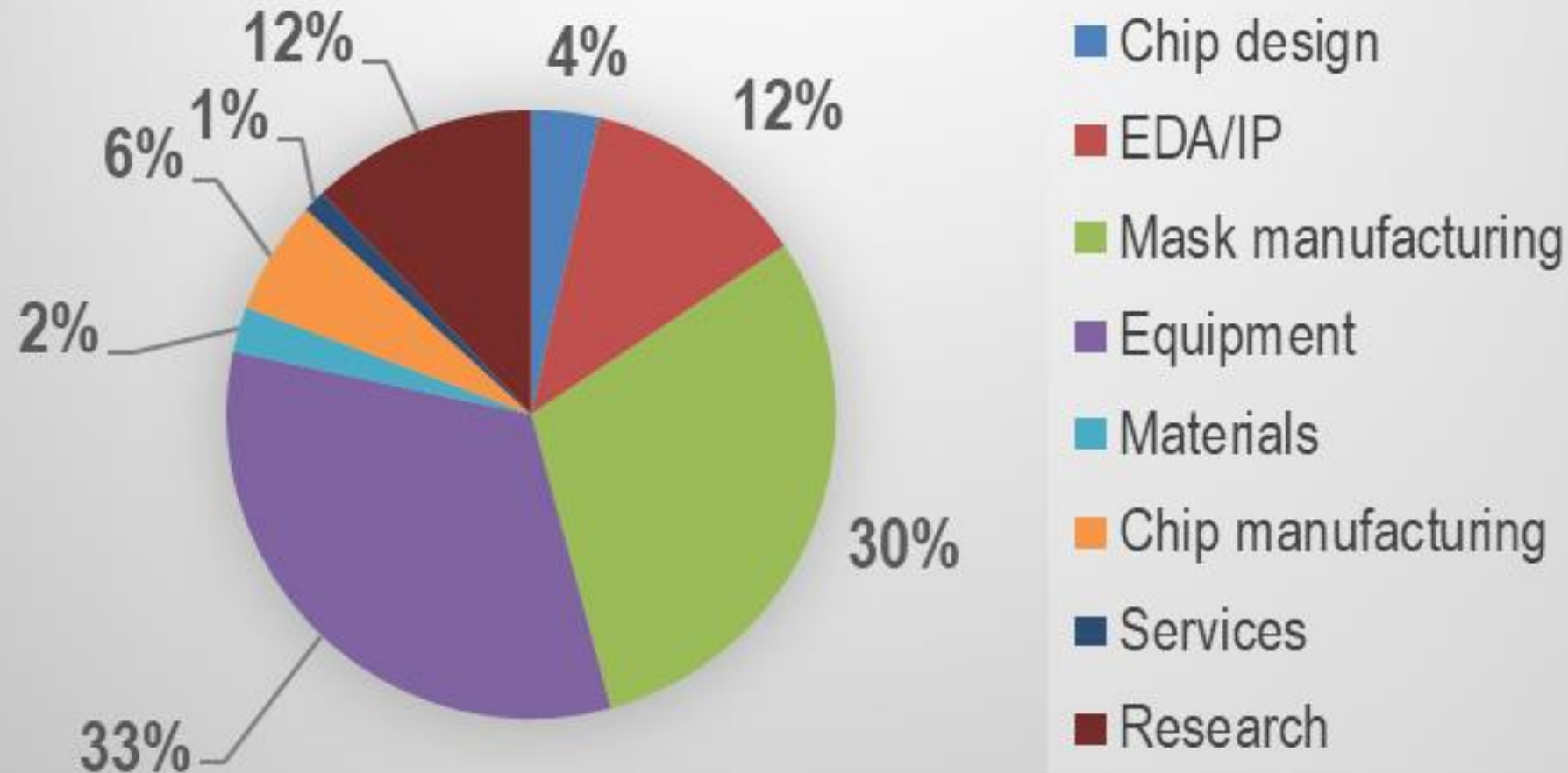


84 Luminaries Participated in the 13th Annual Survey

Representing 49 different companies in July 2024

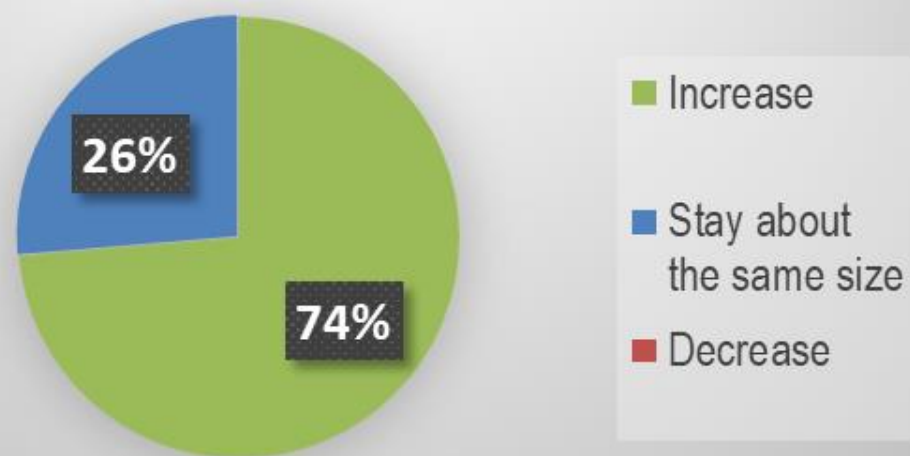
What part of the semiconductor ecosystem is your primary focus?



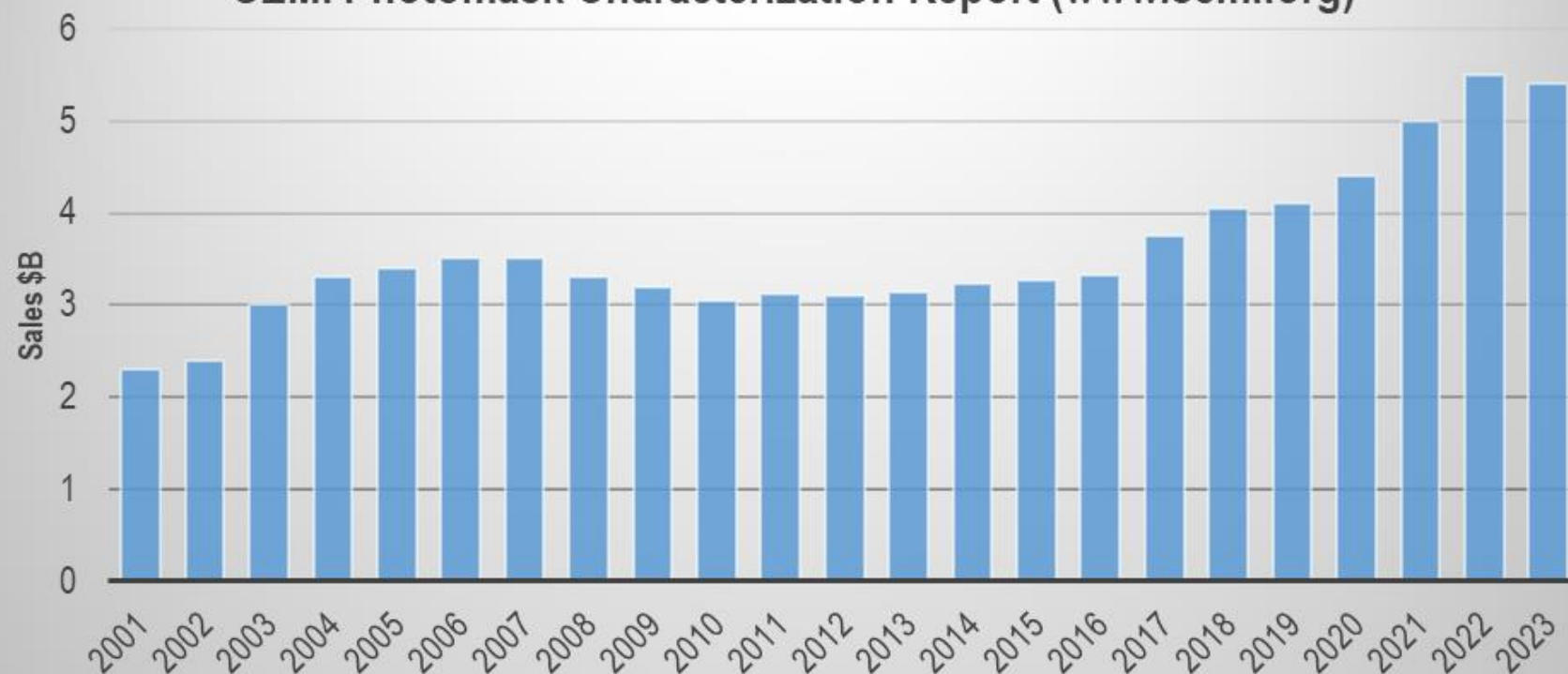
74% Say 2024 Mask Revenues Will Increase Over 2023

SEMI reported \$5.4B for 2023 – 7.2% CAGR since 2016!

Net of all effects, what will happen to the size of the 2024 total mask revenues compared to 2023? n=76

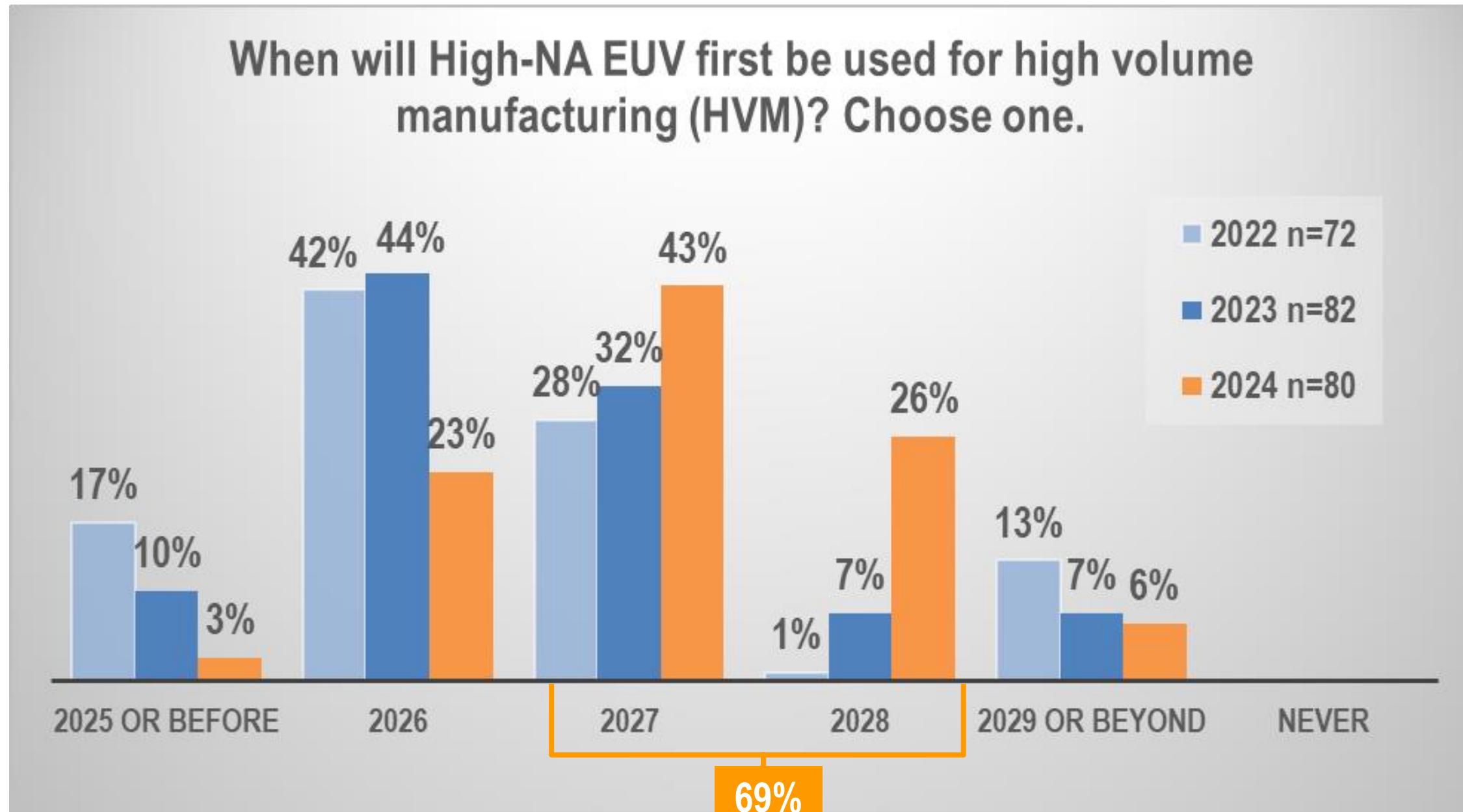


SEMI: Photomask Market 2001-2023
SEMI Photomask Characterization Report (www.semi.org)



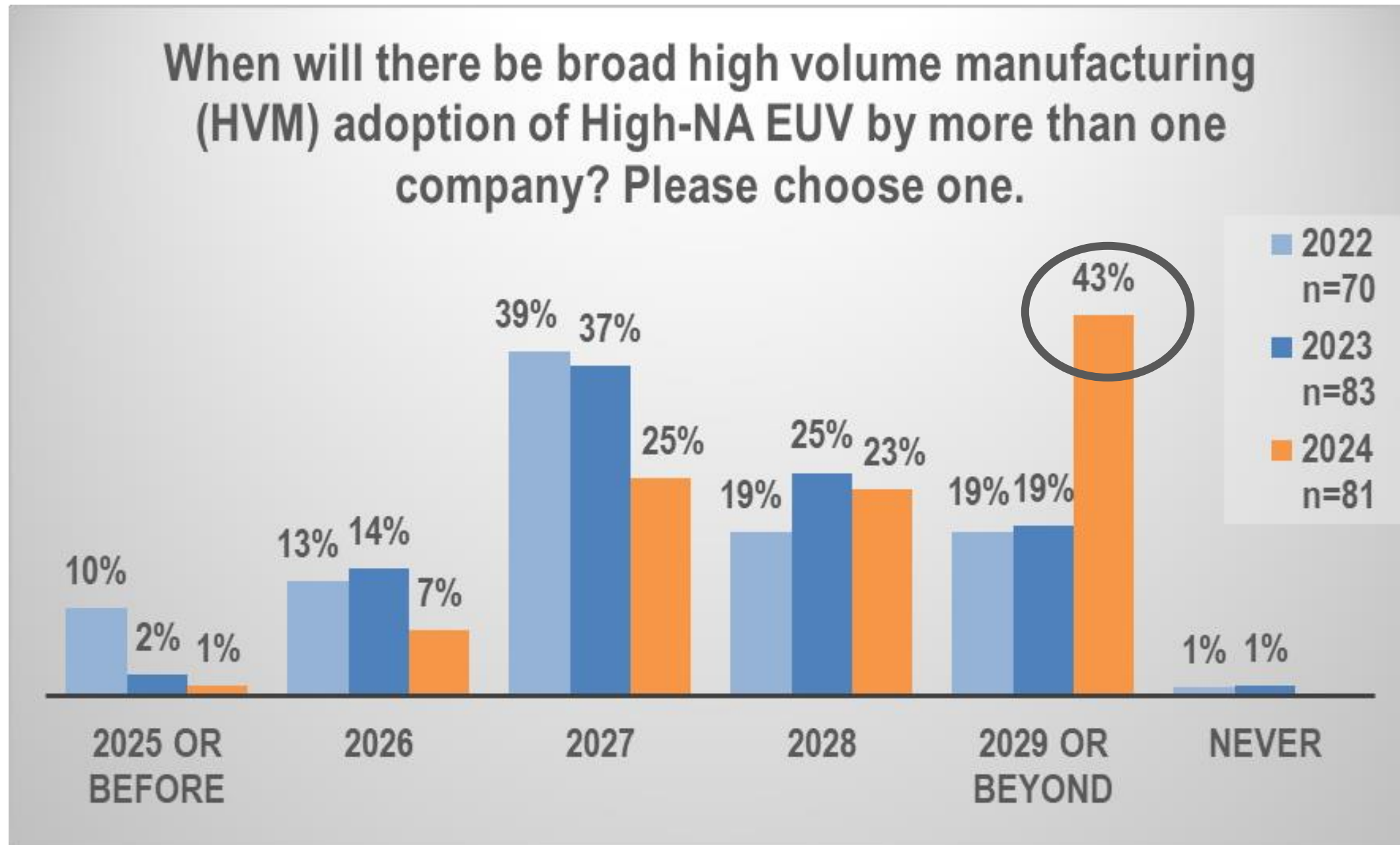
Opinion for High-NA EUV First HVM Usage is Clearer

69% of Luminaries say 2027 or 2028



Estimates of High-NA EUV Broad Usage Shift to 2029 or Beyond

19% said that in 2023 and 43% in 2024, but no one says “never”

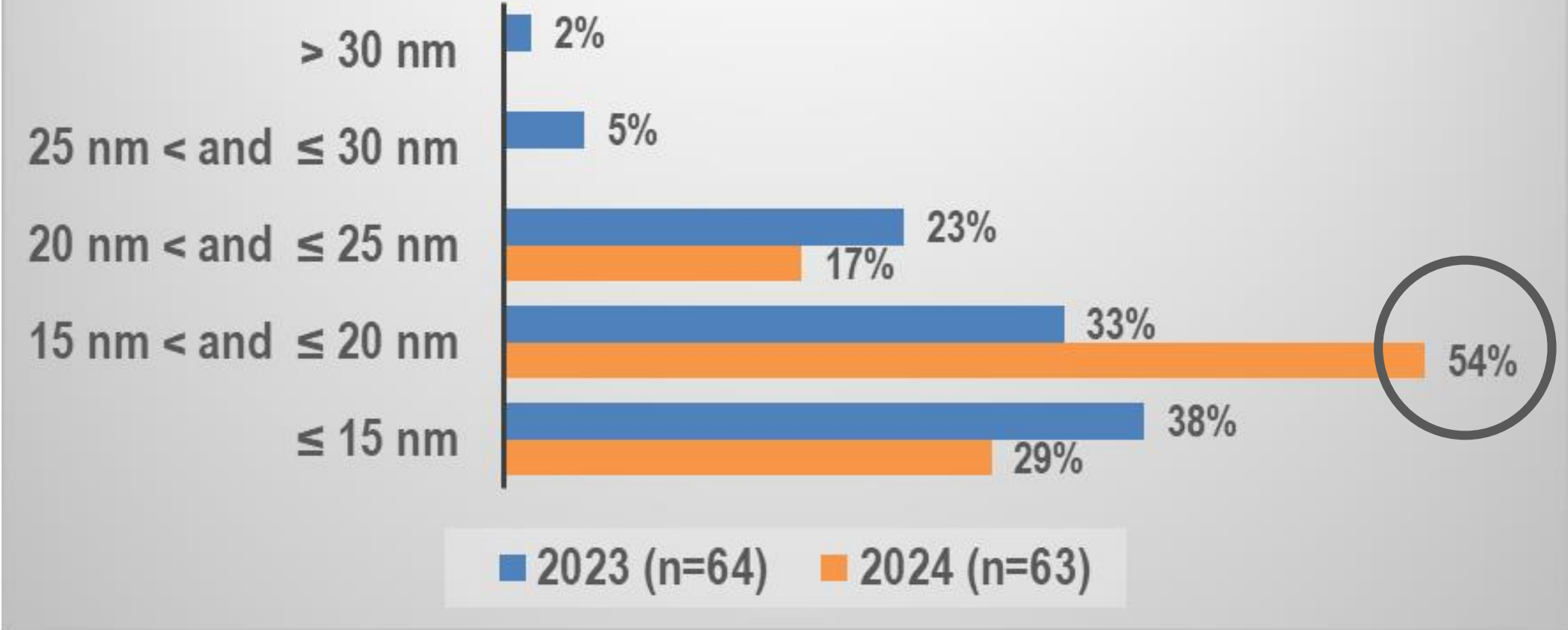


54% Say Min Mask Dimension High-NA EUV >15nm and ≤20nm

33% said that in 2023



SRAFs in the 4X dimension for High-NA EUV masks will need to be smaller. What will be the required minimum dimension (on mask) that mask shops need to manufacture for HVM production using High-NA EUV?



New Questions on Stitching for High-NA EUV Masks



81% Disagree with “stitching won’t be a problem”

73% Agree some layout constraints acceptable to designers to avoid stitching

83% Agree stitching portion requires different design rules

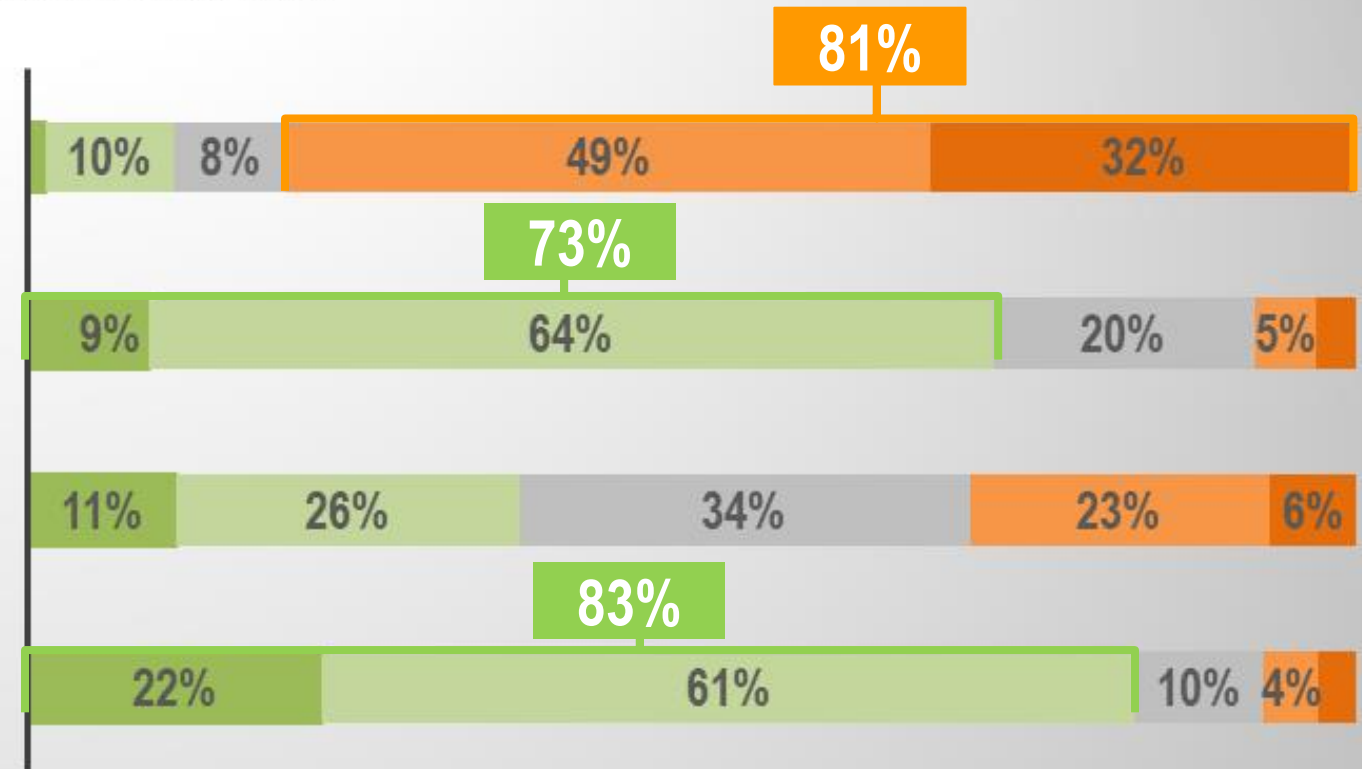
Please indicate your level of agreement or disagreement with the following statements:

Stitching won't be a problem. Designers will be able to design without knowing about the half-field boundaries. n=72

Some layout constraints, for example in floor planning, may be required to avoid stitching of minimum width features across stitching boundaries, but they will be acceptable to the designers. n=66

Restricting metal 1 and below layers not to have features crossing half-field boundaries will be acceptable to designers. n=62

No matter how great a solution, stitching across the half fields will require the design rules to be wider/different for the features crossing the half-field boundaries. n=72



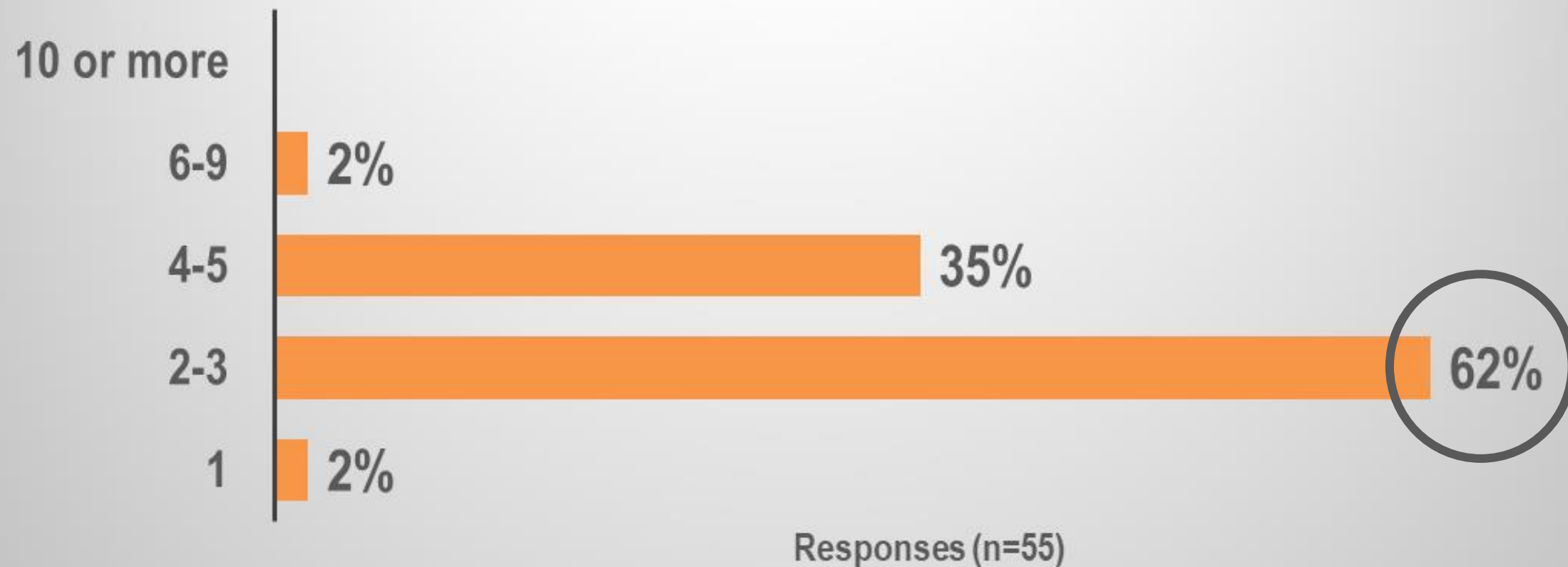
Strongly agree Agree Neither agree or disagree Disagree Strongly disagree

62% Say 2-3 EUV Masks Per Layer Needed if No Pellicles

While design is in production (question reworded from 2023)



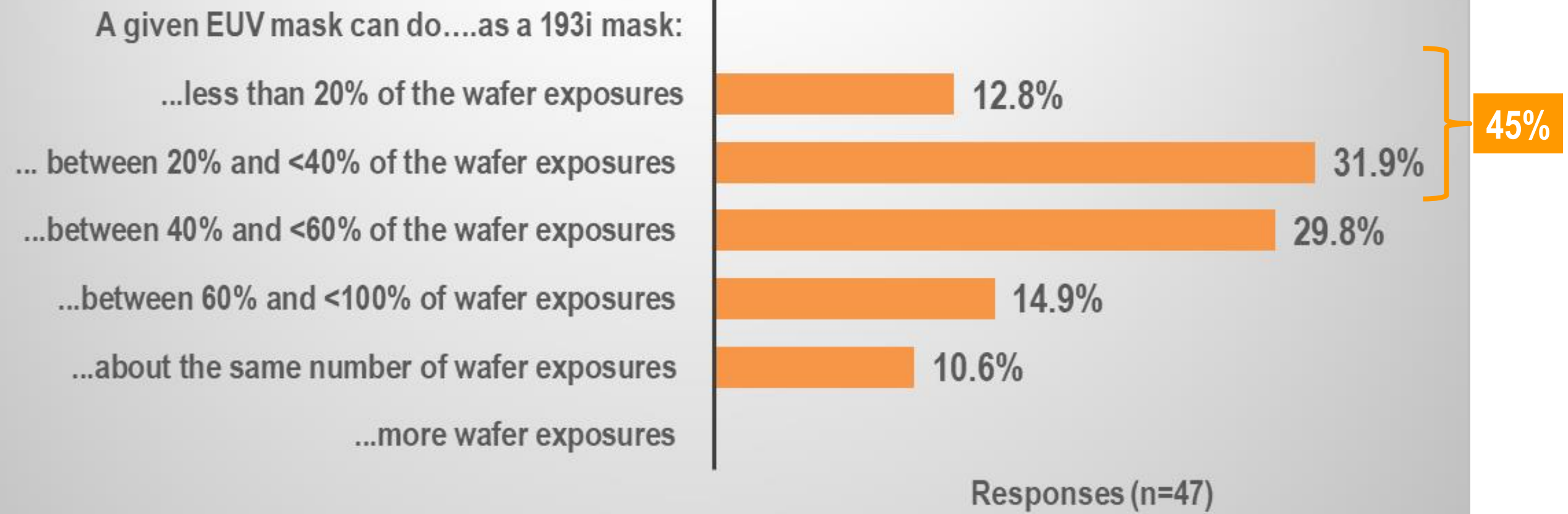
New: On the average overall for the whole industry this year, for EUV masks without pellicles, how many masks are needed per exposure layer of a mask design while that design is in production?



45% Say EUV Masks w/o Pellicles Have <40% Lifetime of 193i

New question (n=47) asks about pellicle impact on lifetime

New: Relative to 193i mask lifetime (based on the number of wafer exposures), what is the average EUV mask lifetime (without pellicles) today?

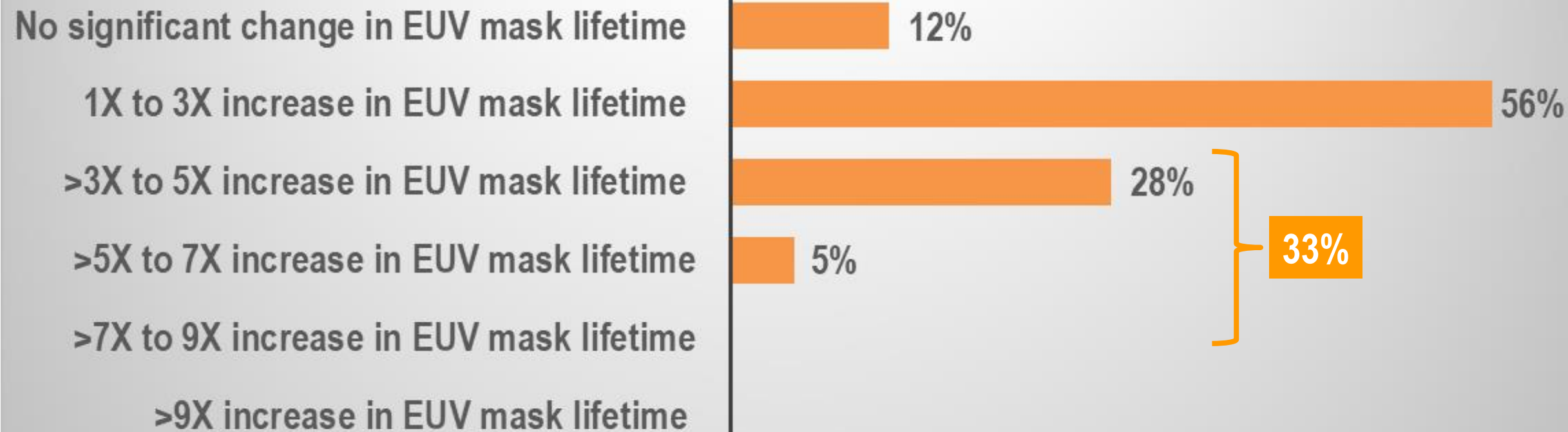


33% Say Pellicles Increase EUV Mask Lifetime at least 3X

New question in 2024 (n=43)



New: How much does a pellicle affect EUV mask lifetime today?



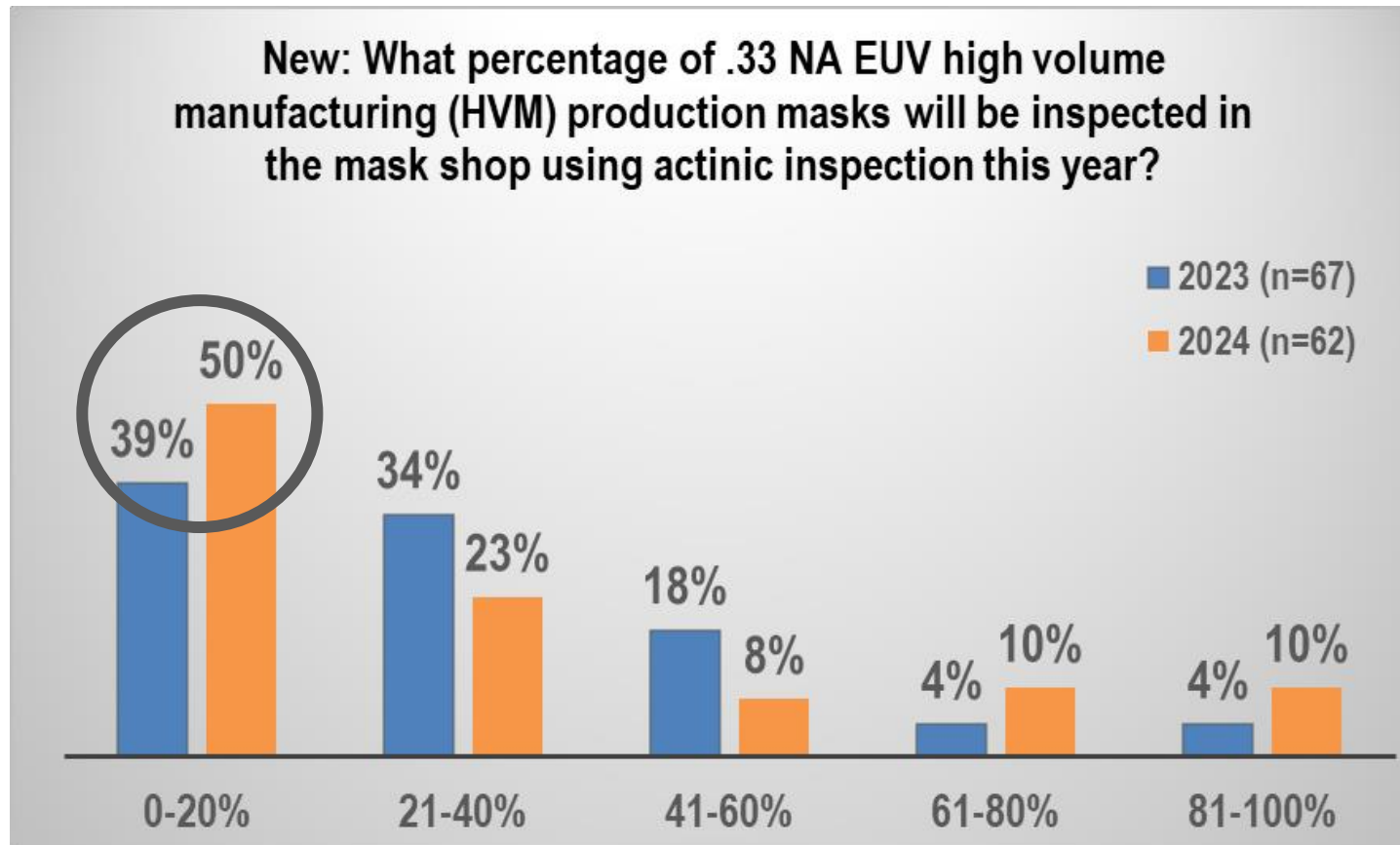
Responses (n=43)

Opinions on Actinic EUV Mask Inspection Clear for Today

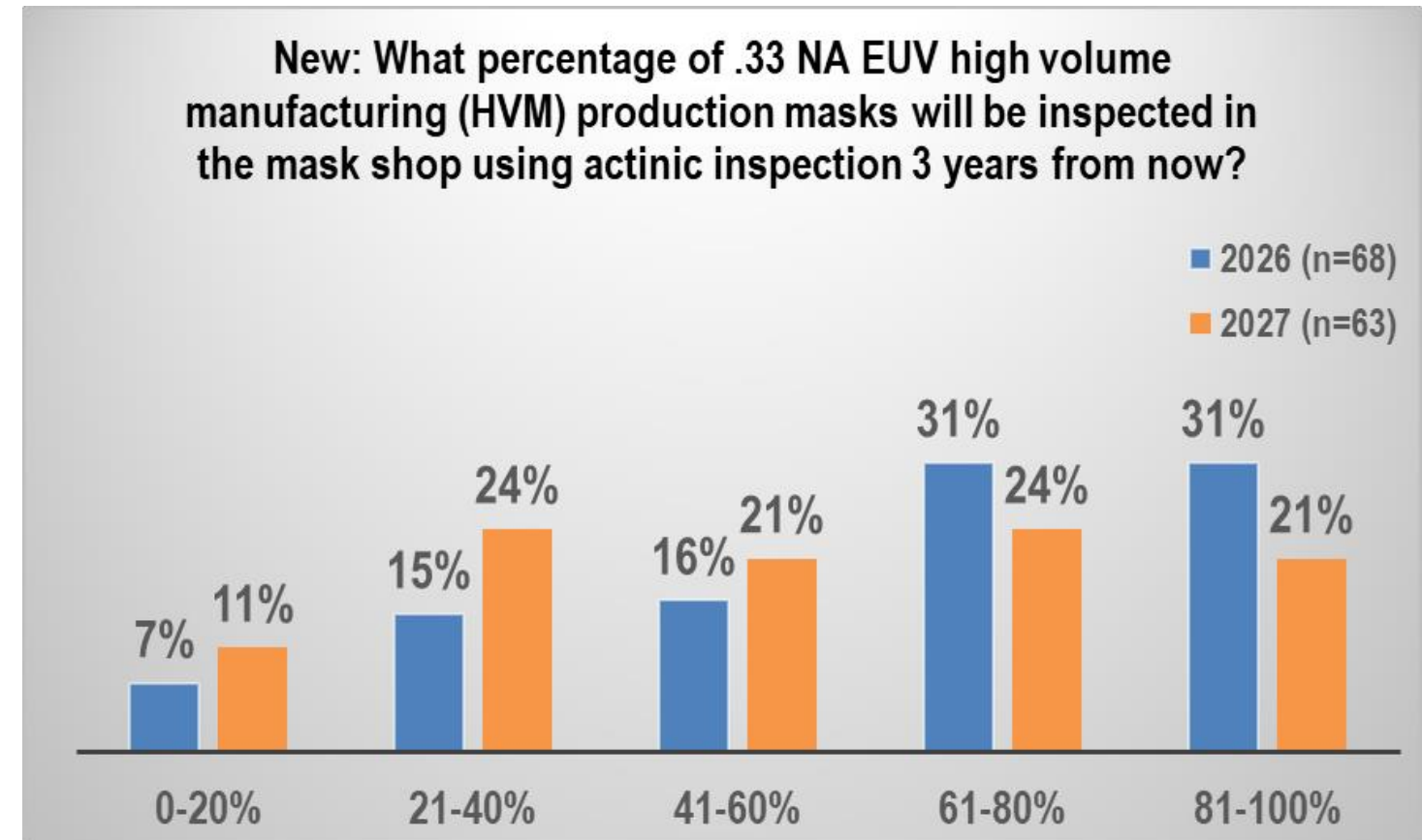
50% say $\leq 20\%$ of HVM masks vs 39% last year; no clear trend in 3 years



Predictions for Today



Predictions in 3 Years

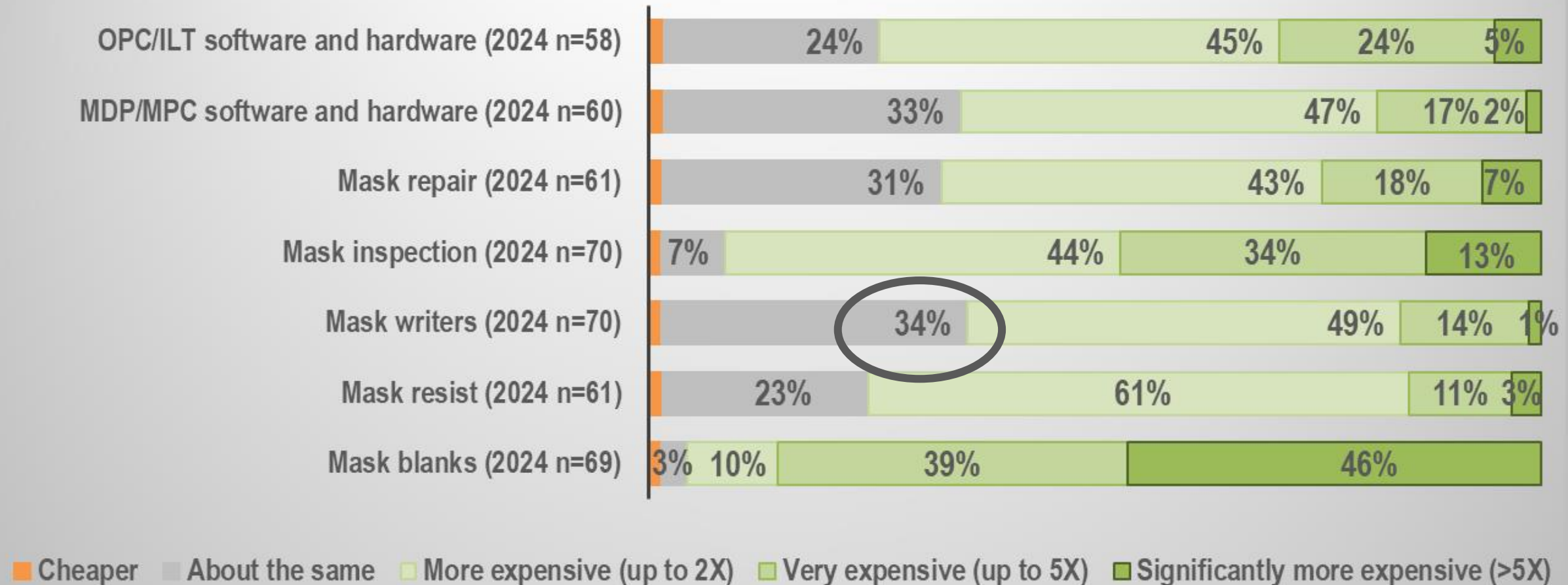


Overall Trend for EUV > 193i Mask Costs Unchanged

Opinion that mask writers are about the same cost increased to 34% from 14%



How much more expensive is EUV versus 193i leading-edge mask equipment, materials and software? Please answer for each type by row.



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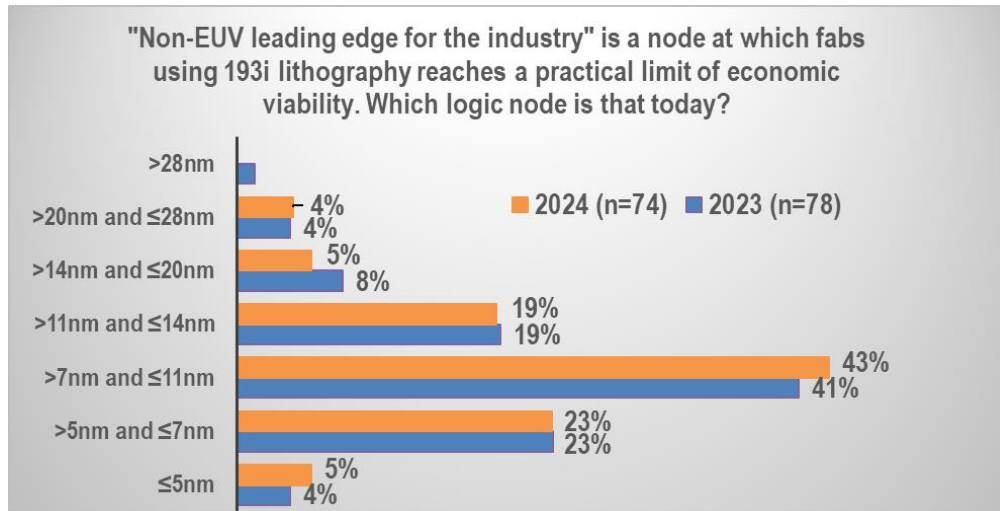


■ Cheaper ■ About the same ■ More expensive (up to 2X) ■ Very expensive (up to 5X) ■ Significantly more expensive (>5X)

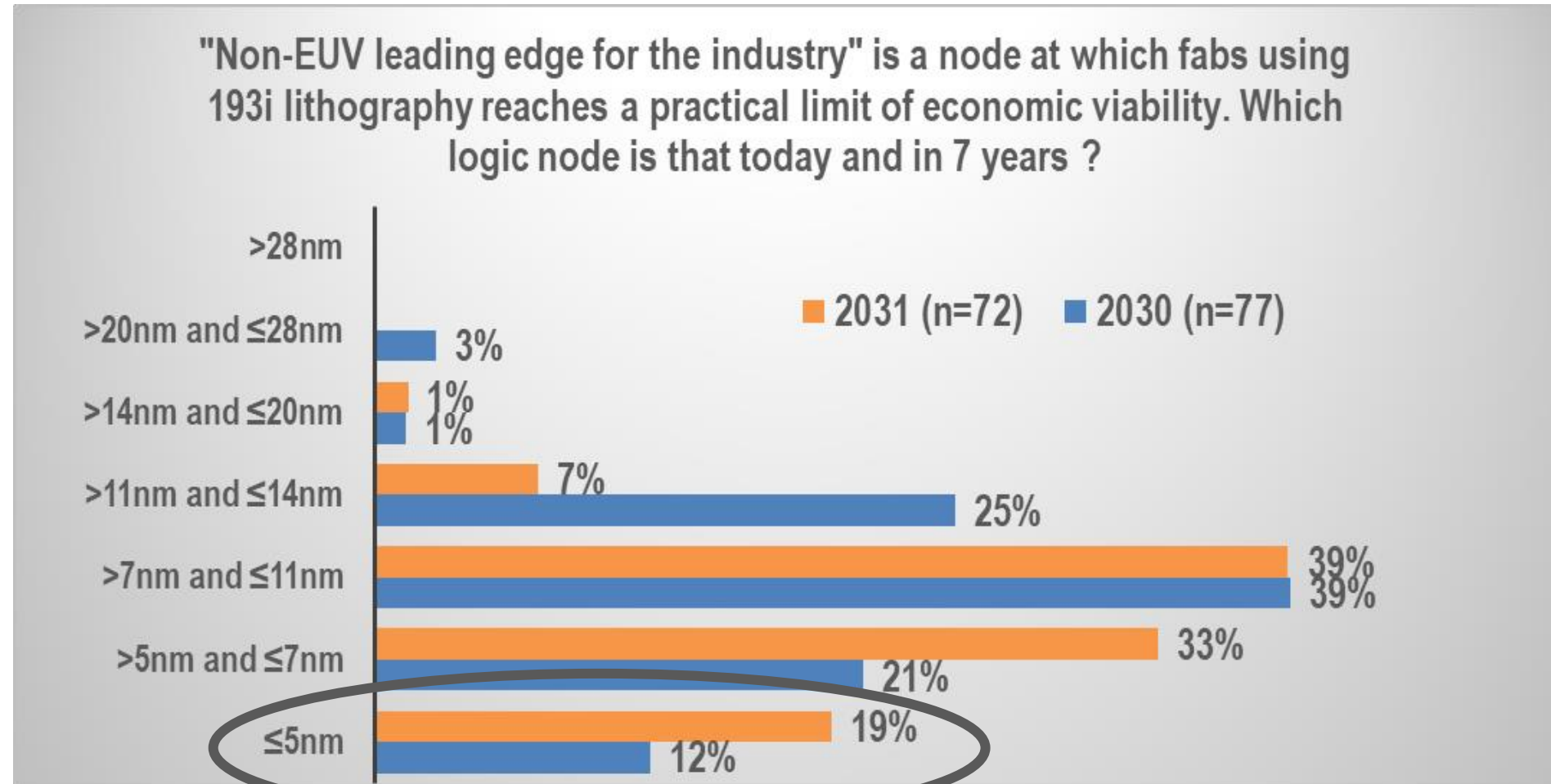
Confidence Increased: Fabs w/o EUV Can Reach $\leq 5\text{nm}$ in 7 Years

19% say $\leq 5\text{nm}$ vs 12% who said that last year

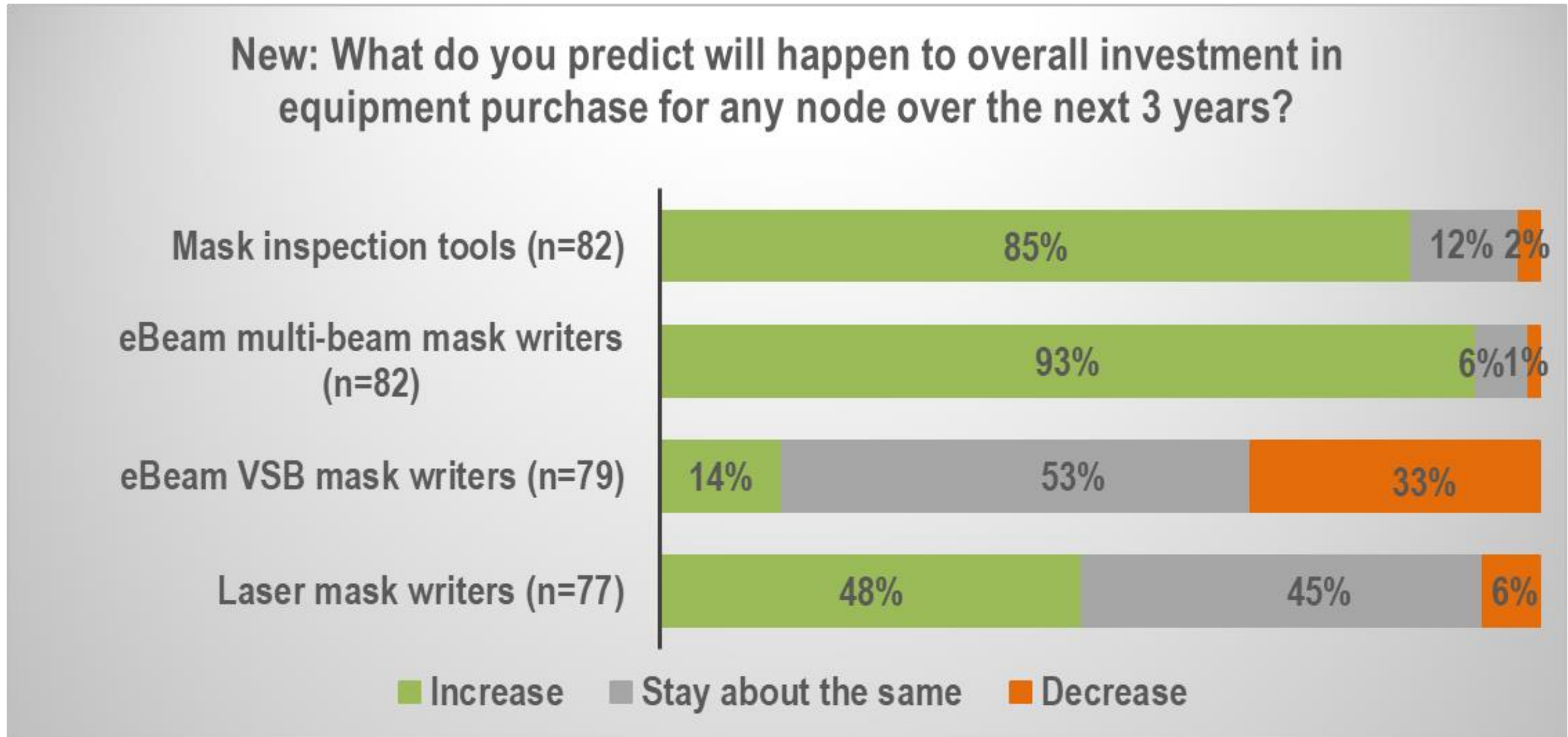
“Today”



“In 7 Years”



Mask Inspection, Multi-beam and Laser Mask Writers: Positive Outlook for Purchasing New Equipment for Any Node*



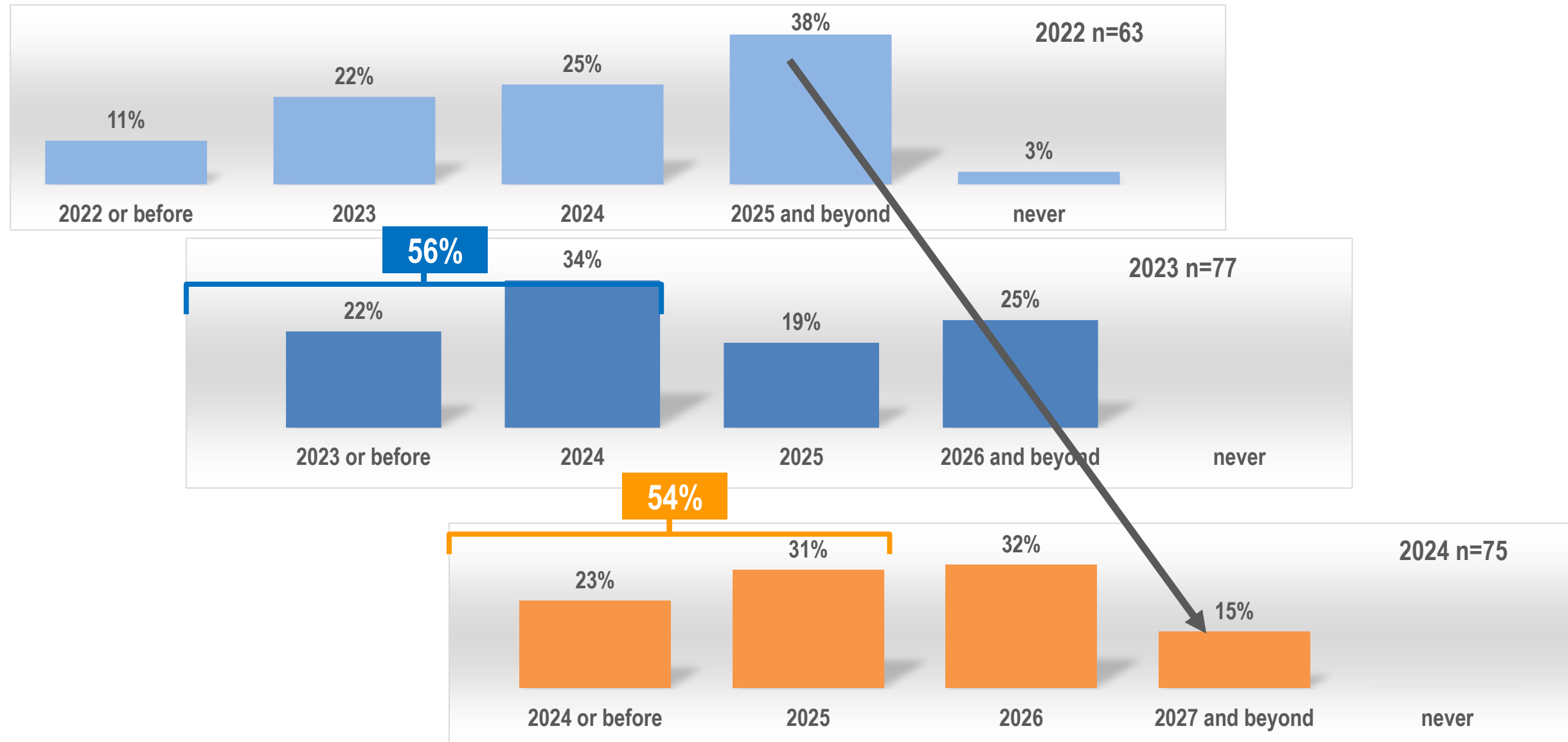
* Note: Question was changed from last year which asked about 193i only purchases

Predictions of Deep Learning Adoption Slip A Year

However, “three years from now” trend has decreased from 38% to 15%

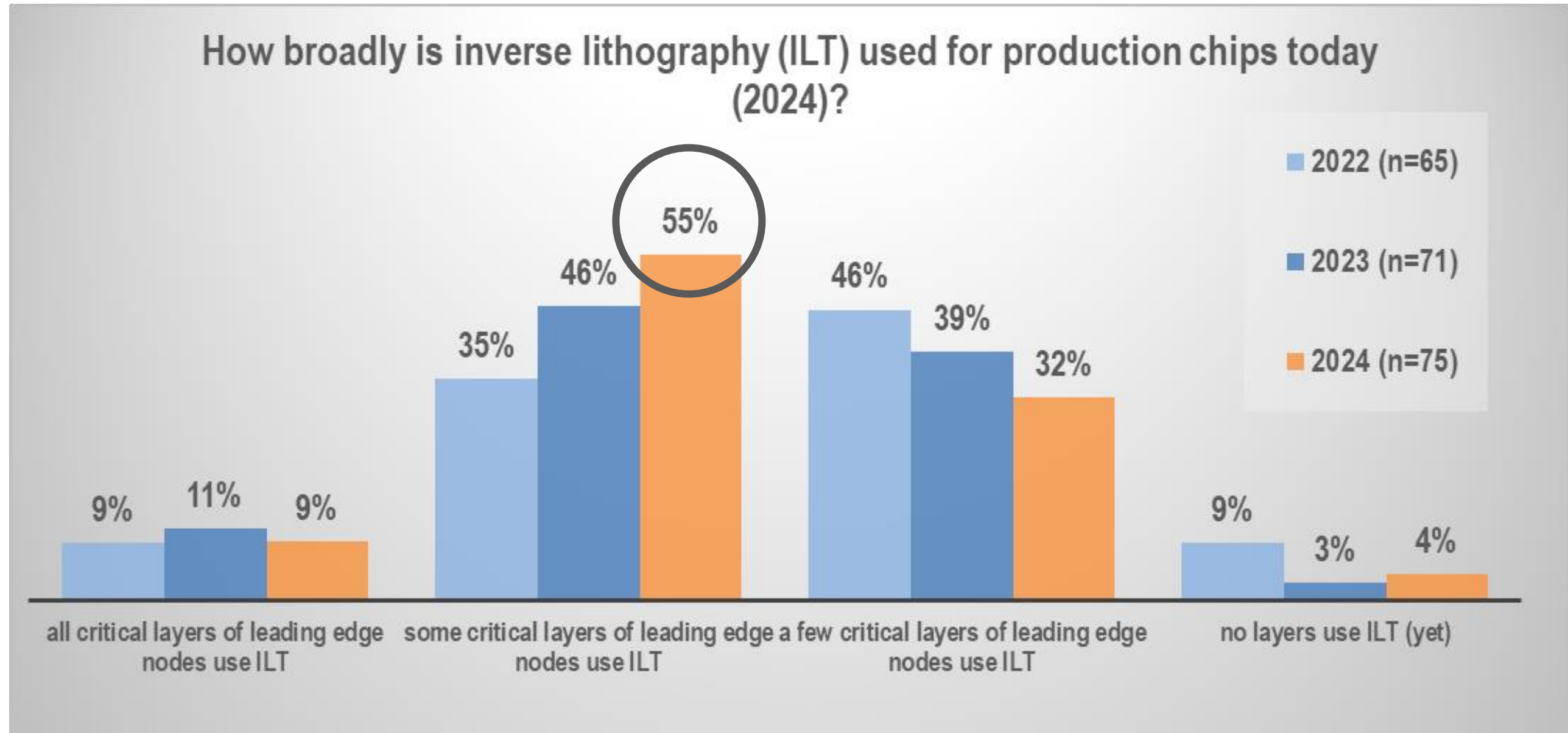


In the mask industry, when will capabilities based on deep learning become a competitive advantage for any step in the mask making process?



Survey Results Point to More Critical Layers Using ILT

55% say “some critical layers” in 2024 vs 46% in 2023



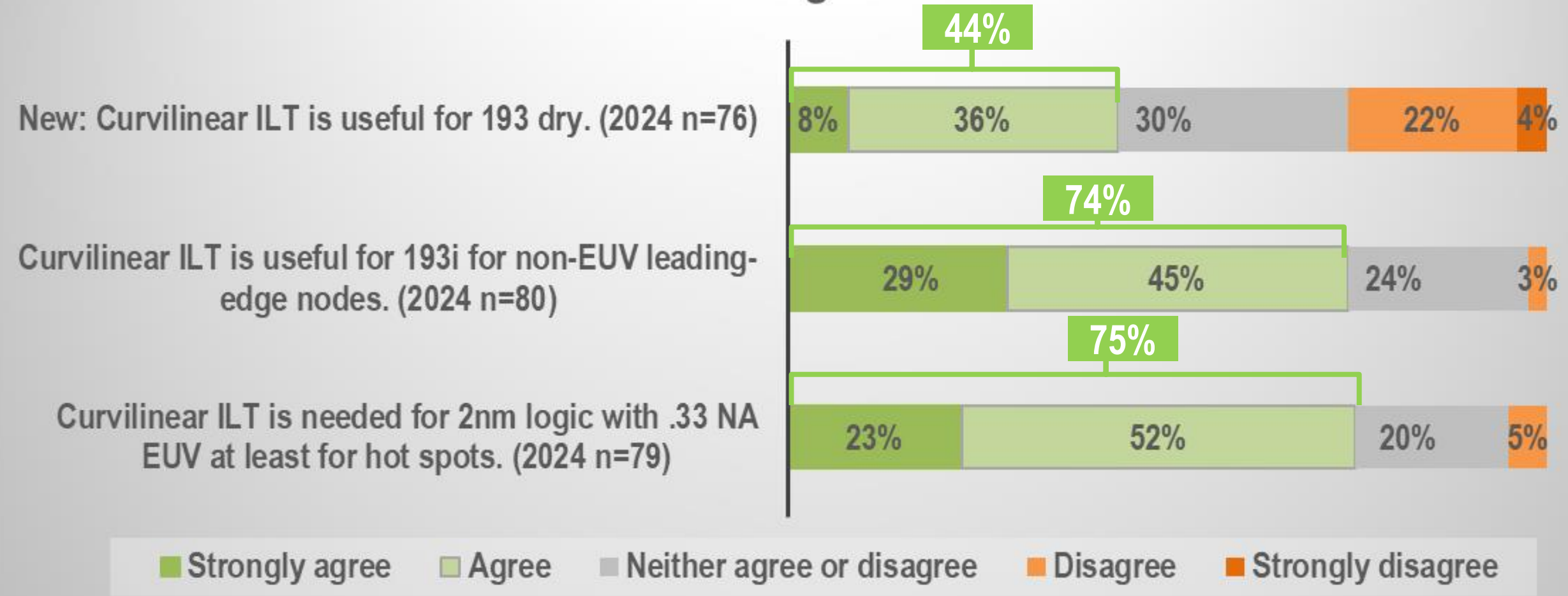
Note: Repeat question since 2017 but only showing most recent 3 years in this chart

New Question: 44% Agree Curvilinear ILT Useful for 193 Dry

74% “agree” useful for 193i, “strongly agree” up 5% to 29%; EUV is similar to 2023



Please indicate your level of agreement or disagreement with the following statements:



Mask Shop Software Infrastructure Top Curvilinear Concern



Difference in opinions on mask inspection, access to MBMW, mask repair

Please rank your biggest concerns in producing masks with curvilinear* shapes. n≥73

#1: Mask shop software infrastructure



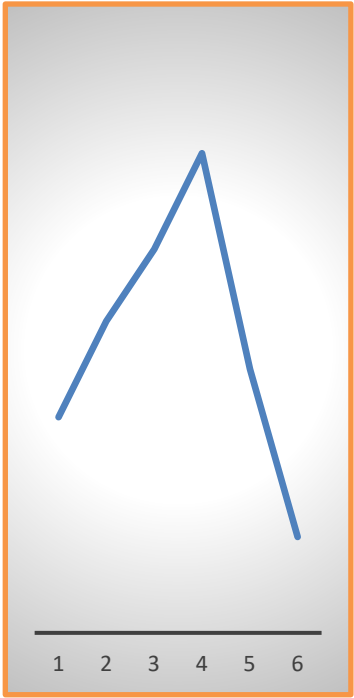
N/A=10%

#2: Mask Inspection



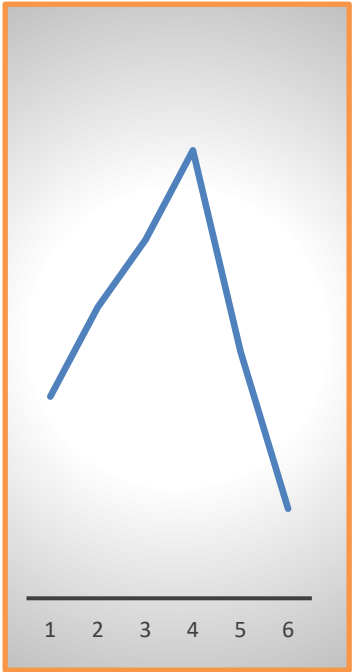
N/A=10%

#3: ILT software



N/A=13%

#4: Mask Metrology



N/A=10%

#5: Access to Multi-beam Mask Writers



N/A=13%

#6: Mask Repair



N/A=11%

Note: 1-6 on X-axis indicate # of respondents that ranked that question as that ordinal number with 1 = highest; height of chart = weighted avg

* The survey question included "Curvilinear shapes can be piecewise linear polygons of some resolution, Bezier, B-spline or other curved-edge descriptions, but excludes shapes that only contain Manhattan or 45-degree straight edges."

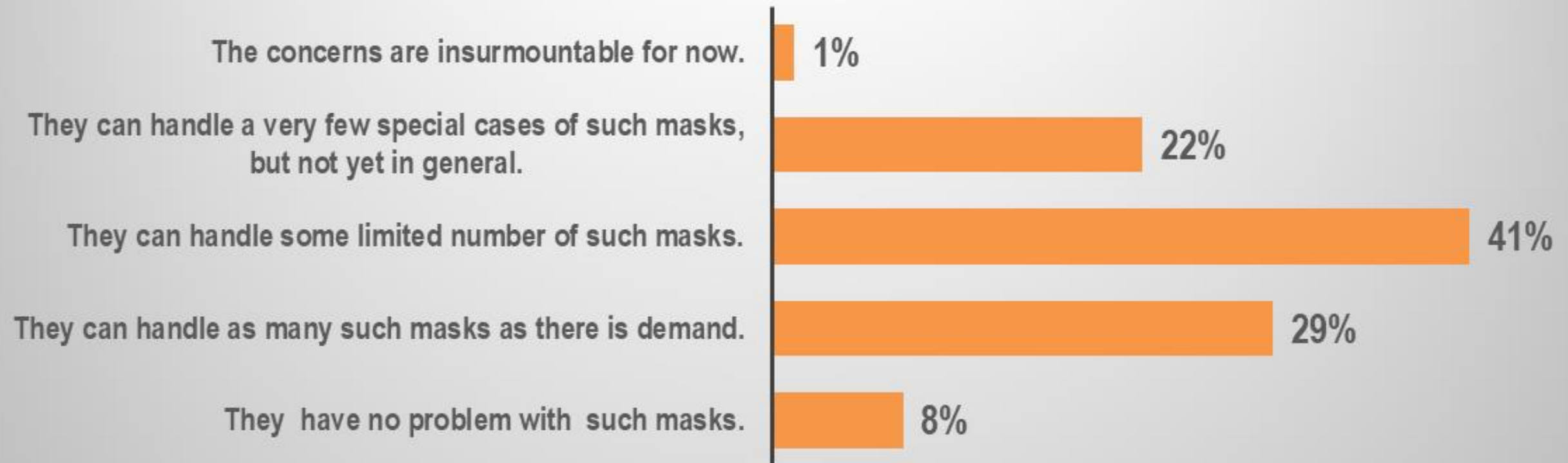
78% Say Mask Shops Can Handle Curvilinear Masks by 2025

Versus 87% who said that last year for the end of 2023



Are the concerns in HVM of masks containing curvilinear features insurmountable for the leading-edge mask shops by end of 2025? Please select the statement you agree with most about the curvilinear capability of leading-edge mask shops by the end of 2025

■ 2024 (n=79)



78%

eBeam Initiative Luminaries Predict 2024 Mask Market Growth

13th Annual Luminaries Survey - July 2024



- 100% of Luminaries say **2024 mask revenues will increase (74%) or stay the same (26%) over 2023** revenues of \$5.4B reported by SEMI.
- **Positive outlook for purchasing new equipment** in the next 3 years with increases predicted for multi-beam mask writers (93%), mask inspection (85%) and laser mask writers (48%).
- Confidence increased that **fabs without EUV can reach 5nm in next 7 years** with 19% who say that this year compared to 12% last year.
- 81% of Luminaries surveyed think that stitching for high-NA EUV masks will require **designers to be aware of the stitching boundaries during design.**

**Thank you to those who participated
in the survey!**

Luminaries survey results available on www.ebeam.org