

**We connect  
chips.**

**EPIC: Two sides of one Coin**

**11 November 2024**



Our story

**black**  
semiconductor

# The Journey to a New Semiconductor Technology in Europe

Cedric Huyghebaert, CTO



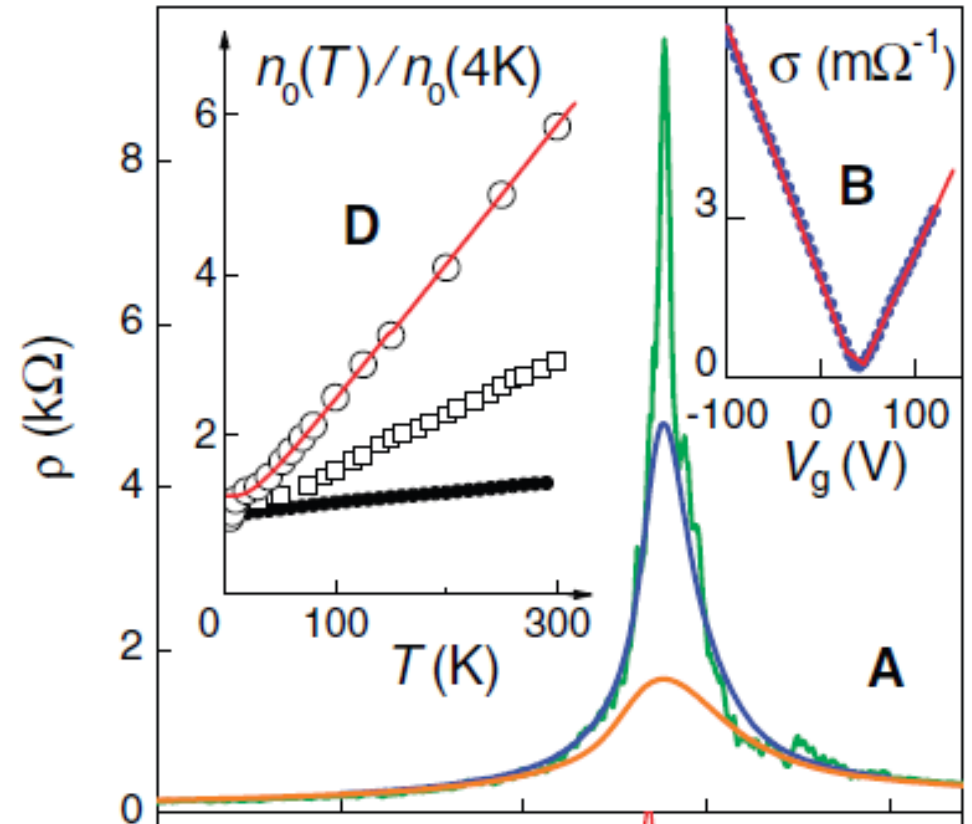
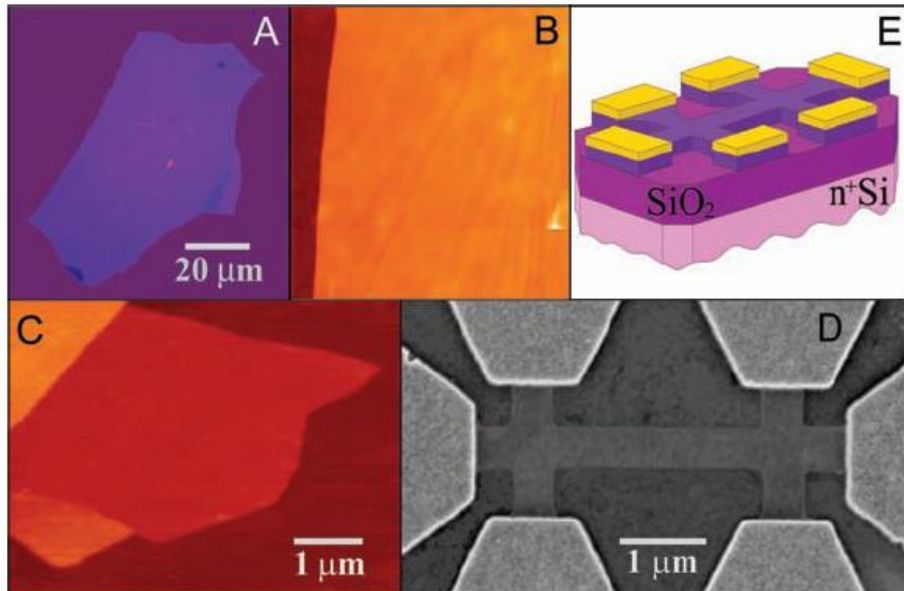
# Graphene “discovery”

22 OCTOBER 2004 VOL 306 SCIENCE www.sciencemag.org Novoselov et al., Science 306, 666 (2004)

## Electric Field Effect in Atomically Thin Carbon Films

K. S. Novoselov,<sup>1</sup> A. K. Geim,<sup>1\*</sup> S. V. Morozov,<sup>2</sup> D. Jiang,<sup>1</sup>  
Y. Zhang,<sup>1</sup> S. V. Dubonos,<sup>2</sup> I. V. Grigorieva,<sup>1</sup> A. A. Firsov<sup>2</sup>

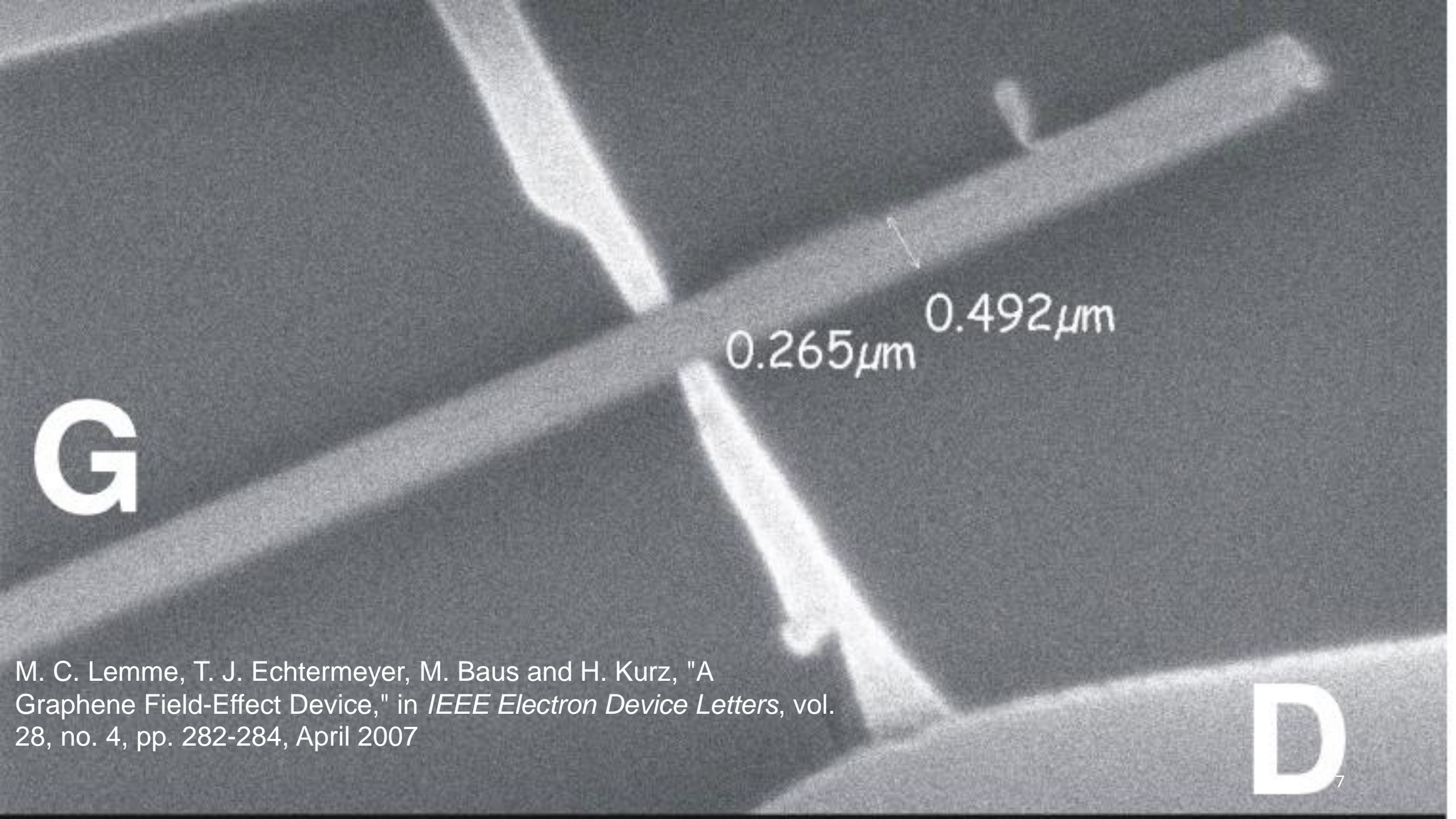
We describe monocrystalline graphitic films, which are a few atoms thick but are nonetheless stable under ambient conditions, metallic, and of remarkably high quality. The films are found to be a two-dimensional semimetal with a tiny overlap between valence and conduction bands, and they exhibit a strong ambipolar electric field effect such that electrons and holes in concentrations up to  $10^{13}$  per square centimeter and with room-temperature mobilities of  $\sim 10,000$  square centimeters per volt-second can be induced by applying gate voltage.



- First report of electric-field effect in (few-layer) graphene



**The new silicon is born**



G

0.265  $\mu\text{m}$  0.492  $\mu\text{m}$

D  
7

M. C. Lemme, T. J. Echtermeyer, M. Baus and H. Kurz, "A Graphene Field-Effect Device," in *IEEE Electron Device Letters*, vol. 28, no. 4, pp. 282-284, April 2007

A scanning electron micrograph (SEM) of a graphene field-effect device. The image shows a central channel of graphene between two electrodes, with various gate electrodes and contacts. The text is overlaid in red and white. Dimensions of 0.265 μm and 0.492 μm are indicated with arrows pointing to specific features in the device.

**NO Bandgap**

**No way to switch it off**

**RIP : GFET**

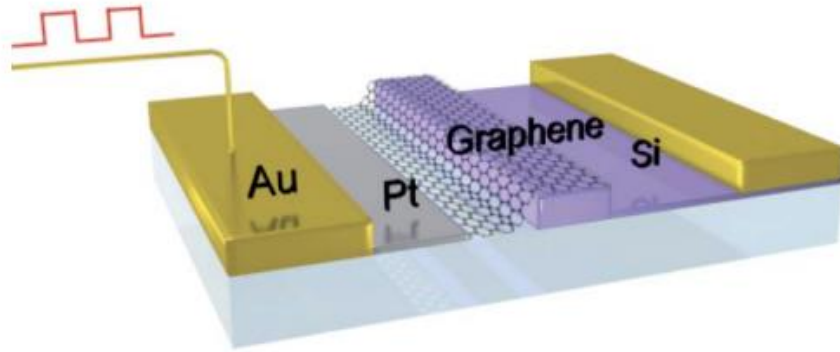
**G**

**D**  
8

M. C. Lemme, T. J. Echtermeyer, M. Baus and H. Kurz, "A Graphene Field-Effect Device," in *IEEE Electron Device Letters*, vol. 28, no. 4, pp. 282-284, April 2007

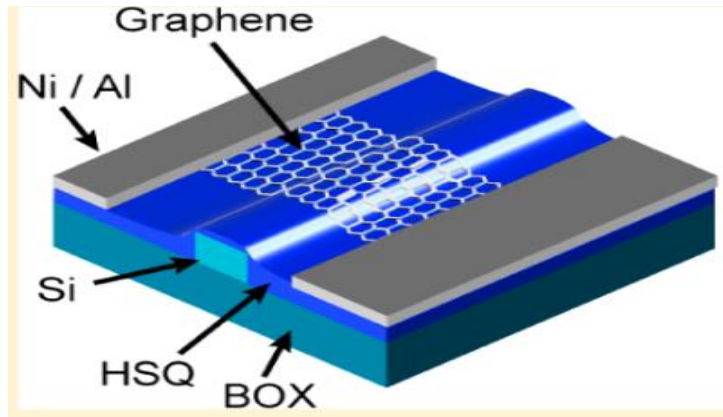
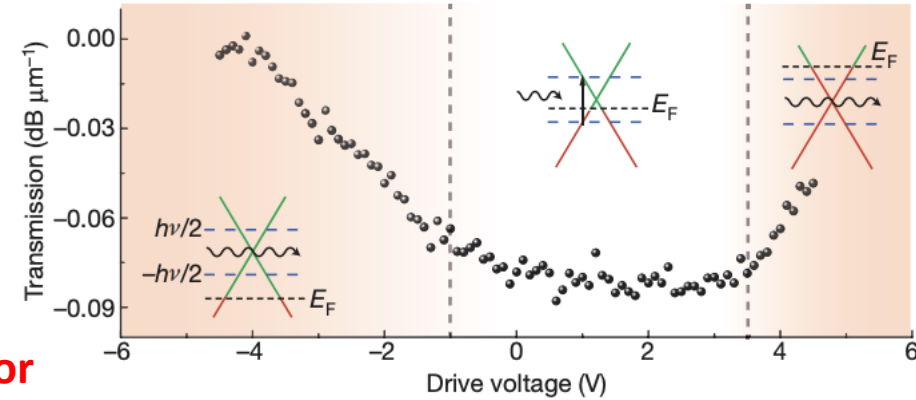


a



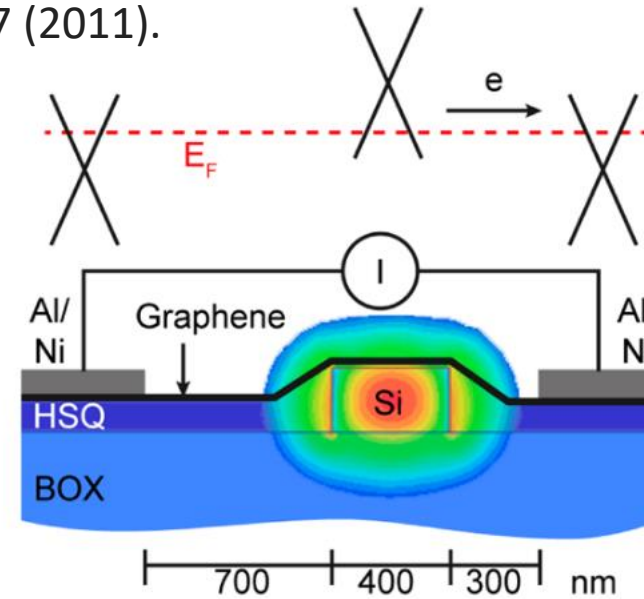
**Modulator**

Liu, M., Yin, X., Ulin-Avila, E. *et al.* A graphene-based broadband optical modulator. *Nature* **474**, 64–67 (2011).



**Photodetector**

D. Schall *et al.* 50 GBit/s Photodetectors Based on Wafer-Scale Graphene for Integrated Silicon Photonic Communication Systems. *ACS Photonics* **1**, 9 (2014).





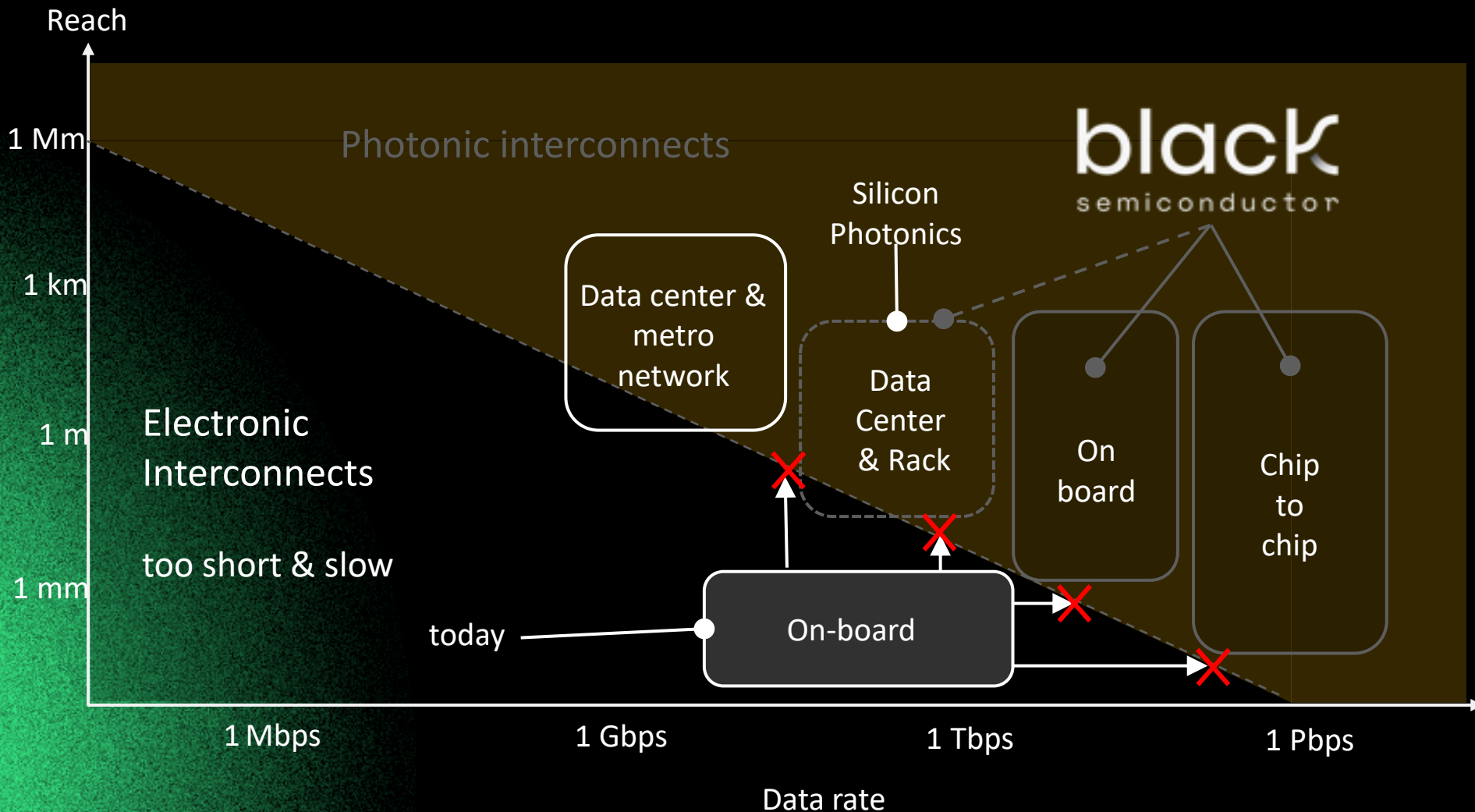
# Company founders.

Combining business and engineering, the brothers Sebastian Schall and Dr. Daniel Schall are the driving force behind Black Semiconductor.

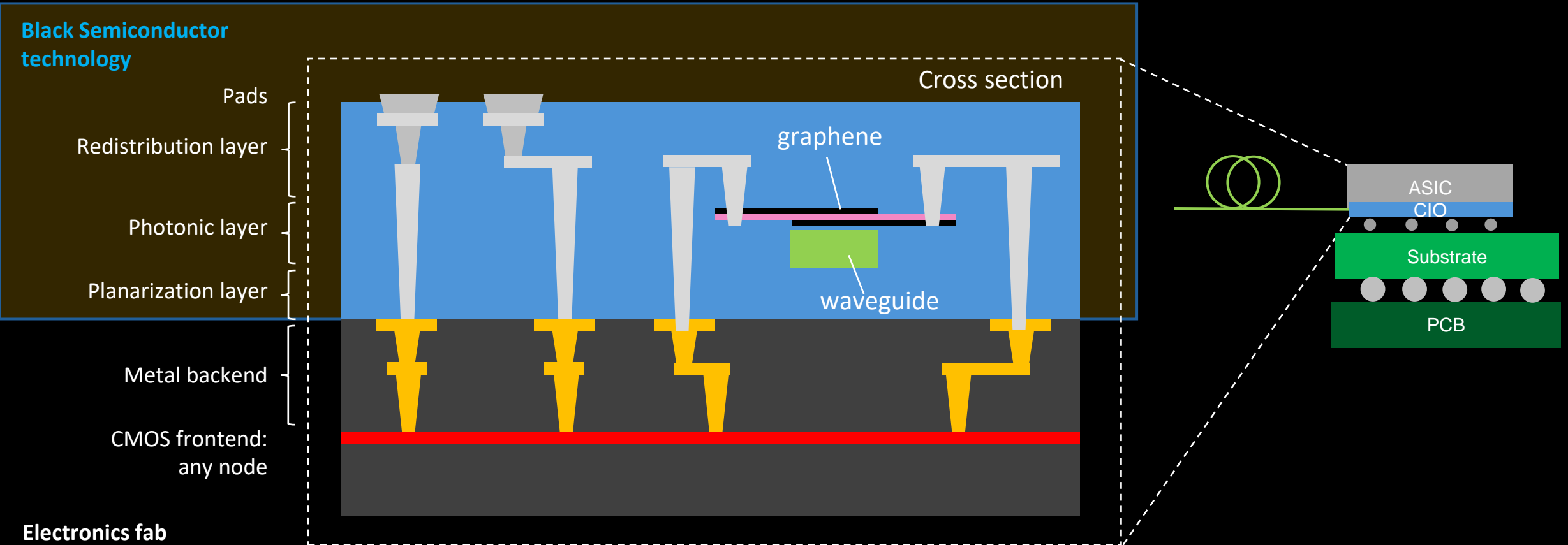
DREAM  
BIG

Problem: connectivity barrier

# Bandwidth per length limits the performance



# Photonic integration concept: co-integrated optics CIO to embedd photonics on any chip.

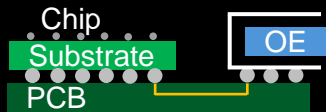
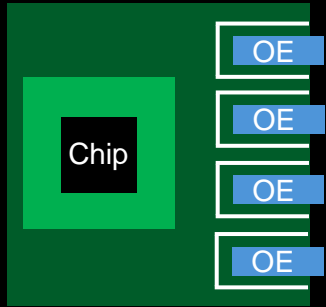


Electronics fab technology

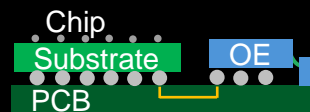
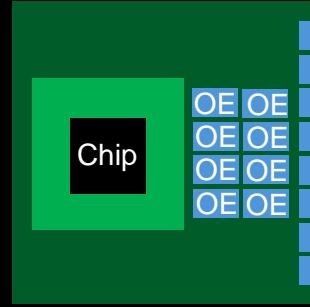


# Co-integration of graphene optics on electronic XPU and memory to boost chip connectivity in large fabrics.

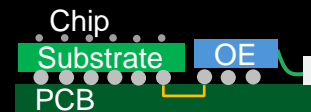
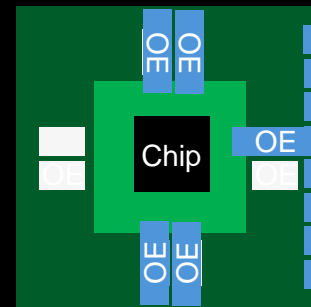
Pluggable optics  
1990 - today



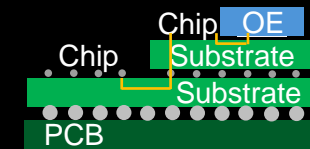
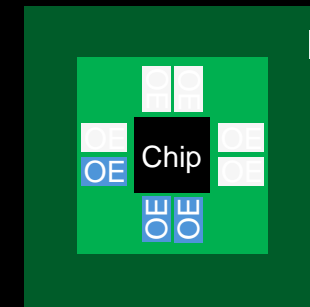
On-board optics 2018 - today



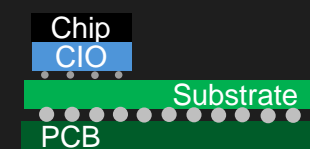
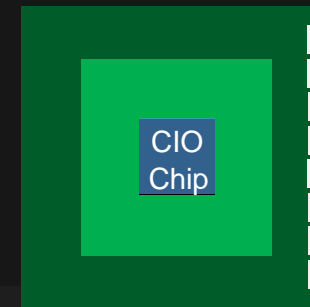
Near-package optics 2018 - today



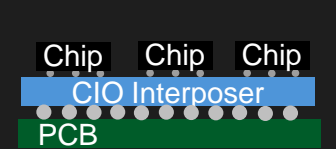
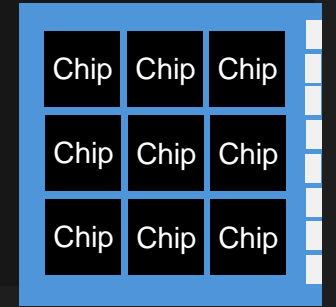
Co-packaged optics today



Co-integrated optics 2030



Co-integrated optics on advanced Si and glass plate. 2030+



**black**  
semiconductor



# Objective 1





# Objective 1

Demonstrate that **graphene** can be **integrated** according to the **semiconductor standards**

# Objective 2



# Objective 2

Demonstrate **Co-Intergated Optics (CIO)** agnostic of the combined **technology node**

# Objective 3



# Objective 3

Demonstrate that **deeptech innovation** that **solves a problem** for the hyperscalers is still possible in Europe

series A

**€ 254.4 million**

public funding \*

**€ 228.7 million**

equity funding \*\*

**€ 25.7 million**

\* 70% of the total funding over 7 years

\*\* first round of 30% of the total funding over 7 years

# A strong support: Our **investors.**

Project A

Cambium Capital

Onsight Ventures<sup>+</sup>



PORSCHE  
VENTURES



Capnamic

TVF TECHVISION  
FONDS



IPCEI Microelectronics and  
Communication Technologies

Gefördert durch:



Bundesministerium  
für Wirtschaft  
und Klimaschutz



Funded by the  
European Union  
NextGenerationEU

Gefördert durch:

Ministerium für Wirtschaft,  
Industrie, Klimaschutz und Energie  
des Landes Nordrhein-Westfalen



# Backup



[www.blacksemicon.de](http://www.blacksemicon.de)



@Black Semiconductor



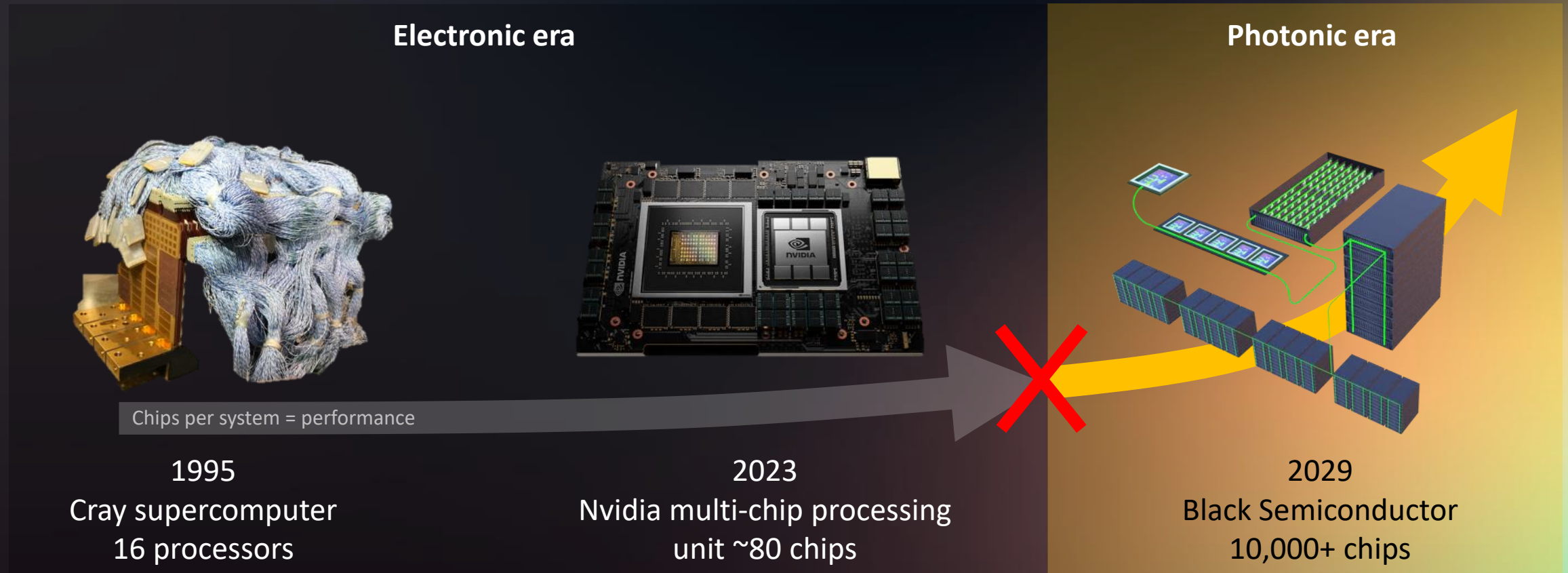
# We are **BRAPHE**: the only startup in the German IPCEI ecosystem.

IPCEI is a joint initiative by several European Union (EU) member states, aimed at fostering the development and innovation in the field of microelectronics and communication technology.

The German federal state and the State of North-Rhine Westphalia committed **EUR 228.7 Mio** in funding to Black Semiconductor to drive a new generation of chip networks.

- IPCEI ME/CT is short for *Important Projects of Common European Interest in Microelectronics and Communication Technology*.
- 31 microelectronics projects are commissioned in Germany - we are the only start up.
- The public support is interconnected with private equity. In 2024, Black Semiconductor raised EUR 25,7 Mio equity funding to secur the first IPCEI interval.

Electronic chip connectivity progressed but fails to enable large chip fabrics.  
Co-integrated optics goes beyond current limits.



our vision

Prove to everybody  
that you can **make a**  
**fundamental change.**