

TRANZYSTOR

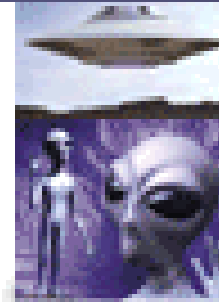
i jego historia...

Plan seminarium:

- Powrót do przeszłości...
- Rodzaje tranzystorów...
- Budowa i działanie tranzystorów...
- Układy scalone...
- Prawo Moore'a...
- Czekaając na przyszłość...

Nieziemska technika:

Did 1947 UFO landing
in Roswell, New Mexico
lead Bell Scientists to
discover the Transistor?



Did Bell Labs
dismantle space
craft & learn
how to make
Lasers & ICs?

Jan. 28, 1930.

J. E. LILIENFELD

1,745,175

METHOD AND APPARATUS FOR CONTROLLING ELECTRIC CURRENTS

Filed Oct. 8, 1926

Sept. 13, 1932.

J. E. LILIENFELD
AMPLIFIER FOR ELECTRIC CURRENTS
Filed Dec. 8, 1926

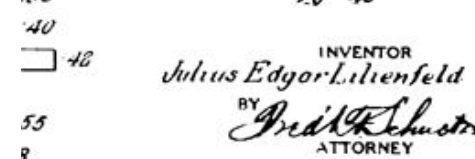
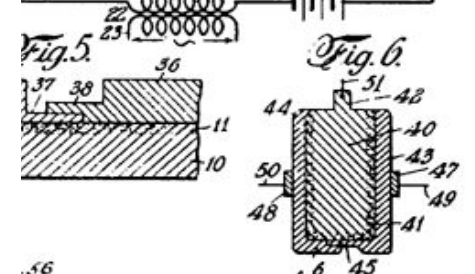
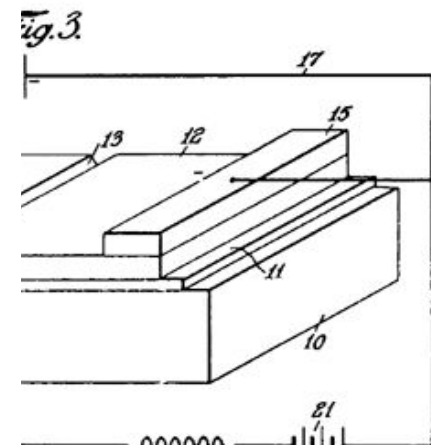
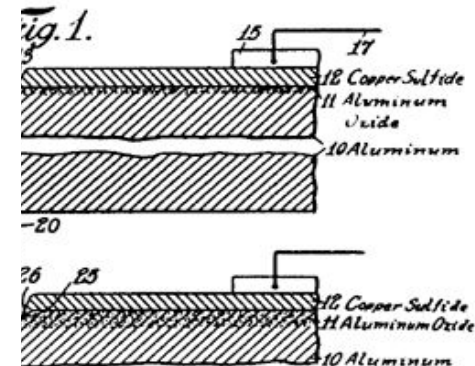
LILIENFELD

1,900,018

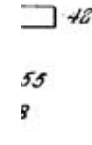
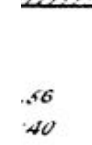
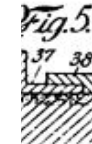
CONTROLLING ELECTRIC CURRENT

March 28, 1928

3 Sheets-Sheet 1



56
40
42
55
8



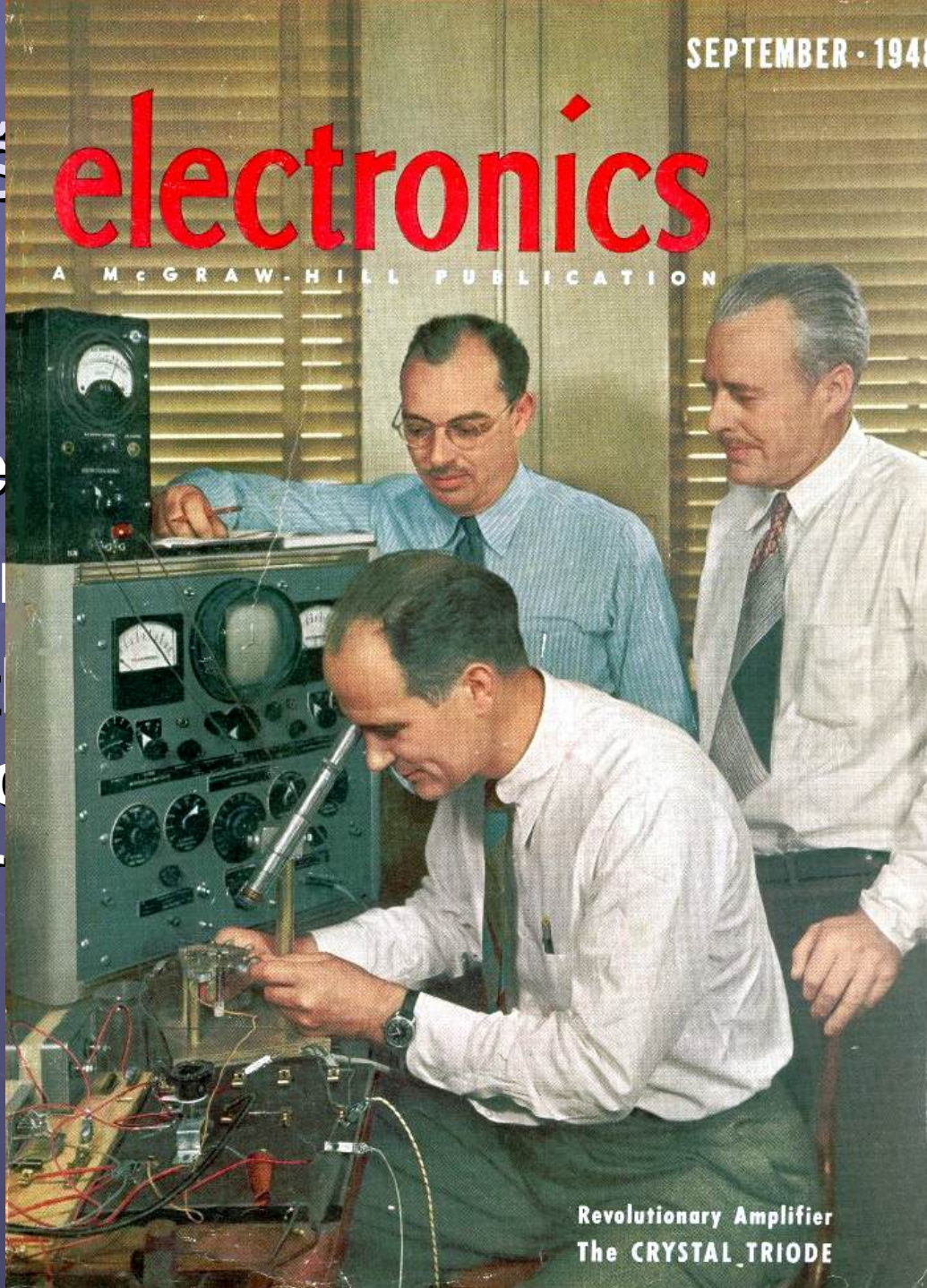
Was

SEPTEMBER · 1948

electronics

A MCGRAW-HILL PUBLICATION

- John
- Walter
- William
- "for the
semiconductor
the transistor"

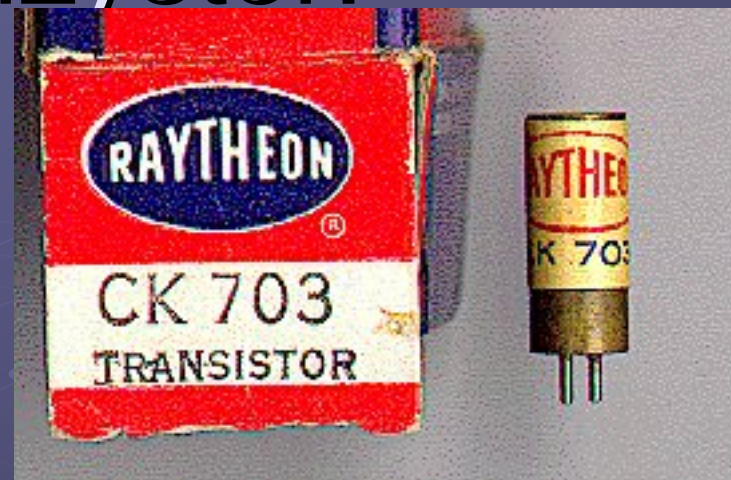
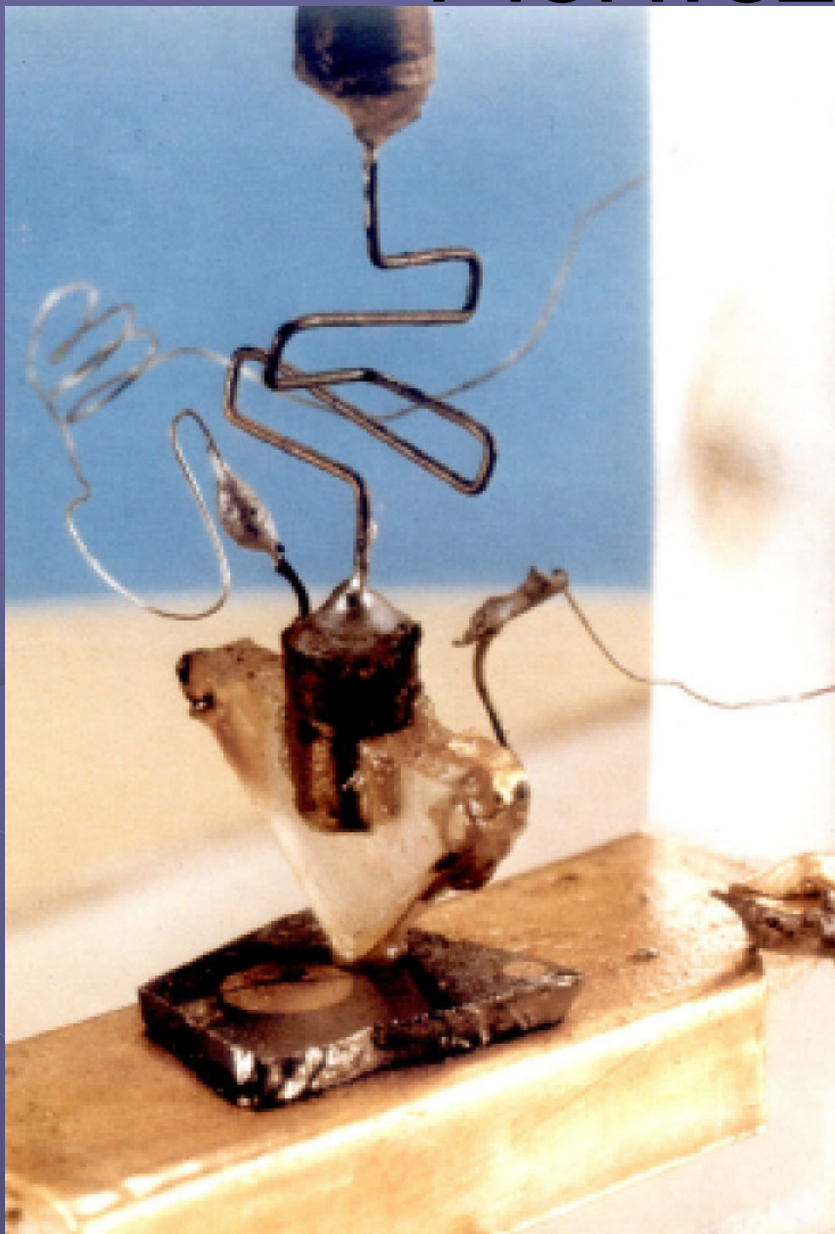


x 1947

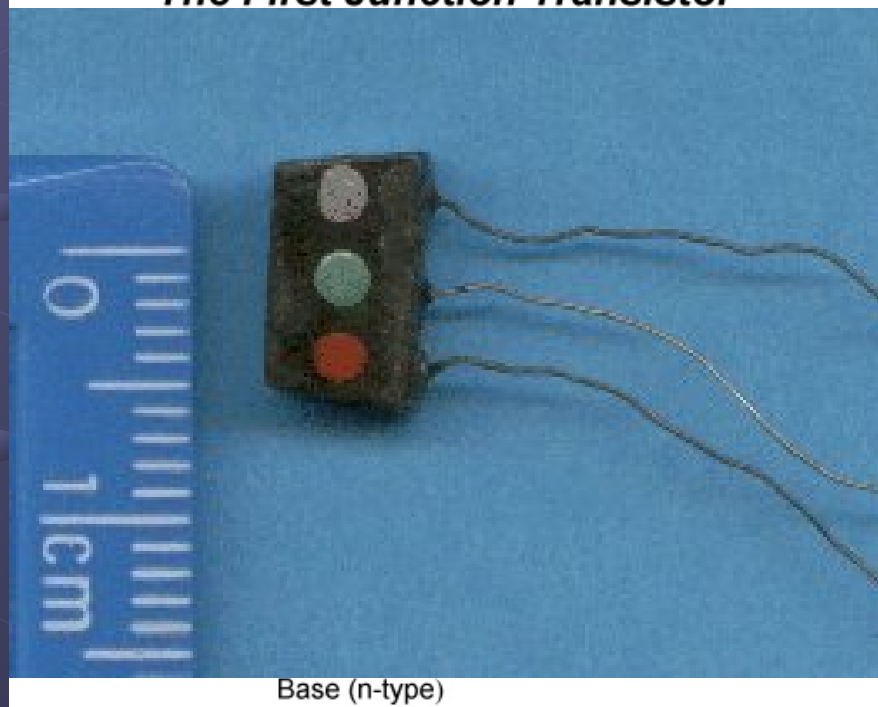
covery of

Revolutionary Amplifier
The CRYSTAL TRIODE

Pierwszy tranzystor:

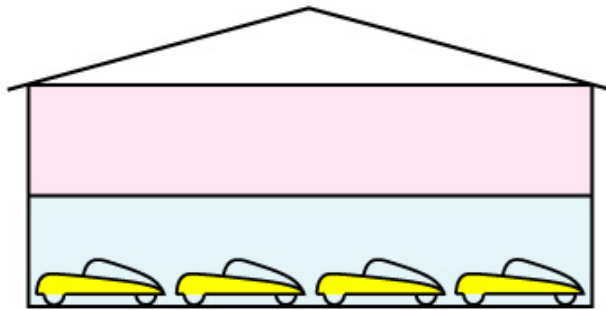


The First Junction Transistor

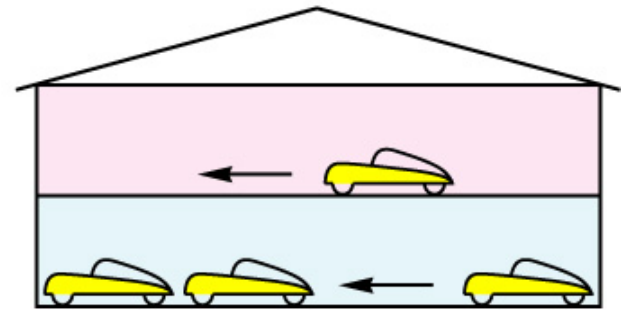


Base (n-type)

(a) Intrinsic semiconductor

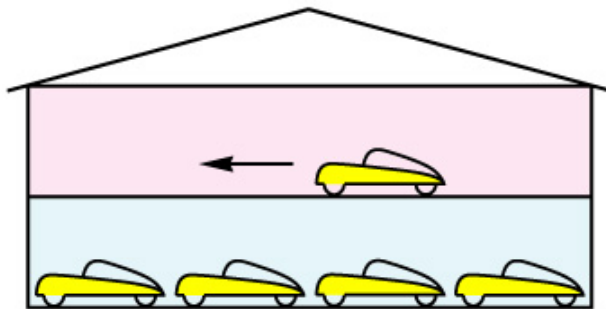


No traffic possible



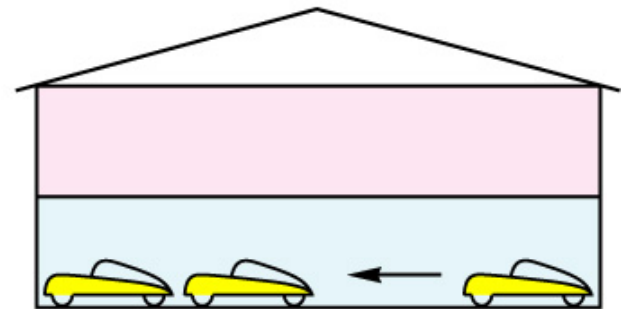
Traffic possible

(b) n -type



Traffic possible

(c) p -type



Traffic possible

Shockley's automobile storage garage model in which electrons in the valence and conduction band are symbolized by cars in a lower and upper level of the garage, respectively.

Rodzaje tranzystorów

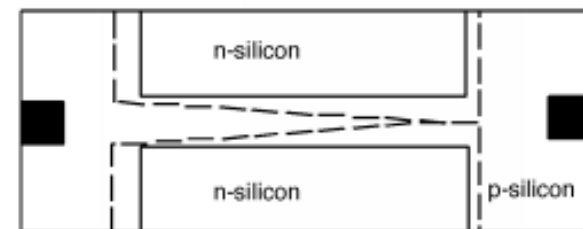
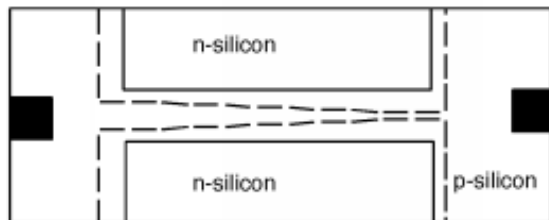
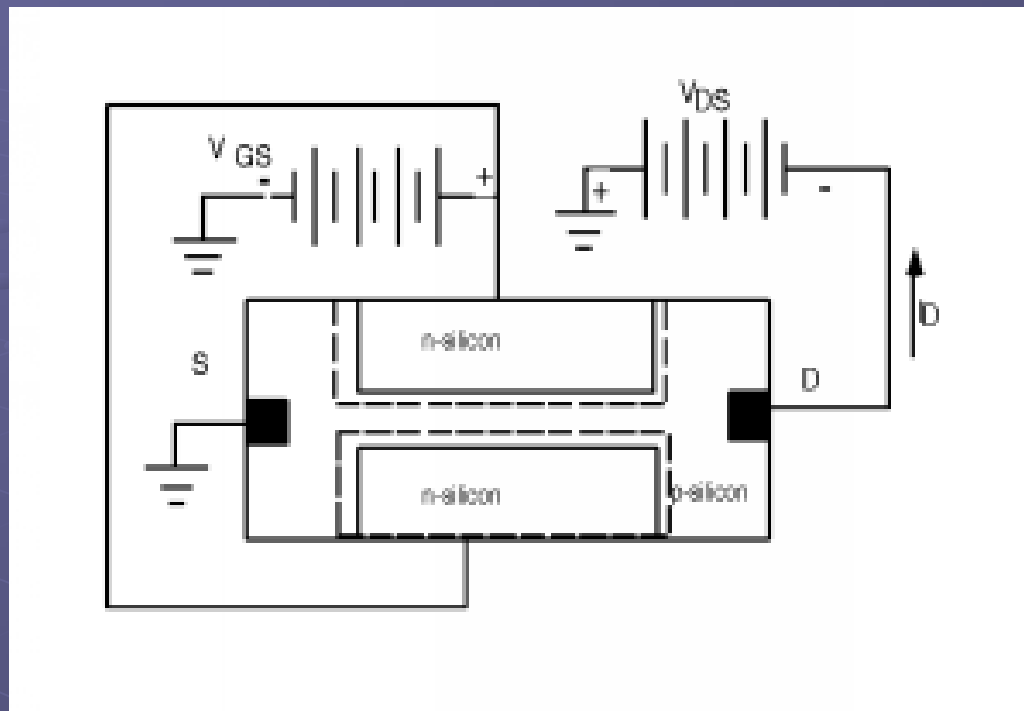
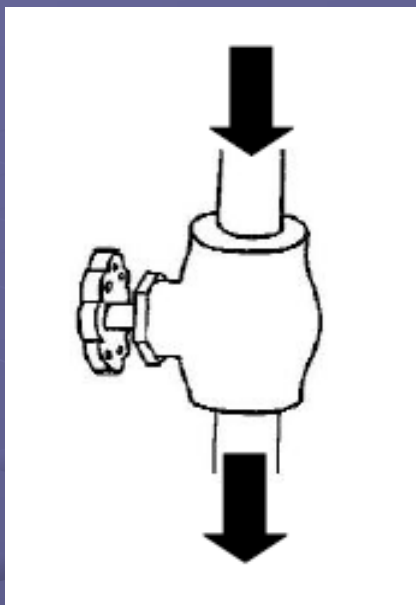
● UNIPOLARNE:

- JUGFET – junction gate field effect transistor
- IGFET – insulated gate field effect transistor
 - Zubażany kanał
 - Wzbogacany kanał

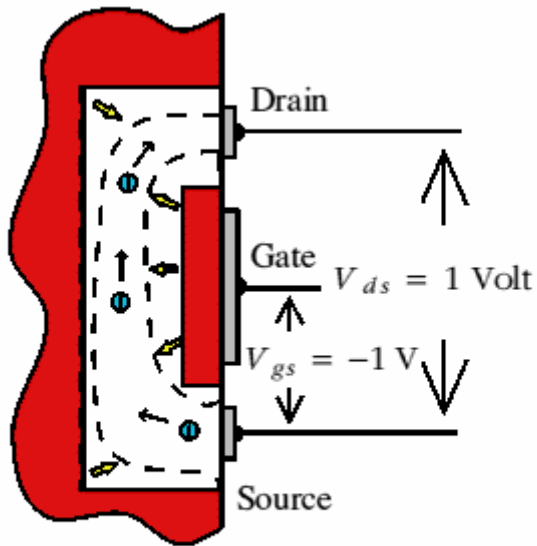
● BIPOLARNE:

- NPN
- PNP

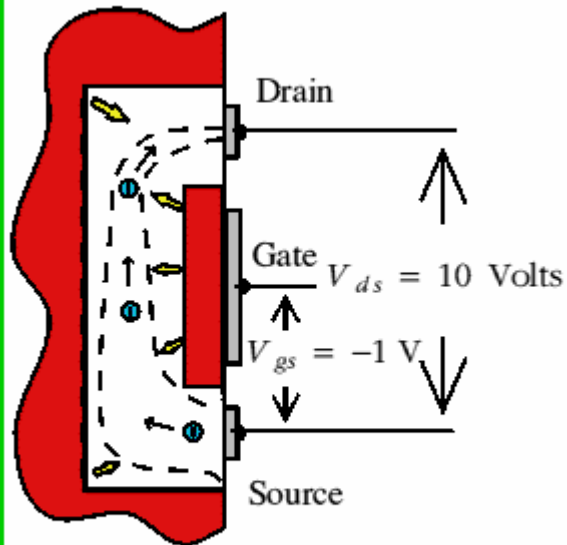
Tranzystor polowy złączowy:



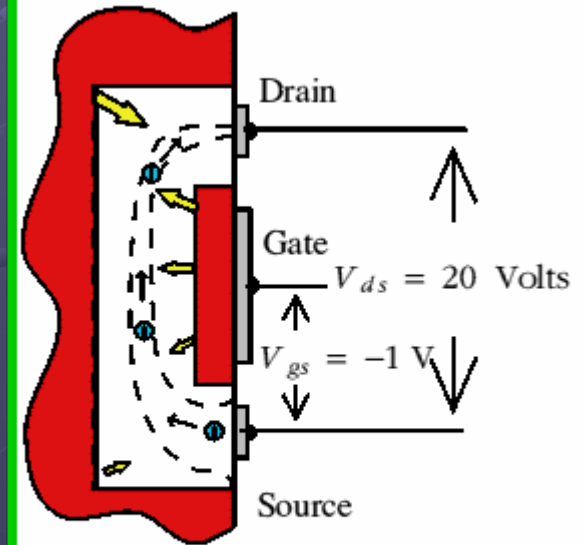
Tranzystor polowy złączowy:



1 Volt drain-source

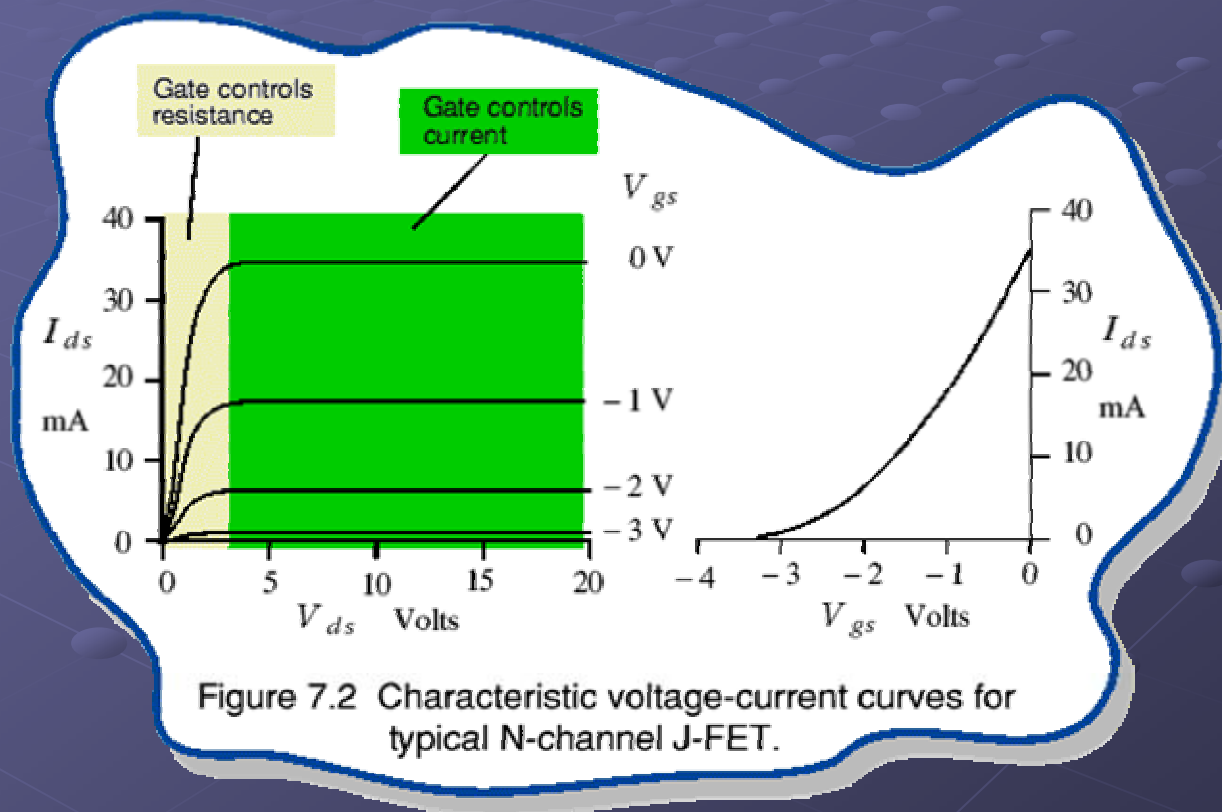


10 Volts drain-source



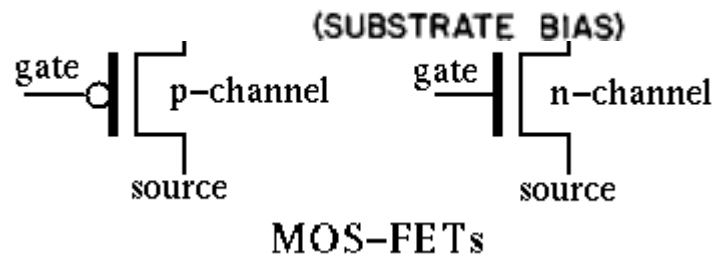
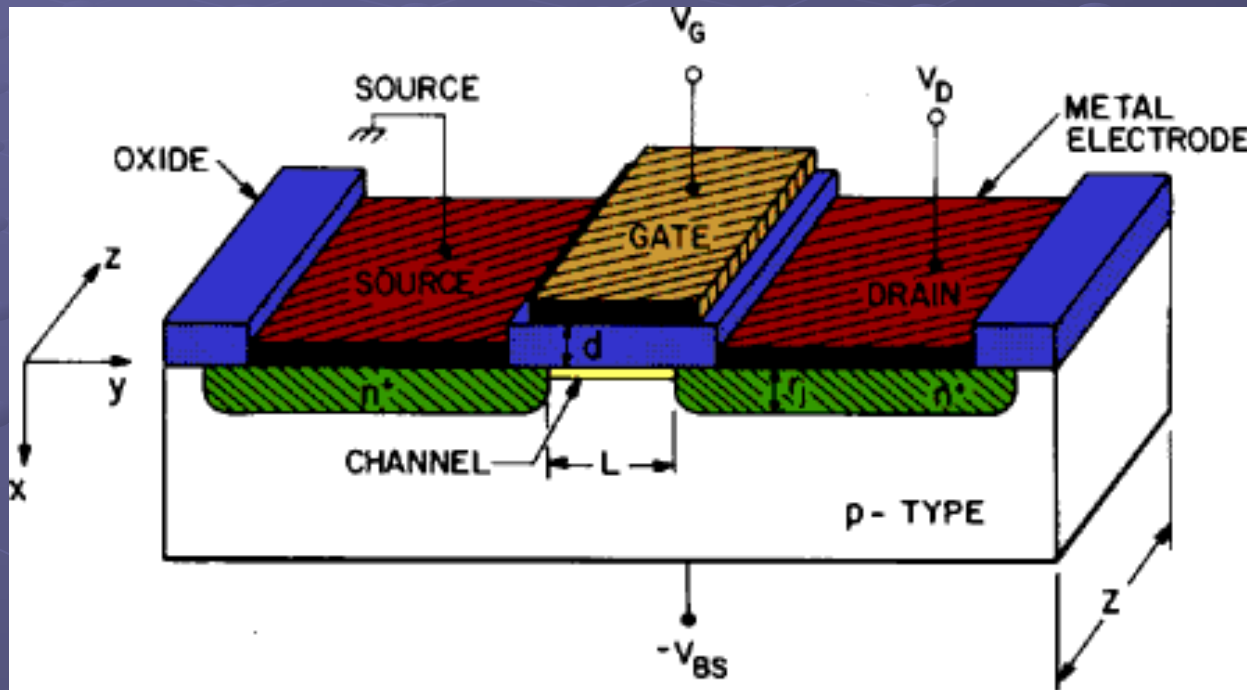
20 Volts drain-source

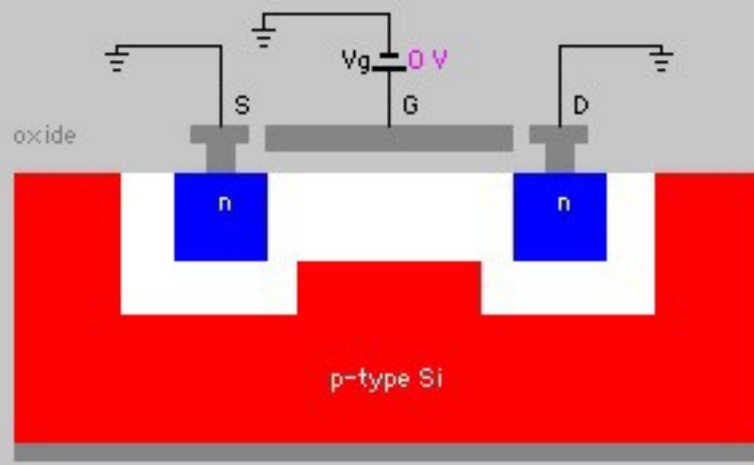
Tranzystor polowy złączowy:



Tranzystory z izolowaną bramką:

● Metal Oxide Semiconductor FET



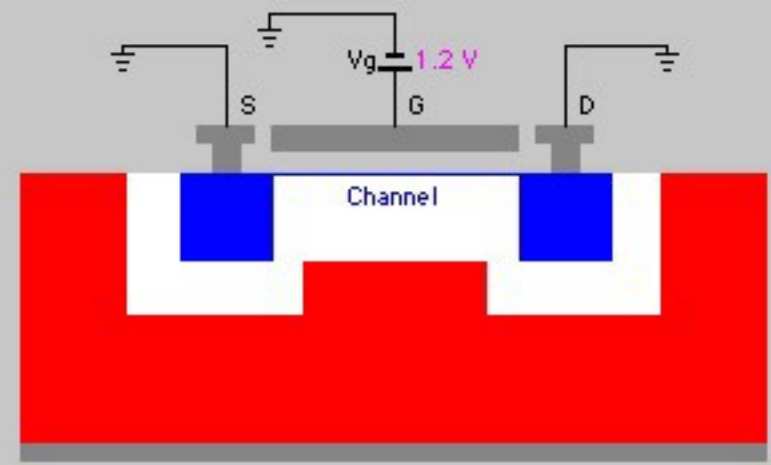


Enhancement-mode (Normally-off) MOSFET

N-channel

$V_g < V_t$: gate bias is less positive than the threshold voltage.

Not enough electrons and no inversion channel is formed.

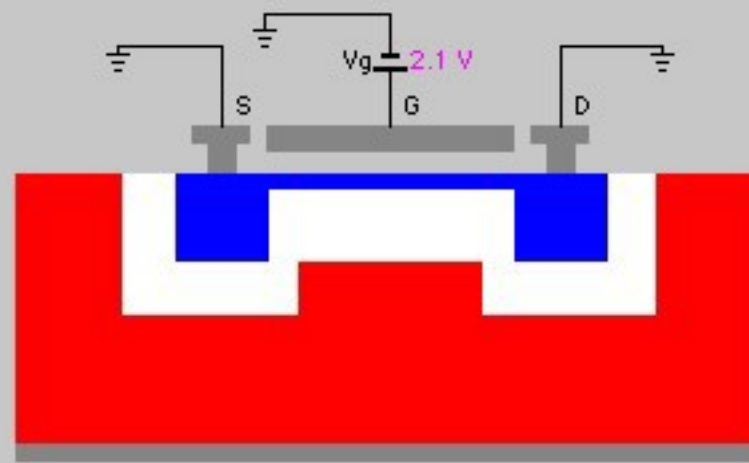


Enhancement-mode (Normally-off) MOSFET

N-channel

$V_g > V_t$: gate bias is more positive than the threshold voltage.

Sufficient electrons accumulate and forms the inversion channel.



Enhancement-mode (Normally-off) MOSFET

N-channel

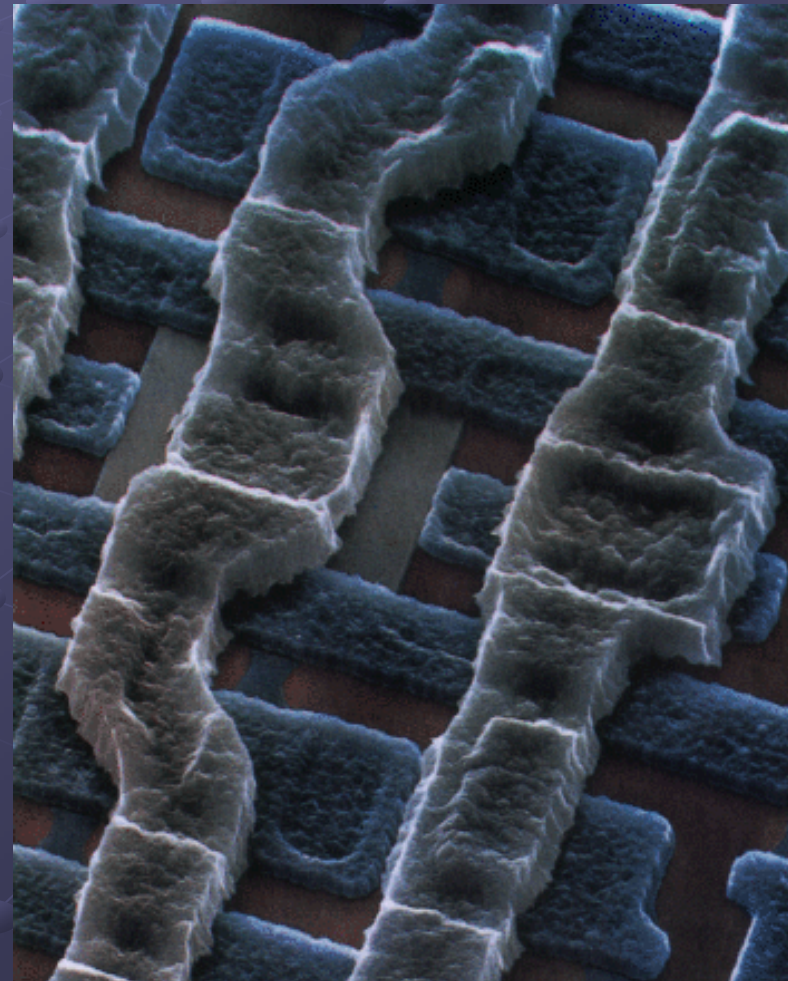
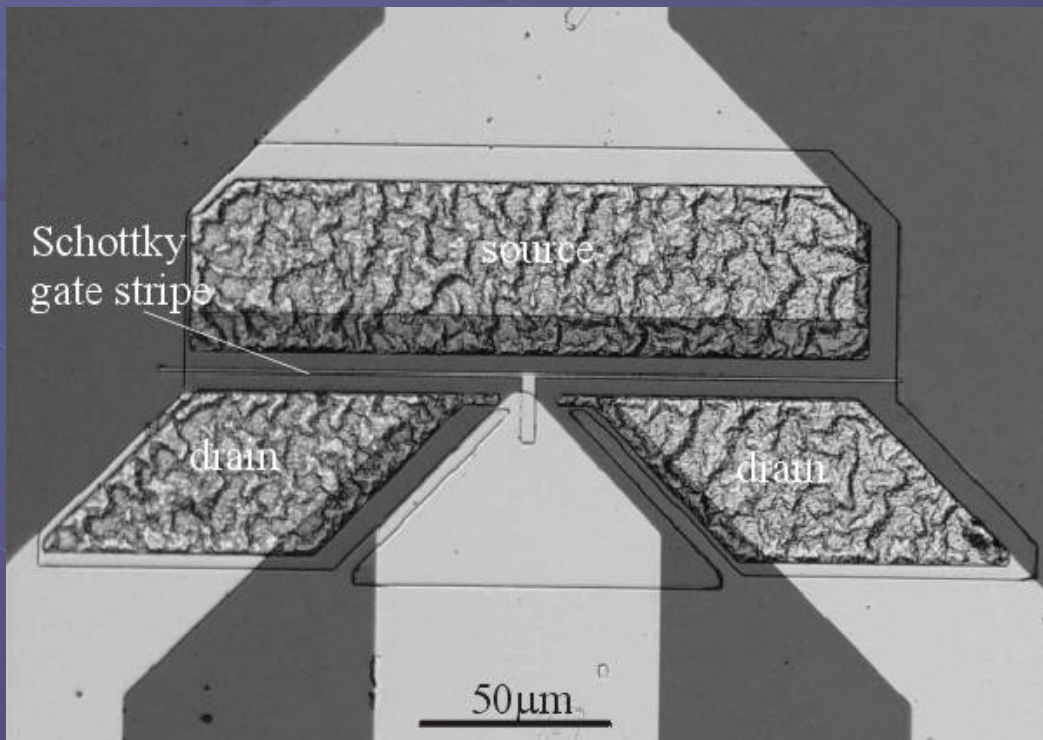
$V_g > V_t$: gate bias is more positive than the threshold voltage.

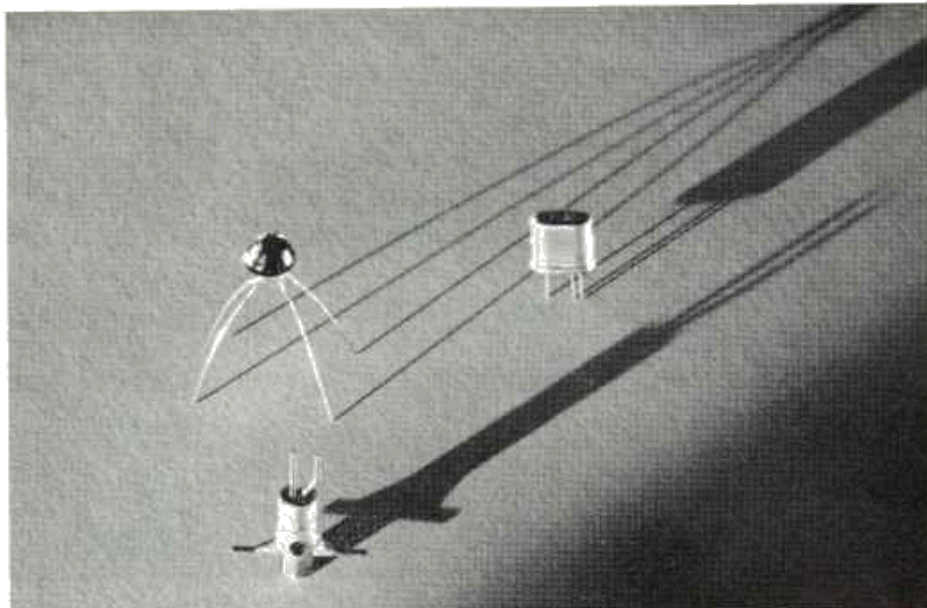
Sufficient electrons accumulate and forms the inversion channel.

Wady i zalety MOSFET:

- Ogromna rezystancja wejściowa
- Sterowanie napięciem
- Groźne ładunki elektrostatyczne dla przebicia izolatora o grubości rzędu nm

Przykładowe struktury:





WHAT IS THE TRANSISTOR? It is a tiny electronic device that can do amazing things for you by amplifying electric signals. It requires only a fraction of the power of a vacuum tube. It will be low in cost and last many times longer. Three types of transistors are shown above, about actual size.

That's the LITTLE GIANT with the Big Future

The *Transistor*—invented at Bell Telephone Laboratories—opens new doors to far-reaching improvements in telephone service and in other fields.

Many important inventions for communications have come from the Bell Telephone Laboratories. Seldom, however, has there been a new discovery with the exciting promise of the *Transistor*.

This tiny device can amplify electric signals a hundred thousand times. It can do many things that vacuum tubes can do and many more besides. It is something entirely new, and works on entirely new principles.

Because it is so small and rugged, and takes so little power, it can be used in ways and places beyond reach of a vacuum tube.

Invented at Bell Laboratories to amplify your telephone voice, the *Transistor* is opening new doors of opportunity in other fields.



The Bell System has licensed thirty-eight other companies to make and sell transistors under its patents. This is in accordance with our established policy of making our inventions available to others on reasonable terms.

These companies include makers of advanced equipment for defense, as well as radios, television sets, hearing aids, and a wide range of electronic apparatus.

The *Transistor* is already being used in the new electronic equipment which enables telephone users to dial Long Distance calls from coast to coast.

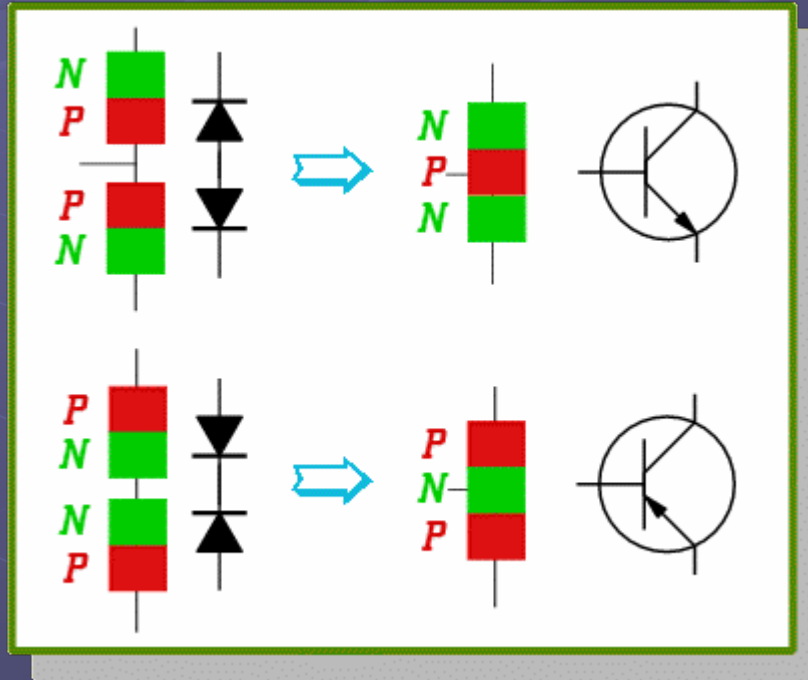
It is another example of the value of Bell System research in bringing you more and better telephone service.

BELL TELEPHONE SYSTEM

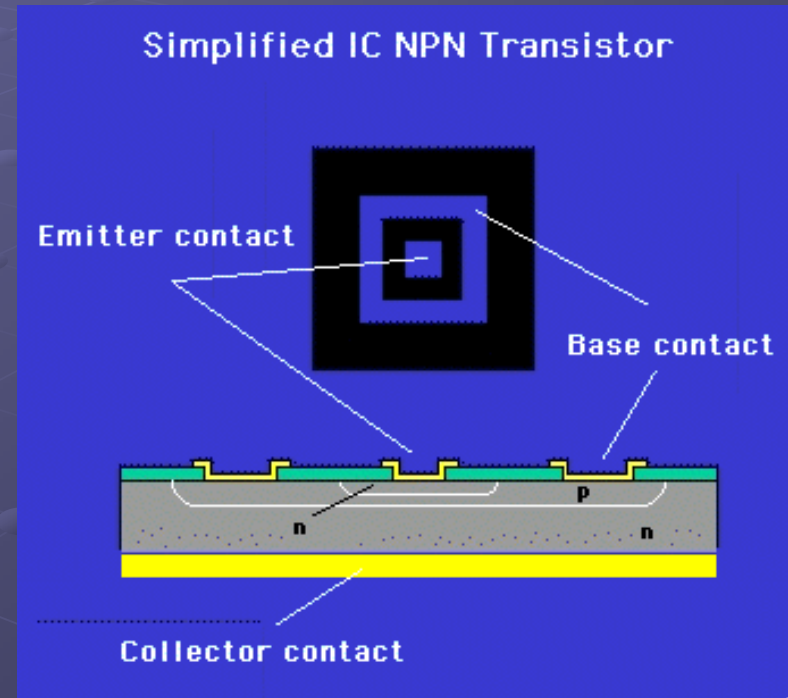
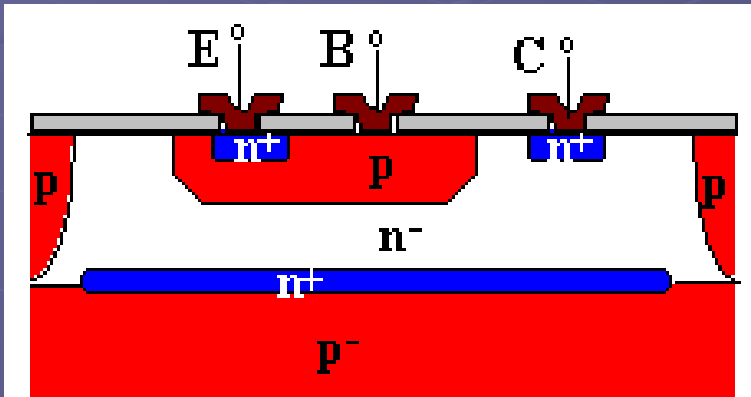


Tranzystor bipolarny:

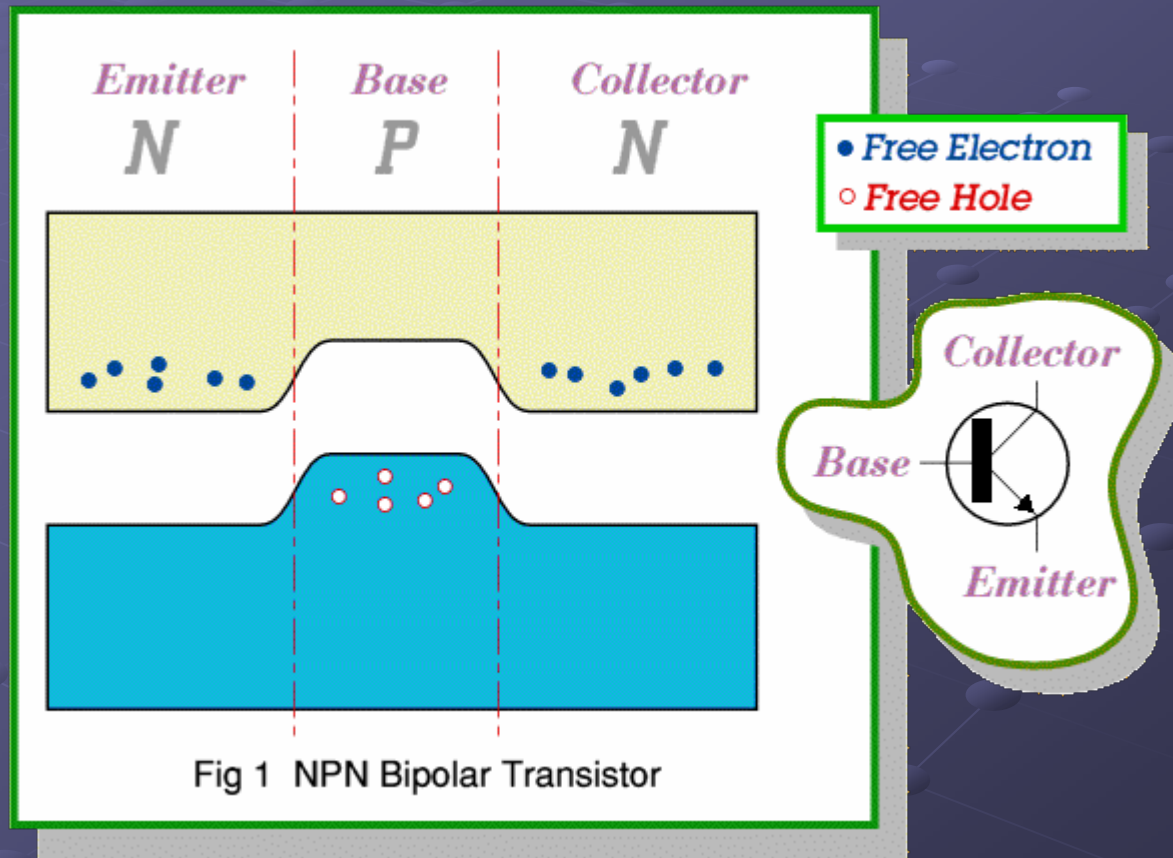
● BJT - Bipolar Junction Transistor



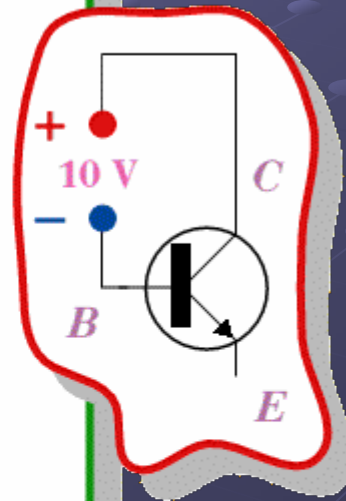
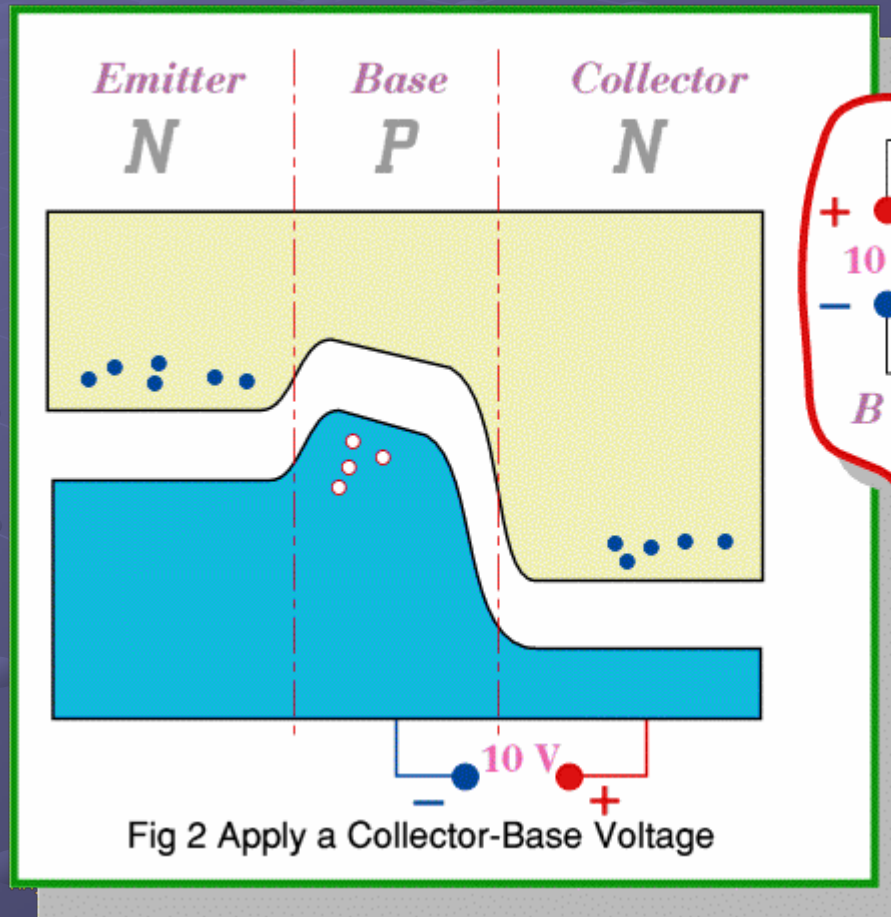
Tranzystor bipolarny:



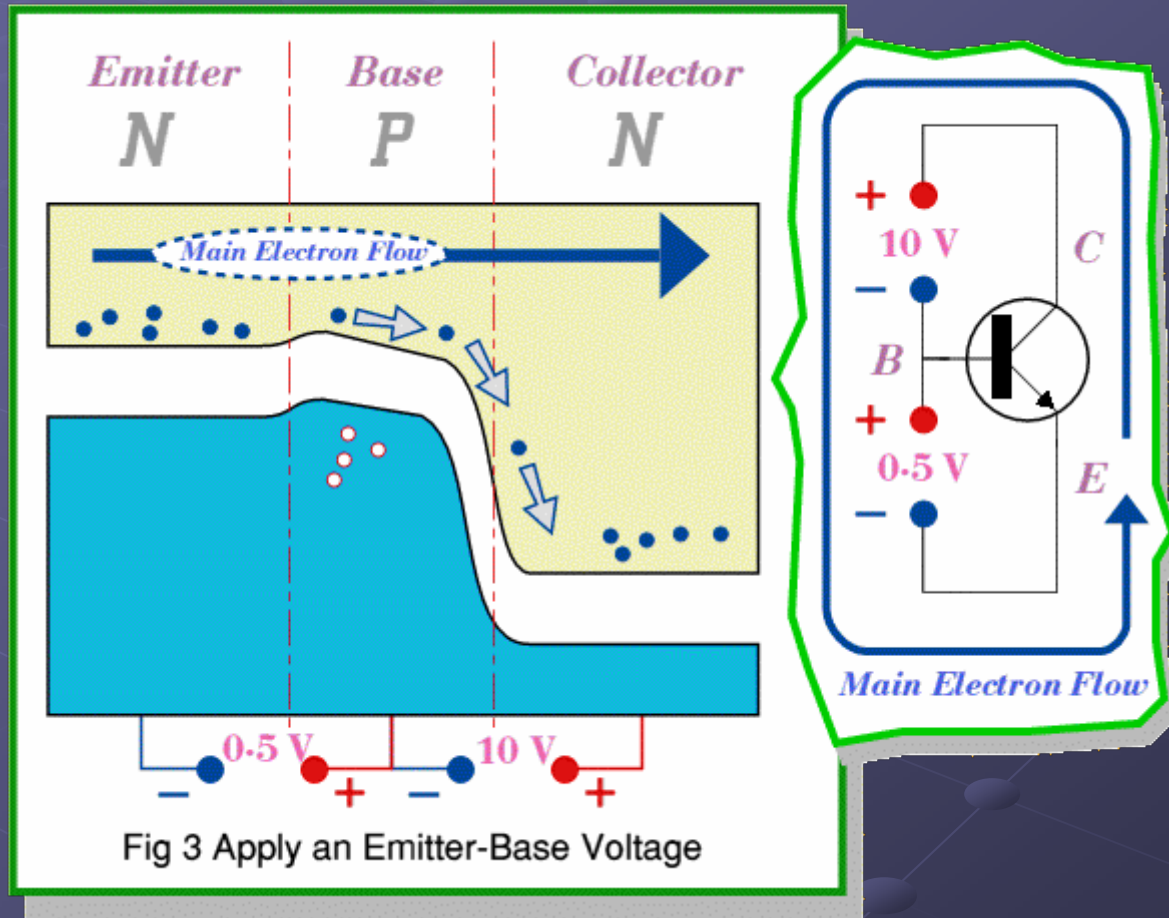
Tranzystor bipolarny:



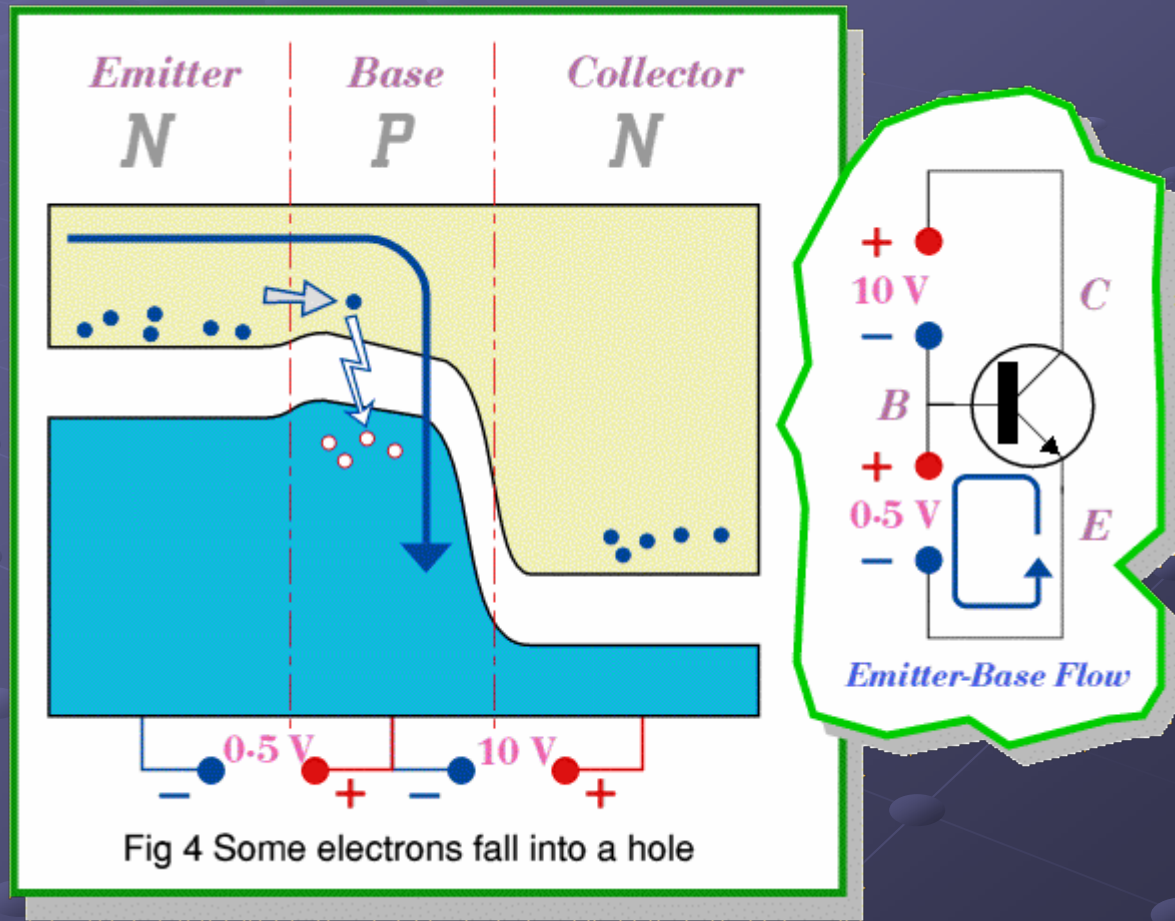
Tranzystor bipolarny:



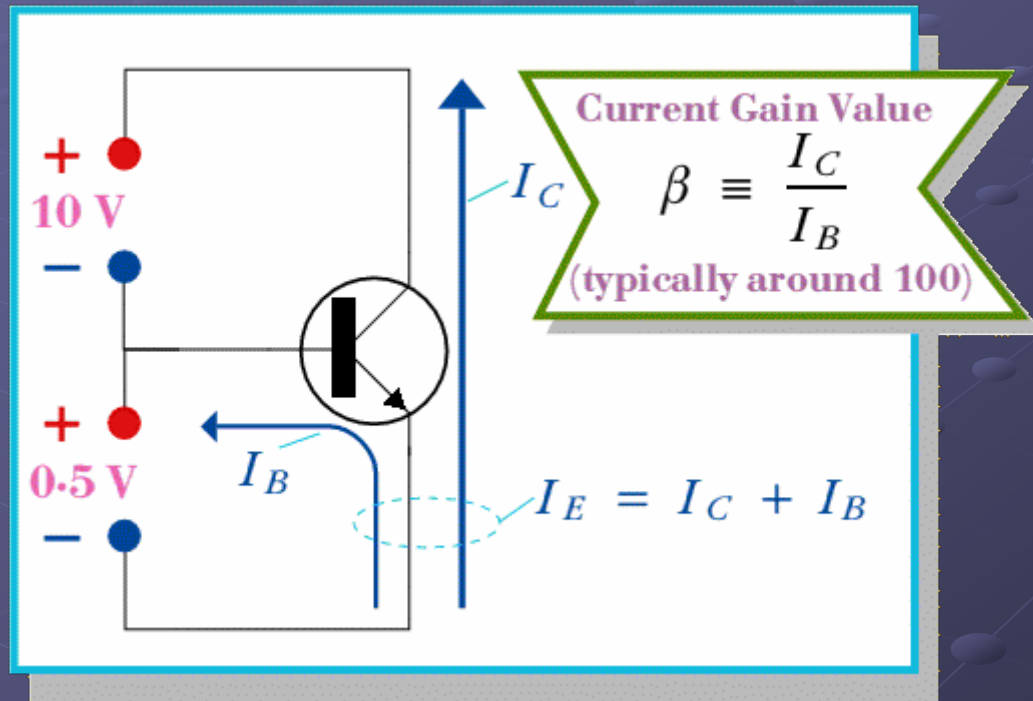
Tranzystor bipolarny:



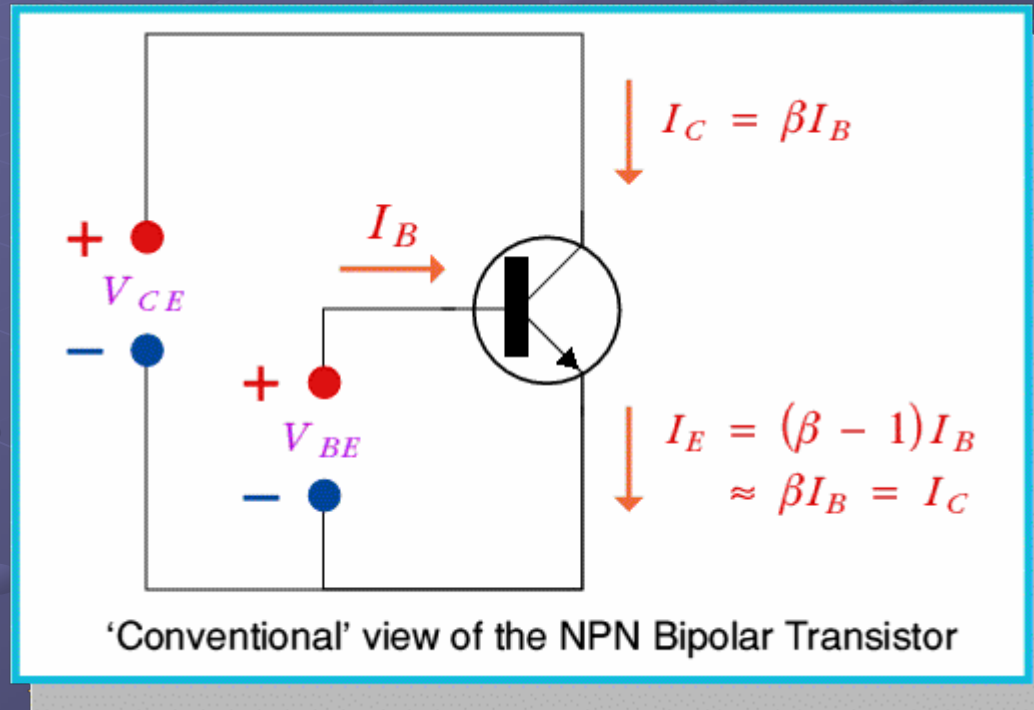
Tranzystor bipolarny:



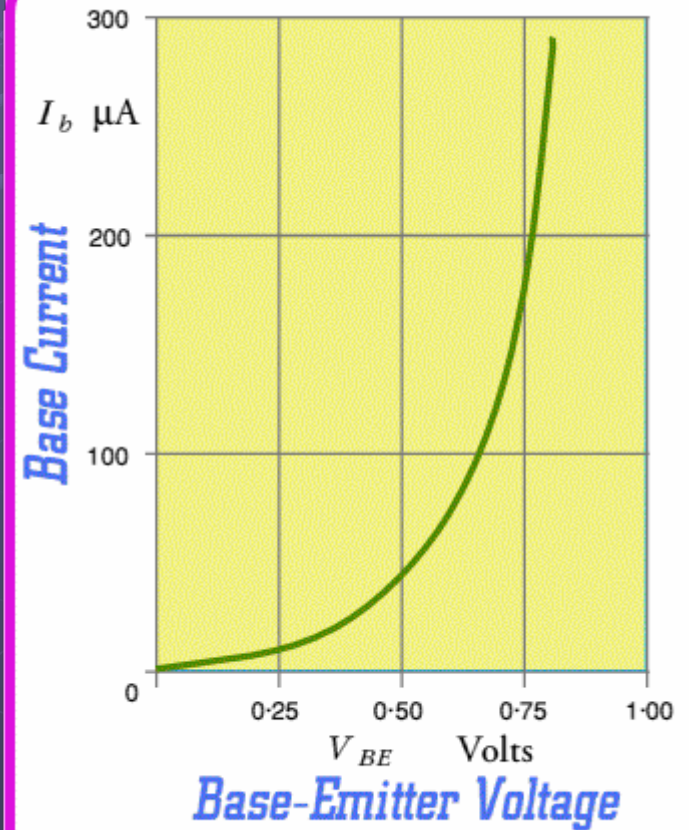
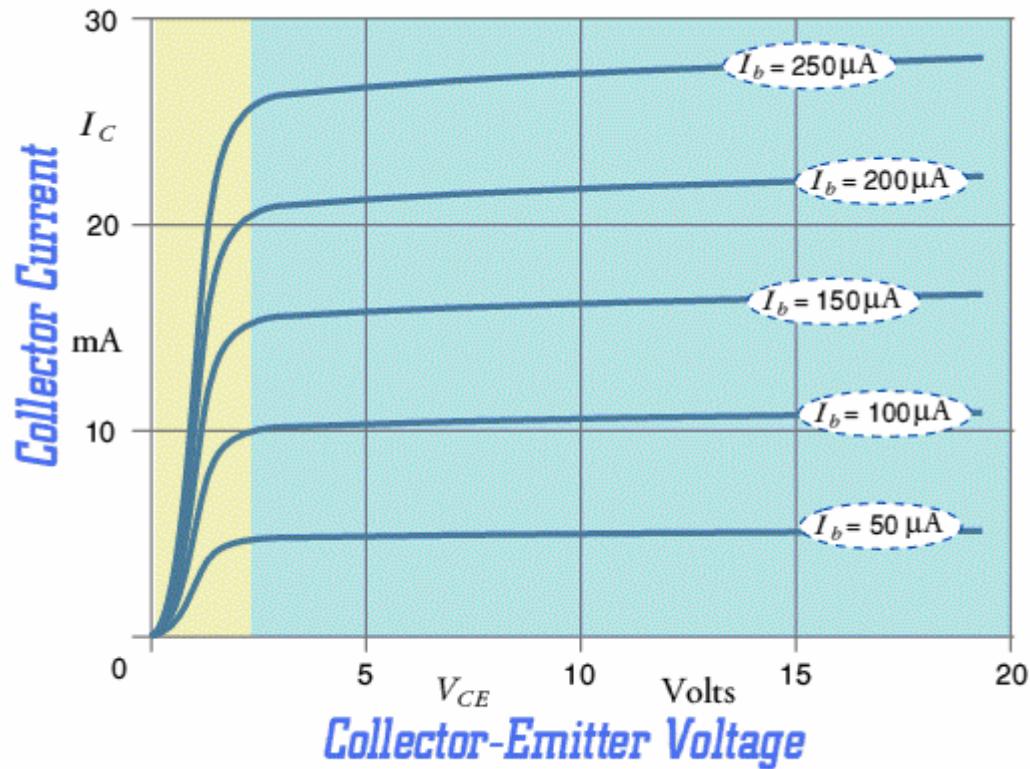
Tranzystor bipolarny:



Tranzystor bipolarny:



Charakterystyka BJT:

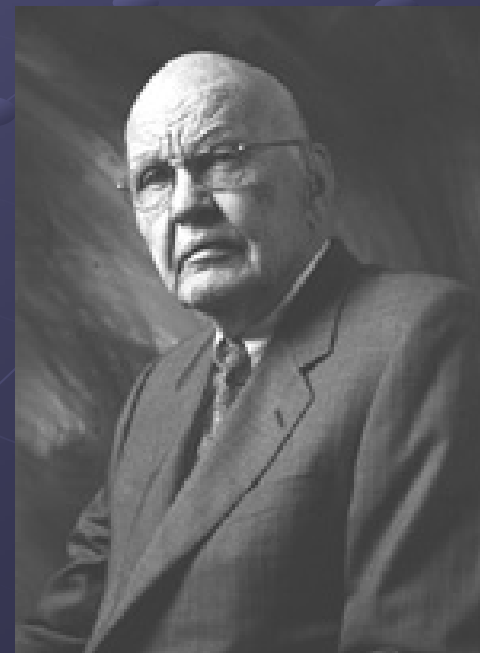
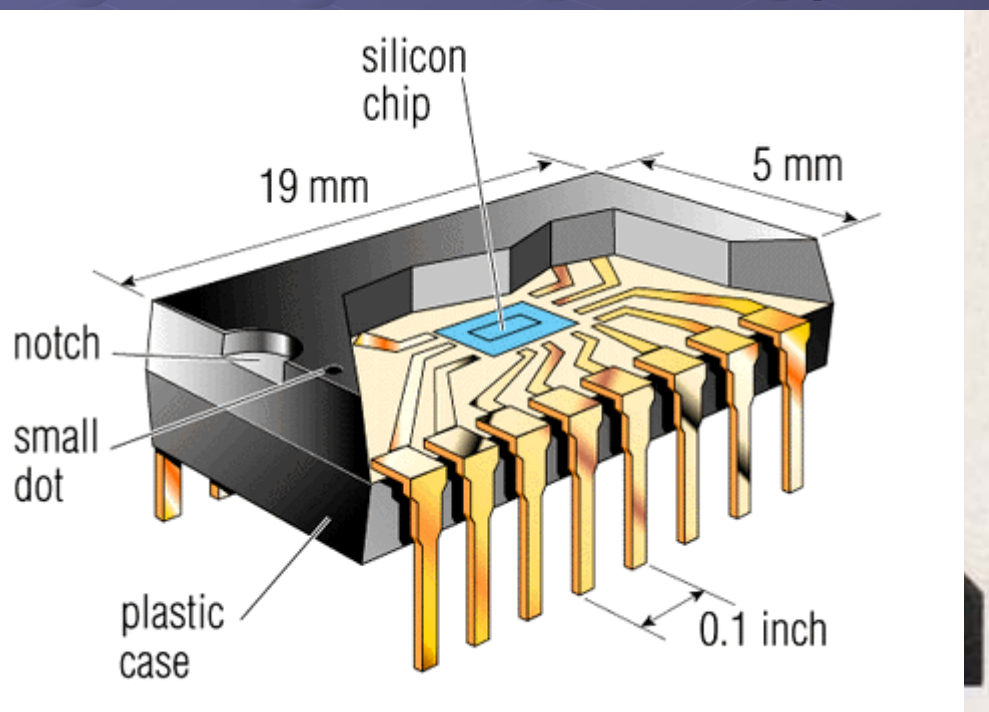


Wady i zalety:

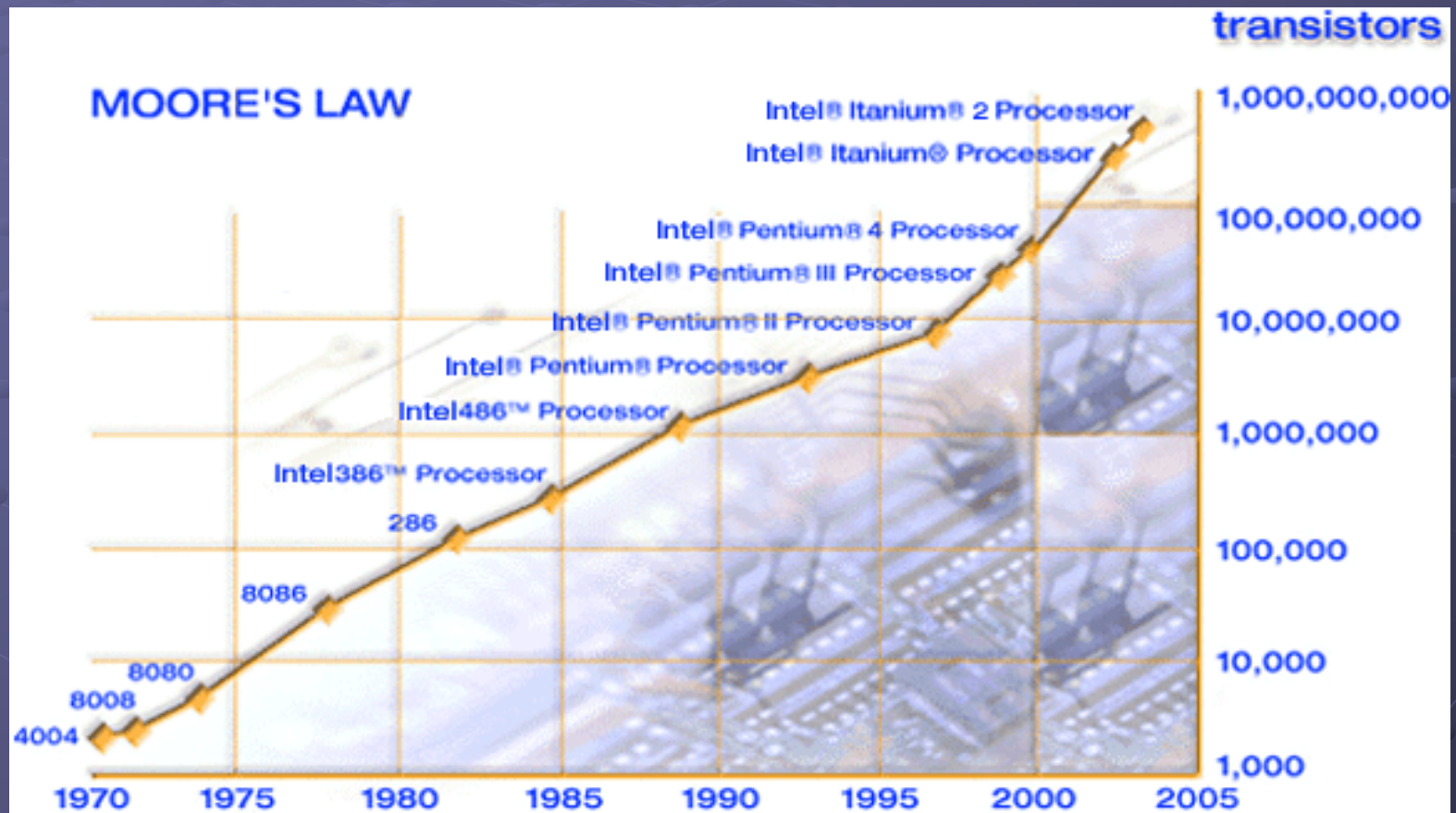
- małe R_{in}
- Sterowanie prądem bazy
- Większe moce niż dla FET
- Większa częstotliwość odcięcia
- Gorsze wytwarzanie w ukł. scalonych

Układ scalony:

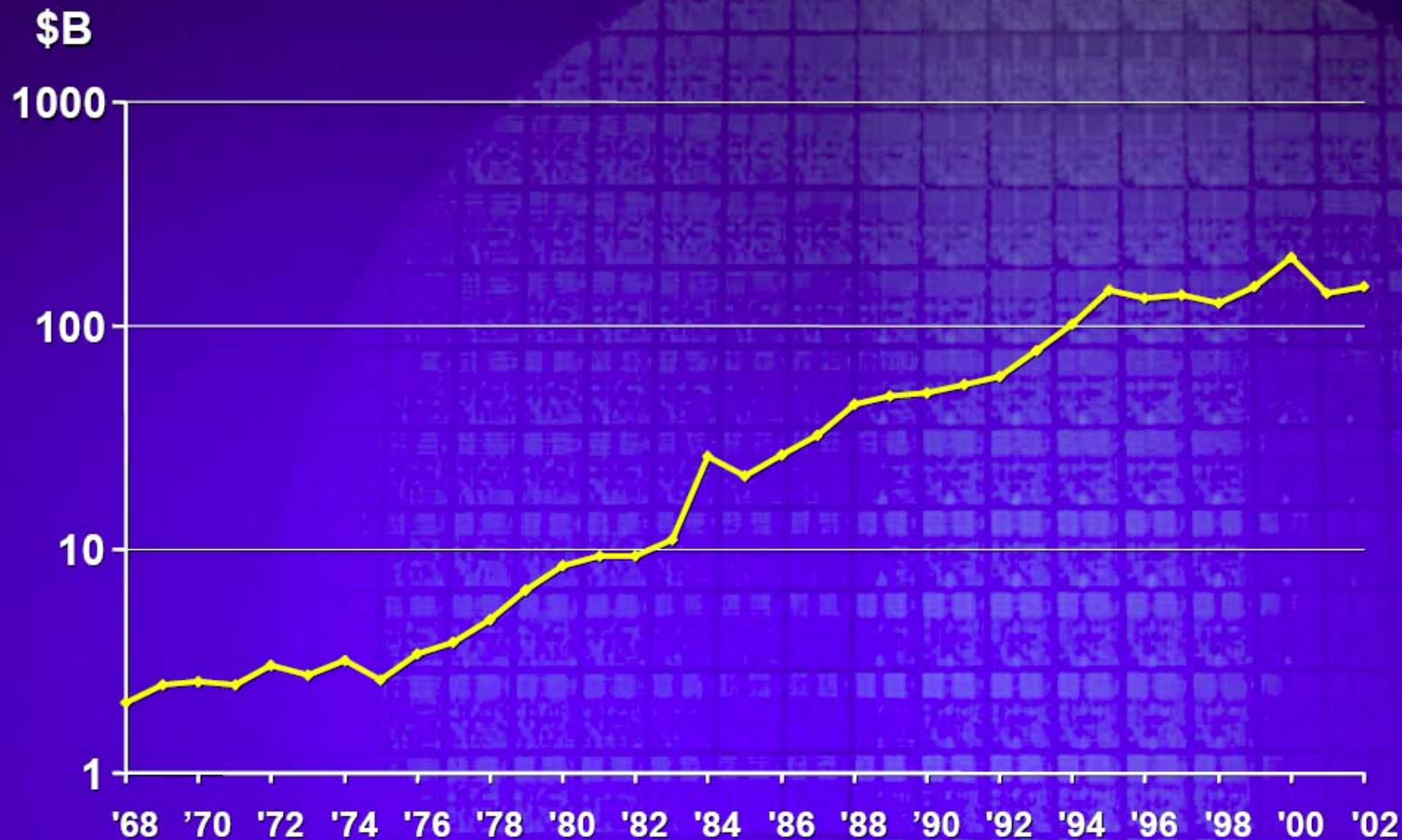
- Jack Kilby – Texas Instruments, 1958
- Rok 2000 – Nagroda Nobla z Fizyki
- Zbudował również pierwszy kalkulator



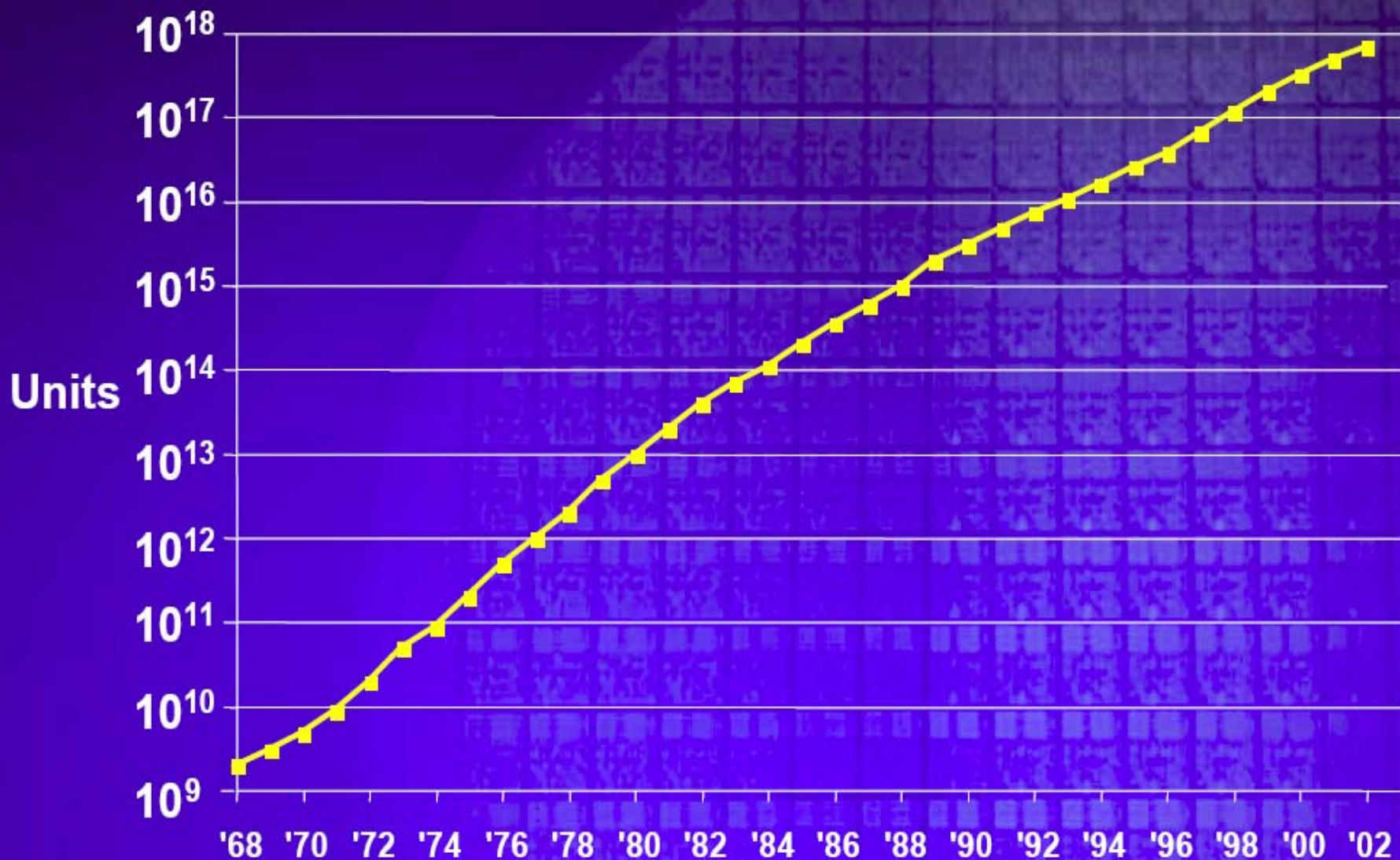
Układ scalony i prawo Moora:



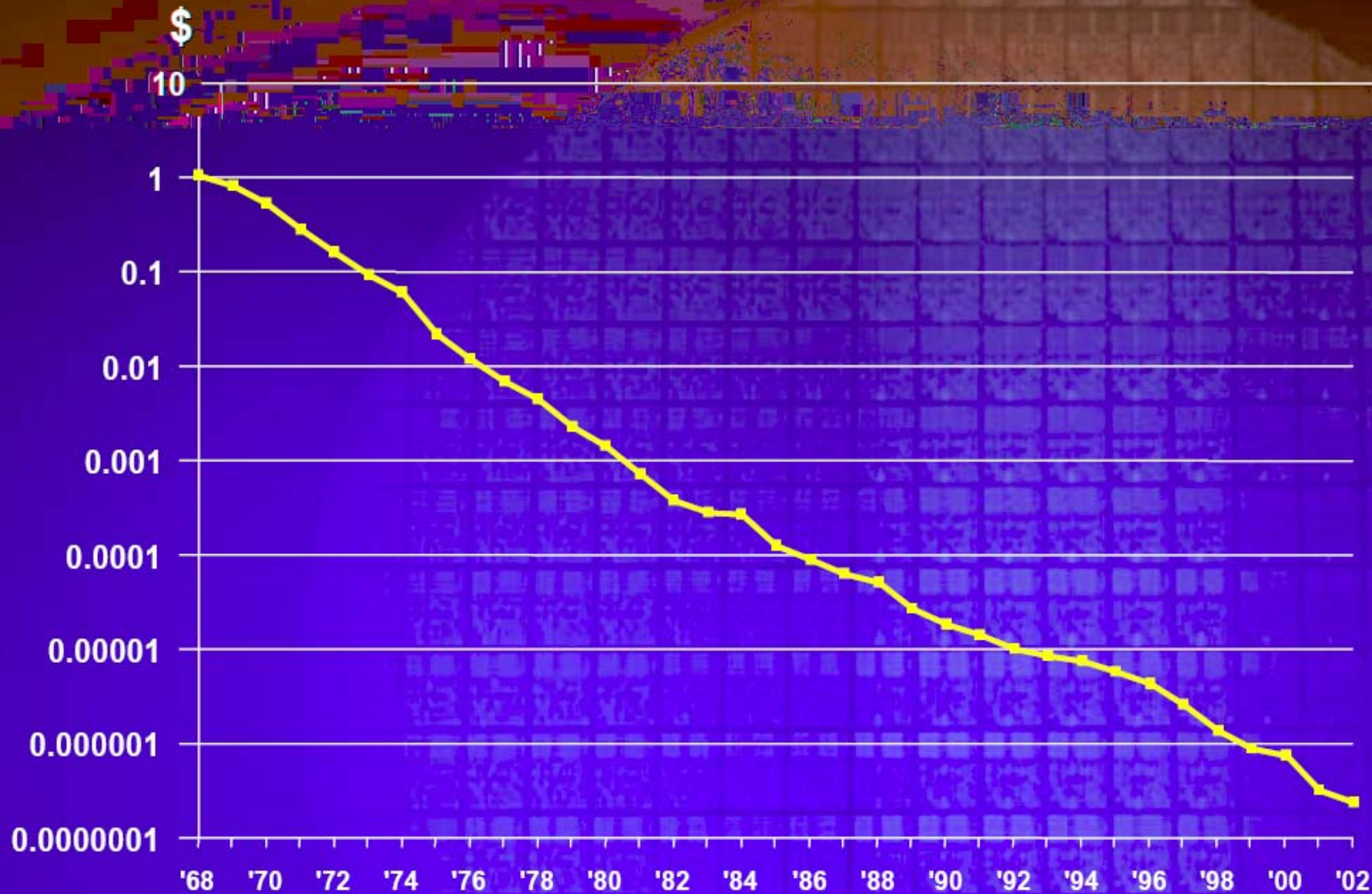
Worldwide Semiconductor Revenues



Transistors Shipped Per Year

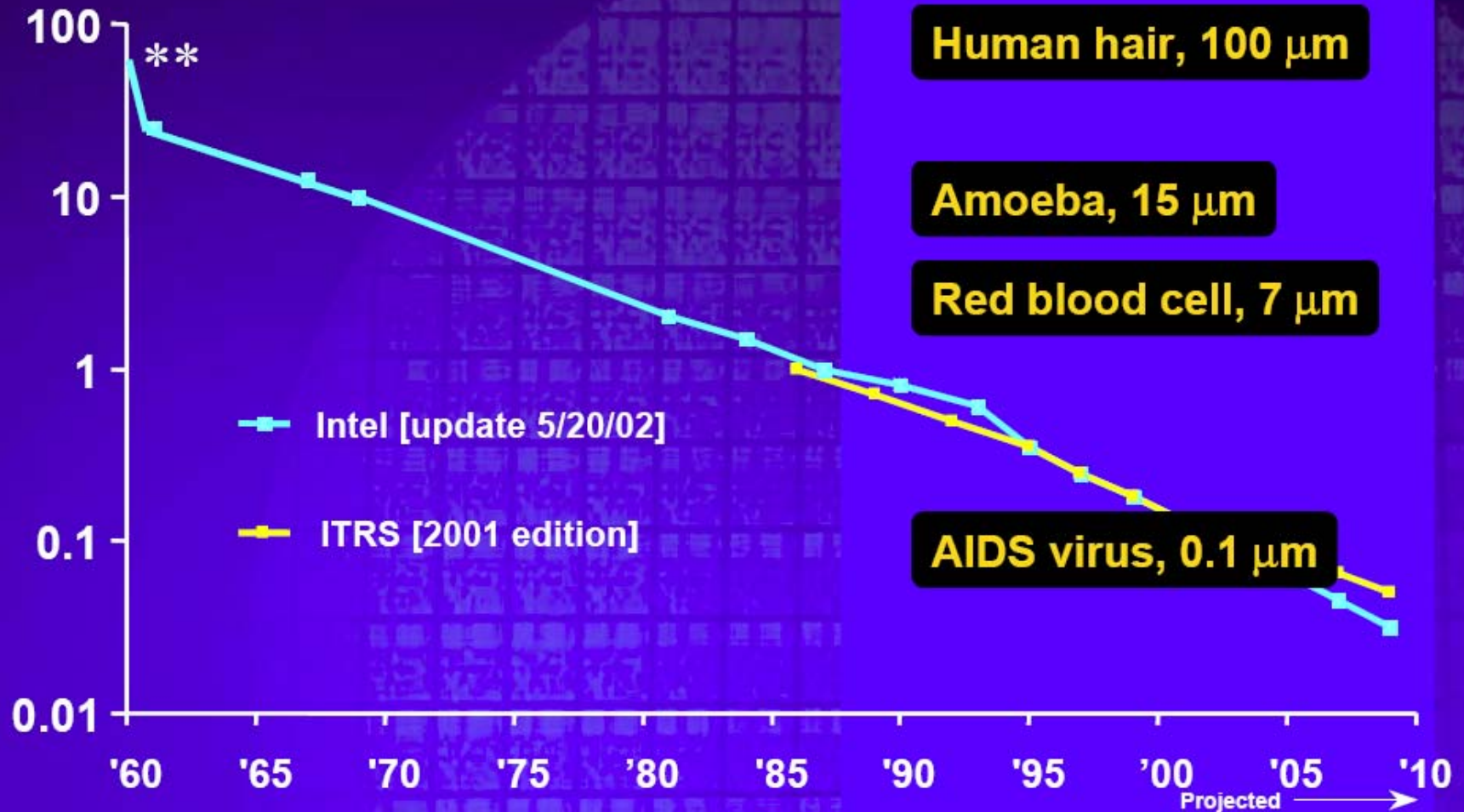


Average Transistor Price By Year



Minimum Feature Size

Feature Size
(microns)

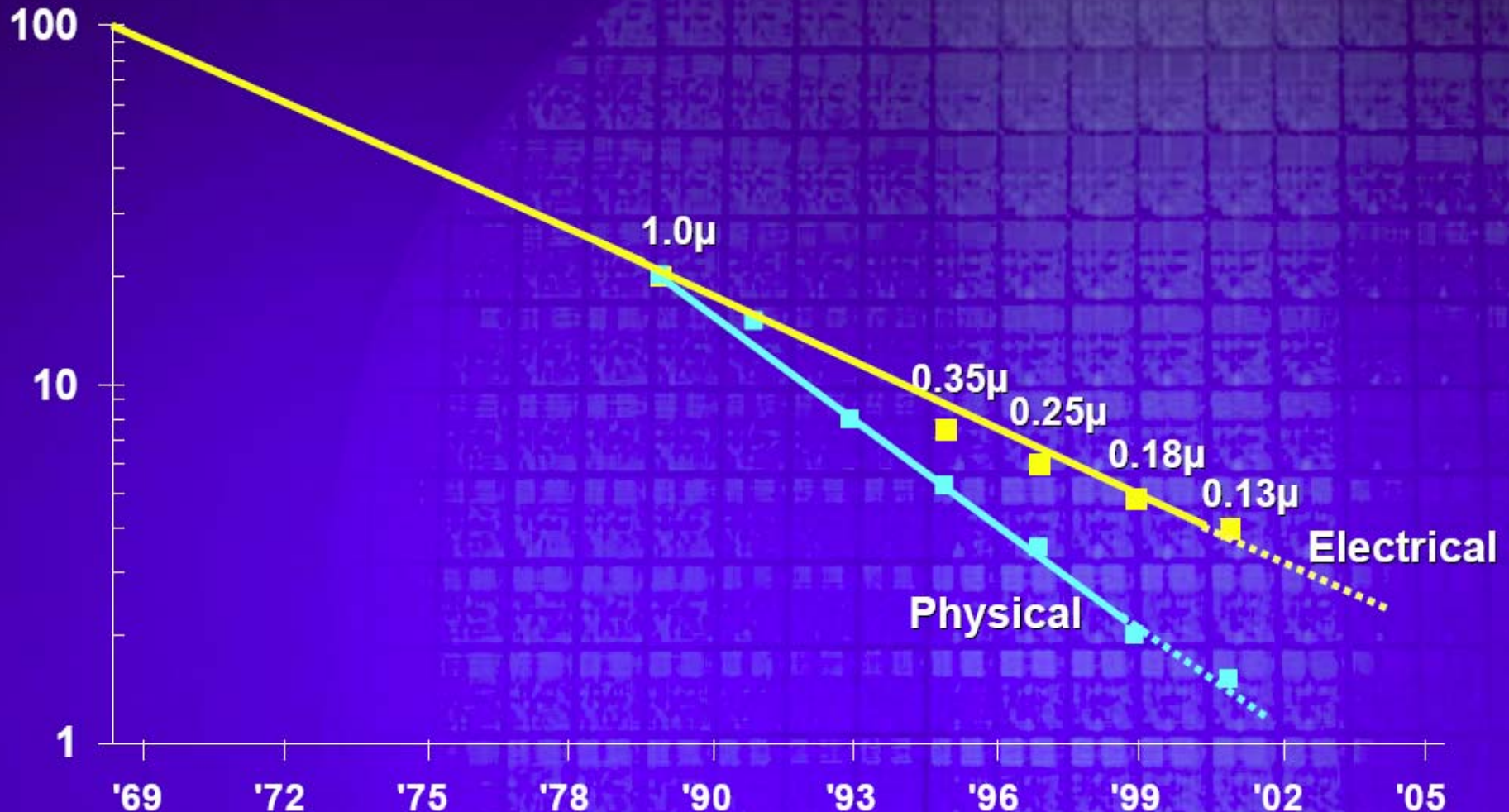


** Planar Transistor; remaining data points are ICs.

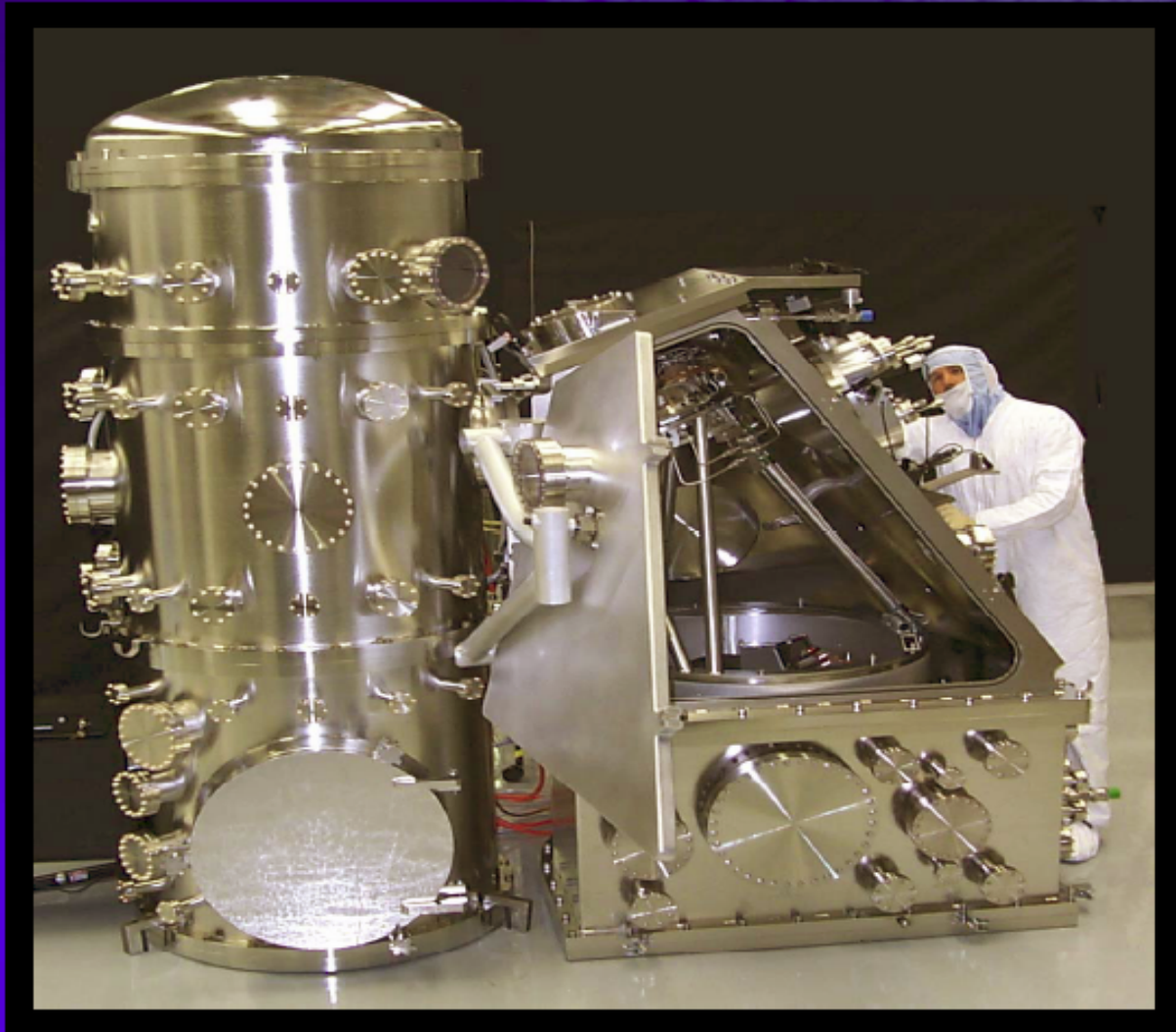
Source: Intel, post '96 trend data provided by SIA
International Technology Roadmap for Semiconductors (ITRS)

Minimum Insulator Thickness vs Time

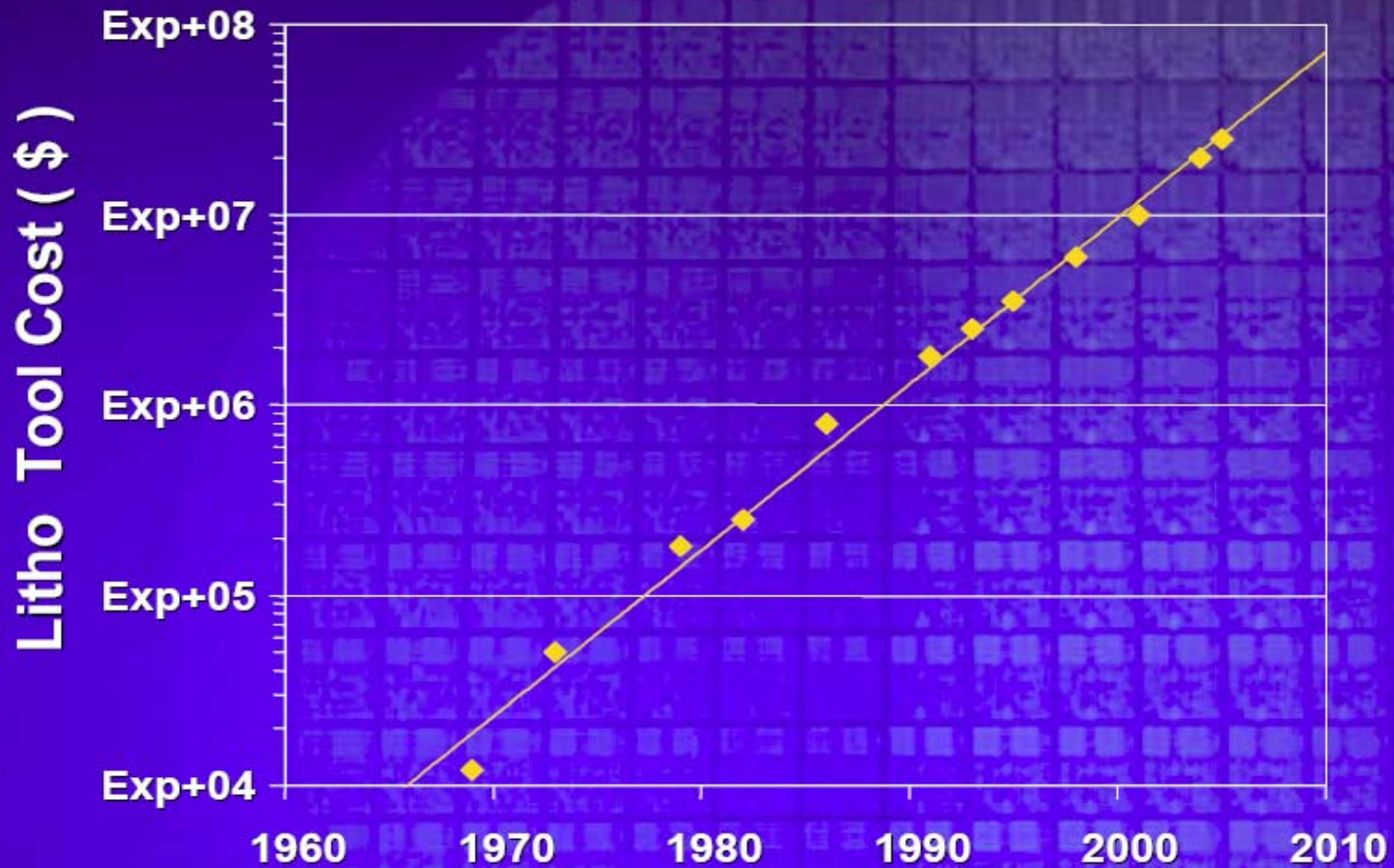
Oxide Thickness
(Nanometers)



Extreme Ultraviolet (EUV) Lithography



Lithography Tool Cost (\$)



NO EXPONENTIAL IS FOREVER ...

BUT

WE CAN DELAY “FOREVER”

nanoF

● Laboratoria Watsona II

Nanotube

