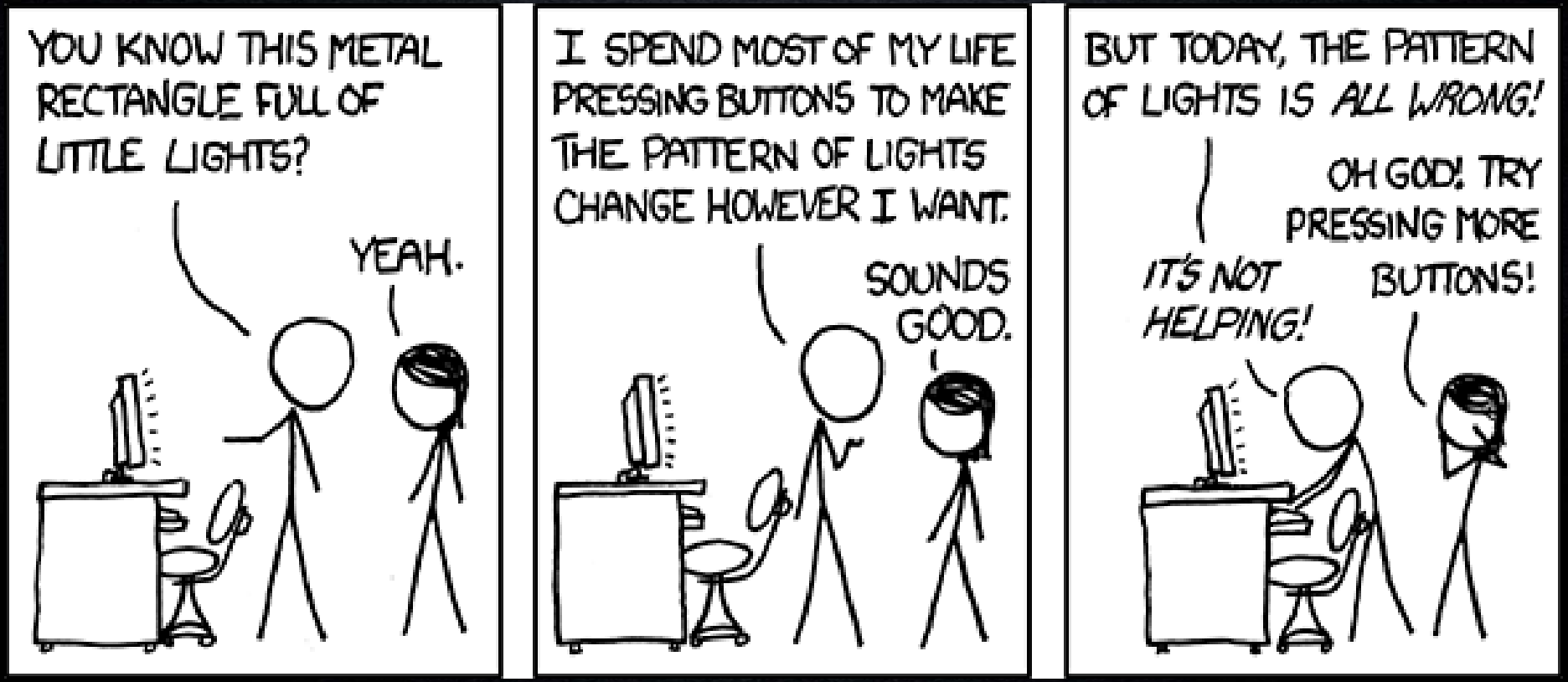
xkcd.com


YOU KNOW THIS METAL RECTANGLE FULL OF LITTLE LIGHTS?
YEAH.
I SPEND MOST OF MY LIFE PRESSING BUTTONS TO MAKE THE PATTERN OF LIGHTS CHANGE HOWEVER I WANT.
SOUNDS GOOD.
BUT TODAY, THE PATTERN OF LIGHTS IS ALL WRONG!
IT'S NOT HELPING!
OH GOD! TRY PRESSING MORE BUTTONS!

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Stimulus Precision using Psychopy

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Appearance

Visual angle
Luminance

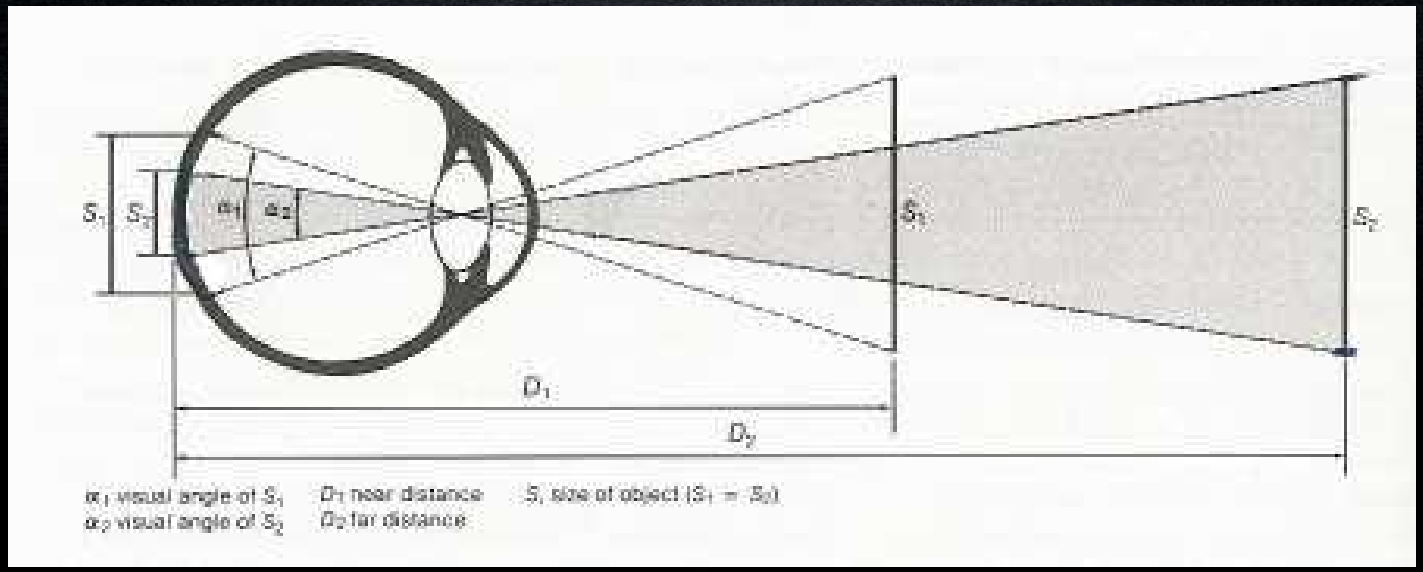
Size and location

- Use cm or visual angle as general unit for size!

```
win = visual.Window(units='deg')
stim = visual.GratingStim(units='degFlat')
```

- Check the actual size and adjust as needed.

```
print ppc.deg2cm(angle=2, distance=60)
Text = visual.TextStim(win, height=2 * 1.6)
```



http://www.psychopy.org/general/units.html

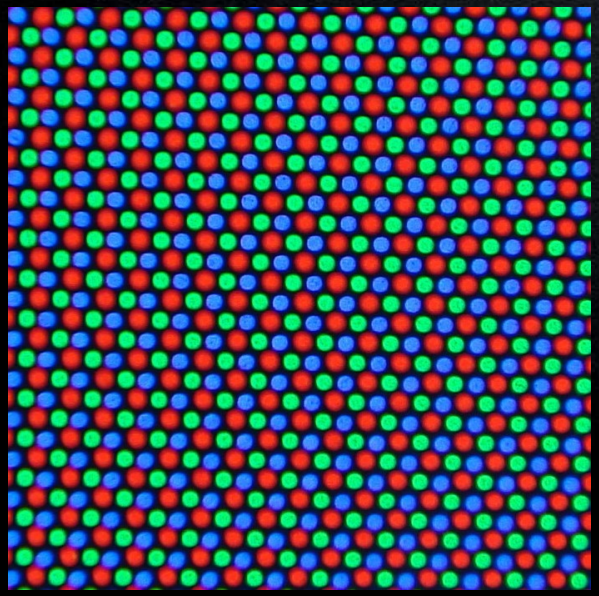
Isoluminant color

- Get isoluminant colors using DKL colorspace.

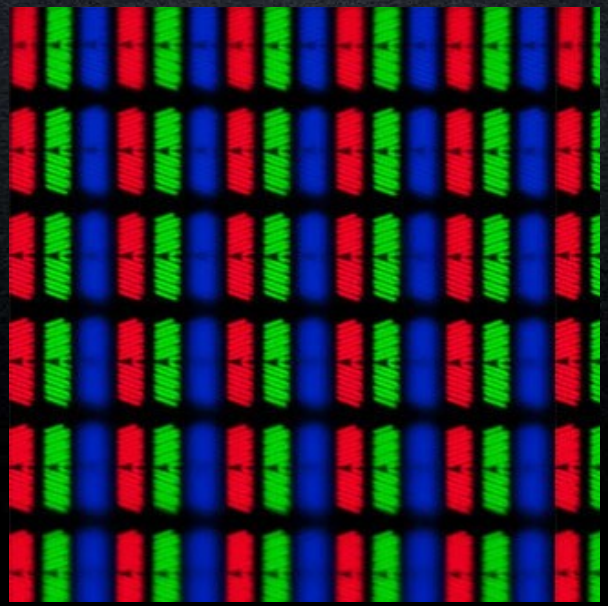
```
visual.ShapeStim(win, colorSpace='dkl',
                 fillColor=[0, 0, 1])
ppc.dkl2rgb([0, 0, 1])
```

- Adjust monitor using photometer.

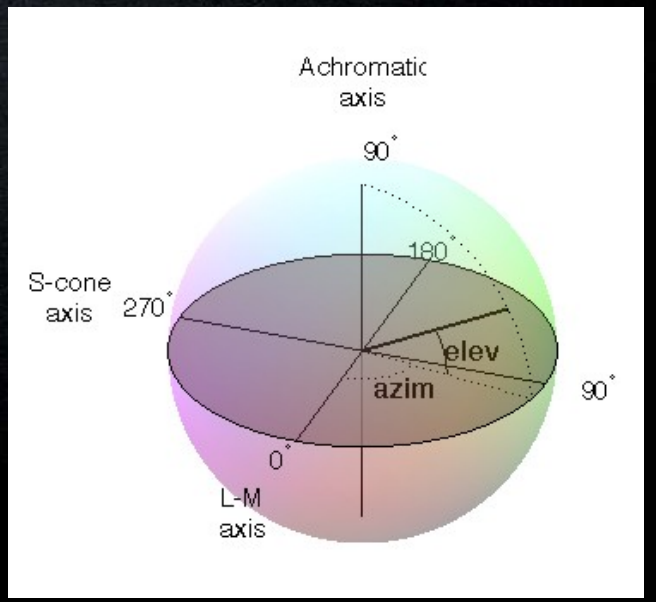
CRT



LCD



DKL colorspace

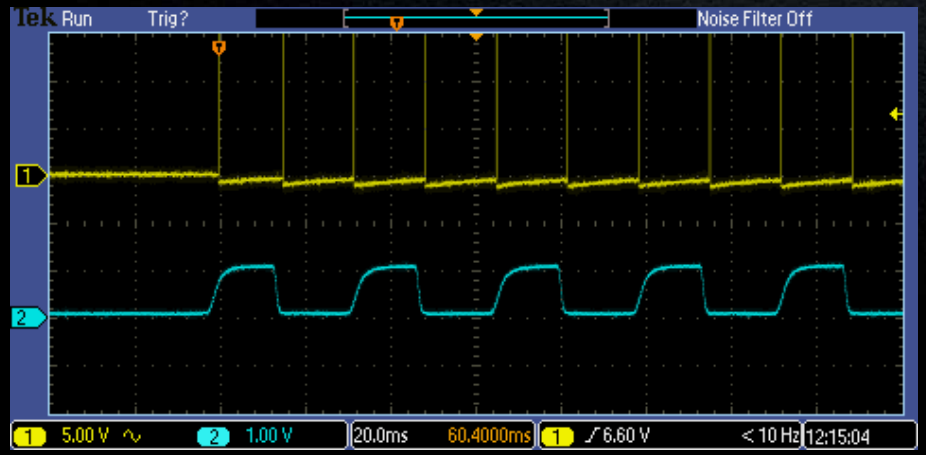


http://www.psychopy.org/general/colours.html

Timing stimulation

Digital sound is pretty continuous. Digital video is not.

- All about resolution!
- Video (ms)
  - 60 Hz: **16.7**, 33.3, 50.0, 66.7, 83.3, 100 ms, …
  - 100 Hz: **10.0**, 20.0, 30.0, 40.0, 50.0, 60.0 ms, ...
- Audio (ms)
  - 44100 Hz: **0.02**, 0.05, 0.07, 0.09, 0.11 ms, …
  - 11025 Hz: **0.09**, 0.18, 0.27, 0.36, 0.45 ms, …



Slow motion videos of minitors:

Visual frames on LCD + CRT + TFT

One frame on big LCD

Visual frames on CRT

Digital sound is pretty continuous. Digital video is not.

- Modern monitors are just fast slide projectors!
- … that draw on the slides just before they are shown and discard them afterwards.

Visual timing to frames

- Use frames for visual timing, NOT `core.wait()`!

```
For frame in range(3):
    stim.draw()
    win.flip()
```

- Check your actual frame rate. I'ts not 60 Hz!

```
ppc.getActualFrameRate()
```

- Triggers and logging AFTER stimulus presentation!

Yes:

```
win.flip()
duration = clock.getTime()
port.setData(15)
```

No:

```
duration = clock.getTime()
port.setData(15)
win.flip()
```

Visual timing to frames

- Test timing of everything in the `win.flip()` loop except `win.flip()` and make sure that processing duration is way below frame interval.

```
Script = """
     stimA.setOri(1.1, '*')
     stimA.setOpacity(0.01, '-')
     stimB.setPos([0.1, 0.1], '+')
     stimA.draw()
     stimB.draw()
     # win.flip()
     duration = clock.getTime()
     clock.reset()
"""

ppc.timer(script, setup='stimA, stimB, clock')
```

Timing sound

- Sound: Use `winsound` on Windows and discard first play. PsychoPy is not precise enough yet.

```
beep = ppc.Sound('myBeep.wav')
beep.play()
```

Timing input

Timing input

- `psychopy.event` run in same process as stimulation.
  Light and easy but bad for simultaneous events.
- `psychopy.iohub` runs in parallel. Good with ”wait functions”, simultaneous inputs, and key releases.

```
from psychopy import iohub
io = iohub.launchHubServer()
keyboard = io.devices.keyboard

flip_times = []
for frame in range(60):
    stim.draw()
    flip_times += [win.flip()]

response = keyboard.getPresses()

print response[0].time - flip_times[0]

# Or use one of these:
keyboard.getReleases()
response = keyboard.getKeys()
```

```
from psychopy import event


flip_times = []
for frame in range(60):
    stim.draw()
    flip_times += [win.flip()]

response =
    event.getKeys(timeStamped=True)
print response[0][0] - flip_times[0]
```

http://www.psychopy.org/api/iohub/device/keyboard.html

General advice

General advice on precision

- A log is suggestive.
  Physical measurement is proof.
- Timing: run the code once before the critical presentation. Slow first-run functions include:

```
core.wait()
ppc.sound.play()
stim.draw()
```

You're the python god and python functions are your slaves.

(Monty Python's impression)

You're the python god and python functions are your slaves.

- You should be in total control. They should do everything that you tell them to and nothing else. Complex modules are threads!
- Test them frequently, don't trust them until they've prooved that they are true to your wishes for all eternity!
- Good functions should be able to serve you properly. Give them proper hardware!