

# The Optics of XR for Productivity

Lessons we learned from Spacetop™  
Early Access

# Agenda

# What users want of AR displays

- Large FoV
- Coole design
- High resolution
- High sharpness
- Low weight
- Outside-in transparency
- No heating of skull
- Low cost
- ... but you already know al this

***What are the specific requirements for productivity?***

Background

# Meet Spacetop

The World's First AR Laptop



A 100-inch laptop that fits in your backpack



# The Future of PC

- Proper laptop replacement
- Multi-monitor workspace  
...wherever you are
- Fully private
- Same size, weight, price as laptop



... Wherever you are.



## Market | Press Coverage

*"Sometimes one computer monitor isn't enough. Why not put on a headset and see all your open windows in your line of sight? Last week, I tried out the **Spacetop** ... I was totally skeptical, but it was pretty awesome to try out."*

Joanna Stern | **THE WALL STREET JOURNAL.**

*"Even if **Apple** manages to build one of the most sophisticated mixed reality headsets on the market, it's still unclear what the mainstream pitch for such a device would be ... One possibility came to mind a few weeks ago when **Sightful** unveiled its augmented reality laptop, **Spacetop**."*

Devindra Hardawar | **engadget** 

*"We were pleasantly surprised to find it easy to use ... **Spacetop** operates exactly like any other PC"*

Michael Kan | **PCMAG.COM**

*"A new augmented reality laptop creates a virtual screen of 100 inches ... It's giving major Tony Stark vibes."*

Alex Mitchell | **NEW YORK POST**

*"Instead of making a bigger physical screen, **Spacetop** creates a virtual screen that can be absolutely massive."*

William Hunter | **Daily Mail** 

*"**Apple** has apparently taken a very general approach to what the Vision Pro can do. Can it watch movies? Sure. Can users use it to work in Office, like the **Spacetop** AR laptop? Yep."*

Mark Hachman | **PCWorld**

*"It can double as a huge monitor for your Mac: As we've seen with similar concepts like the **Sightful Spacetop**, one of the big benefits of AR headsets is that they can give you a massive virtual monitor (or several of them)..."*

Mark Wilson | **techradar.**

# Our Data

# Studying Spacetop users

- **UXR labs in Tel Aviv, Palo Alto, New York**
  - >400 subjects over 3½ years
- **Usage metrics**
  - Hundreds of Spacetops delivered
  - Consumer / prosumer / F500 users
- **User interviews**

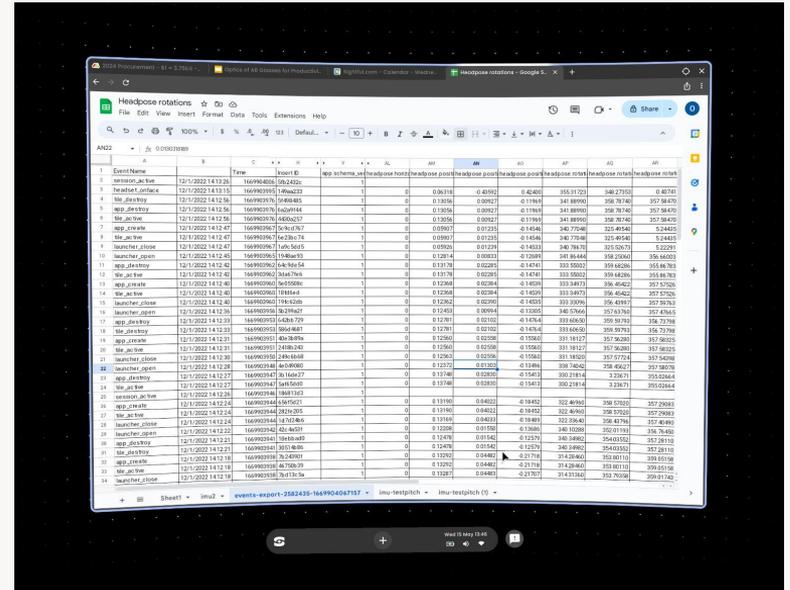
# Actual usage of Spacetop

- 8-10 hours/day total use
- >2hr in one sitting
- Project managers, marketing managers, executives
  - Web browsing (data gathering & SaaS)
  - Office apps - word processing, presentations, spreadsheets (!)
  - Video calls
- Most users in 35-45, 45-55 age groups

# Observations and Conclusions

# What's typically displayed on Spacetop

- Apps designed for desktop
- White background
- Text and borders, video



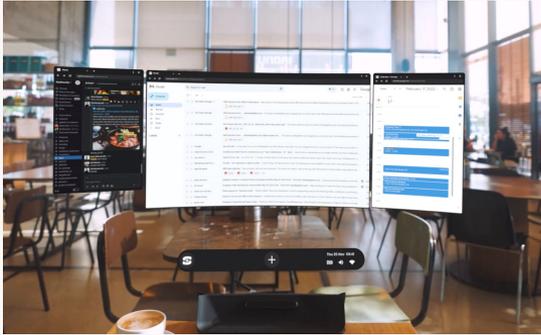
The screenshot shows a Spacetop window titled "Headbase rotations" with a white background. The window contains a table with 14 columns (A-M) and 14 rows of data. The table lists various events and their corresponding rotation values for different axes.

	A	B	C	D	E	F	G	H	I	J	K	L	M
1	Event Name	Time	Event ID	app instance	headbase hontz	headbase postz	headbase postx	headbase posty	headbase postz	headbase postx	headbase posty	headbase rontz	headbase rontz
2	season_pc_btn	12/1/2022 14:12:26	166992405_1264225		0	0	0.06181	-0.40950	-0.40240	355.51700	340.27500	0.87343	
3	headset_contact	12/1/2022 14:12:26	166992405_1264225		0	0	0.19356	0.09027	-0.11963	341.88900	358.78740	357.58470	
4	imu_data_try	12/1/2022 14:12:26	166992405_1264225		0	0	0.19356	0.09027	-0.11963	341.88900	358.78740	357.58470	
5	app_data_try	12/1/2022 14:12:26	166992405_1264225		0	0	0.19356	0.09027	-0.11963	341.88900	358.78740	357.58470	
6	imu_pc_try	12/1/2022 14:12:26	166992405_1264225		0	0	0.19356	0.09027	-0.11963	341.88900	358.78740	357.58470	
7	app_data_try	12/1/2022 14:12:27	166992405_1264225		0	0	0.09507	-0.01255	-0.14568	340.77400	351.49540	0.53451	
8	imu_pc_try	12/1/2022 14:12:27	166992405_1264225		0	0	0.09507	-0.01255	-0.14568	340.77400	351.49540	0.53451	
9	headset_close	12/1/2022 14:12:47	166992405_1264225		0	0	0.09507	-0.01255	-0.14568	340.77400	351.49540	0.53451	
10	headset_close	12/1/2022 14:12:48	166992405_1264225		0	0	0.12418	0.00000	-0.03000	341.84840	358.62000	358.62000	
11	app_data_try	12/1/2022 14:12:48	166992405_1264225		0	0	0.13170	0.02285	-0.14741	333.55300	339.46300	352.86700	
12	imu_pc_try	12/1/2022 14:12:48	166992405_1264225		0	0	0.13170	0.02285	-0.14741	333.55300	339.46300	352.86700	
13	app_data_try	12/1/2022 14:12:48	166992405_1264225		0	0	0.12368	0.02044	-0.14070	333.34910	338.46422	351.57620	
14	imu_pc_try	12/1/2022 14:12:48	166992405_1264225		0	0	0.12368	0.02044	-0.14070	333.34910	338.46422	351.57620	
15	headset_close	12/1/2022 14:12:48	166992405_1264225		0	0	0.12368	0.02044	-0.14070	333.34910	338.46422	351.57620	
16	headset_close	12/1/2022 14:12:48	166992405_1264225		0	0	0.12368	0.02044	-0.14070	333.34910	338.46422	351.57620	
17	imu_data_try	12/1/2022 14:12:36	166992405_1264225		0	0	0.12403	0.00994	-0.13305	340.57660	352.63700	352.47615	
18	app_data_try	12/1/2022 14:12:36	166992405_1264225		0	0	0.12403	0.00994	-0.13305	340.57660	352.63700	352.47615	
19	imu_data_try	12/1/2022 14:12:33	166992405_1264225		0	0	0.12701	0.01702	-0.14574	331.60000	339.39310	358.77910	
20	imu_data_try	12/1/2022 14:12:33	166992405_1264225		0	0	0.12701	0.01702	-0.14574	331.60000	339.39310	358.77910	
21	app_data_try	12/1/2022 14:12:31	166992405_1264225		0	0	0.12860	0.02000	-0.15060	331.18127	337.76200	351.58105	
22	imu_pc_try	12/1/2022 14:12:31	166992405_1264225		0	0	0.12860	0.02000	-0.15060	331.18127	337.76200	351.58105	
23	headset_close	12/1/2022 14:12:31	166992405_1264225		0	0	0.12860	0.02000	-0.15060	331.18127	337.76200	351.58105	
24	headset_close	12/1/2022 14:12:31	166992405_1264225		0	0	0.12860	0.02000	-0.15060	331.18127	337.76200	351.58105	
25	imu_data_try	12/1/2022 14:12:27	166992405_1264225		0	0	0.13746	0.03370	-0.15401	332.29114	336.23671	350.52644	
26	imu_pc_try	12/1/2022 14:12:27	166992405_1264225		0	0	0.13746	0.03370	-0.15401	332.29114	336.23671	350.52644	
27	season_pc_btn	12/1/2022 14:12:26	166992405_1264225		0	0	0.13746	0.03370	-0.15401	332.29114	336.23671	350.52644	
28	imu_data_try	12/1/2022 14:12:24	166992405_1264225		0	0	0.13190	0.04002	-0.14842	332.40900	338.57000	352.70000	
29	imu_pc_try	12/1/2022 14:12:24	166992405_1264225		0	0	0.13190	0.04002	-0.14842	332.40900	338.57000	352.70000	
30	headset_close	12/1/2022 14:12:23	166992405_1264225		0	0	0.13190	0.04002	-0.14842	332.40900	338.57000	352.70000	
31	headset_close	12/1/2022 14:12:23	166992405_1264225		0	0	0.13190	0.04002	-0.14842	332.40900	338.57000	352.70000	
32	imu_data_try	12/1/2022 14:12:21	166992405_1264225		0	0	0.12478	0.01540	-0.14270	340.38800	354.03300	352.28100	
33	imu_data_try	12/1/2022 14:12:21	166992405_1264225		0	0	0.12478	0.01540	-0.14270	340.38800	354.03300	352.28100	
34	app_data_try	12/1/2022 14:12:18	166992405_1264225		0	0	0.13702	0.04440	-0.15710	314.24600	333.00110	359.35100	
35	imu_data_try	12/1/2022 14:12:18	166992405_1264225		0	0	0.13702	0.04440	-0.15710	314.24600	333.00110	359.35100	
36	imu_pc_try	12/1/2022 14:12:18	166992405_1264225		0	0	0.13702	0.04440	-0.15710	314.24600	333.00110	359.35100	
37	headset_close	12/1/2022 14:12:18	166992405_1264225		0	0	0.13702	0.04440	-0.15710	314.24600	333.00110	359.35100	



# How Spacetop is typically viewed

- Transitions between physical and virtual
- Focus transitions to near objects (desk, keyboard, smartphone)



# Specific display requirements for Spacetop

- **>45° degrees HFOV**  
Whole width of an app
- **Black-on-white content**  
Good white uniformity, good CTF
- **PPD >40**  
Good text readability, no aliasing/moiré

# Specific optics requirements for Spacectop

- Low variance in depth of field

AID  $> -0.65\text{D}$  to ensure comfort of presbyopians

AID  $< -0.4\text{D}$  to avoid focus at infinity and beyond

*Challenges:*

Minimizing the manufacturing tolerance

Metrology in center + edges of eyebox

AID bounds apply to entire IPD range

- Rx correction for virtual and physical

Large VFOV of inserts

Support reading segment or progressive lens

# Summary

(how to ensure your optics fit the use-case)

# The challenge

- Optical architecture
  - Capable of large FOV
  - White uniformity (challenge with waveguide displays)
- Optical specifications
  - High FOV + high PPD challenge
- System design specifications
  - Large passthrough FOV
  - Wide real-world FOV for Rx solution
- Manufacturing challenge
  - Low AID tolerance
  - Metrology at all edges of the eyebox
- **Overall high quality (CTF/MTF, brightness, comfort/weight/heat)**

Q&A

Have a **Sightful** day.

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