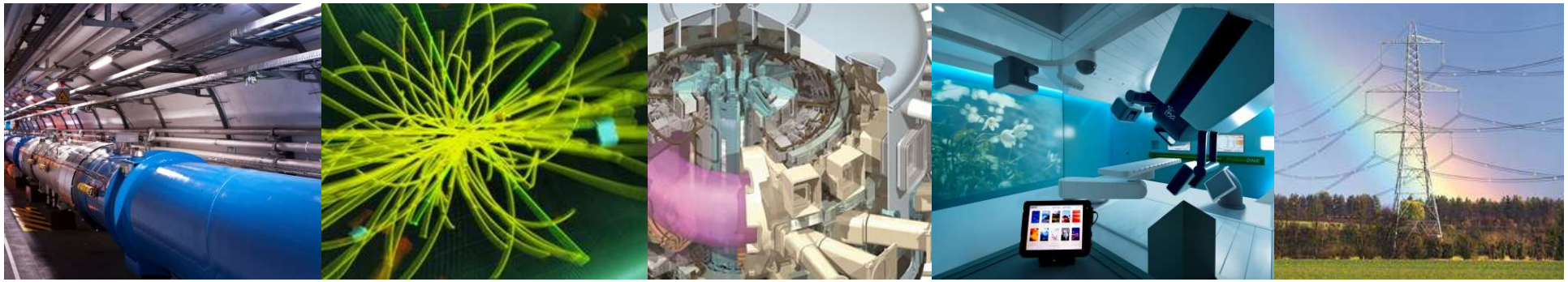


Opportunities for Industry to Exploit Technologies in Co-Innovation Activities

Antonio PELLECCHIA

07/02/2018

www.asgsuperconductors.com

FCC Magnet R&D

- **High-field Magnets** enabling technology for **Energy Frontier Hadron Collider**

Stronger Magnetic Field	→	Higher Energy of circulating particles
• Bending magnets field of **16 Tesla**		• **50 TeV beams** on a track of **100 km circumference**

- Conceptual and engineering design **16 Tesla accelerator dipole magnet in LTS**
- Conceptual design and proof-of-principle **20 Tesla accelerator dipole magnet**
- Achieve **Accelerator-grade field quality in 50 mm aperture**
- Explore different **coil geometries and novel magnet concepts**
- **Master Manufacturing aspects at large scale**
- **Optimize manufacturing and operation costs**

EUROPEAN COMPANIES IN THE FIELD OF SUPERCONDUCTIVITY

- Superconductors Industry in Europe is **SHRINKING OVER THE LAST DECADE:** root cause is the **DISCONTINUITY IN R&D PROJECTS**
- The only **SELF SUSTAINING COMPANIES** are strongly active in the **HEALTHCARE DOMAIN** or are a **DIVISION OF A LARGE CORPORATION**
- **MAGNET BUSINESS IS UNFORGIVING AND REQUIRES CONTINUITY AND HIGHLY SPECIALIZED PERSONNEL**

Future Superconducting Magnet Technology
FuSuMaTech

European Superconducting Magnet Initiative

- Oxford Instruments (UK)
- Siemens Magnet Technology (UK)
- Tesla Engineering (UK)
- Bruker (CH)
- Alstom (FR)
- Columbus (IT)
- ASG (IT)
- Sigmaphi (FR)
- Danfysik (DK)
- Babcock Noell (DE) Planned in Q1 2016
- Elytt (ES)
- ANTEC (ES)) Planned in Q1 2016

SOURCE: FuSuMaTech - A. Daël

EUROPEAN INITIATIVES FOR THE DEFINITION OF ROADMAPS OF COLLABORATION AND CO-INNOVATION

Accelerator and Magnet Infrastructure for Cooperation and Innovation

Future Superconducting Magnet Technology

Italian Entities in the field of superconductivity

INFN

SPIN

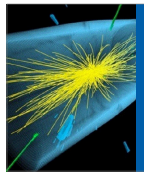
ASG Superconductors

PARAmed MEDICAL SYSTEMS

Columbus Superconductors

Malacalza family

Superconductivity Cluster in Genoa



HIGH ENERGY PHYSICS ROUTE

ADONE, PS, VERTEX, SPS, HERA, FINUDA, DAΦNE, BABAR, ATLAS, LHC, CMS, Mu2e, MPD, HiLumi, Super-FRS

FUSION ROUTE

COMPASS, ASDEX, FTU, JET, TORE SUPRA, ITER TFMC, W7X, JT60-SA, ITER PFC, ITER TFC

INDUSTRIAL ROUTE

MRO, MgB_2, FCL, Proton therapy, IMGRT, SMES, UHF MRI

HIGH-FIELD MAGNET TECHNOLOGY

1950 1960 1970 1980 1990 2000 2005 2010 2015 2020 2040

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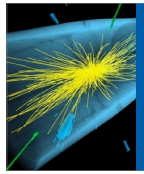
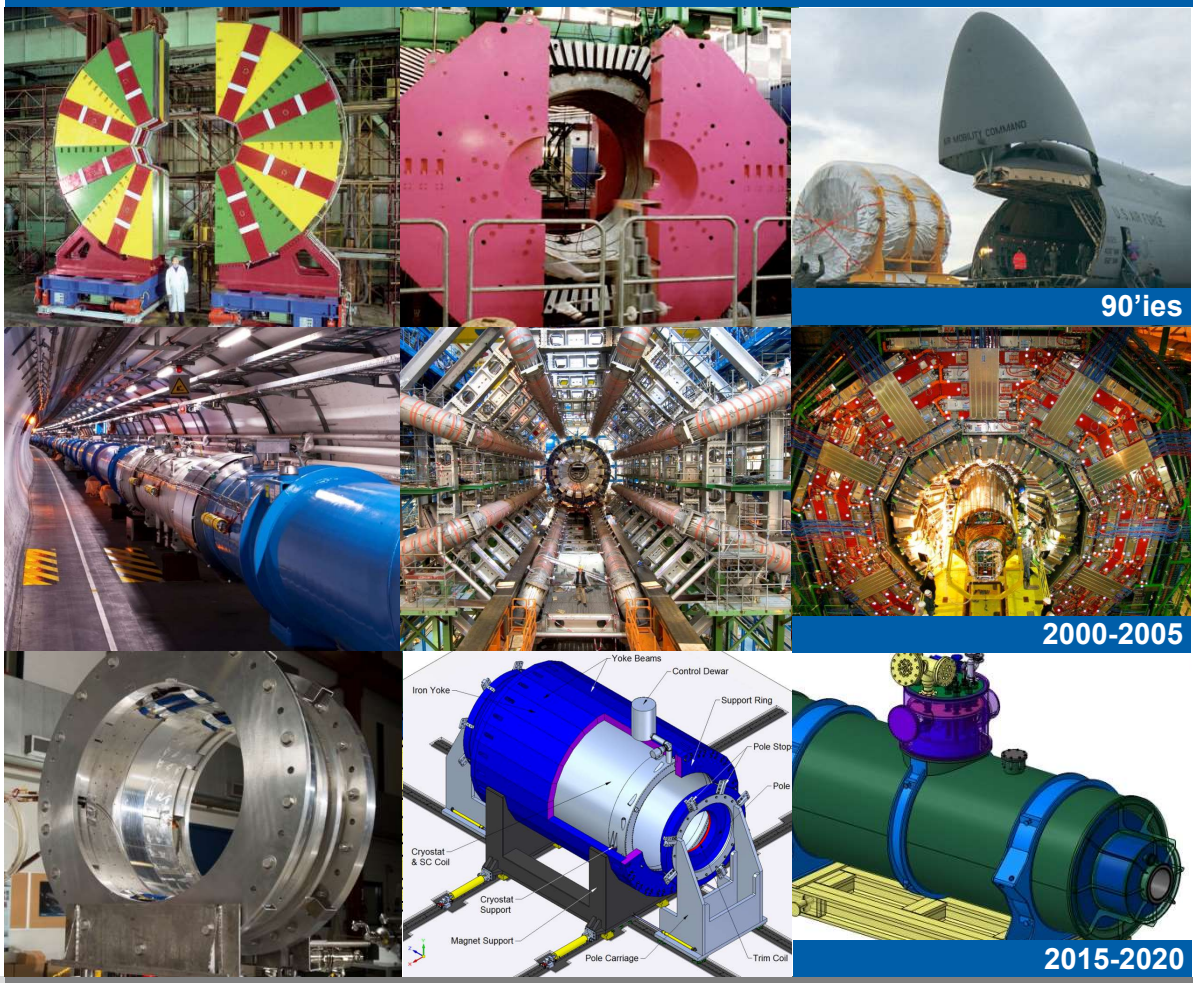
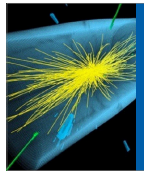


HIGH ENERGY PHYSICS ROUTE

HIGH ENERGY PHYSICS

- In time **MAGNETS FOR HIGH ENERGY PHYSICS** have become **MORE CHALLENGING** in terms of **FIELD INTENSITY AND HOMOGENEITY**
- With **INCREASING PERFORMANCE** goes **HIGHER COMPLEXITY**



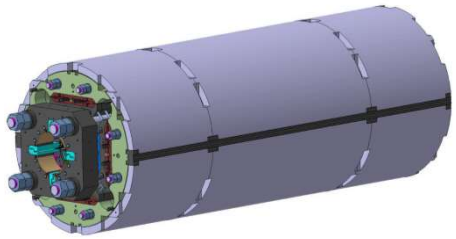


HIGH ENERGY PHYSICS ROUTE

- **DEVELOPMENT OF THE NEW TECHNOLOGIES OF Nb3Sn SUPERCONDUCTING MAGNETS** for particles accelerators
- Collaboration with and at CERN for the construction of **PROTOTYPE MAGNETS**
- Collaboration with INFN and CERN at ASG for the definition of manufacturing route and construction of **PROTOTYPE MAGNETS**

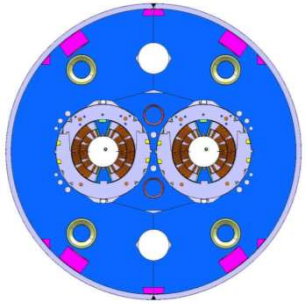
MQXF QUADRUPOLES

ASG has collaborated with CERN for the short models of the cold mass, to the **MANUFACTURING OF THE 1.5m COLLARED COILS**, in order to **SET UP THE PRODUCTION PROCESS** and to **TEST THESE COILS IN A FIRST SHORT COLD MASS.**



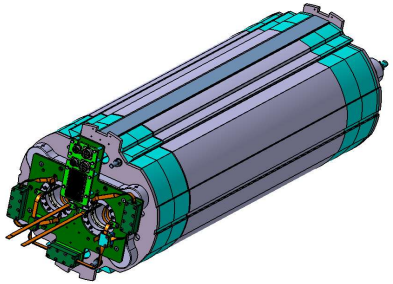
11T DIPOLES

ASG was in charge of the **DESIGN AND PROCUREMENT OF THE TOOLS** for the **COLLARING OF THE 5.5M COILS**.

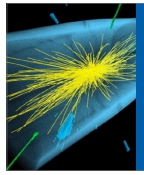


D2 SHORT COIL MODEL

ASG is currently building a 1.5m model of the D2 coils for HI-Lumi collaboration with INFN and CERN in preparation of the prototype and series of the D2 dipoles

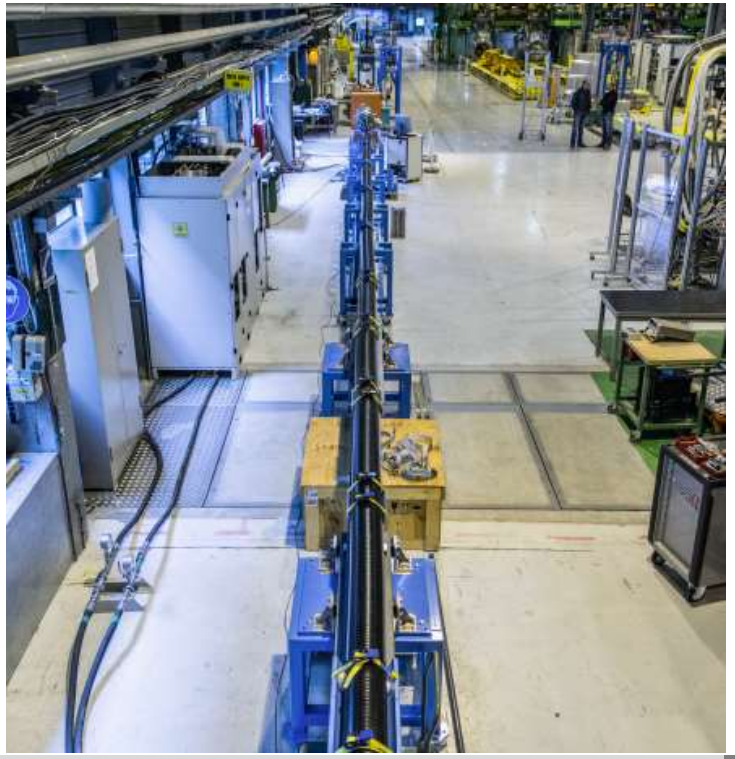


HL-LHC Project



HIGH ENERGY PHYSICS ROUTE

HiLumi HL-LHC PROJECT



- In the framework of HiLumi **CERN IS DEVELOPING IN CLOSE COOPERATION WITH INDUSTRY SC ELECTRIC LINKS IN ORDER TO POWER LHC ARC DIPOLES** moving the power supplies in a radiation free area
- **COLUMBUS SUPERCONDUCTORS HAS MANUFACTURED AND CERN SUCCESSFULLY TESTED 160 KM OF MgB_2 OVER A TOTAL ORDERED OF 200KM** cable proving its fitness to transport 150 kA
- The above results from the **OUTSTANDING LEVEL OF COLLABORATION ACHIEVED BETWEEN CERN AND COLUMBUS**

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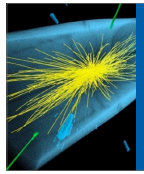


HIGH ENERGY PHYSICS ROUTE

HIGH ENERGY PHYSICS

Collaboration with the most important **SCIENTIFIC RESEARCH INSTITUTIONS**

INFN Istituto Nazionale di Fisica Nucleare

CERN

Fermilab

JINR

MERE SUPPLIER → PARTNER FOR DEVELOPMENT

HiLumi HL-LHC PROJECT

- **ASG STAFF RESIDENT** @ CERN
- **FEASIBILITY STUDIES** with INFN and JINR
- **PROTOTYPING OF MODELS** for/with INFN, CERN and Fermilab

GSI

ASG is involved also in the **DESIGN PHASE**

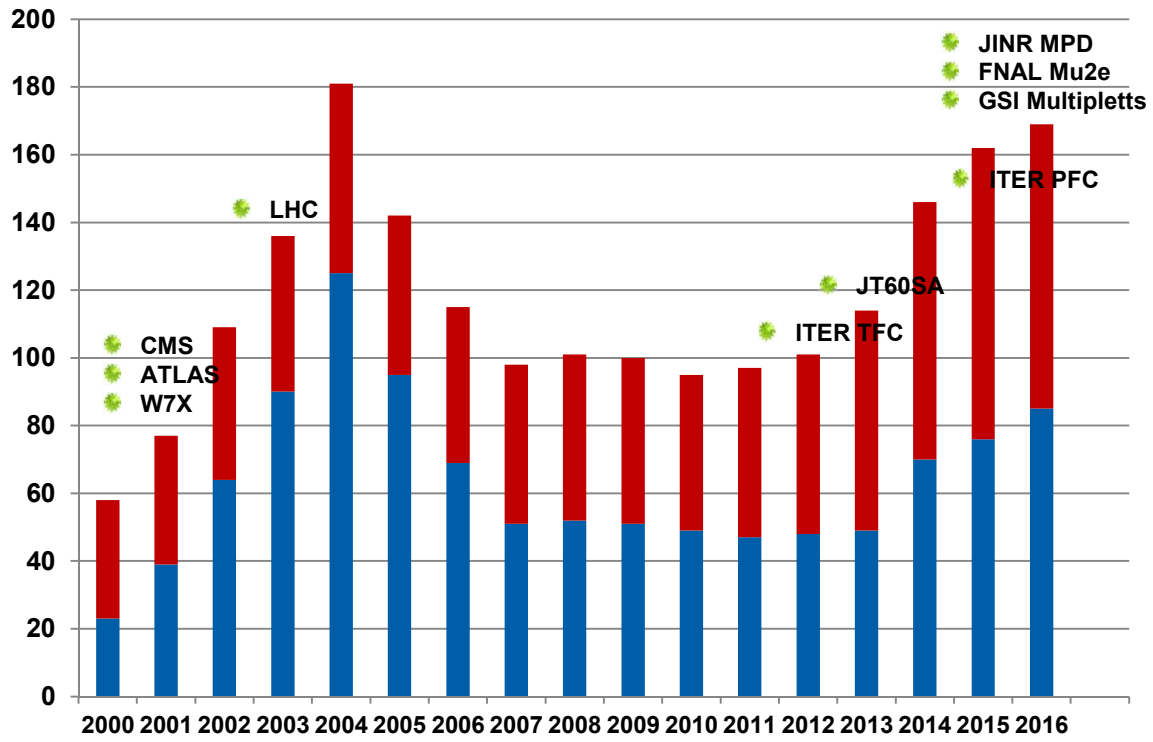
FUSION ROUTE

- ASG has contributed **MAGNETS FOR FUSION TO ALL EUROPEAN RESEARCH CENTERS**
- In turn delivering magnet systems for
  - **STELLARATOR**
  - **TOKAMAK**
- And all orders of magnets:
  - **CENTRAL SOLENOID**
  - **TOROIDAL FIELD COILS**
  - **POLOIDAL FIELD COILS**
  - **DIVERTOR COILS**

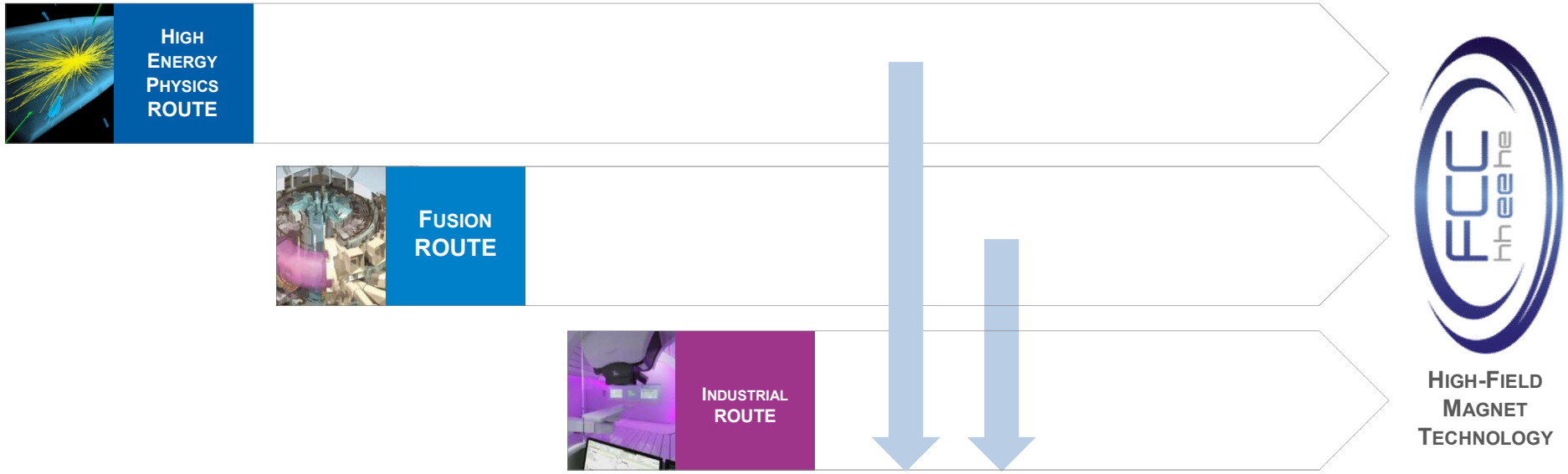
RESEARCH RELATED SC MAGNETS MARKET TRENDS

Continuously facing with unpredictable and **CYCLICAL NATURE** of the business:

- Difficulty remaining active on the market,
- Disqualification if personnel with specific experience is not offered,
- Duration of projects highly unpredictable
- **LACK OF ATTRACTIVENESS** for qualified personnel



- **SINERGY**
- Transfer of **COMPETENCIES**



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INDUSTRIAL ROUTE

- Make a **REAL BUSINESS** of SC magnets
- **OFFSET THE ERRATIC NATURE IN RESEARCH MARKET TRENDS**
- Make use of **COMPETENCES GAINED IN HIGH ENERGY PHYSICS AND FUSION**
- **MgB_2**

INDUSTRIAL APPLICATIONS

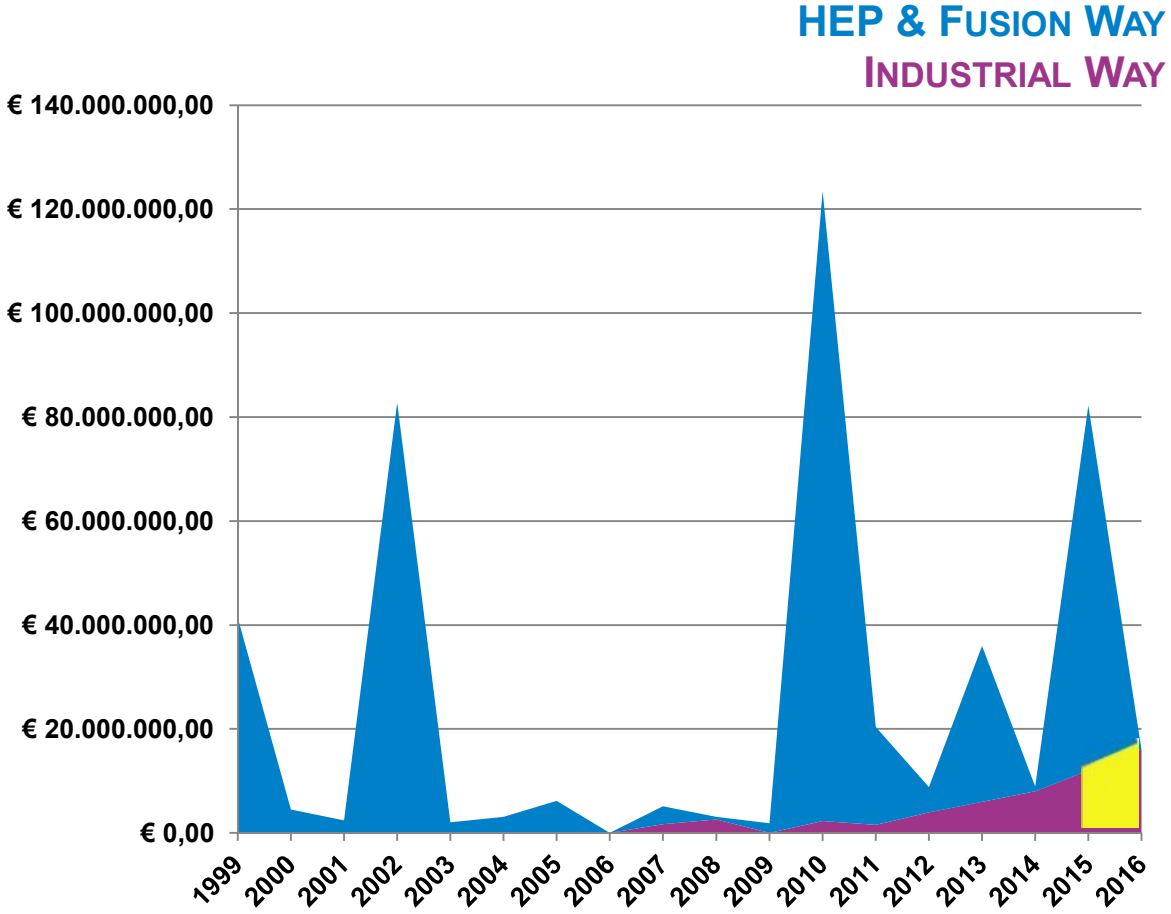
DIAGNOSTICS

THERAPY

POWER QUALITY

ASG Acquisitions

- Majority of **SC Magnets** designed and manufactured in Genoa benefits of the **virtuous collaboration between industry and public research**
- We are the **only Italian company designing and manufacturing of superconducting systems**
- Multi decennial **collaboration with INFN**



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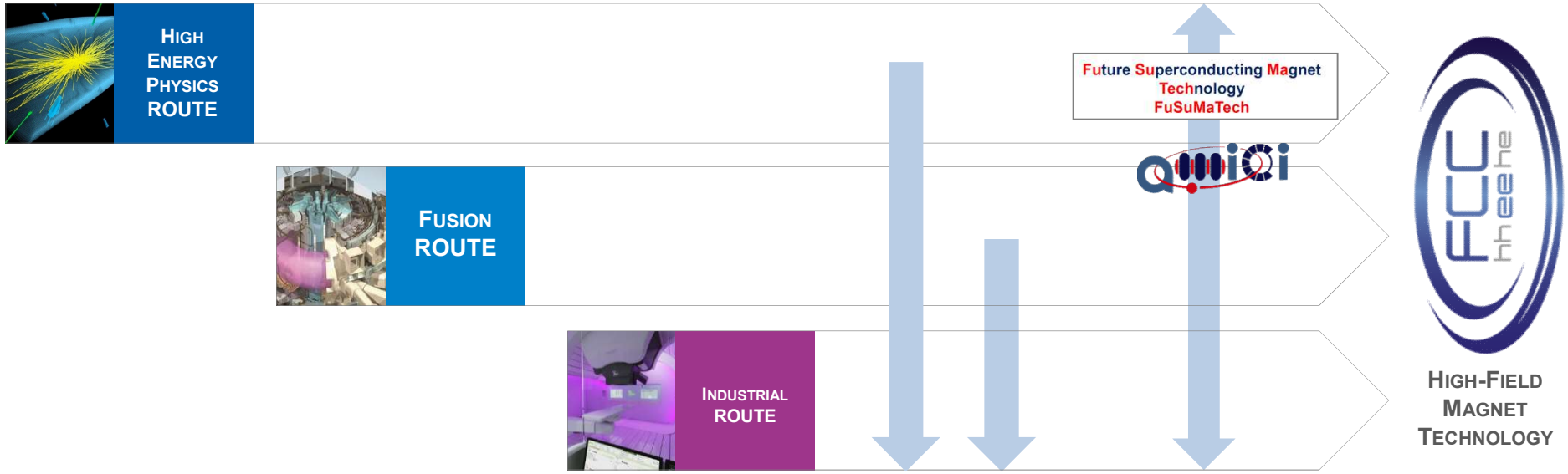

CONCLUSIONS

- Know-how exchange and materials science are at the foundations of the collaboration between Research Institutions and Industry,

- Co-innovation is possible in those cases where:
  - the technologies required by the experiments do overlap with those to be embedded in products directly (cyclotrons/synchrotrons)
  - specific enabling aspects linked to manufacturing techniques and or material science required by the experiments do overlap with those to be embedded in products directly (UHF MRI)

- IPR remains the biggest hurdle among Research Institutions and Industries

- Discontinuity and Discretionality by Country of funding remains the biggest hurdle in order to set a strategic innovation agenda

- Can initiatives as Fusumatech and Amici make the difference?

- FCC does represent the best chance for setting a new frame of co-innovation