

Premio Nobel in Fisica 2014

(by Catalina Curceanu)

The Royal Swedish Academy of Sciences has decided to award the

2014 NOBEL PRIZE IN PHYSICS

to:



Illustrations: Niklas Elmehed © Nobel Media AB

Isamu Akasaki, Hiroshi Amano and Shuji Nakamura

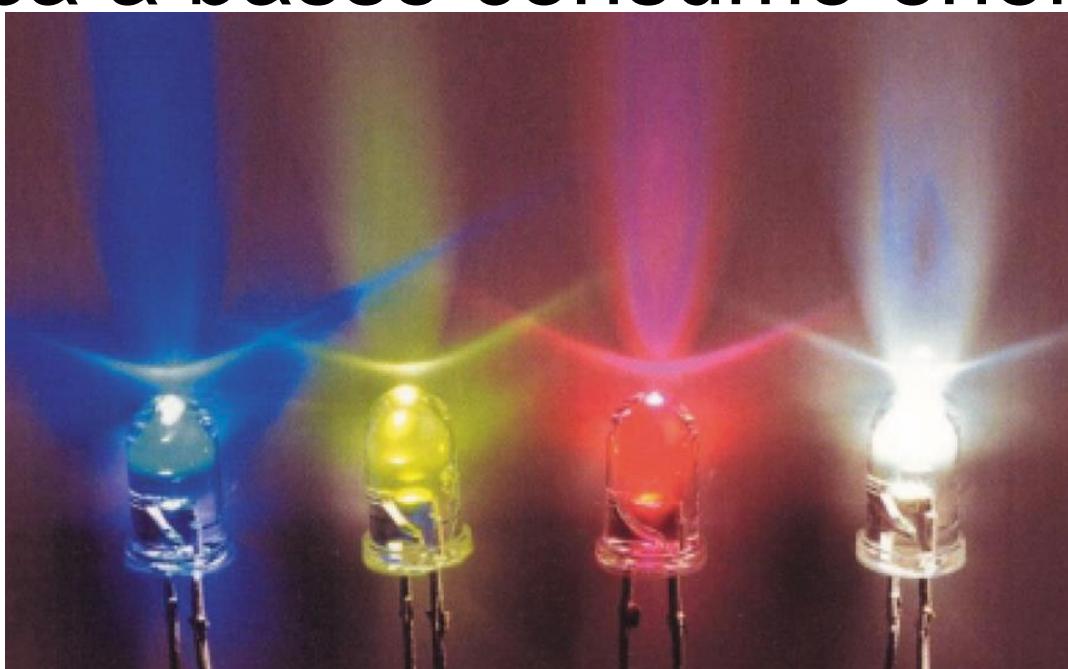
"for the invention of efficient blue light-emitting diodes which has enabled bright and energy-saving white light sources"

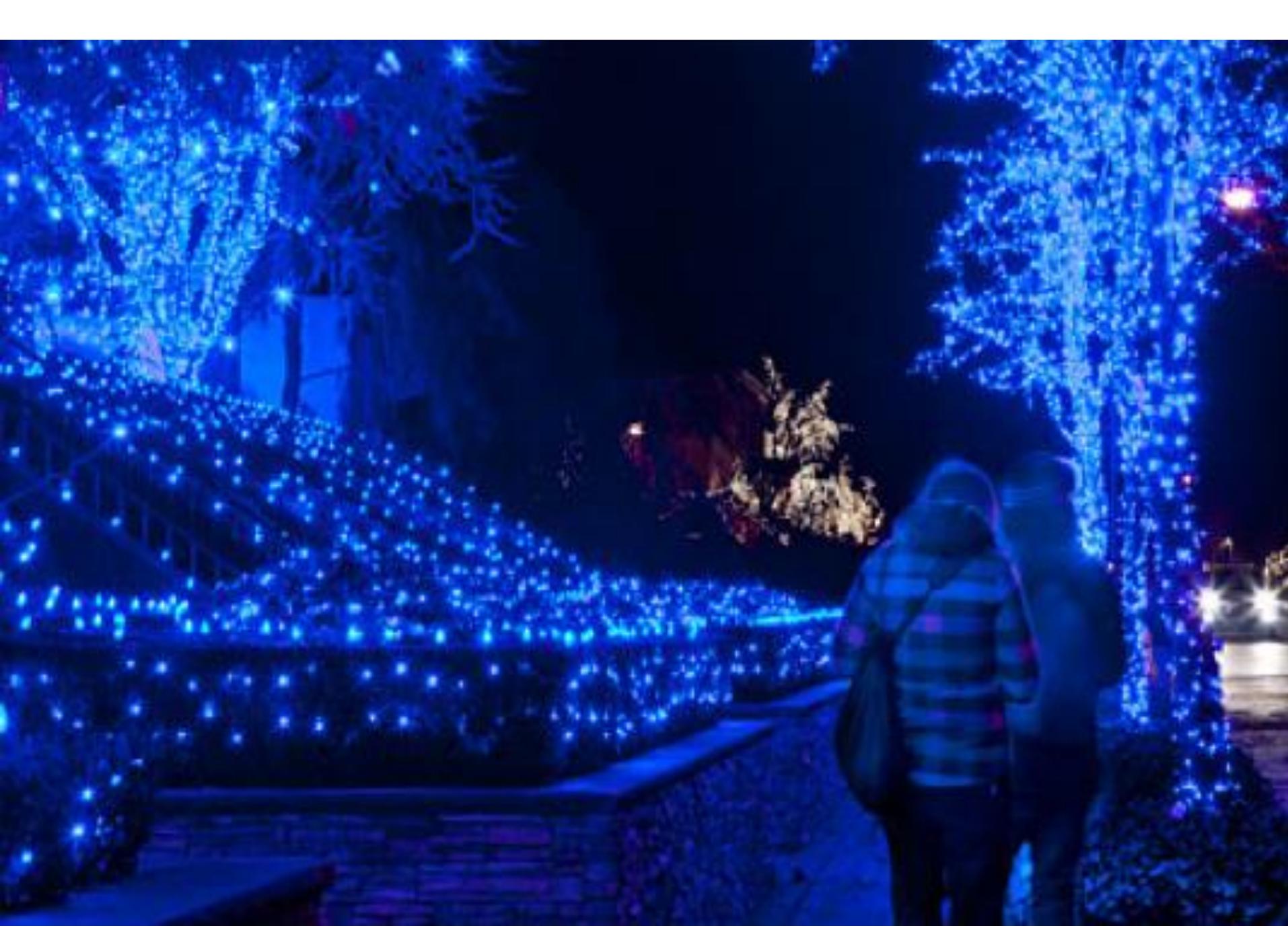
Isamu Akasaki
Citadino giapponese
nato nel 1929
Prof. Meijo Univ., Nagoya

Hiroshi Amano
Cittadino giapponese
Nato nel 1960
Prof. Nagoya Univ.

Shuji Nakamura
Cittadino americano
Nato nel 1954
Prof. Univ. califorinia
(PhD 1994 Univ.
Tokushima)

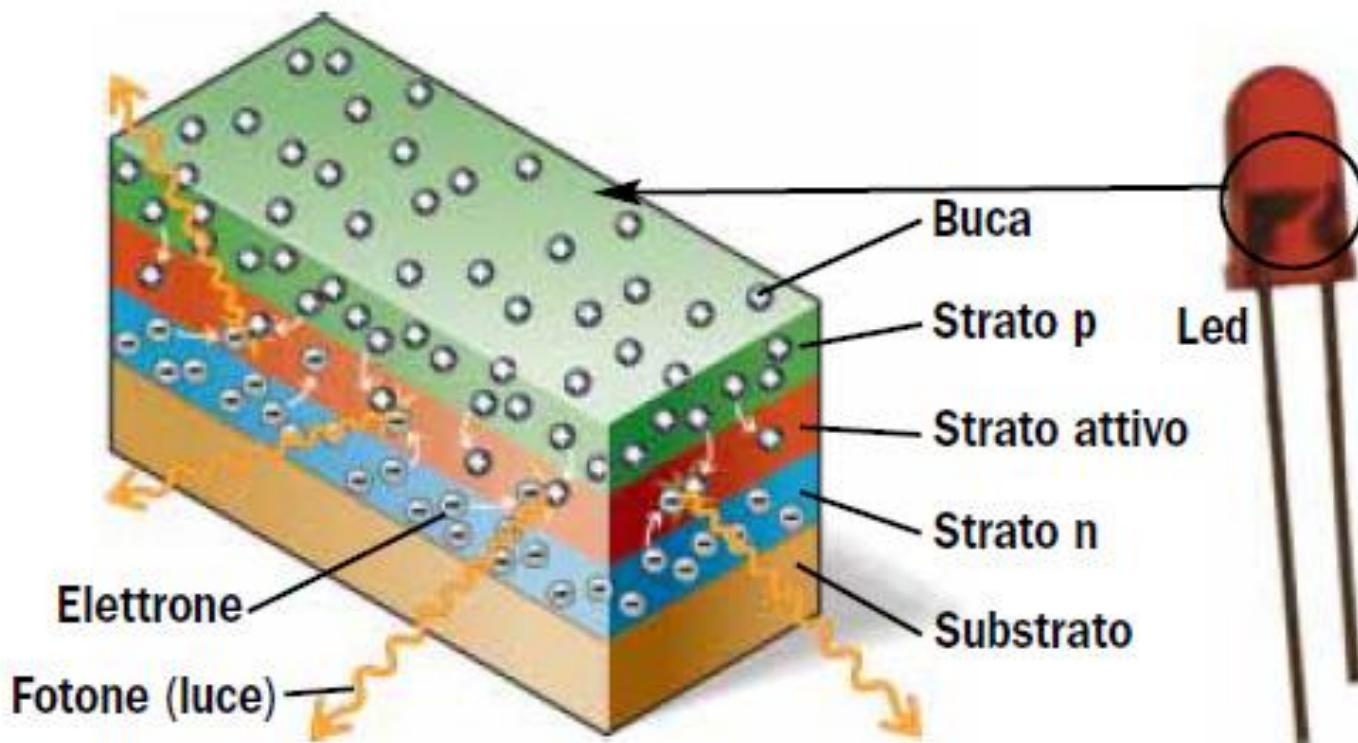
Il Premio Nobel per la Fisica 2014 è stato assegnato congiuntamente a Isamu Akasaki , Hiroshi Amano e Shuji Nakamura **per l'invenzione di LED (Light Emitting Diode) a luce blu**, che hanno permesso lo sviluppo di sorgenti molto efficienti e di luce bianca a basso consumo energetico



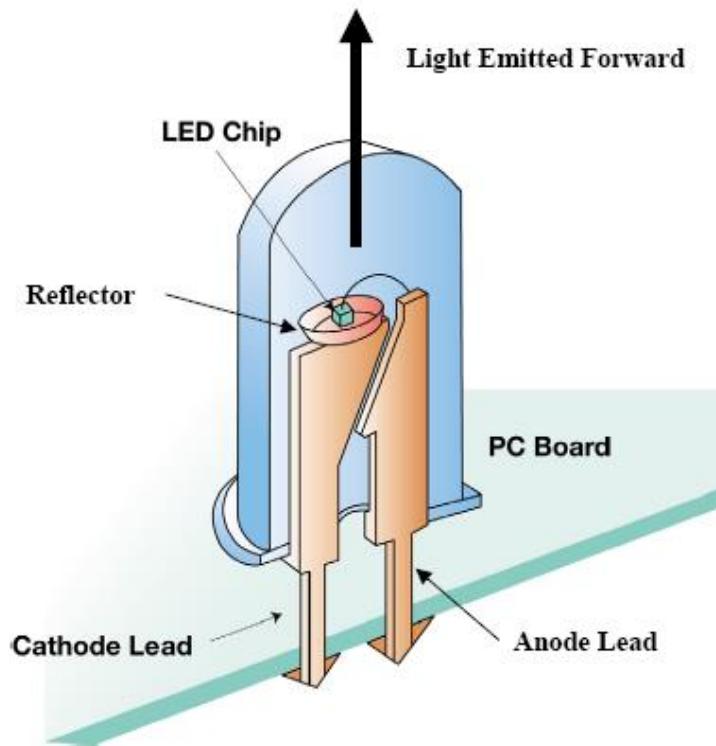
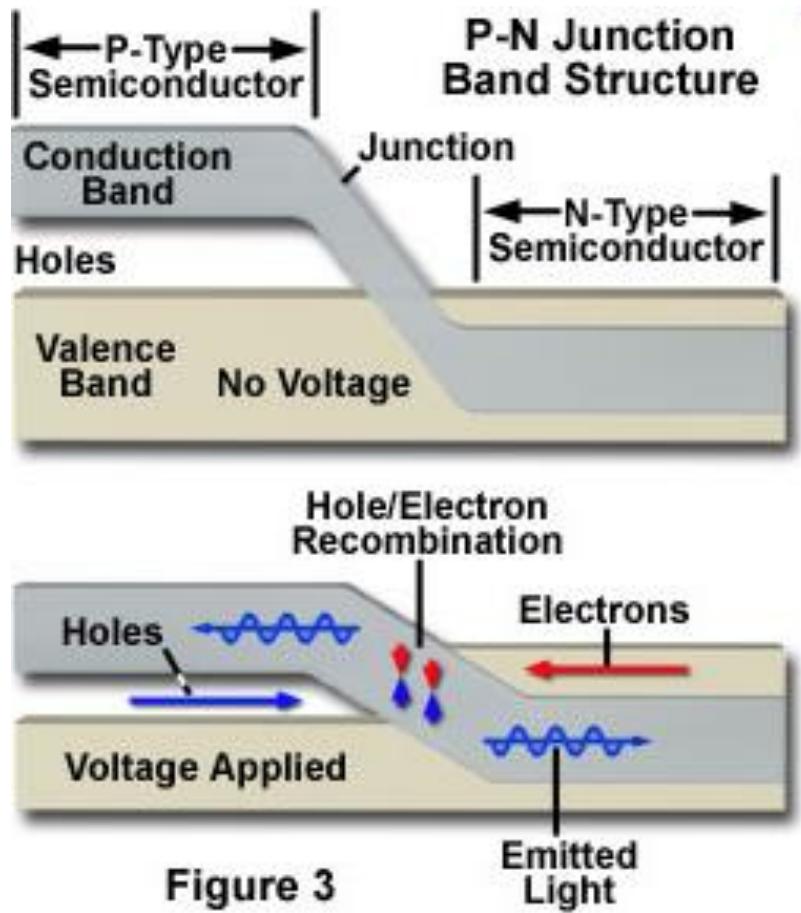
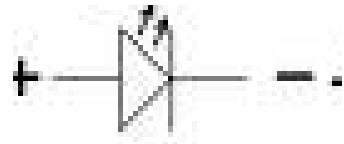


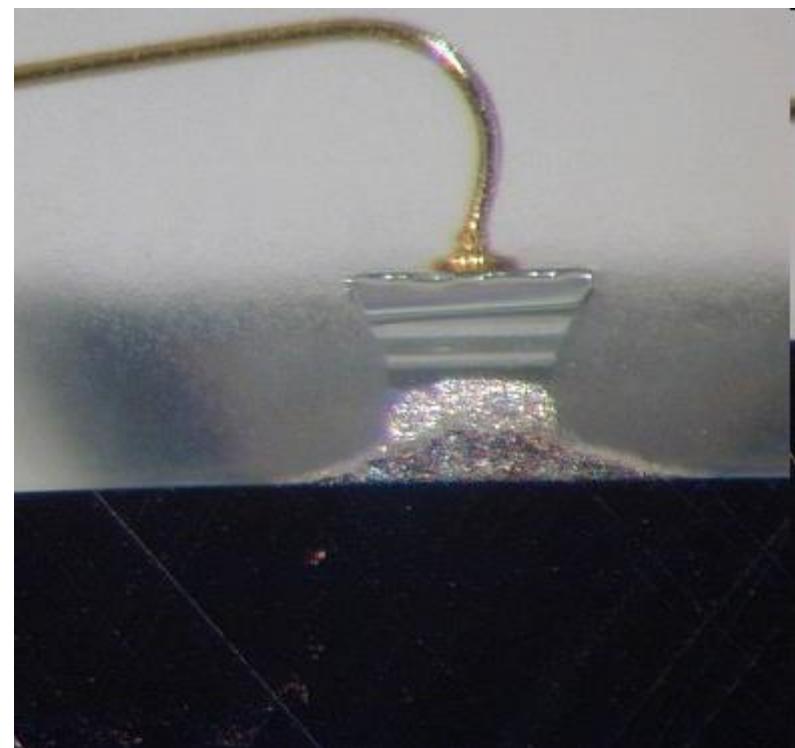
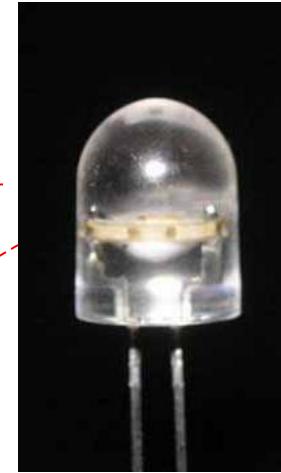
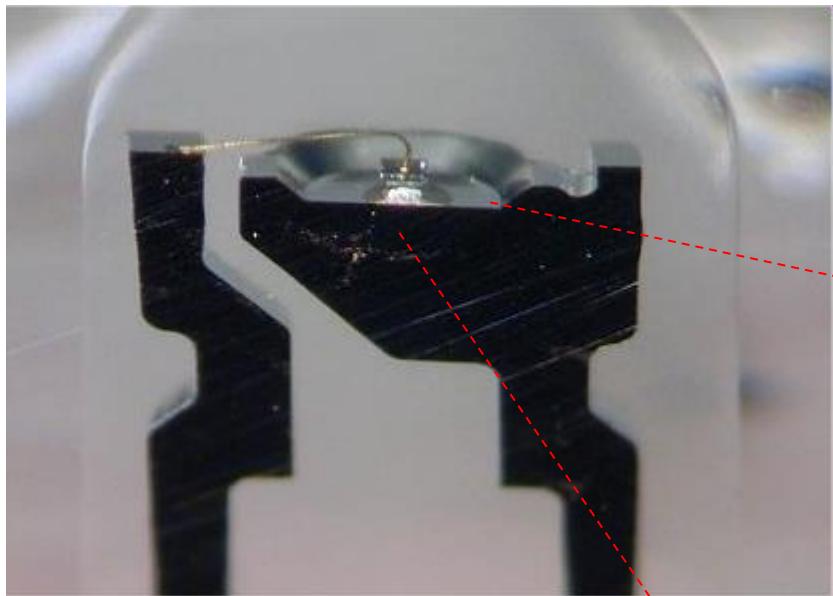
Cosa e' un LED?

I LED (da “Light emitting diode”: diodo che emette luce) sono dispositivi realizzati in una serie di vari strati di semiconduttori che trasformano l'elettricità in luce (fotoni). – **Meccanica Quantistica!**



Pompaggio elettrico LED





Fenomeno già visto agli inizi nel 1907 - emissione di luce da parte di alcuni materiali attraversati da corrente elettrica (MQ ancora da venire!)

1962 – LED a luce rossa:

Nick Holonyak ha fatto il primo LED con luce rossa con l'emissione abbastanza brillante da poter essere utilizzato come indicatore



1968 – LED a luce rossa: prima produzione di massa

Hewlett Packard calculators



1980 – LED a luce rossa, verde, gialla



Mancavano i LED **BLU**...grave problema!

Flusso luminoso

$$\eta_{lum} = \frac{\int_0^{\infty} \bar{y}(\lambda) I(\lambda) d\lambda}{\int_0^{\infty} I(\lambda) d\lambda}$$

($\lambda=450$ nm) 40 lumen/watt

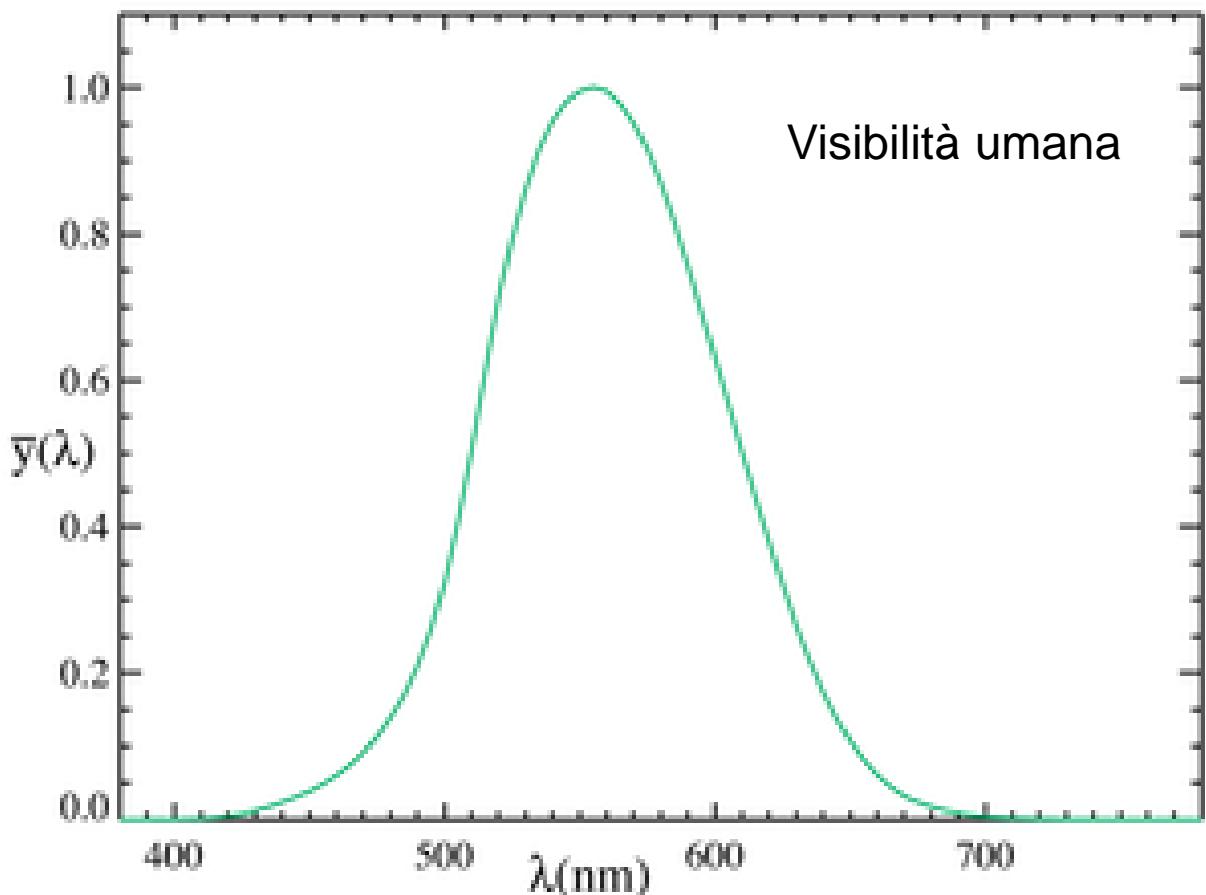
($\lambda=500$ nm) 200 lumen/watt

($\lambda=555$ nm) 683 lumen/watt

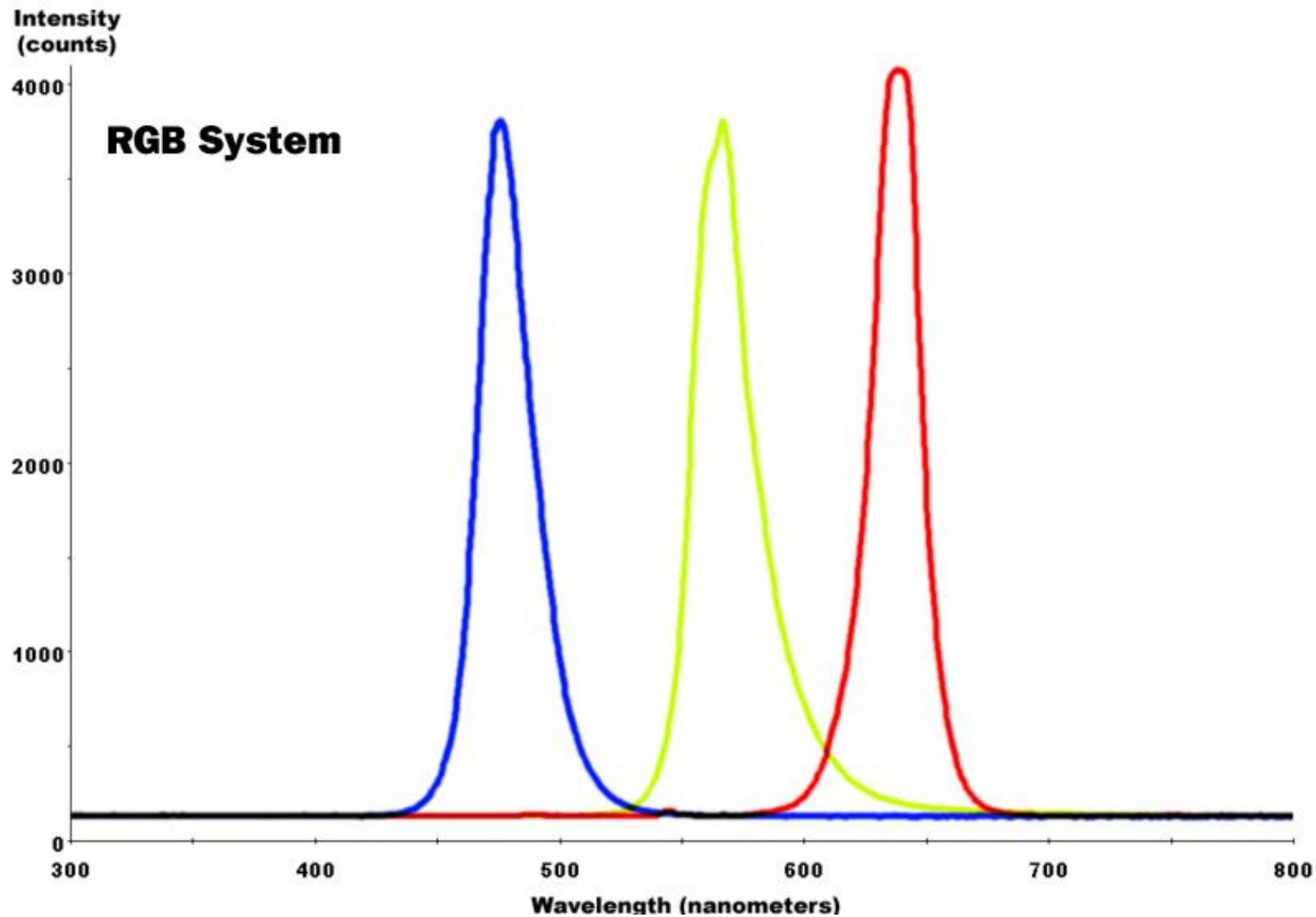
($\lambda=600$ nm) 400 lumen/watt

($\lambda=650$ nm) 70 lumen/watt

(Luce bianca) 250 lumen/watt



Serve il diodo BLU – LUCE BIANCA



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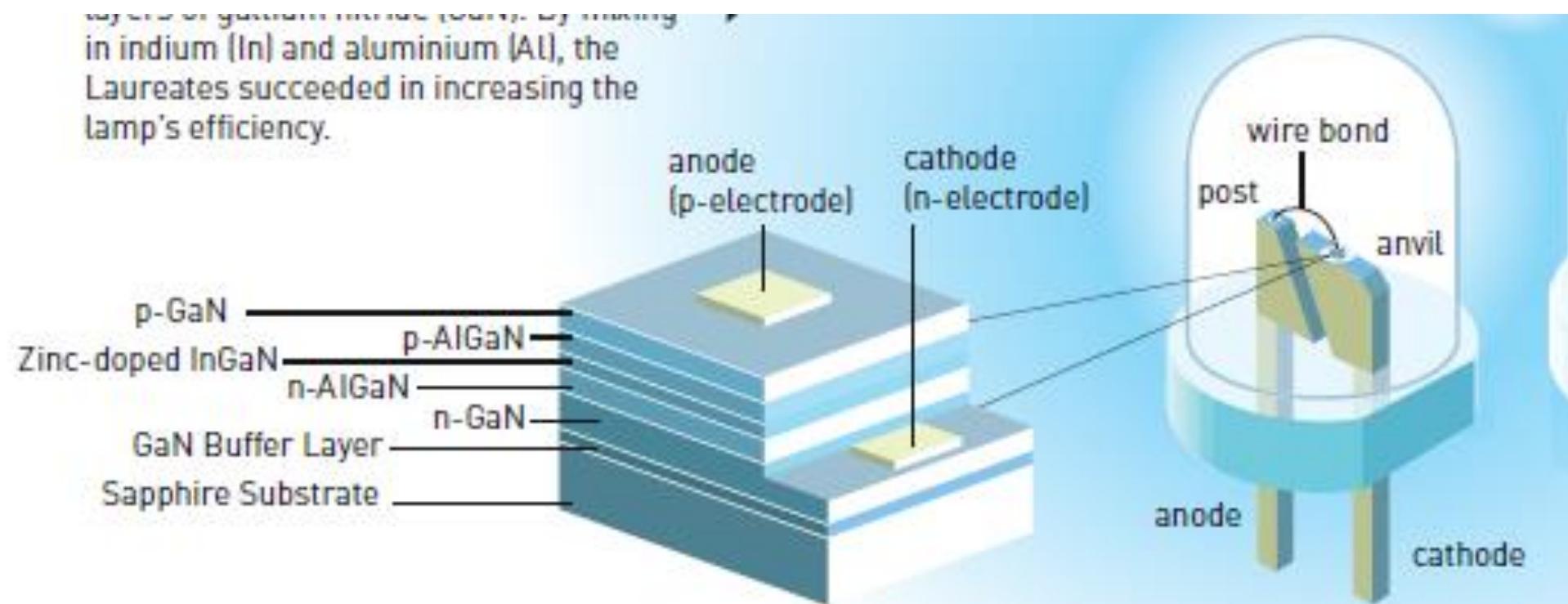
"for the invention of efficient blue light-emitting diodes which has enabled bright and energy-saving white light sources"

Illustration: Niklas Elmehed © Nobel Media AB

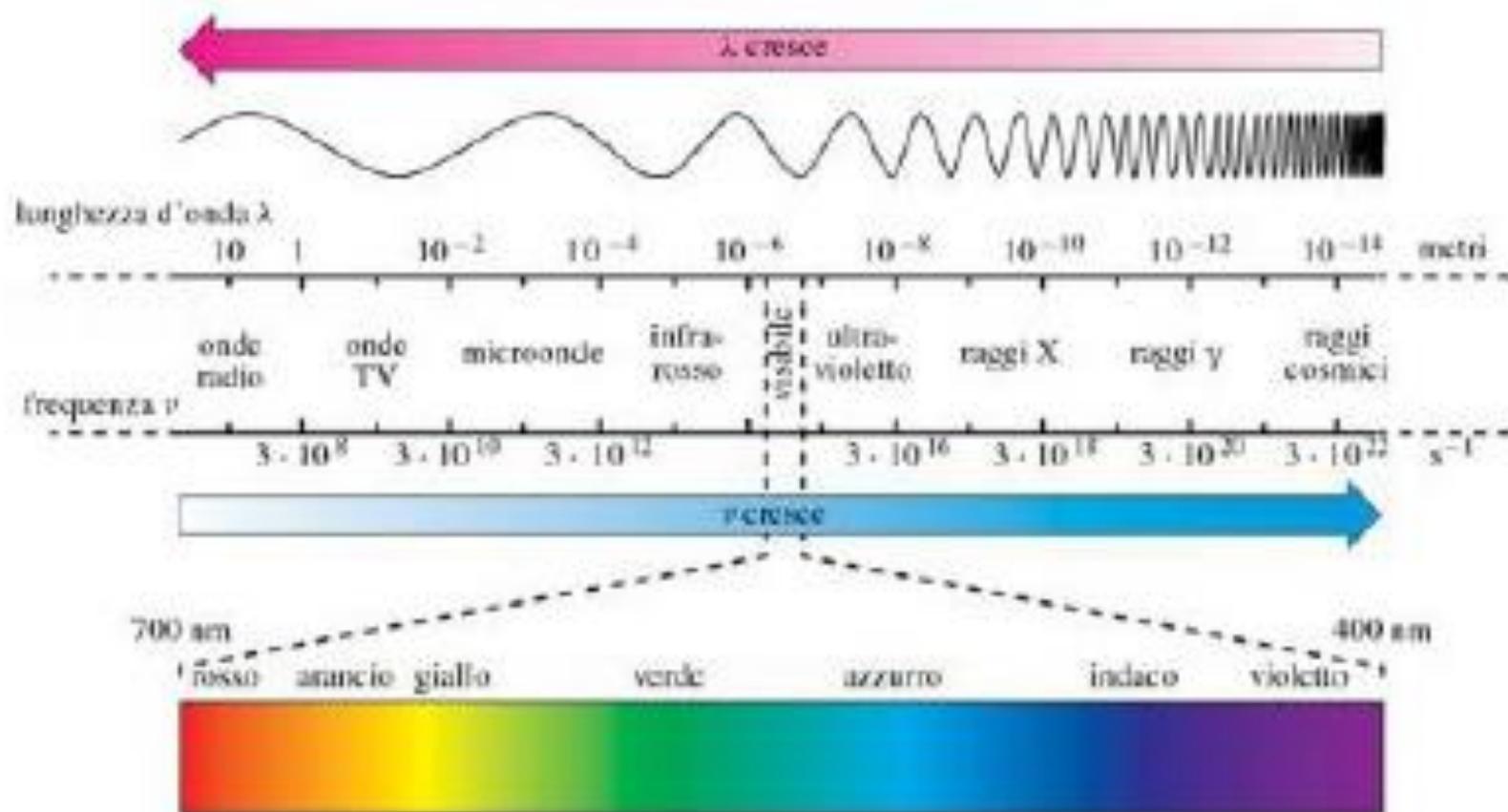


Lavoro MOLTO DIFFICILE sulla scelta dei materiali e delle tecnologie per la deposizione (anni '80 – inizi anni '90)

in indium (In) and aluminium (Al), the Laureates succeeded in increasing the lamp's efficiency.



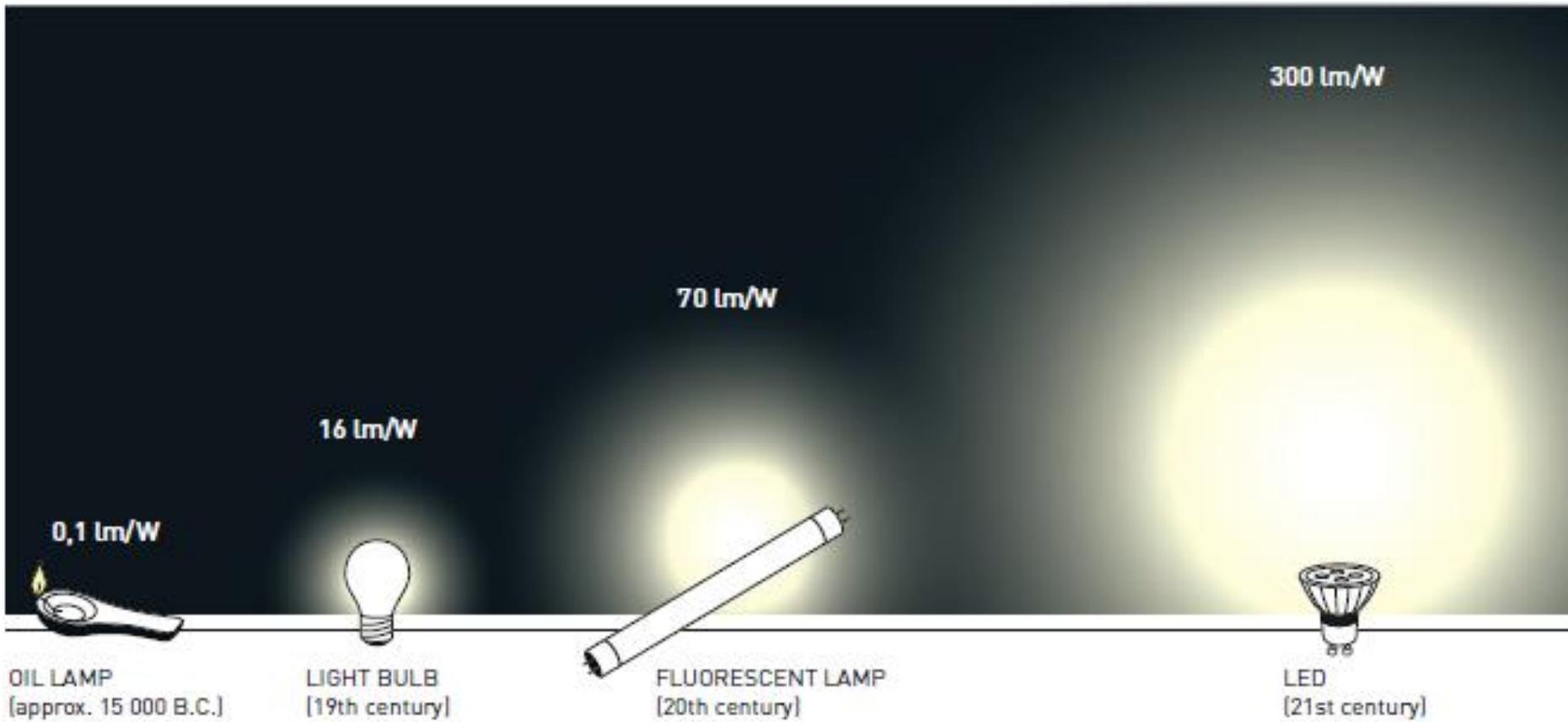
Frequenze del visibile



Drogature - colori - tensioni

- GaAsP = rosso, rosso-arancione, arancione, giallo (1,1-1,2 V)
- GaAIP = verde (2-22 V)
- InGaN = blu-verde, blu (4 V)

Altissima efficienza (piu' tempi di vita lunghissimi! 100,000 ore; circa 11.4 anni):



Definizioni

FLUSSO LUMINOSO prodotto tra la potenza emessa da una sorgente luminosa puntiforme e il coefficiente di visibilità dell'occhio umano. Il coefficiente di visibilità è ottenuto statisticamente come il valore atteso o medio tra un certo numero di soggetti testati.

LUMEN: Equivale al flusso luminoso rilevabile in un angolo solido di 1 steradiante emesso da una sorgente isotropa con intensità luminosa di 1 candela.

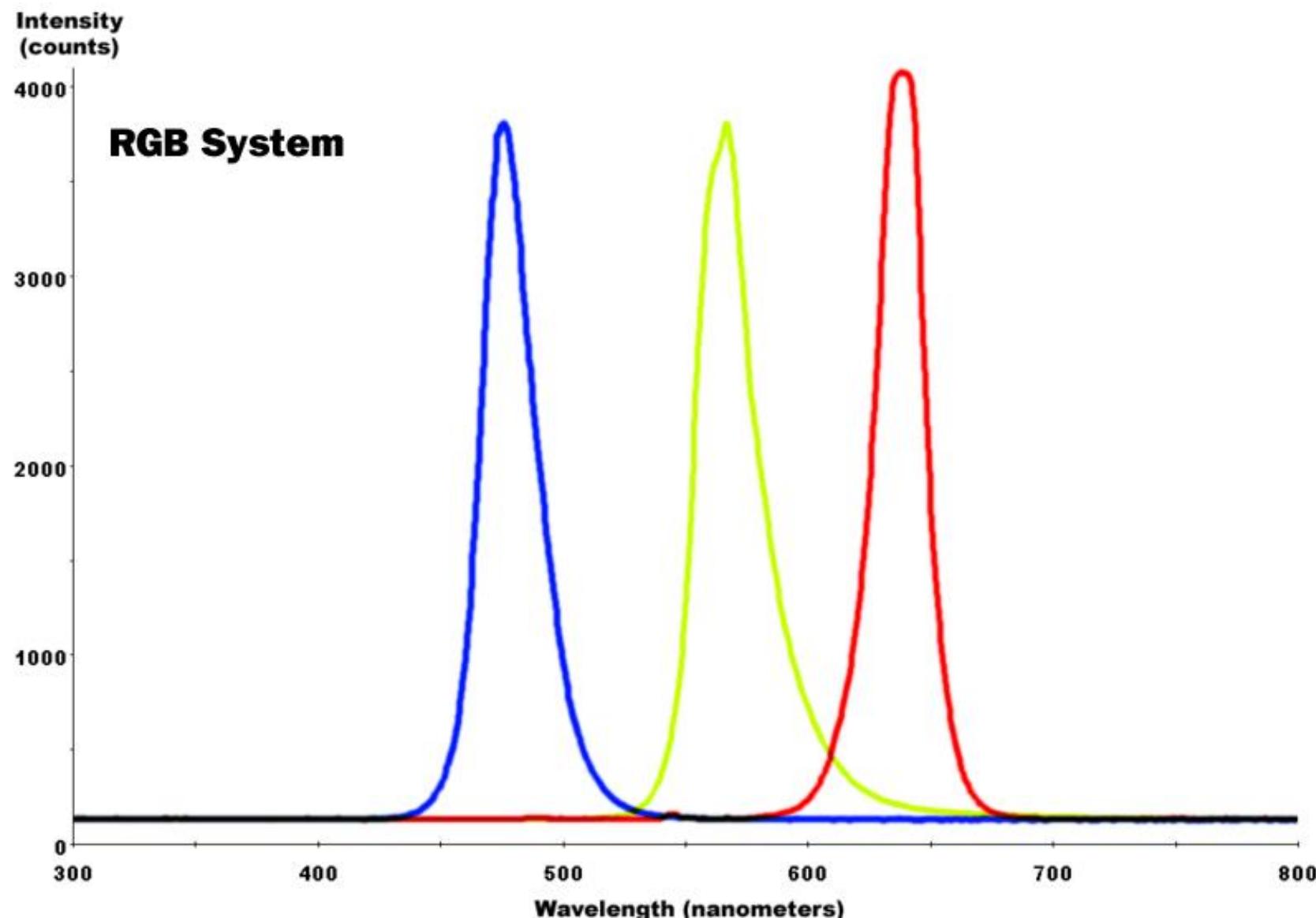
CANDELA: Una candela è pari all'intensità luminosa, in una data direzione, di una sorgente emettente una radiazione monocromatica di frequenza pari a $540 \cdot 10^{12}$ Hz ($\lambda=555$ nm) e di intensità in quella direzione di 1/683 di watt per steradiante.

LED luce bianca (varie tecnologie) – fondamentale

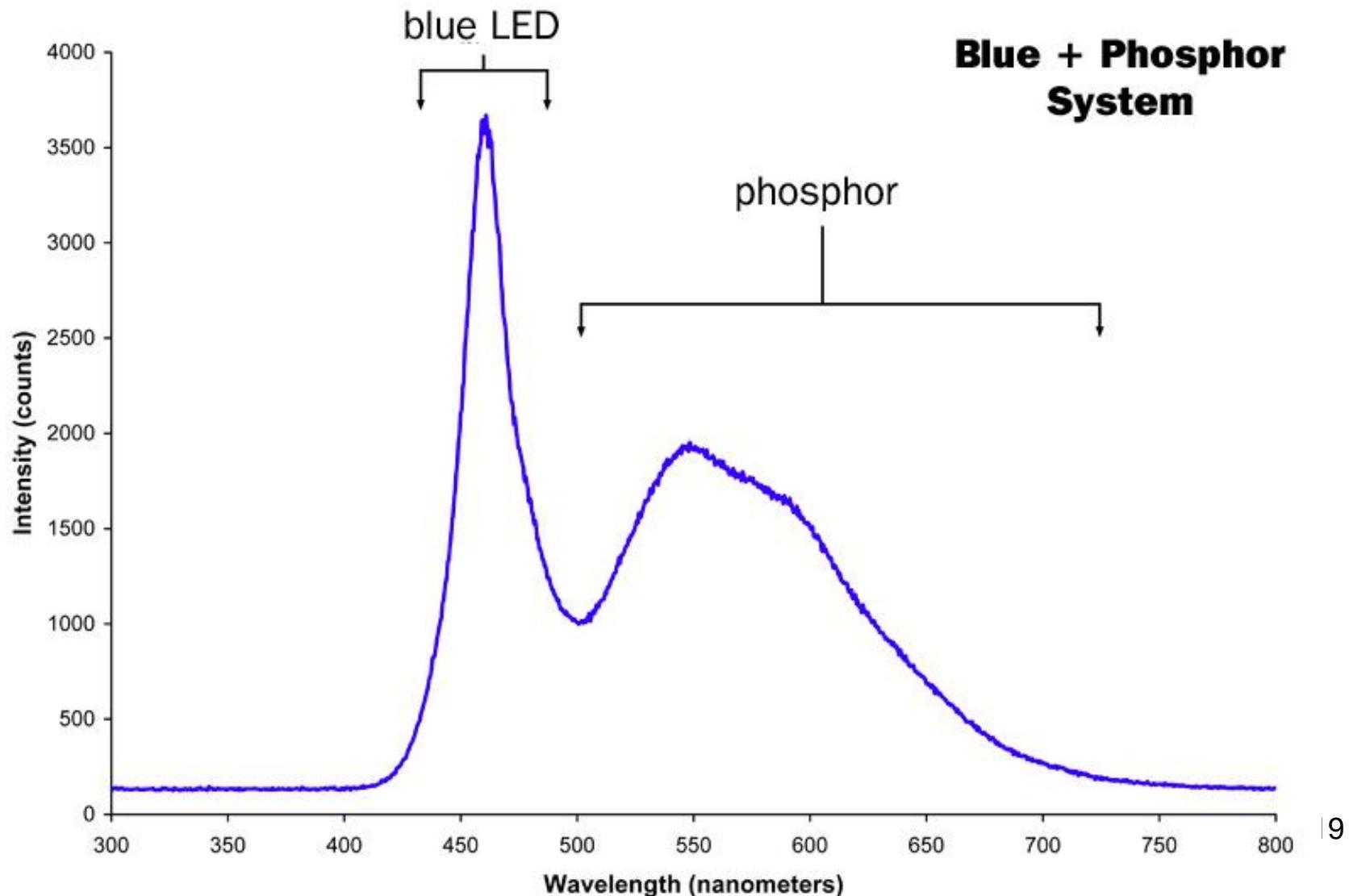
Il LED a luce BLU



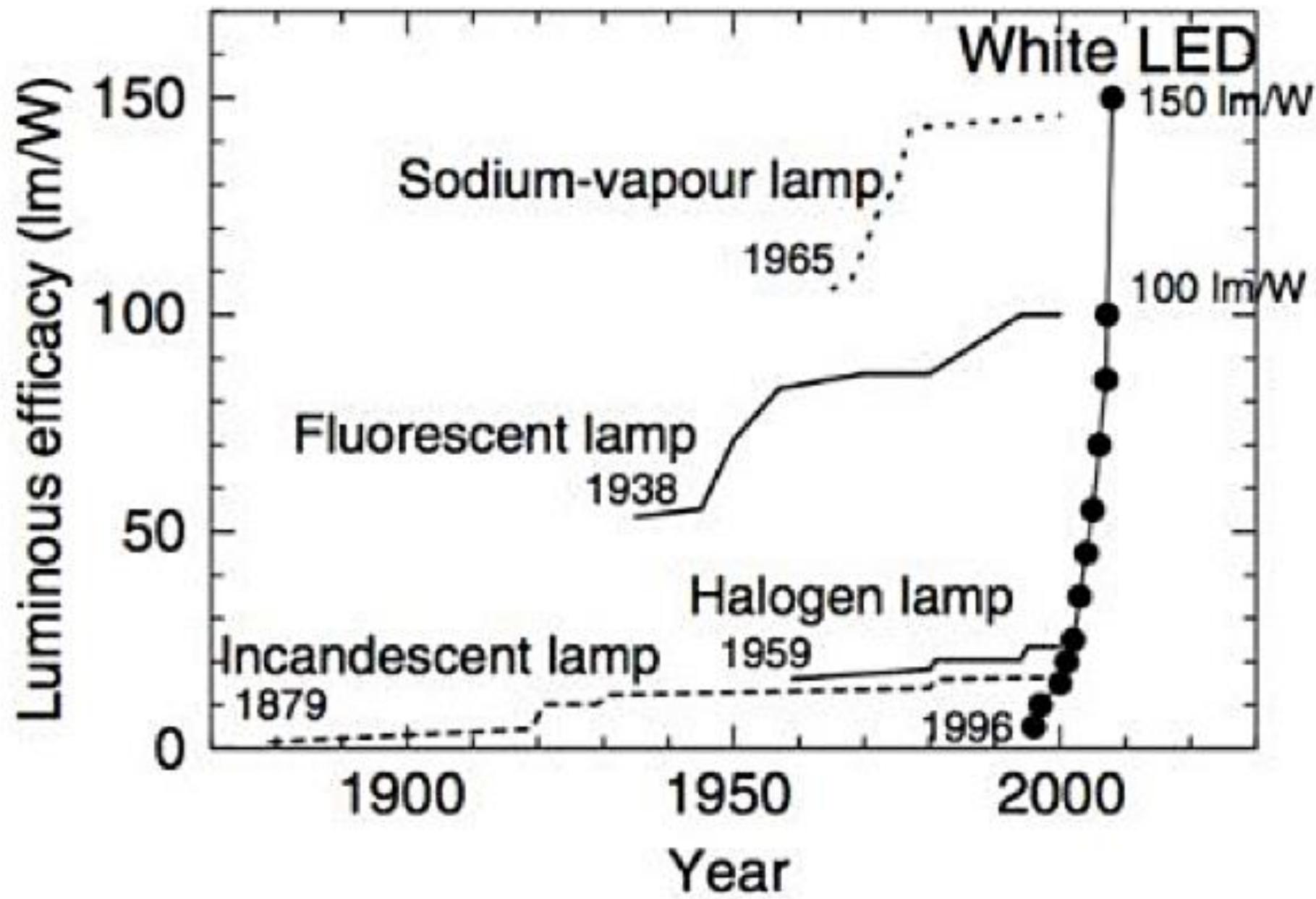
Luce bianca - 3 led: rosso, verde, blu



Luce bianca – LED blu + schermo fosforo



Categoria	Tipo	Efficienza (lm/W)	Efficienza
<u>Combustione</u>	<u>candela</u>	0,3	0,04%
	<u>lampada a gas</u>	2	0,3%
<u>Incandescente</u>	100 W tungsteno, incandescente (13,8	2,0%
	100 W tungsteno, <u>alogena</u>	16,7 [2,4%
	500 W tungsteno, <u>alogena</u>	19,8 [2,9%
<u>Lampada ad arco</u>	<u>Lampada allo xeno</u>	30–50	4,4–7,3%
	Lampade a <u>mercurio-xeno</u>	50–55	7,3–8,0%
<u>Fluorescente</u>	9–26 W fluorescente compatta	57–72	8–11%
	T8 tubo fluorescente	80–100	12–15%
<u>Lampada a scarica</u>	<u>Lampada a vapori di sodio</u> (alta pressione)	85–150	12–22%
	<u>Lampada a vapori di sodio</u> (bassa pressione)	100–200	15–29%
<u>LED</u>	LED bianco	10–160	1,5–24%
Massimo teorico	Luce bianca	250	36%
Massimo teorico	Luce monocromatica verde	683	100% 20





Se tutte le luci del mondo fossero a LED:



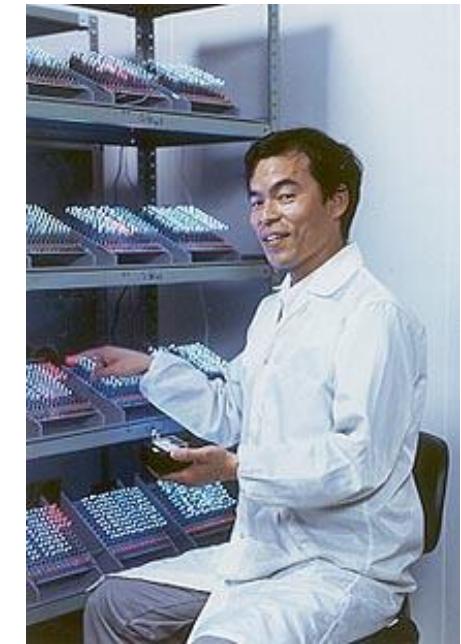
40%
ELECTRICITY
SAVINGS

**È un Nobel nello spirito di Alfred Nobel:
Premiare le invenzioni e gli studi che hanno
una tangibile ricaduta sull'Umanità.**

The Laureates challenged established truths; they worked hard and took considerable risks. They built their equipment themselves, learnt the technology, and carried out thousands of experiments. Most of the time they failed, but they did not despair; this was laboratory artistry at the highest level. :

....But my bosses said it would be impossible to create a blue LED at Nichia, because many big companies and many research teams in big universities were trying to do it and were failing. So I went to my company's chairman, Nobuo Ogawa, who was my professor's friend, and the president Eji Ogawa, who was his son-in-law. I asked them if they would let me do research on blue LEDs and they said "Sure. No problem. Go ahead." I was very surprised. I asked them to give me a large budget so I could do it. "Please give me three million U.S. dollars," and they said "Sure. No problem." They had faith in me because, despite the dismal sales

(interview 2004 to Nakamura)



For most years the thickness of the coloured line denotes how many laureates shared the prize in that year. In years when the prize was split between two disciplines (in 1970, for example), two lines are used, with each denoting the number of laureates in that discipline.

Timeline key

- No prize
- One laureate
- Two laureates
- Three laureates

