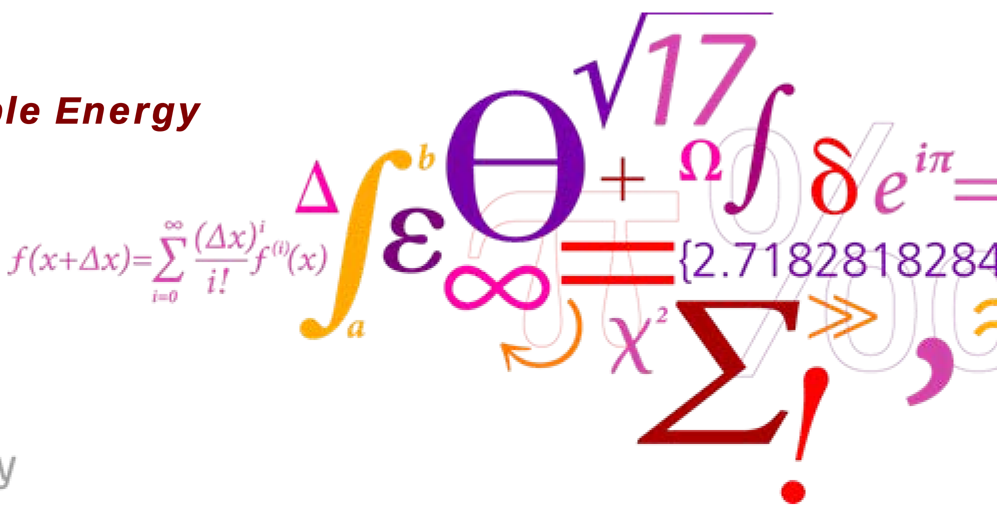
Tendinte internationale pentru integrarea inovarii in cercetare

Eugen Stamate
Plasma Processing
Risø National Laboratory for Sustainable Energy
Technical University of Denmark

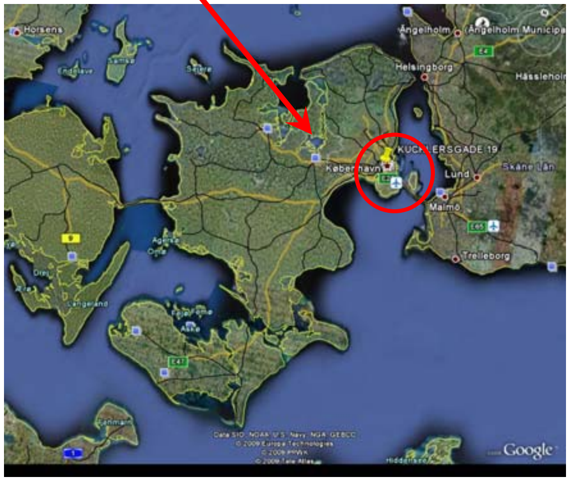
Acknowledgement: **Jens-Peter Lynov**
Research Innovation Activities
Risø National Laboratory for Sustainable Energy
Technical University of Denmark



Outline

- Risø DTU - short introduction
- Discrete and modal focusing effects
- Innovation: same problem – different contexts
- Innovation activities at Risø DTU

Roskilde



Risø DTU

Roskilde

Danish nuclear programme established at Risø

1954: Nuclear Energy Committee headed by Niels Bohr

1957: First reactor critical

1958: 2 more reactors under construction

Bohr inspects Risø worksite

Car free Sundays
Nuclear Power No Thanks

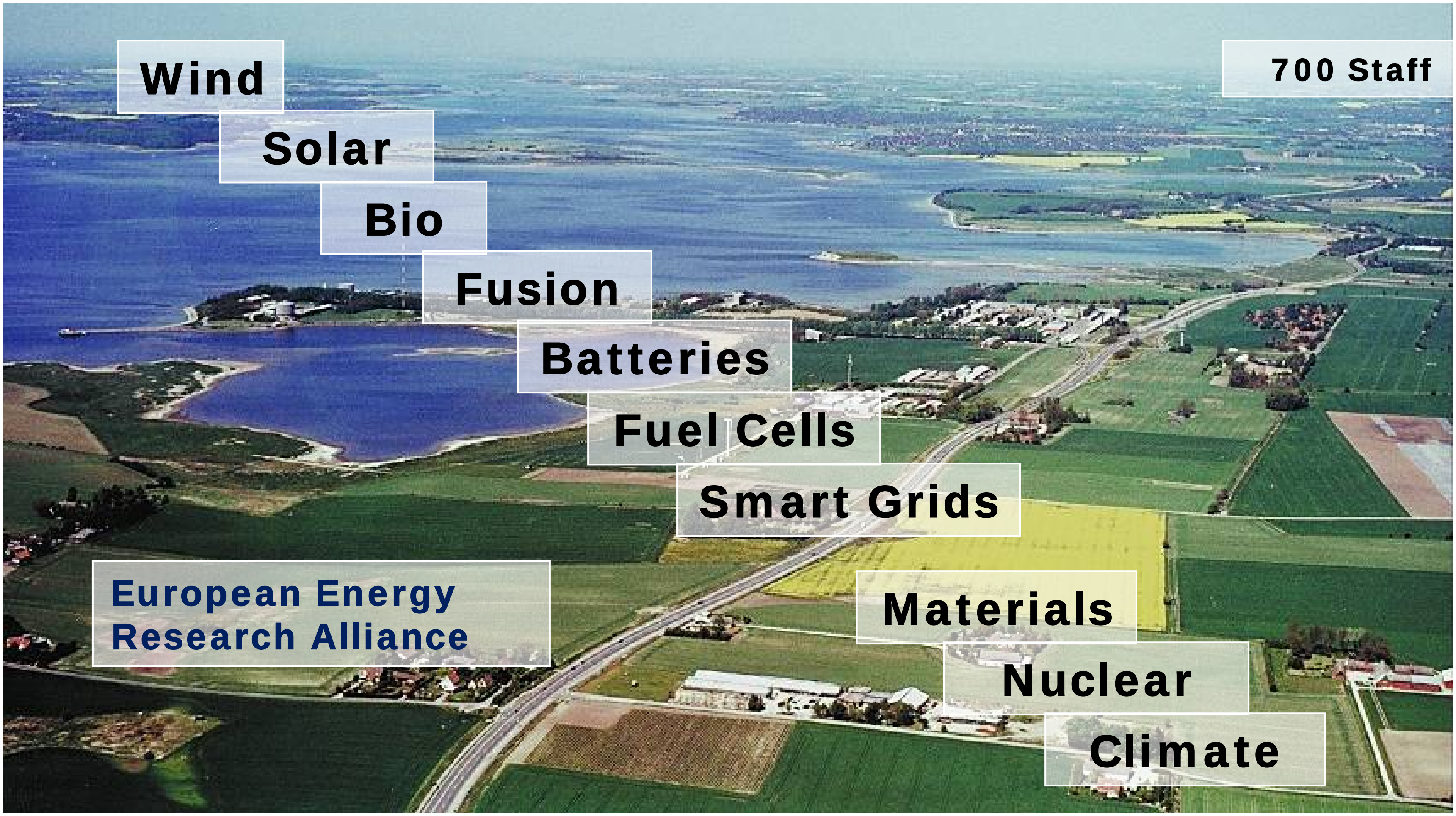
1976 Nuclear power and other energy technologies.

1985 No Nuclear Power in Denmark. Reactors serve as neutron sources for materials research.

2000 Decommissioning of last Nuclear reactor.

2007 Part of the Technical University of Denmark.

Risø DTU 2010



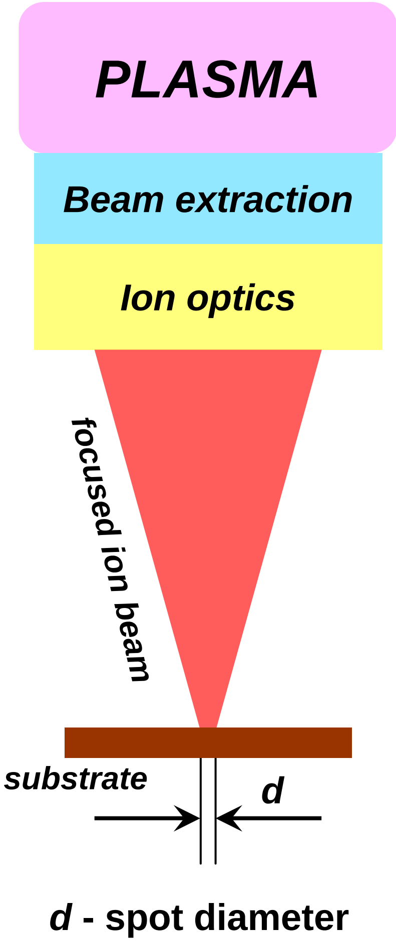
Introduction

Plasma Processing
Plasma Physics and Technology Programme

Research expertise:

- Development and characterization of plasma sources
- Three dimensional plasma-sheath-lenses;
- Negative ion etching
- Productions and diagnostics of negative ions
- Ozone production and NOx reduction;
- Plasma immersion ion implantation;
- Plasma sterilization and bio-inactivation;
- Molecular beam epitaxy

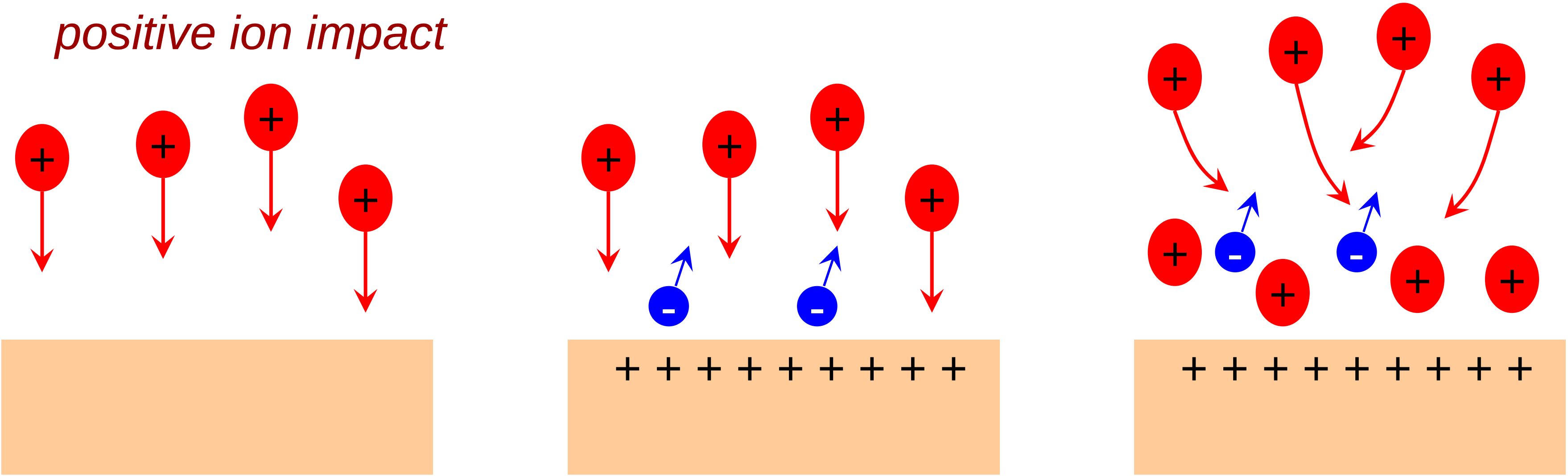
Introduction - applications for focused ion beams



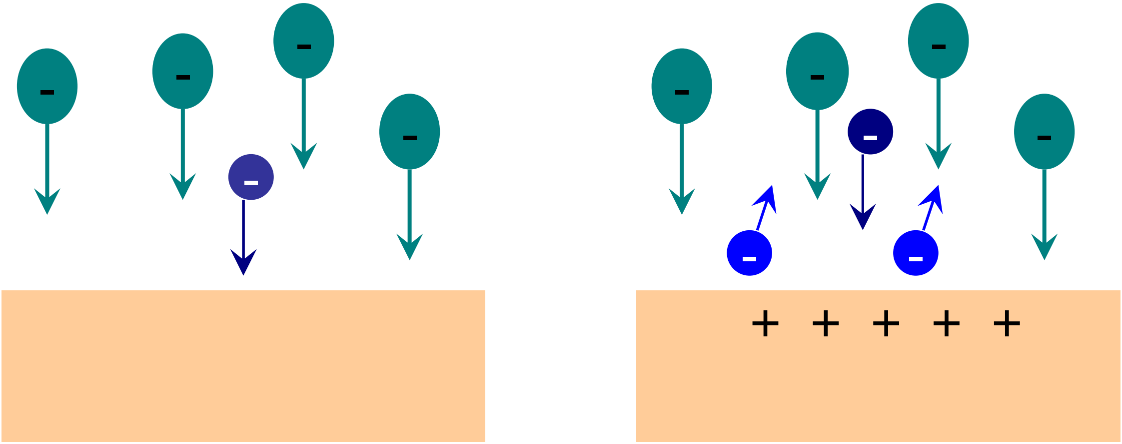
Application	Details
Scanning probe sensors	Cantilevers with ultra sharp high-aspect-ratio tips used in atomic force microscopes to sense a variety of properties with nanometer resolution
Nano-photonics	Two dimensional photonic crystals and plasmonic resonance structures in metal membranes – deposit or etch high-aspect-ratio cylinders and pitches with low surface roughness
Micro- and nanoelectronics	Three dimensional single step fabrications of resistors, wires, bonds, transistors and sensors.
Insulators and resistors	High resistance, high breakdown voltages, low intrinsic charges
Repair of photomask	Deposit of opaque or transparent material or remove material with high selectivity and without damage to the underlying material
Mask fabrication for pattern transfer	Applicable for three dimensional profiling
Mechanical applications	Sensors, miniature motors, switches
Bio – applications	Nanopore membranes for high-speed DNA sequencing, neutral interface systems, cutting tool for subcellular cutting, capture tool for organelles
Circuit editing	Rewire integrated circuits in the prototyping phase – connections can be cut or made. Specially used in integrated circuits with multilevels of metallization.
Field emitters	Flat panel displays, prototype field emitters

Ion beam surface interaction (sputtering, implantation)

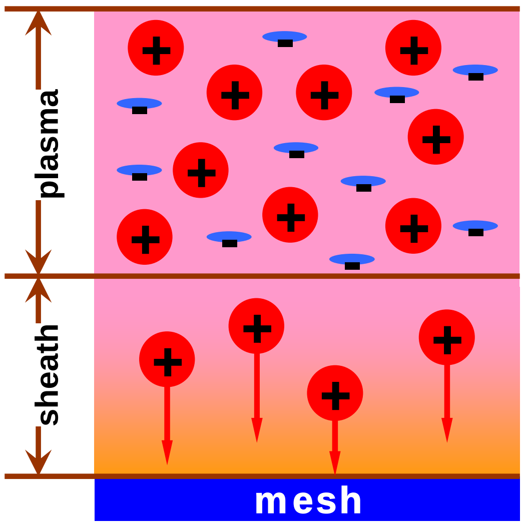
positive ion impact

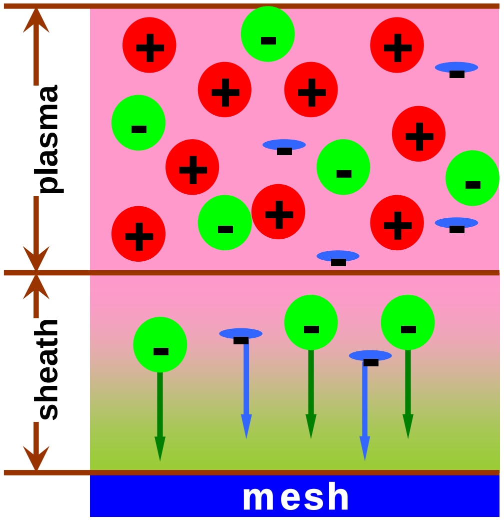


negative ion impact



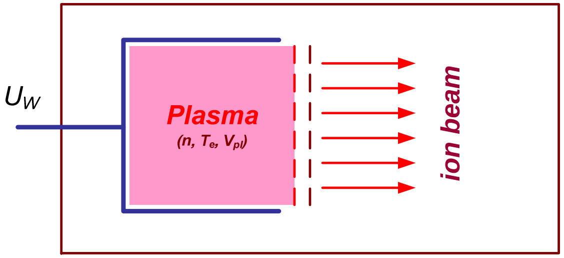
Electropositive versus electronegative plasmas

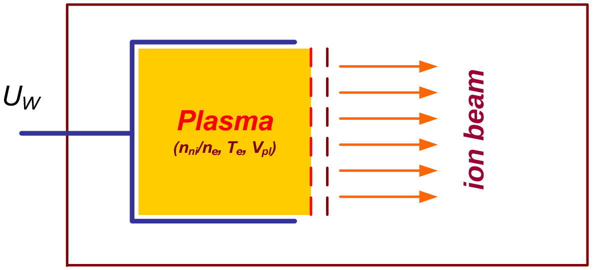




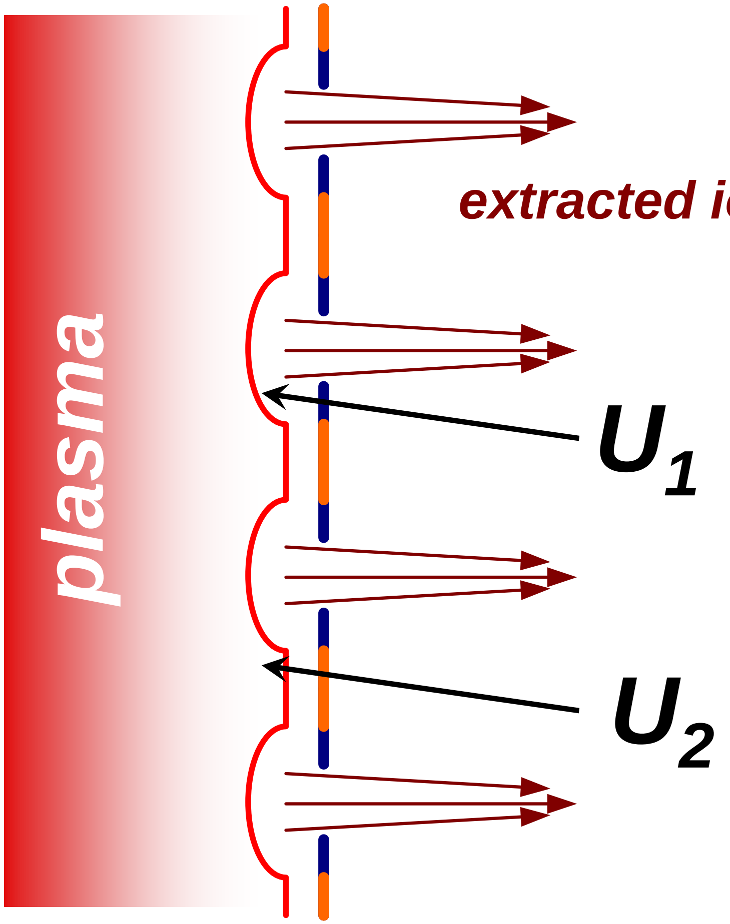
- $m_i >> m_e$
- easy to produce
- ion acceleration requires $V < V_{pl}$
- possible to control V_{pl}

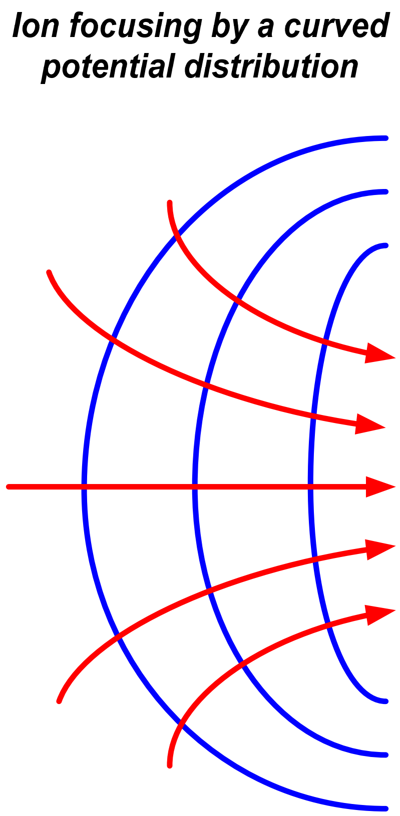
- $m_{ni} \sim m_i$
- difficult to produce (requires low T_e and n_e)
- ion acceleration requires $V > V_{pl}$ (glow)
- possible excessive heating by electrons



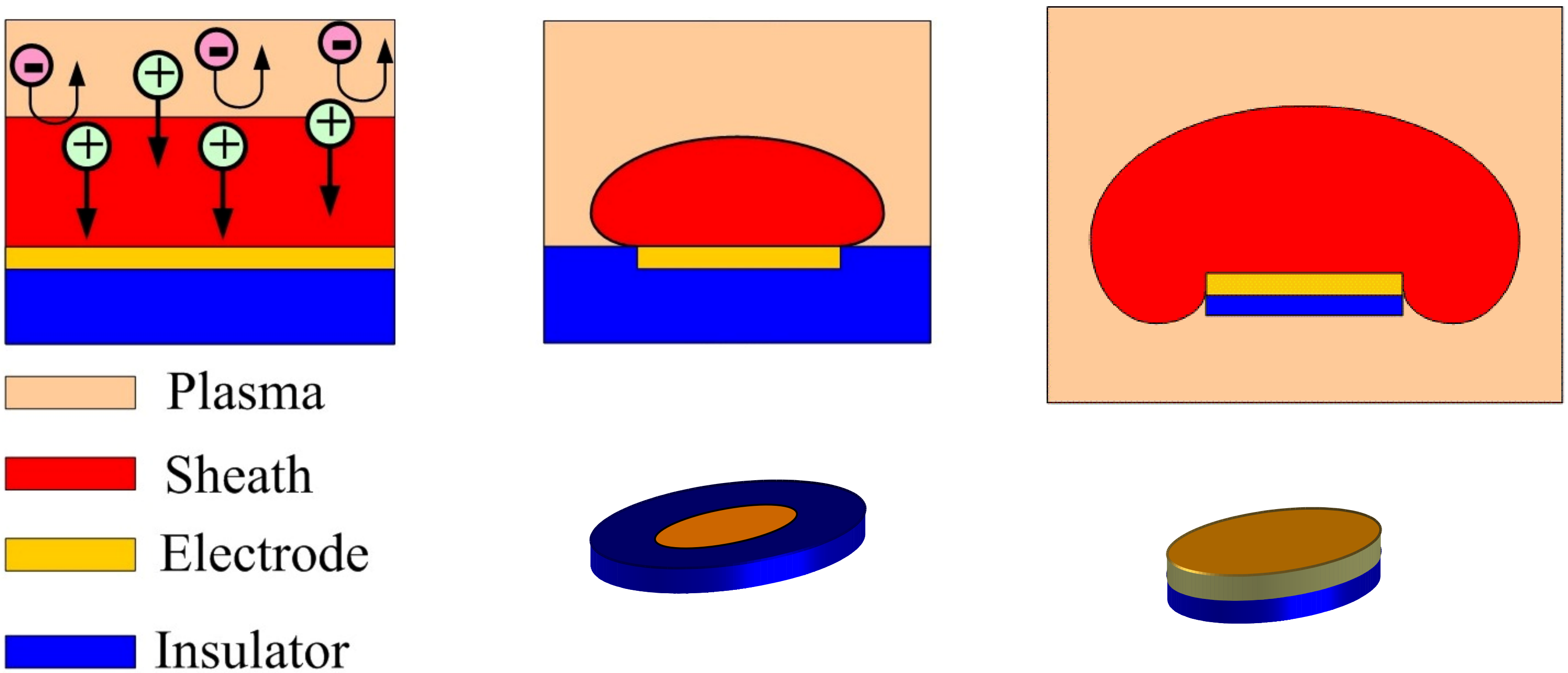


Ion beam extraction

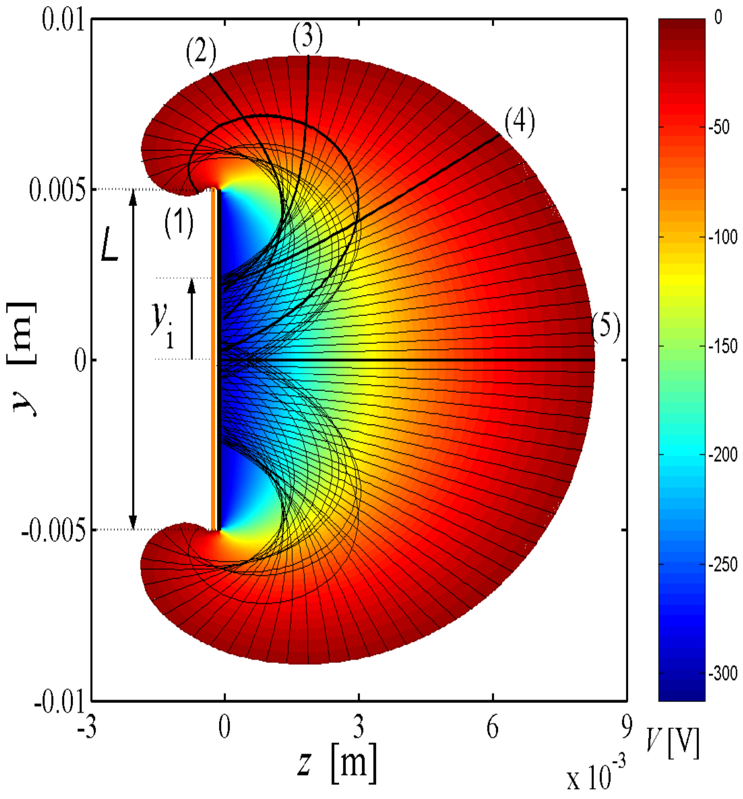




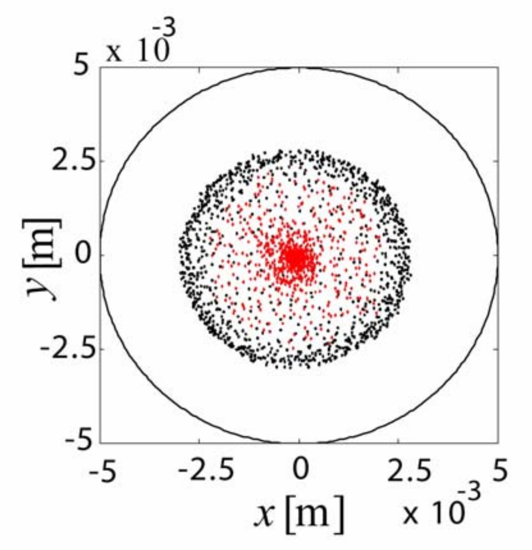
Plasma-sheath-lens

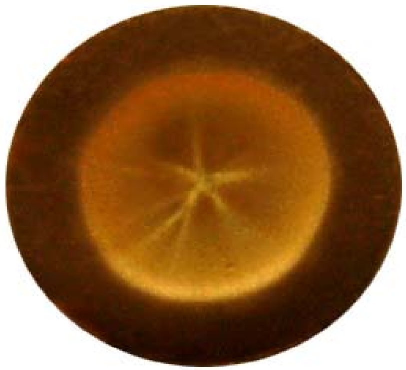


2D potential distribution – discrete focusing



$V(x\!=\!0,\, y,\, z)$, disk electrode
L=0.01 m, V_o=–300 V,
n_i=10^{15} m^{-3}, T_e=2 eV,
T_i=0.2 eV and n_{ni}=0;

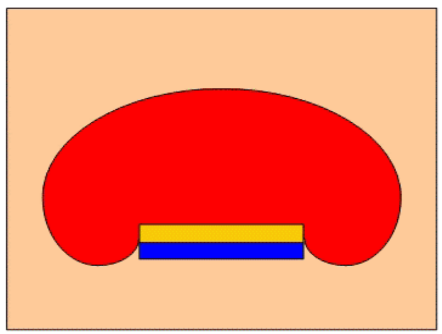




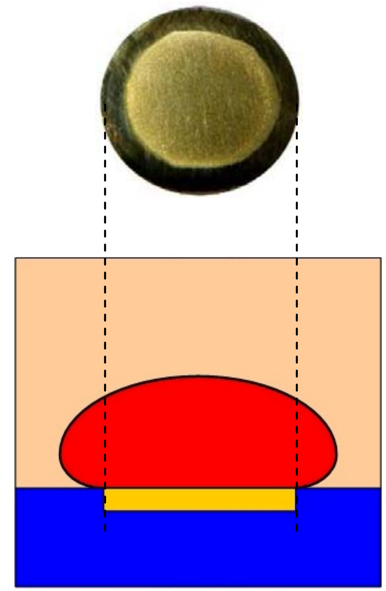
New terminology

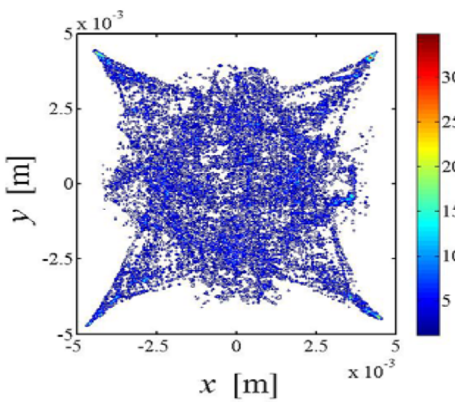
- Passive surface
- Discrete focusing
- Modal focusing
- Impact radius

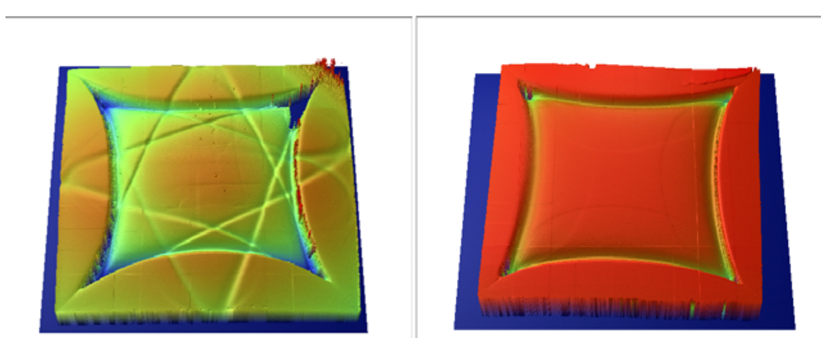
Separation of discrete and modal focusing

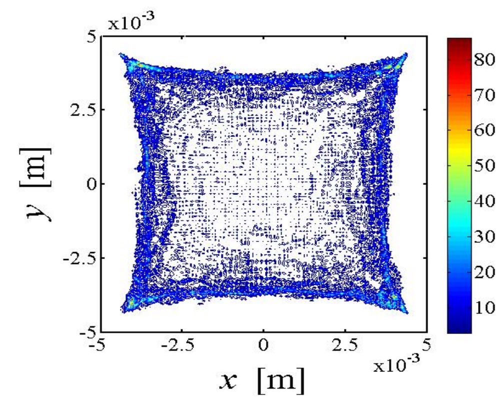


r_d=5 mm
Brass,
Ar plasma
t=60 min,
V_o=–300 V
n_i= 10^{15}m^{-3}
T_e=1.7 eV



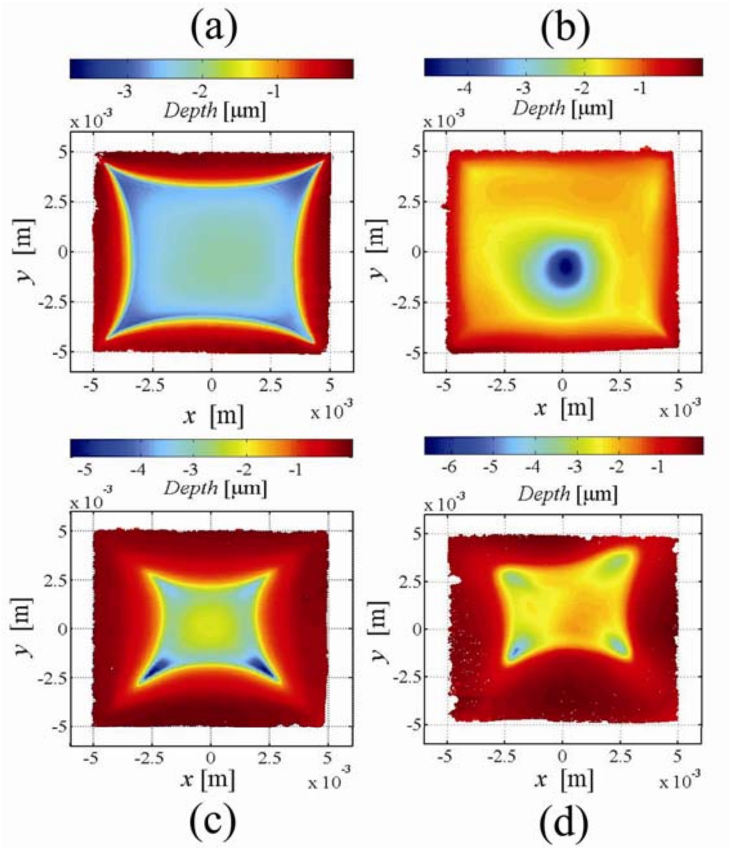


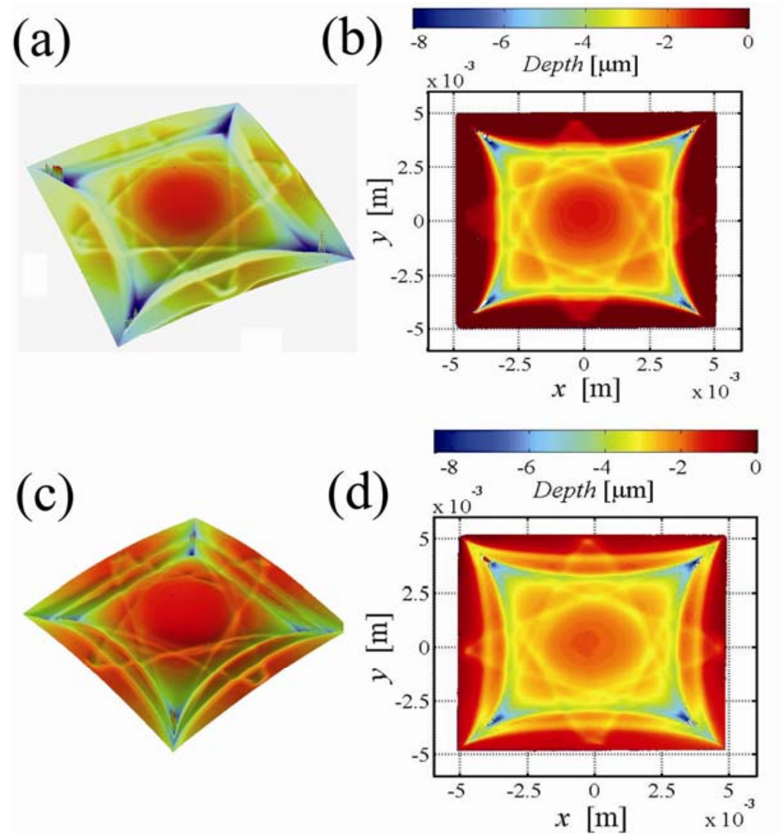




[E. Stamate and H. Sugai, Phys. Rev. Lett. (2005) 94, 125004]

Experiments – discrete and modal focusing





Discrete ion focusing

ICP: a) positive ions

b) negative ions

DC: c) postive ions

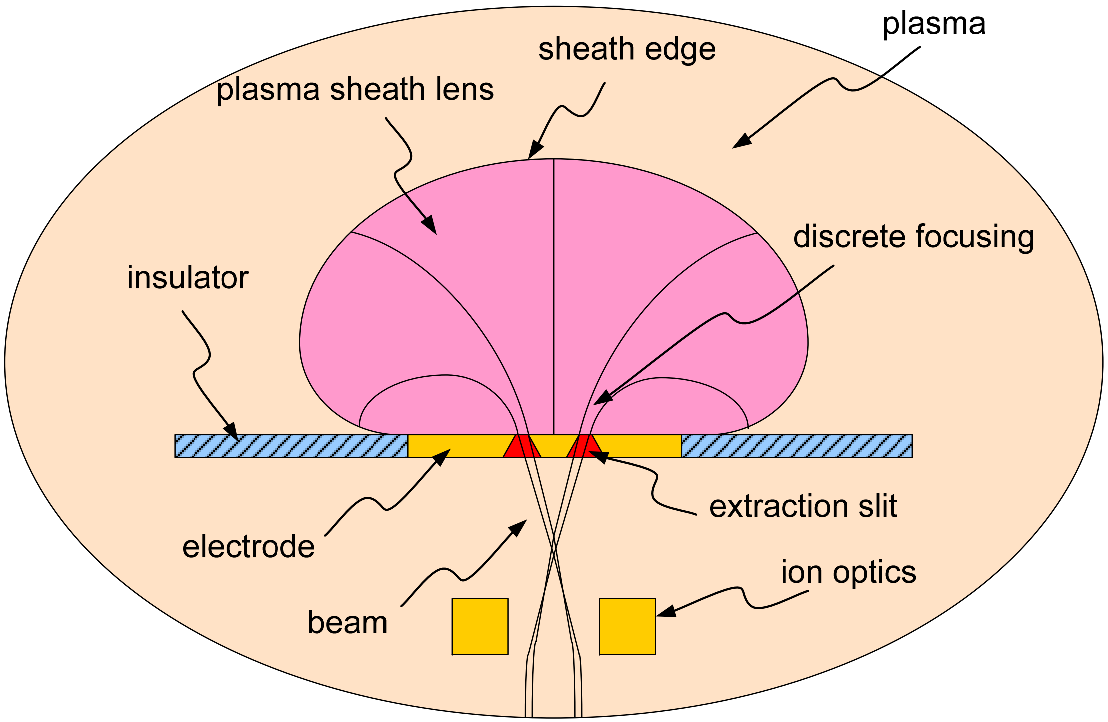
d) negative ions

Modal Focusing

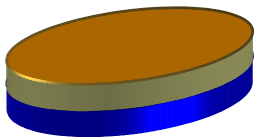
a) V_o=- 300 V

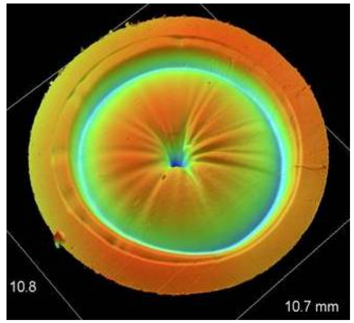
c) V_o=- 150 V 15 min, - 400 V 15 min

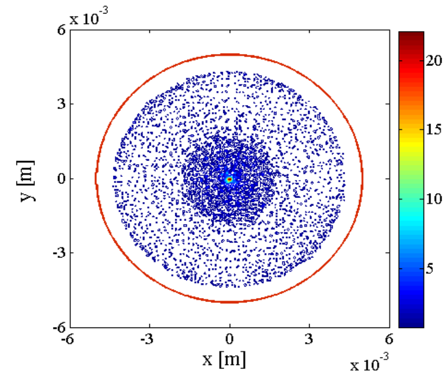
Ion beam extraction

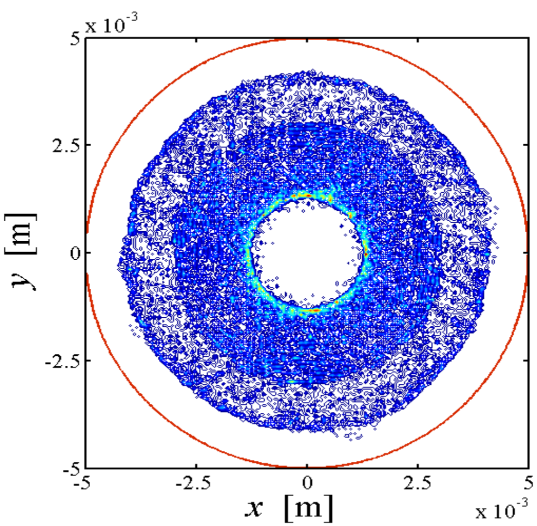


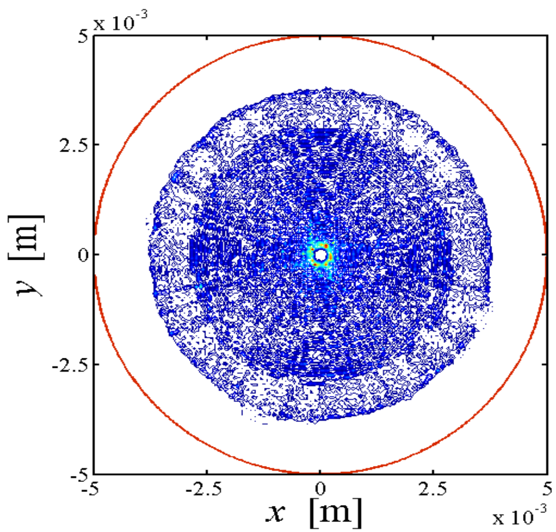
Ion impact locations for Bz≠0

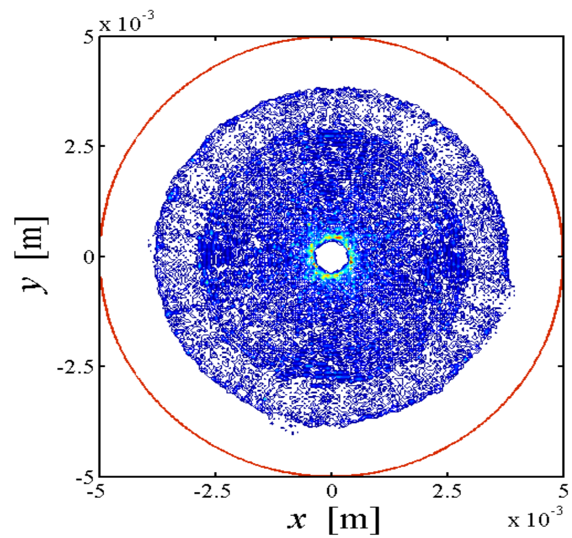












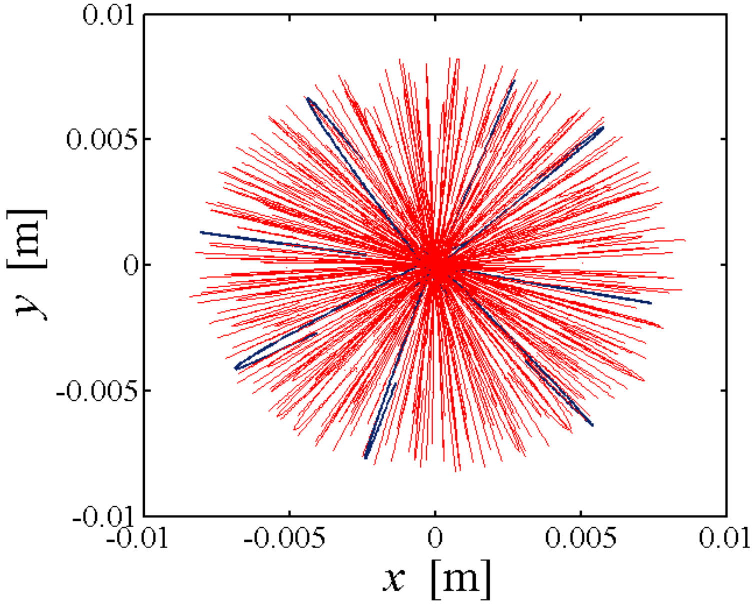
m=1, B_z=1000 Gauss

m=40, B_z=1000

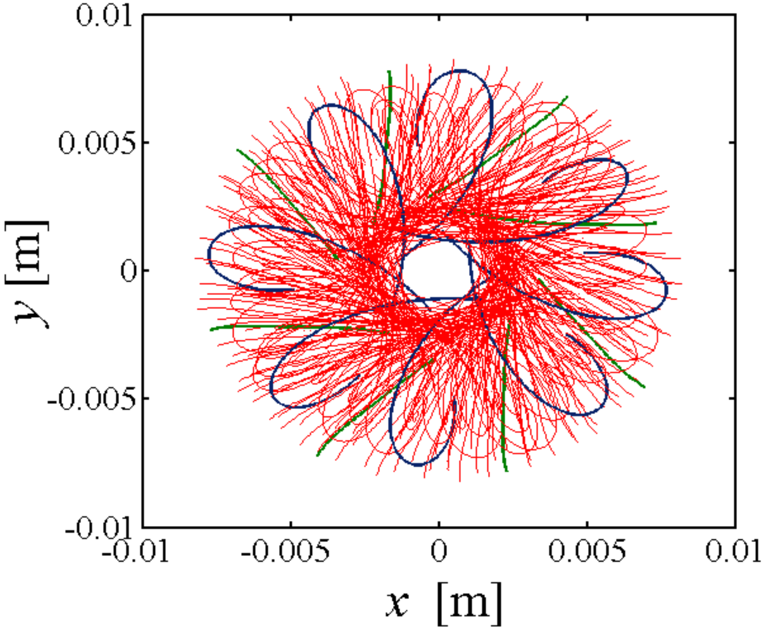
m=40, B_z=2000 Gauss

Details on ion trajectories

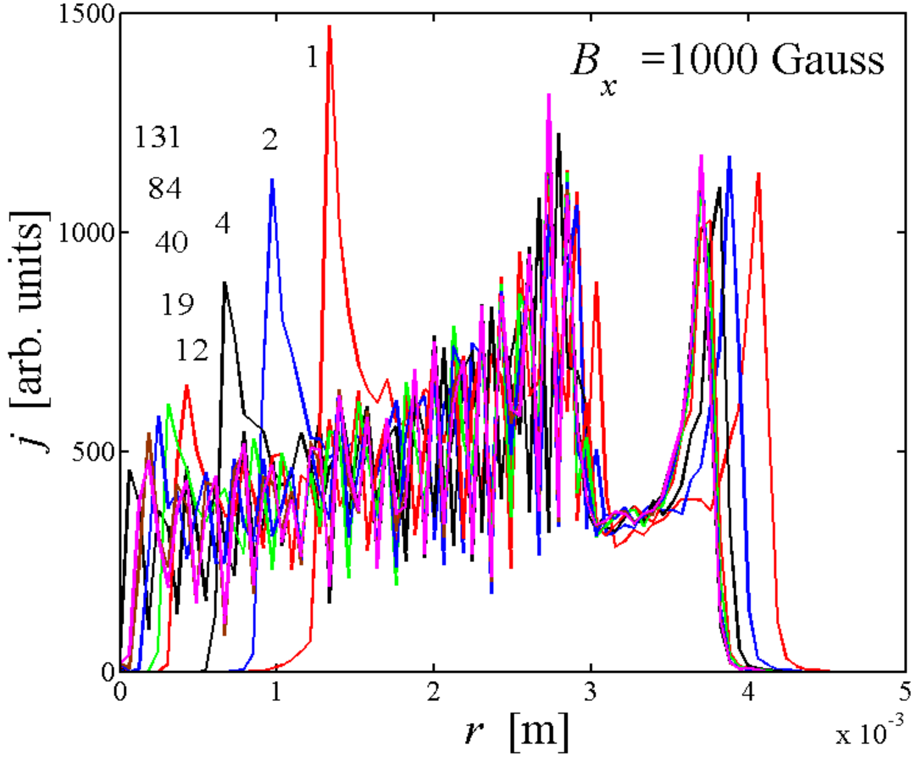
B=0

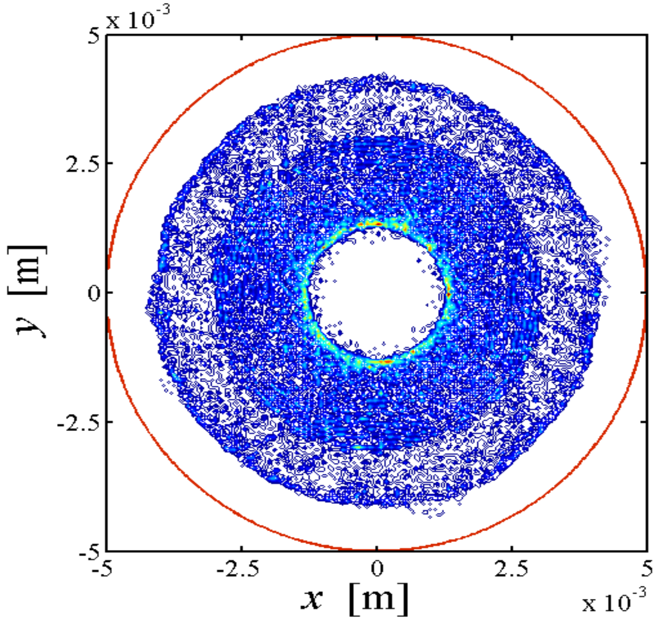


$B_z \neq 0$, $B_x = B_y = 0$



Mass resolution





Innovation Japan versus Denmark

Japan	Denmark
126 mil Tokyo (Edo) 1 mil. in 1600	5.5 mil
2004 Corporative universities (10% decrease of basic founds in next 10 years)	2007 Merge of major research institutions 3 universities in top 200, 5 in top 500
2009 more patent applications than USA	10 % success rate for grant applications
Research diversity	Pragmatism on spending public money
High acceptance for technological development	High social values

Innovation at Risø DTU

Chief Advisor for Innovation (management)

Coordination group for innovation (1 president, 6 membres)

RIA – Research Innovation Activities (administrative unit of 20 about 15 staff)

Total income in 2009 (DKK mill.)	**622 (83 mil euro)**	
– ***Basis appropriation***	***306***	***(49 %)***
– ***Program activities***	***202***	***(33 %)***
– ***Market controlled activities***	***114***	***(18 %)***

- Capacity doubled every 3 to 4 years
- 1.7 % of world electricity production
- Denmark: 20 % today 50 % expected in 2025

World 2050:

IEA BLUE: 4 per hour

Risø DTU: 10 per hour

25 % of world electricity

Nysted

72 x 2.3 MW

- on a nice day

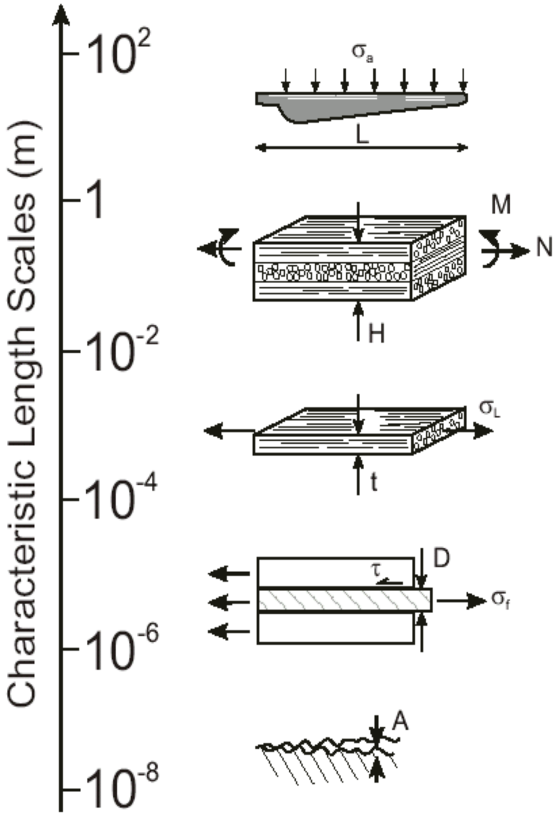
Wind Conditions

- Siting
- design
- forecasting

- Resources
- Extreme wind
- Vertical profile
- Turbulence
- Complex terrain
- Wakes
- Offshore

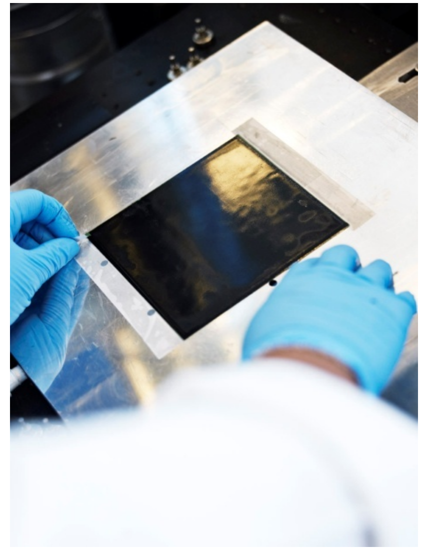
Turbine design

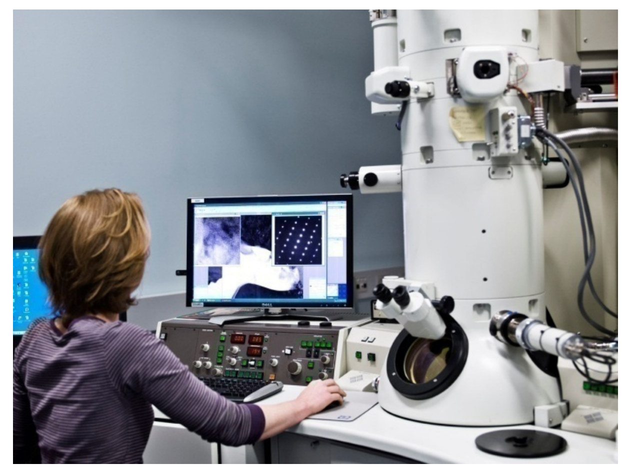
- Aerodynamics
- Aeroelastics
- Stability
- Control
- **Materials**
- **Structures**
- Electrical
- Hydrodynamics

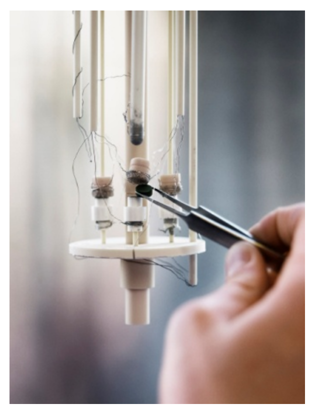


Batteries
Fuel Cells
Electrolysis

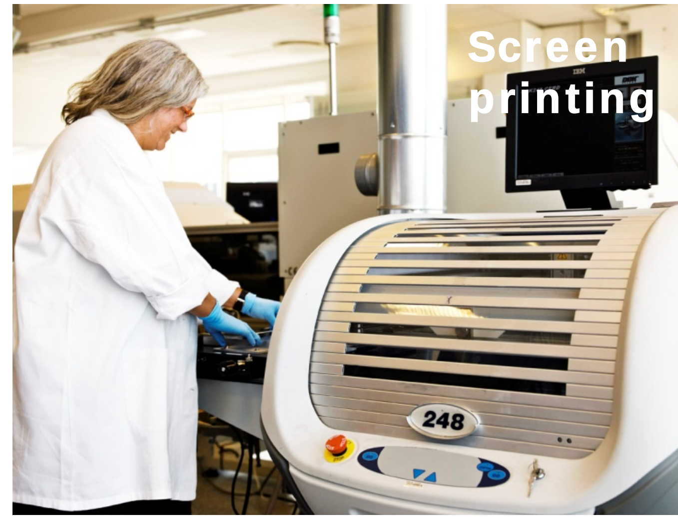
- Materials development
- Characterization
- Modelling
- Testing







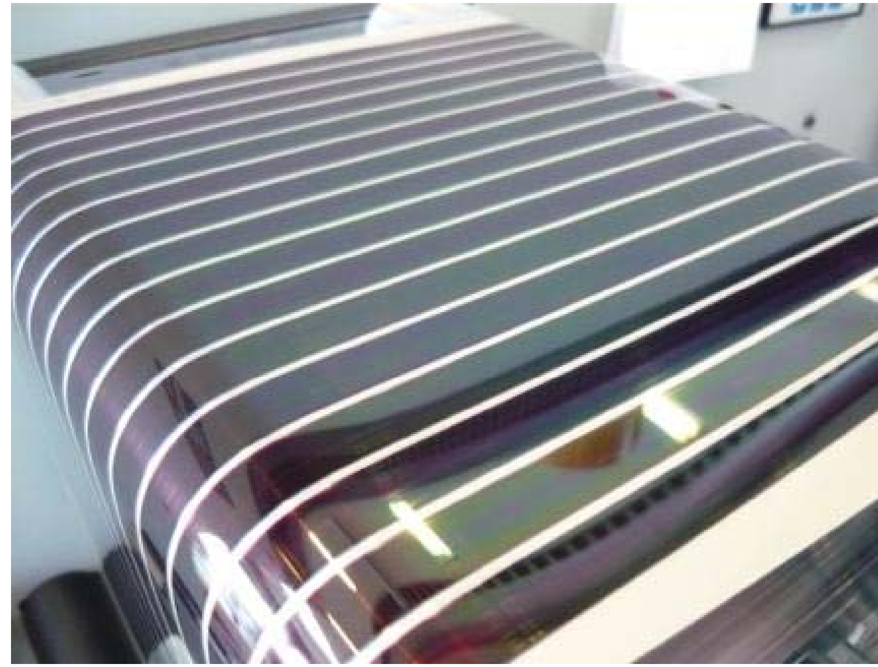
Fuell cell
Pre-pilot facility



Capacity of 10,000s
of units per year

Biomass, bio energy and bio materials

Polymer solar cell
Roll-to-roll production

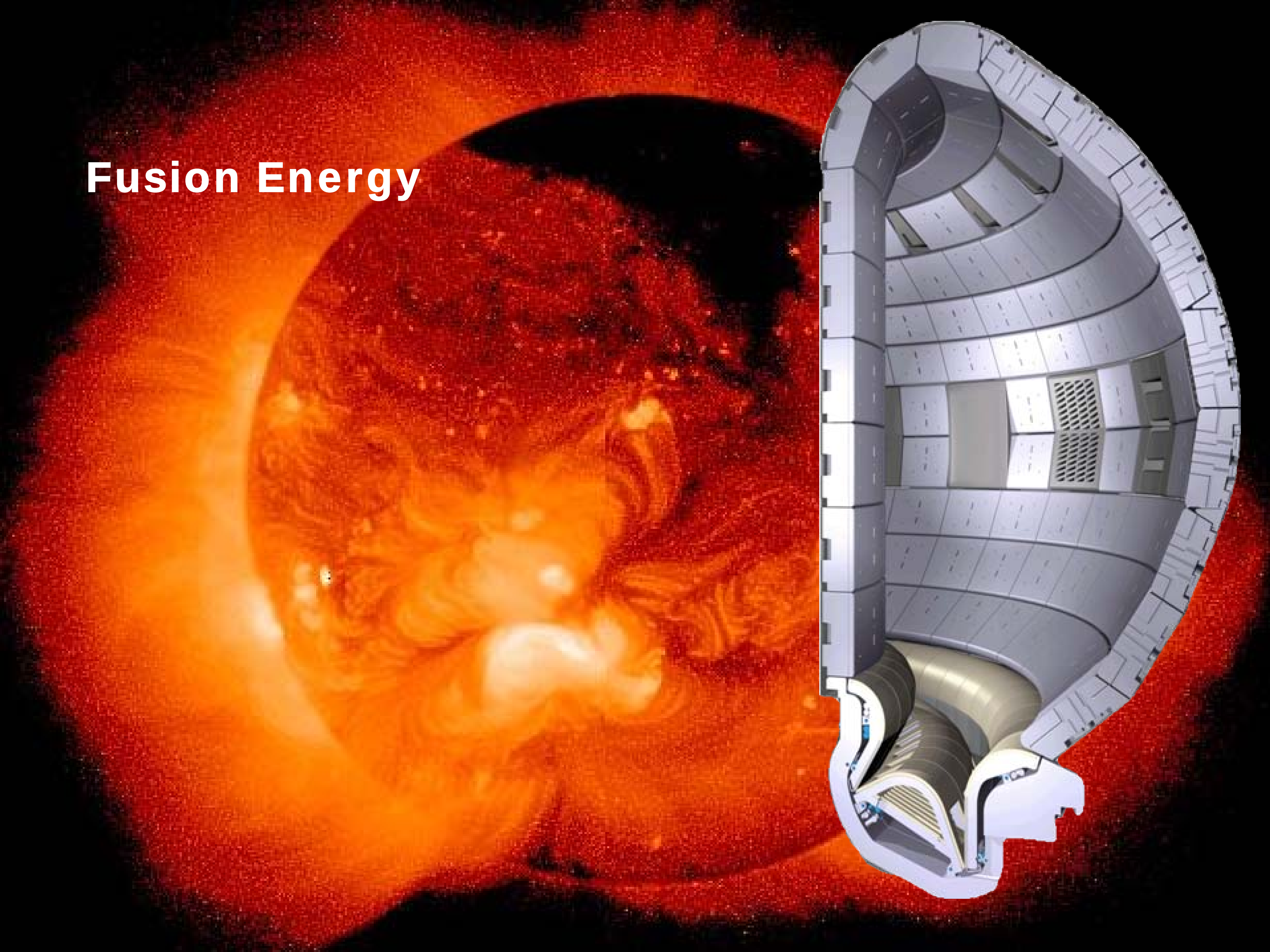


2,3 % efficiency

1+ year durability

Cheap production

Polymer solar cell
produced by printing technology


Fusion Energy

Strategic foundation for innovation

Mission

Risø DTU contributes to research, development and international exploitation of sustainable energy technologies and **strengthens economic development** in Denmark.

Vision

Risø DTU is one of Europe's leading research laboratories in sustainable energy and is a significant player in nuclear technologies. Risø creates pioneering research results and **contributes actively to their exploitation, both in close dialogue with the wider society**.

What is innovation to us?

- Activities and results that lead to **commercial applications** of Risø's science based knowledge.
- Contribution to a sustainable development of the society with **growth and knowledge intensive jobs** – both short and long term.
- Within our competences we take responsibility for creating something that makes a difference – on an **international, national as well as a regional** level.

Types of commercial activities

	Customer-defined tasks	Need driven innovation	Technology driven innovation	Long term research cooperations
Time to market	Here and now	1 - 3 years	2 - 5 years	> 5 years
Examples	Standard products, analysis, measurements etc.	New product concepts generated through eg. workshops and network activities	New product concepts generated by trying to match a new technology with an application. Licensing and selling patents.	Strategic partnerships Innovation Consortia
Characteristics	The company knows the problem – we know that we have the answer.	The problem is defined in coope-ration between the company and Risø. We do not know for sure whether we may solve the problem.	We know an answer / a technological solution but we do not know the problem.	Longterm cooperation between research and industry rooted in a common field of interest.

Roskilde Festival 2003

naturejobs

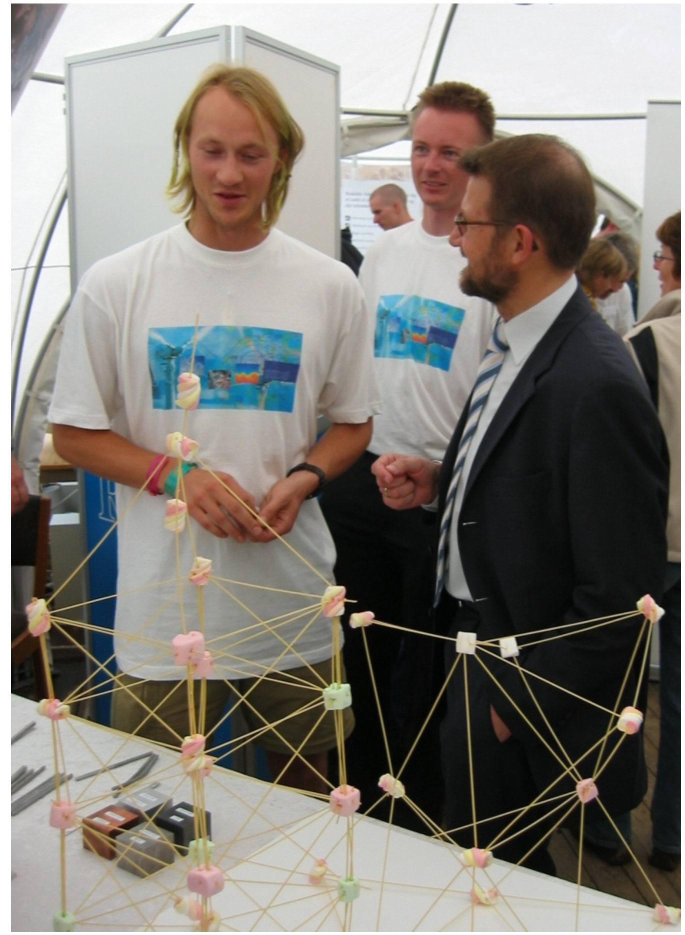
Science rocks

In Denmark last month, scientists tried to fix a pipeline with an amplifier. Across Western Europe, the past decade has seen a decline in the number of young people going into scientific fields, and the Danes are no exception. Many are suspicious of technology, associating high-energy physics with nuclear power, chemistry with pollution, and biology with genetically modified foods.

So when the city of Roskilde approached Jens-Peter Lynov, director of the department of optics and fluid dynamics at Risø National Laboratory, to bring some of his lab's work to Europe's largest music festival, he accepted. Under the auspices of 'Musicon Valley', a riff on the region's Medicon Valley moniker, Risø applied some of its technologies to the festival. These included fibre-composite materials for stage construction, plasma treatment of materials to make them water-repellent, and biodegradable tents.

Between sets, Risø also drew a steady stream of festival-goers to a booth that highlighted these technologies, provided some

Roskilde Festival 2004

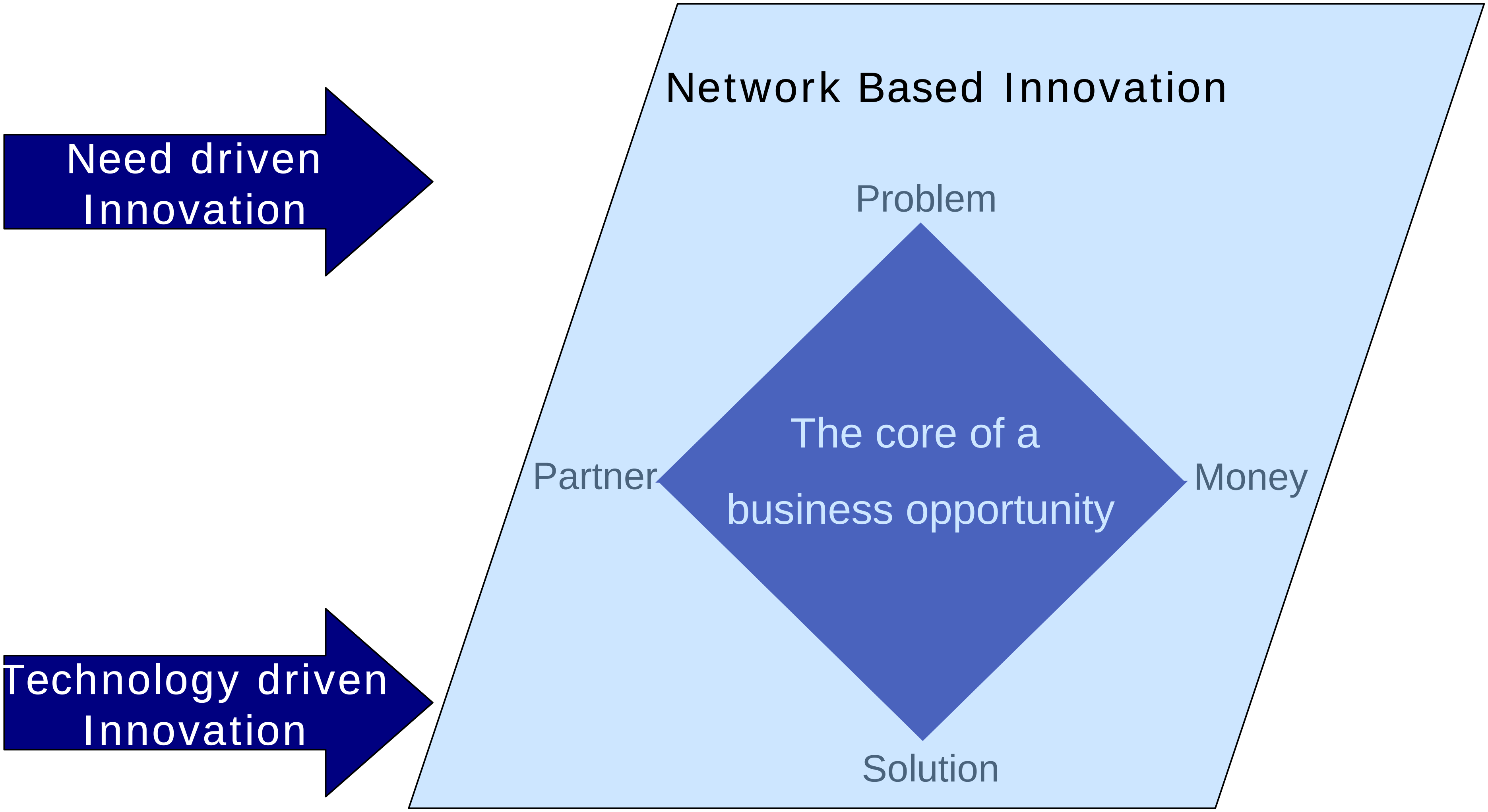


Innovative LED lamps

- Risø approached by inventor Dan Friis, RGB Lamps, about LED lighting
- Light Emmitting Diodes (LEDs):
  Low power consumption & long life – but, no white LED
- Problem: Mix light from coloured LEDs to give “white light”
- Solution: Microstructured optical elements
- 5 mill. dkr. grants from PSO fund
- Risø collaboration with 2 private companies, 1 electricity company and 2 designer companies
- Post-education at Risø of 10 designers from Louis Poulsen
- Receiver of the ELFORSK 2006 Award

Worlds first designer chair of bio-composites - May 2006

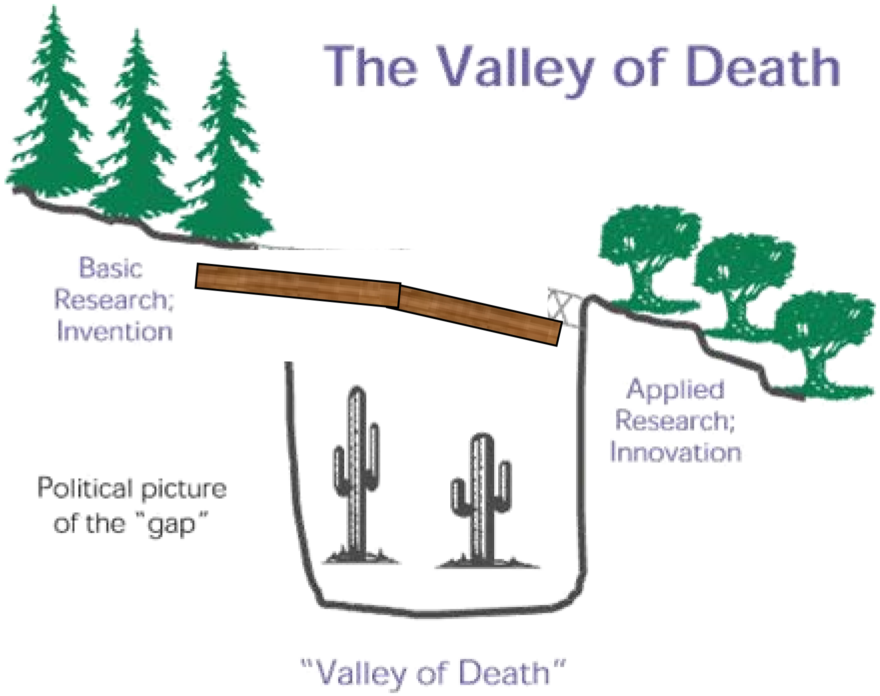
What is our understanding of innovation?



Technology Driven Innovation - Gap funding

❖ Promote the commercial application of scientific knowledge by bridging ”The Valley of Death”

❖ Finance the development of a concept or technology (commercially and technologically) fare enough to be able to sell it on commercial terms or attract external funding to finish the development



Copenhagen Cleantech Cluster

- **5 year project - started April 2010**
- **Budget: 143 mill. DKR (19 mil Euro)**
- **46,7 mill. DKK to activities at DTU**
- **Risø is gateway to DTU:**
  Total staff 4.500 -
  2.000 researchers
  incl. PhD students

COPENHAGEN CLEANTECH CLUSTER

Cleantech stakeholders in CCC

Founders

COPENHAGEN CAPACITY

SCION DTU

DTU

Risø DTU
Nationallaboratoriet for Bæredygtig Energi

DI

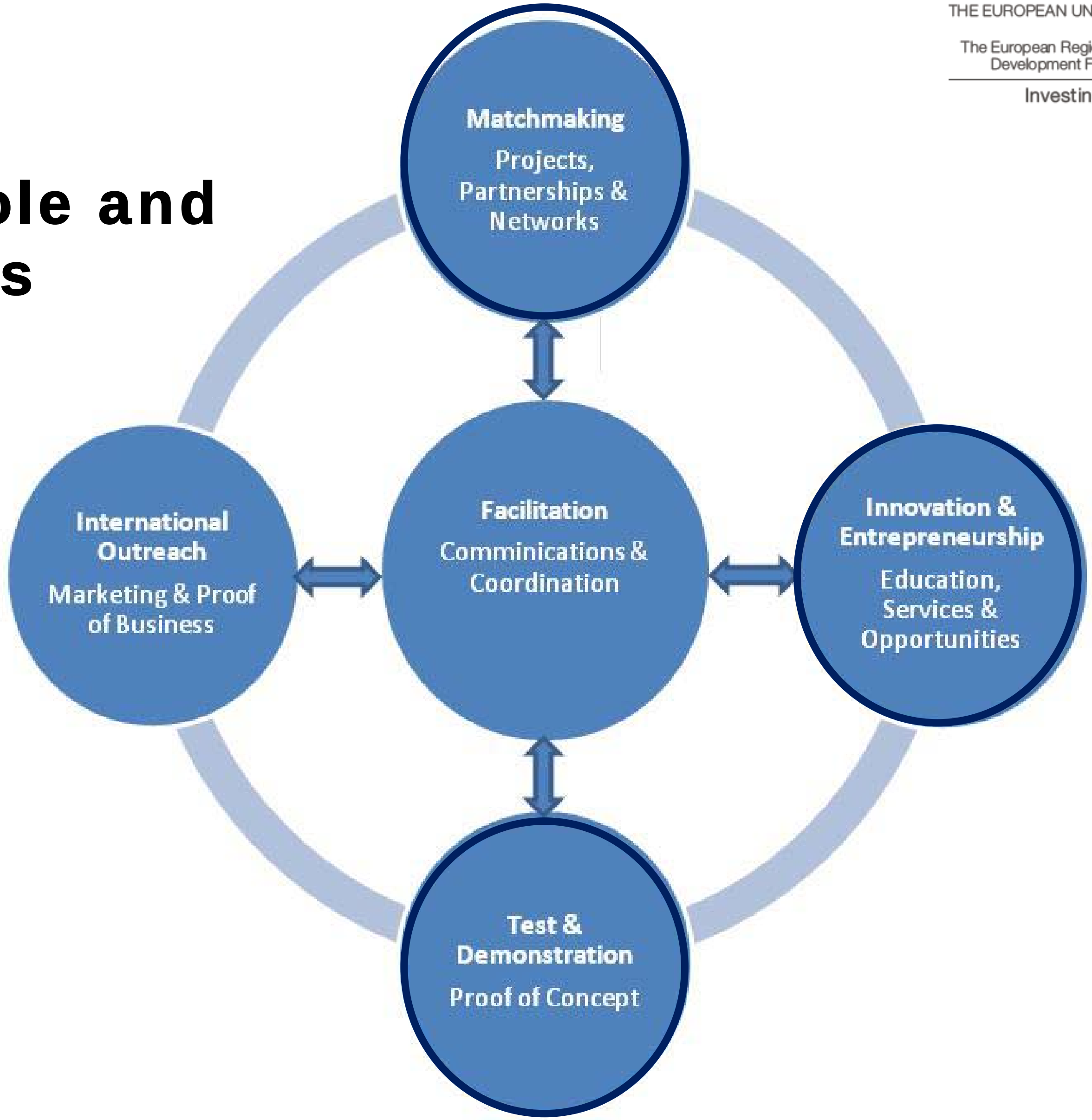
Partners (20)

- Symbion A/S
- EnergyMap.dk
- Frederikssund Erhvervs- og Turistråd
- DHI
- Siemens Danmark A/S
- Novozymes A/S
- Haldor Topsøe A/S
- Better Place Danmark
- Vestas
- Copenhagen Resource Institute (CRI)
- Roskilde Municipality
- Kalundborg Municipality
- Ernst & Young
- Væksthus Hovedstadsregionen
- Væksthus Sjælland
- GEUS
- Øland A/S
- Seas-NVE
- Deloitte
- Dong Energy A/S

Network participants (13)

- Region Hovedstaden
- Region Sjælland
- Lolland Kommune
- Albertslund Kommune
- Invest in Skåne
- Cluster Biofuel Denmark
- CBS – Copenhagen Business School
- Seed Capital
- Wonderful Copenhagen
- Copenhagen Goodwill Ambassador Corps
- Connect Denmark
- Cleanfield Aps
- Vækstfonden

DTU's role and activities



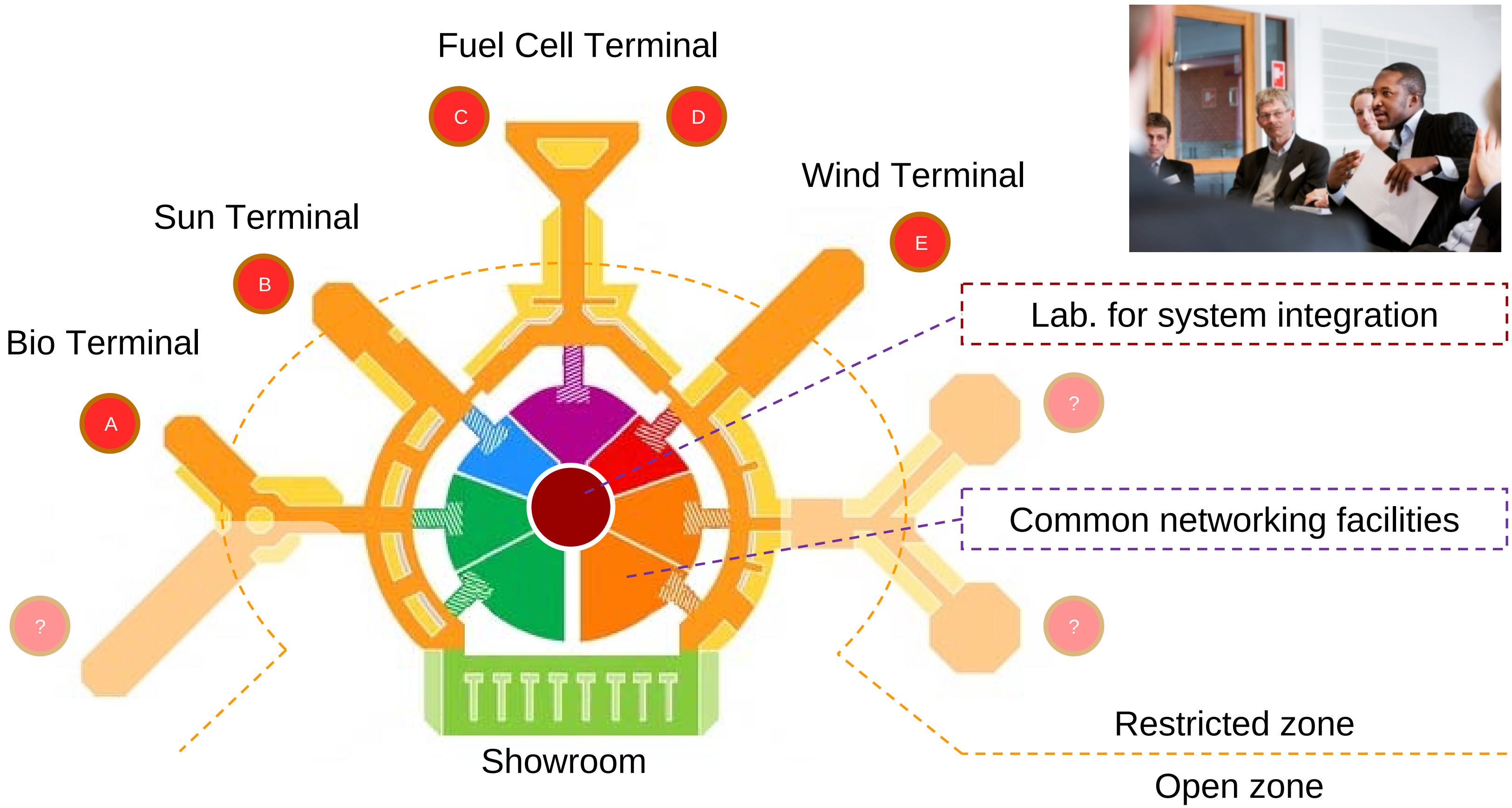
Matchmaking

- Seminars on broad themes
- Topical workshops
- Networks (time limited)
- Inspiration events for single companies
- One-to-one meetings with companies

Innovation & Entrepreneurship – Moving faster from research to business

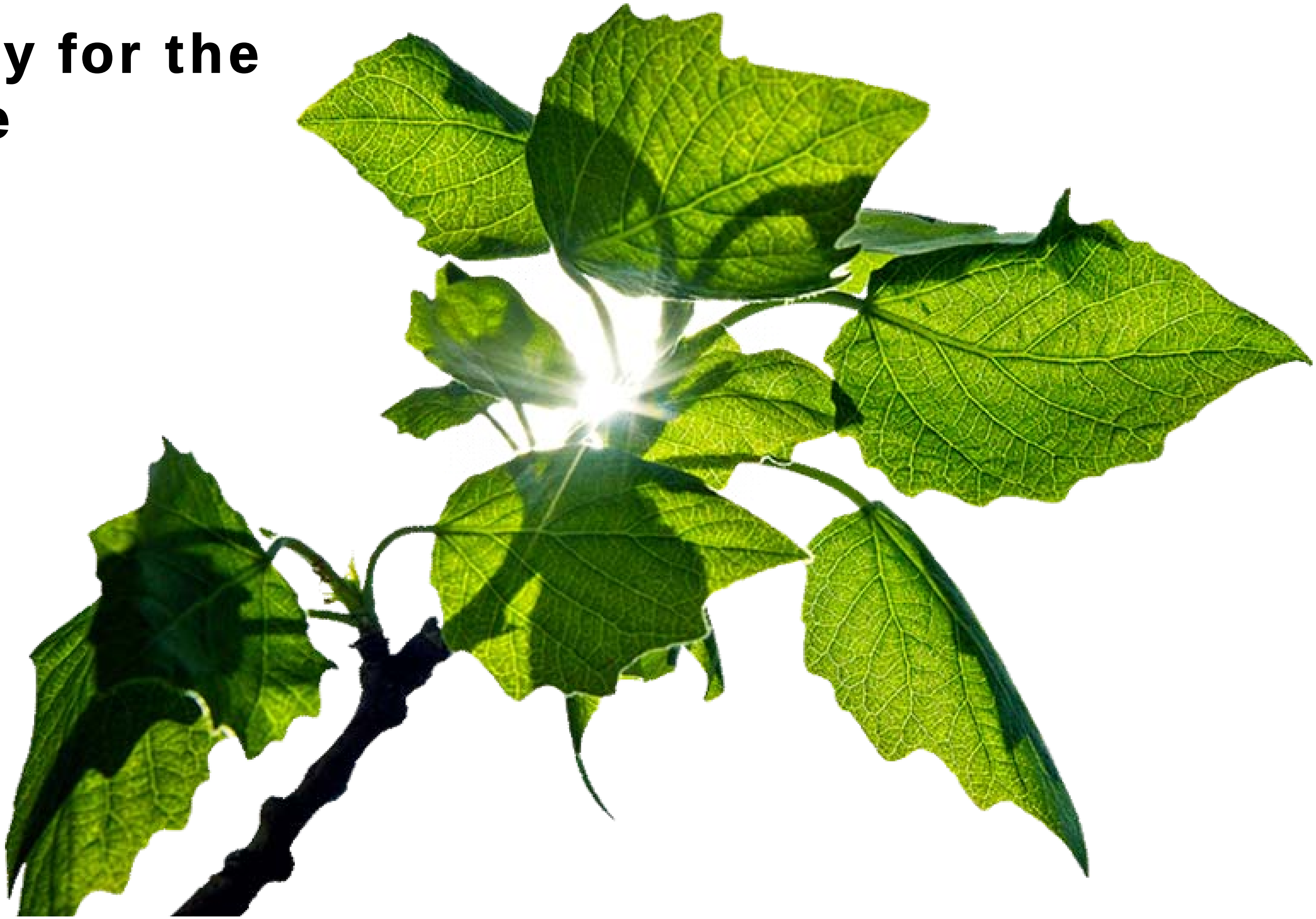
- Gap funding
- Cleantech PhD's
- Cleantech Accelerator
- Need driven competence development
- Laboratory equipment for cleantech

Plan for Green Energy System Lab



Risø Park - Roskilde Municipality's vision for a cleantech business development area

Energy for the future



Risø DTU

National Laboratory for Sustainable Energy

For more see
www.risoe.dtu.dk