External Monitors

M1 Mac Triple Monitor Setup

plugable

PMUG General Meeting February, 2024

External Displays

- Why

- Computer

- Monitor

- Cable

- Connector

- Setting up

- Use

Why Add External Display

- Provide additional and larger screen on which to view things

- Example: Video editing - Video on one screen, commands on the second

- Example: Creating web sites - view the web page on one screen while editing objects on the second to insert into web page

- Gaming

- Using Windows 11 under VM on one screen and MacOS on second screen

- Comparing products, files, images, etc.

- Magazine editing using vertical (page layout) & horizontal (inputs) display

Computer Requirements

- Adding a second screen requires more RAM for the windows and Apps that will run there

- If running a second OS, add in the RAM for the 2nd OS (min 8GB per OS, 16GB per OS better)

- Graphic card/SoC powerful enough to run external monitor(s)

- All Apple M series based computers support at at least one external monitor

- Number of monitors and resolution of monitors dependent on CPU & GPU

- Port for connecting a cable to second monitor

Computer Requirements

- Intel based MacBook Air 2015 or later can support at least one external monitor

- Intel based MacBook Pro 2015 or later can support at least one external monitors, and many of them 2 or more

- Intel based iMac 2015 or later can support at least one external monitor

- Resolution of external monitor support jumps from 4k on Intel based computers to 6k and 8k on new M series computers

- Refresh rate of monitors goes from 60Hz on Intel Macs to 240Hz on new M series Macs

Computer Requirements - MBP M3

Up to two external displays with up to 6K resolution at 60Hz over Thunderbolt, or one external display with up to 6K resolution at 60Hz over Thunderbolt and one external display with up to 4K resolution at 144Hz over HDMI; One external display supported at 8K resolution at 60Hz or one external display at 4K resolution at 240Hz over HDMI (M3 Pro); Up to four external displays: Up to three external displays with 6K resolution at 60Hz over Thunderbolt and one external display with up to 4K resolution at 144Hz over HDMI, Up to three external displays: Up to two external displays with 6K resolution at 60Hz over Thunderbolt and one external display with up to 8K resolution at 60Hz or one external display with 4K resolution at 240Hz over HDMI (M3 Max)
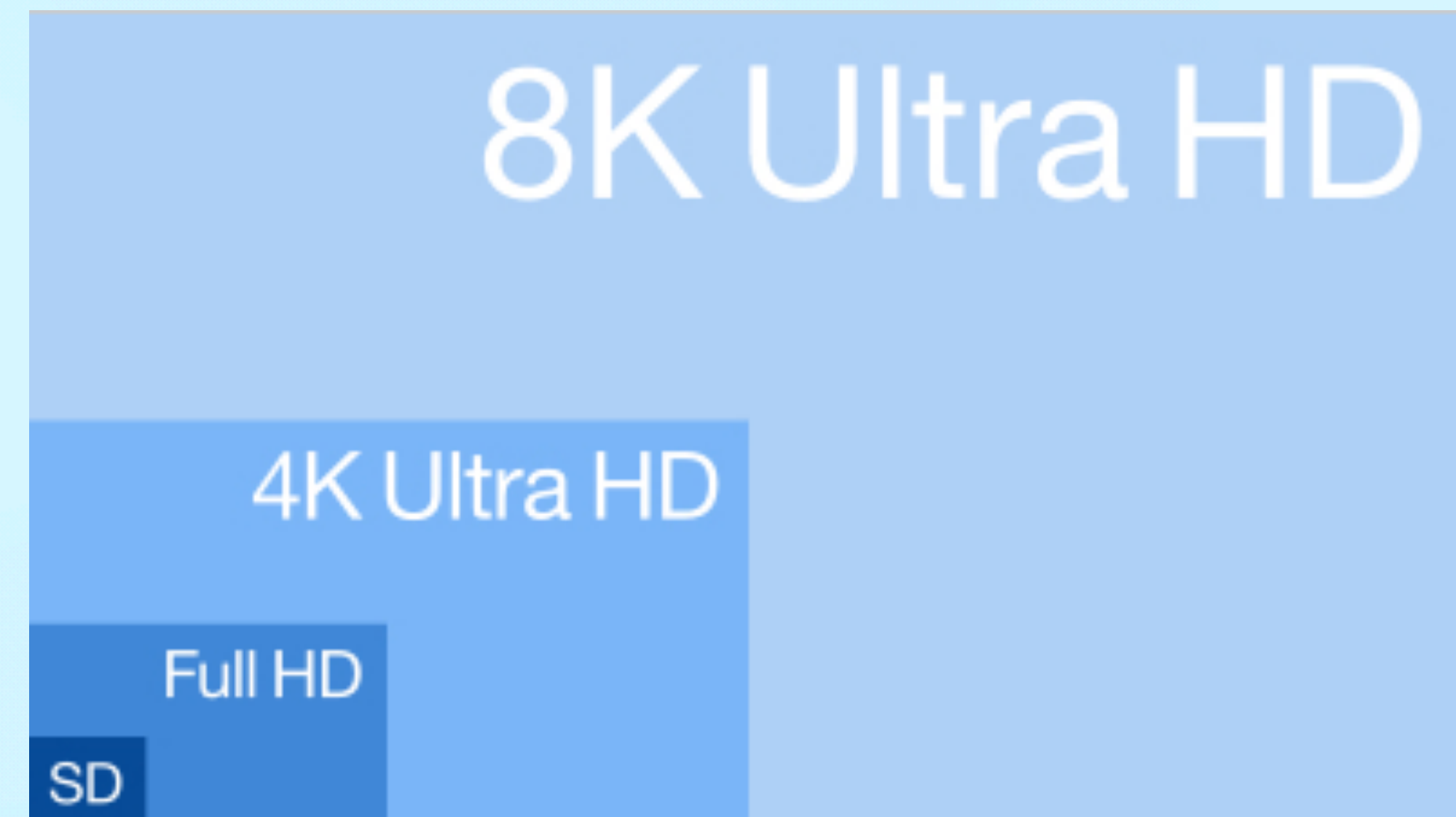
Monitor Issues

- First, EVERY manufacturer produces TV's and/or monitors with varying resolutions

- There are MANY different standards

- Created by MANY different organizations

  - Horizontal x Vertical pixels

  - Interlaced (i) vs Progressive (P)

  - Aspect ratio (4:3, 1.9:1, 16:9, 16:10, 1:1, 21:9, etc)

8K Ultra HD

4K Ultra HD

Full HD

SD
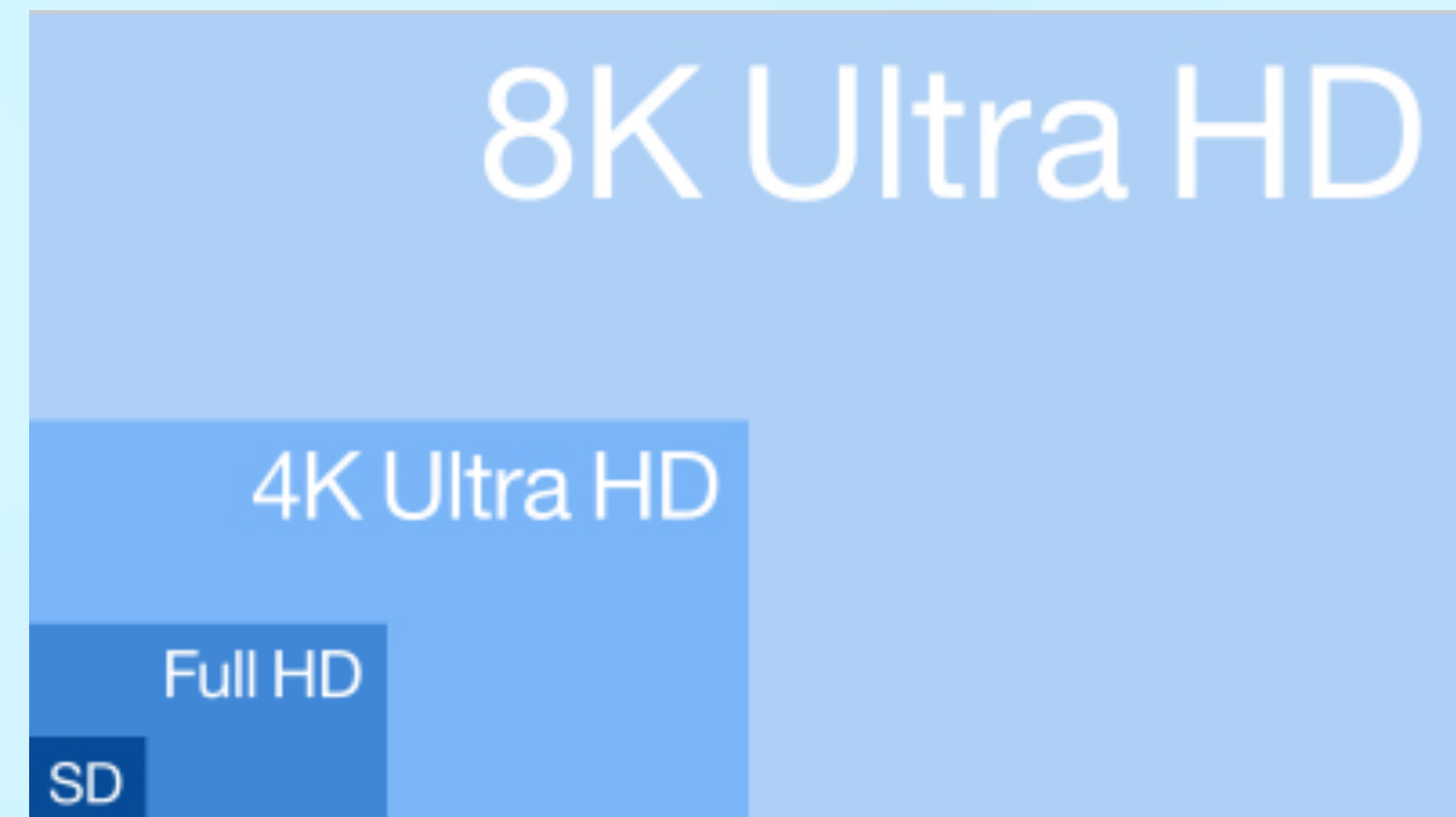
Note: the terms used to describe the resolution changed from vertical lines (720, 1080) to horizontal pixels (2k, 4k, 5k, 8k)

Monitor Issues

- SD - 480p is 640 x 480 or 576p is 768 x 576

- HD - 720p is 1280 x 720, 1080i or 1080p is 1920 x 1080

- Quad HD (4*720) 1440p is 2560 x 1440

- 4K Ultra HDTV-1 2160p is 3840 x 2160

- 5K 2880p is 5120 x 2880

- 8K Ultra HDTV-2 4320p is 7680 x 4320

- ALL resolutions above are subject to change!

Note: the terms used to describe the resolution changed from vertical (720, 1080) to horizontal (4k, 5k, 8k)

Monitor Issues

8K Ultra HD

4K Ultra HD

Full HD

SD

4K sizes

Resolution	Aspect ratio	Pixels
4096 × 3072	$1.\overline{33}$:1 (4:3)	12,582,912
4096 × 2560	1.60:1 (16:10)	10,485,760
4096 × 2304	$1.\overline{77}$:1 (16:9)	9,437,184
4096 × 2160	≈1.90:1 (256:135)	8,847,360
4096 × 1716	≈2.39:1 (1024:429)	7,020,544
3996 × 2160	1.85:1 (37:20)	8,631,360
3840 × 2400	1.60:1 (16:10)	9,216,000
3840 × 2160	$1.\overline{77}$:1 (16:9)	8,294,400
3840 × 1600	2.40:1 (12:5)	6,144,000
3840 × 1080	$3.\overline{55}$:1 (32:9)	4,147,200
2160 × 3840	9:16	8,294,400

UW sizes

common name	aspect ratio	resolution
WFHD	64:27	2560×1080
WFHD+	12:5	2880×1200
WQHD	43:18	3440×1440
WQHD+	12:5	3840×1600
UW4K	12:5	4320×1800
UW5K (WUHD)	64:27	5120×2160
UW5K+	12:5	5760×2400
UW6K	43:18	6880×2880
UW7K	12:5	7680×3200
UW8K	12:5	8640×3600
UW10K	64:27	10240×4320

8K sizes

Resolution	Aspect ratio		Total pixels
7680 × 2160	$3.\overline{5}$	32:9	16.59 Mpx
7680 × 2400	3.2	16:5	18.43 Mpx
7680 × 3200	2.4	12:5	24.58 Mpx
7680 × 3240	$2.\overline{370}$	64:27	24.88 Mpx
7680 × 4320	$1.\overline{7}$	16:9	33.18 Mpx
8192 × 4320	$1.8\overline{962}$	256:135	35.39 Mpx
8192 × 4608	$1.\overline{7}$	16:9	37.75 Mpx
8192 × 5120	1.6	8:5	41.94 Mpx
8192 × 8192	1	1:1	67.11 Mpx

Monitor Issues

- Physical Size - up to 49" for 5k Computer Monitor or 8K TV's up to 85"

- What is the refresh rate of the monitor (60hz - 240hz)

- Aspect ratio - 4:3, 16:9, 21:9, 31:9 et al.

- What Ports does it support (VGA, DVI, Display Port, HDMI, Thunderbolt 1 or 2 (Mini Display port) or Thunderbolt 3, 4, or 5

- How many Ports does it have

- What is the brightness of the monitor (200-500 nits) (LCD<LED<OLED)

- Curved or flat design, horizontal or vertical

Connecting via Cable

- Cable ends most important since the each interface supports different speeds of transfer which controls the resolution of the monitor and refresh rates

- Different cables allow for different data throughput

- One way or symmetrical flow

- Thunderbolt 3 vs 4 vs 5 requires different cabling (internal wiring, but still "looks" the same) to support the transfer speeds

- Length of cable is an issue - longer the cable, the poorer the signal quality

- Gold plated contacts better than others

Ports

- VGA (Video Graphics Array)

  - XVGA, Super VGA - IBM developed,

  - PC industry standard

  - Developed for Analog monitors

- DVI (Digital Visual Interface)

  - Industry developed in 1999

  - Support both analog & digital displays (with the correct cable)

  - Maxed out at 2560x1600

Ports

- HDMI (High Definition Multimedia Interface)

  - 2003 release, included audio channel, grew from 1k support to 4K support

  - Now 8K support using upgraded cable bandwidth - max speed 48Gb/s for 2.1 spec

- Thunderbolt

  - 2015 release for Mac

  - Moved to PC's, Monitors & TVs, max speed now 120Gb/s for T5 spec

  - Thunderbolt delivers both DATA & POWER - HDMI is data ONLY

Connectors/Dongles

- DisplayPort

  - VESA standard in 2006,

  - More common as computer monitor connector, includes Audio channel

- Thunderbolt 1&2

  - Implemented in 2011, AKA Mini DisplayPort - 20 pin connector

- USB-C

  - Implement in 2015, supports Thunderbolt 3, Display Port and HDMI

Connectors/Dongles

- Thunderbolt 3

  - Implemented in 2015

  - Superset of USB-C, 2x faster than USB-C

- Thunderbolt 4

  - Implemented in 2020, support for dual 4K displays

- Thunderbolt 5

  - Implemented in 2023, support for dual 8K displays, 2x faster than Thunderbolt 4

Connectors/Ports

VGA

DVI

Thunder-bolt 1&2

Thunder-bolt 3-5

Display Port

USB-C

Pay attention to the "lightning" icon!!!

USB-C 'looks like' Thunderbolt

Dongles, Cables, Hubs

USB-C
VGA

TB2 to
TB3

USB-C
HDMI

DVI to HDMI

Display Port
to VGA

Display Port
to HDMI

Setting Up

- Confirm your computer supports a second monitor

- Verify output port for video on your machine

- Get the right cable for your video output

- Get a monitor with the same port your computer has

- Go to System Settings>Displays>Monitor Name, then click on the desired resolution and whether it will be your main display or mirror your first display

- Arrange the displays so they match the physical layout of your monitors
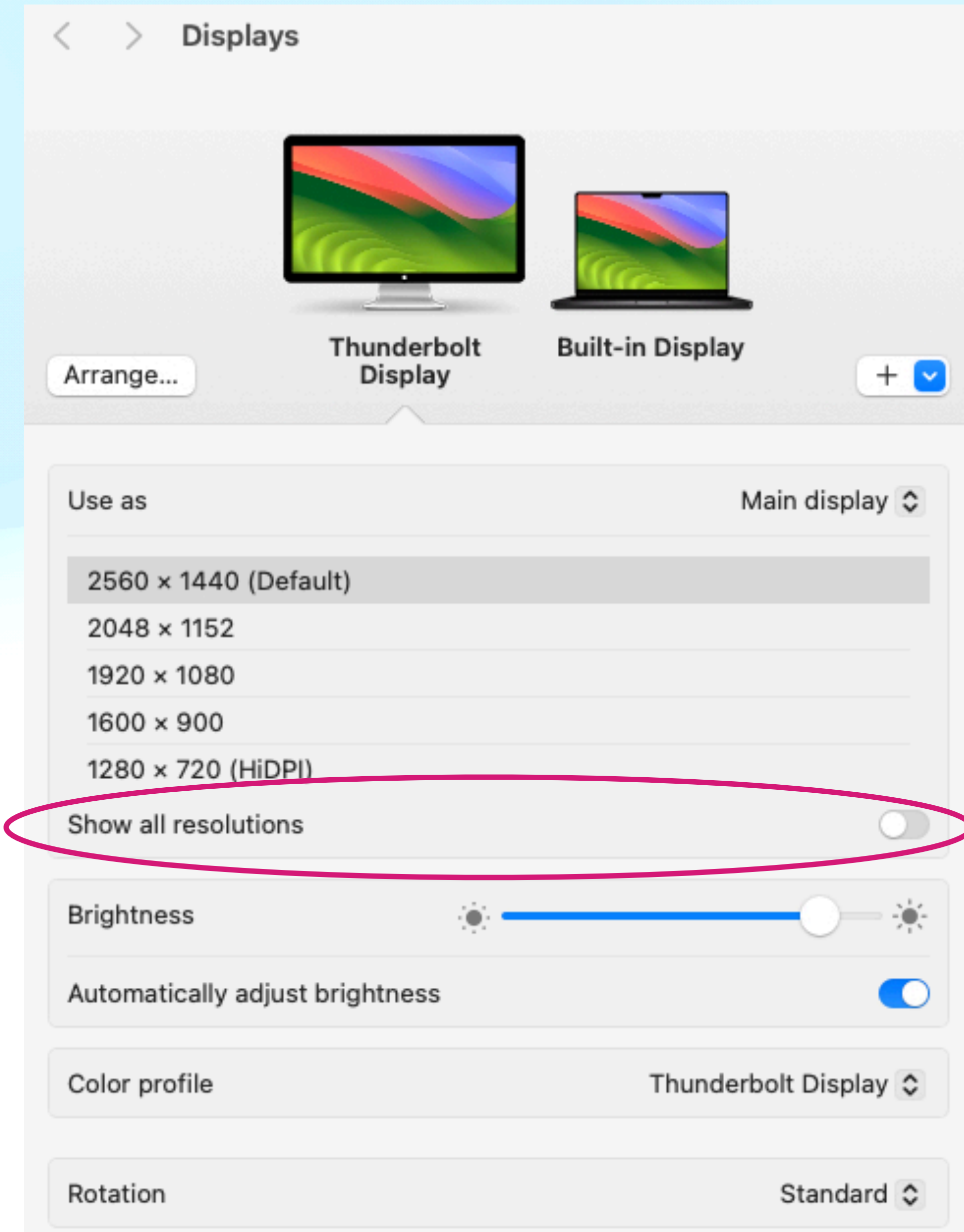
Apple Studio Display

27-inch 5K Retina display. 12MP Ultra Wide camera with Center Stage. Studio-quality mics. Six-speaker sound system with Spatial Audio.

Standard glass has an industry-leading anti-reflective coating for viewing comfort and readability.

Display

Choose from two anti-reflective glass options. Standard glass is engineered for extremely low reflectivity. Nano-texture glass scatters light to further minimize glare while delivering outstanding image quality in workspaces with bright light sources.
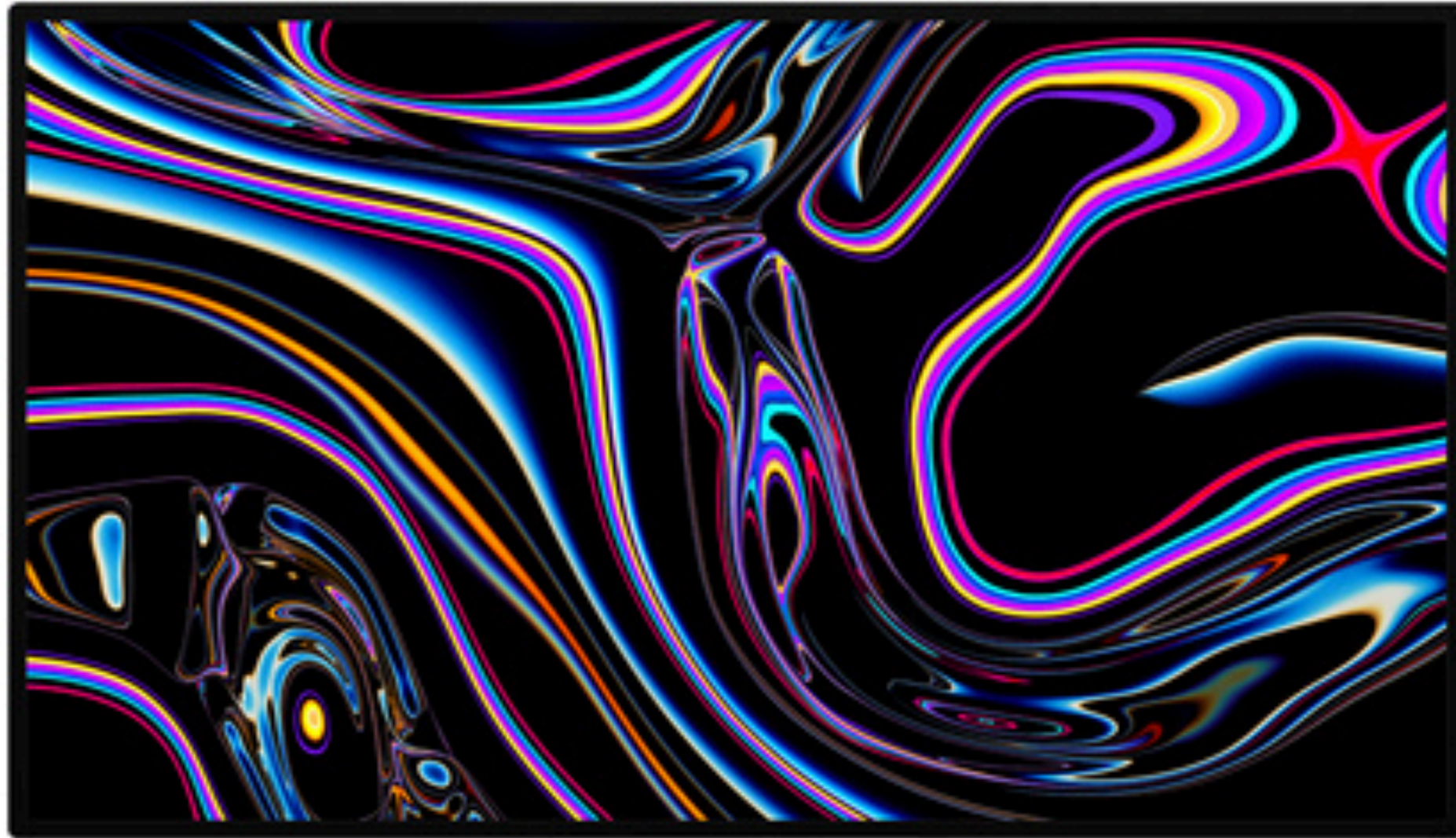
Standard glass
From $1599
or $133.25/mo. for 12 mo.*

Nano-texture glass
From $1899
or $158.25/mo. for 12 mo.*

Apple Pro Display XDR

View gallery

Buy Pro Display XDR

Free shipping. And free returns.

Pro Display XDR

32-inch Retina 6K. Astonishing color accuracy. Superwide viewing angle. And Extreme Dynamic Range.

Display stand sold separately.
Which glass is right for you?

Standard glass	$4,999.00 or $416.58/mo. for 12 mo.*
Nano-texture glass	$5,999.00 or $499.91/mo. for 12 mo.*

MacWorld - Best Mac Monitors

- https://www.macworld.com/article/668700/best-mac-monitors-displays.html
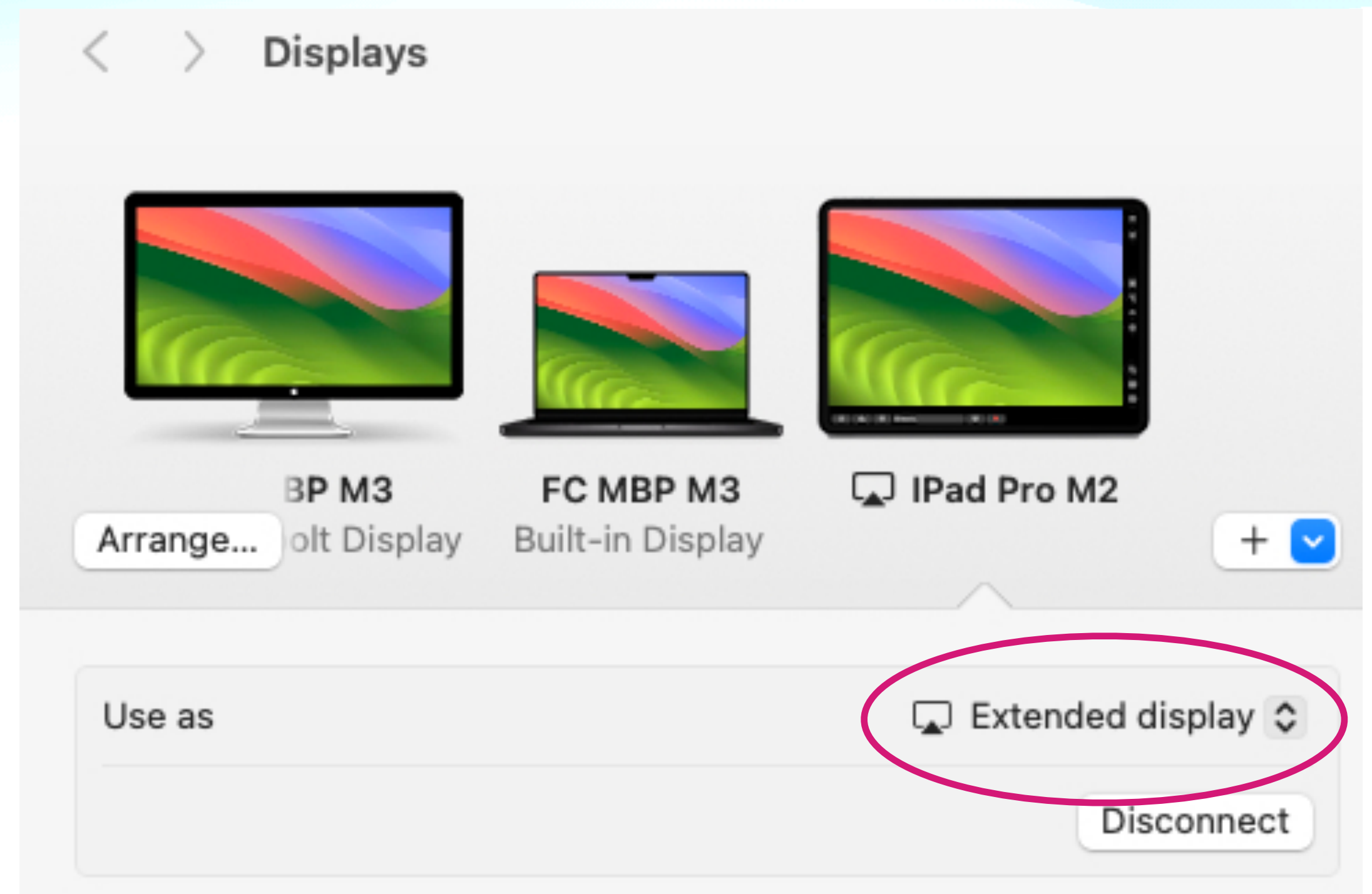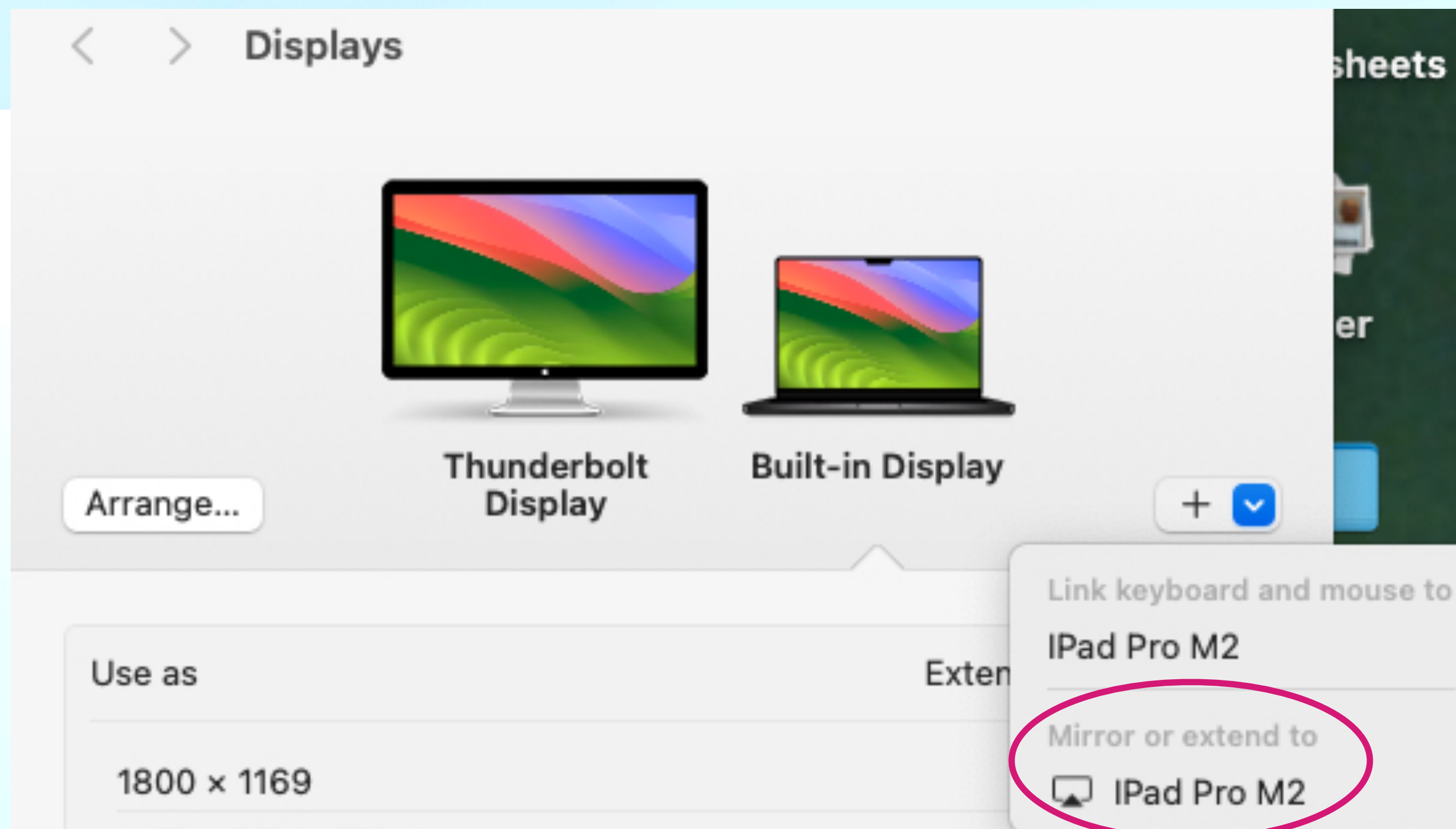
Use iPad as Second Display

- Connect iPad with cable to Mac

- Click on System Settings>Displays>"+">Mirror or extend to "iPad name"

- Click on Arrange to move pictures to reflect physical position of displays

Controlling iPad with the Mac

- Sit your iPad next to your Mac

- Log into the iPad and change Display & Brightness to keep it awake

- Open Control Center on the Mac

- On the Mac, move your cursor over the Display and Click on the small monitor icon

- Click on your iPad's Name under the section "Link keyboard and mouse to.."

- Open Display settings and Arrange iPad & Mac displays

The Future of Monitors??