Fachhochschule
Münster University of
Applied Sciences

Gas Discharge Light Sources

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Presentation incoherent light sources

Outline

- Historical overview
- Types of gas discharge light sources
  - Build-up and function
  - Advantages and Disadvantages
  - Applications

Historical overview

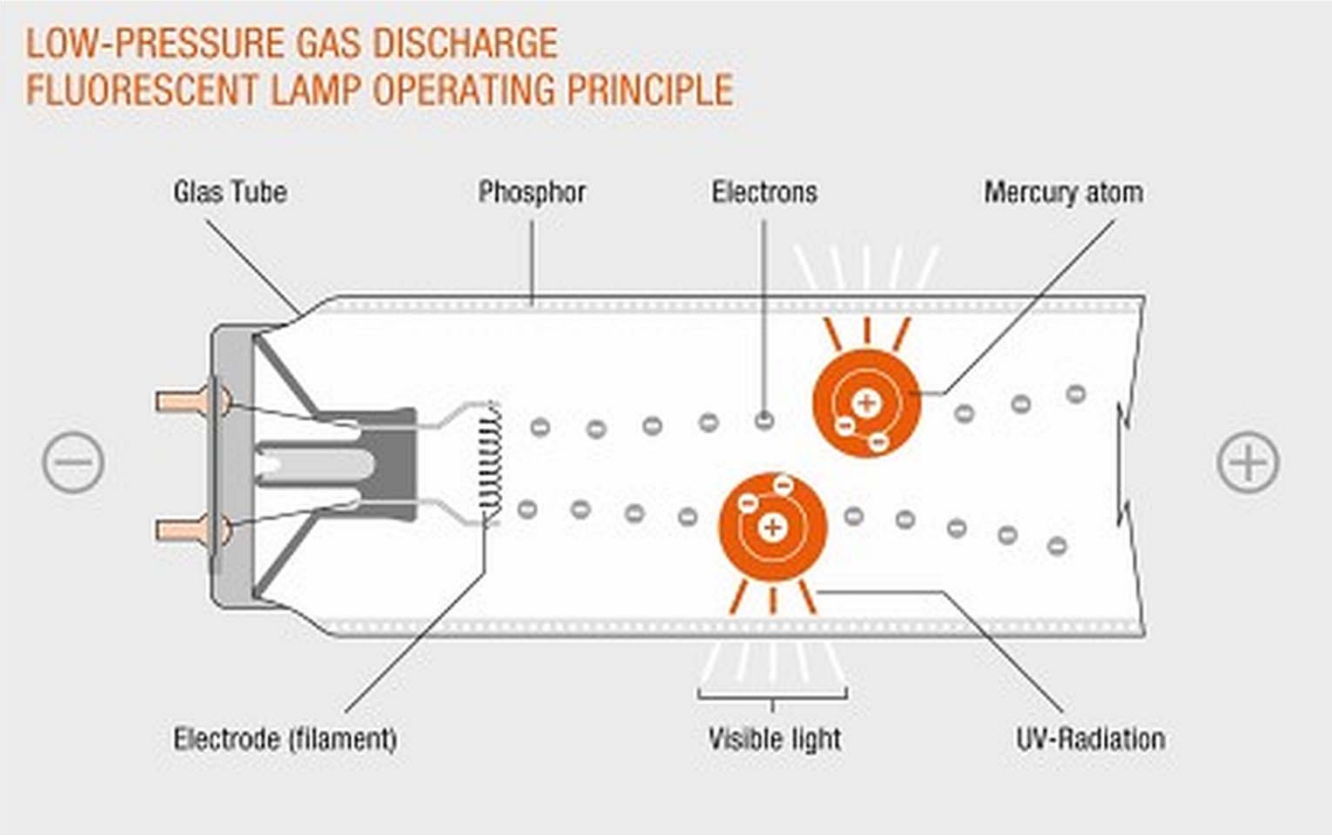
- 1675: Phenomenon of glowing vacant space in a Barometer while moving it, discovered by Jean-Felix Picard
- 1705: First Demonstration of gas discharge lamp by Francis Hauksbee
- 1857: Development of Geissler Tubes (low-pressure gas discharge tubes) by Heinrich Geissler
- 1898: Discovery of Neon by William Ramsay and Morris W. Travers
- 1910: Commercialization of Geissler Tubes as neon lighting, used in neon signs

Overview:

- Low pressure gas discharge lamps
- High pressure gas discharge lamps
- Excimer lamp

Types of gas light sources

Low pressure gas discharge lamp



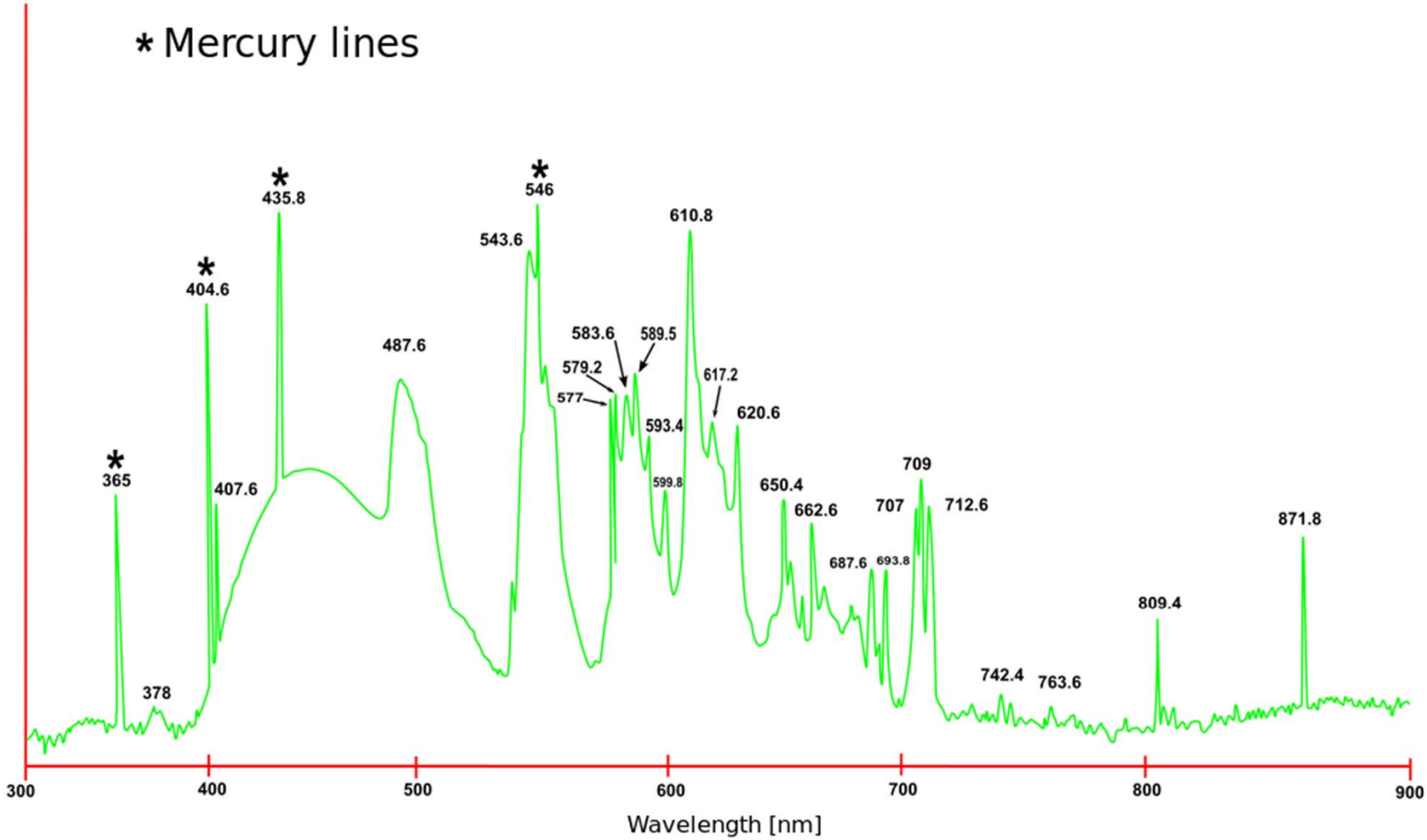
Sketch of a low pressure mercury vapour gas discharge fluorescent lamp.

Phosphor composition:

- „Old“ Halophosphate-type Phosphor:
  - Mainly emits yellow and blue light
  - Weak emission of red and green light
  - Appears white to the eye
  - Has incomplete Spectrum => CRI ~ 60
- „New“ Triphosphor mixture (since 1990s):
  - Based on Eu and Tb
  - More evenly distributed VIS spectrum
  - CRI typically 82-100

Types of gas light sources

Low pressure gas discharge lamp



Spectrum from a 48" Philips F32T8 natural sunshine fluorescent light

Types of gas light sources

Low pressure gas discharge lamp

Advantages:

- ~ 22 % energy conversion (incandescent lamp 5 %)
- ~ 9000 h lifetime (10-20x of equivalent incandescent lamp)
- Diffuse and large light source
- Low heat emission (1/5 of equivalent incandescent lamp)

Disadvantages

- Rapid aging if switched on and off frequently
- Safety issues if broken (due to Mercury)
- Disposal and recycling
- Generation of harmonic currents in power supply
- Arc generates radio frequency noise

Types of gas light sources

Low pressure gas discharge lamp

Applications

- Lighting in shops, offices, tunnels, etc.
- Lighting in private households
- Plant cultivation

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Other types of low pressure gas discharge lamps

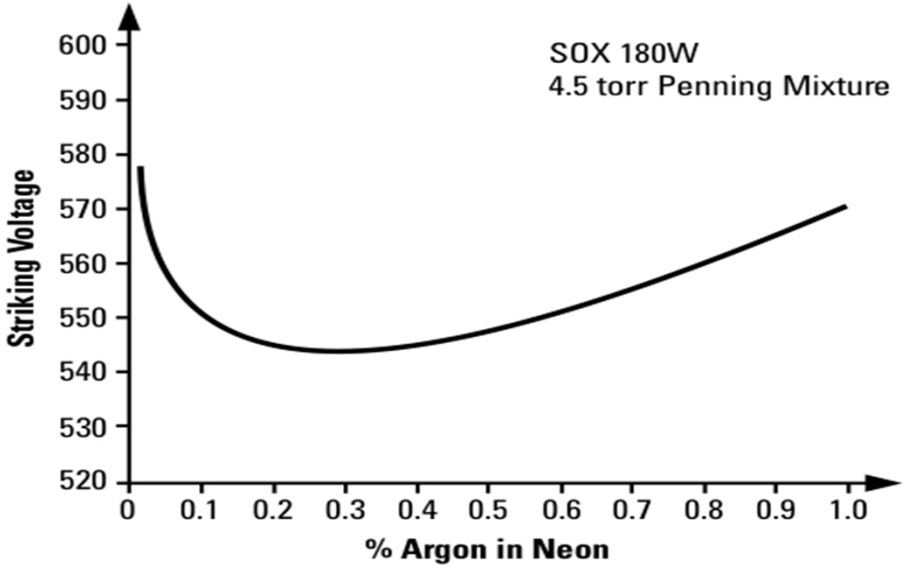
- Neon lighting
  - Color depends on gas in the discharge tube:
    - Neon (orange)
    - Hydrogen (red)
    - Helium (yellow)
    - Carbon dioxide (white)
    - Mercury (blue)
- Neon glow lamp
  - Electronic indicator

Types of gas light sources

Low pressure gas discharge lamp

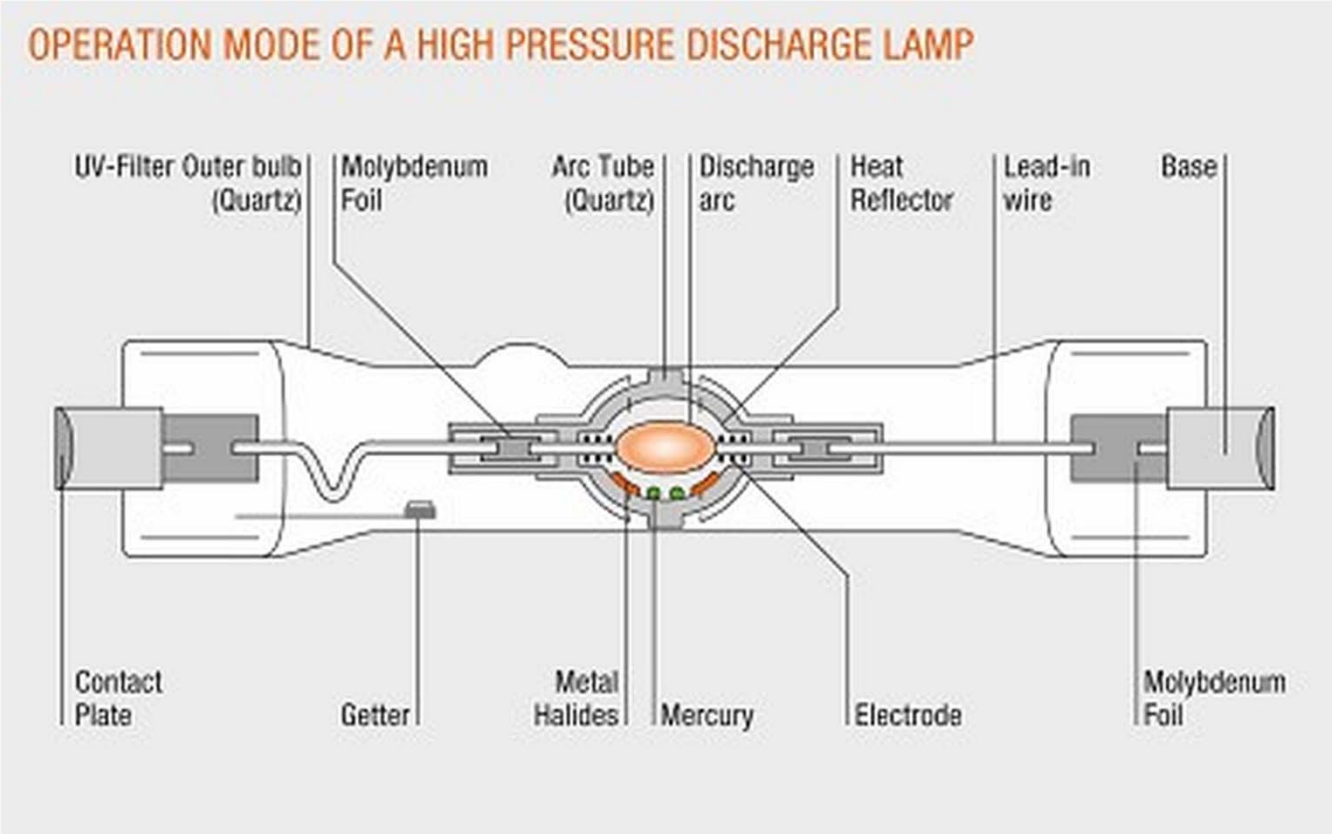
- Low pressure sodium-vapor lamp
  - Solid Na + Ne/Ar penning mixture
  - Very efficient (up to 200 lm/W)
  - Virtually monochromatic @589,3 nm
  - Poor color rendering

- Penning mixture:
  - More efficient ionization
  - Reduces striking voltage



Types of gas light sources

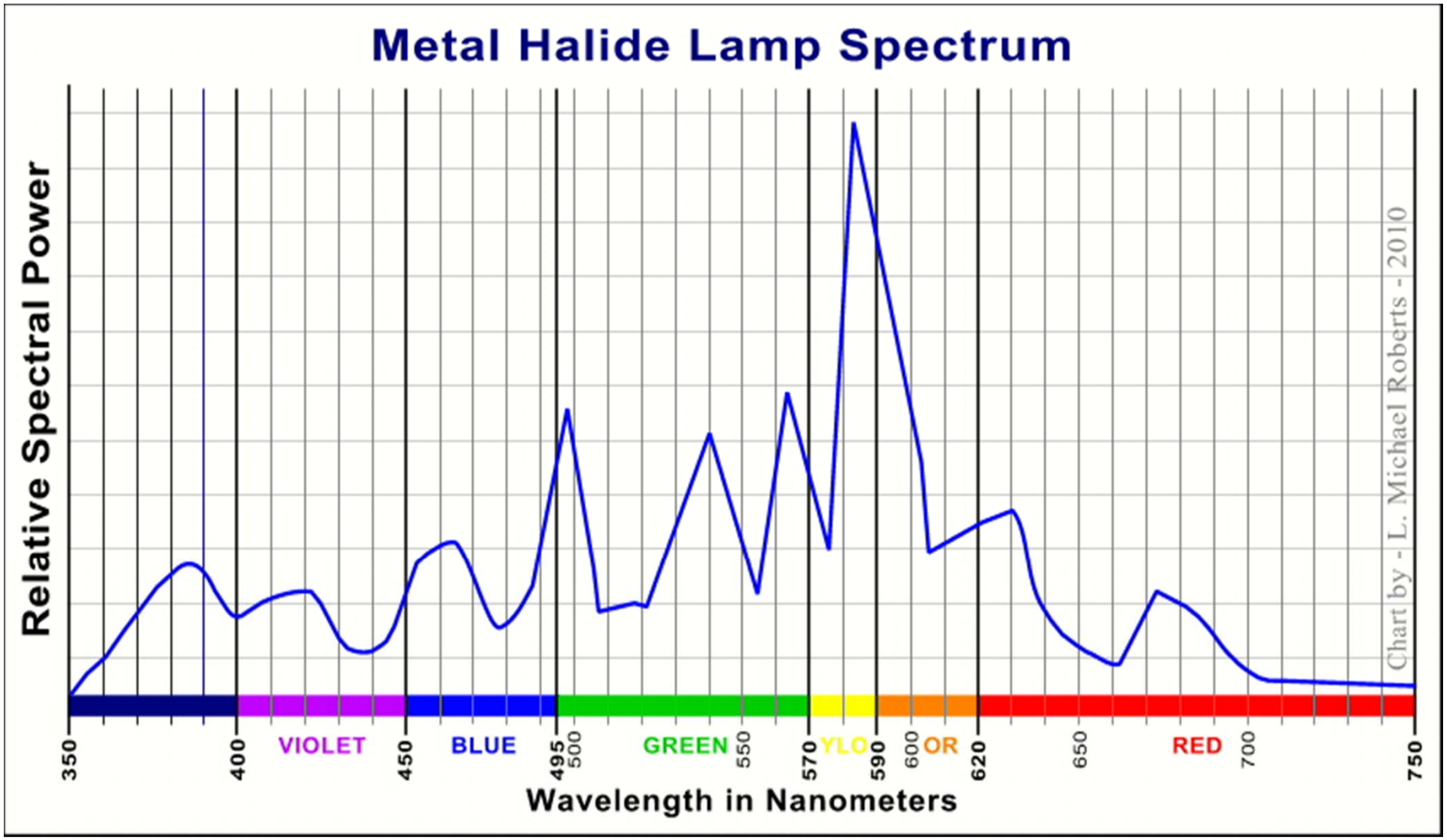
High pressure gas discharge lamp



Sketch of a high pressure metal halide / mercury vapour gas discharge lamp.

Types of gas light sources

High pressure gas discharge lamp



Types of gas light sources

Low pressure gas discharge lamp

Advantages:

- ~ 24 % energy conversion
- Lifetime about 6000 - 15000 h
- Can attain efficacy of 100 lm/W
- High CRI ~ 75 - 90

Types of gas light sources

Low pressure gas discharge lamp

Disadvantages:

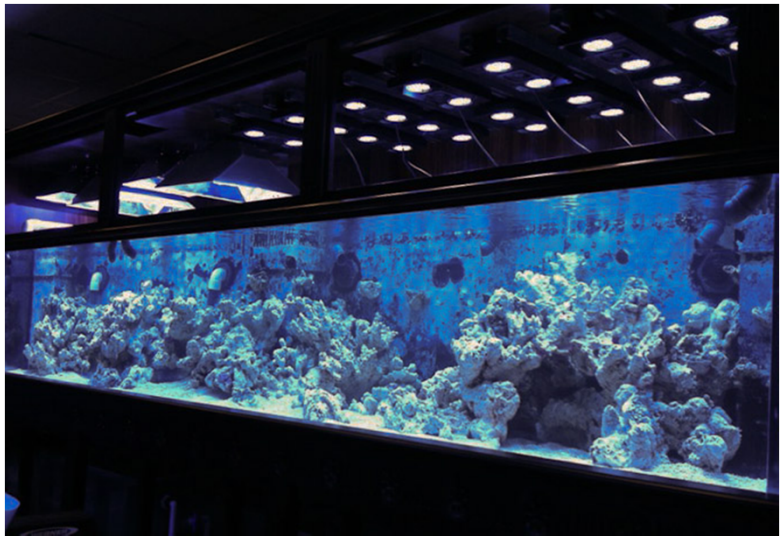
- Warm up perios of up to 5 minutes
- Cannot be restarted for 5-10 minutes if interrupted
  - Special ignitor and lamp design needed to circumvent this problem
- Expensive per-bulb cost

Types of gas light sources

High pressure gas discharge lamp

Applications:

- Illumination of stadium, parking area, airfield, etc.
- Projection
- Greenhouse / Aquarium



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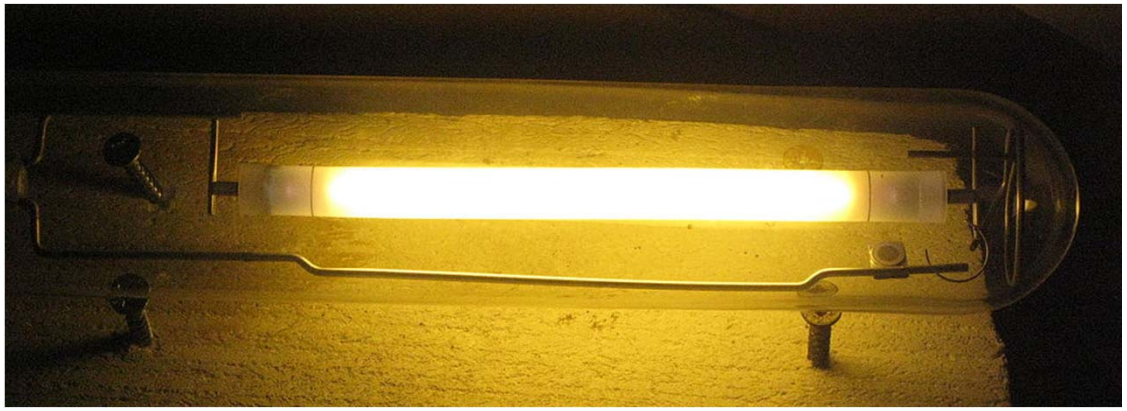
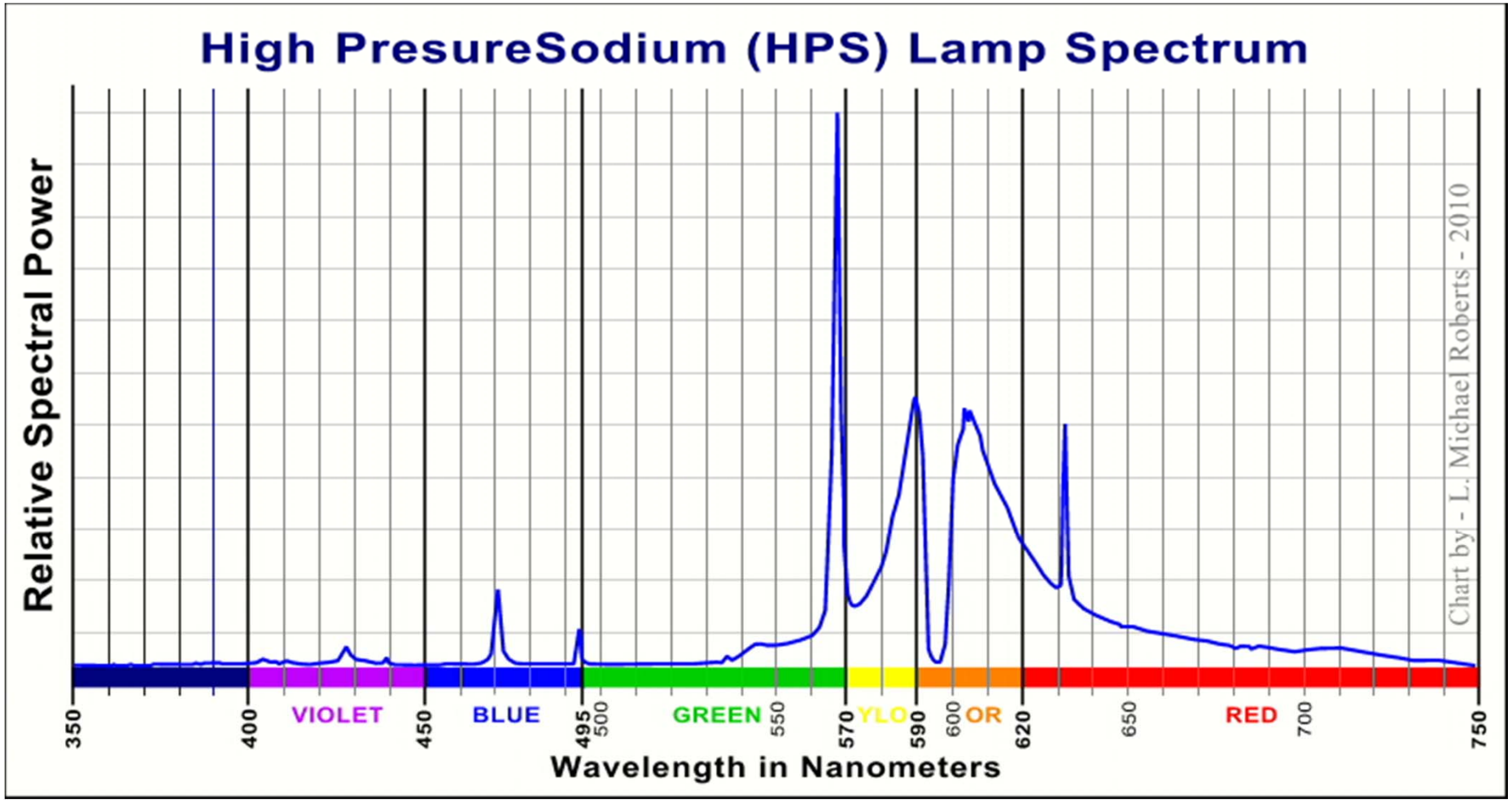
Other types of high pressure gas discharge lamps:

- High pressure sodium lamps
  - Containing sodium amalgam
  - Aluminium oxide arc tube
  - High pressure leads to broadened spectrum
  - Used for street lighting, plant cultivation



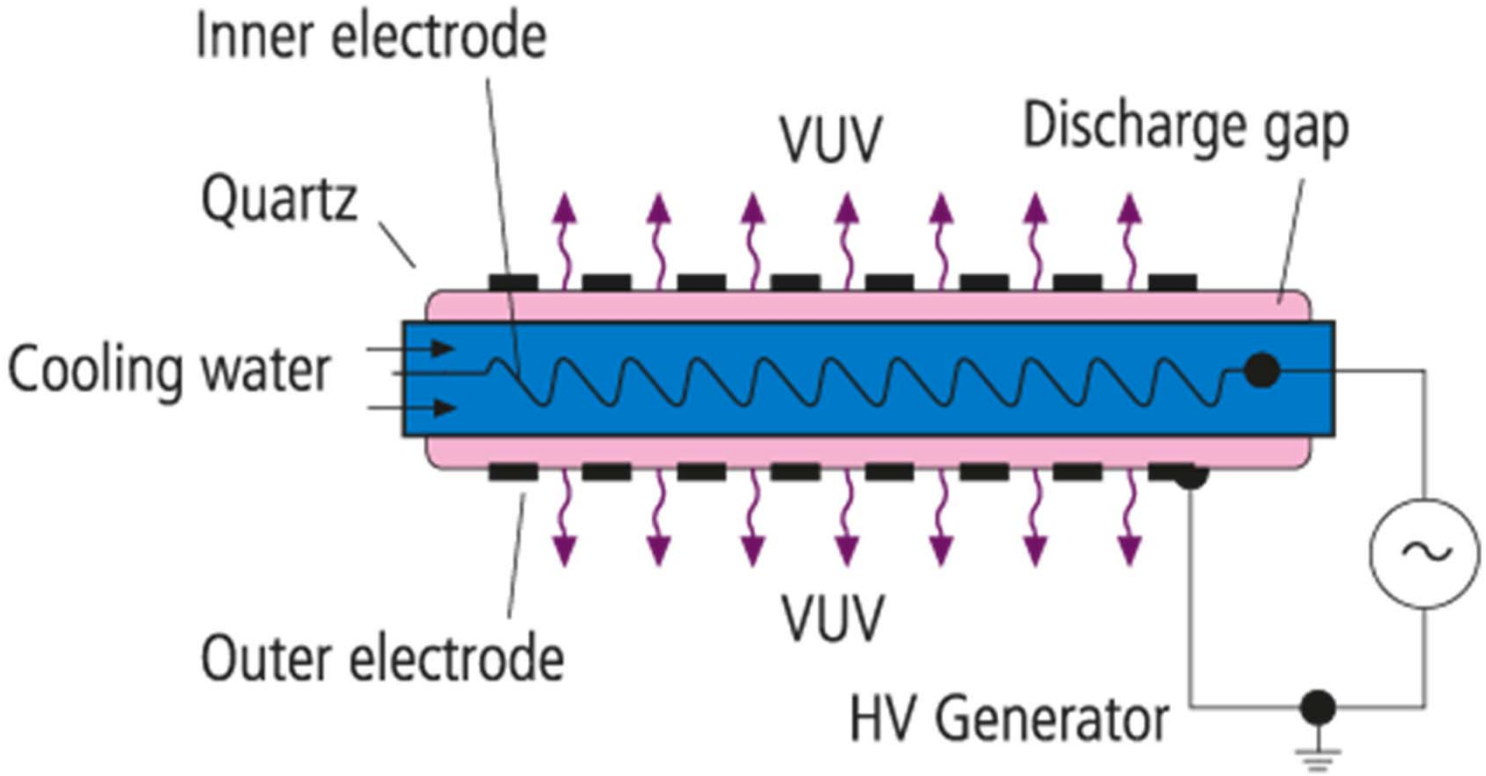
Types of gas light sources

High pressure gas discharge lamp



Types of gas light sources

Excimer lamp



Types of gas light sources

Excimer lamp

Reaction:

- $e^- + Xe \rightarrow Xe^*, Xe^+$
- $Xe^* + 2Xe \rightarrow Xe_2^* + Xe$
- $Xe_2^* \rightarrow 2Xe + h\nu$ (172 nm)

Excimer	Wavelength (nm)
NeF*	108
Kr_2^*	146
Xe_2^*	172
KrCl*	222
XeCl*	308
XeF*	351

Types of gas light sources

Excimer lamp

Benefits of excimer lamps from other UV sources:

- Quasimonochromatic (FWHM 2-15 nm)
- Great range of wavelengths for specific purposes
- Instant attainment of operating mode
- Low heating of radiating surface
- No mercury

Application:

- Photochemical Processes
  - Drying of adhesives, printing-inks
  - Photolitography
  - Surface modification
  - Cleaning
- Sterilization
- Ozone Generation

Thank you for your attention.