

Lasery



a ich využitie v technológií a biomedicíne

Dr. Dušan Chorvát

Medzinárodné laserové centrum

SVETLO

Dúha – jav ktorý vzniká na základe lomu slnečného svetla na kvapkách dažďa



SVETLO

Polárna žiara – jav ktorý vzniká pri zrážke častíc slnečného vetra s atmosférou



SVETLO

Laser - najpokrokovější ľudmi vytvorený zdroj svetla



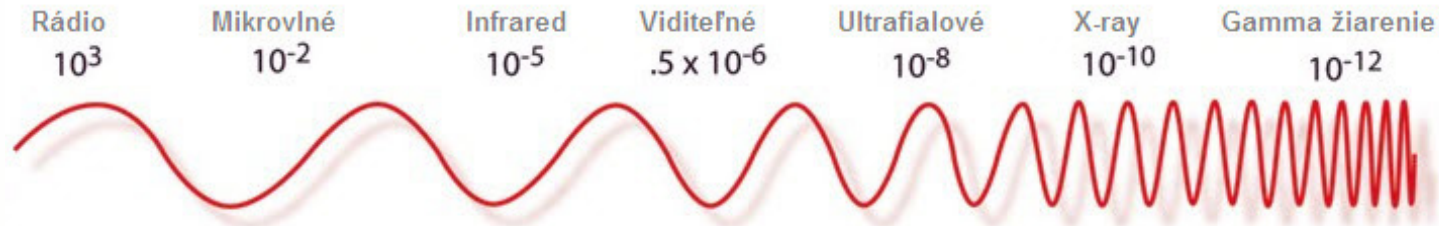


Princípy

SVETLO

Spektrum elektromagnetického žiarenia

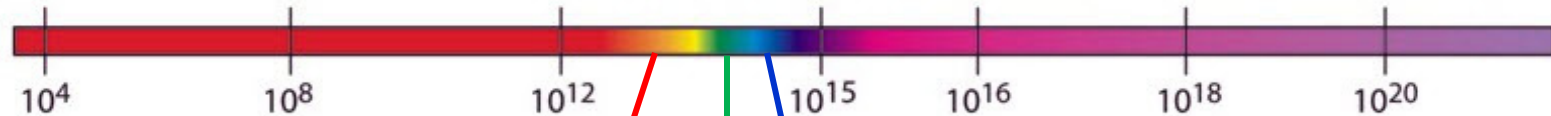
Dĺžka vln (v metroch)



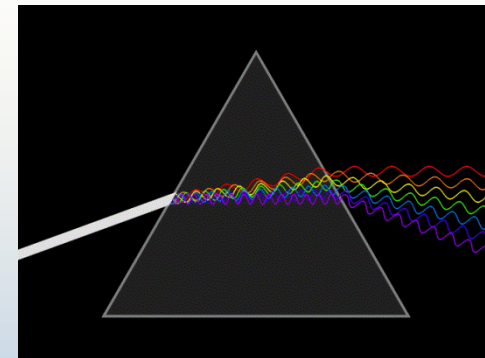
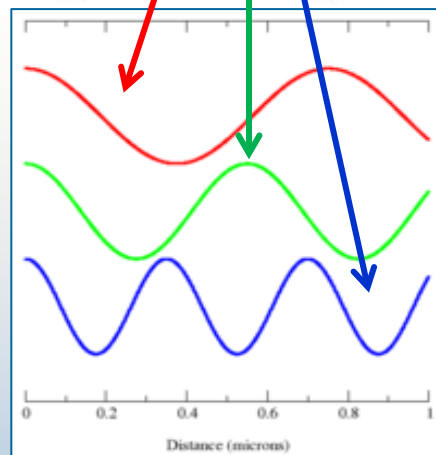
Približné porovnanie veľkosti ...



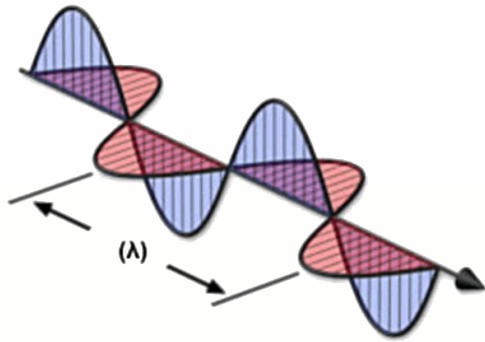
Frekvencia (Hz)



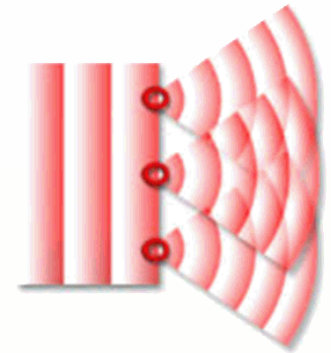
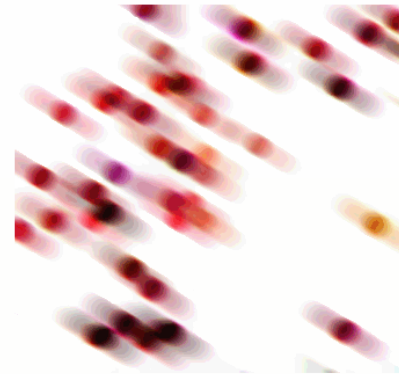
Svetlom nazývame okom viditeľné elektromagnetické žiarenie s vlnovou dĺžkou $\sim 400\text{nm}$ až 700nm



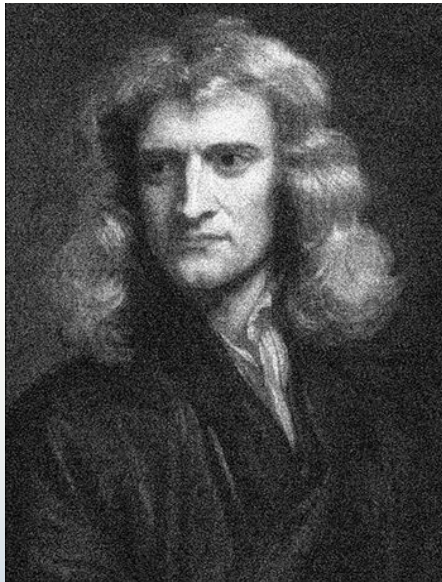
OPTIKA a FOTONIKA ... vedy o svetle



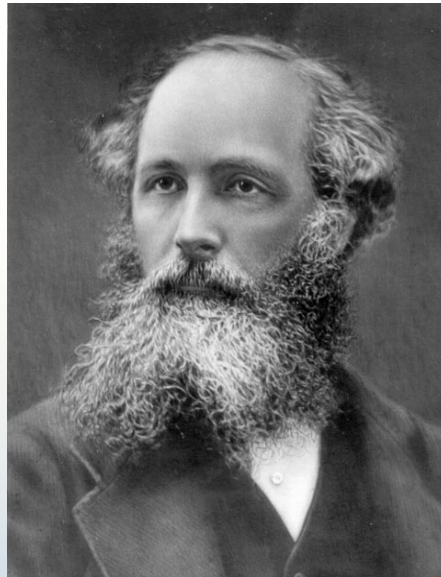
princíp - **elektromagnetické vlnenie**



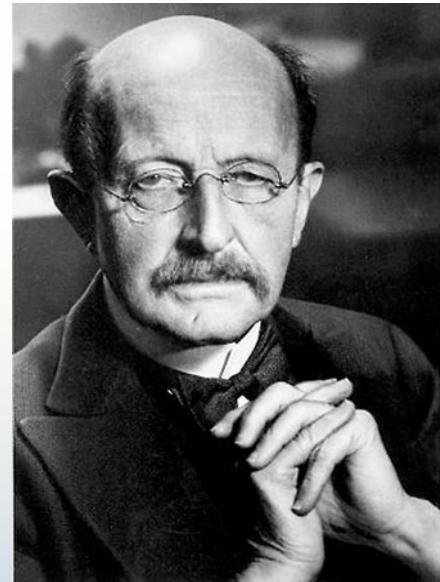
šírenie vo forme častíc (kvánt): **fotónov**



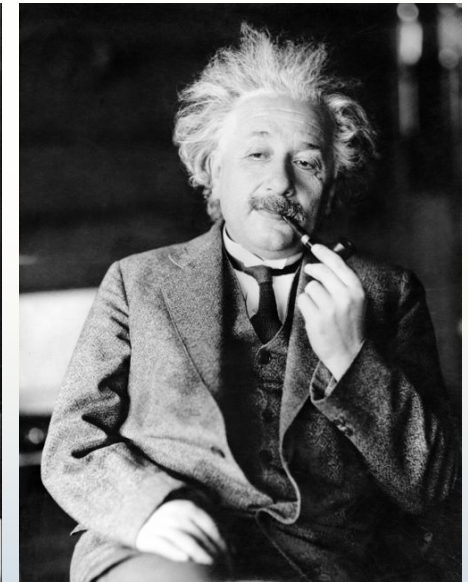
Isaac Newton



James C. Maxwell



Max Planck



Albert Einstein

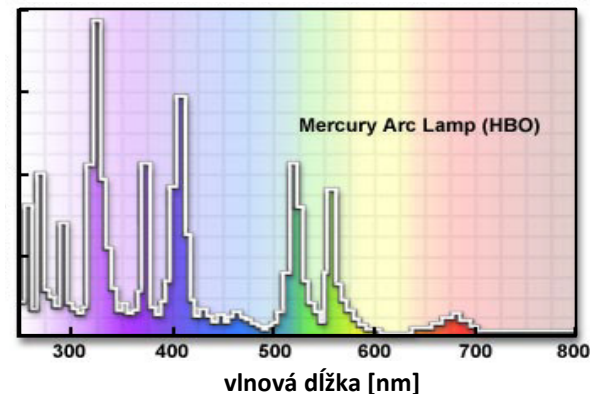
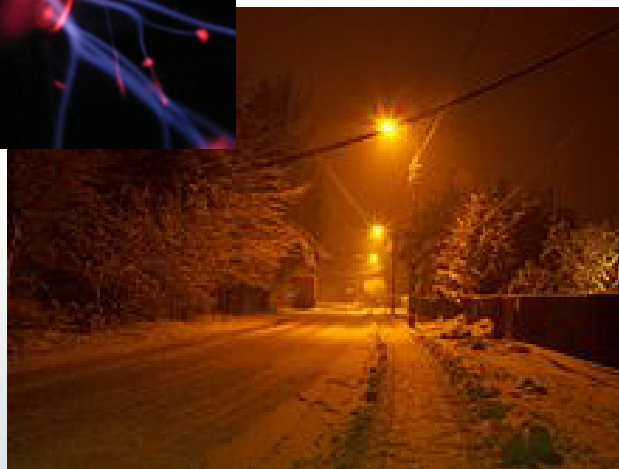
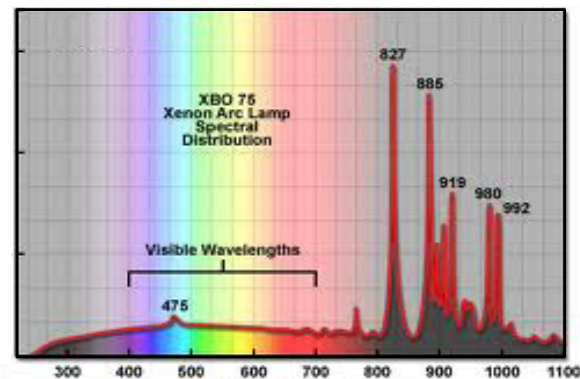
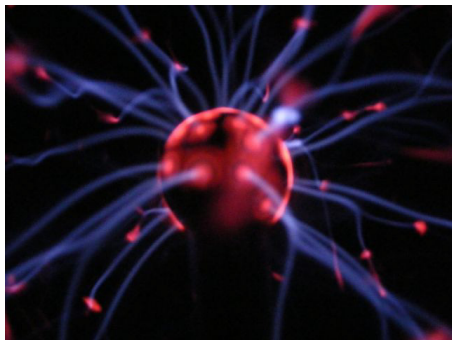
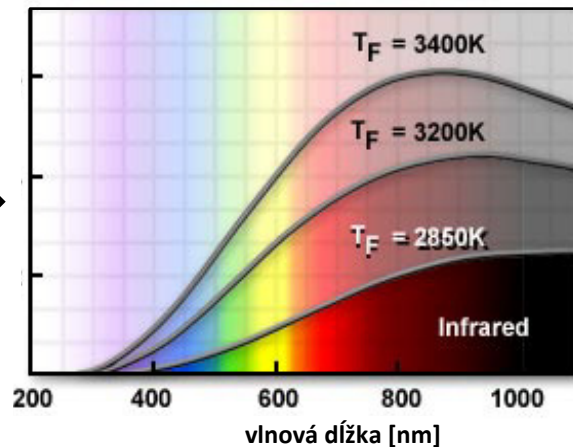
Klasické zdroje žiarenia



žiarovka,
halogénová lampa



Spektrum žiarovky a výbojky



žiarivka, výbojka (xenónová / ortuťová sodíková)

Kvantové zdroje žiarenia

LASER: Light Amplification by Stimulated Emission of Radiation
(Zosilnenie svetla pomocou stimulovanej emisie radiácie)

Theodore Maiman a Alexander Prochorov



Photo courtesy Bettman/Corbis



Theodore Maiman zostrojil prvý funkčný laser 16 mája 1960 v Hughes Research Laboratory v Kalifornii, keď svietil vysoko výkonnou výbojkou na postriebrenú rubínovú tyč.

Princíp laseru

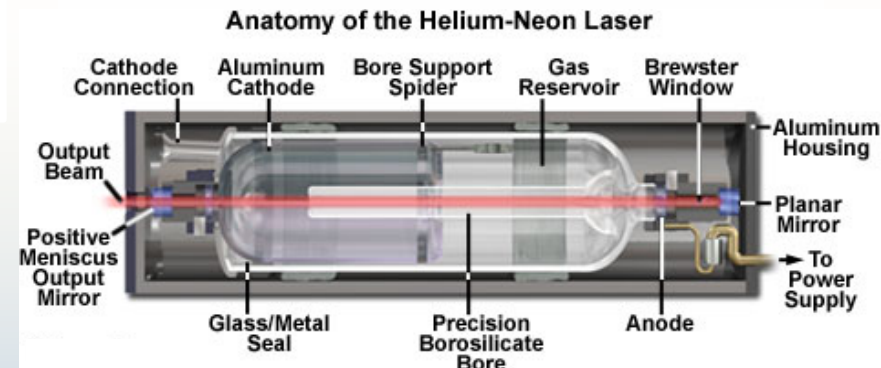
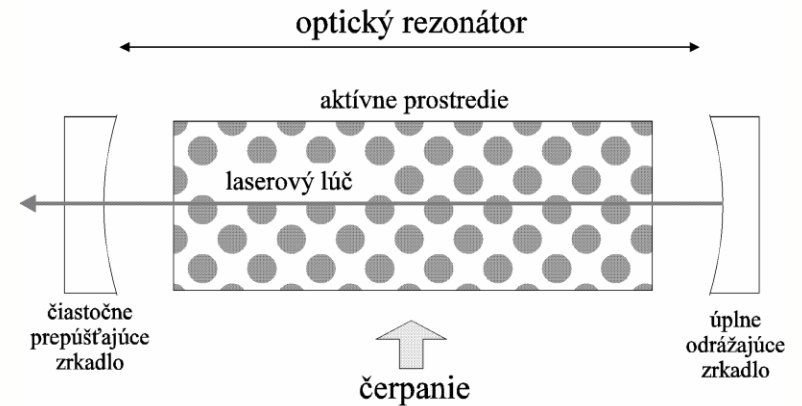
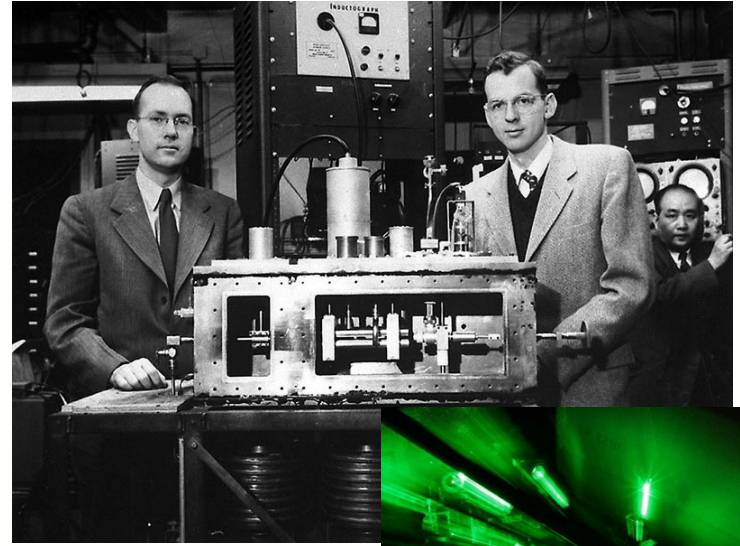


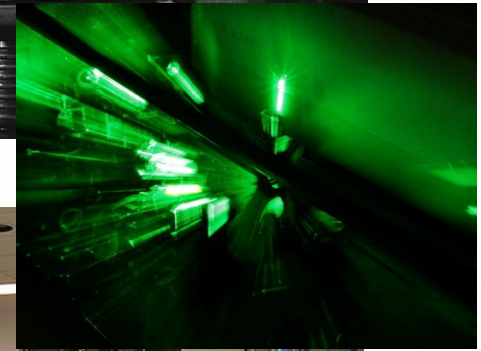
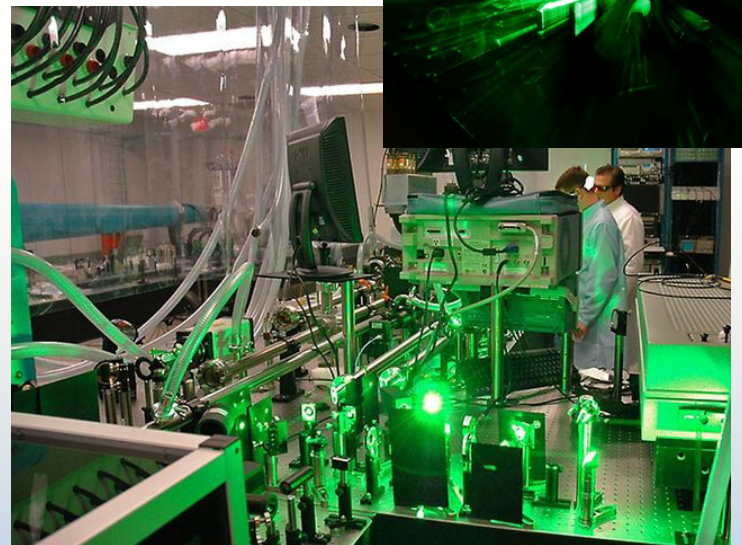
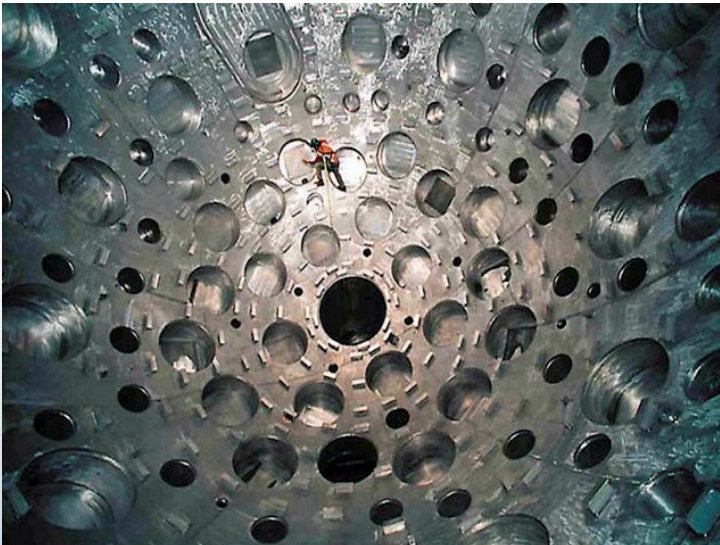
Photo courtesy Olympus Microscopy Resource Center

História laseru

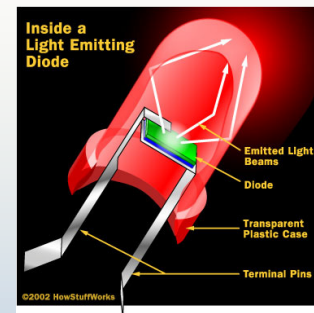
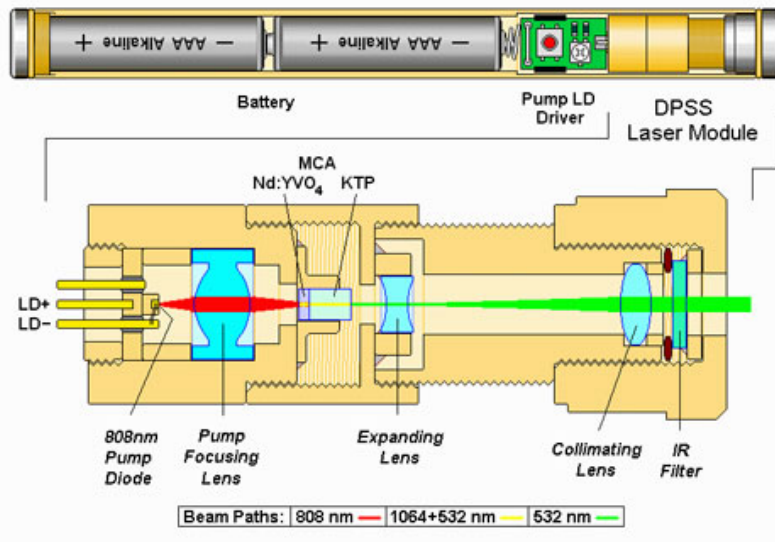
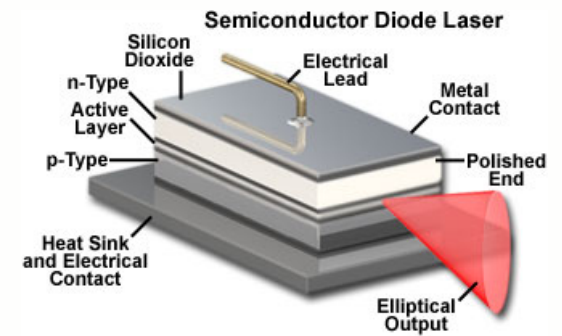
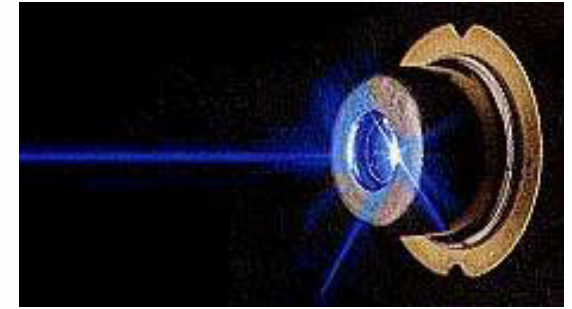
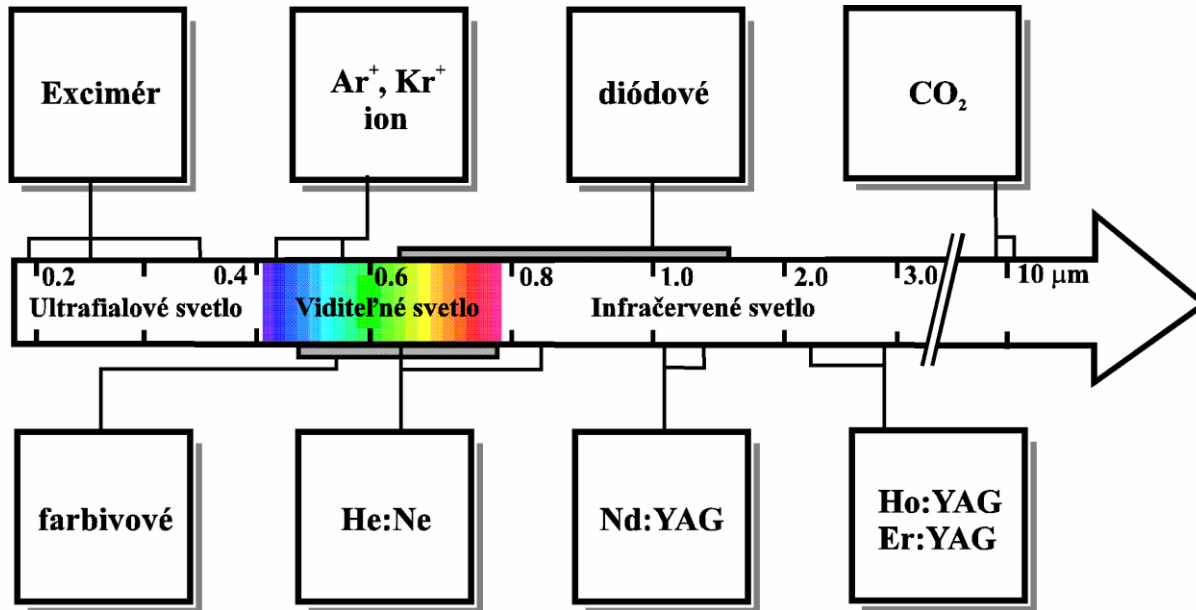
1960



2010

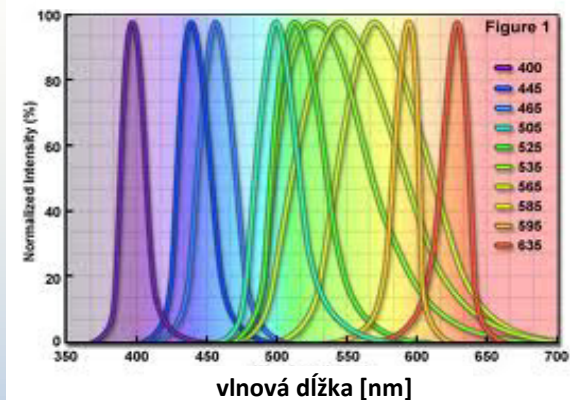


Typy laserov



elektroluminiscenčné diódy
LED (light emitting diode)

Spektrum LED





Aplikácie

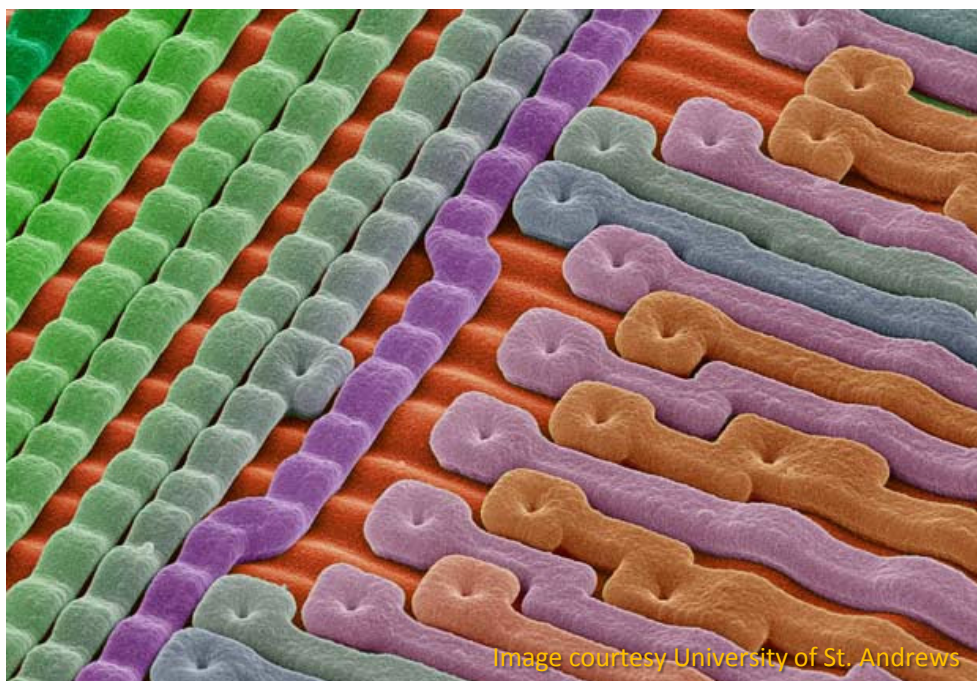
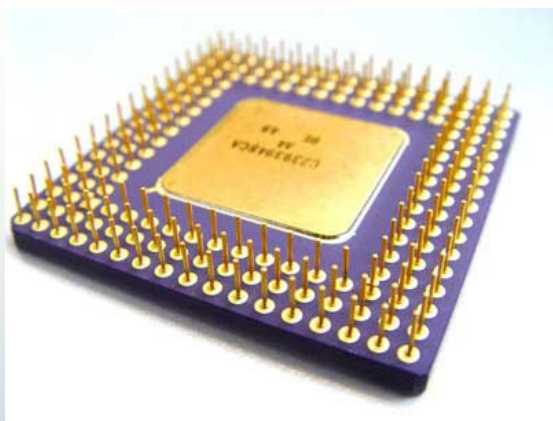
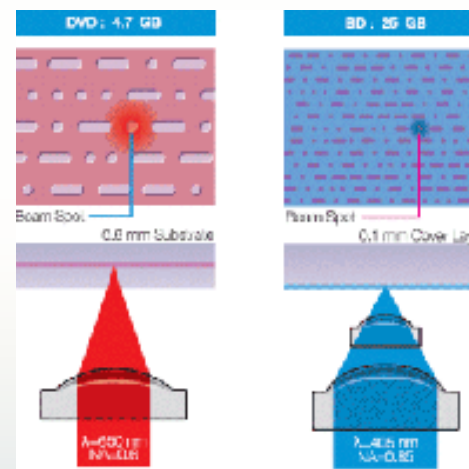


Image courtesy University of St. Andrews

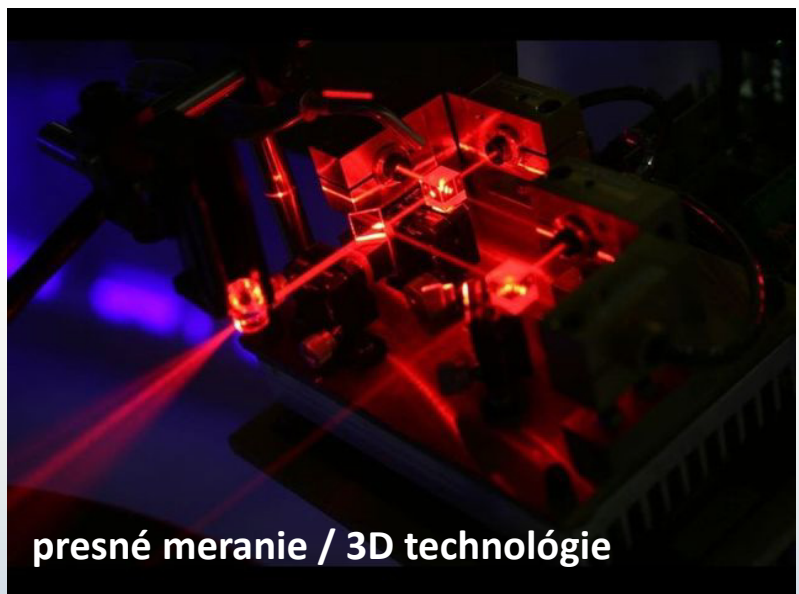
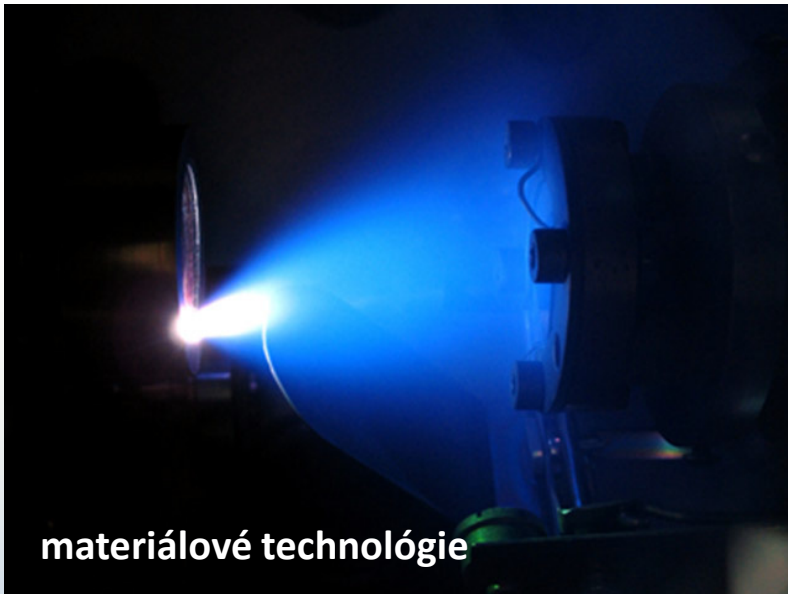
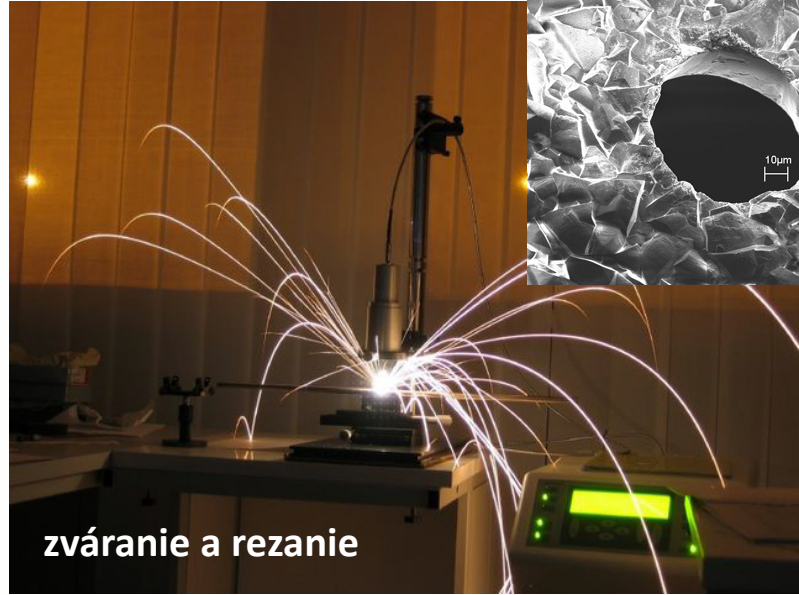
elektronický čip, pripravený pomocou **fotolitografie**



Priemysel



princíp
DVD / Blu-ray mechaniky





Architektúra



Vizualizácia



Laserové show

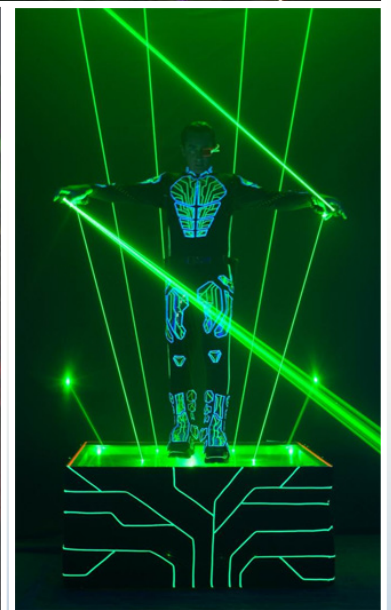
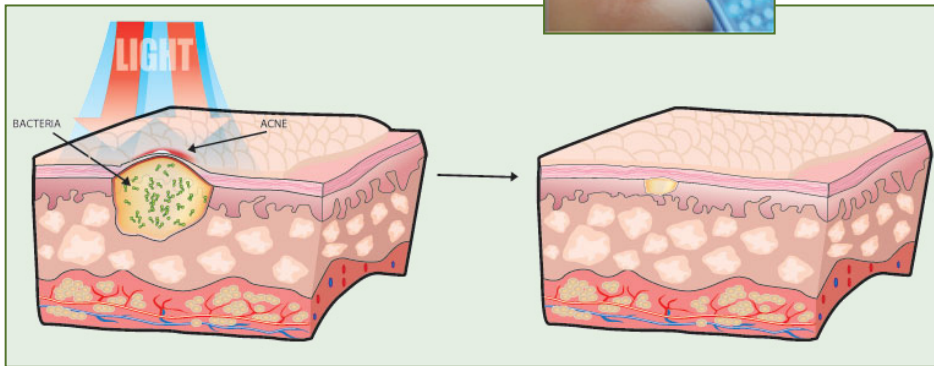


Photo courtesy KVANT s.r.o.

<http://www.youtube.com/v/ljuicXGdS8E>

Kozmetika



liečba akné, biostimulácia, rejuvenizácia



odstraňovanie tetovania

Laserová medicína

Oftalmológia

laserové operácie očí - LASIK



odstraňovanie ruže a kŕčových žíl



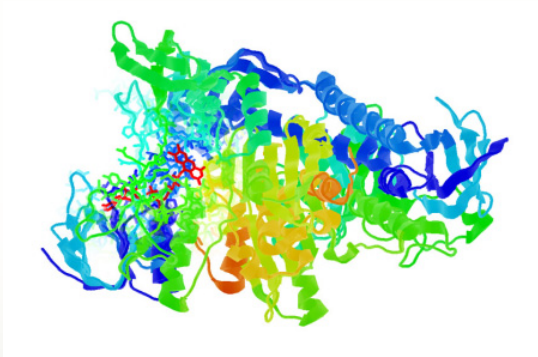
trvalá epilácia



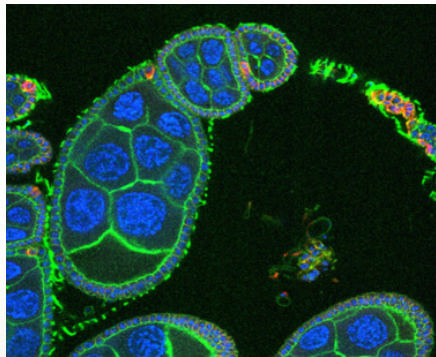
Lasery a veda

FOTONIKA

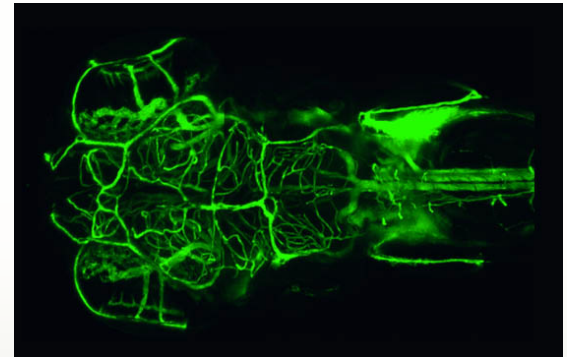
sledovanie a vytváranie štruktúr s pomocou svetla



molekulárna biológia
nanotechnológie

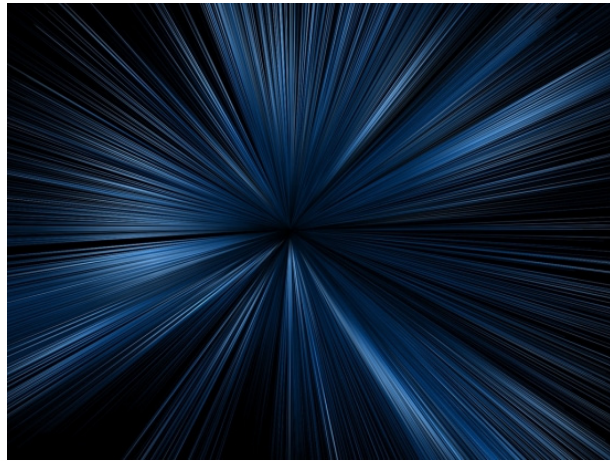


výskum buniek
mikrotechnológie



vývojová biológia
elektrotechnika

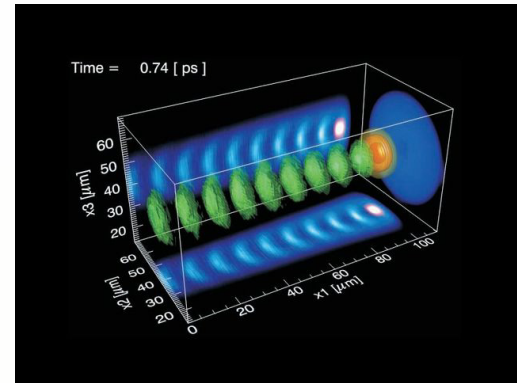
Lasery a čas



299 792 458 metrov za sekundu

=

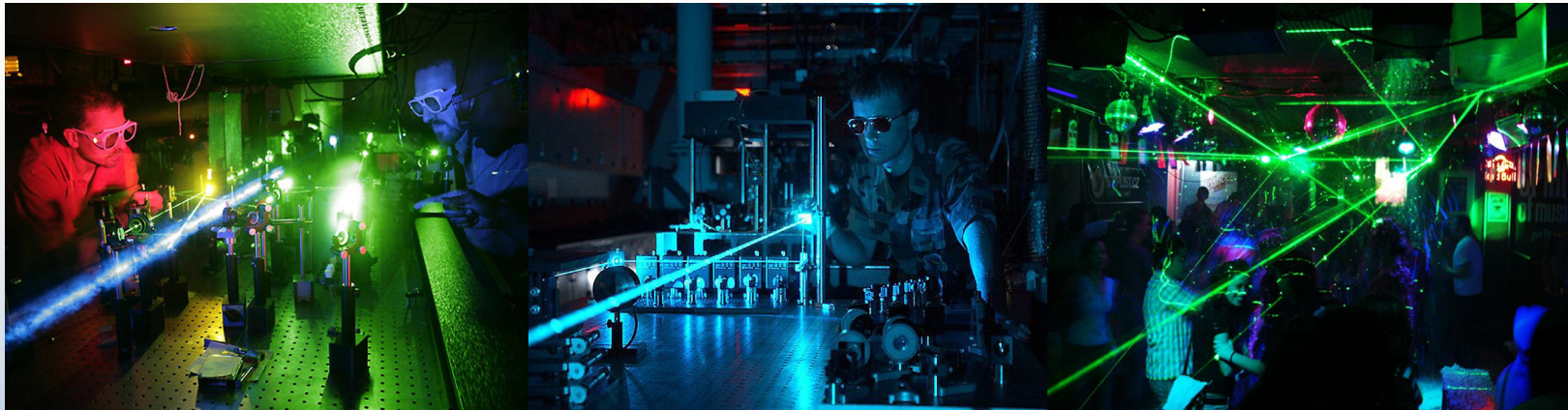
0,3mm za 1ps



vnútroatómové /
vnútromolekulové deje

molekulové pohyby /
medzimolekulové reakcie

Mikrosvet << >> Makrosvet



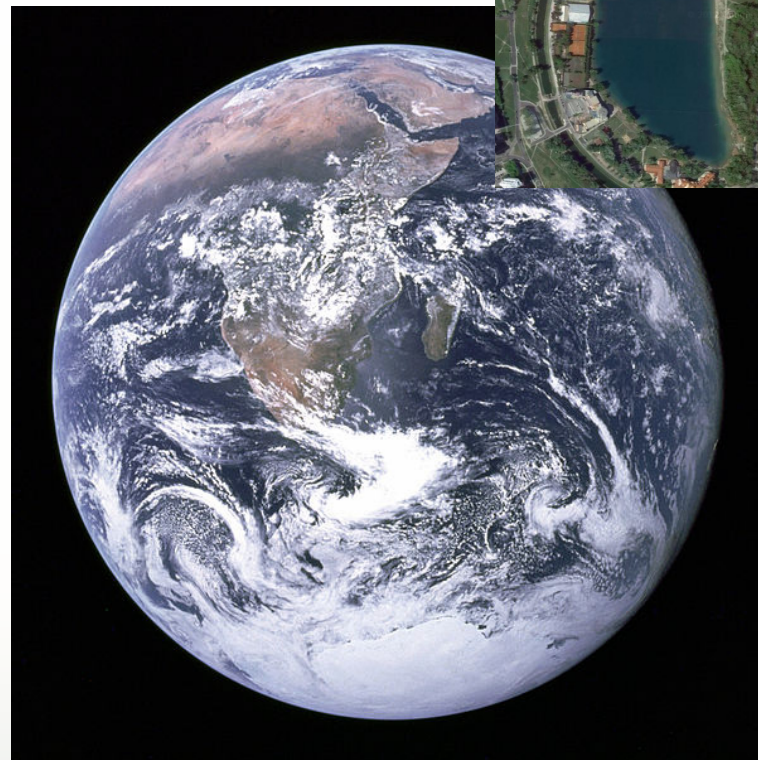
Vlastnosti optického zobrazovania



Záhrada

100 m²

rozlíšenie 500 nm



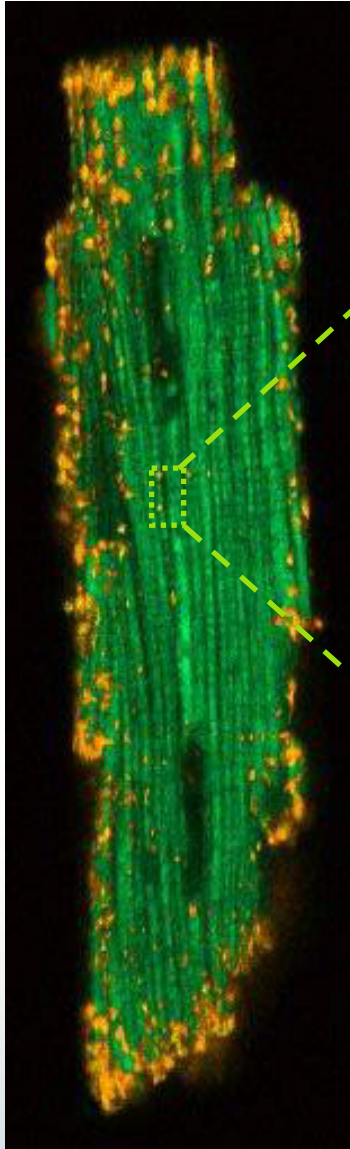
Zem

510 miliónov km²

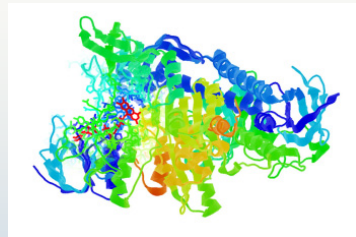
rozlíšenie 1m

pre správne pochopenie toho čo vidíme
je dôležité rozlíšenie

10-100 μ m



10km



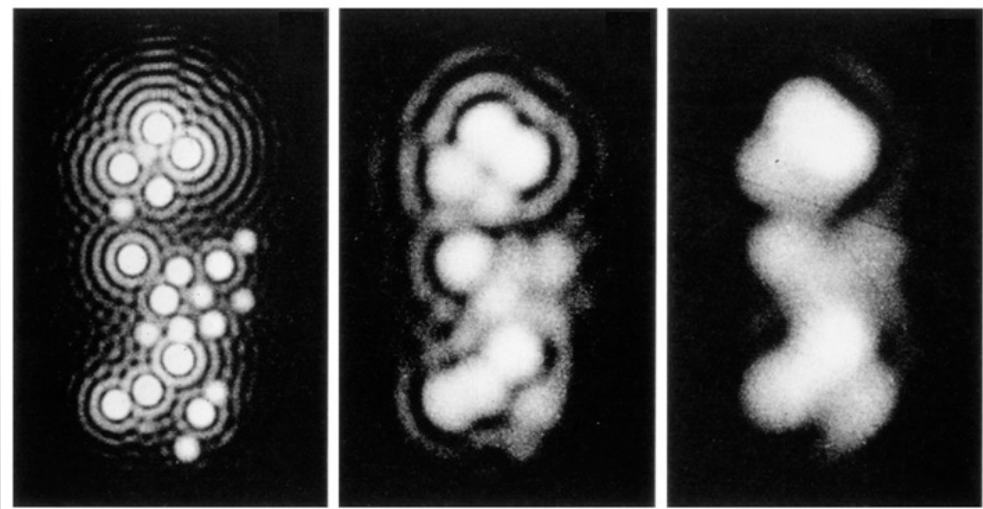
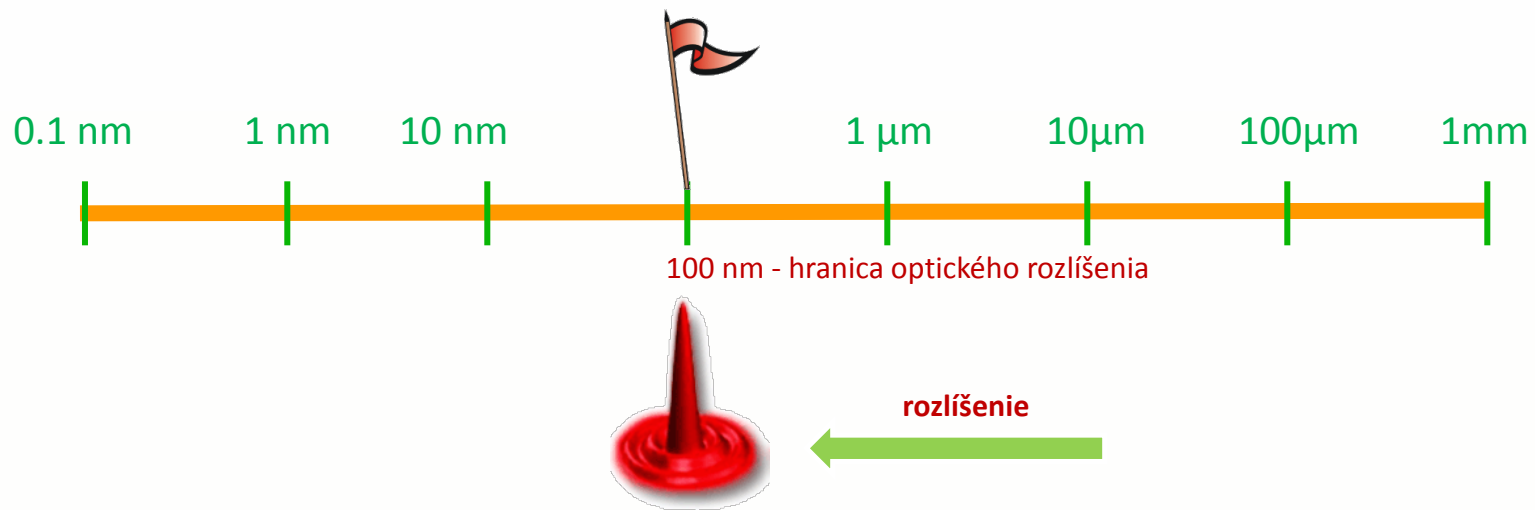
1nm



1m

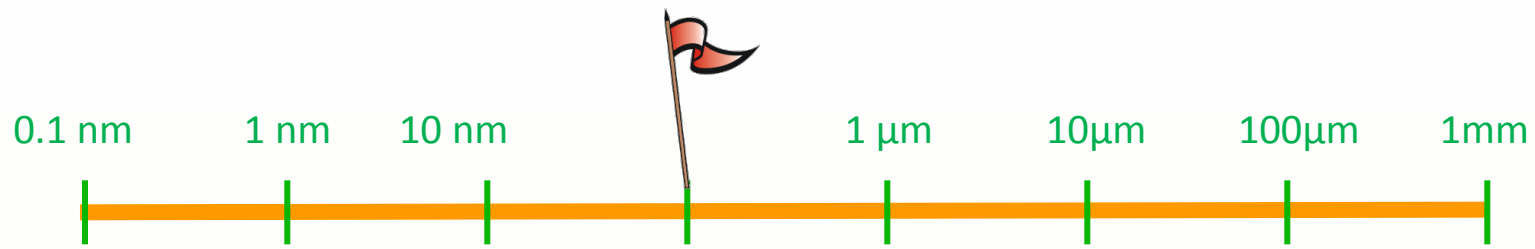
Difrakčný limit

– bariéra pre naše skúmanie sveta s použitím svetla

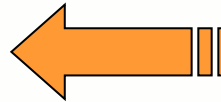


Difrakčný limit

– bariéra pre naše skúmanie sveta s použitím svetla



spektroskopia



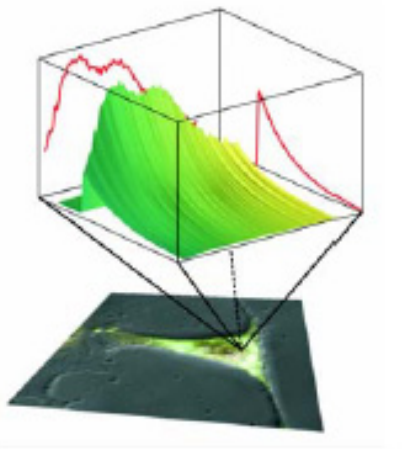
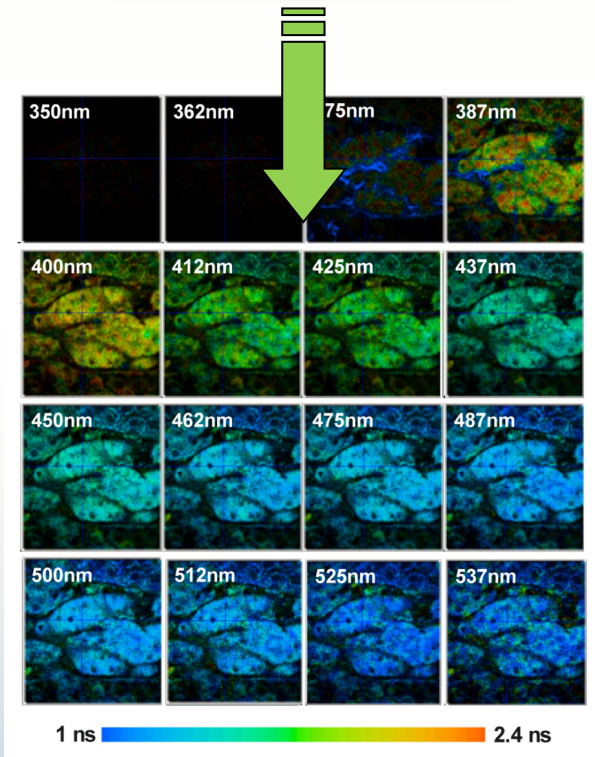
zobrazovanie / mikroskopia



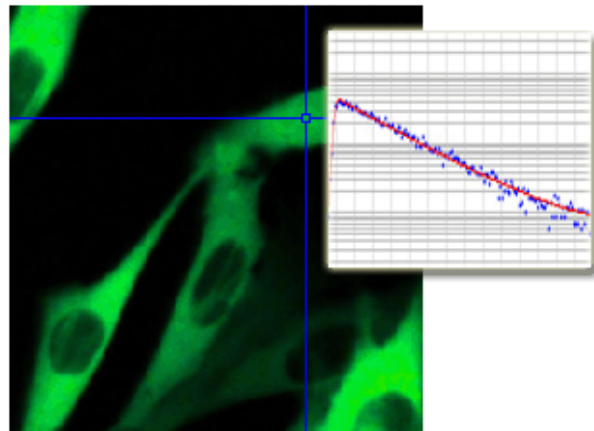
Inteligentní špióni

- proteíny, značky, nanočastice

Metódy modernej optickej mikroskopie



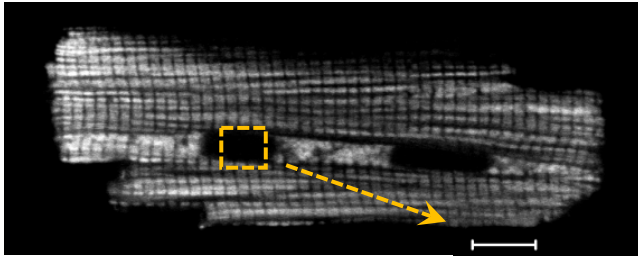
spektrálne zobrazovanie



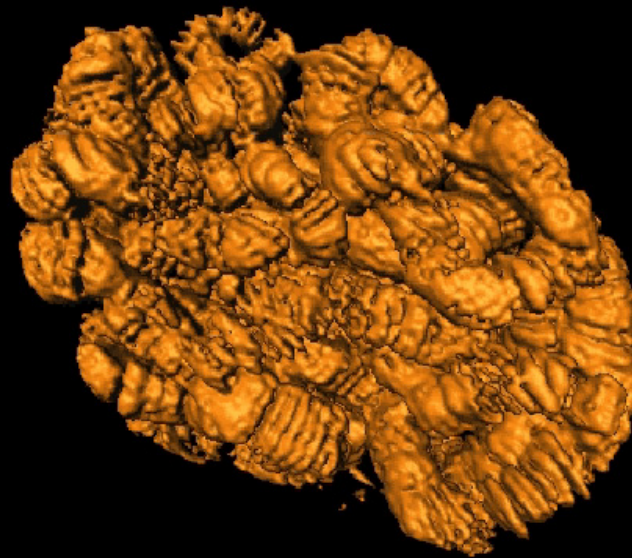
časovo rozlíšené zobrazovanie

multidimenzionálne zobrazovanie

Chromozómy

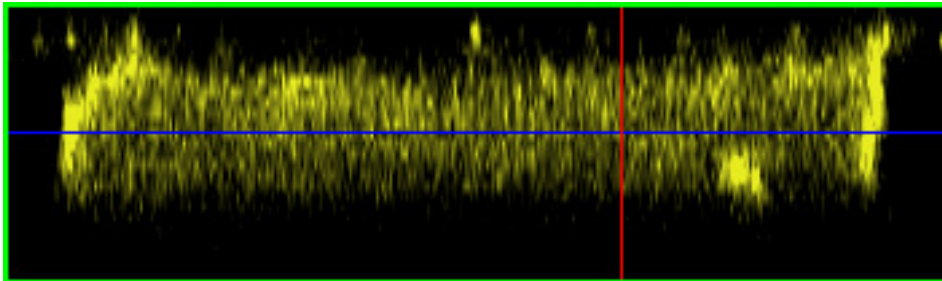


Jadrové chromozómy: naše knižnice



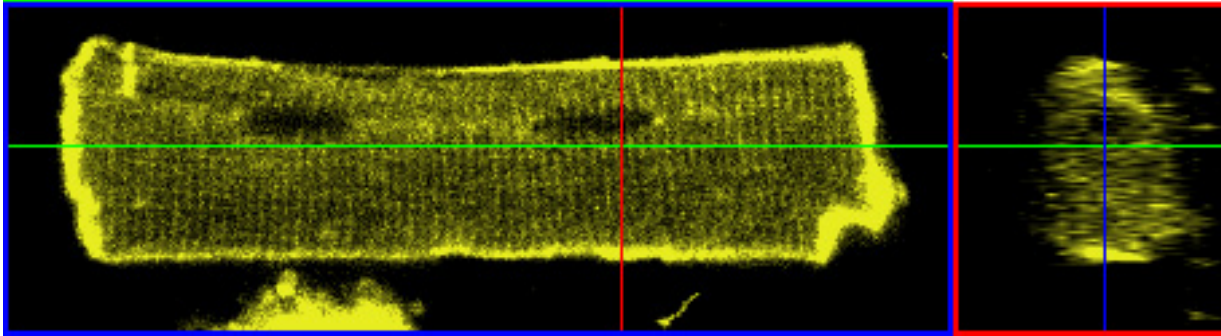
vysoko rozlíšený snímok DNA (spolupráca s ÚEE SAV)

Plazmatická membrána

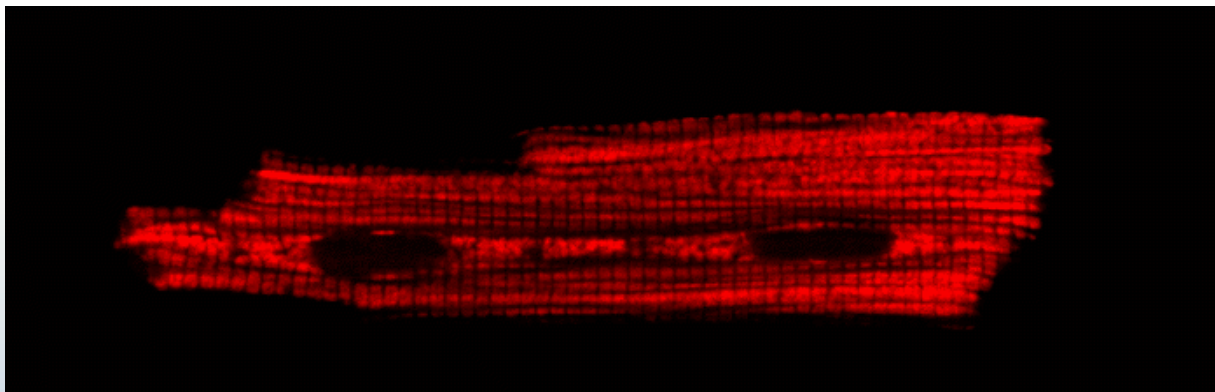


zdroj **elektriny** srdcovej bunky

3D obrázok srdcovej bunky
označených membránovou farbičkou di-8-Anneps



Mitochondrie

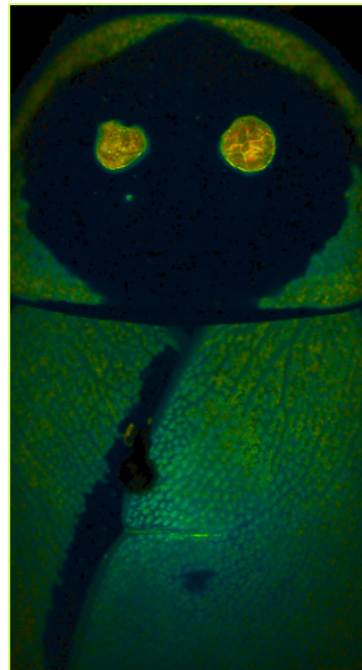
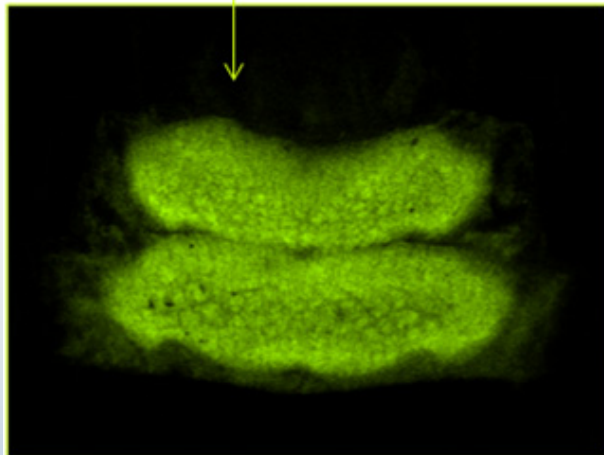
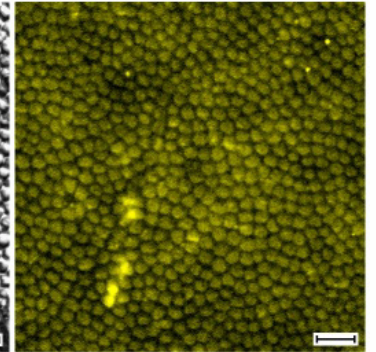
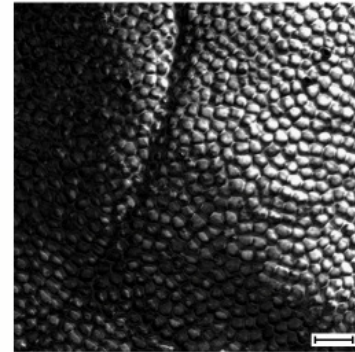
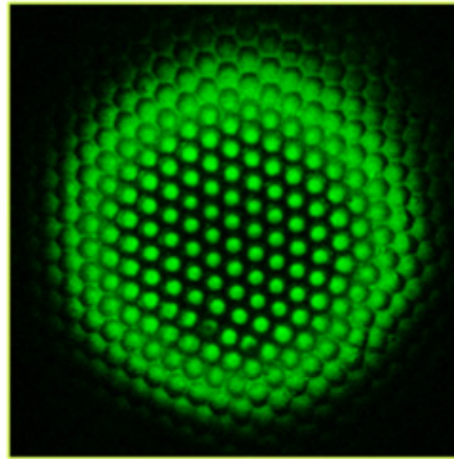
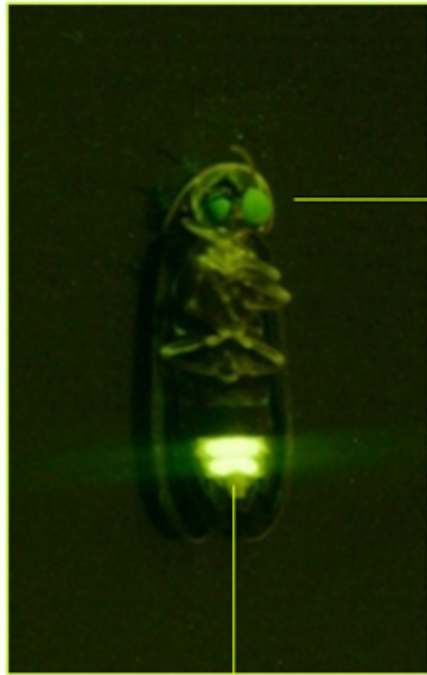


zdroj **energie**
srdcovej bunky

Mitochondrie srdcovej bunky označené fluorescenčnou farbičkou MitoTracker

Výskum bioluminiscencie hmyzu

(spolupráca s GÚ a ZÚ SAV)





Ďakujem za pozornosť

V prezentácií boli použité obrazové materiály z nasledovných zdrojov:

Olympus microscopy resource center / <http://www.olympusmicro.com>

Carl Zeiss / www.zeiss.de

Invitrogen - QuantumDots www.qdots.com

University of St. Andrews

Slovak Academy of Sciences

Laserlab Europe www.laserlab-europe.eu

International Laser Centre www.ilc.sk