This project has received funding from the European Union's Horizon 2020 Research and Innovation programme under GA No 101004730.

IFAST WP4 – Task 4.4:
Large scale Carbide-Carbon Materials for multipurpose applications

Meeting to prepare the milestone D4.4

F. Carra (CERN)

27th October 2022

iFAST

Task 4.4 – Deliverables and Budget

Milestone/Deliverable Number	Title	Lead beneficiary	Type	Dissemination level	Due Date (in months)
MS14	Evaluation of a CCM alternative to Molybdenum-Graphite	CERN	Report	Public	16
D4.4	Production of large-size CCM plates	CERN	Demonstrator	Public	24

D4.4 description

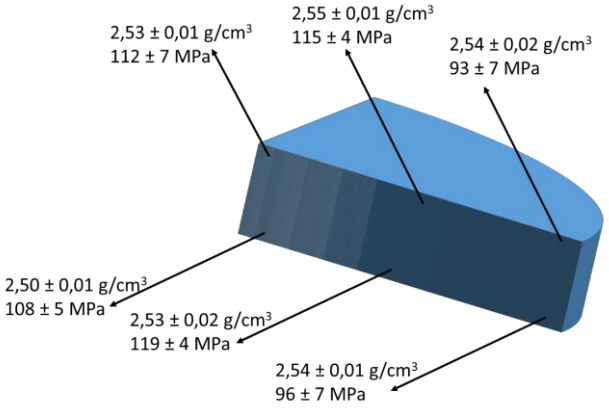
- Produce two large CCM plates (cross section >400 cm^2) in a single sintering cycle

Beneficiary short name	Person-months	Monthly personnel cost	Personnel costs	Travel	Equipment and consumables	Other direct costs	Sub-contracting	Material direct costs	Total direct costs	Total indirect costs	Total costs (direct + indirect)	EC requested funding
CERN	3.0	8,000.00	24,000.00	16,000.00	20,000.00	10,000.00		46,000.00	70,000.00	17,500.00	87,500.00	35,000.00
Nanoker	10.0	3,500.00	35,000.00	3,000.00	95,000.00			98,000.00	133,000.00	33,250.00	166,250.00	85,000.00
Total	**13.0**		**59,000.00**	**19,000.00**	**115,000.00**	**10,000.00**	**0.00**	**144,000.00**	**203,000.00**	**50,750.00**	**253,750.00**	**120,000.00**

Year 1 – Increase of volume per cycle

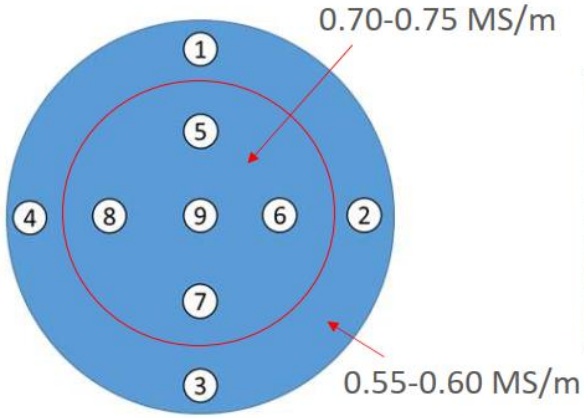
- **Molybdenum-Graphite** (sintered at 2640°C)

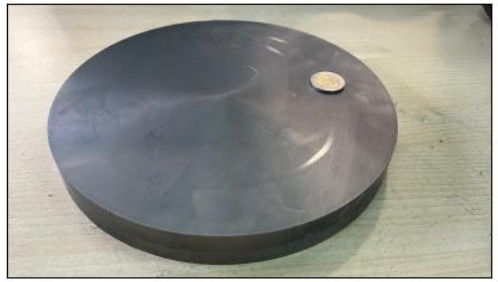
2 plates produced with 230 mm Diameter (2x bigger section than before IFAST)



Disk (230 mm diameter)	Density (g/cm³)	Electrical Conductivity (Mean values on each side) (MS/m)
Plate #1 (p=26 MPa)	**2,53**	**0,6 – 0,63**
Plate #2 (p=40 MPa)	**2,60**	**0,65 – 0,68**
Specification	**2,3 ÷2,6**	**>0,8**

Lower electrical conductivity values than in the 170 mm diameter disks





Pre-compaction of the green powder:

Maximum Applied Force Uniaxial Hydraulic Press ~ 900 kN

- 170 mm Ø → 40 MPa → 2,00 g/cm³
- 230 mm Ø → 21 MPa → 1,65 g/cm³

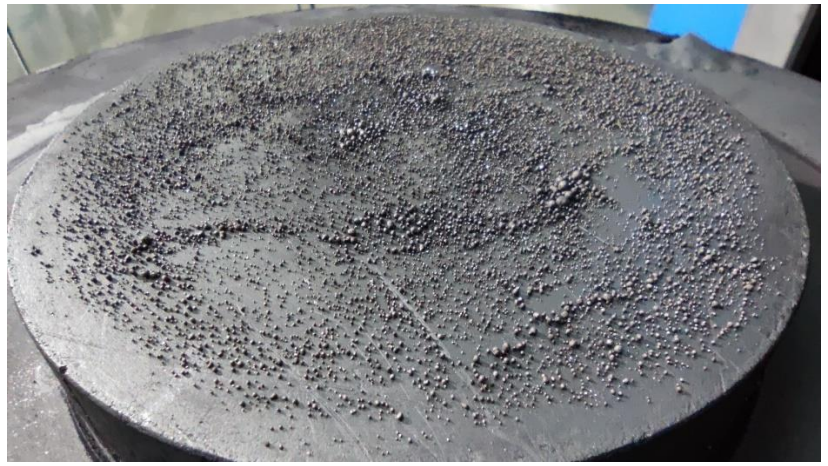
Next: increase the metal content, together with the higher sintering pressure

Year 1 – Decrease of sintering Temperature

- **Chromium-Graphite** (sintered at 2000°C – 1.3x lower T)
- Concept proposed by **Jorge Guardia** within ARIES WP14 & WP17, technically was not demonstrated yet (very poor mechanical properties)

3 plates produced with 170 mm Diameter

Disk (170 mm diameter)	Density (g/cm^3)	Electrical Conductivity (MS/m)
Plate #1	2,30	1,00 – 1,07
Plates #2 & #3	2,30	0.75/0.81
Specification	2,3 ÷2,6	>0,8



Reusable Mold and Parts → Important Cost Reduction

- **Plate #1 produced in a single plate per cycle**, very promising properties, decision for full characterization at CERN
- **Plates #2 and #3 double-plate per cycle**, losing a bit in conductivity → composition and cycle to be optimized

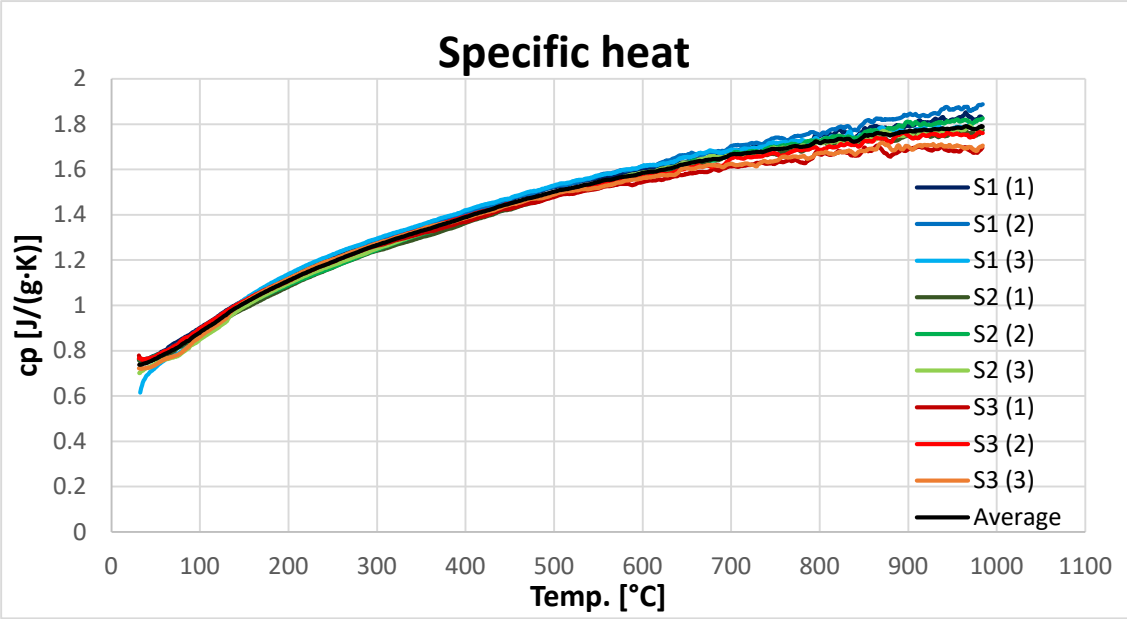
Year 1 – CrGr Characterization

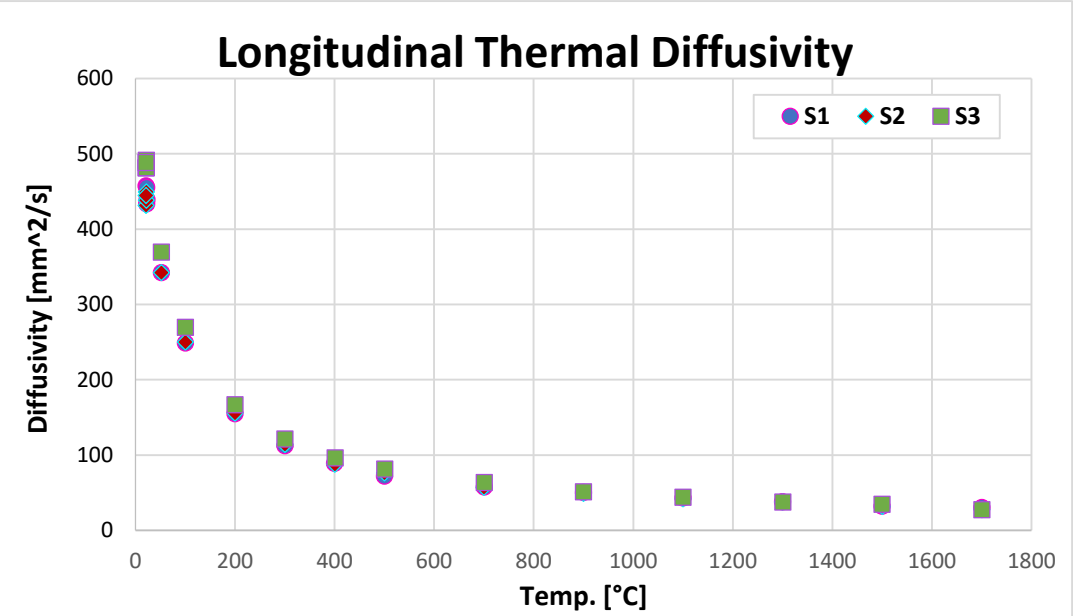
- **Full thermomechanical characterization** done at CERN Mechanical La
- **Very promising results**, some parameters to be improved durin
- strength increased by a factor of 5 wrt ARIES!

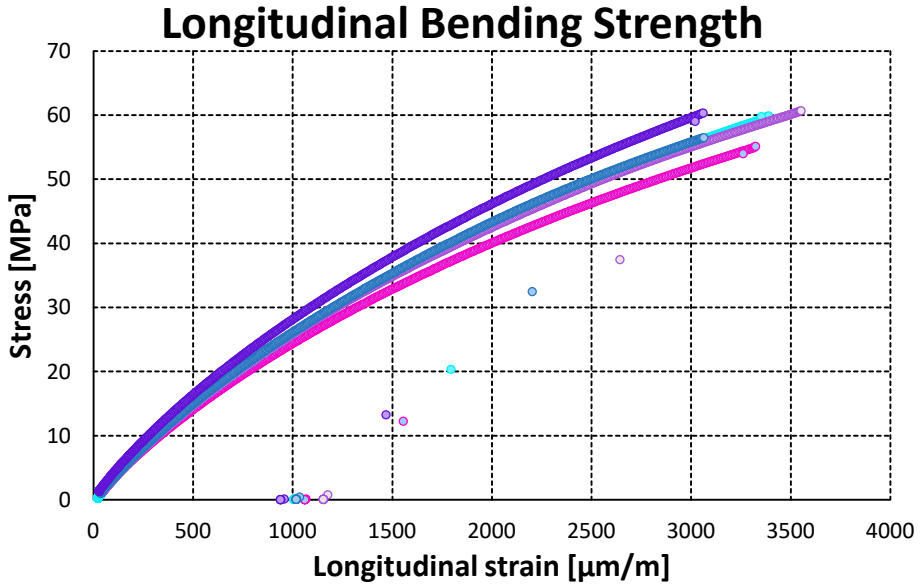
Milestone MS14 achieved!
Alternative to MoGr identified, report finalized

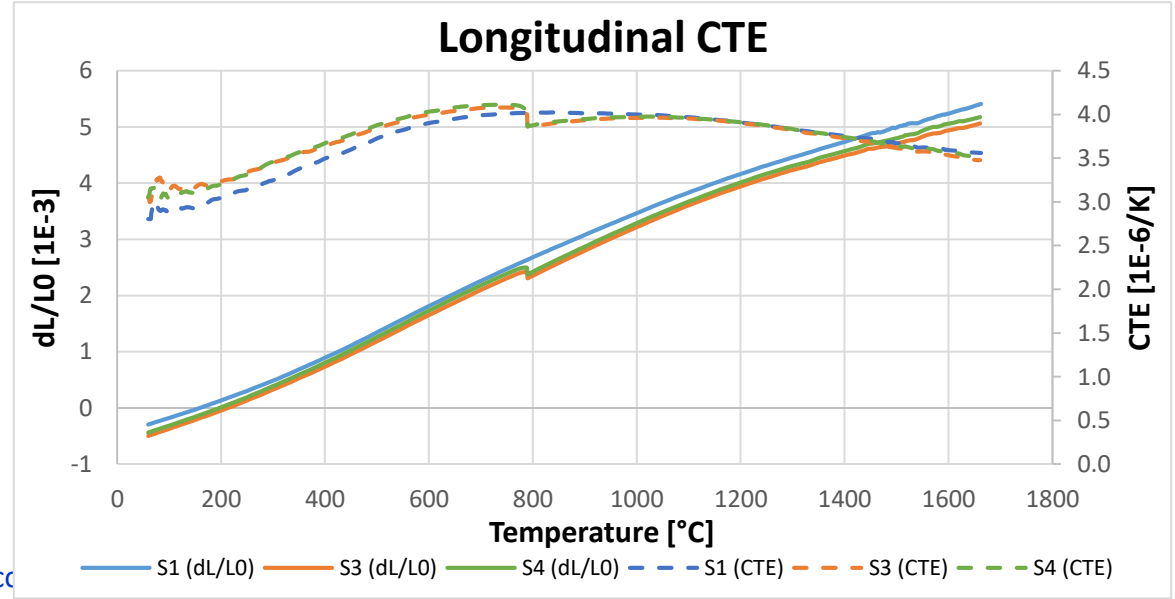
Property	Sp			F	Unit
Density at 20ºC			2.32		[g/cm³]
Specific heat at 20ºC			0.687		[J/(g·K)]
Electrical conductivity			1.02		[MS/m]
Thermal Diffusivity		/6	470/120	33/9	[mm^2/s]
Thermal conduct		> 35/20	750/350	52/27	[W/(m·K)]
Volu		7	6.7		[$10^{-6}K^{-1}$]
Coefficie		< 15	4.0	12.0	[$10^{-6}K^{-1}$]
		5 < E < 8	46	3	[GPa]
	> 60	> 10	58	8	[MPa]
F	> 2500	> 4000	3280	4200	[µm/m]
	< 0.05	< 0.25	-0.05	0.45	%

Year 1 – CrGr Characterization









D4.4 (month 24 →April 2023)

- Produce two large CCM plates (cross section >400 cm2) in a single sintering cycle (task 4.4)
- No need of fulfilling the spec here (yet) → this is an objective for the end of the project (2025)
- **Translation: to produce two Ø230mm plates in the same cycle**
  - Which material? MoGr or CrGr?
  - Which intermediate steps? MoGr looks more advanced, but probably require first more iterations with single Ø230mm plate… whereas CrGr would probably be cheaper

D4.4 (month 24 → April 2023)

Possible roadmap:

- **MoGr**:
  - **End 2022?** 1 single Ø230mm plate, discuss together about possible changes wrt past tests
  - **Q1 2023** → preparation of 2x Ø230mm plates test
  - **March 2023** → sintering of 2x Ø230mm plates in one cycle
  - **April 2023** → D4.4 reporting
- **CrGr**:
  - **End 2022**
    - Nanoker:
      - Machine a collimator block from plate #1?
      - Make another trial on 2x Ø170mm plates in one cycle
  - **Q1 2023**
    - CERN:
      - Perform UHV and metrology on collimator block from plate #1

iFAST

Thank you for your attention!

This project has received funding from the European Union's Horizon 2020 Research and Innovation programme under GA No 101004730.