INFN PADOVA

# Development & Innovation on Additive Manufacturing


# AM Workshop 2019

Present and future of Additive Manufacturing in Industry and Research

**Ing. Adriano Pepato – INFN PD**

*Hotel Biri – Padova*
*20° Sept 2019*

UNIONE EUROPEA
Fondi strutturali e di investimento europei

REPVBBLICA ITALIANA

POR FSE 2014-2020
REGIONE DEL VENETO

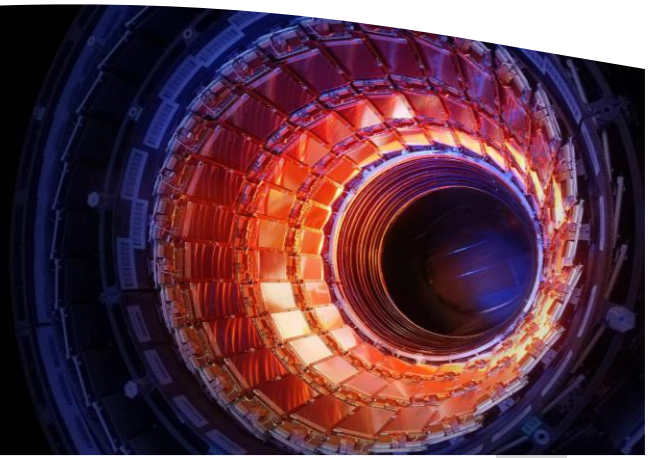
INFN PADOVA


# Istituto nazionale di Fisica Nucleare

Italian research agency dedicated to the study of the **fundamental constituents of matter** and the **laws that govern them**.

- It conducts theoretical and experimental research in the fields of **subnuclear**, **nuclear** and **astroparticle physics**.
- The INFN research activities are in close collaboration with **universities** and other **research institutes**.
- Fundamental research in these sectors requires the use of **cutting-edge technologies**.

*It is strongly present in the national territory.*



# INFN – Padova: the section

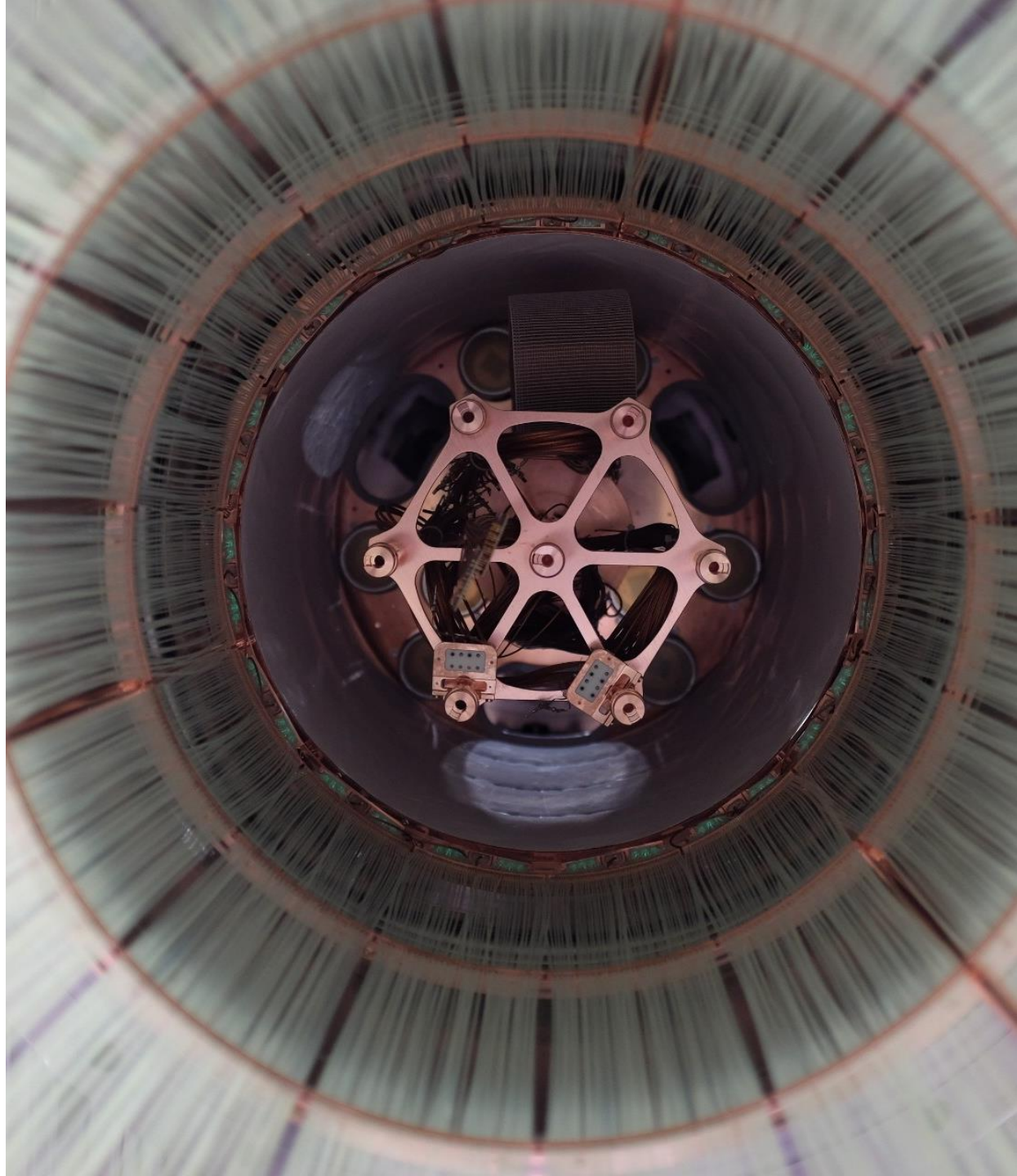
**The INFN Section of Padua has a long tradition of designing and building complex equipment for experiments.**

The DIAM Additive Metal Printing Laboratory integrates the available mechanical technologies and promotes an AM network within the INFN, which includes:

- the HAMMER laboratory of LNGS;
- the INFN Genoa Section

The Mechanical Design Service (INFN PD) consists of:

- 4 engineers, 4 designers (staff);
- 3 PhD students and 3 research fellow;
- mechanical workshop (14 technicians);
- collaboration with and INFN-LNL surface treatments Laboratory.



# Technology transfer

- The peculiar element of INFN (Sections&Laboratories) is the presence of **interdisciplinary skills** (mechanics, electronics, computing resources, ecc.) supported by an adequate **availability of resources** (laboratories&workshops) and **qualified personel**.
  *It is eligible for funding*

- Design, development and management of extremely complex devices is shared among **worldwide** leading research centers: the *access to resources is made easier by sharing knowledge and capabilities*

- In such conditions one can achieve a **wide** and **robust** professional **formation**, especially young neo-graduate students (thesis, doctorate degree, research grants)

- The idea of DIAM starts trying to satisfy concrete research problems of INFN PD with the help of instruments discussed above

The group also offers support for Industries, within the territory, for implementing in their production processes such technologies

# INFN – DIAM

1. About us
2. Machines & Tools
3. Partners & Collaborations
4. Why DIAM?

# DIAM – About us

## Members of the Research Group

**Adriano Pepato[a], Massimo Benettoni[a], Razvan Dima[a], Marco Romanato[a], Giacomo Cogo[a], Guido Pastore[a],Marco Marigo[a], Massimiliano Bonesso[a,b], Mattia Lago[a,b], Pietro Rebesan[a,c]**

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[b] Department of Industrial Engineering (DII), Università di Padova, Italy
[c] Department of Mechanical Engineering (DMEC), Politecnico di Milano, Italy

# DIAM
# Machines & Tools

- **SLM Printers**
  - EOS M100
  - EOS M280
- **Internal Special Facilities (OFM):**
  - EDM - Electrical Discharge Machining
  - Okuma MILLAC 800 VH Multi-Plane Machining Center
  - CMM facility Zeiss ACCURA MASS

| Technical data | EOS M100 | EOS M280 |
|---|---|---|
| Building volume | Ø 100 mm x 95 mm | 250 × 250 × 325 mm |
| Laser type(maxpower) | Yb (200W) | Yb (400W) |
| Focus diameter | 40 µm | 100-500 µm |
| Scan speed | up to 7 m/s | up to 7 m/s |
| Inert gas supply | max 50 L/m | max 100 L/m |

# DIAM
# Partners & Collaborations

- **Supplying and Maintenance** of machines and tools
- **Coaching** regarding SLM process and AM software
- **Training** courses at DIAM lab

e-Manufacturing Solutions

- **Software** for design & simulation
- **CAD software** for Topological optimization (NX)
- **Software for data preparation** Materialise Magics, 3DXpert
- **FEM software** ANSYS suite, Workbench AM & CFX simulation

PLM Software SIEMENS NX

ANSYS

3DXpert™

Materialise Magics Essentials Data Preparation

- **Industrial & External** supervisor
- **Definition** of case studies
- **Monitoring** of planned activity
- **Advisor** on research outcomes

POLITECNICO CALZATURIERO

DEL BRENTA

agenzia spaziale italiana

CONSORZIO RFX Ricerca Formazione Innovazione

REGIONE DEL VENETO

POLIDORO for excellence in combustion

ENGINSOFT

- **Research** supervisor
- **Coaching** regarding CAD software and ANSYS simulation
- **Support** for not-AM mechanical production and finish (OFM)
- **Monitoring** of research activity
- **Advisor** on research steps
- **Support** for SEM characterization of samples
- **Mechanical** testing of final ASTM specimens

INFN Istituto Nazionale di Fisica Nucleare

POLITECNICO DI MILANO

mecc

CERN

UNIVERSITÀ DEGLI STUDI DI PADOVA

amp Advanced Metal Powders

TEKNA

TLS Technik Spezialpulver

LEGOR

- **Support** on SLM powder supply

# DIAM
# Why DIAM?

**BENEFITS**

- Increased design freedom
  - Light weight structures
  - Complex internal parts
- Net shape process
  - Less material consumption
  - One step production
- No tools needed
- Short production cycle time

**In use**

| | | | |
|---|---|---|---|
| Al6061 | AlSi7Mg | AlSi10Mg | AlSi12 |
| CoCr | | | |
| 17-4PH | 316L | Maraging steel | |
| In625 | In718 | HastelloyX | |
| CPTi | Ti Gd5 | Ti Gd23 | |
| CuSn10 | | | |
| Precious Metals | | | |

**Under development**

Tantalum

Copper Copper Alloys

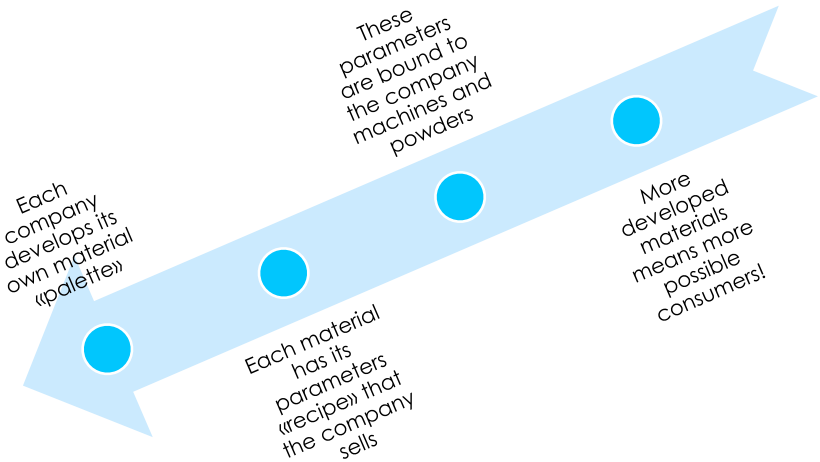
Tungsten

Niobium

Molibdenum

**LIMITS**

- Only wealdable materials
- Only in powder form
- Material
- Part size
- Small series production
- Supports
- Anisotropy



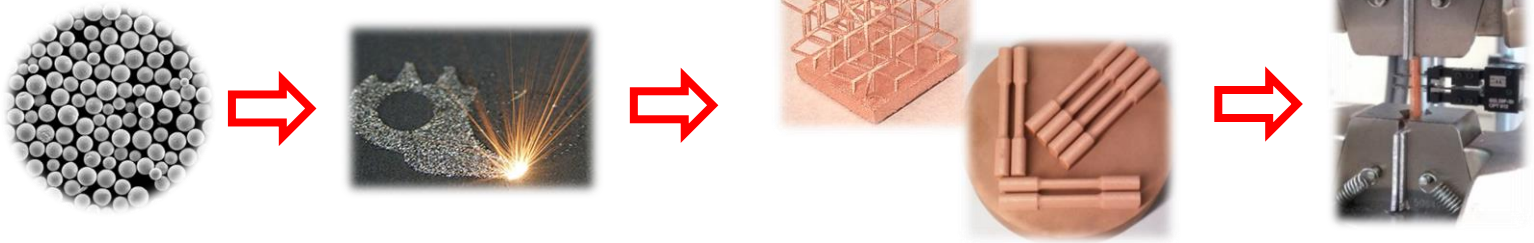

**Developing new materials for SLM is the *research core* of each SLM company**

INDUSTRIAL AND ACADEMIC R&D ON

- NEW TECHNIQUES FOR THE PRODUCTION OF METAL POWDERS
- PROCESS PARAMETERS FOR NEW METAL ALLOY
- METAL ALLOY SPECIFICALLY DESIGNED FOR SLM

# DIAM Focus on...

## Developing new materials for high energy physics and for aerospace application.



## Working on

| Powder Properties | Powder Properties |
|---|---|
| • Particle size and distribution<br>• Particle shape<br>• Chemical composition<br>• Thermal conductivity<br>• Melting temperature<br>• Absorptivity/reflectivity<br>• Material properties | • Particle size and distribution<br>• Particle shape<br>• Chemical composition<br>• Thermal conductivity<br>• Melting temperature<br>• Absorptivity/reflectivity<br>• Material properties |

## Designing and testing new geometries

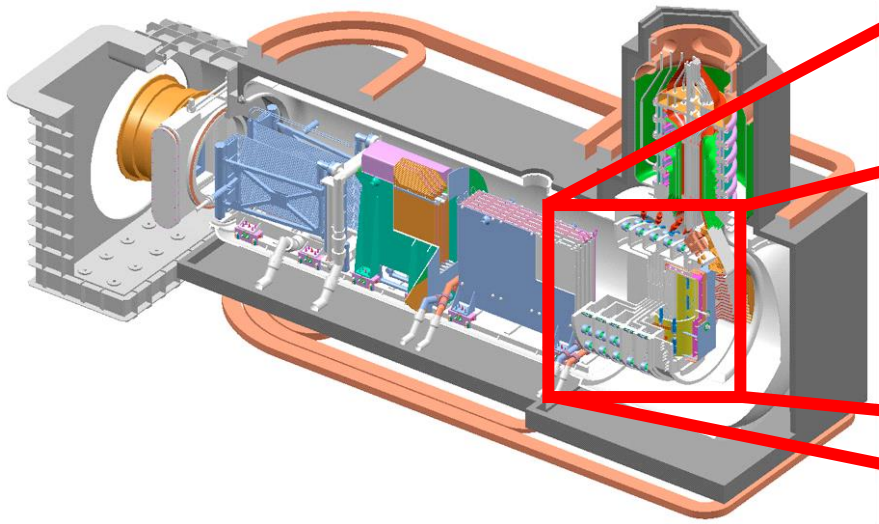
Developing new materials for high energy physics and for aerospace application.

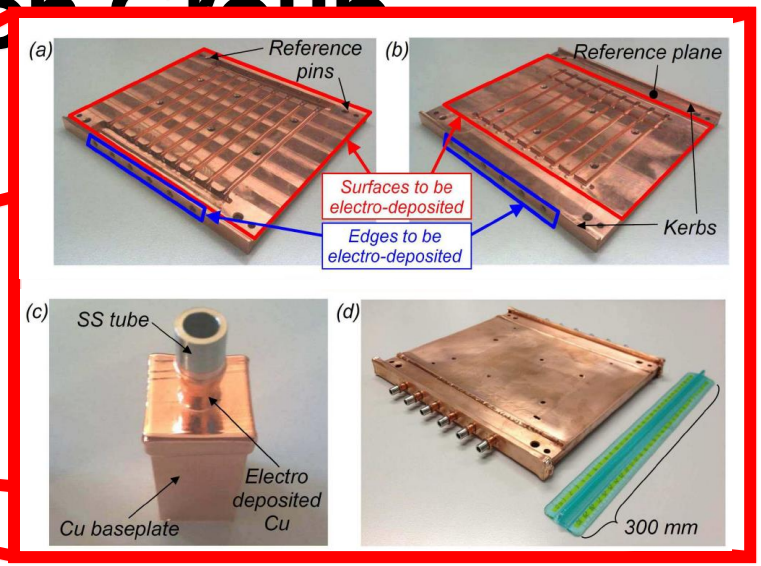
HIGH ENERGY PHYSICS

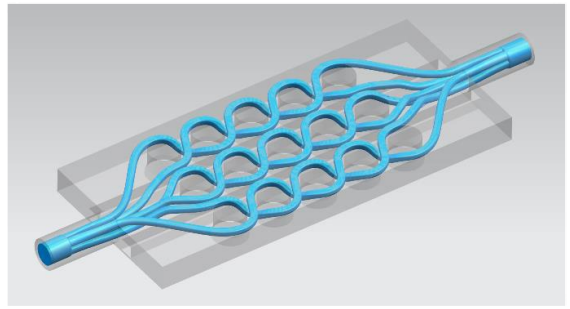
SPACE&AEROSPACE

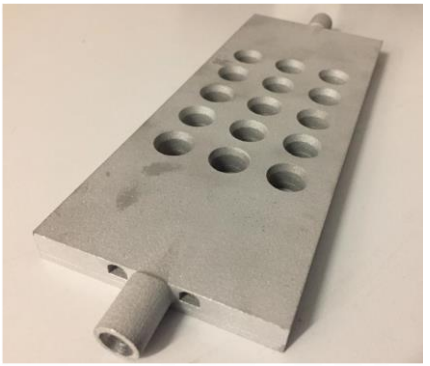
TECHNOLOGY TRANSFER

# DIAM
# Origins of the Research Group







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DIAM 1.0: POR-FSE 2016

sisma

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OFFICINA DEI MATERIALI

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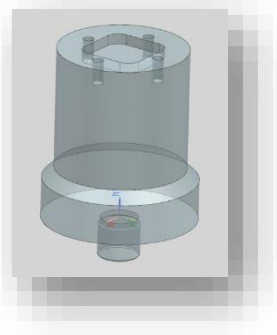

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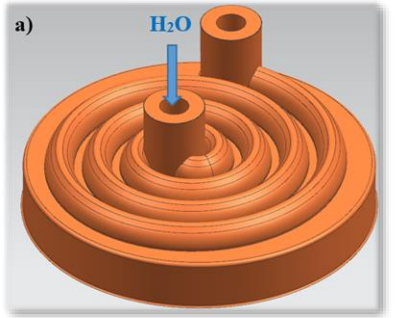
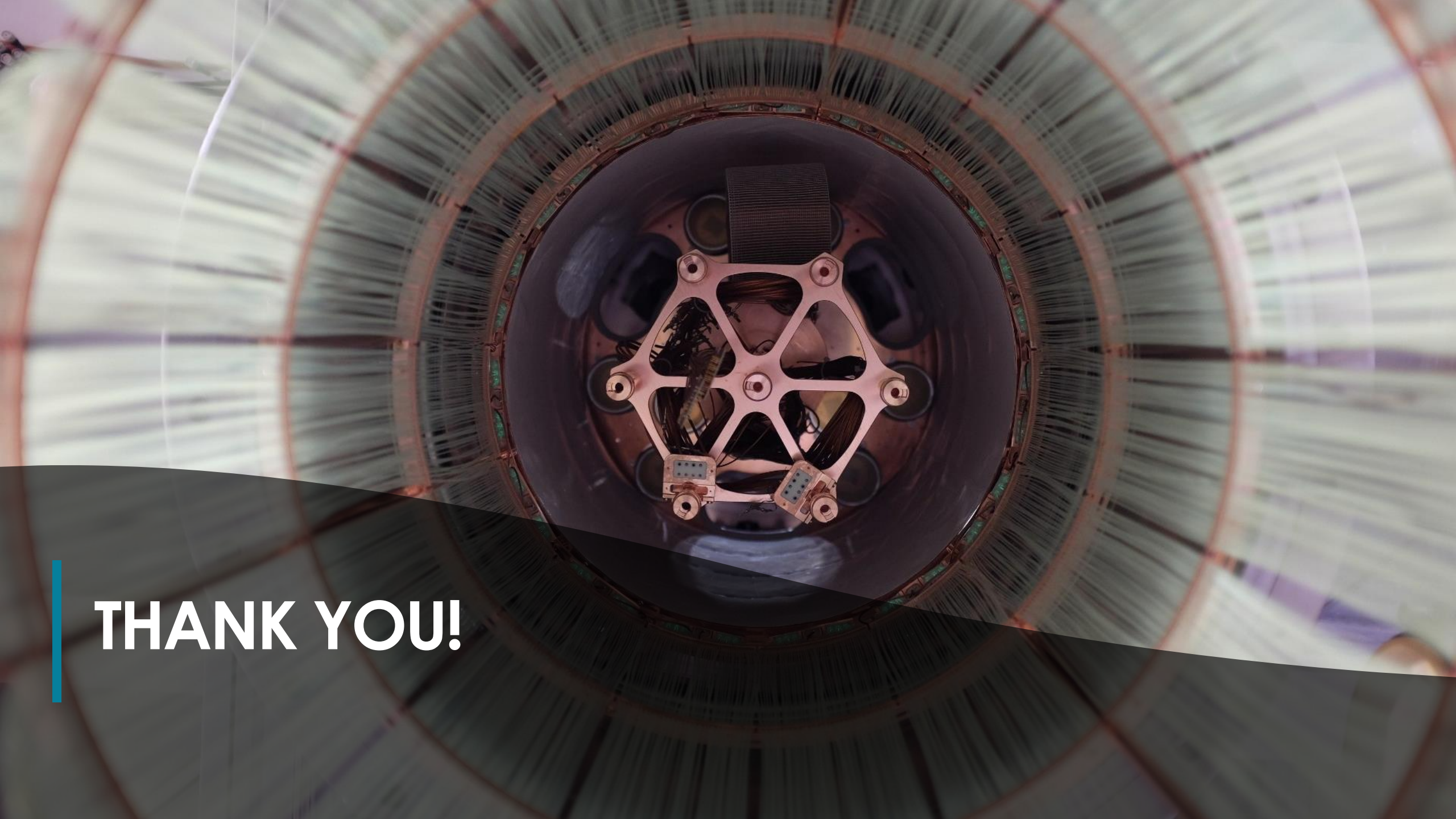


# DIAM Network



# THANK YOU!