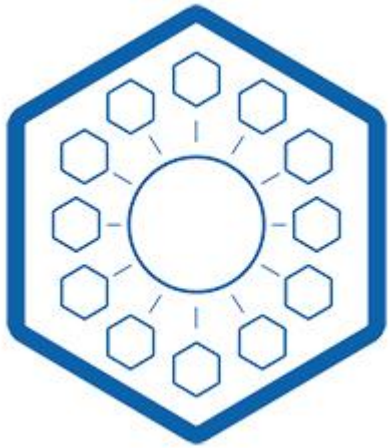
GRAPHENE FLAGSHIP

Graphene Flagship:
Approaching the half-way point
Collaboration with member states



Funded by
the European Union

Introduction

FET Flagships:

"FET Flagships are ambitious **large-scale**, **science-driven**, *research initiatives that aim to achieve a visionary goal.*
The scientific advance should provide a strong and broad basis for future **technological innovation and economic exploitation** *in a variety of areas, as well as novel benefits for society."*

Graphene Flagship mission:

"*To take* ***graphene and related layered materials*** *from a state of raw potential to a point where they can revolutionize multiple industries. This will bring a new dimension to future technology – a faster, thinner, stronger, flexible, and broadband revolution. Our program will put* ***Europe*** *firmly at the heart of the process, with a manifold return on the EU investment, both in terms of* ***technological innovation and economic growth***."

General Remarks

- We are approaching the half-way point in terms of project time (45%) but not in terms of project EC funding (29%)
- The Graphene Flagship is well on its way to reach its ambitious targets
  - Increasing industrial interest and activity both within the flagship consortium and outside it
  - More and more products are being launched, and with higher added value
- The growth of the Flagship takes now mostly place through partnering projects and associated members; the EC-funded core consortium has likely reached (and passed) its maximum size

General Remarks

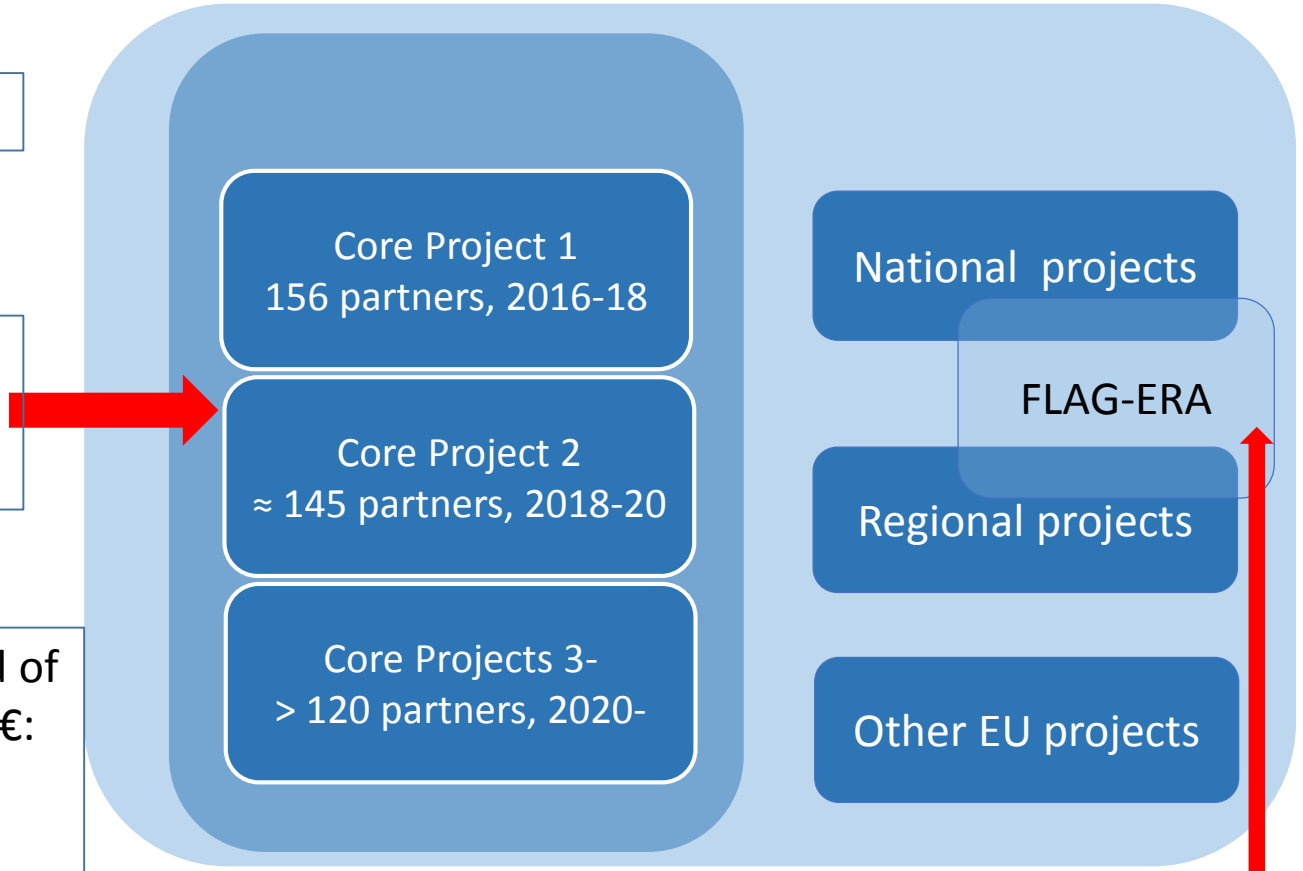
- Long project period, of the order of 10 years, is a necessity. Different topics mature at different rates, and only now are we starting to see products and prototypes on the system level
- The model suffers from long time lags: we are now closing Core 1, have just launched Core 2, and are planning Core 3 – 1.5 years' advance planning with little chance to adjust later on
- The routines and IT tools of the EC are not optimized for projects with 150 partners – delays, at times frustration, despite good help from the Flagship Unit

7th Framework Programme

Ramp-up phase,
74-142 partners, 2013-2016

Horizon 2020

By now:
45% of time
29% of funding



EC funding until the end of H2020 will be ≈ 381 M€:
Horizon Europe (9th Framework Programme) ?

FLAG-ERA: 2 calls completed, 1 in preparation

CHALMERS
UNIVERSITY OF TECHNOLOGY

GRAPHENE FLAGSHIP

Platform

One Atom Thin

Linear spectrum

Strength

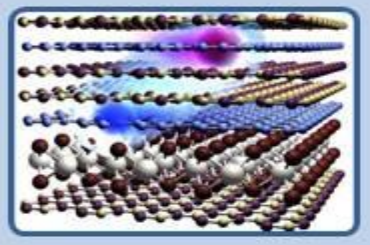
Graphene

High mobility

Highly flexible

Unique optical properties

Hybrid 2d structures



Industrial
Academic

Industrial workshare
Academic workshare

System Integration

- Flexible electronic
- Superfast optical communication
- Ultrafast low-power electronics
- Self-powered devices
- Automotive
- …

Components

- Transistors
- Spin valves
- Flexible displays
- RF tags
- Ultra-light batteries
- Solar cells
- Ultrafast lasers
- Composite materials
- Prostheses
- Sensors
- …

Production techniques

- Large scale synthesis
- On demand growth
- Nanoribbons
- Growth on flexible substrates
- Inks
- Interfaces
- Doping
- Superstructures
- Toxicology
- …

Industrial workshare
Academic workshare

2013

2016

2023

Vision beyond 2023

ICT

- Faster
- Cheaper
- Flexible

Energy storage and conversion

- Efficient
- Cost effective
- Renewable
- Sustainable

Health

- Cost effective
- Bio compatible

- **Societal benefits**
- **Jobs**
- **Education**

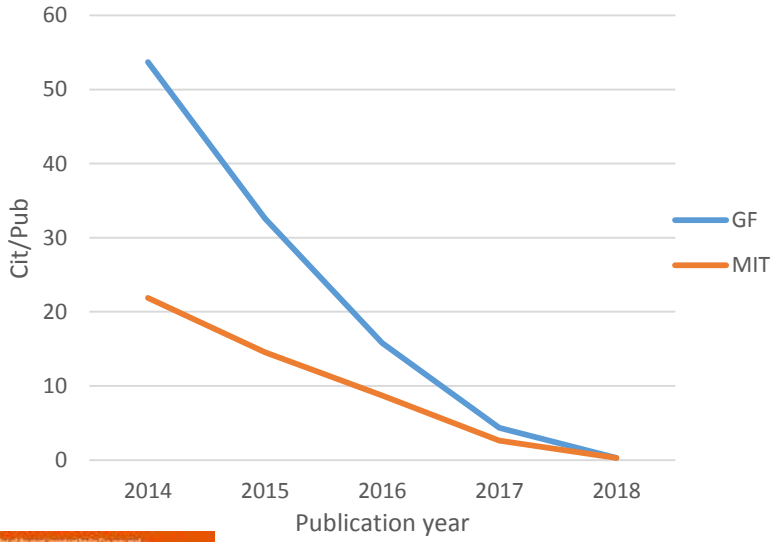
Measuring performance: examples of numbers

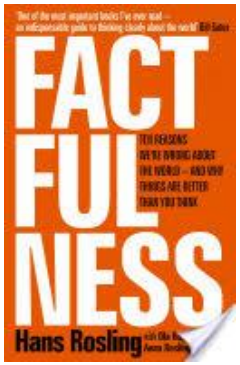
Numeric		
KPI	Achieved	Target
Effort	11,377[1] pm	10,464 pm
Publications (Onboard) (May 23, 2017)	**Core 1:** 907 (published, Onboard) + 456 (awaiting publication, Onboard) [597 (published, WoS)] **Total:** 1888 (published, Onboard) + 645 (awaiting publication, Onboard) [2,219 (published, WoS)]	675 for Core 1
Citations (WoS) (May 23, 2017)	**2,572** for Core 1 **42,768** total	4,000 for Core 1

[1]Partial reporting, number may change

What do the numbers tell?

- The quality and impact of the flagship is hard to assess since there are few comparison points
- One possible comparison is against a broad engineering schol – MIT – which shows that the GF is very competitve
- Impact takes up to 15 years to materialize according to experts, and even simple quality measures such as citations take several years to mature
- We may need to complement hard numbers with a softer narrative to get a more complete picture – data is crucial but it is not everything





Numerical KPIs for Core 1

	Achieved	Target
Number of research agreements	50	21
Number of scientific publications	907	675
Number of invited talks at conferences	1,624	478
Number of citations	**2,572** (42,768)	4,000
Number of awards to individual researchers	46	10
Initial intellectual asset reports	4	4
Number of invention disclosures	**34**	46
Number of patent applications		62
Number of patents	20	10
Number of licenses executed	4	0
Total license income, €	65,315	0
Number of prototypes	**69**	23

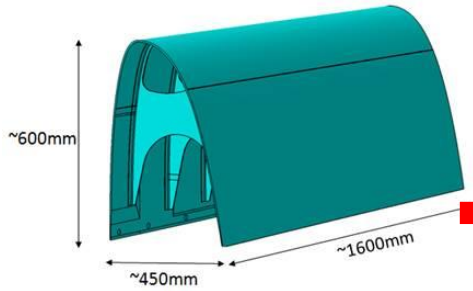
	Achieved	Target
Number of PhDs and Postdocs recruited into the Flagship	141	285
Number of PhDs graduated	43	35
Number of PhDs going out as key experts in European industry	6	20
Number of utilisation training courses developed	6	4
Number of utilisation training occasions delivered to Flagship partners	6	6
Number of Innovation Work Task workshops held	4	4
Number of Flagship partner representatives participating in utilisation courses	72	70
Number of spin-offs established	5	4
Number of enterprises that actively use academic facilities	15	48
Number of products on market	30	19
Number of industry/academy collaborations, in particular SME collaborations	134	92
Number of SMEs on e-mail distribution list	169	150
Number of Graphene Connect industrial workshops	5	5

	Achieved	Target
Number of participants at Graphene Connects representing SME's	**139**	70
Number of technology and innovation areas mapped	**6**	3
Number of external markets mapped	15	15
Number of industry actors providing input to innovation plan	**42**	20
Number of standardised methods	19	16
Number of key features about the Graphene Flagship in public media (not including scientific publications)	14	12
Number of conferences for the professional community, commissioned by the Graphene Flagship	11	8
Number of scientific news stories and press releases	**181**	100
Number of newsletters	8	8
Number of member states and associated countries engaged in a dialogue with the flagship either directly or through an ERA-NET	26	20
Number of international workshops organised	6	6
Calls for Expression on Interest for inclusion of new partners in the Core Project 2	1	1

Some highlights

- First high added value products on the market: photodetector by Emberion for gas detection and spectroscopy (May 2018); multipixel versions in March and September 2019.
  EU Fast-track-to-Innovation funding jointly with Graphenea and AMO GmbH.

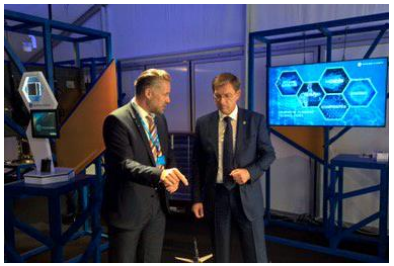
- Very promising photonic switch (CNIT + Ericsson + Nokia) for 5G technology, shown by Ericsson at the MWC
- Prototype of the leading edge of the rear horizontal stabilizer of Airbus A350




WEARABLES AND HEALTH
ICFO
Graphene Roadmap


The future of EU Finances
EU Budget Focused on Results

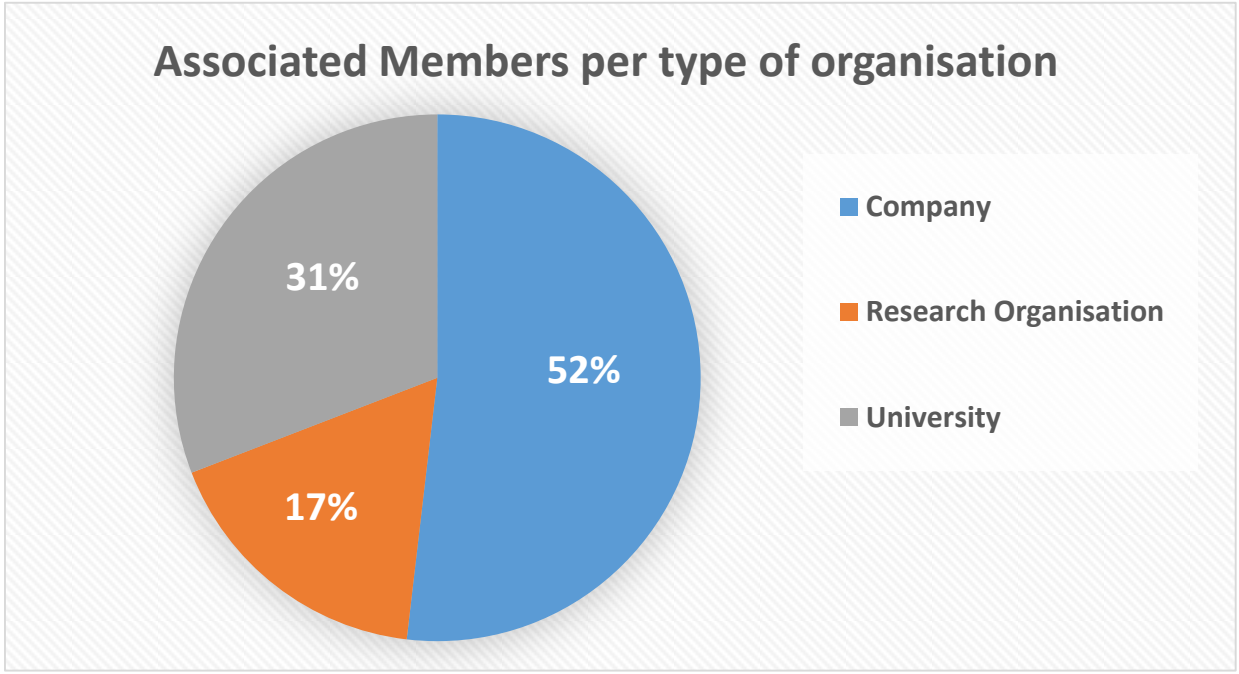
EU2017.EE



Core 1: PPs/AMs Association

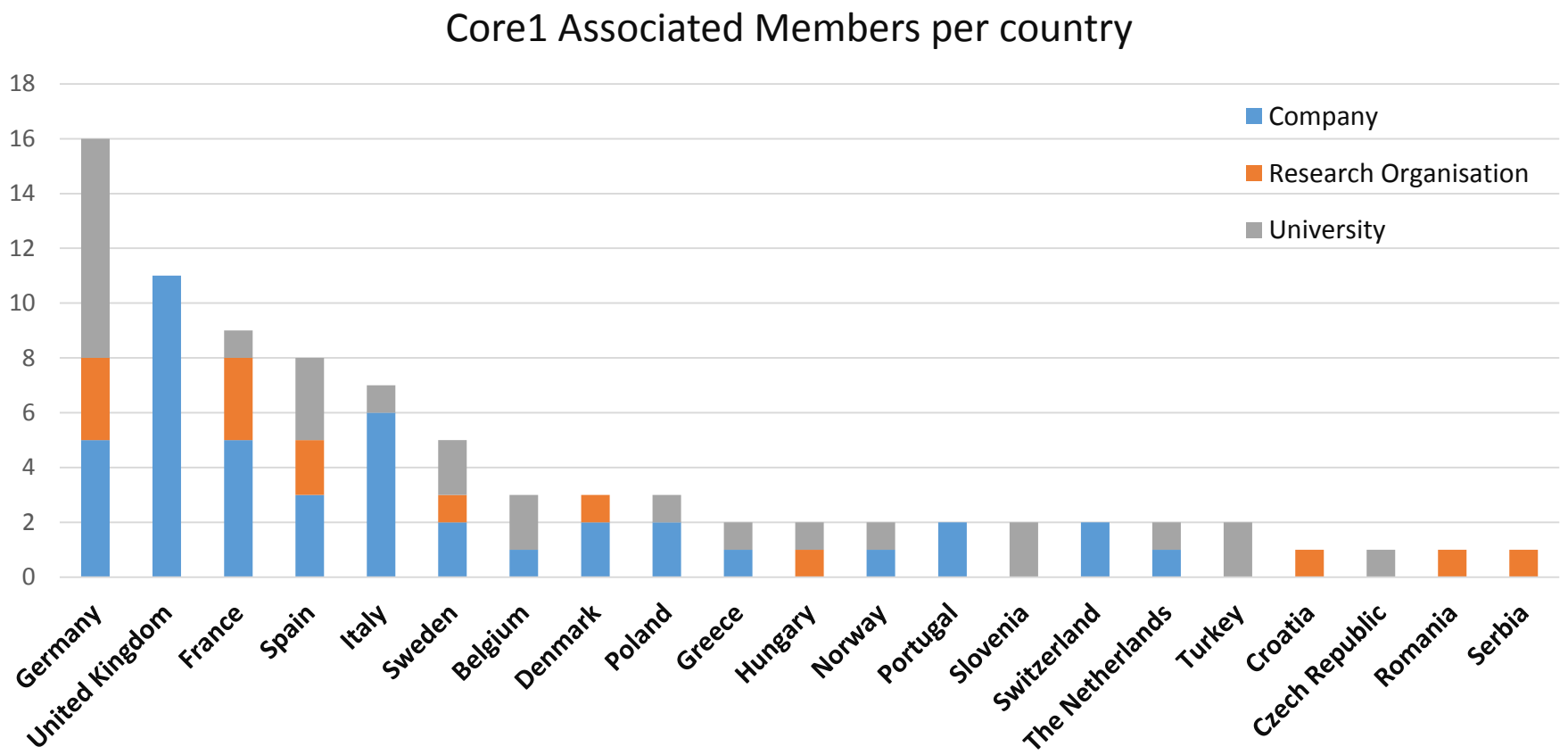
85 Associated Members: **48** through **19** Partnering Projects
37 Individual Associated Members

21 European countries



Strong industrial participation

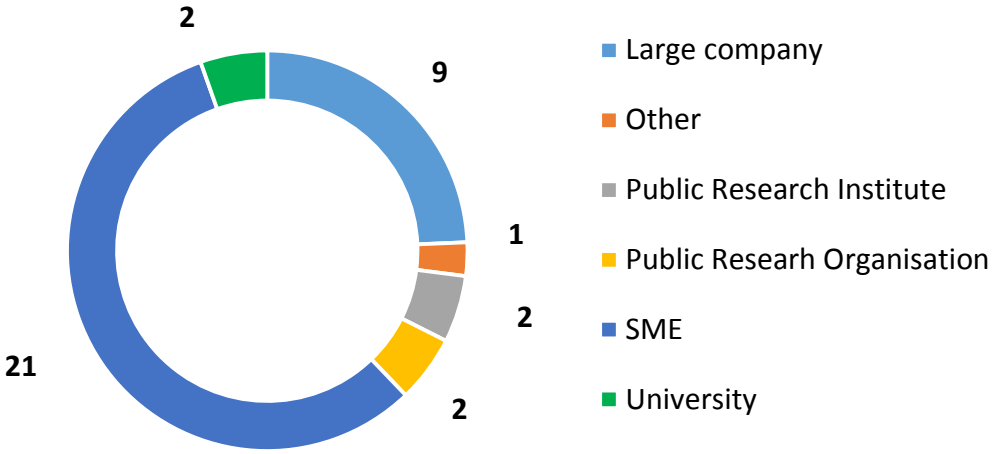
Core 1: PPs/AMs Association



85 Associated Members from **21** European countries

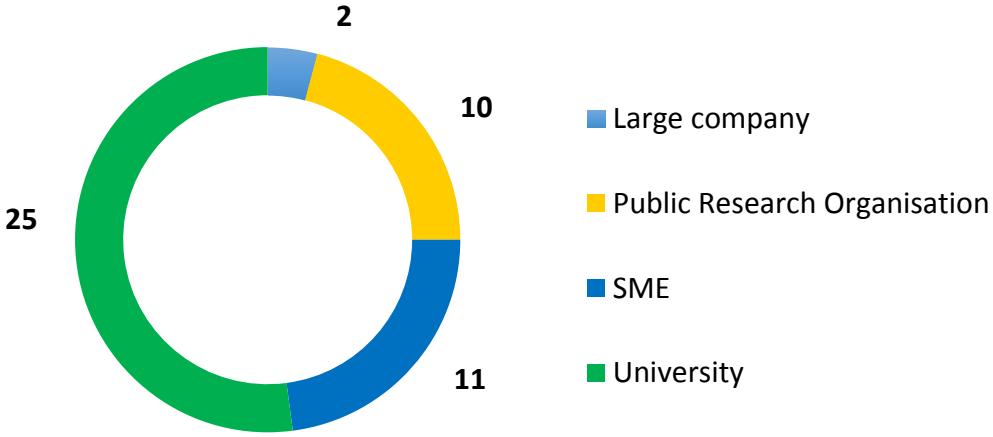
Core 1: PPs/AMs Association

Individual AMs



> 80% of Individual AMs are SMEs and companies

AMs in Partnering Projects



> 70 % of AMs in PPs are universities and research organisation

Core 2 AMs status

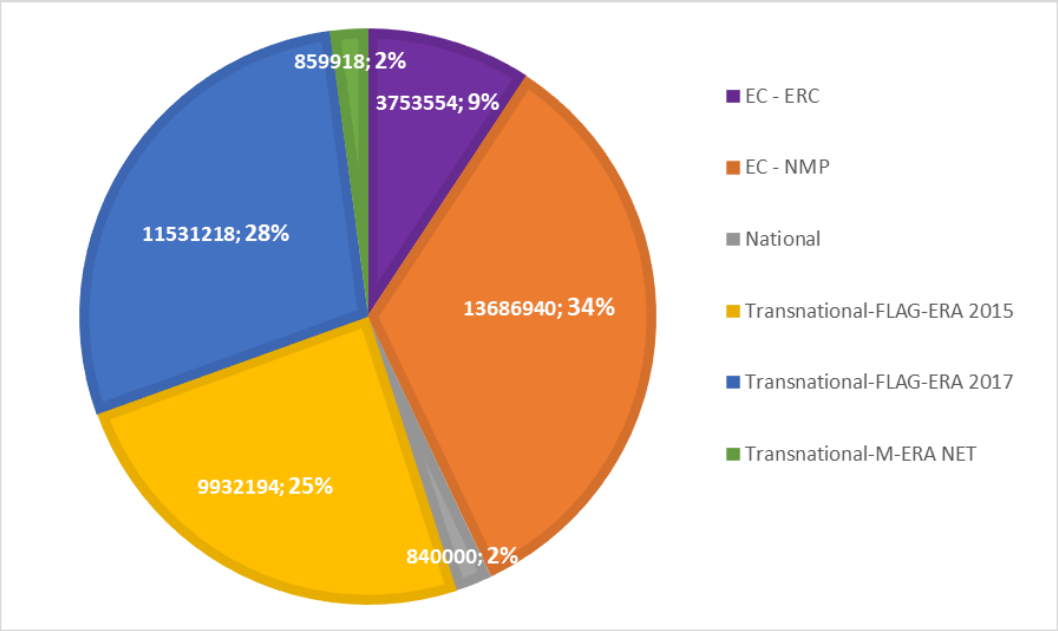
- Currently: 77 AMs and 29 PPs
- 45 AMs renewed from Core 1 (22 individual and 23 through PPs)
- 12 PPs renewed from Core 1 (10 FLAG-ERA JTC2015 and 2 ERC)
- 17 new FLAG-ERA JTC2017 PPs (28 new AMs)

Core 2 WP	Partnering Projects
WP1 – Enabing Research	1 PP: **TopoGraph**
WP2 - Spintronics	1 PP: **MORE-MXenes**
WP3 – Enabling Materials	6 PP: **2D-SbGe**; **GRANSPORT**; **H2O**; **LaMeS**; **SIMPLANT**; **GRAPH-EYE**
WP5 – Biomedical Technologies	2 PP: **EPIGRAPH**; **GRAFIN**
WP6 - Sensors	1 PP: **CO2-DETECT**
WP11 – Energy Generation	1 PP: **MELoDICA**
WP13 – Functional Foams and Coatings	3 PP: **CERANEA**; **GATES**; **MX-OSMOPED**
WP14 - Composites	2 PP: **GraSage**; **MECHANIC**

Partnering Project funding

Summary of PP funding from the start of the Flagship until June 5, 2018.

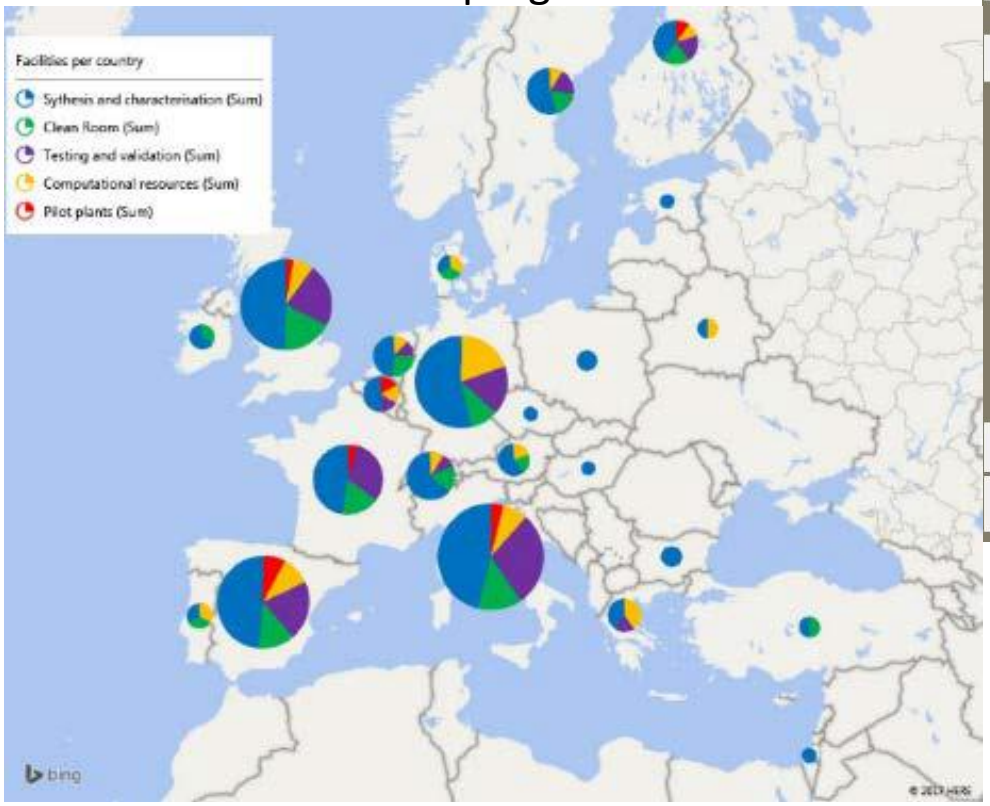
Note: only one nationally funded project (PHONAMP from Serbia) has applied for a PP status

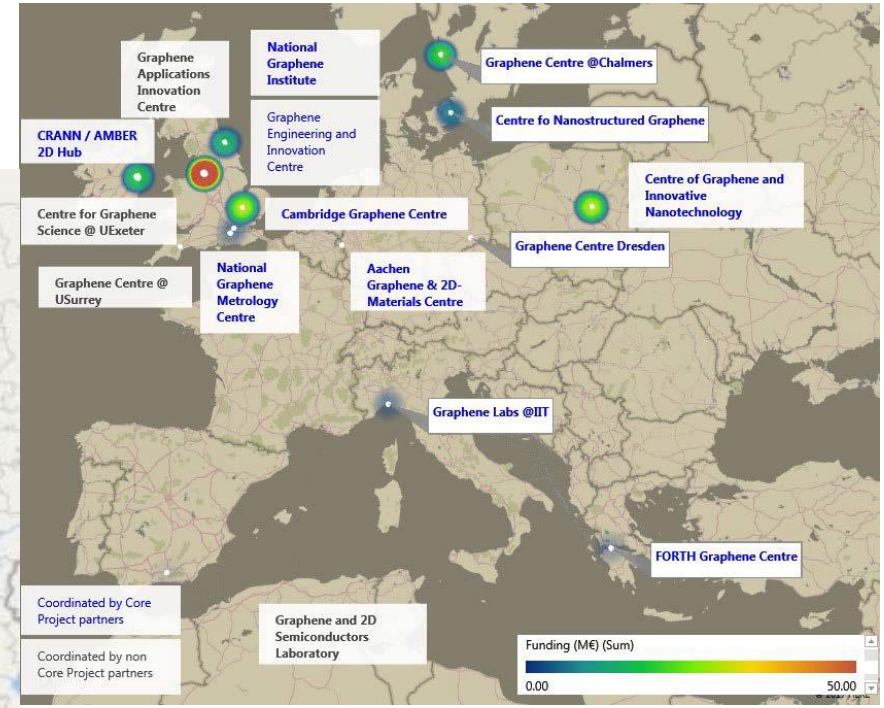


Row Labels	Sum of Funding per type (€)
EC - ERC	3753554
EC - NMP	13686940
National	840000
Transnational-FLAG-ERA 2015	9932194
Transnational-FLAG-ERA 2017	11531218
Transnational-M-ERA NET	859918
Grand Total	**40603824**

Examples of other MS investments

- MS funding is hard to quantify in terms of euros, best estimate is 35 M€/yr, largely via centers and broad programs





- Other EC funding (structural funds, ERC etc.) adds another few M€/yr

(Data by ESF)

Associated Members Highlights

MOBILE WORLD CONGRESS 2017 (3 AMs) and 2018 (4 AMs):

7 AMs exhibited at the Graphene Pavilion

- ✓ Conductive paint for electronic signal transmission *(G-Next)*
- ✓ Smart printed textiles *(GrapheneTech)*

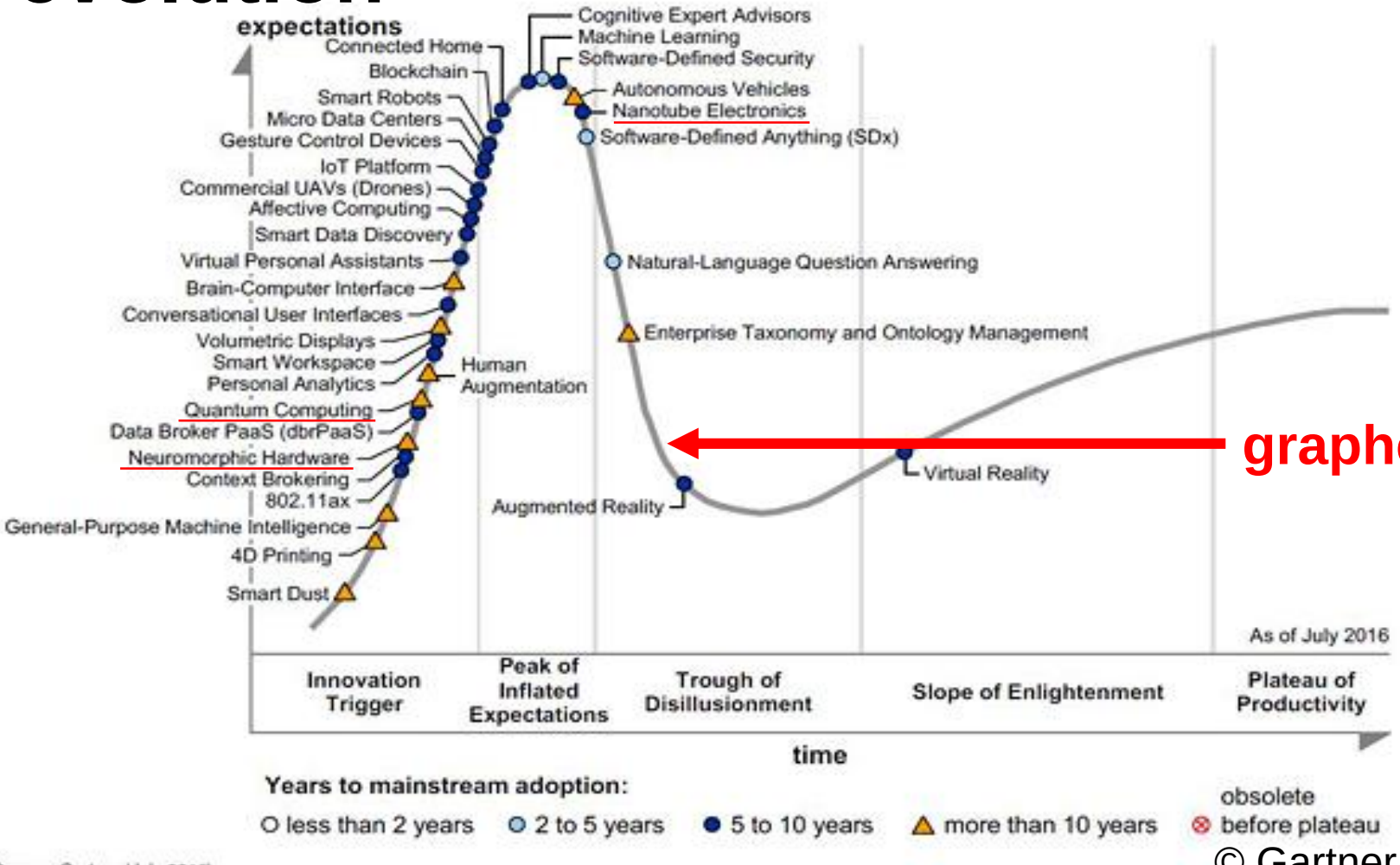
- ✓ 'Spray-on' graphene heating system *(FGV Cambridge Nanosystems)*
- ✓ Miniaturised graphene-based cooling pump *(APR Technologies)*
- ✓ Smart heat for smart textiles *(BeDimensional)*

- ✓ Graphene-enhanced footwear *(BeDimensional)*
- ✓ Point-of-Care diagnostics for infection monitoring *(KTH Royal Institute of Technology)*

- ✓ Graphene supercar (graphene -carbon fibercomposites) *(Haydale)*

Graphene Flagship Roadmap: Contributions from 14 AMs in 6 workshops

Disruptive technologies evolution



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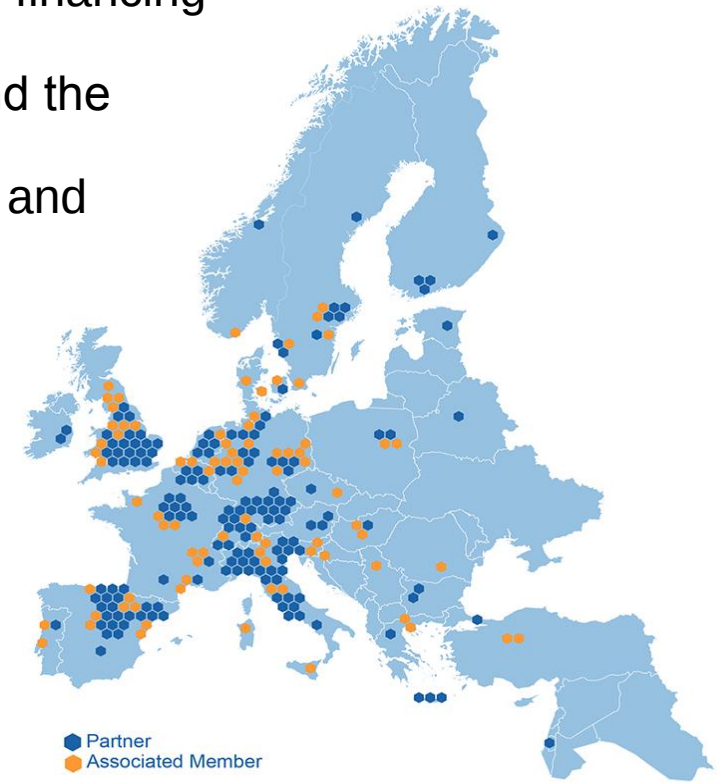
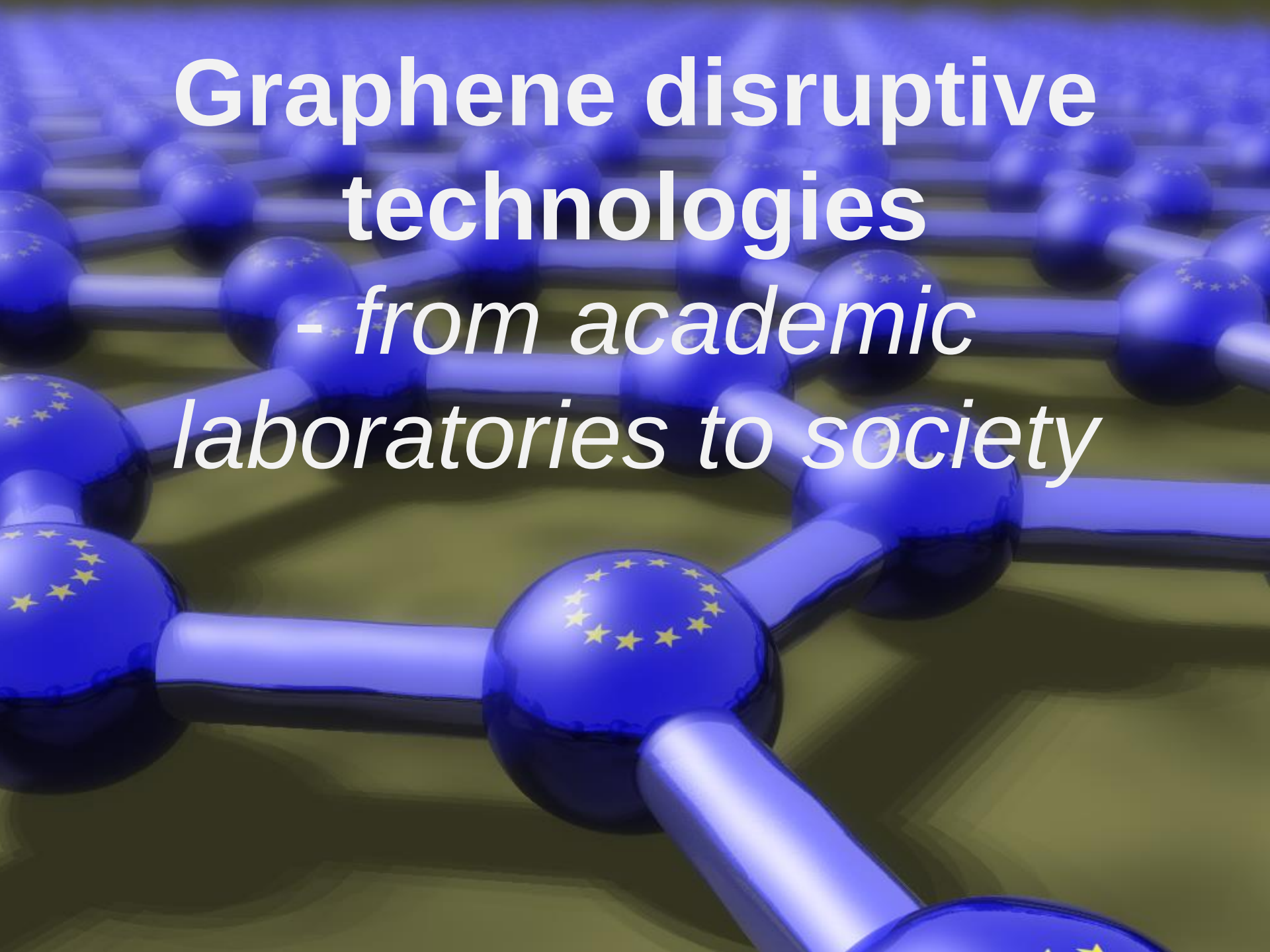
Discussion points

- The flagship has spent about 29% of its planned EC financing and about 45% of its duration
  → we expect an extension to Horizon Europe beyond the planned 10 year life time (flagships *vs*. missions).
  EC proposal on Horizon Europe, Global Challenges and Industrial Competitiveness:
  "*'FET Flagships' supported under Horizon 2020 will continue to be supported under this Programme.*"
- The core project consortium has probably passed its largest size, 156 organizations at the end of Core 1: slightly larger funding per partner in Core 2 and Core 3
- Growth expected in Associated Members (~80) and Partnering Projects (~30);
  collaboration with Member States is crucial (**WP20**): important to support both national and trans-national (FLAG-ERA) activities
- Distribution of risk: focused actions with higher uncertainties *vs.* broader actions with more dispersed impacts




Graphene disruptive technologies
- from academic laboratories to society