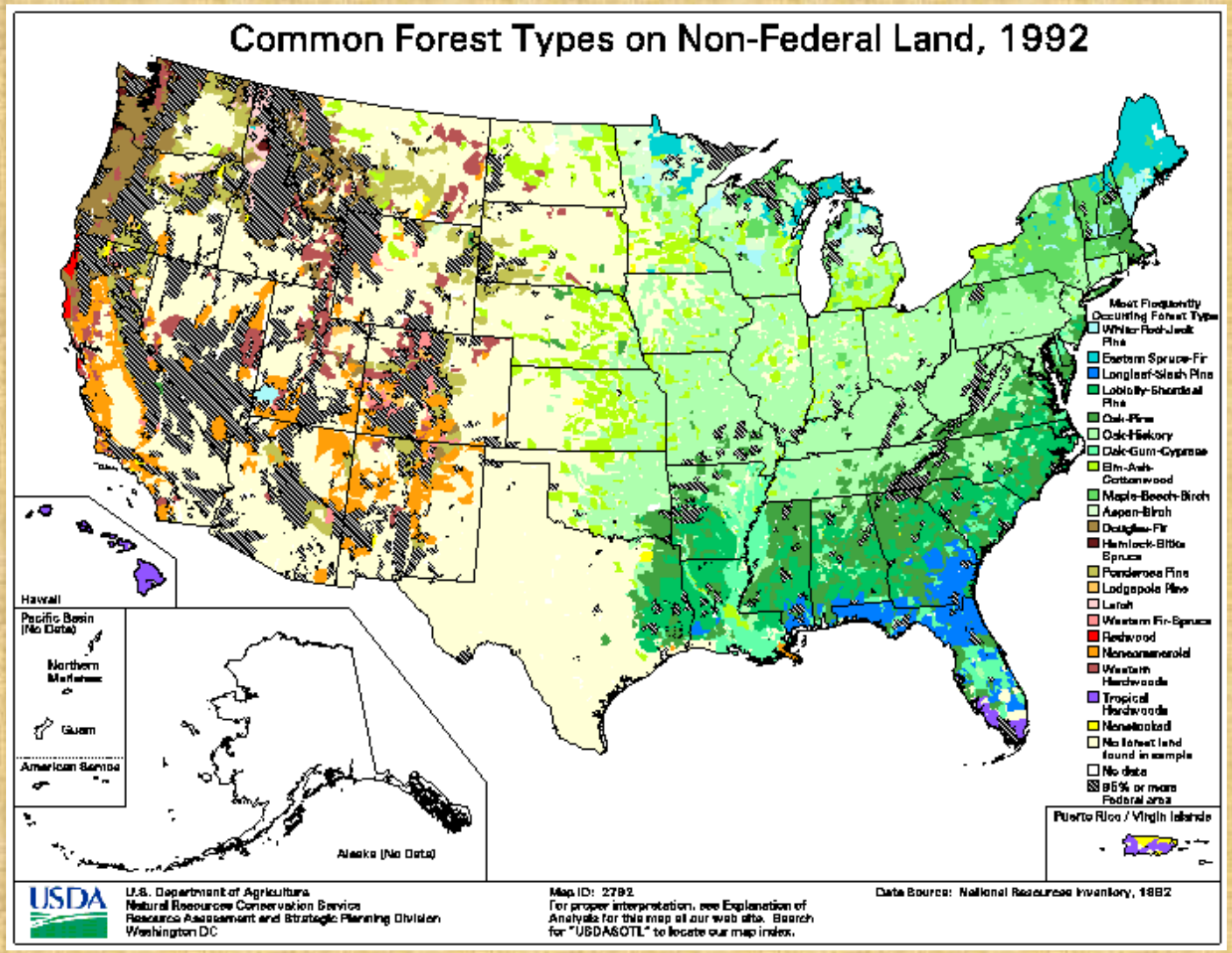
## Example: CT Scanning of Logs

# Past scanning studies

Numerous past research studies have examined log breakdown value improvements.

| Year | Author | # of Logs | Species | % Improvement |
|---|---|---|---|---|
| 1962 | Peter | 10 | Southern Pine | 3% |
| 1967 | Peter | 50 | Yellow Poplar | 9% |
| 1969 | Tsolakides | 6 | Red Oak | 21% |
| 1975 | Wagner and Taylor | 10 | Southern Pine | 8% |
| 1980 | Richards *et al.* | 320 | Red Oak | 11% |
| 1989 | Steele *et al.* | 24 | Red Oak | 12% |
| 1994 | Steele *et al.* | 6 | Red Oak | 10% |
| '94-'99 | Chang and Guddanti | 10 | Red Oak | 18% -28% |

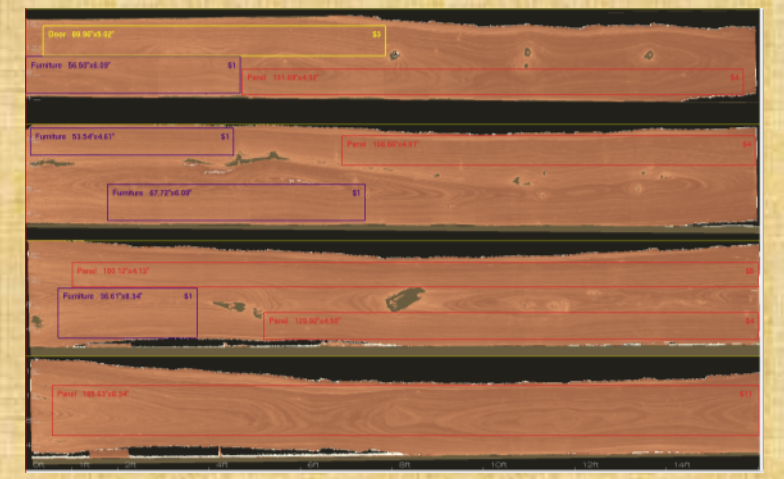
# Softwood vs. Hardwood Log Processing



# Softwood vs. Hardwood Log Processing

- Softwoods – grading system is based on prediction of strength of lumber.
- Production process is more automated and much faster.

- Hardwoods – grading system is based on appearance characteristics of lumber or sliced veneer.
- Production process relies heavily on experience and skill of operator (headrig, resaw, edger).



# Hardwood Scanning Center Goal

- Help in development of Hardwood Log CT scanner
- Develop optimization software
- Assist in industry adoption of CT scanning technology

# Proof of Concept

- 60 Logs
- 5 Species (Black Cherry, Yellow Poplar, Red Oak, White Oak and Hard Maple)
- 3 Log Grades (Grade 1, 2 and 3)
- 4 Logs (2 pairs) per grade
- Pair is a close match in diameter, length, location within a tree and defects
- Logs were 10’ to 16’ long and up to 16” in diameter

# Proof of Concept

# Proof of Concept

# Results – Sawmill vs. CT Scanner

| Gain (%) | Black Cherry | Hard Maple | Red Oak | White Oak | Yellow Poplar | Overall |
|---|---|---|---|---|---|---|
| All Grades | 42 | 33 | 24 | 60 | 87 | **46** |

# Results – Sawmill vs. CT Scanner

| Gain (%) | Black Cherry | Hard Maple | Red Oak | White Oak | Yellow Poplar | Overall |
|---|---|---|---|---|---|---|
| All Grades | 42 | 33 | 24 | 60 | 87 | **46** |
| Grade 1 | 20 | 21 | 8 | 83 | 23 | 27 |

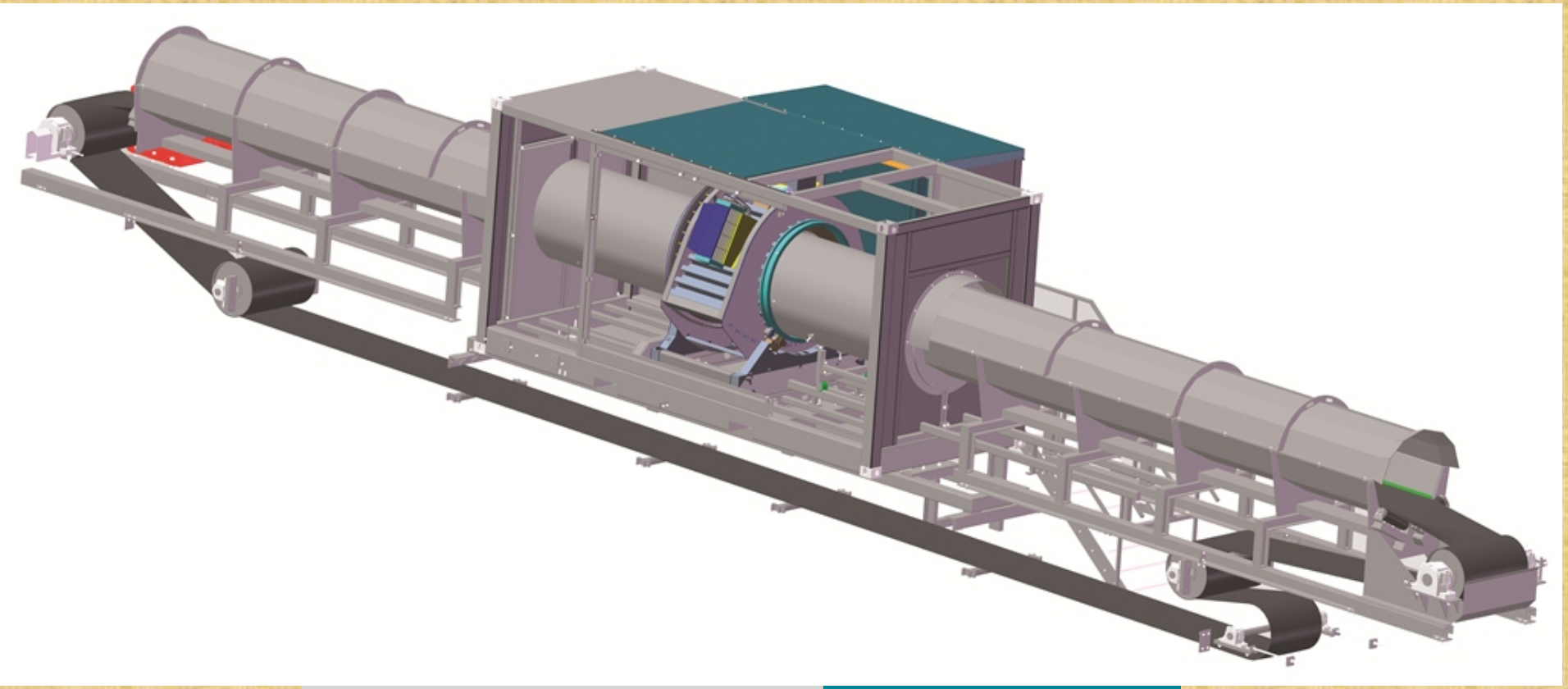
# Results – Sawmill vs. CT Scanner

| Gain (%) | Black Cherry | Hard Maple | Red Oak | White Oak | Yellow Poplar | Overall |
|---|---|---|---|---|---|---|
| All Grades | 42 | 33 | 24 | 60 | 87 | **46** |
| Grade 1 | 20 | 21 | 8 | 83 | 23 | 27 |
| Grade 2 | 45 | 34 | 22 | 42 | 99 | 47 |

# Results – Sawmill vs. CT Scanner

| Gain (%) | Black Cherry | Hard Maple | Red Oak | White Oak | Yellow Poplar | Overall |
|---|---|---|---|---|---|---|
| All Grades | 42 | 33 | 24 | 60 | 87 | **46** |
| Grade 1 | 20 | 21 | 8 | 83 | 23 | 27 |
| Grade 2 | 45 | 34 | 22 | 42 | 99 | 47 |
| Grade 3 | 194 | 75 | 67 | 46 | 221 | 97 |

# CT Scanner Development
# Medical vs. Security



MiCROTEC® INNOVATING WOOD CT.LOG

# CT Scanner Development

- Log Length: No limit
- Max. Log Diameter: 700 mm
- Gantry aperture: 1200 mm
- Max Log speed: 60 m/min
- X–Y resolution: approx. 1mm

MiCROTEC® INNOVATING WOOD CT.LOG


CT.LOG
MICROTEC

# Software Development

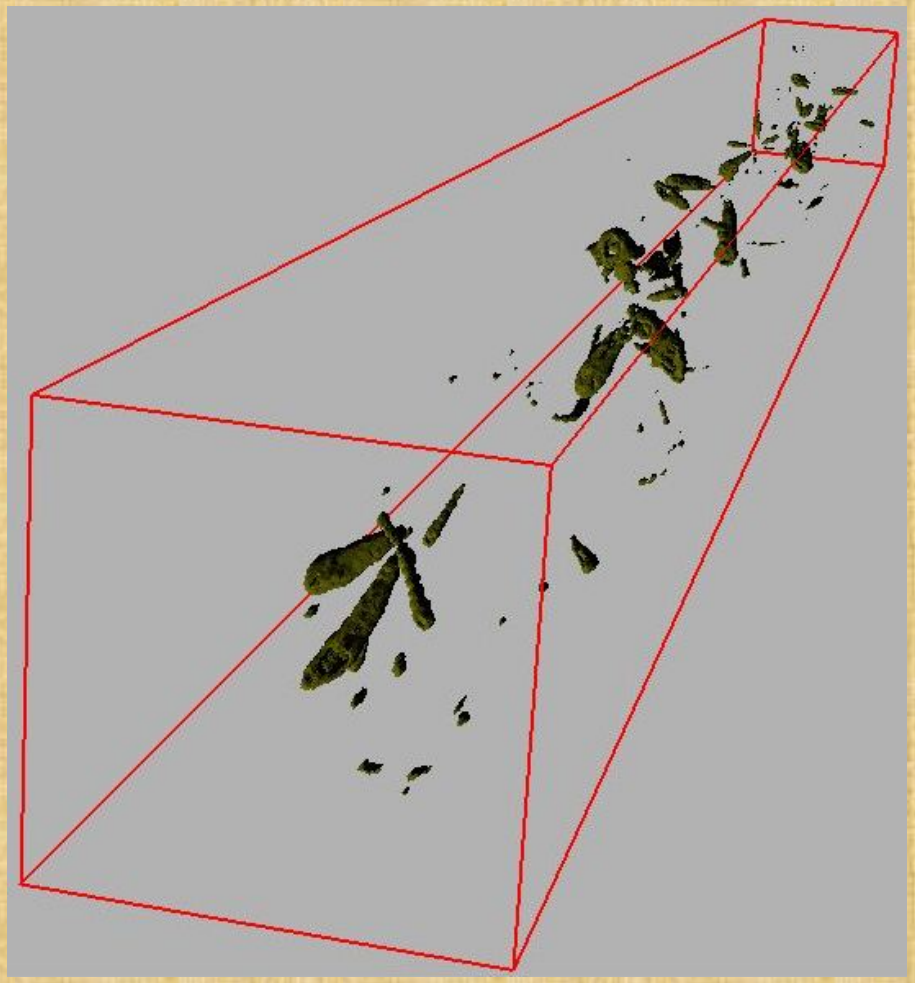
- LogView
  - Veneer (full optimization)
  - Sawmill (full optimization)

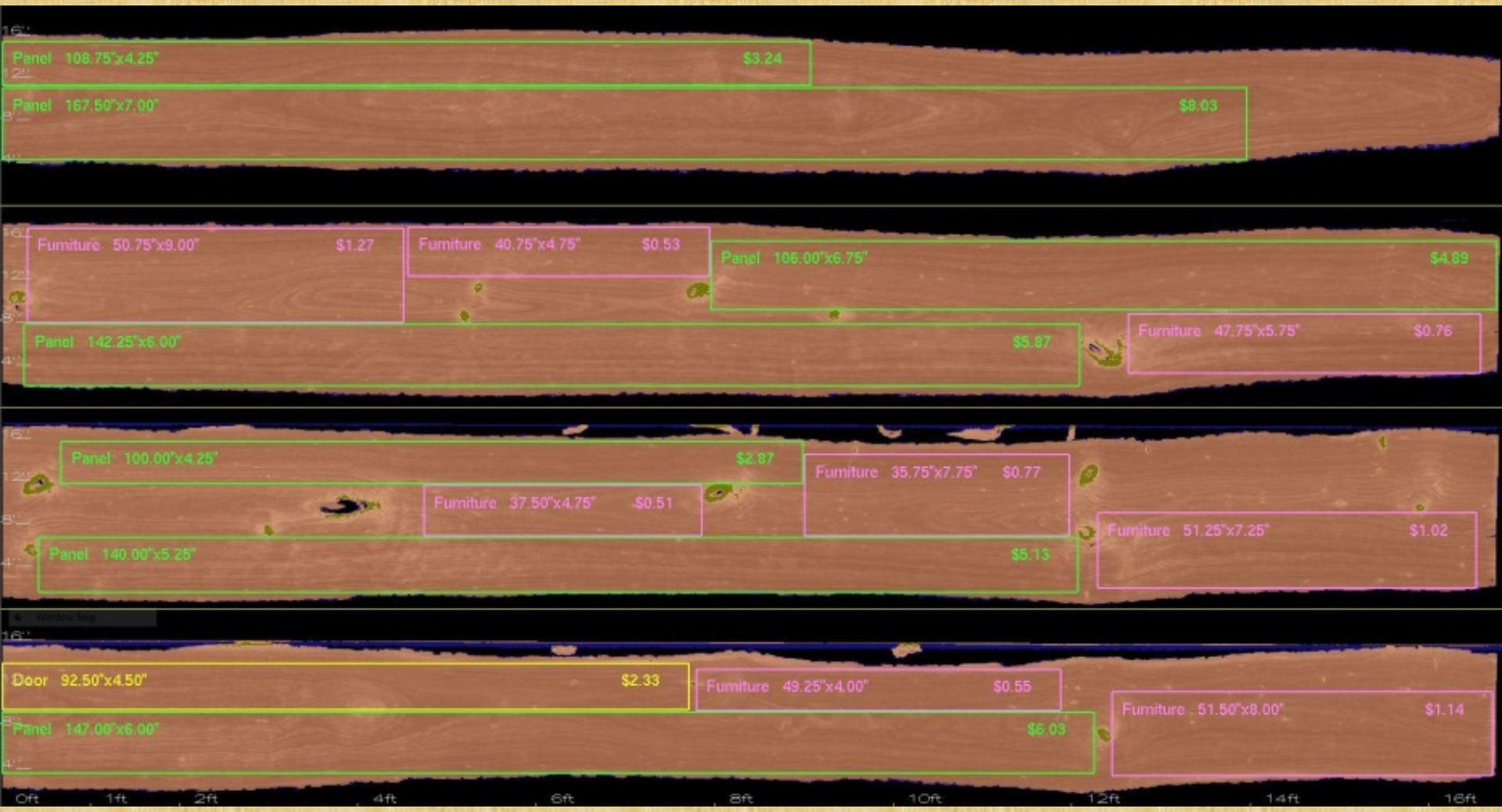
- Developed by Purdue University Hardwood Scanning Center

- Commercialized by LogView, LLC

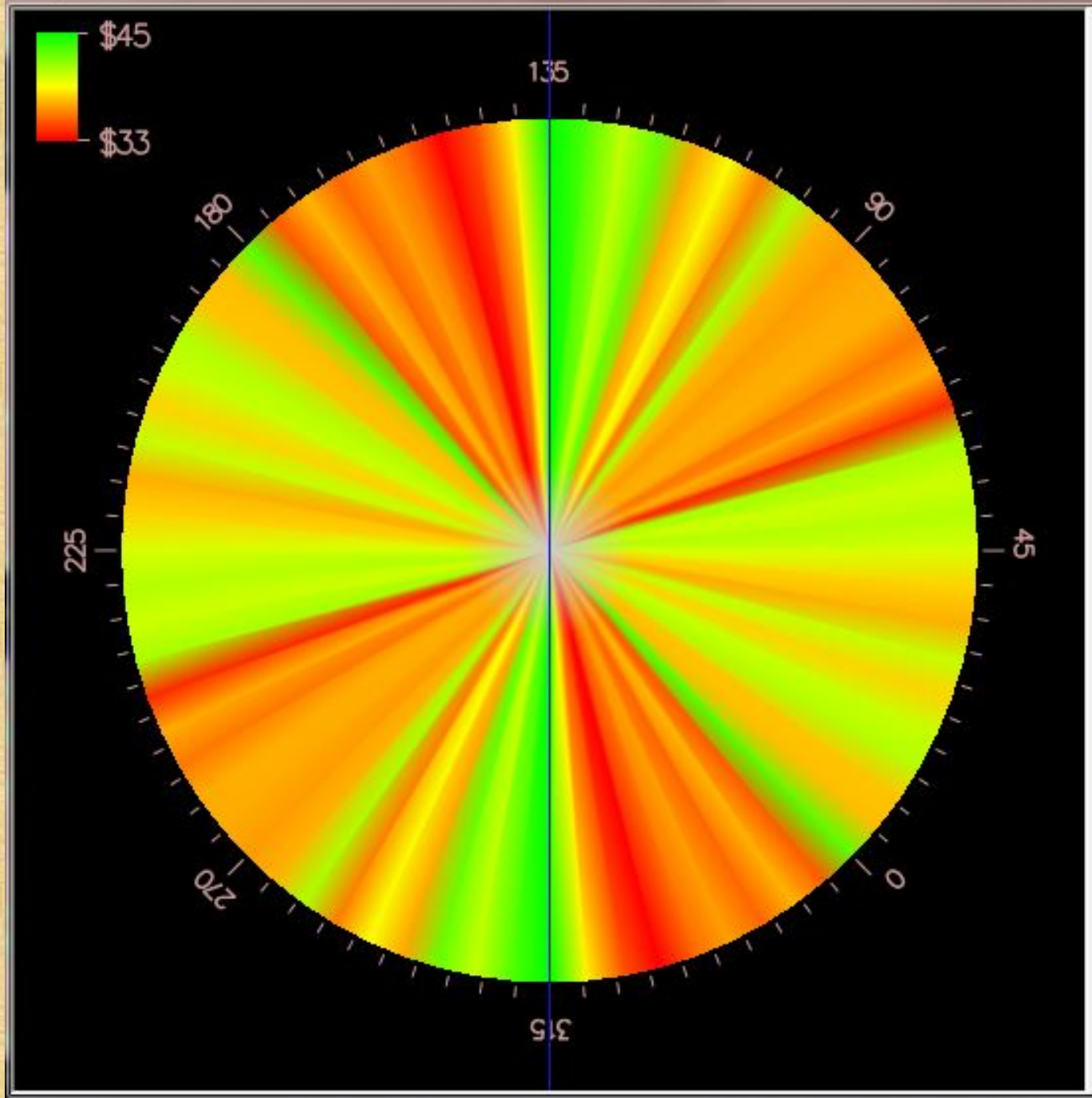
# Industry Adoption

- Public test demonstration in selected mills
  - Veneer
  - Sawmill




Panel 108.75"x4.25" $3.24
Panel 167.50"x7.00" $8.03
Furniture 50.75"x9.00" $1.27
Furniture 40.75"x4.75" $0.53
Panel 106.00"x6.75" $4.89
Panel 142.25"x6.00" $5.87
Furniture 47.75"x5.75" $0.76
Panel 100.00"x4.25" $2.87
Furniture 35.75"x7.75" $0.77
Furniture 37.50"x4.75" $0.51
Furniture 51.25"x7.25" $1.02
Panel 140.00"x5.25" $5.13
Door 92.50"x4.50" $2.33
Furniture 49.25"x4.00" $0.55
Furniture .. 51.50"x8.00" $1.14
Panel 147.00"x6.00" $6.03
0ft
1ft
2ft
4ft
6ft
8ft
10ft
12ft
14ft
16ft

Analysis Results




Selected Angle 135

Total Price [$] 45

Improvement [%] 36

sq ft

| | |
|---|---|
| Panel | 16.40 |
| Door | 0.00 |
| Desk | 2.92 |
| Furniture | 36.05 |

Results By Method

- (•) Value
- ( ) Volume
- ( ) Figure

Display Options

- [ ] Show Log Ends

Active Results

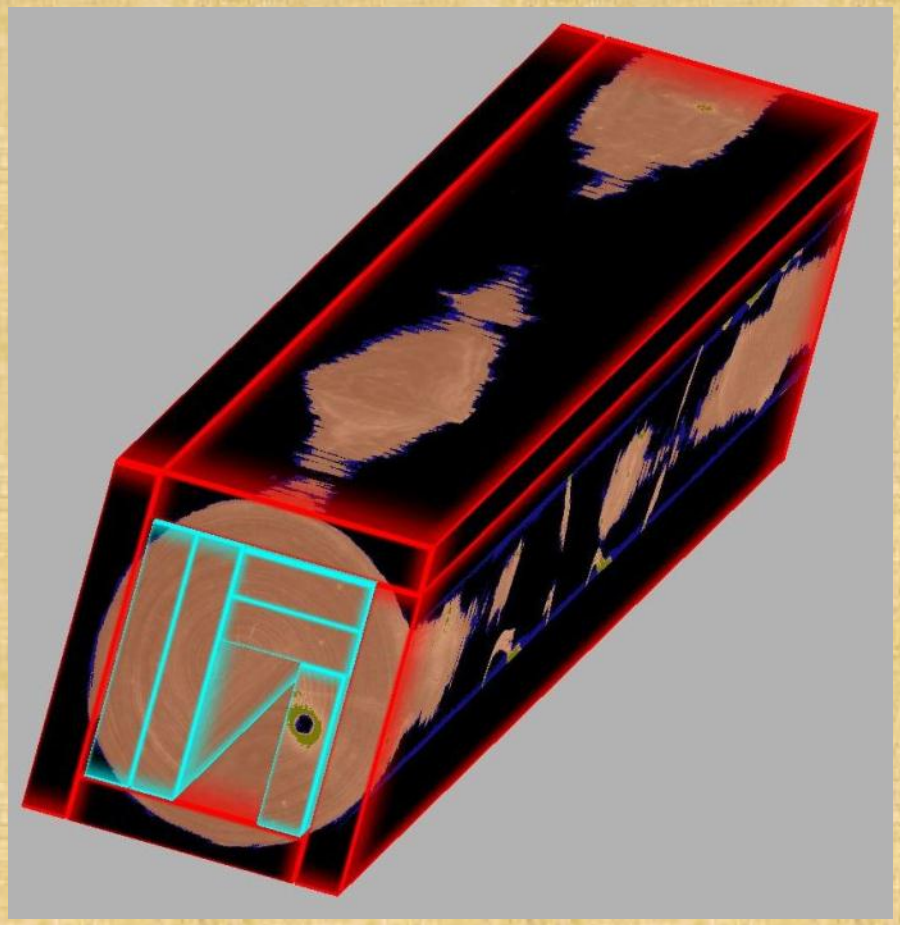
Result 0

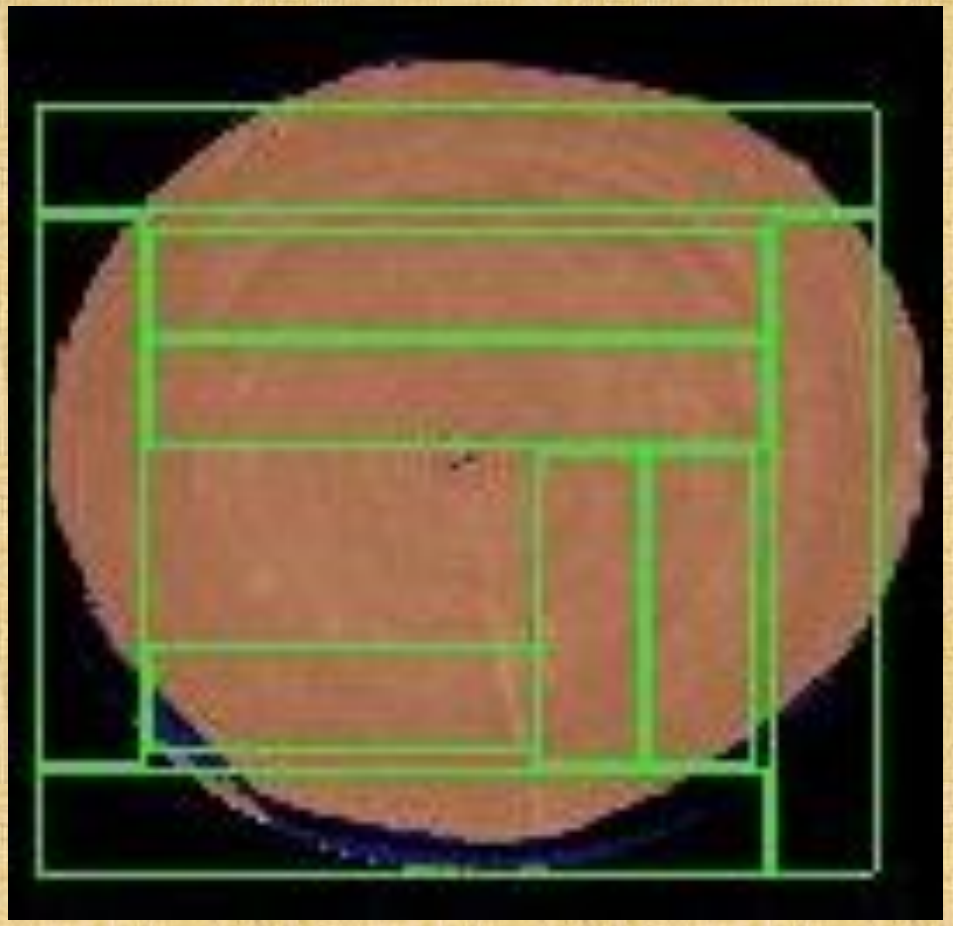
Select Best Angle

The log was analyzed in:

6 s

OK






18"
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0ft 1ft 2ft 4ft 6ft 8ft 10ft 12ft 14ft

# How and Where Can This Technology Be Applied?

- Log merchandising and bucking
- Slicing vs. Peeling
- Hardwood Veneer Slicing – Optimize splitting log into flitches (off-line or in-line)
- Hardwood Sawmills - Optimize log “opening” at headrig to maximize yield of premium product (in-line between debarker and headrig)

# CT Log Scanning

**Summary**

- **CT Technology exists today to see *inside* a log**
- **CT Technology can be applied at various points in the process to satisfy multiple applications**

# The Species

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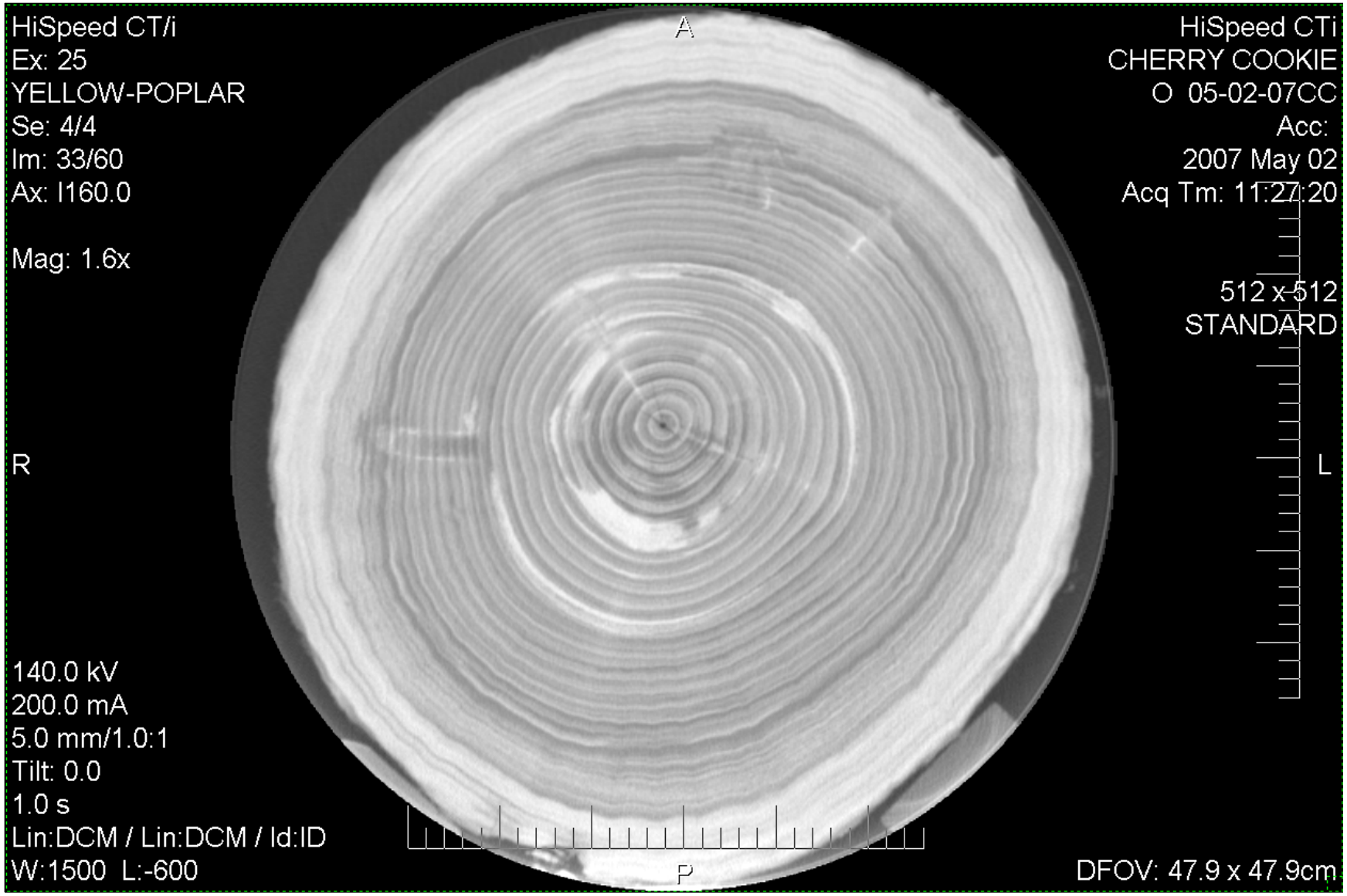


**Yellow Popular**

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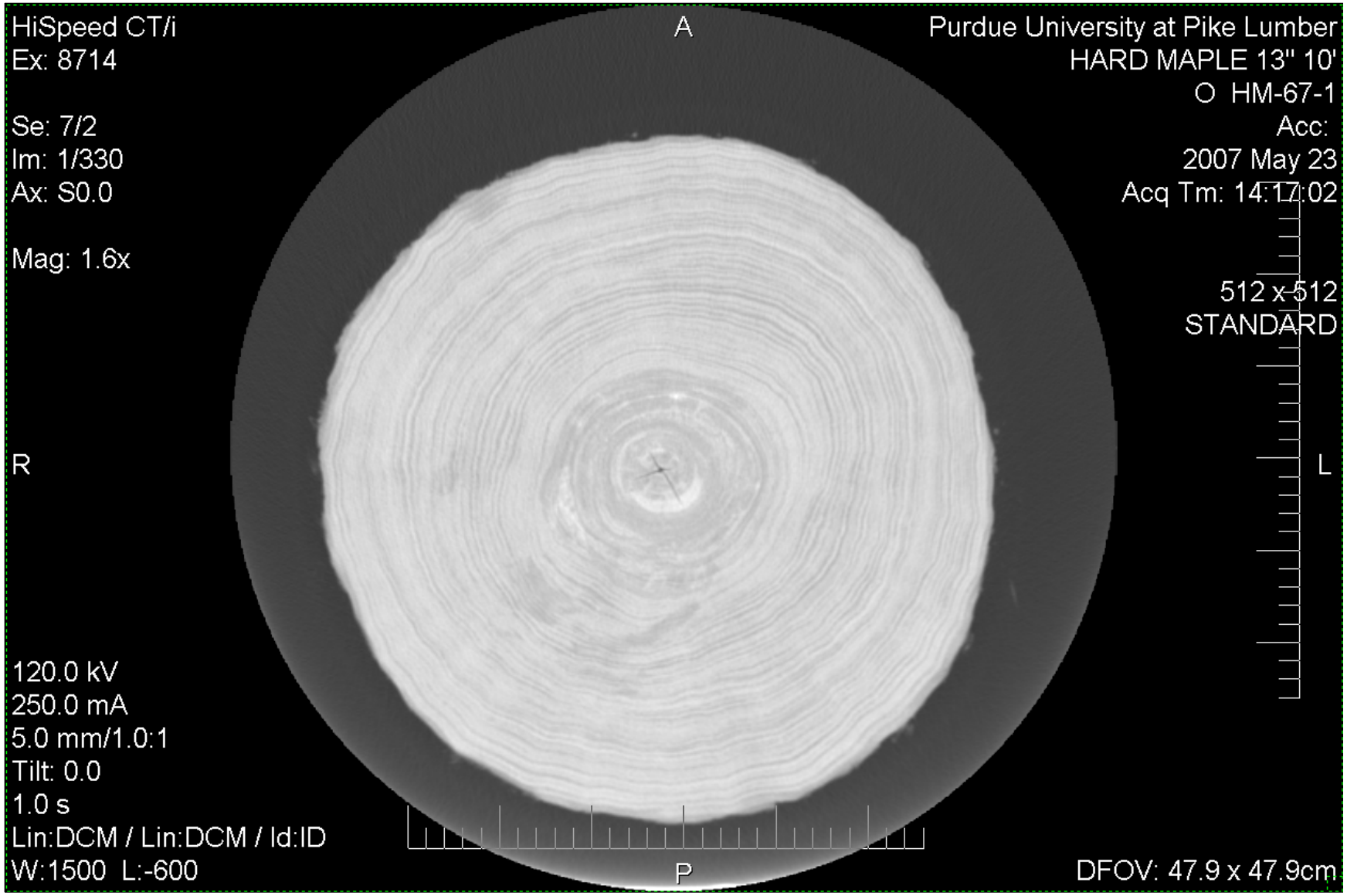


**Hard Maple**

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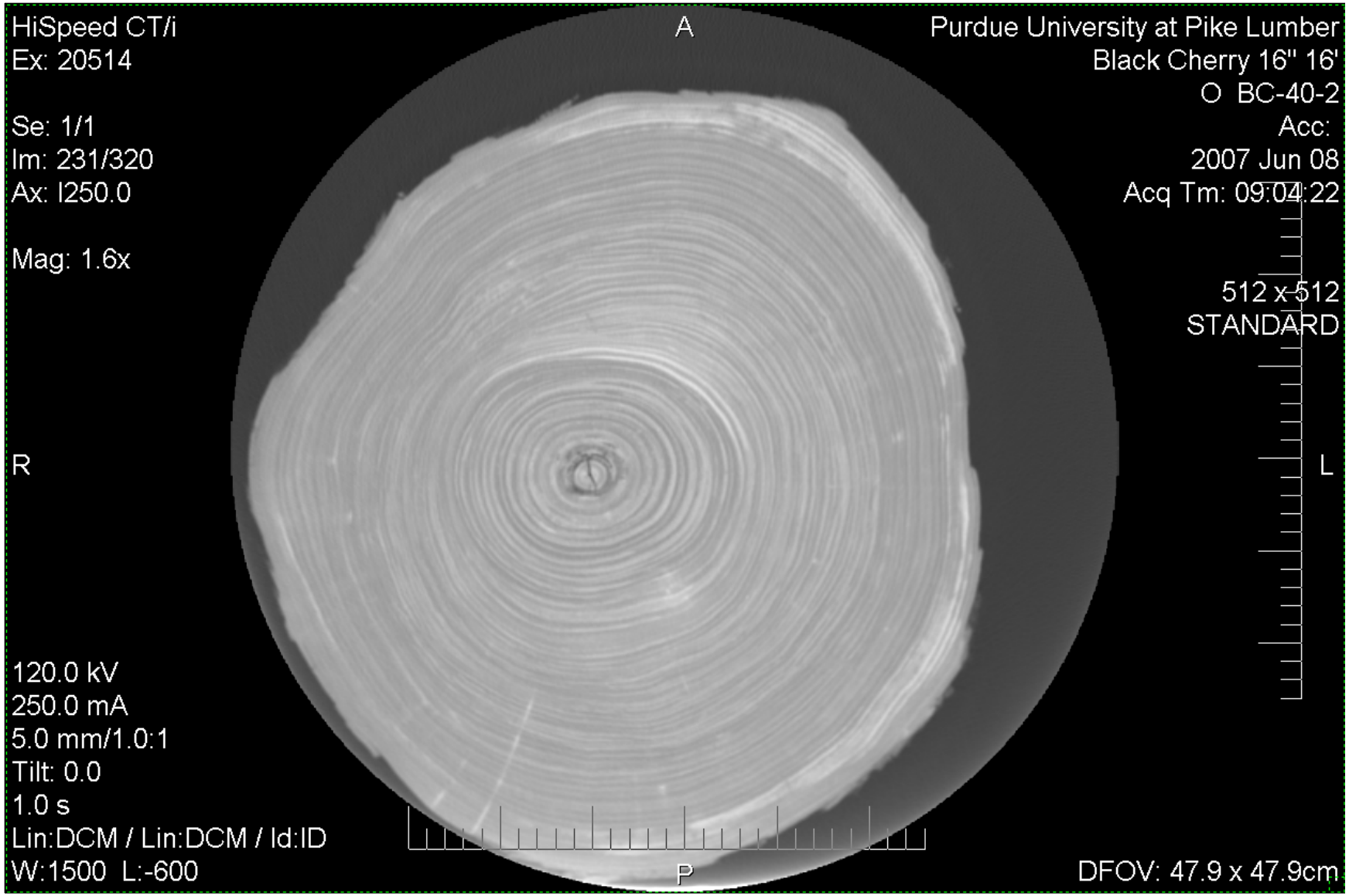


**Black Cherry**

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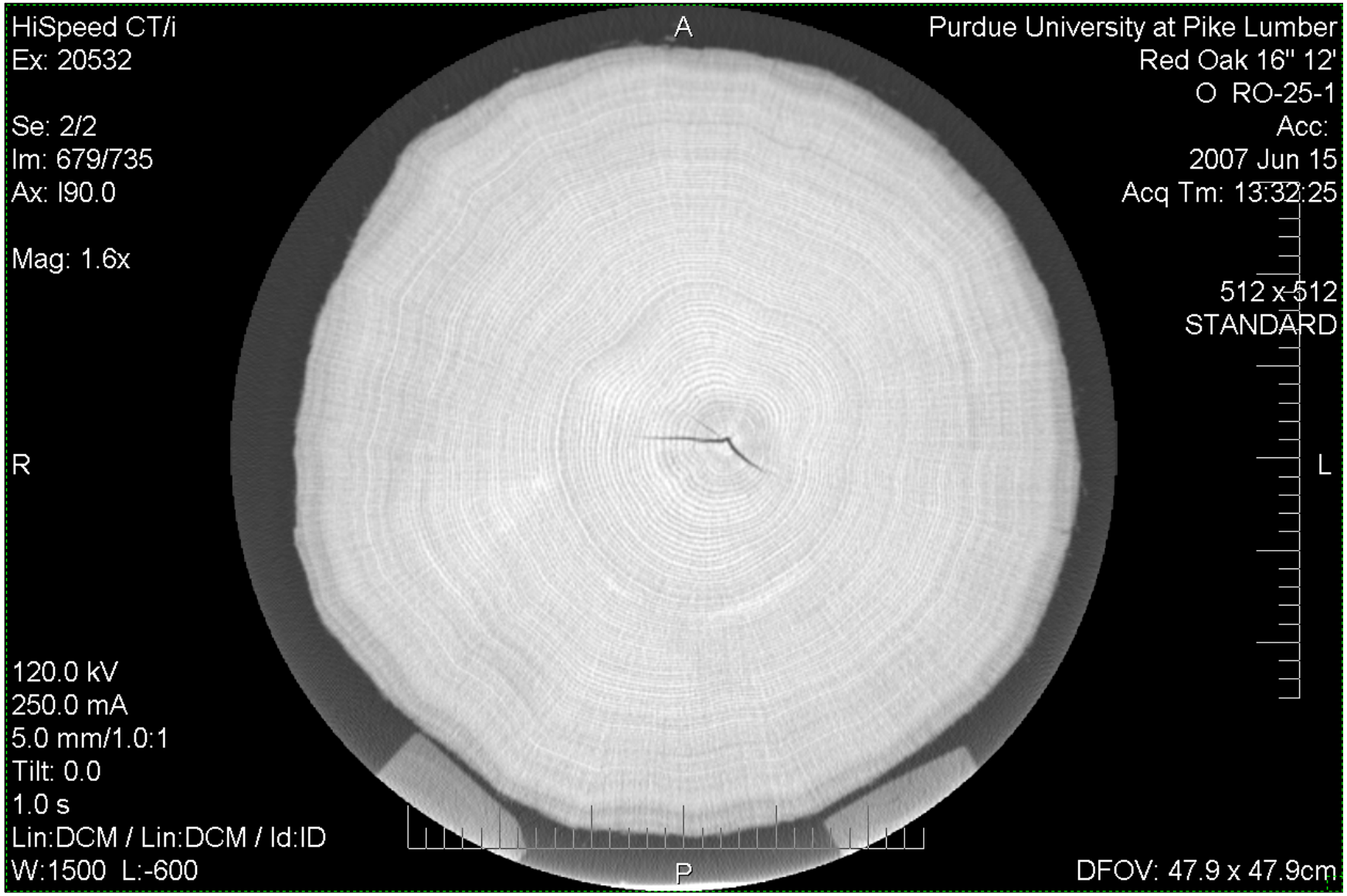


**Red Oak**

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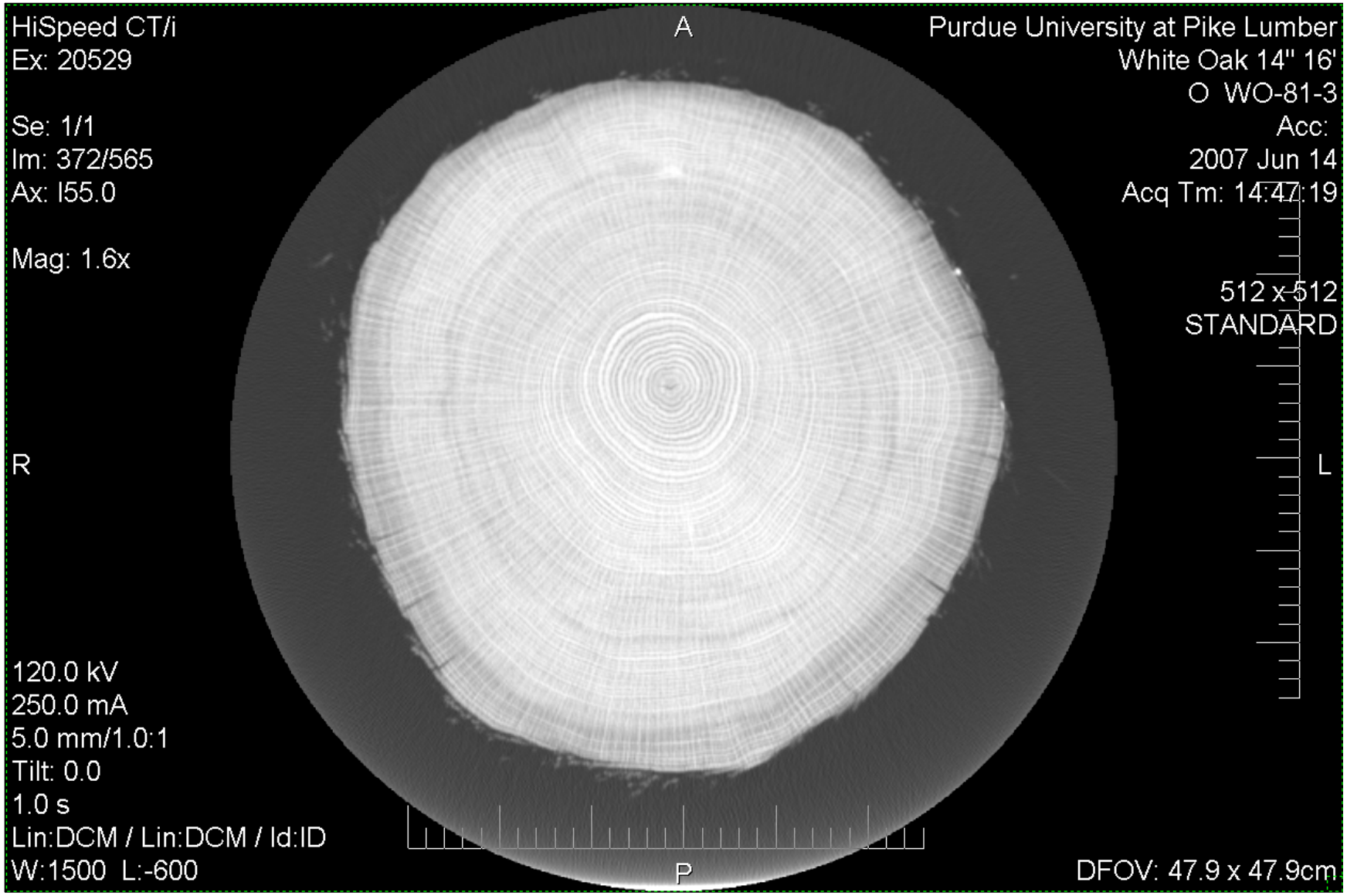


**White Oak**

# What can we see in wood?

We can see…

# Knots & Voids

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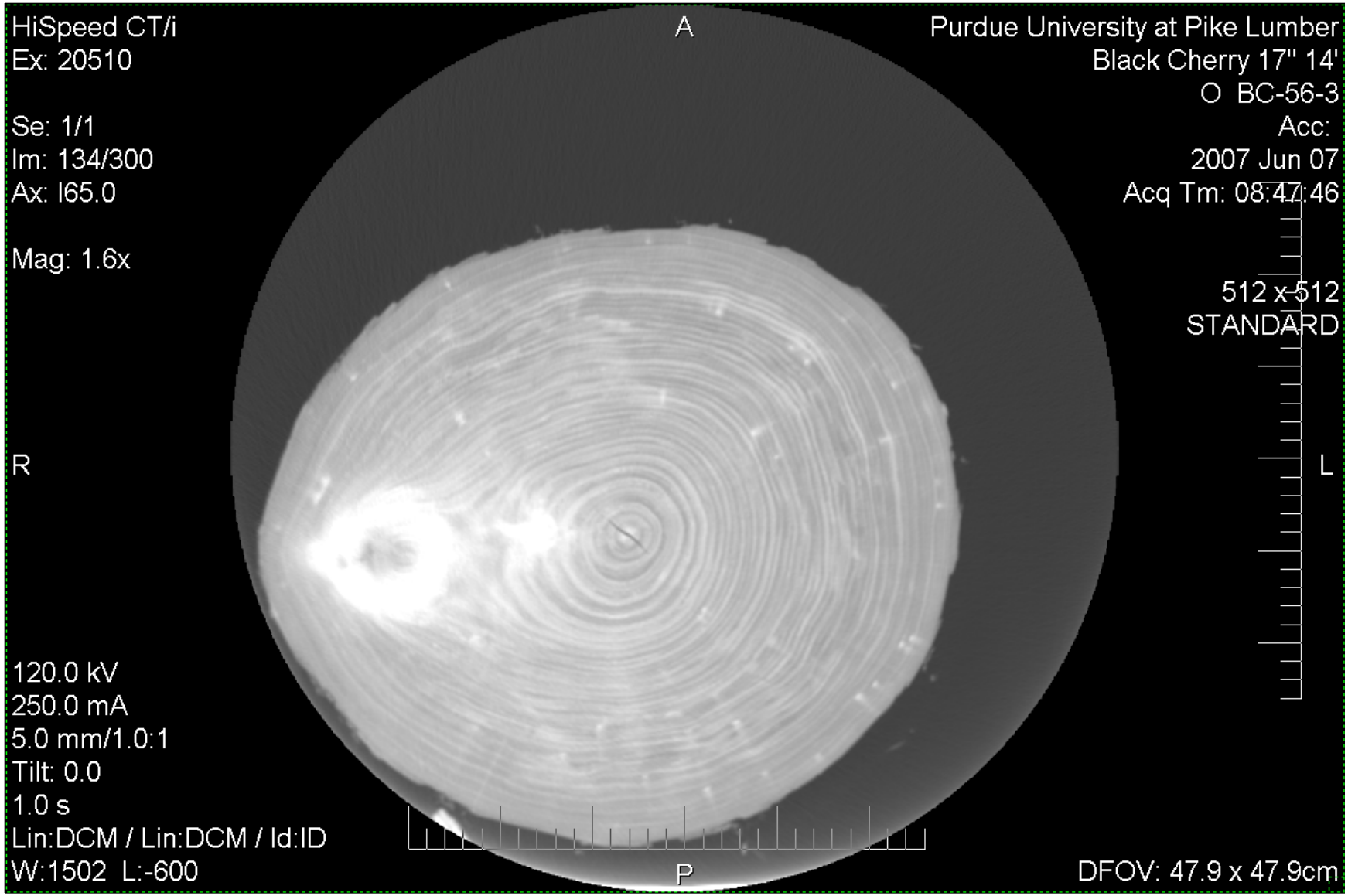


**Sound Knot in Black Cherry**

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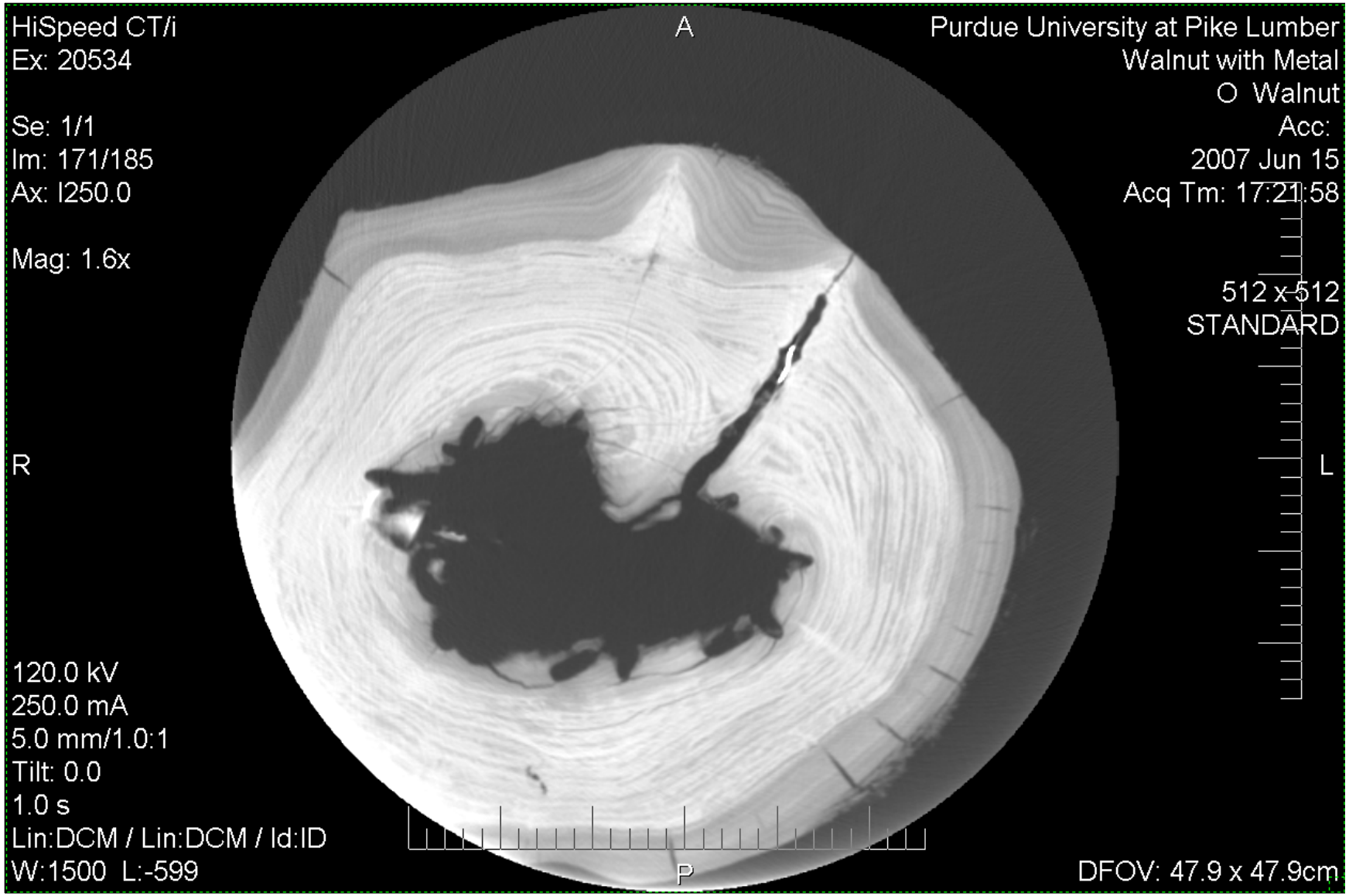
# Hardwood Scanning Center




**Carpenter Ants in Black Walnut**

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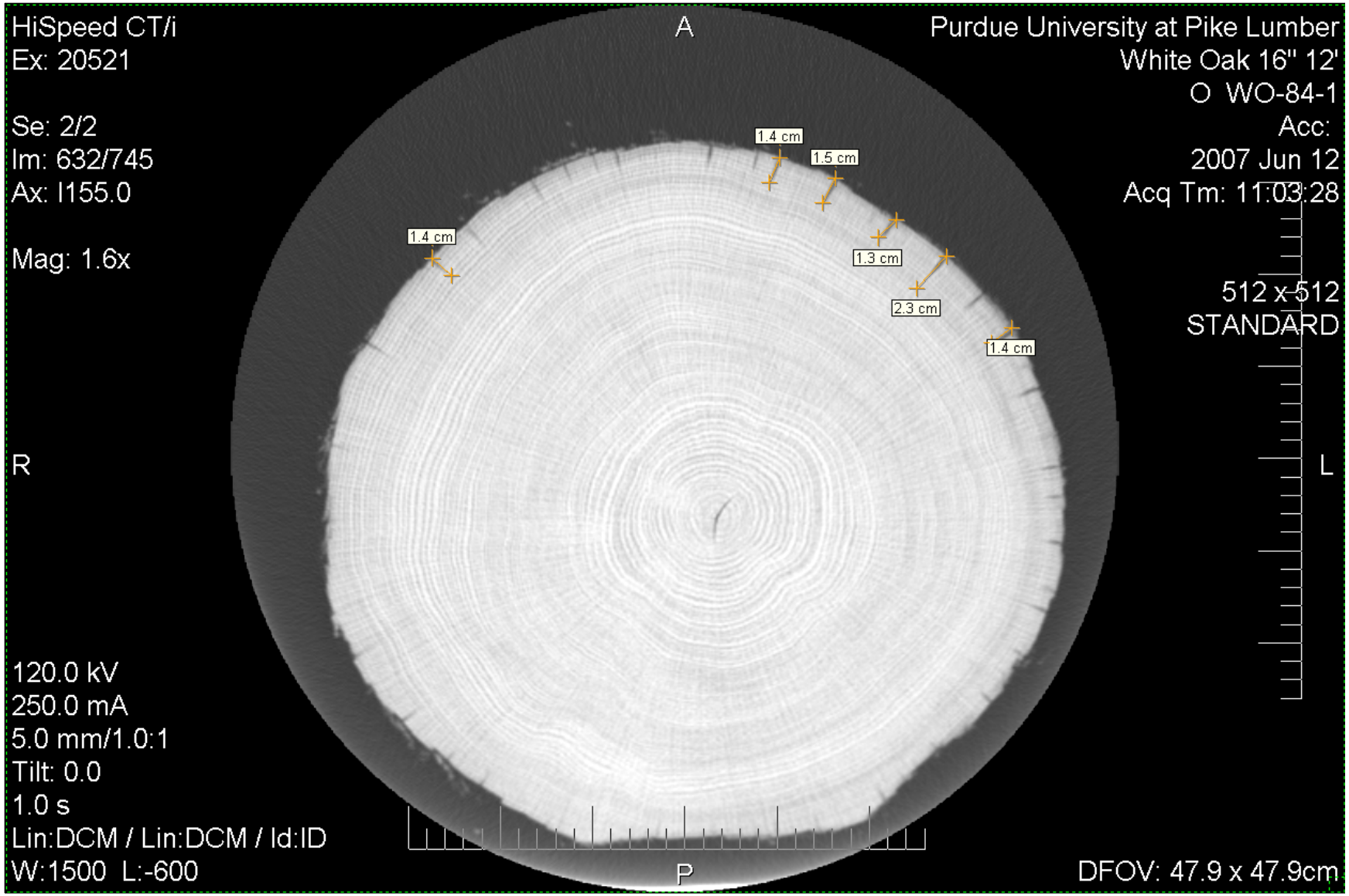


**Checking In White Oak**

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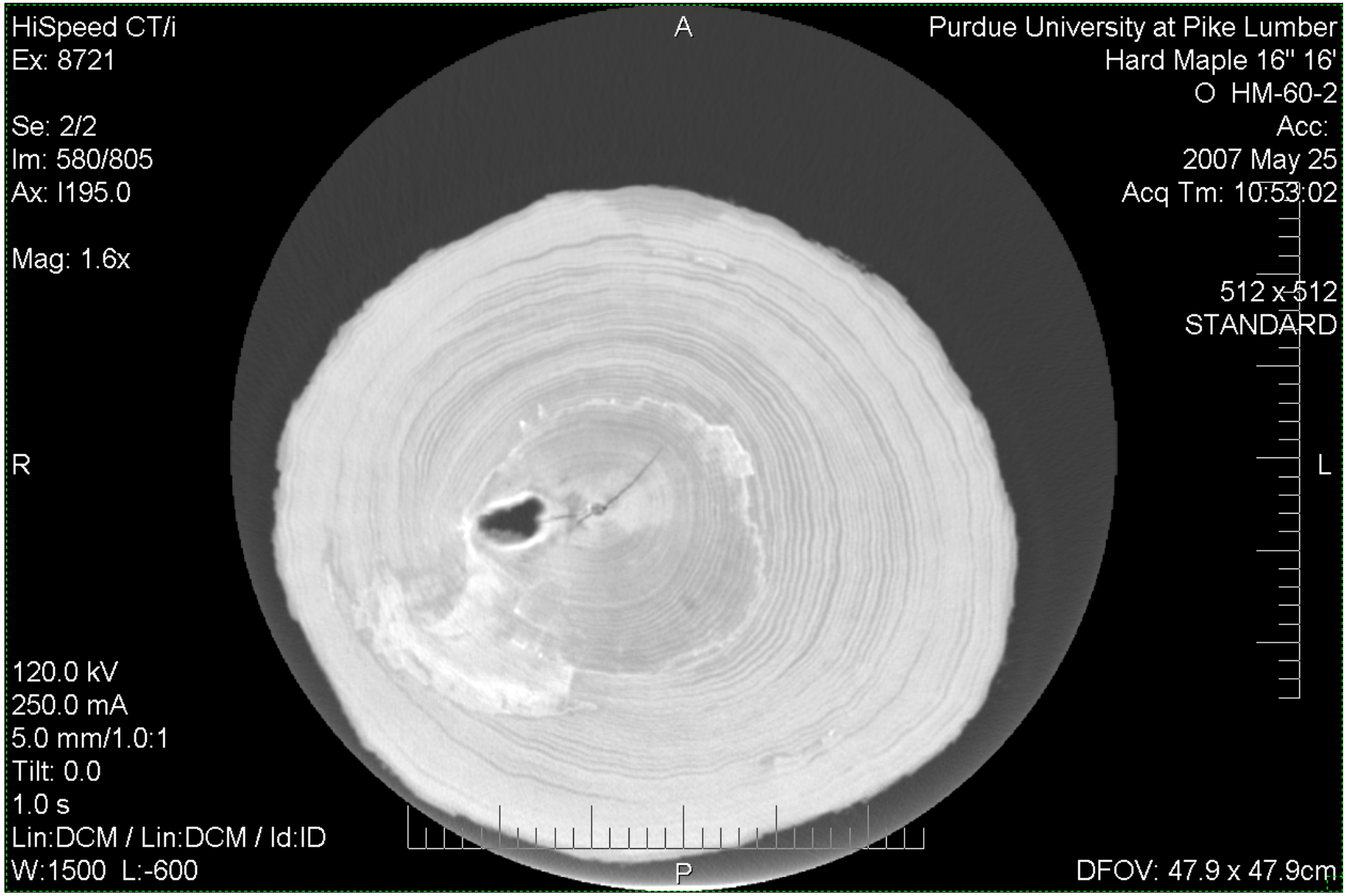
# Hardwood Scanning Center




**Un-Sound Knot in Hard Maple**

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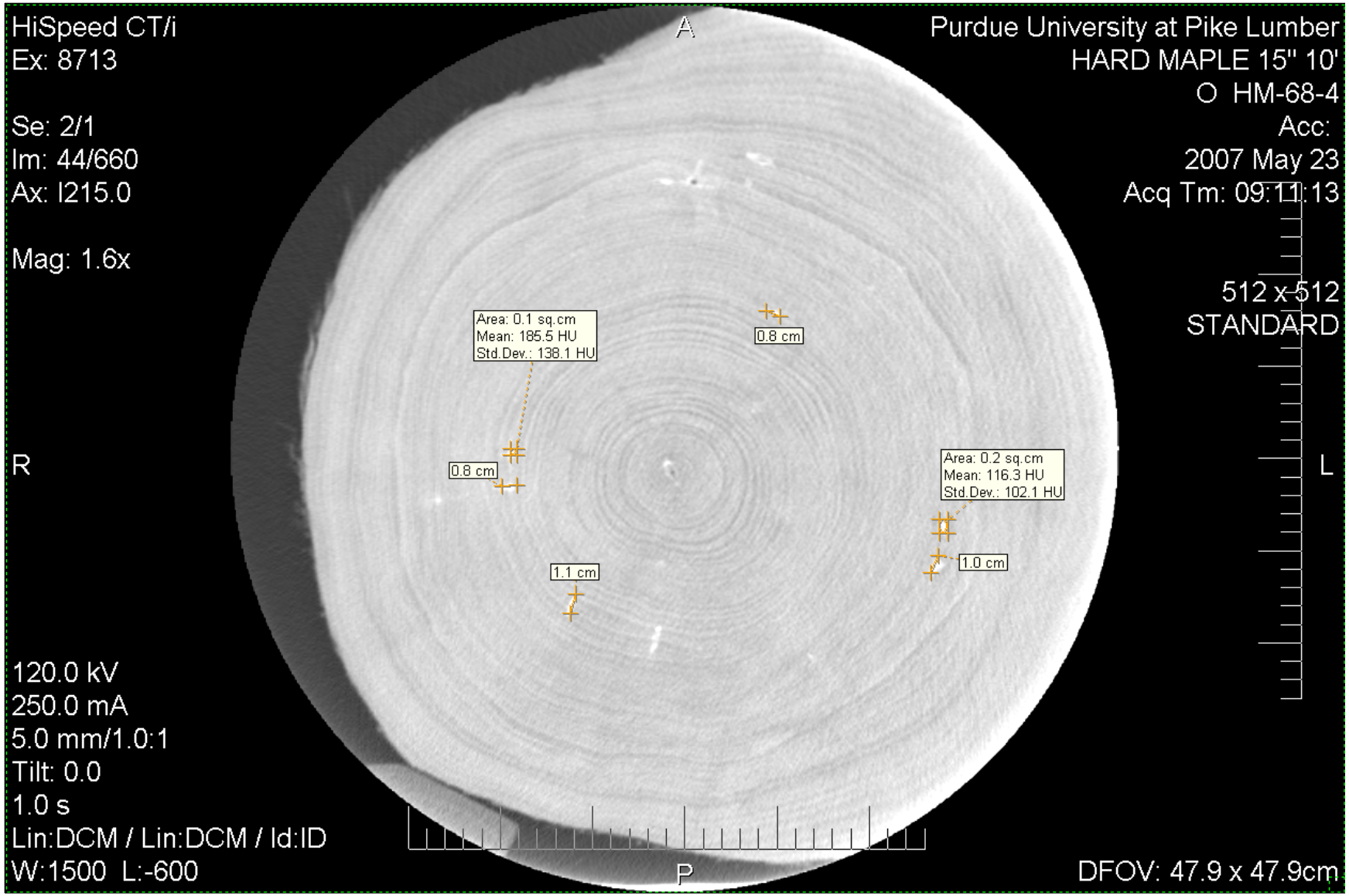
# Hardwood Scanning Center




**Pin Knots in Hard Maple**

We can see...

# Sapwood vs. Heartwood

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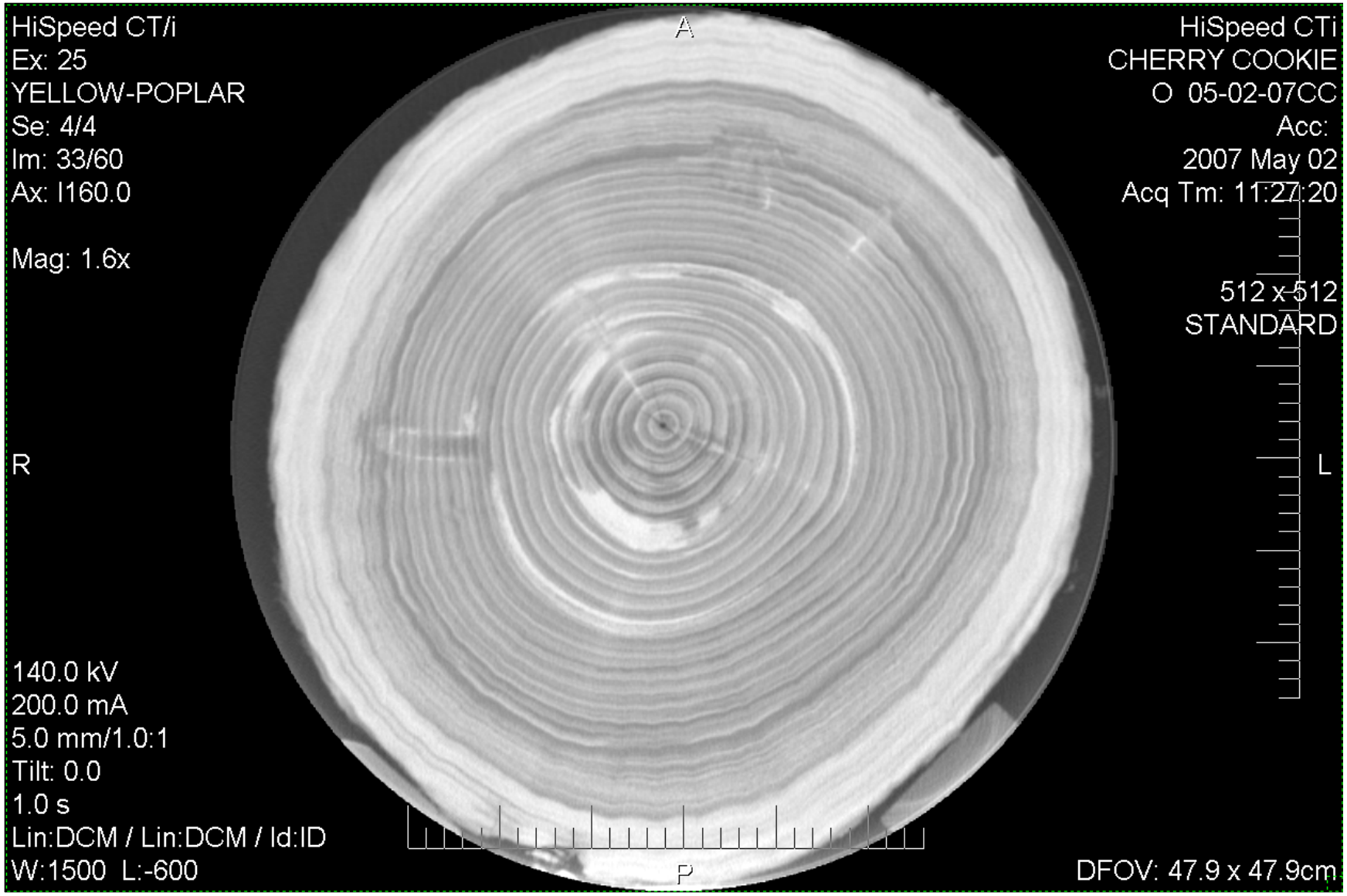


**Sap vs. Heart in Yellow Popular**

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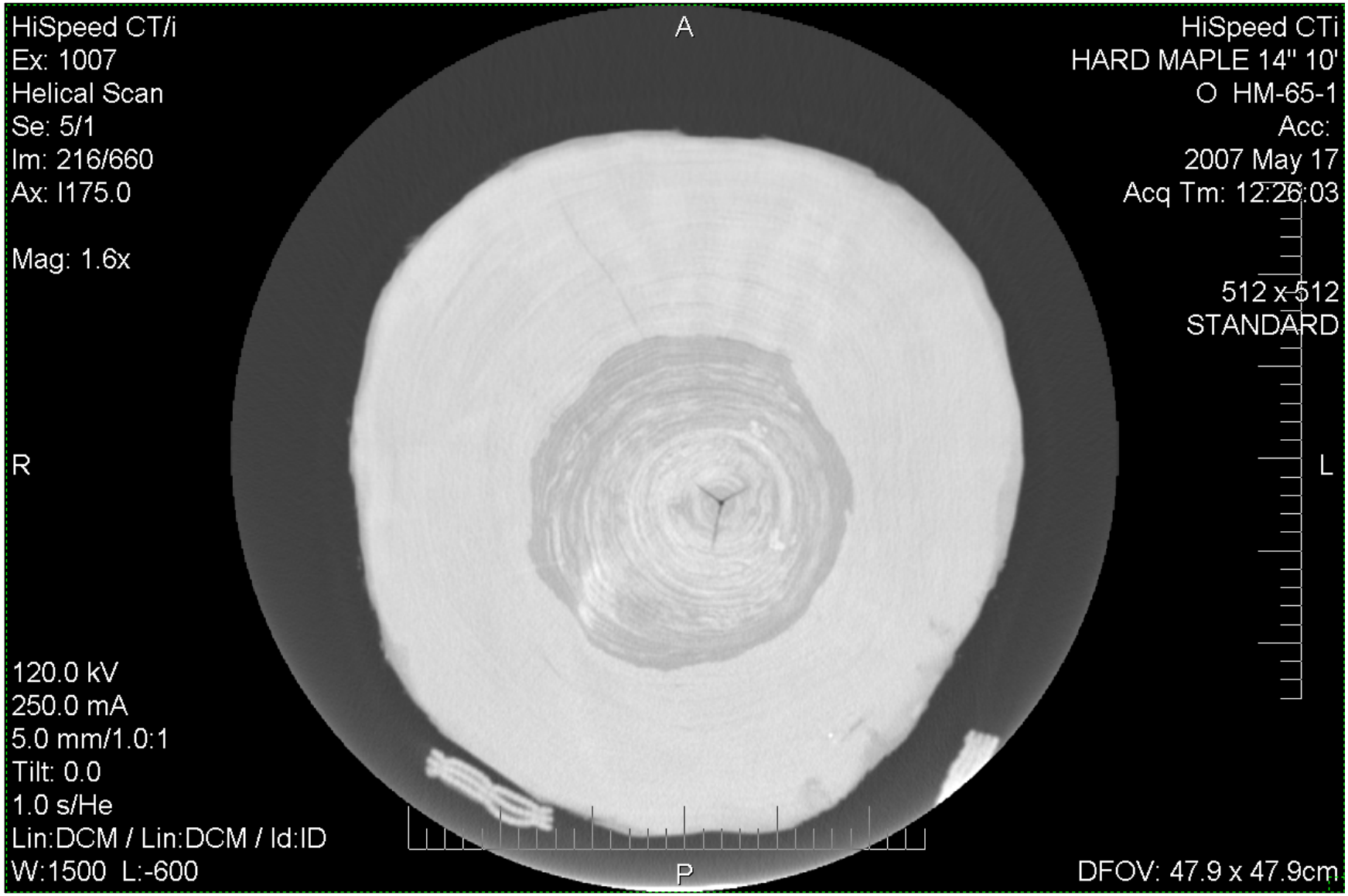
# Hardwood Scanning Center




**Sap vs. Heart in Hard Maple**

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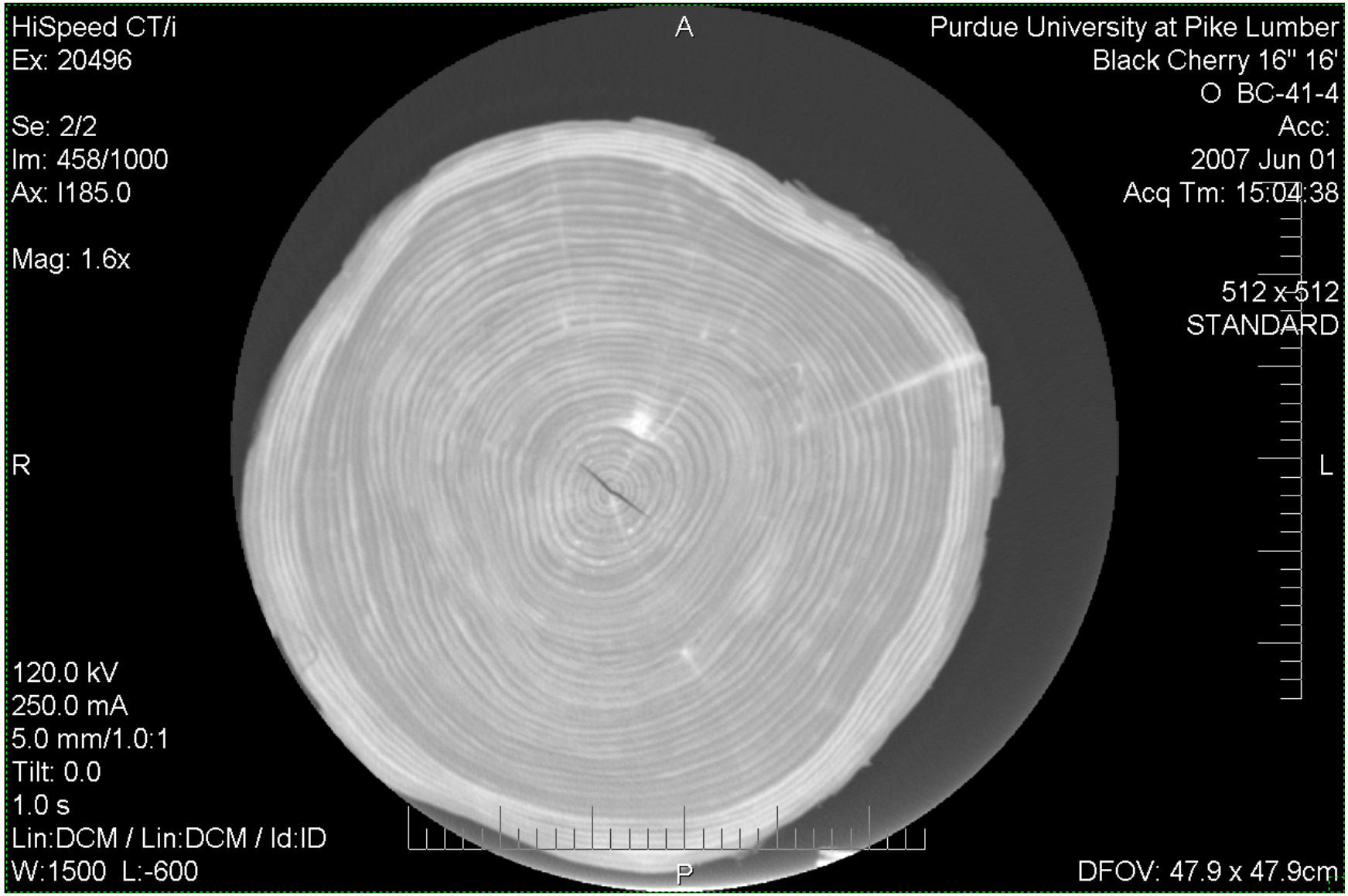
# Hardwood Scanning Center




**Sap vs. Heart in Black Cherry**

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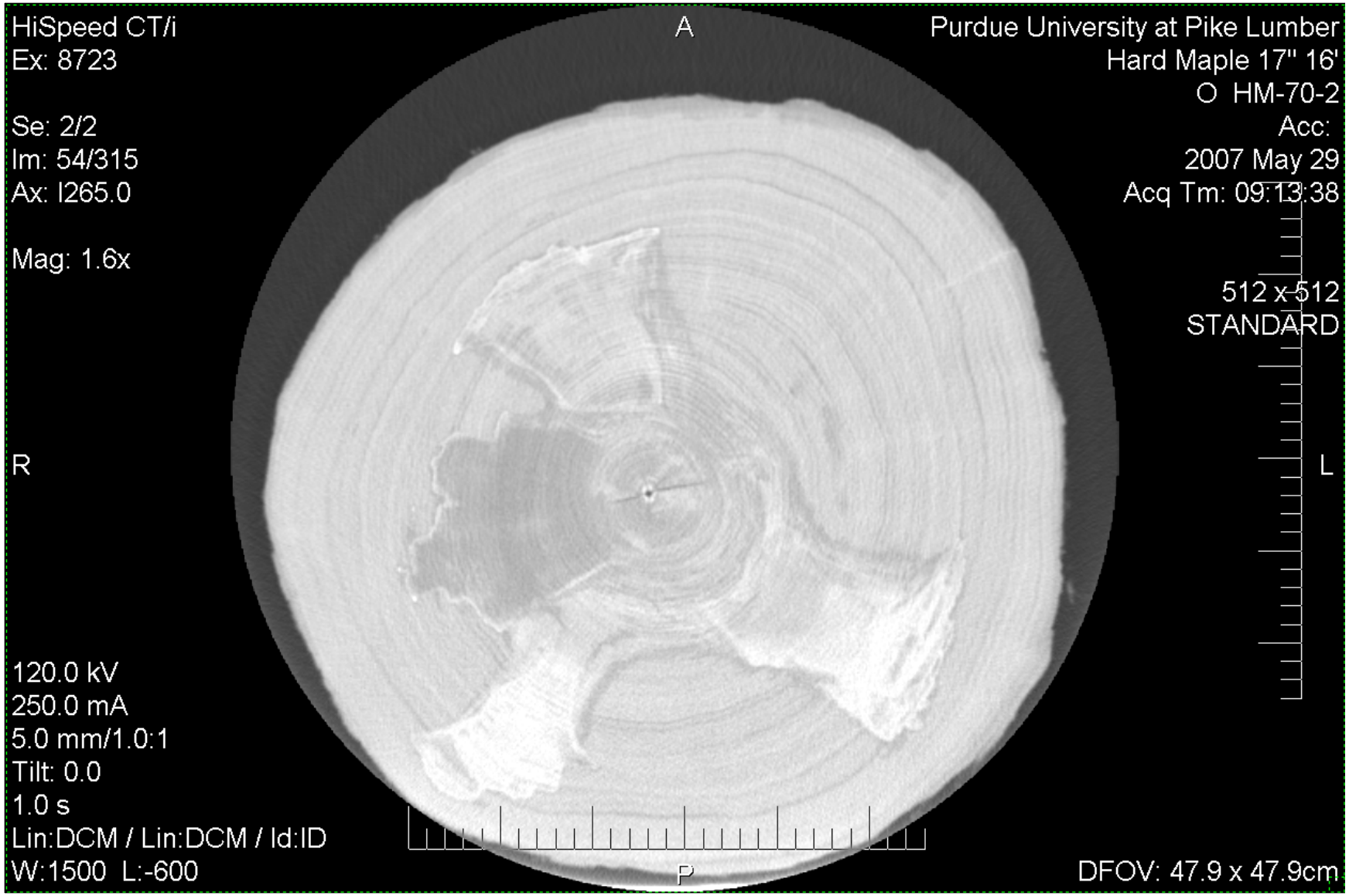
# Hardwood Scanning Center




**Stain in Hard Maple**

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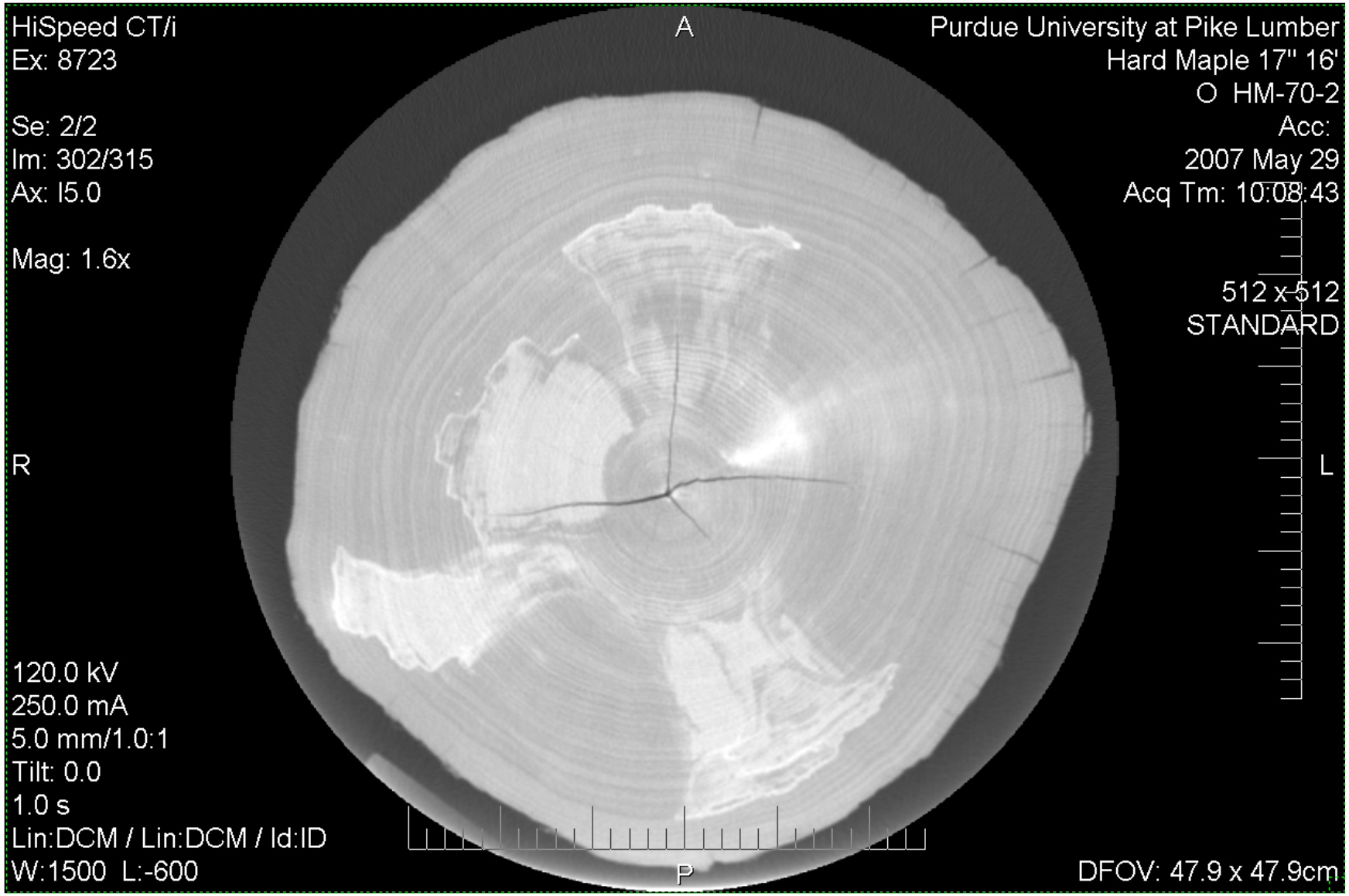
# Hardwood Scanning Center




**Stain in Hard Maple**

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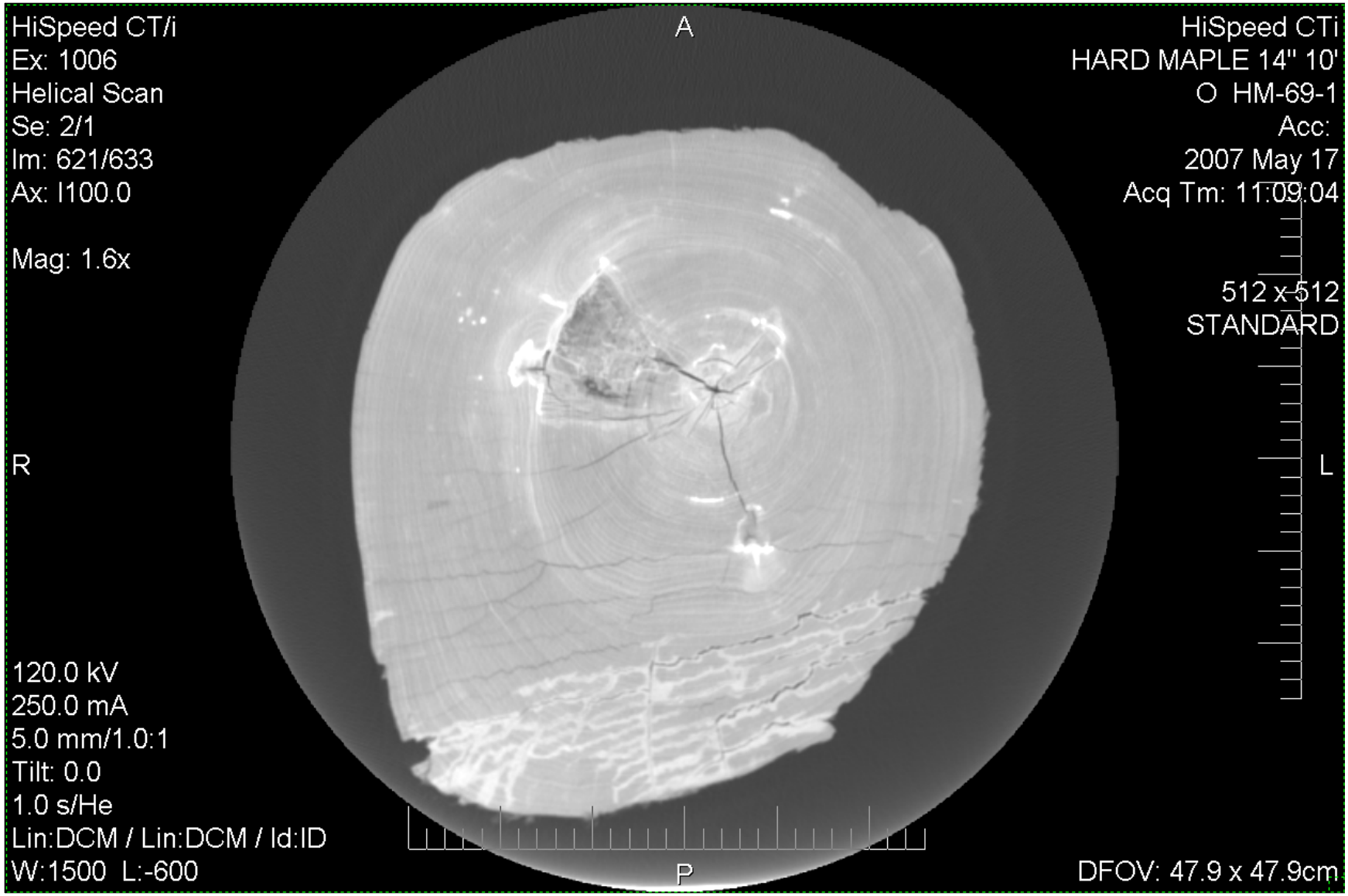


**Stain in Hard Maple**

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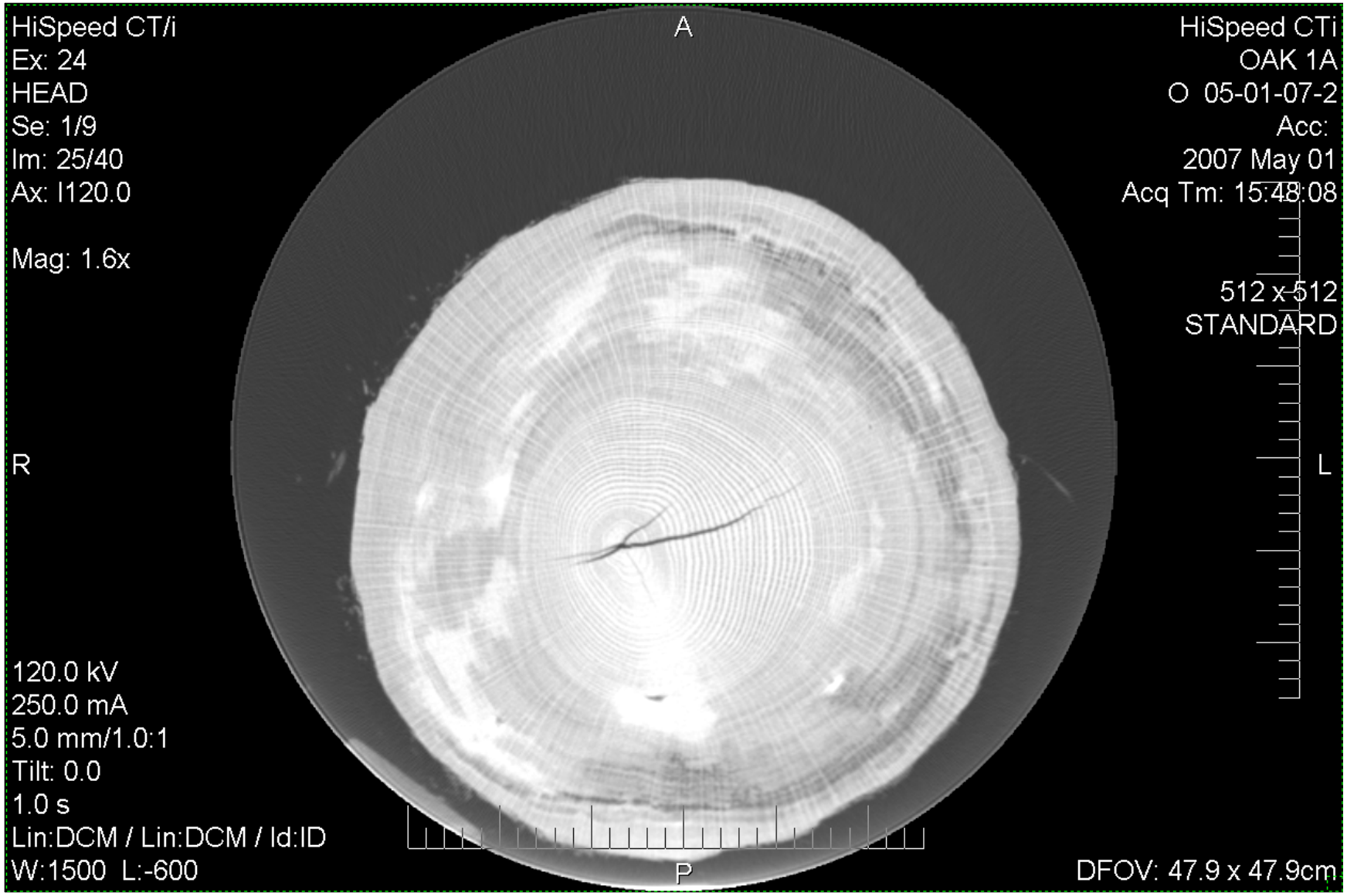
# Hardwood Scanning Center




**Stain in Red Oak**

We can see...

# Lumber Defects

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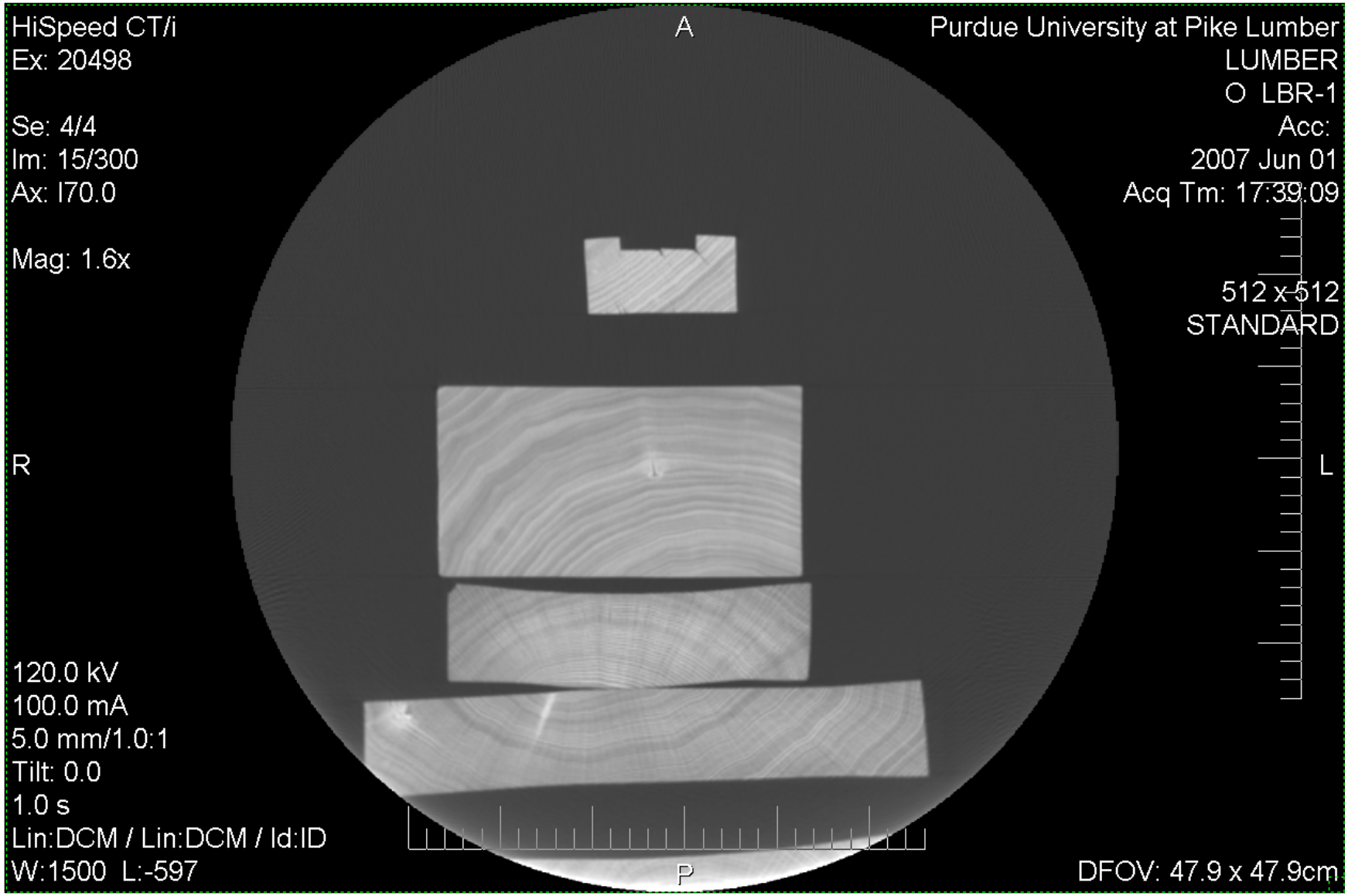
# Hardwood Scanning Center




**Pin Knot in Black Walnut Lumber**

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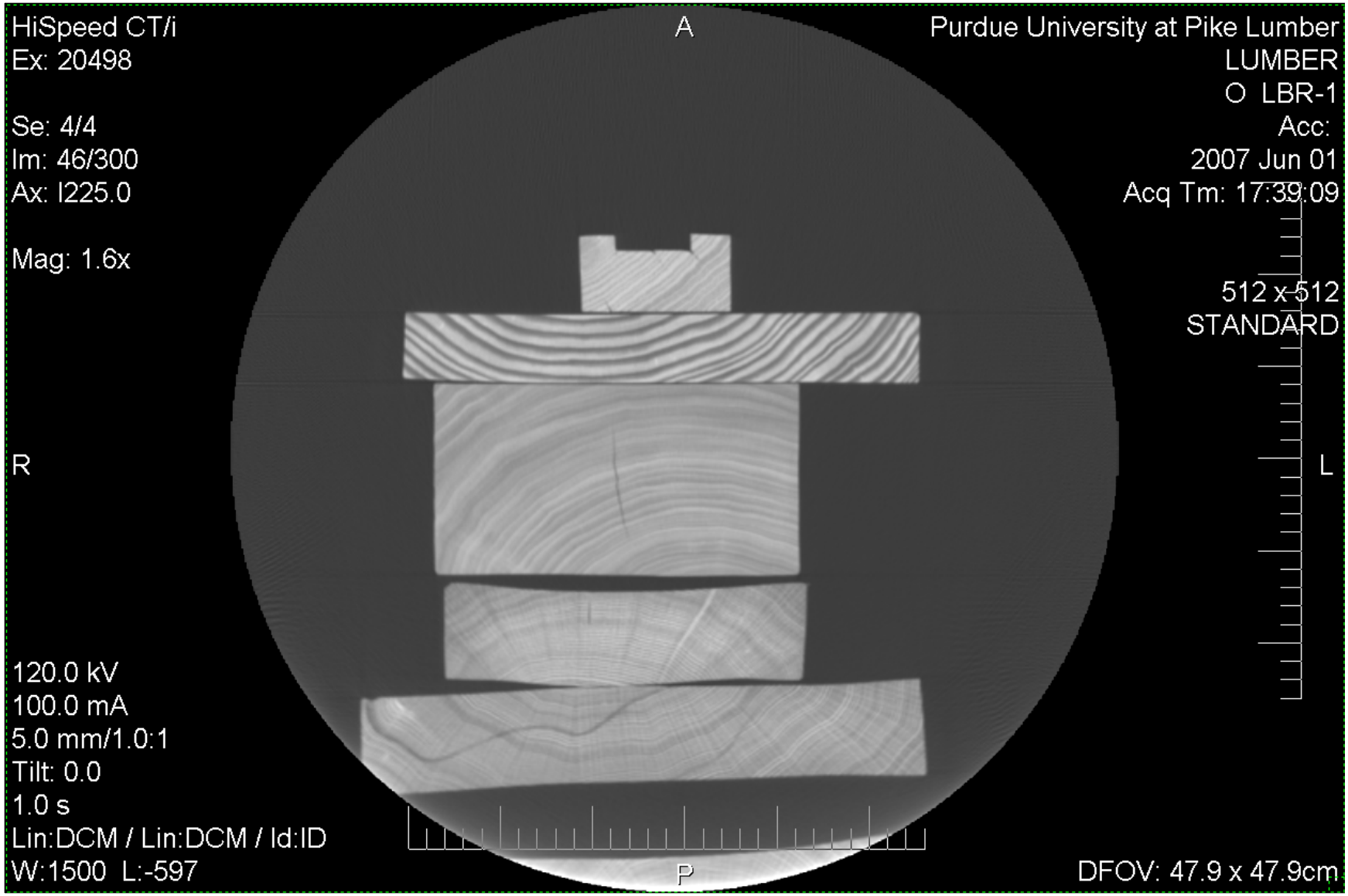
# Hardwood Scanning Center




**Powder Post Beatle in Red Oak Lumber**

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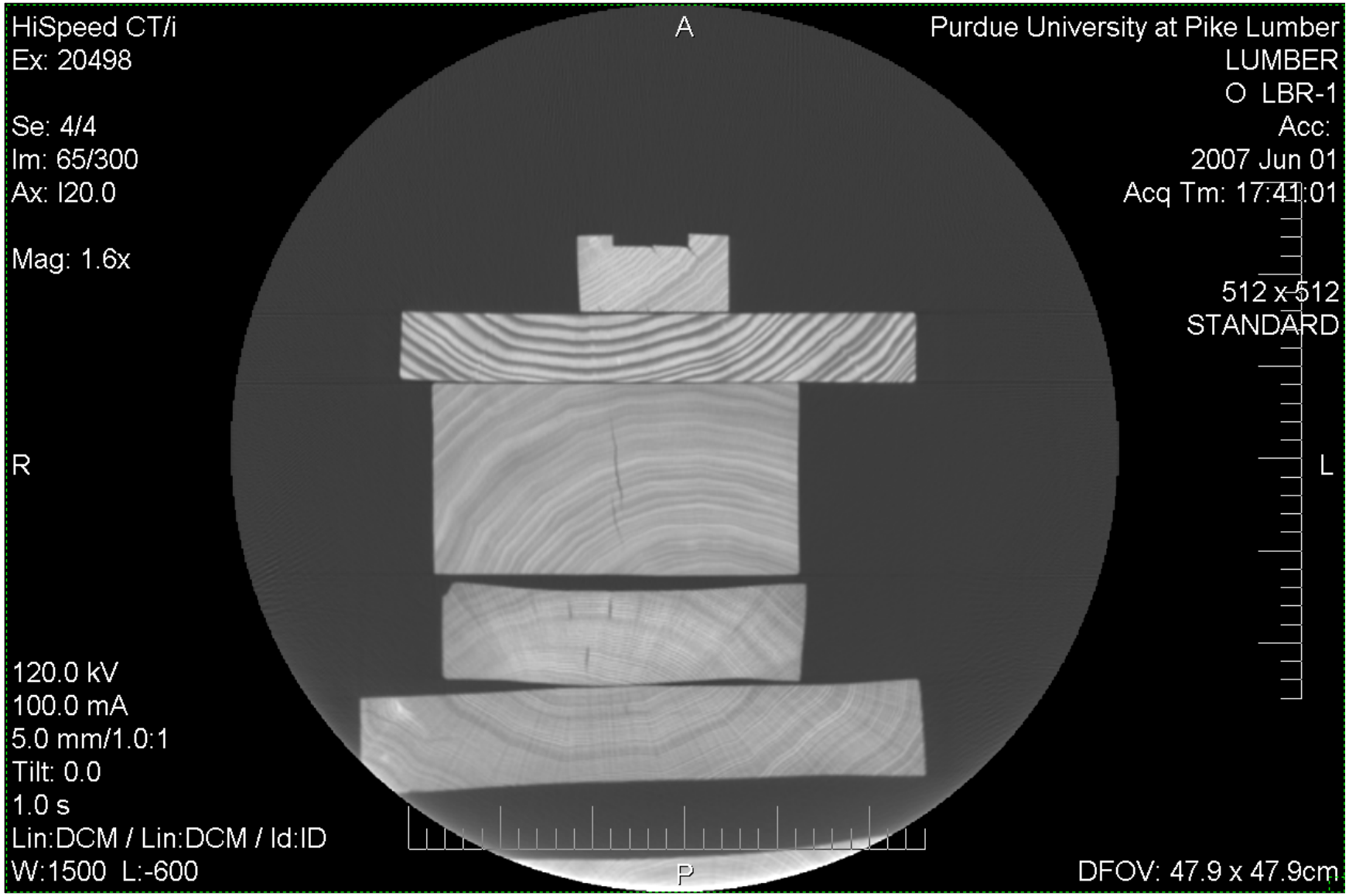
# Hardwood Scanning Center




**Honeycomb in Red Oak & Black Walnut Lumber**

We can see...

# The Unpredictable

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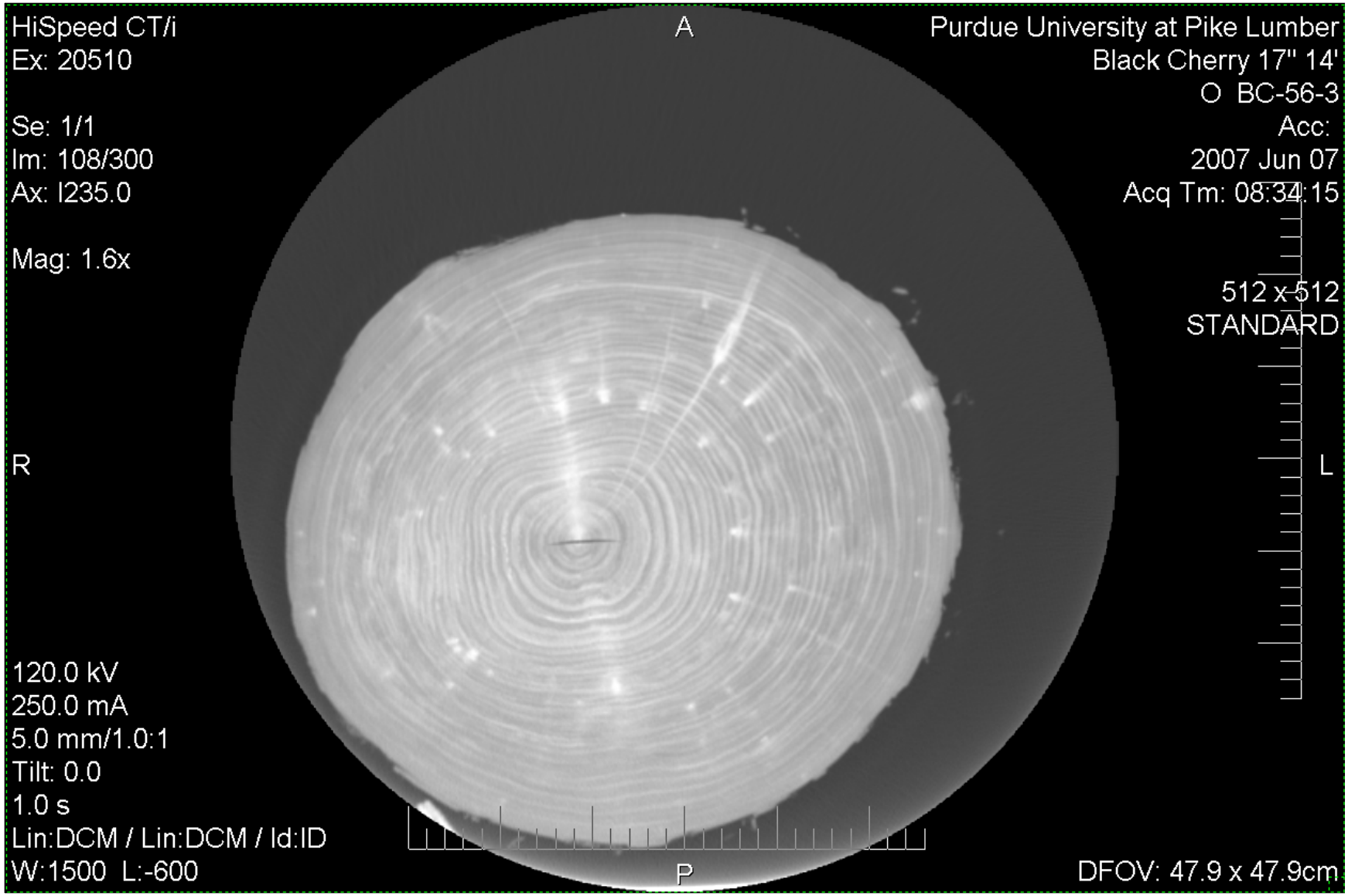


**Gum in Black Cherry**

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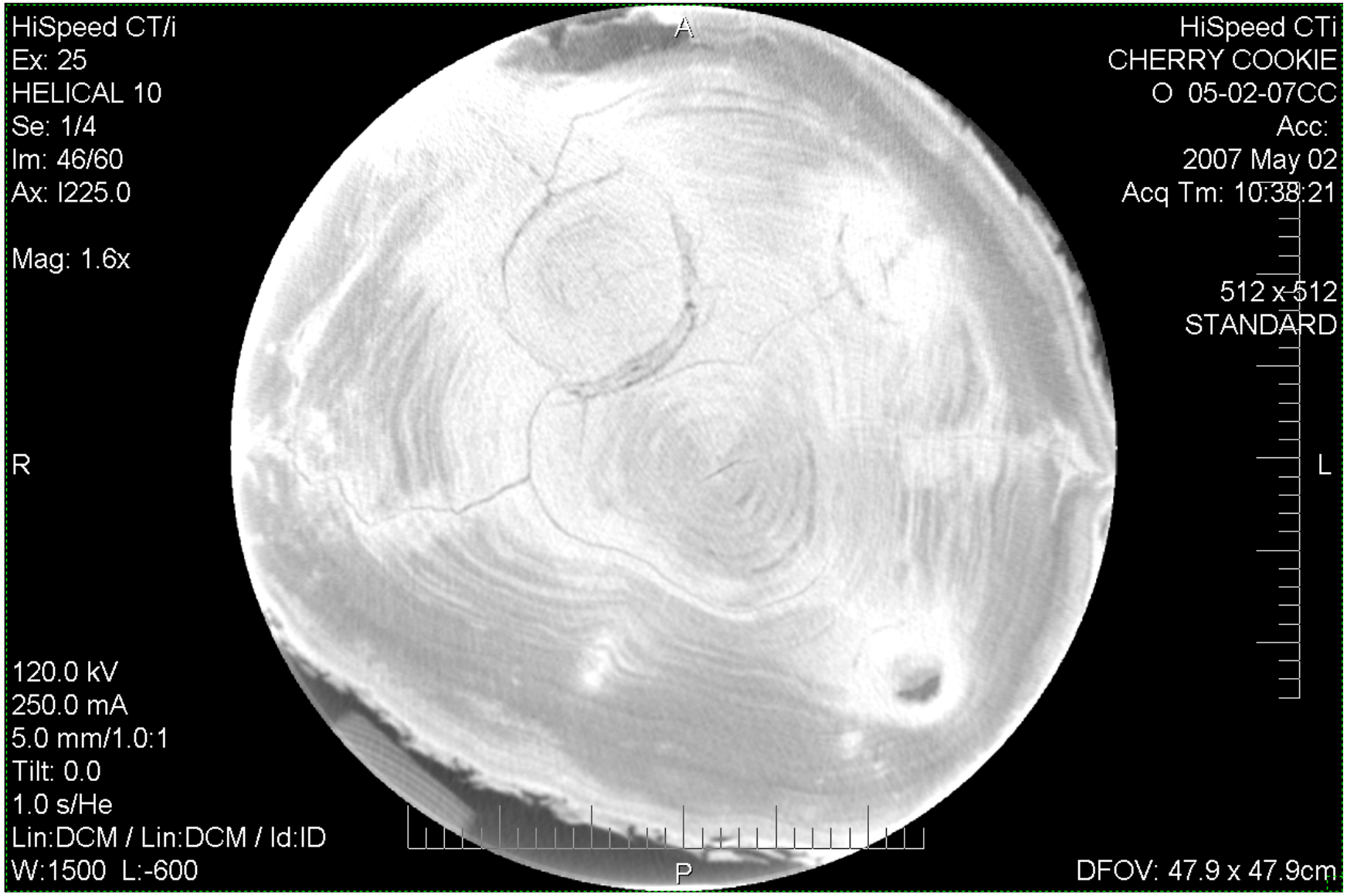
# Hardwood Scanning Center




**Bark Inclusion in Hard Maple**

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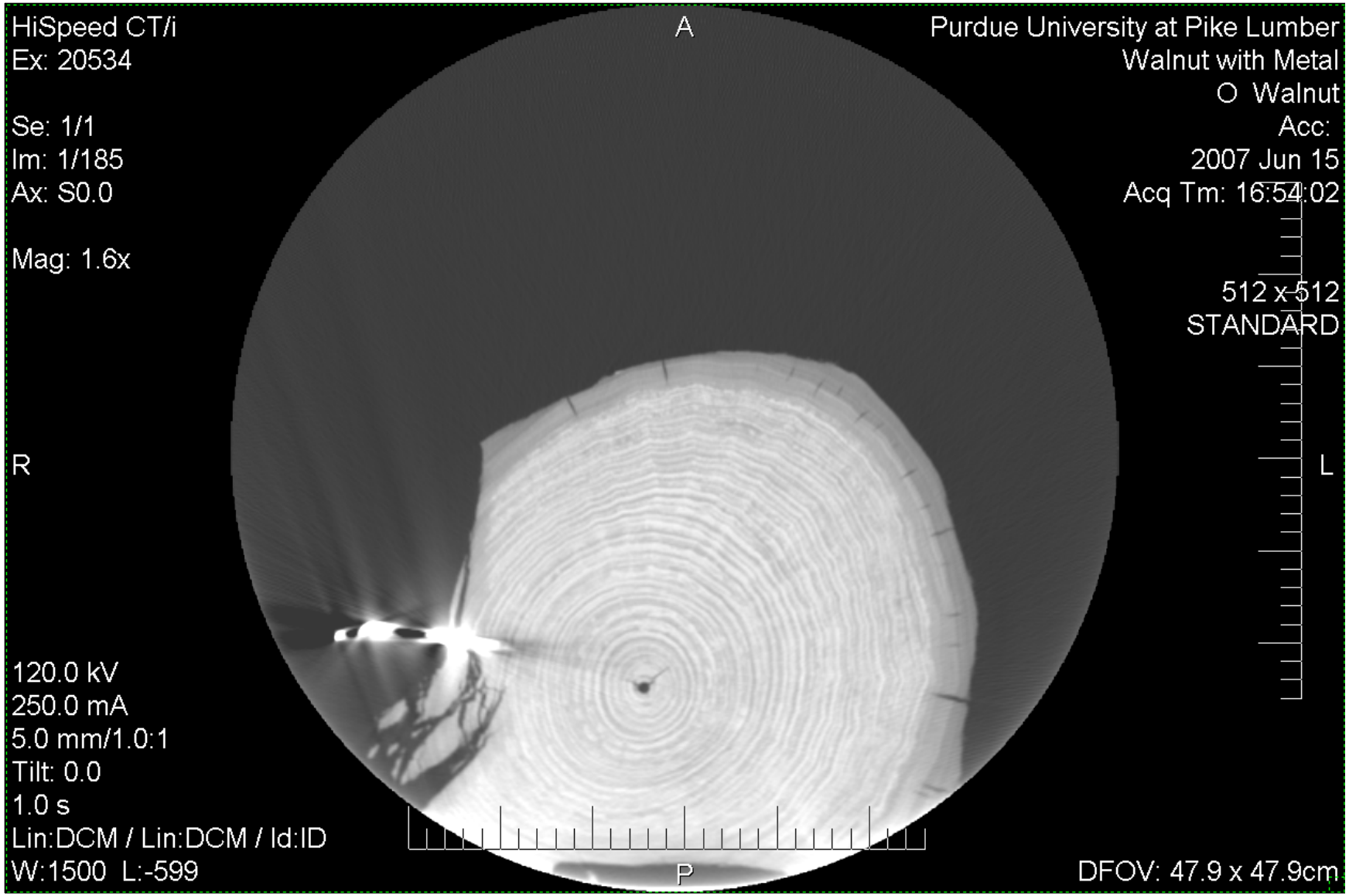


**Nail in Black Walnut**

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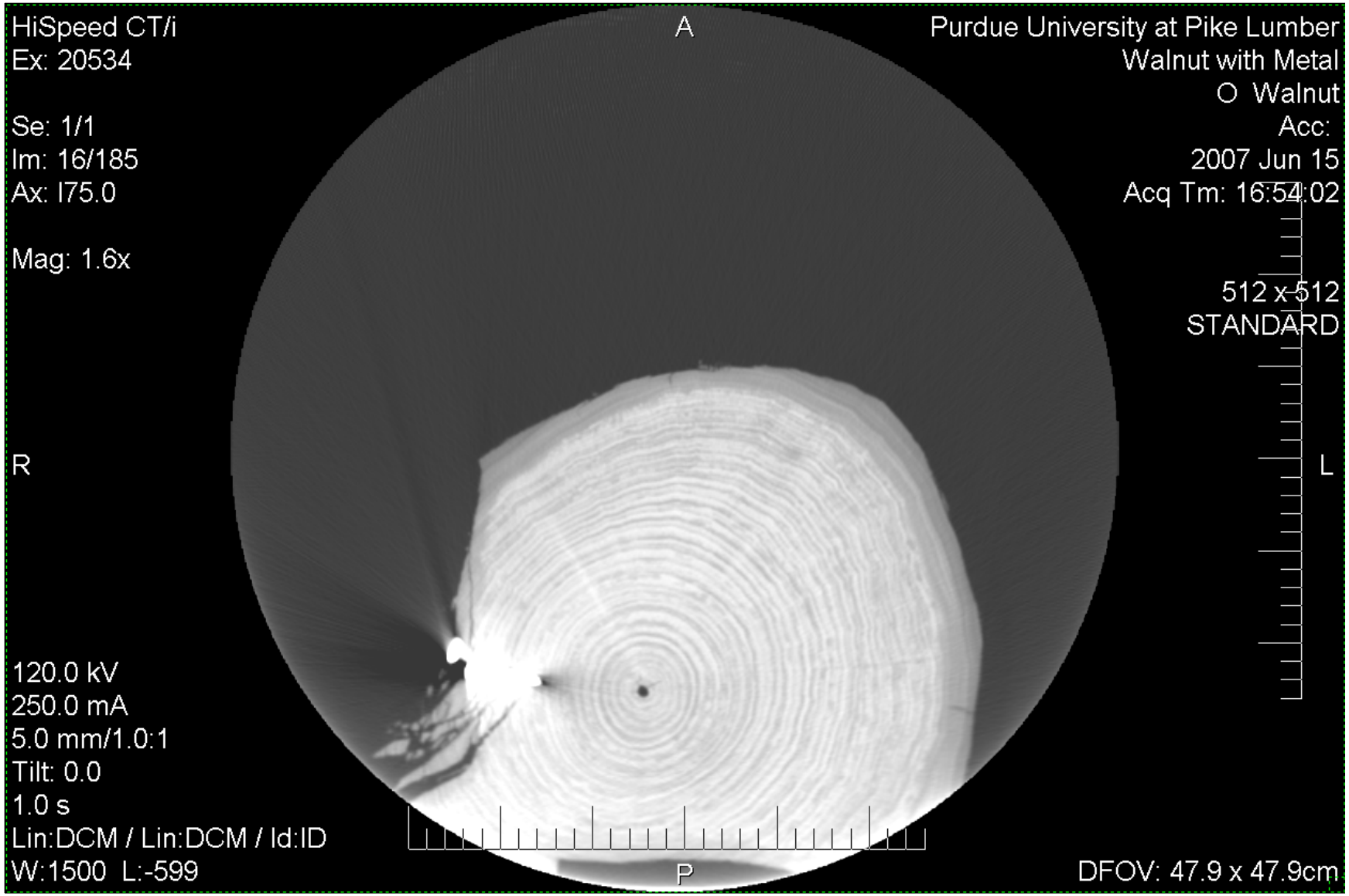
# Hardwood Scanning Center




**Nail in Black Walnut**

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**Tap Hole in Hard Maple**

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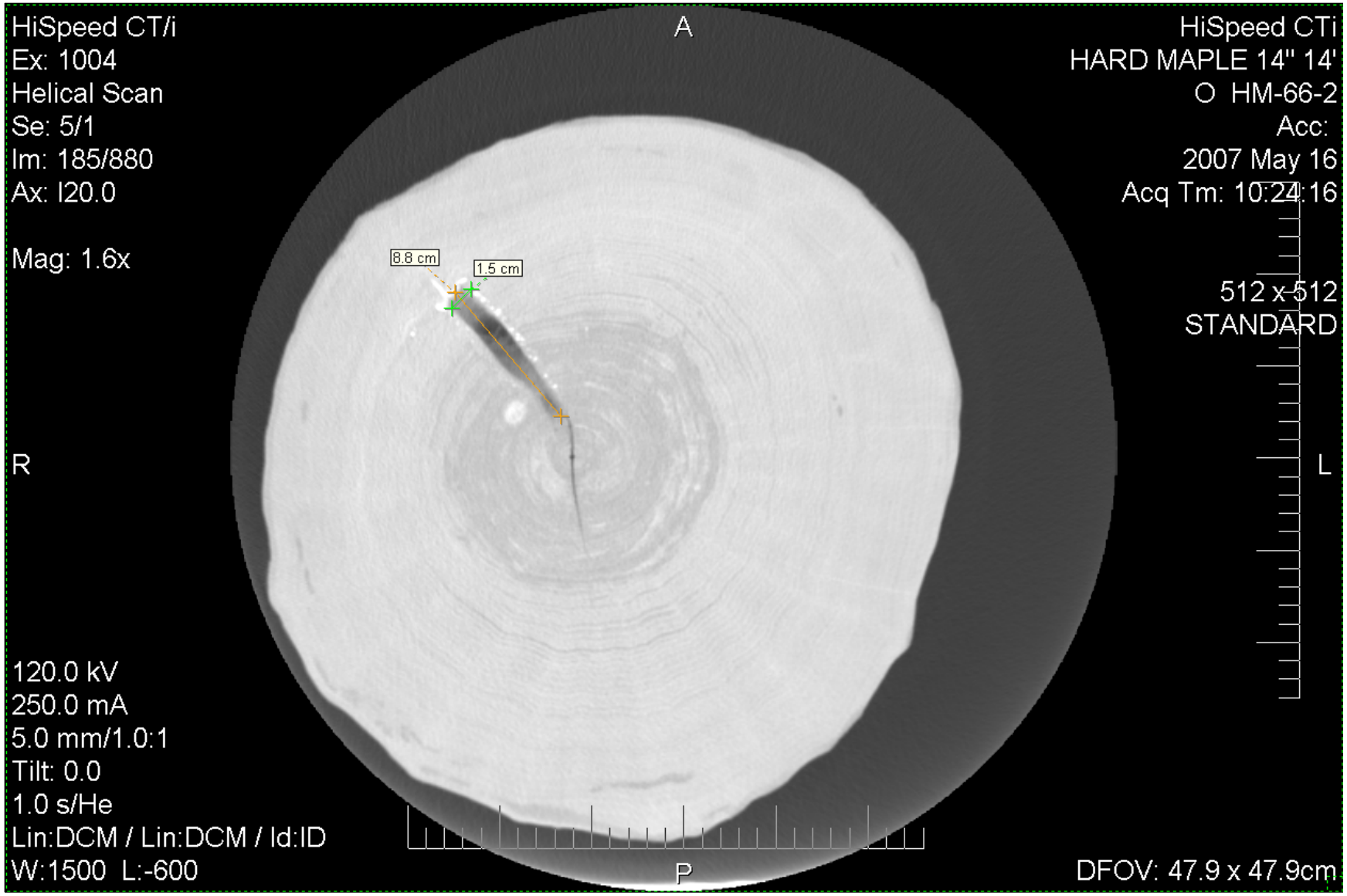
# Hardwood Scanning Center




**Tap Whole in Hard Maple**

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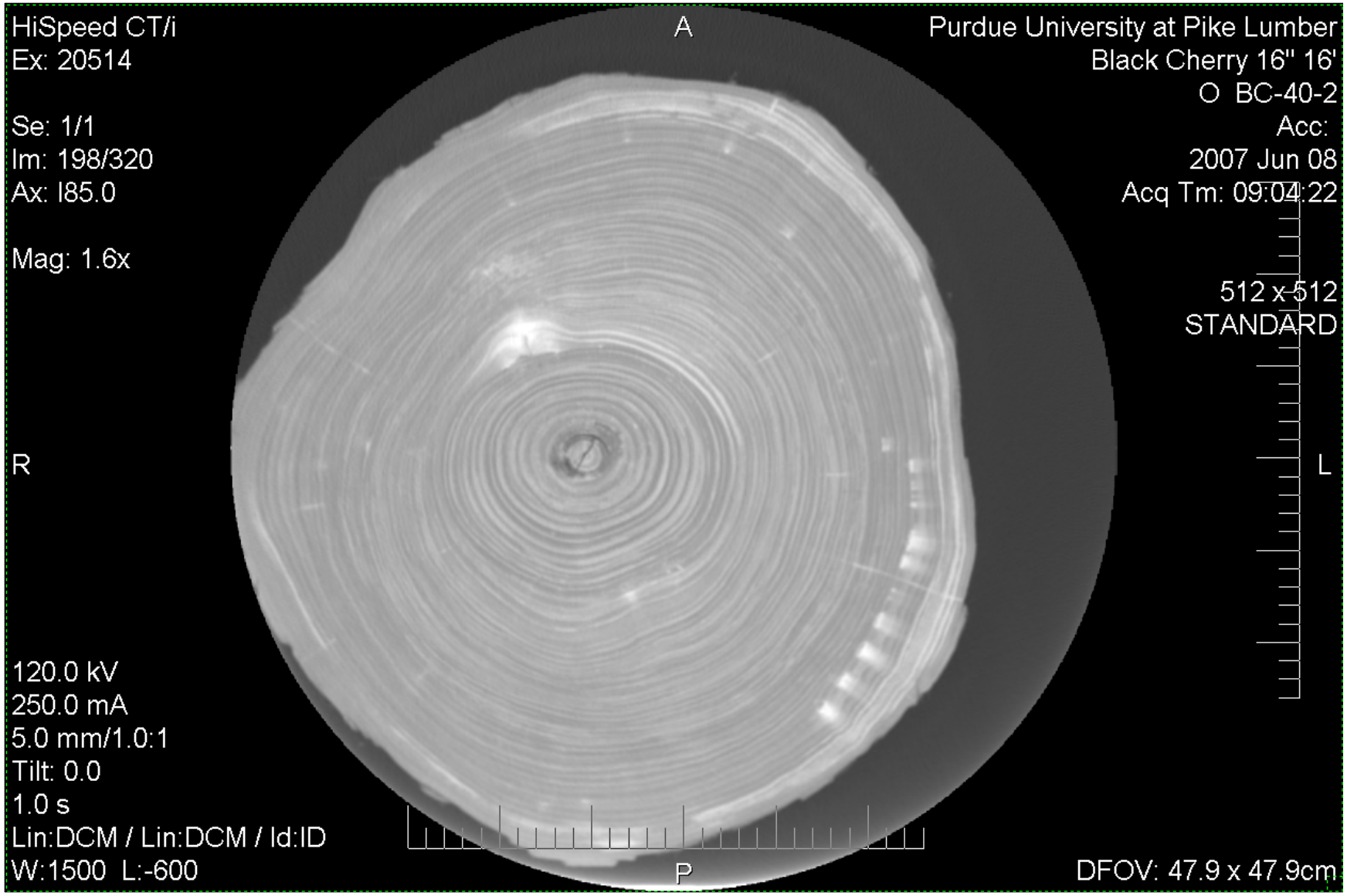
# Hardwood Scanning Center




**? In Black Cherry**

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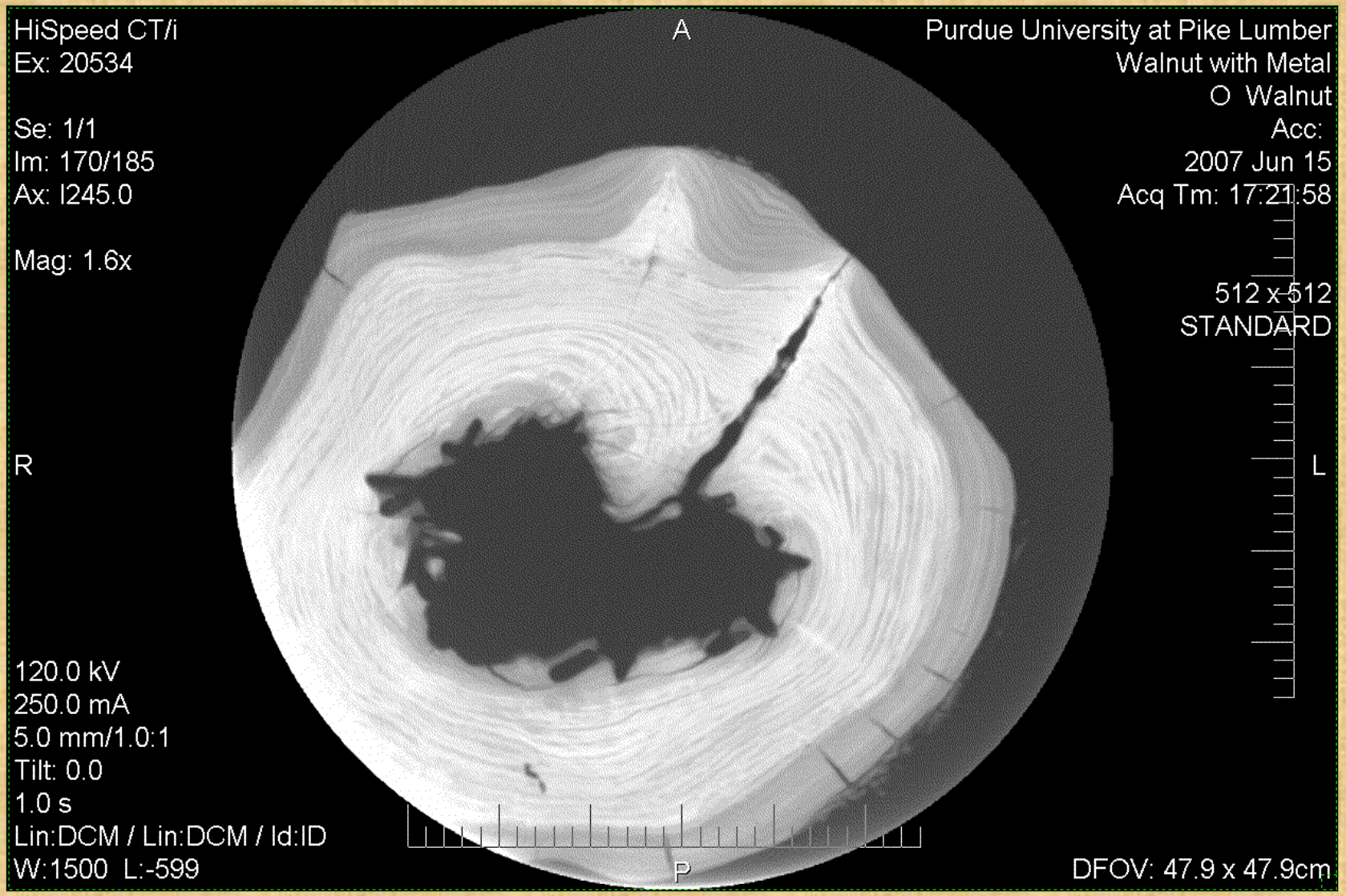


**Metal in Black Walnut**

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**The Full Extent of Grubs in Red Oak**

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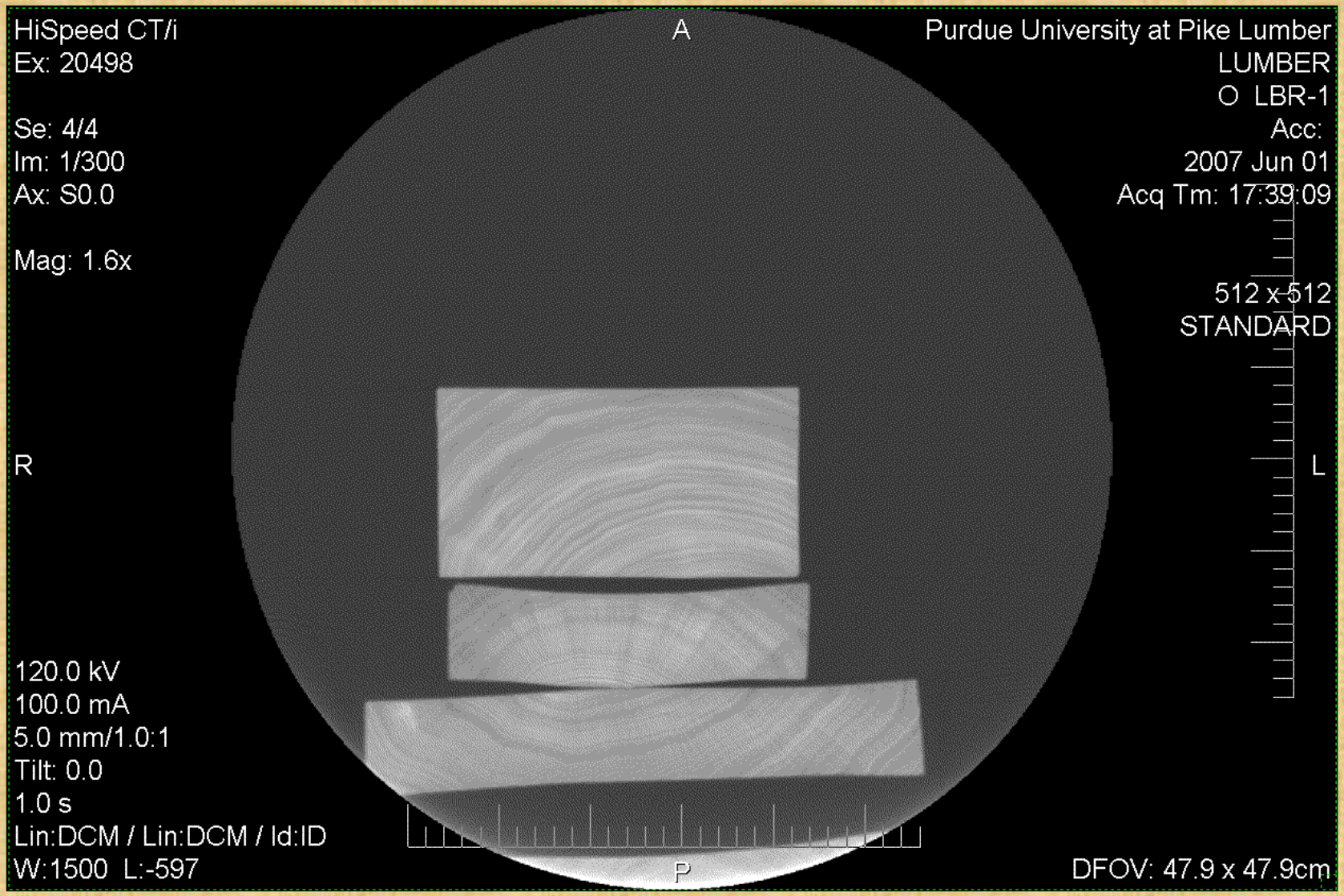


**Lumber**

# Random

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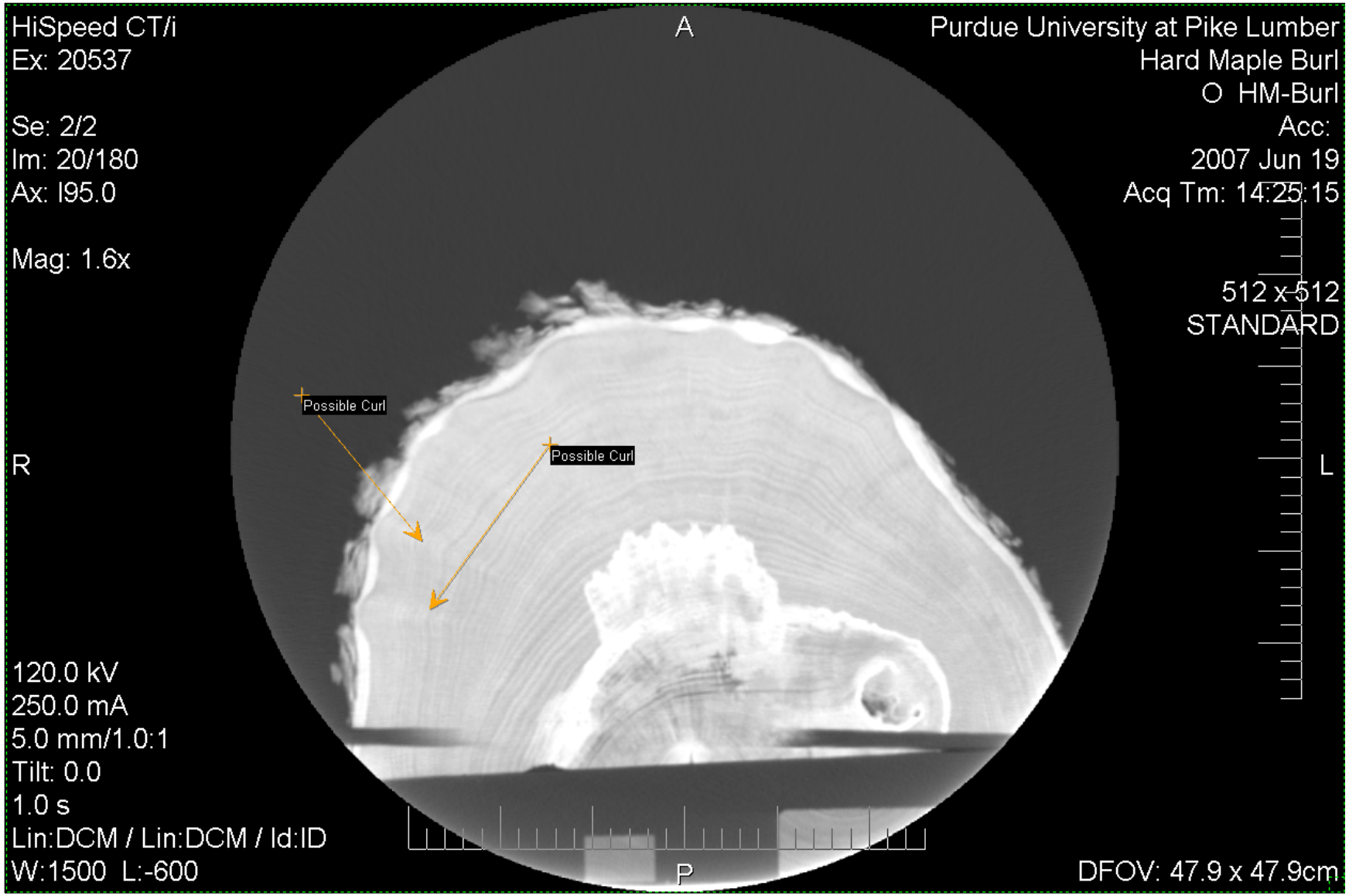


**Curl**

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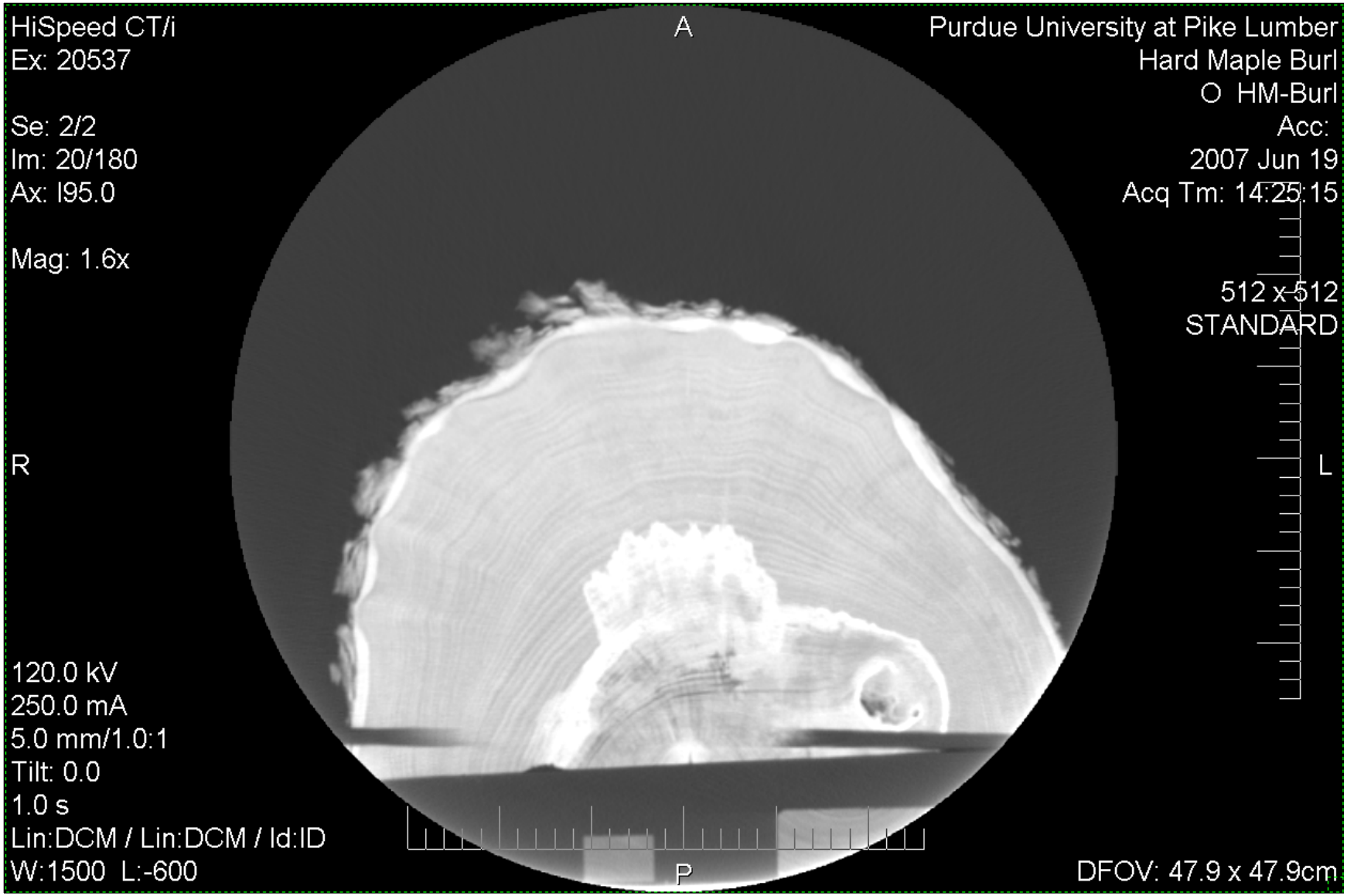
# Hardwood Scanning Center




**Curl**

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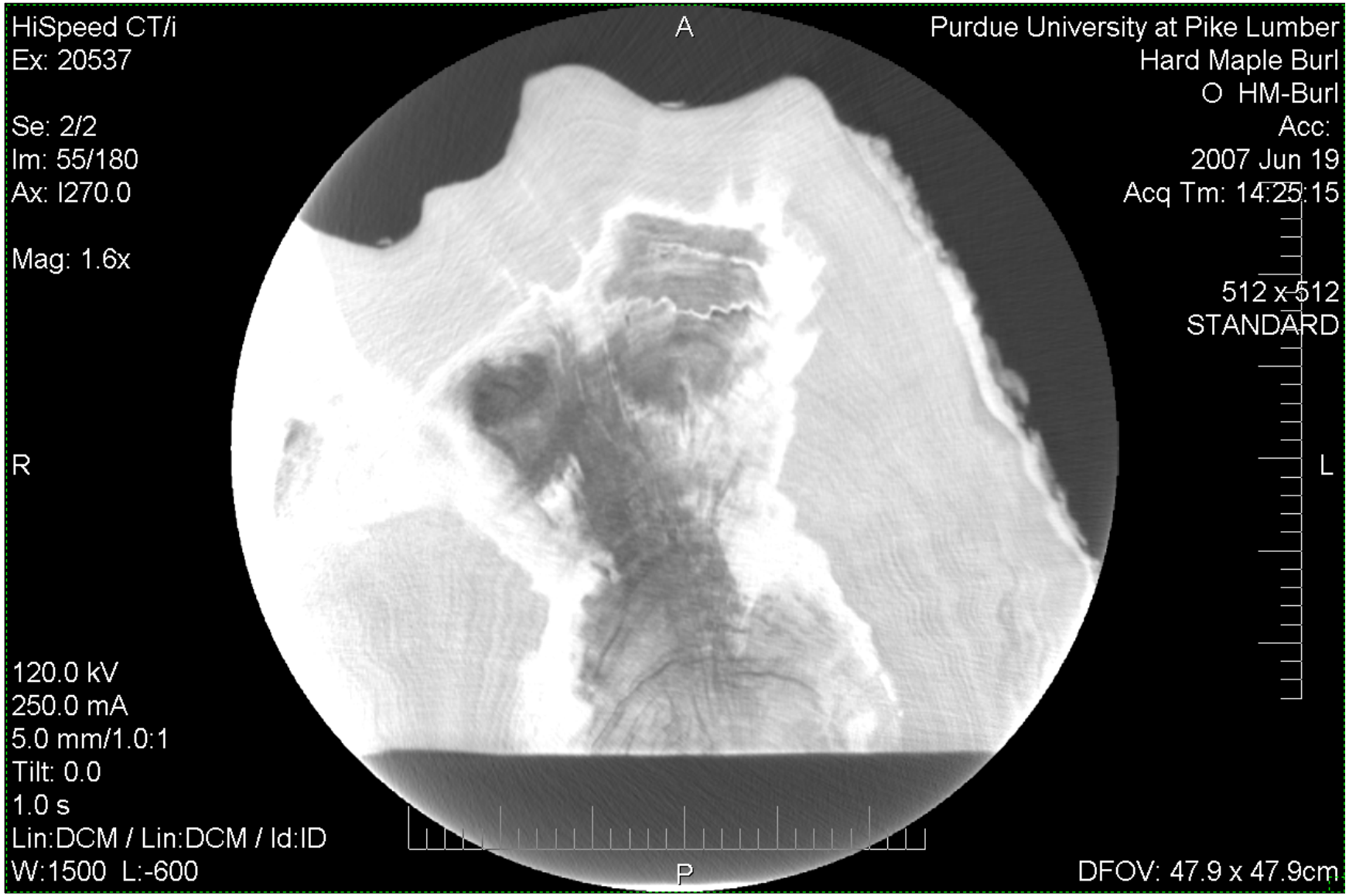


**Spalting**

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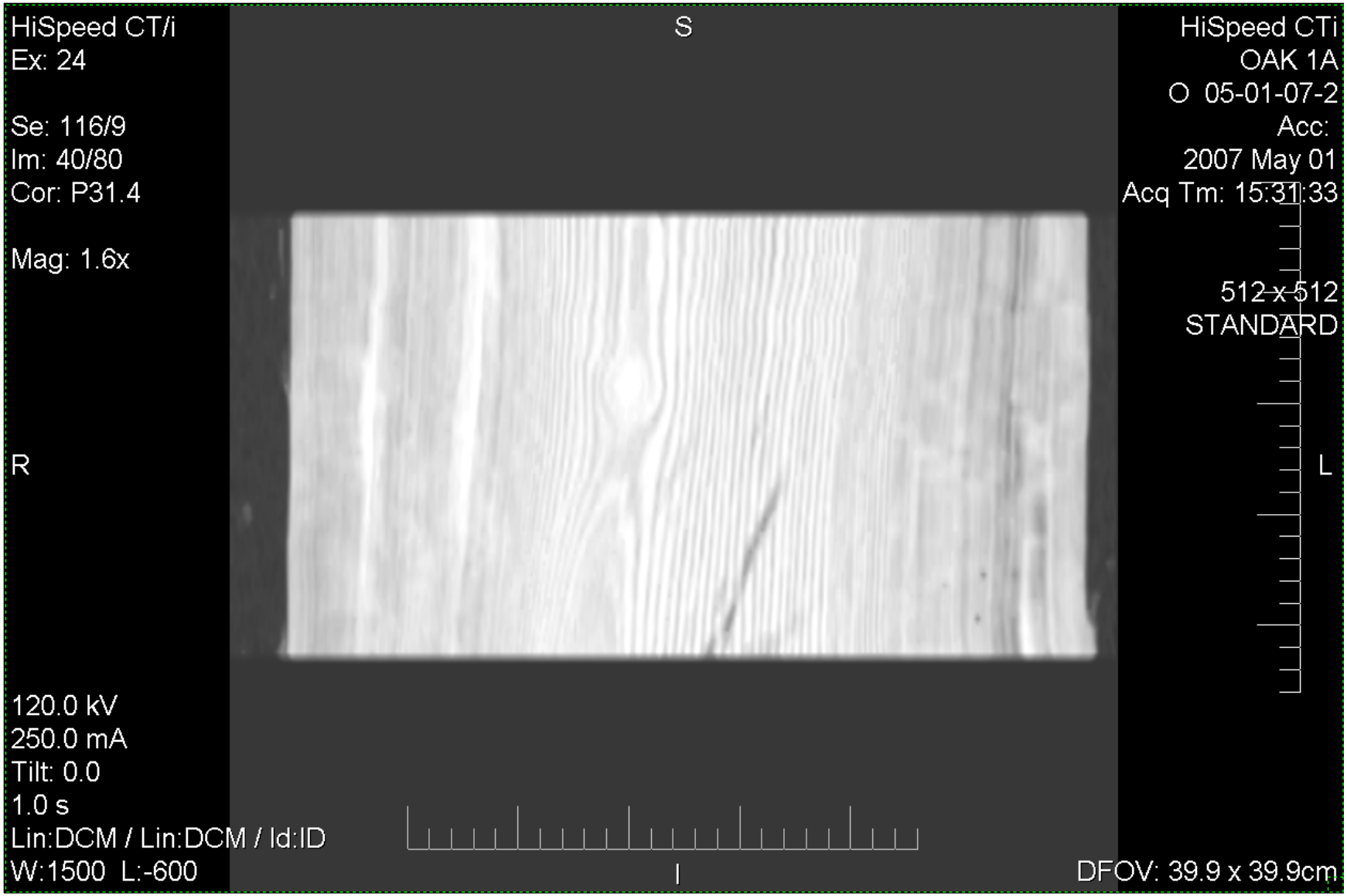
# Hardwood Scanning Center




**Oak Board**

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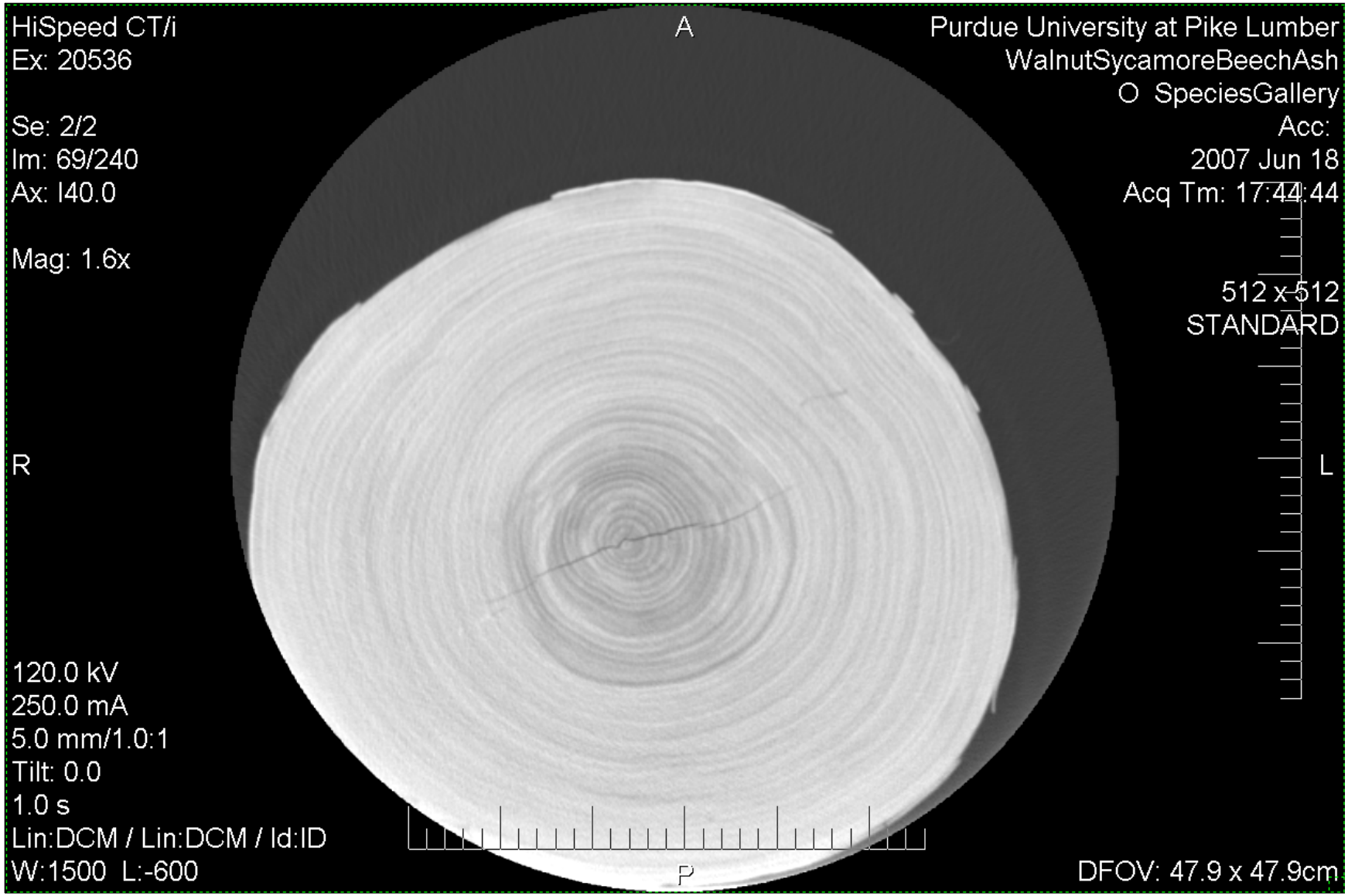
# Hardwood Scanning Center




**Sycamore**

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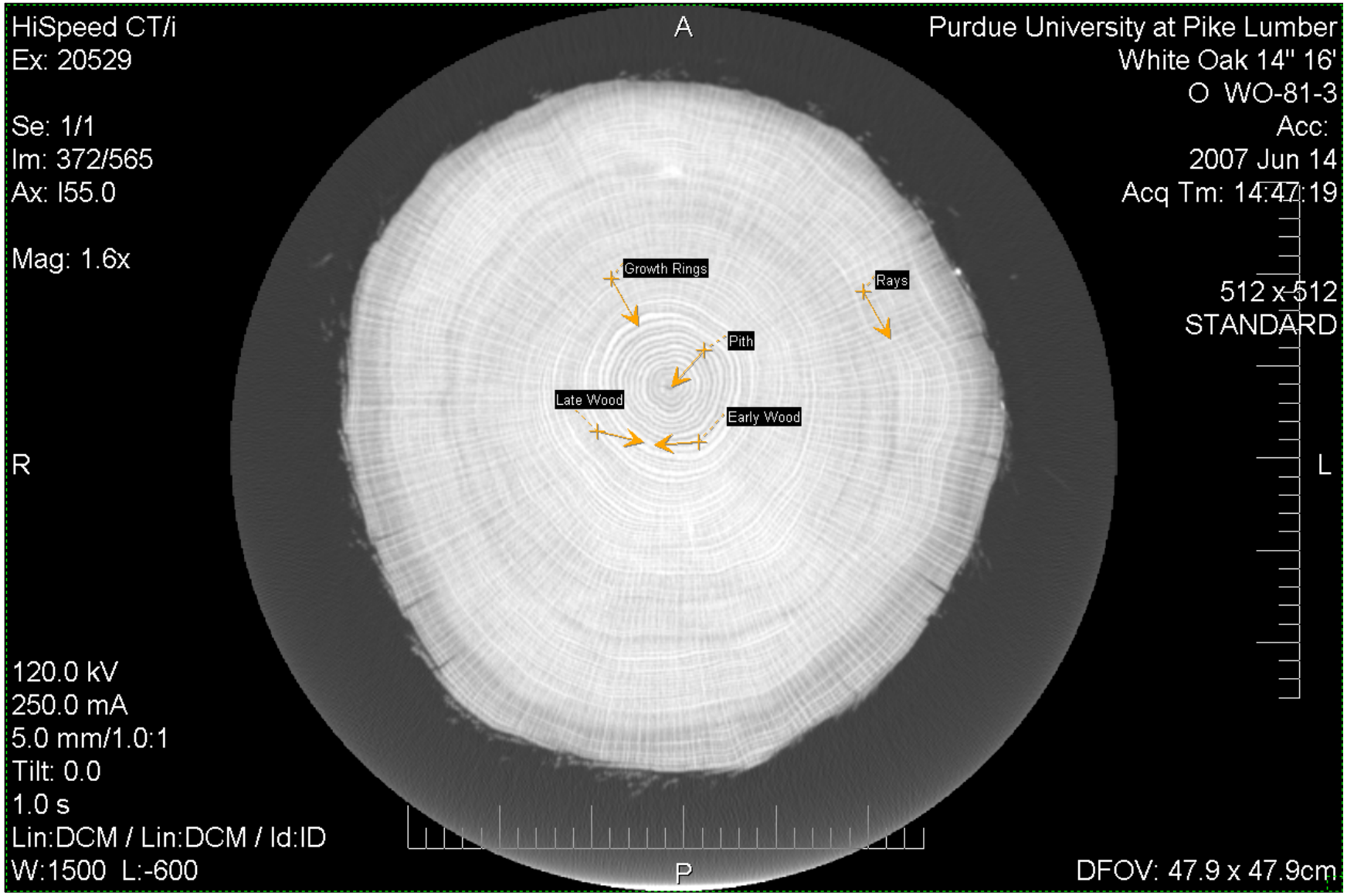


## Features

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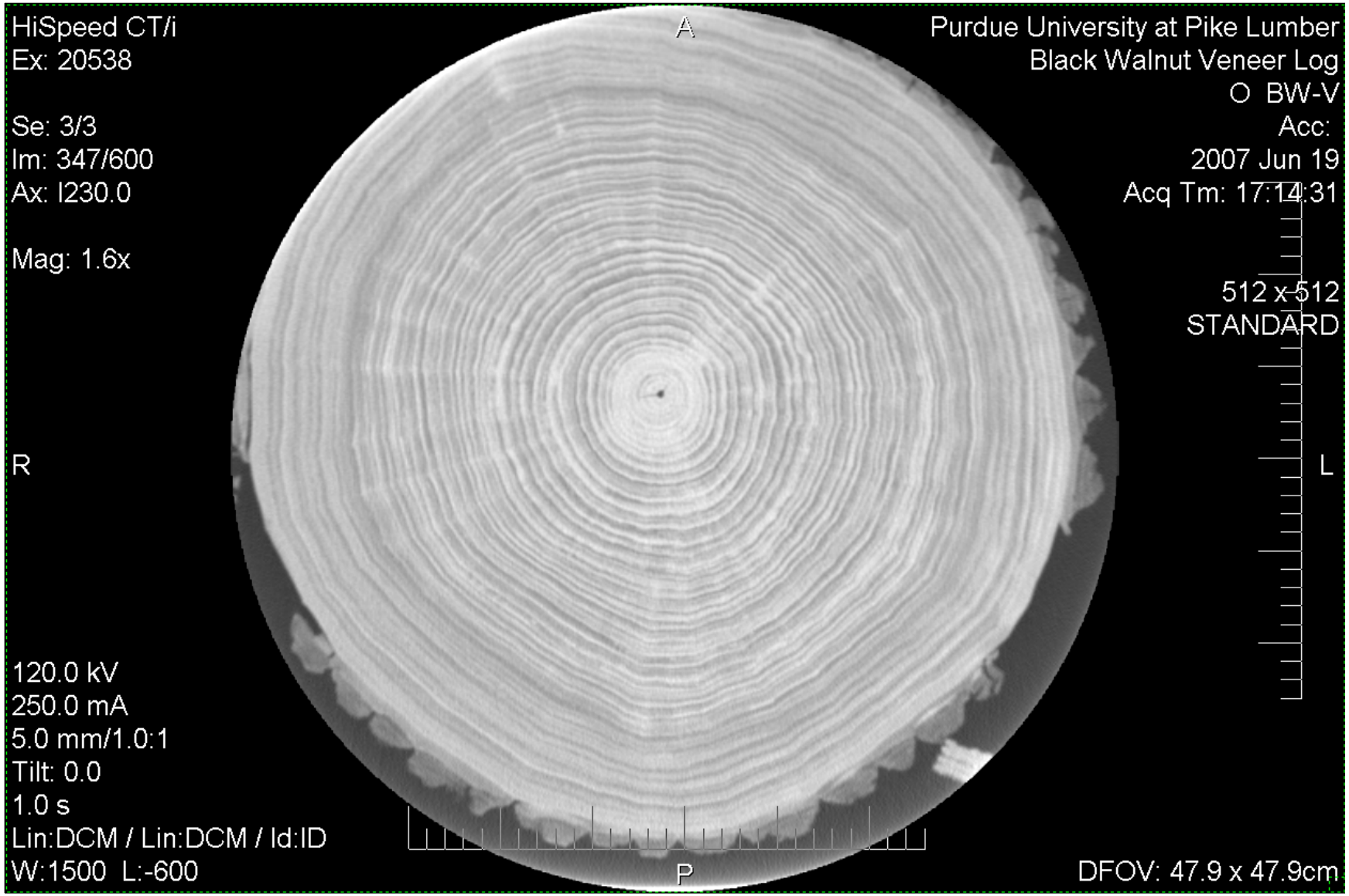


**Black Walnut**