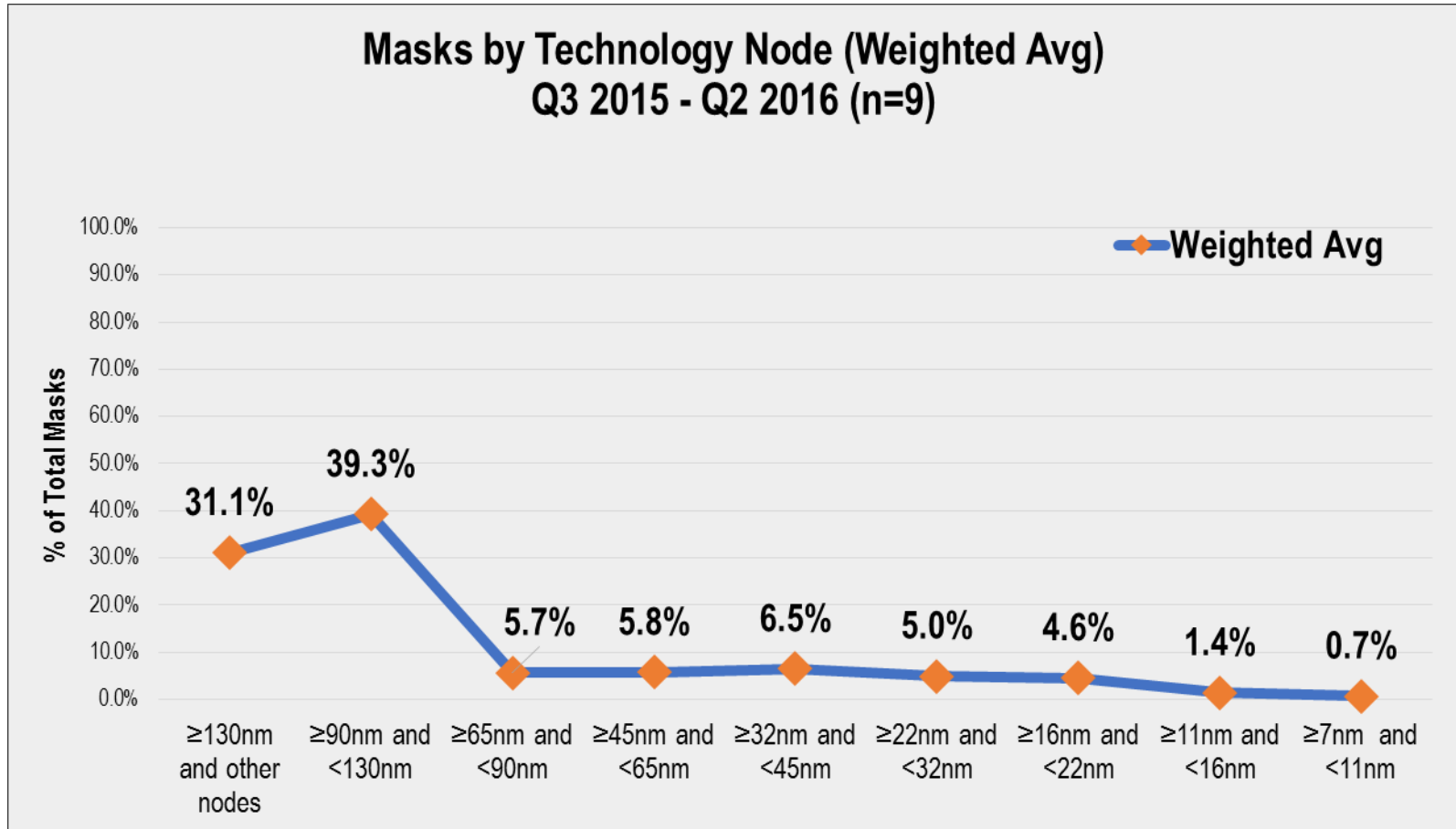# The Mask Maker Survey 2016

- **2015: Members requested the eBeam Initiative to "fill the gap" that the SEMATECH survey had served through 2013**
  - 8 participating mask makers
  - AMTC, DNP, GLOBALFOUNDRIES, HOYA, Photronics, Samsung, SMIC and Toppan
- **2016: Thank you to the 10 participating mask makers**
  - AMTC, DNP, GLOBALFOUNDRIES, HOYA, Intel, PDMC, Photronics, Samsung, SMIC and Toppan
  - More survey questions to capture historical data from Q3 2015-Q2 2016
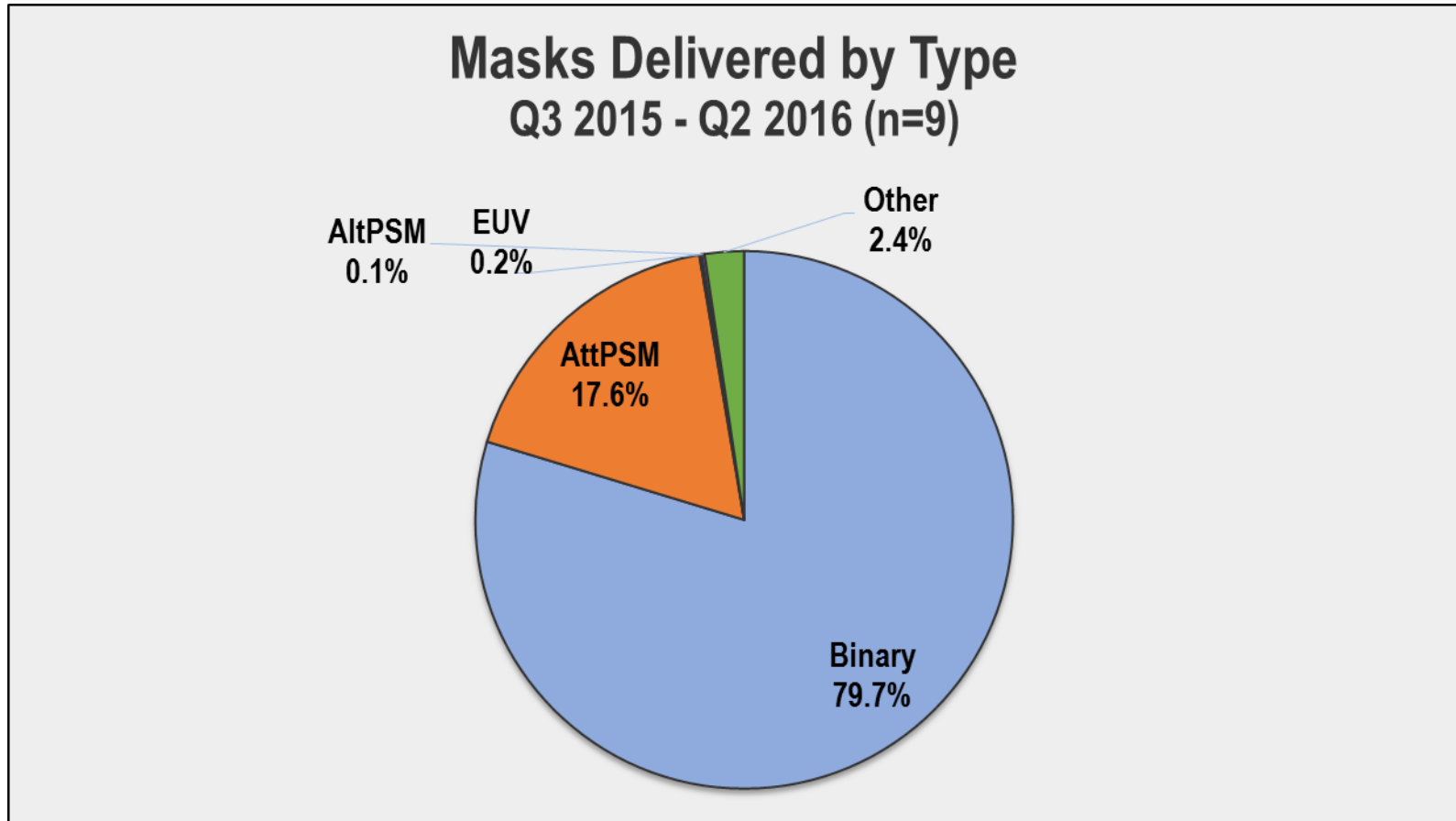
212,965 Masks Delivered by 9 Companies
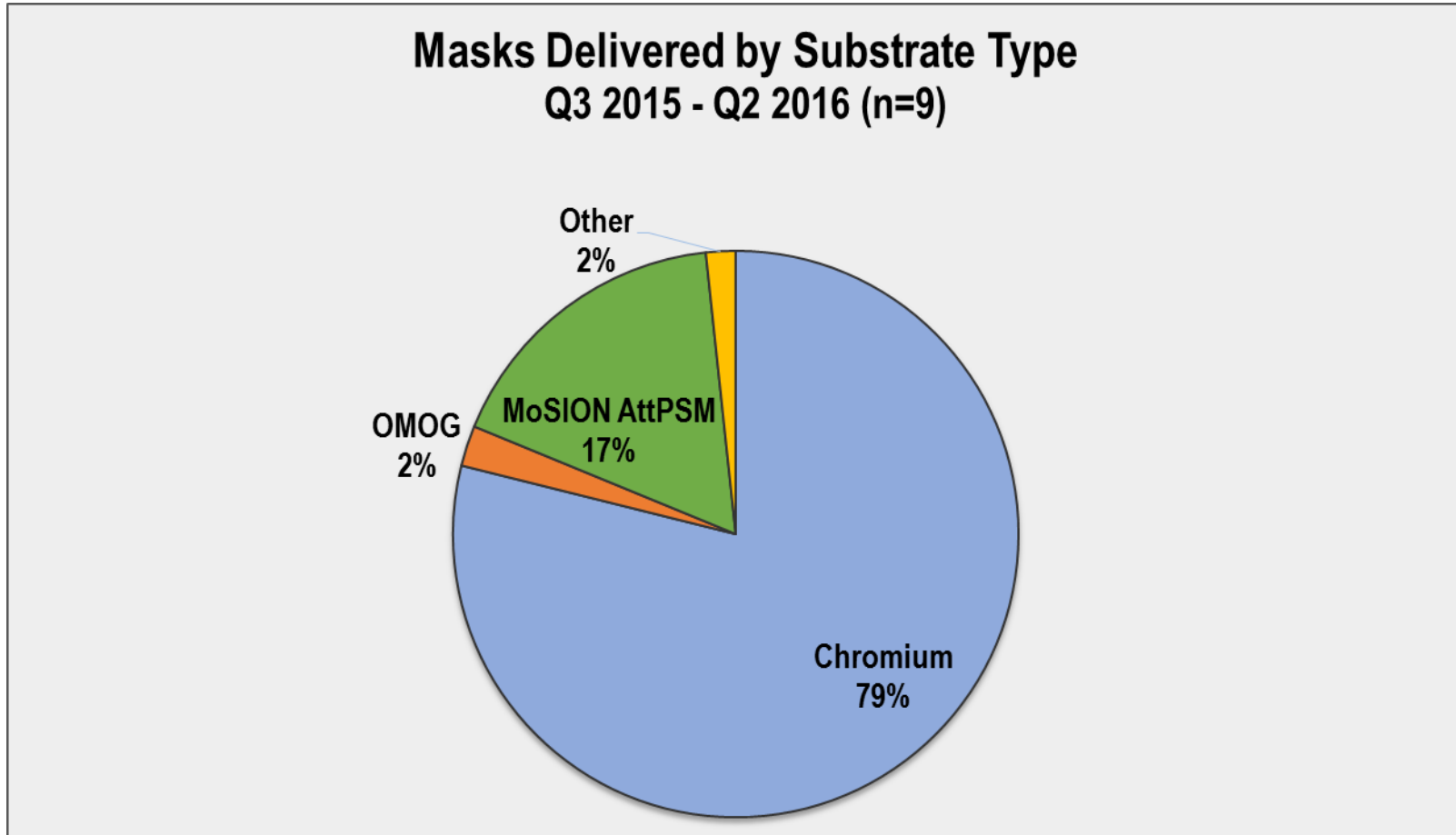## Q3 2015 – Q2 2016

Masks by Technology Node (Weighted Avg)
Q3 2015 - Q2 2016 (n=9)

Weighted Avg

% of Total Masks

Node	Weighted Avg
≥130nm and other nodes	31.1%
≥90nm and <130nm	39.3%
≥65nm and <90nm	5.7%
≥45nm and <65nm	5.8%
≥32nm and <45nm	6.5%
≥22nm and <32nm	5.0%
≥16nm and <22nm	4.6%
≥11nm and <16nm	1.4%
≥7nm and <11nm	0.7%

Q: What was the number of masks delivered in the last 12 months? Percent by technology node?
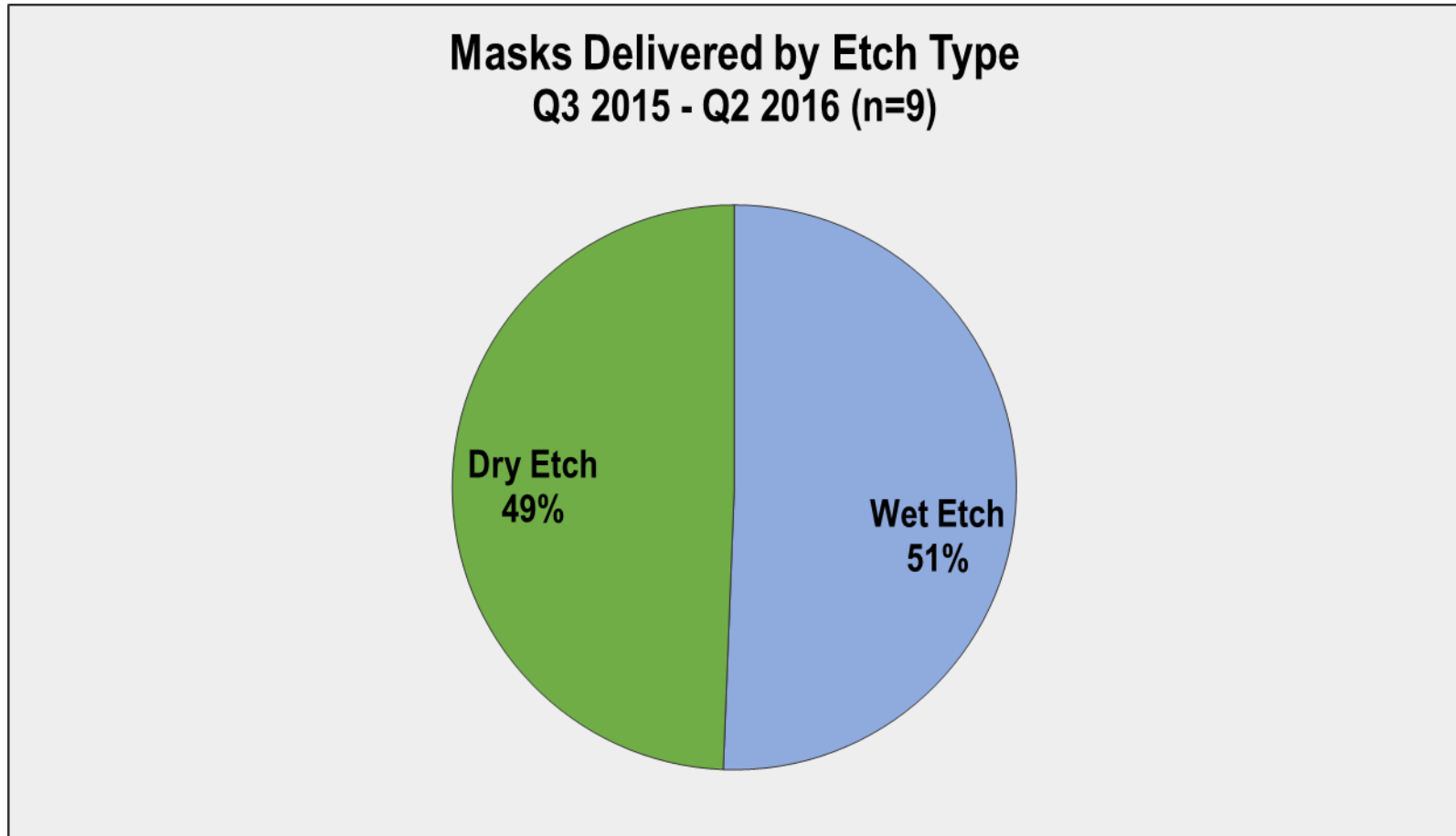
Majority of Masks (79.7%) are Binary

Masks Delivered by Type
Q3 2015 - Q2 2016 (n=9)

AltPSM
0.1%

EUV
0.2%

Other
2.4%

AttPSM
17.6%

Binary
79.7%

Q: What was the % by type?

Chromium Substrates in the Majority (79%)

Masks Delivered by Substrate Type
Q3 2015 - Q2 2016 (n=9)

- Other 2%
- OMOG 2%
- MoSION AttPSM 17%
- Chromium 79%

Q: What was the % by substrate type?

Even Split in Etch Type Reported

Masks Delivered by Etch Type
Q3 2015 - Q2 2016 (n=9)

Dry Etch
49%

Wet Etch
51%

Q: What was the % wet vs dry etch?

eBeam Pattern Generation Used on 34%

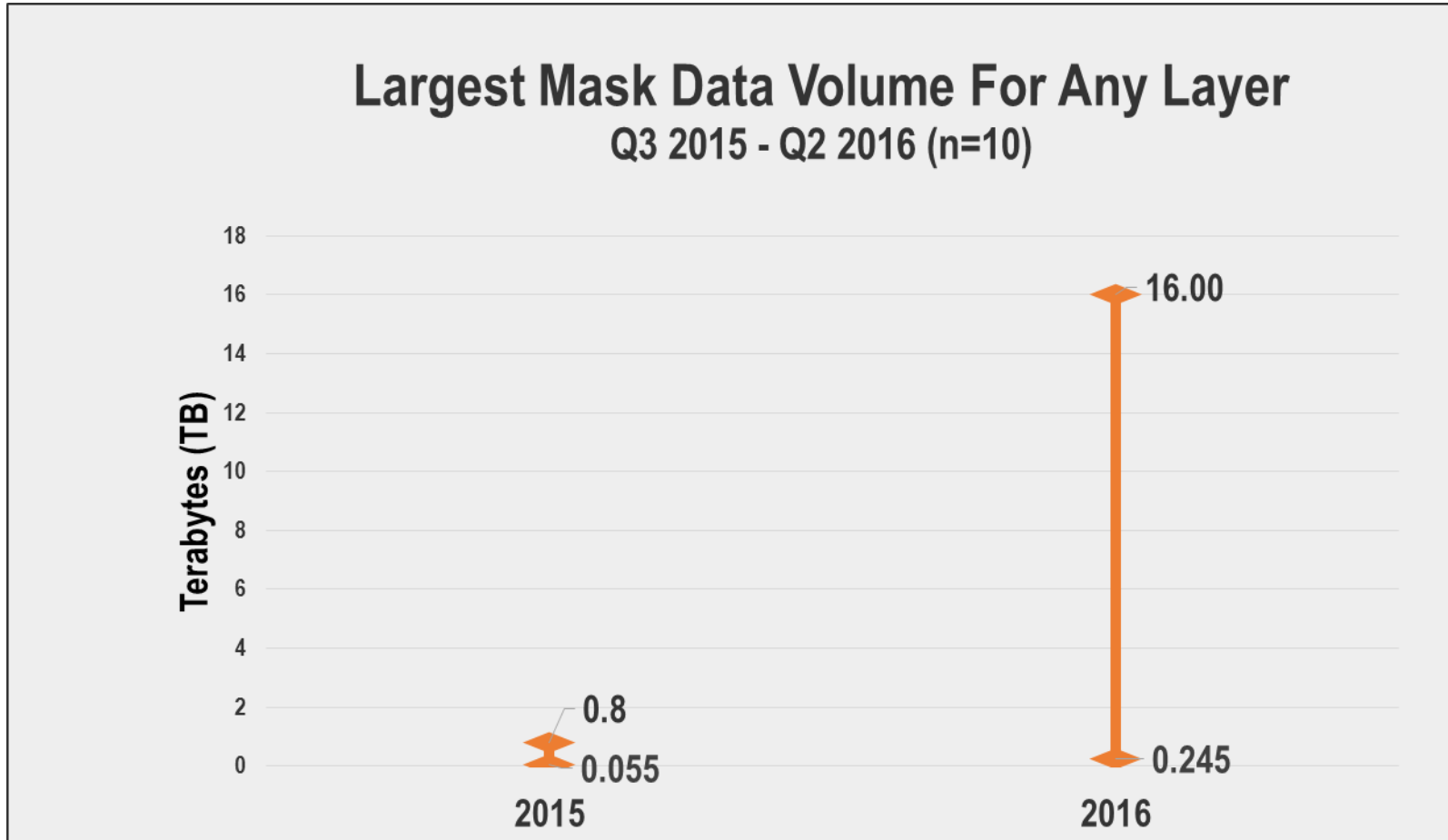**Masks Delivered by Pattern Generation Type**
Q3 2015 - Q2 2016 (n=9)

Other 0.1%
eBeam 33.5%
Laser 66.4%
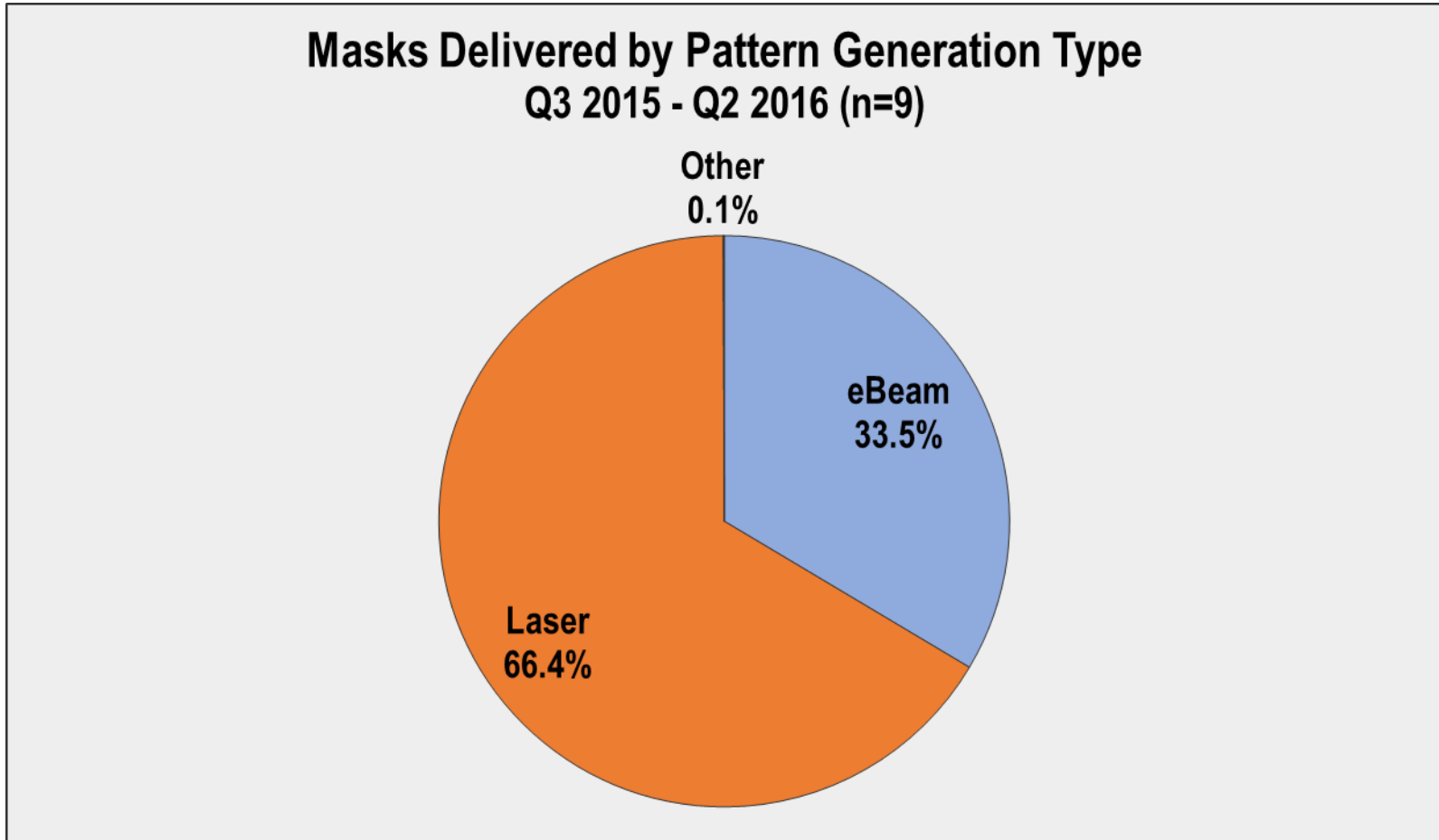
Q: What was the % written by the following pattern generation: eBeam, Laser, other?

Largest Data Volume Reported – 16 TB
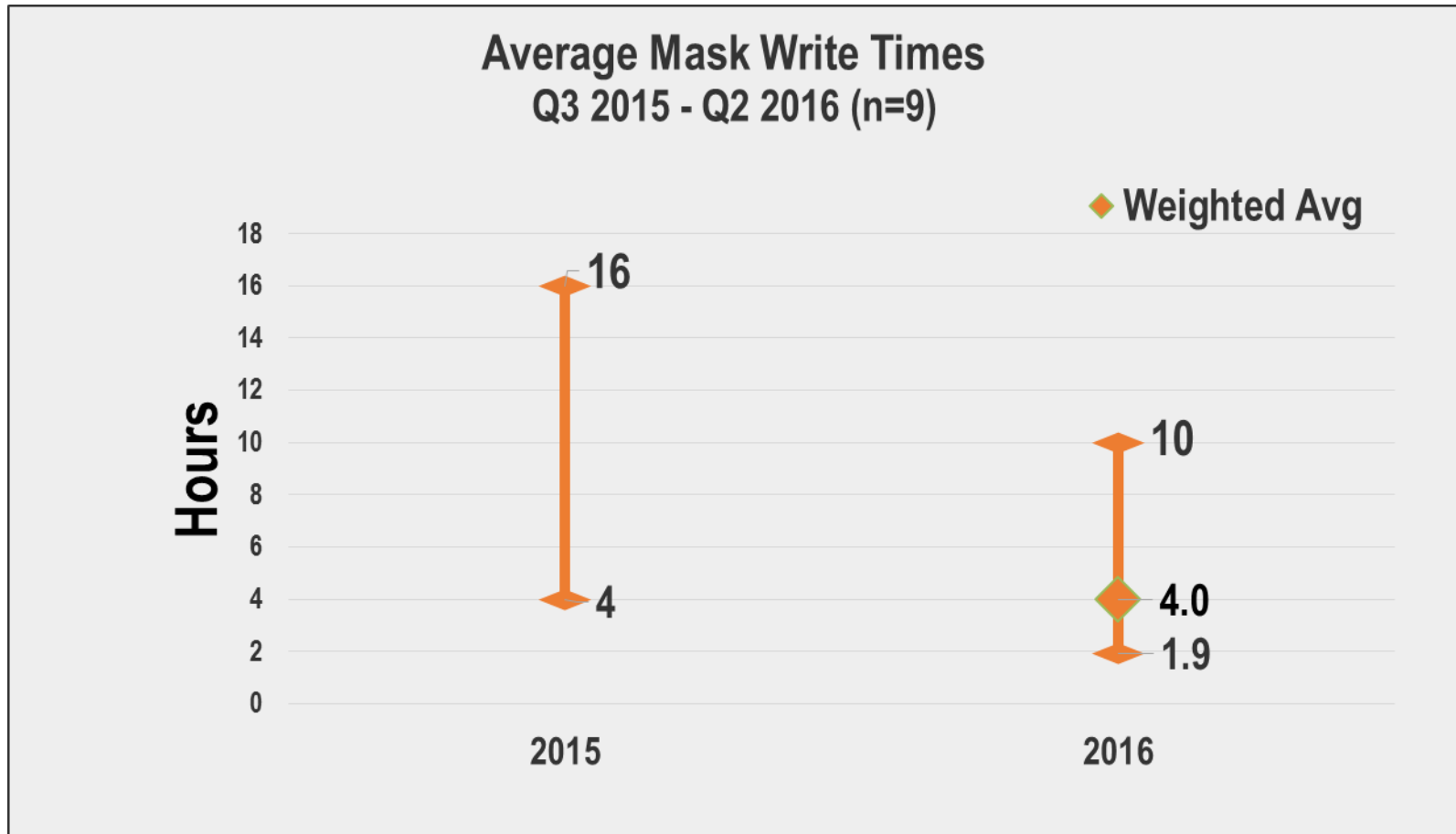## Could it be due to multi-beam?

Largest Mask Data Volume For Any Layer
Q3 2015 - Q2 2016 (n=10)

Q: What was the largest data volume for any mask level?

Average Mask Write Times Decreased
2016 span down to 1.9-10 hours; 4 hours weighted average

Average Mask Write Times
Q3 2015 - Q2 2016 (n=9)

Q: What was the average write time over the past 12 months?

Longest Write Time Reported – 48 Hours

Longest Mask Write Times
Q3 2015 - Q2 2016 (n=10)
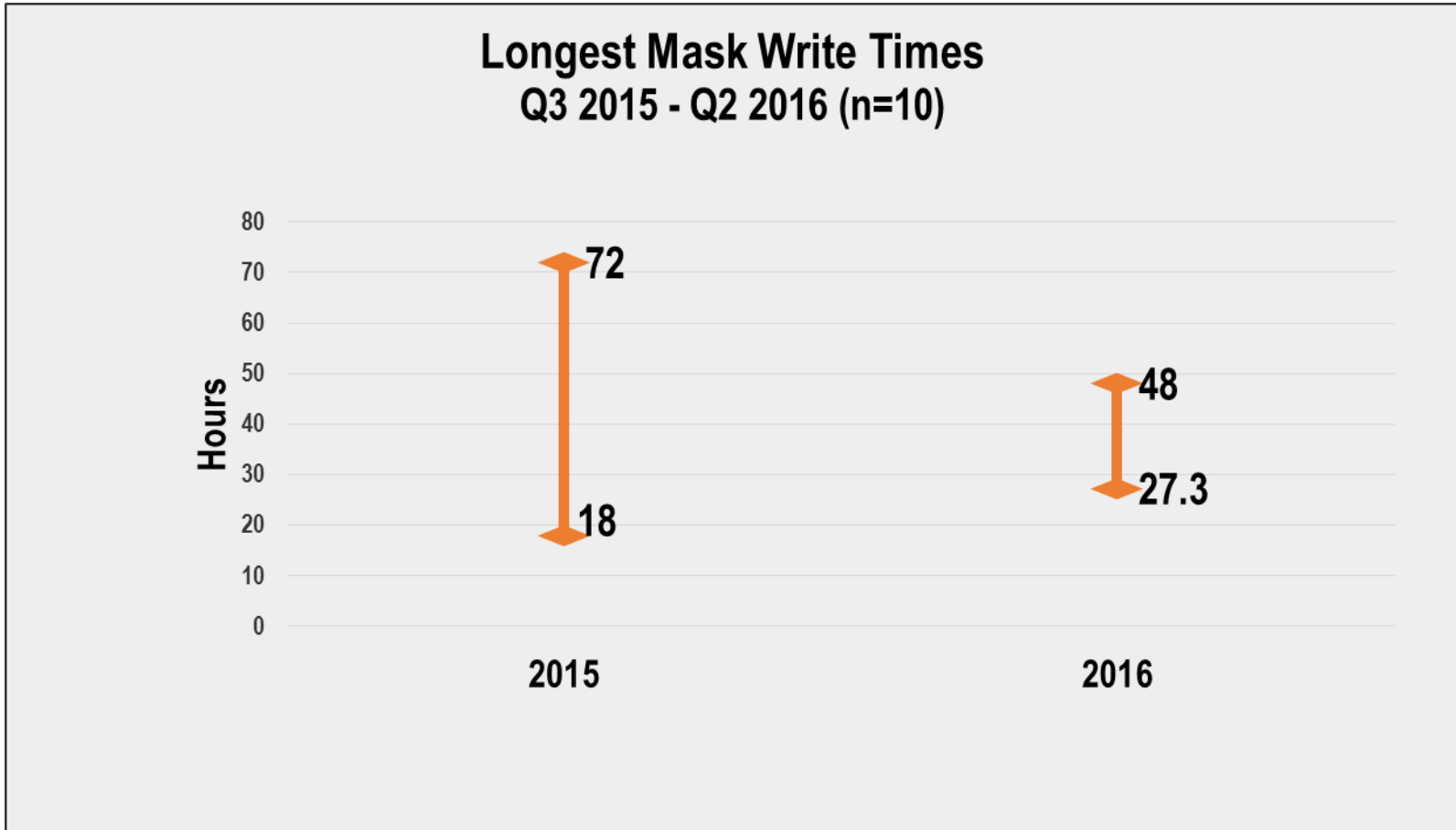
Q: What was the longest write time over the past 12 months?

Resist Usage Spans 30-69µC/cm^2
Majority (4) in 40-49µC/cm^2 range

Slowest Resist for Production Mask
Q3 2015 - Q2 2016 (n=9)

Median: 40µC/cm^2

# of responses

30-39 40-49 50-59 60-69

µC/cm^2

3 4 1 1
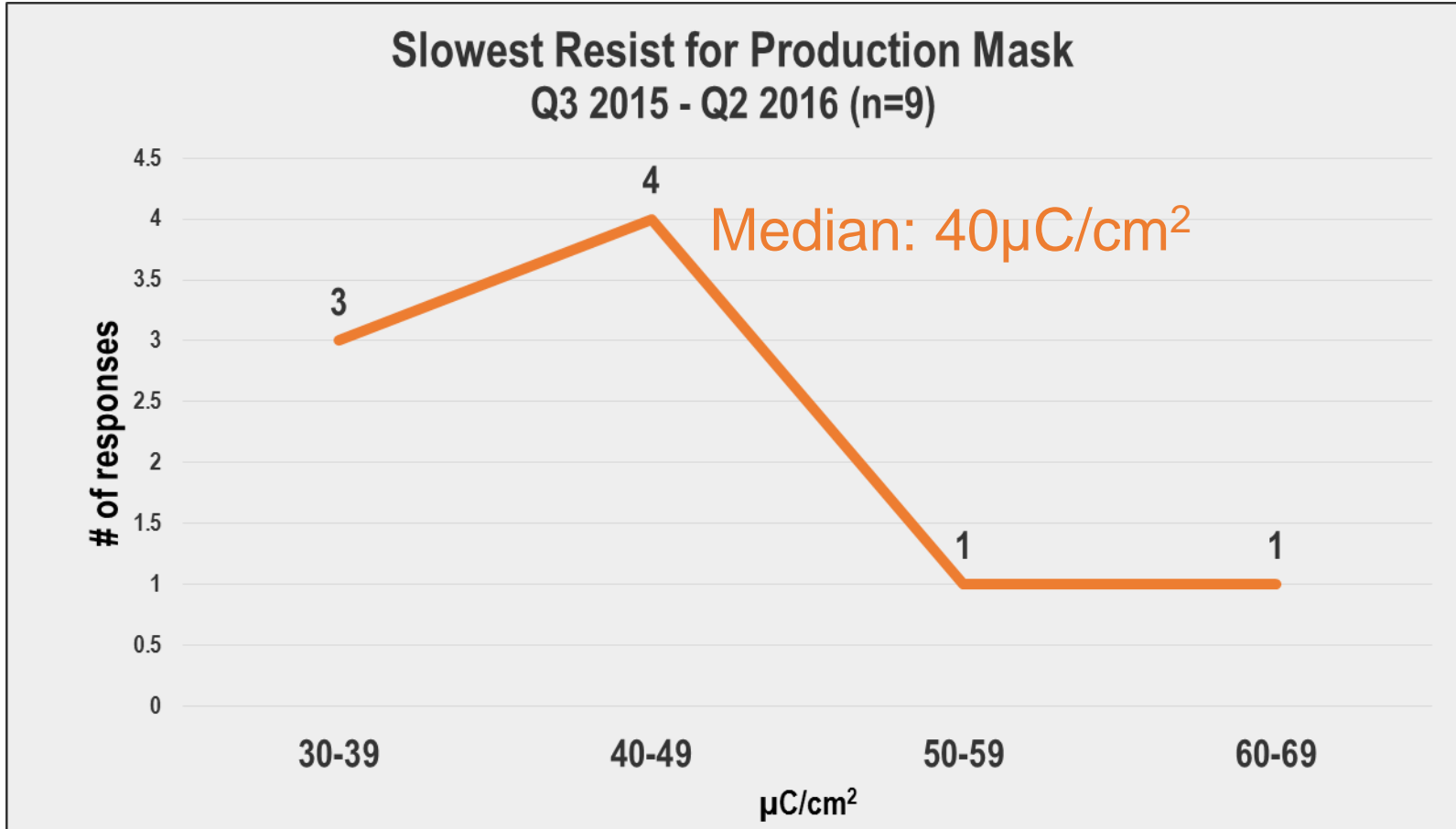
Q: In the past year, what was the slowest resist that was used for a production mask intended for production wafer manufacturing?
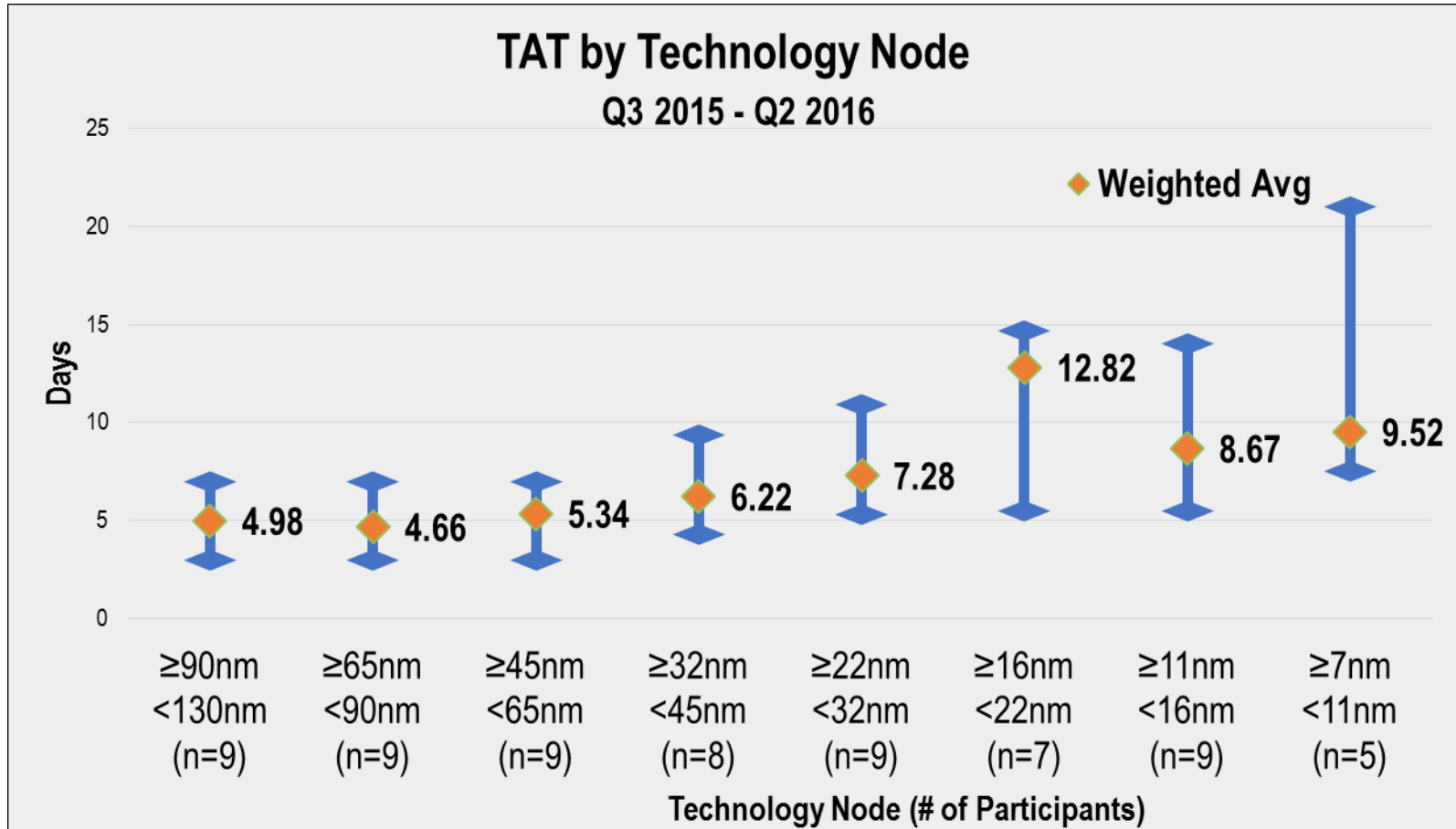
Dose Assignment Reported by 7 out of 9
5 reported between 1.3x to 1.8x, 2 reported ≥ 2.8x
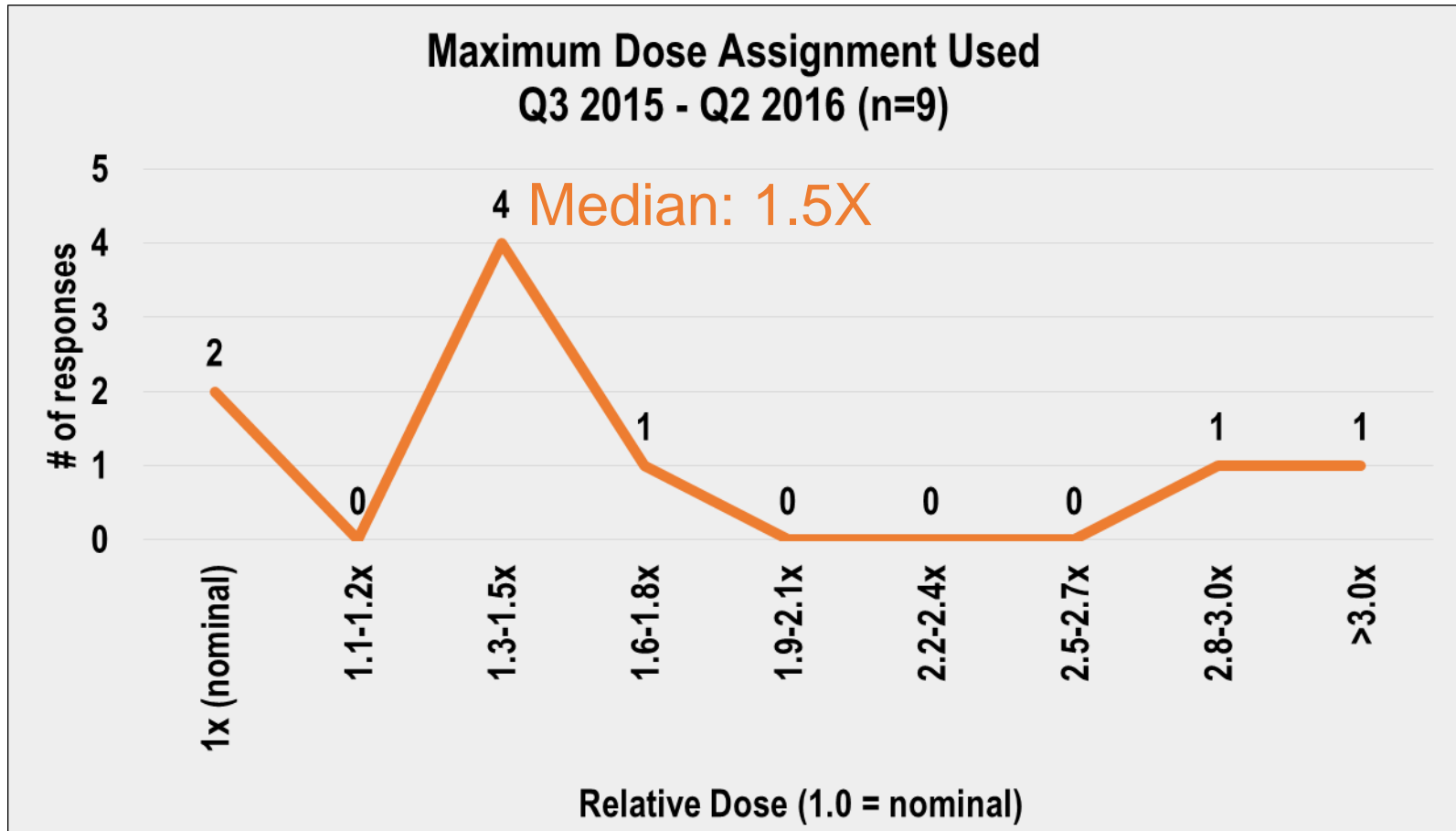
Q: In the past year, what was the max dose assigned to shots in the data provided to the mask writing machine? Please answer relative to 1.0 (nominal dose)
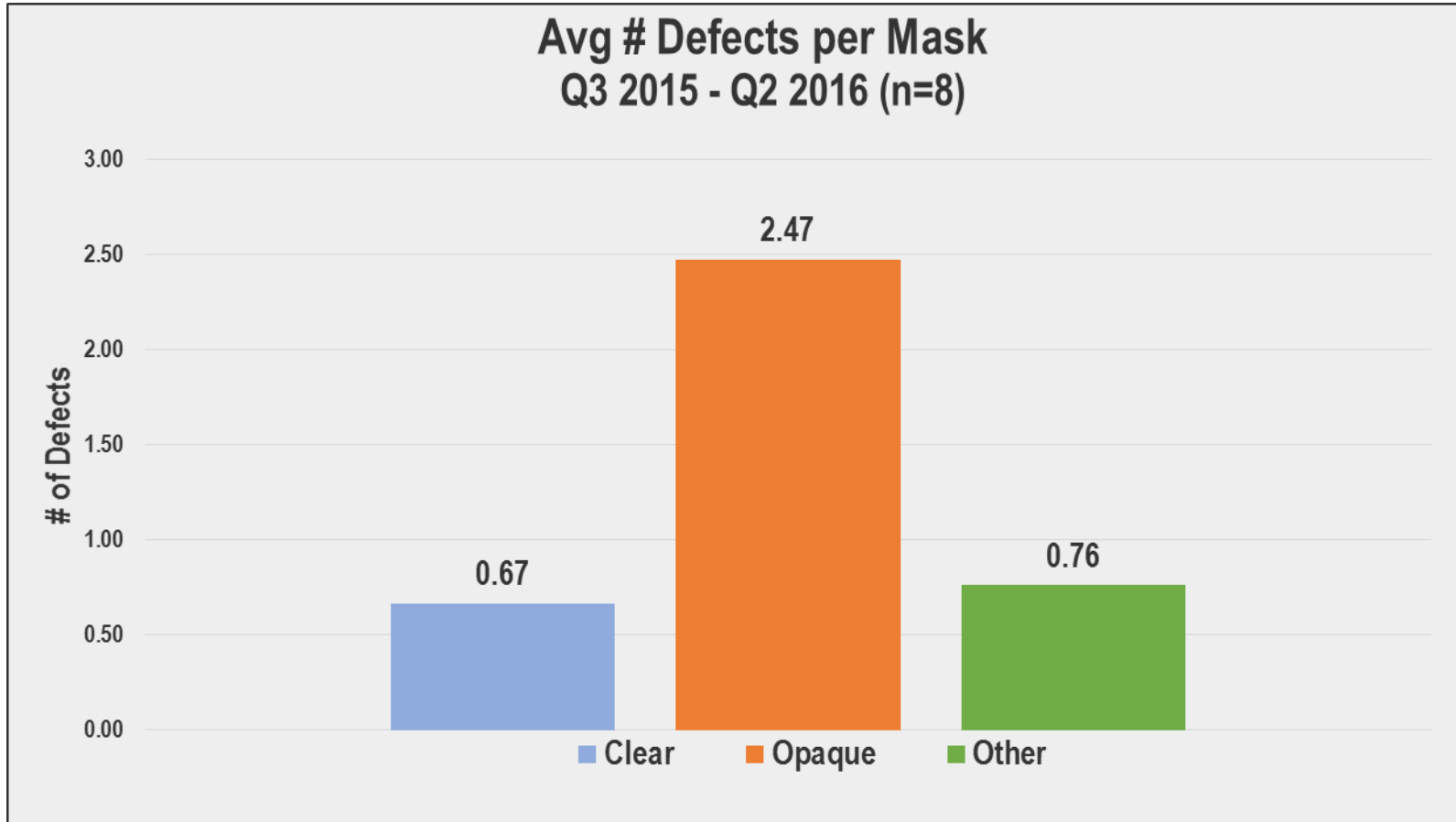
TAT Approaching 10 Days
Did TAT increase dramatically at 16-20nm?

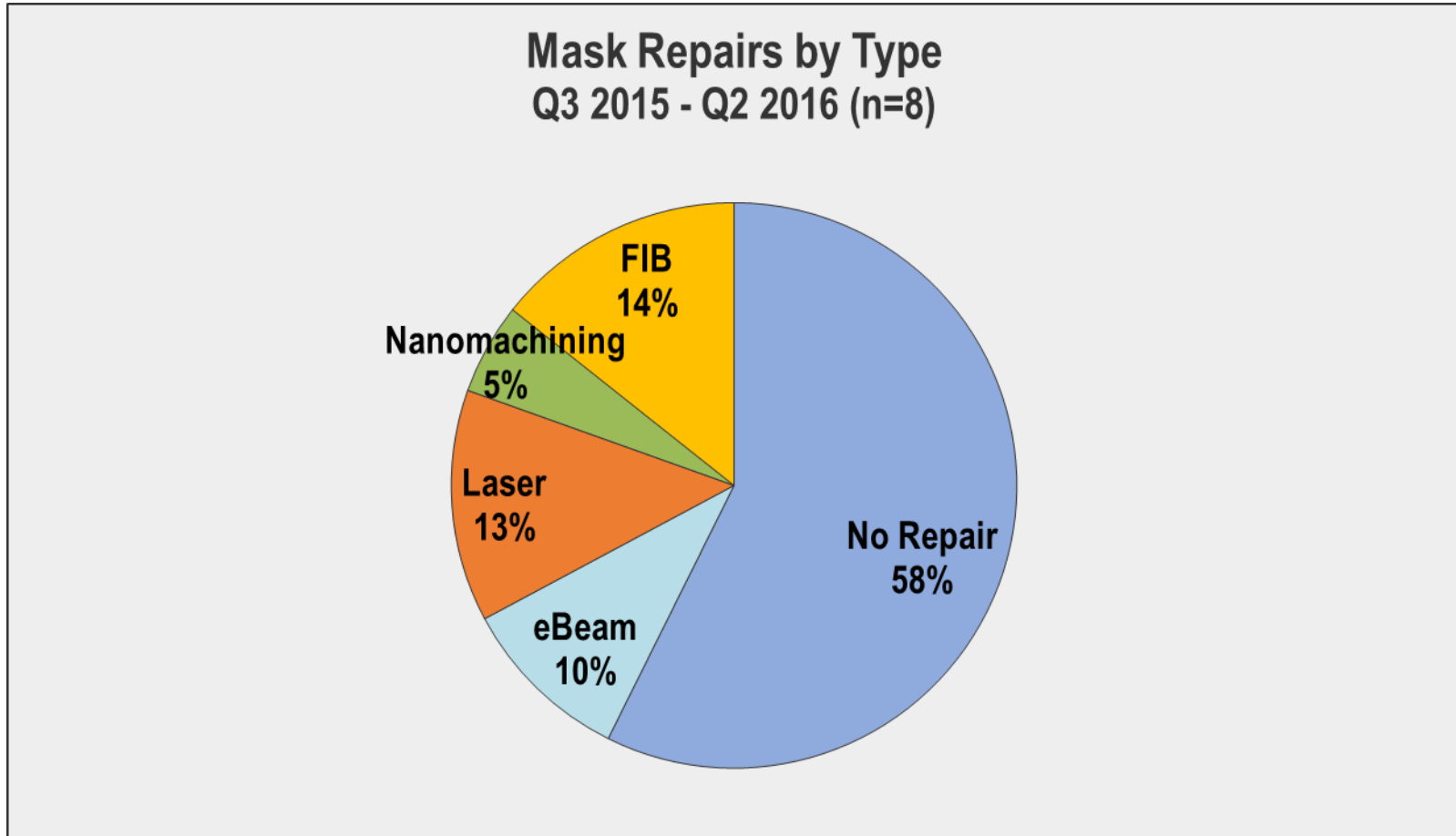TAT by Technology Node
Q3 2015 - Q2 2016

Q: What was the average turn-around-time (TAT) by technology node?

Most Mask Defects Are Opaque

Q: What was the average number of defects per mask for the past 12 months?

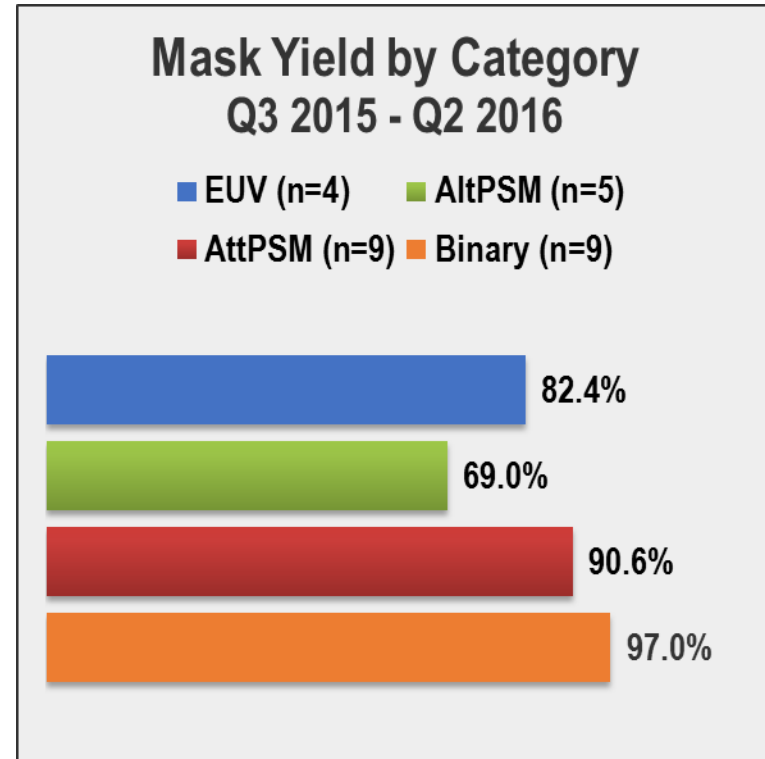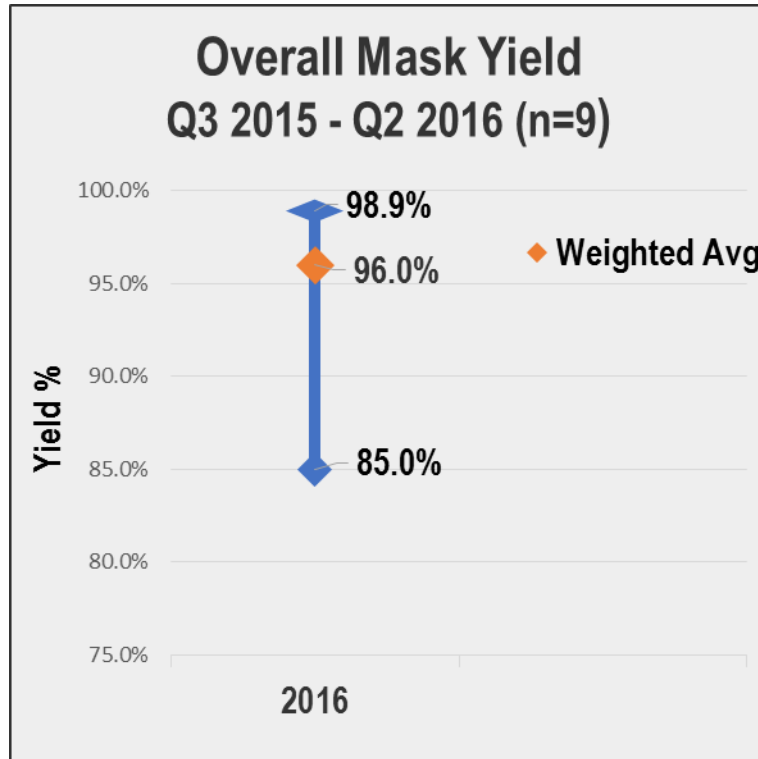# FIB Used Most for Mask Repairs at 14.3%

Mask Repairs by Type
Q3 2015 - Q2 2016 (n=8)

- FIB 14%
- Nanomachining 5%
- Laser 13%
- eBeam 10%
- No Repair 58%

Q: What was the percentage of masks repaired by…no repair, eBeam, laser, nanomachining, FIB?

Average Mask Yield of 96% Reported
EUV mask yield on average >80% (4 reported)

Overall Mask Yield
Q3 2015 - Q2 2016 (n=9)

- 98.9%
- 96.0% ◆ Weighted Avg
- 85.0%

Yield %

100.0%
95.0%
90.0%
85.0%
80.0%
75.0%

2016

Mask Yield by Category
Q3 2015 - Q2 2016

- ■ EUV (n=4)   ■ AltPSM (n=5)
- ■ AttPSM (n=9)   ■ Binary (n=9)

- EUV: 82.4%
- AltPSM: 69.0%
- AttPSM: 90.6%
- Binary: 97.0%

Q: What was your overall mask yield for the past 12 months?
Q: What was your percent mask yield by category?

Strong Participation in 2016 Mask Survey

- **10 mask makers in total – merchant and captive**

- **Largest data set reported to be 16 TB**

- **But mask write times decreased significantly with a weighted average of 4 hours**

- **TAT continues to increase, approaching 10 days**