

Plan for test beam 2021 of Korea-DRC team

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On behalf of the Korea
Dual-Readout Calorimeter team



Introduction

- Physics goals
 - Module 1: measurement of nuclear interaction length using proton beam
 - Module 2: measurement of energy and position resolution using electron beam

- R&D goals

- Readout test (MCP vs. SiPM)
- Time resolution (< 50 ps)
- Optical fibers (various types)



2 MCP-PMT's

Signal starting time difference: 2 ns/m

Time resolution: 10 ps \rightarrow 5 mm precision

Time resolution: 50 ps \rightarrow 25 mm precision

Time resolution: 100 ps \rightarrow 50 mm precision

Time resolution: 500 ps \rightarrow 250 mm precision (achieved with PMT+TDC and Pb-fiber (Pavia) modules)

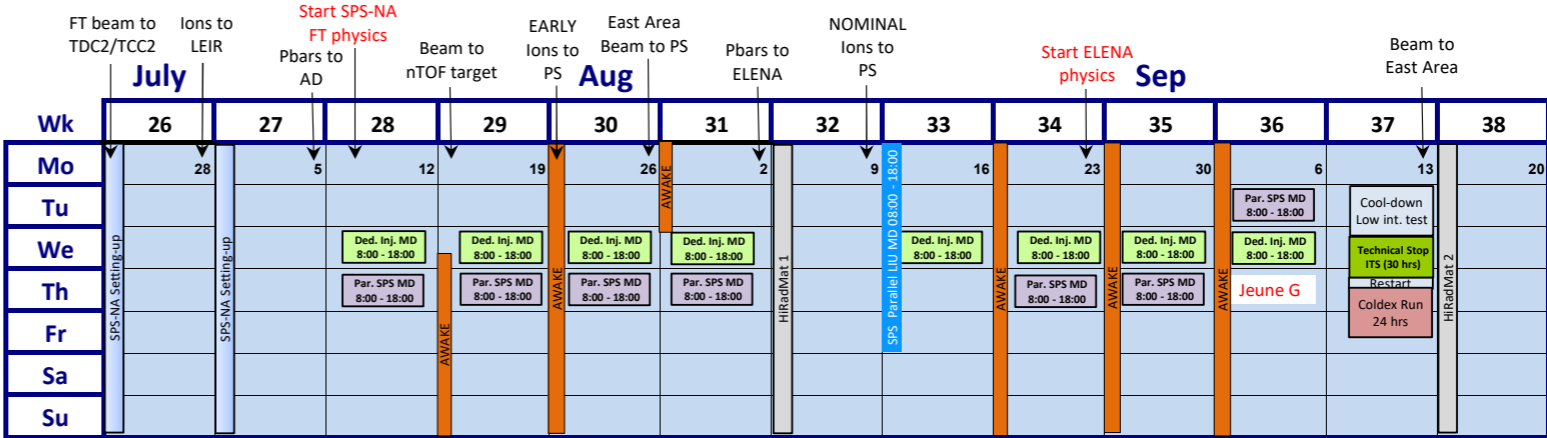
- Training goals

- Next generation experts for DRC HW

Timeline

- Target to have beam-time at the end of Oct. or early Nov.

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Module	rebuilding		Assembly			Test / Commissioning			Shipping to CERN	Test Beam	Analysis	
Readout	order to purchase		fabrication									



3) The draft 2021 Injector Accelerator Schedule.
 In this schedule the proton run is from:
 - week 42 to week 45, included, for the PS East Area.
 - week 28 to week 45, included, for the SPS North Area.



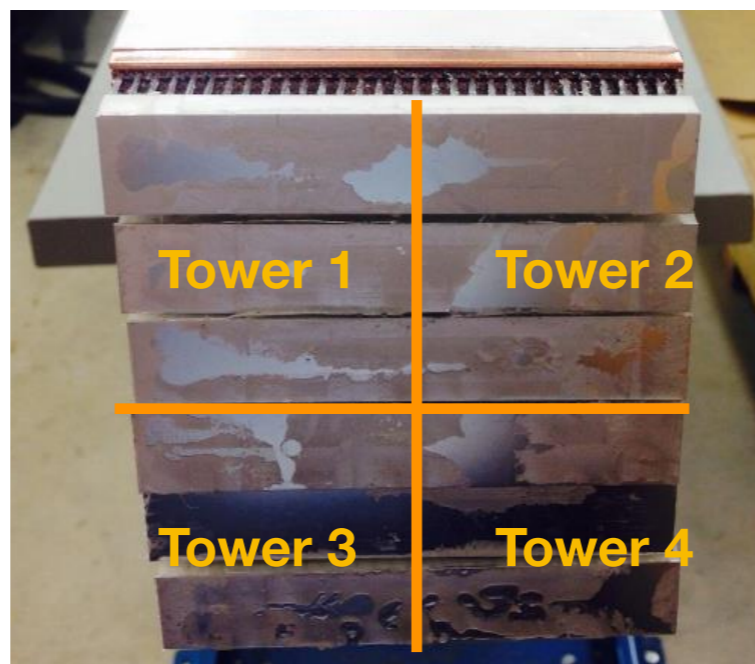
- Injector Complex MD Block (dedicated)
- Injectors Technical Stop
- Protons physics
- LHC beam test period
- Special Run
- HiRadMat Run
- AWAKE Run
- LIU parallel MD
- Pb ion commissioning
- Special interventions/stops
- CERN Official Holidays
- Controls system interventions
- SPS MD block (parallel)
- YETS & HWC 2021

Plan for Module Rebuilding

- Have two copper-based modules used at 2016 test-beam
 - Need to rebuild completely as they are significantly damaged
- Plan
 - Disassemble and cleanup all fibers and other components from copper plates
 - Repair plates and assemble new fibers



Module #1 (2x2)

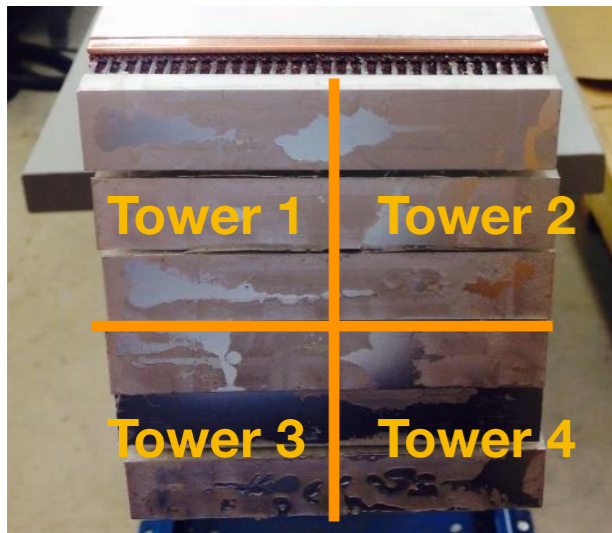


Module #2 (3x3)



Fiber Configuration

Module #1 (2x2)



Tower#1	Tower#2
Tower#3	Tower#4

Combination of fibers for Module#1

	Tower #1	Tower #2	Tower #3	Tower #4
Scintillation fibers	Round / Single cladding	Round / Single cladding	Round / Double cladding	Square / Single cladding
Cherenkov fibers	Round / Single cladding			
Readout detector (2*4 ch)	2 PMTs	2 MCP-PMTs	2 PMTs	2 PMTs

Module #2 (3x3)



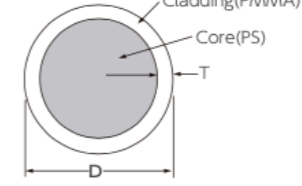
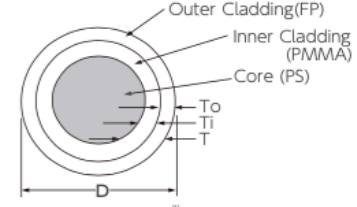
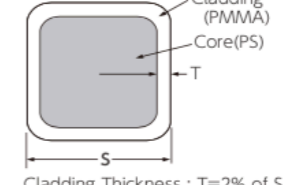
Tower#1	Tower#2	Tower#3
Tower#4	Tower#5	Tower#6
Tower#7	Tower#8	Tower#9

Combination of fibers for Module#2

	Tower #1~4 and #6~9	Tower #5
Scintillation fibers	Round / Single cladding	
Cherenkov fibers	Round / Single cladding	
Readout detector (400+16 ch)	16 PMTs	400 SiPMs

Optical Fibers

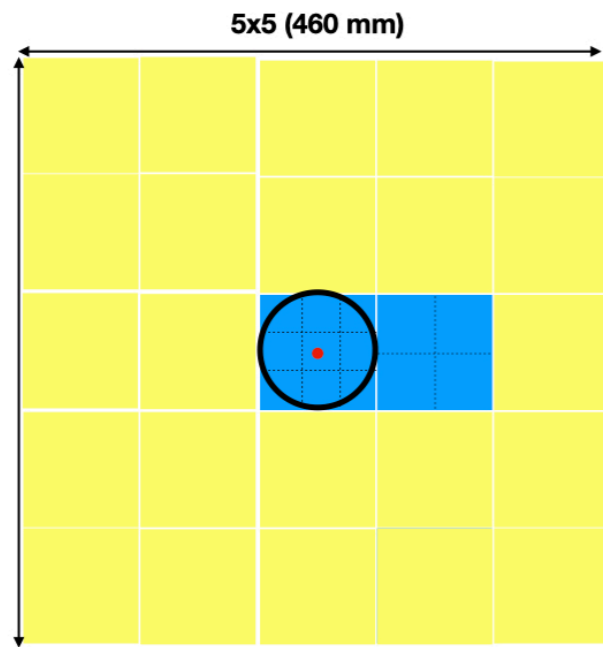
- Scintillating fibers: Kuraray SCSF-78
 - 1.0 mm single cladding, round: 4667 pcs (3m/pcs)
 - 1.0 mm multi-cladding, round: 500 pcs
 - 1.0 mm single cladding, square: 500 pcs
- Cerenkov fibers: Mitsubishi SK-40
 - 1.0 mm: 12 sp (1500 m/sp)
 - Under cutting (3m/pcs) and straightening
- Expected to deliver at the end of February

	Single Cladding	Multi-Cladding (M)
Round Fiber (D)	 <p>Cladding Thickness¹: $T=2\%$ of D Numerical Aperture: NA=0.55 Trapping Efficiency : 3.1%</p>	 <p>Cladding Thickness²: $T=2\%(T_o)+2\%(T_i)$ $=4\%$ of D Numerical Aperture : NA=0.72 Trapping Efficiency : 5.4%</p>
Square Fiber (SQ)	 <p>Cladding Thickness : $T=2\%$ of S Numerical Aperture : NA=0.55 Trapping Efficiency : 4.2%</p>	Not available

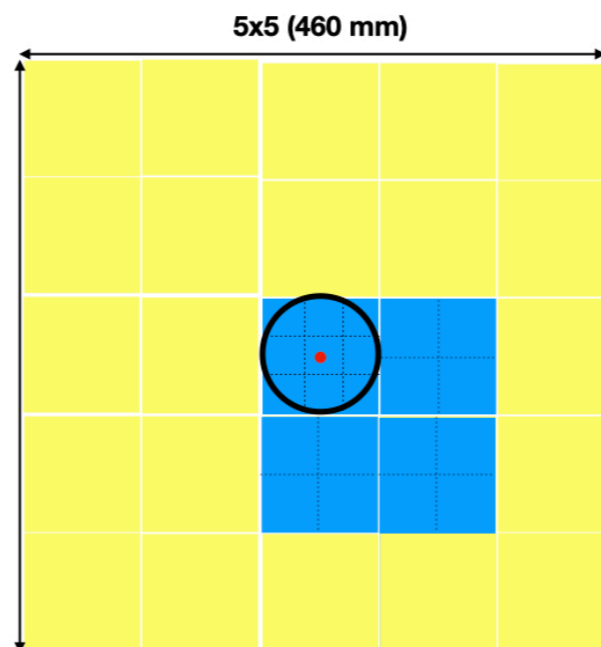


Roadmap of DRC Prototype Detector

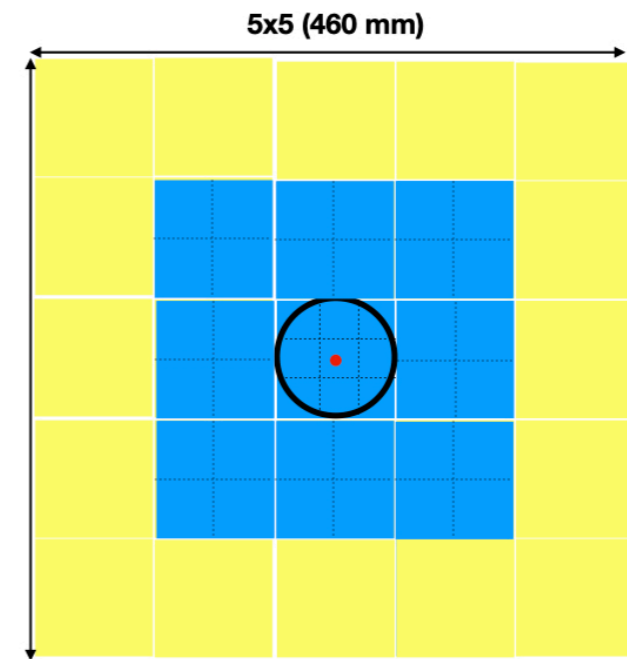
Prototype Detector (2021)



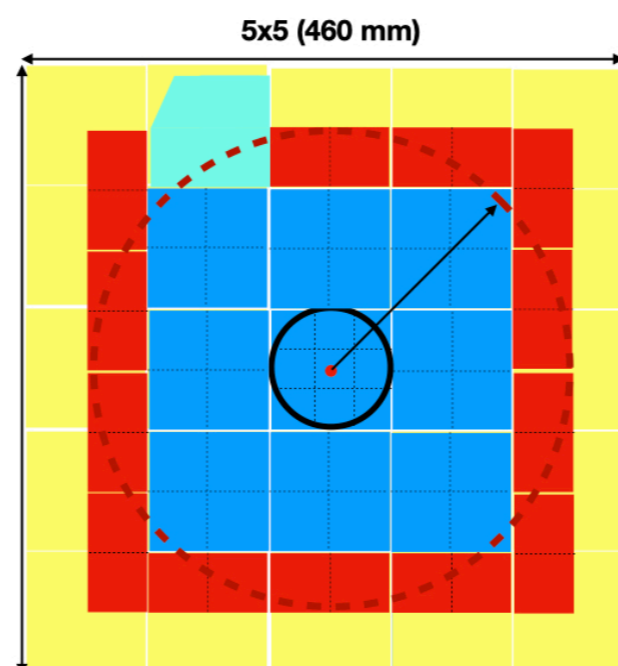
Prototype Detector (2022)



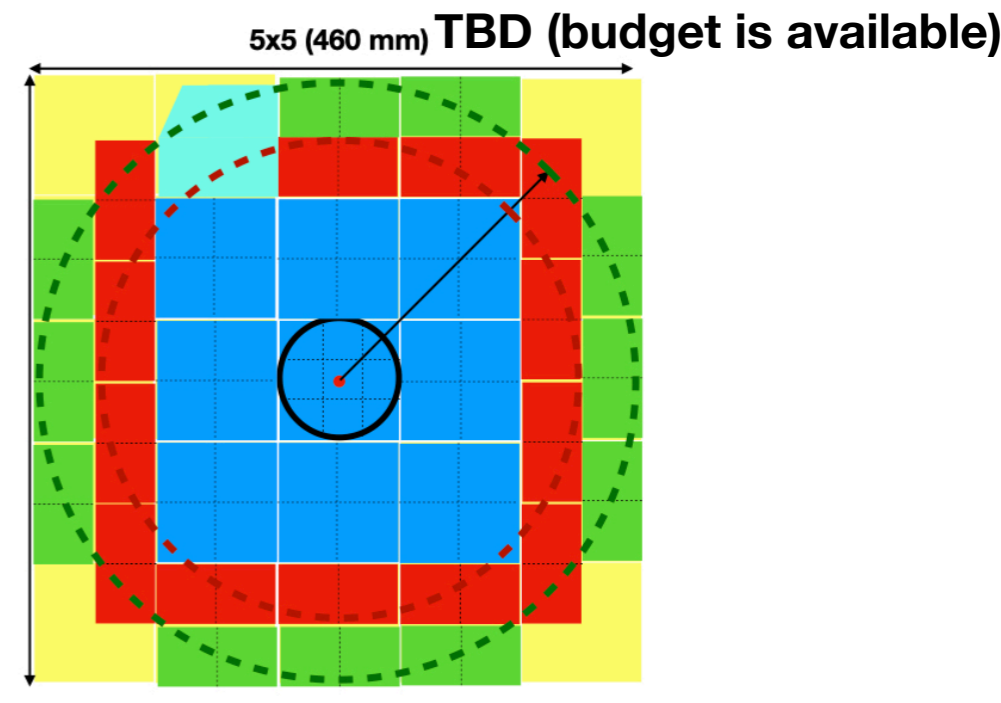
Prototype Detector (2023)



Prototype Detector (2024)



Prototype Detector (2025)



**Aim to assemble
the modules at CERN
and do test beam
every year**

- Mechanical supporter
- 3D-printing module
- 9.2x9.2cm modules: 9
- 1/2 modules: 13 (Opt1)
- 1/2 modules: 11 (Opt2)

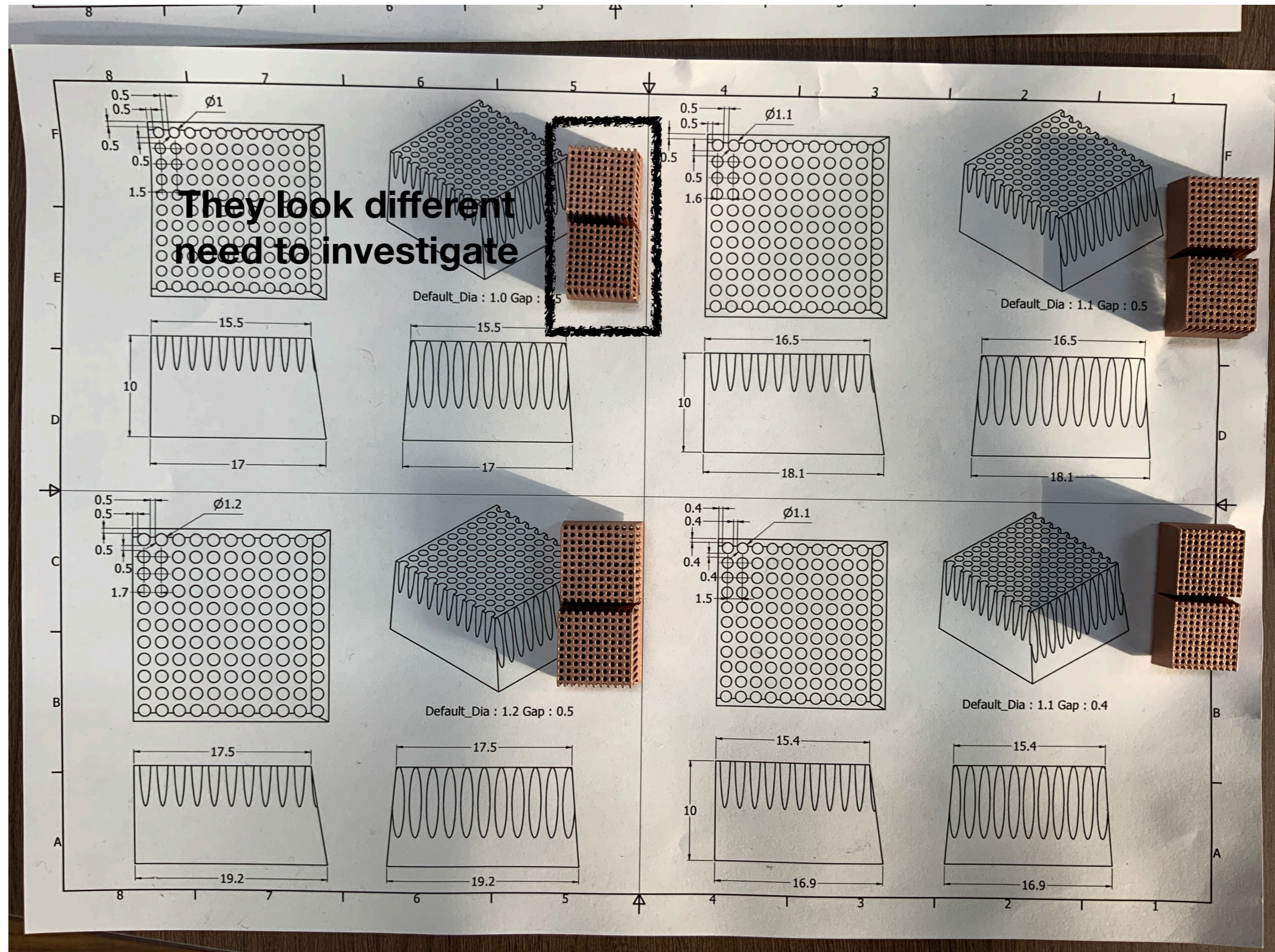
Status of 3D Printing

- Ordered to Farsoon (China)
 - 10 different design of samples
 - 10 x 10 holes (front) and 11 x 11 holes (rear) with 1 cm height
- Quite impressive results with more accurate outcome
- Measured density: ~93%

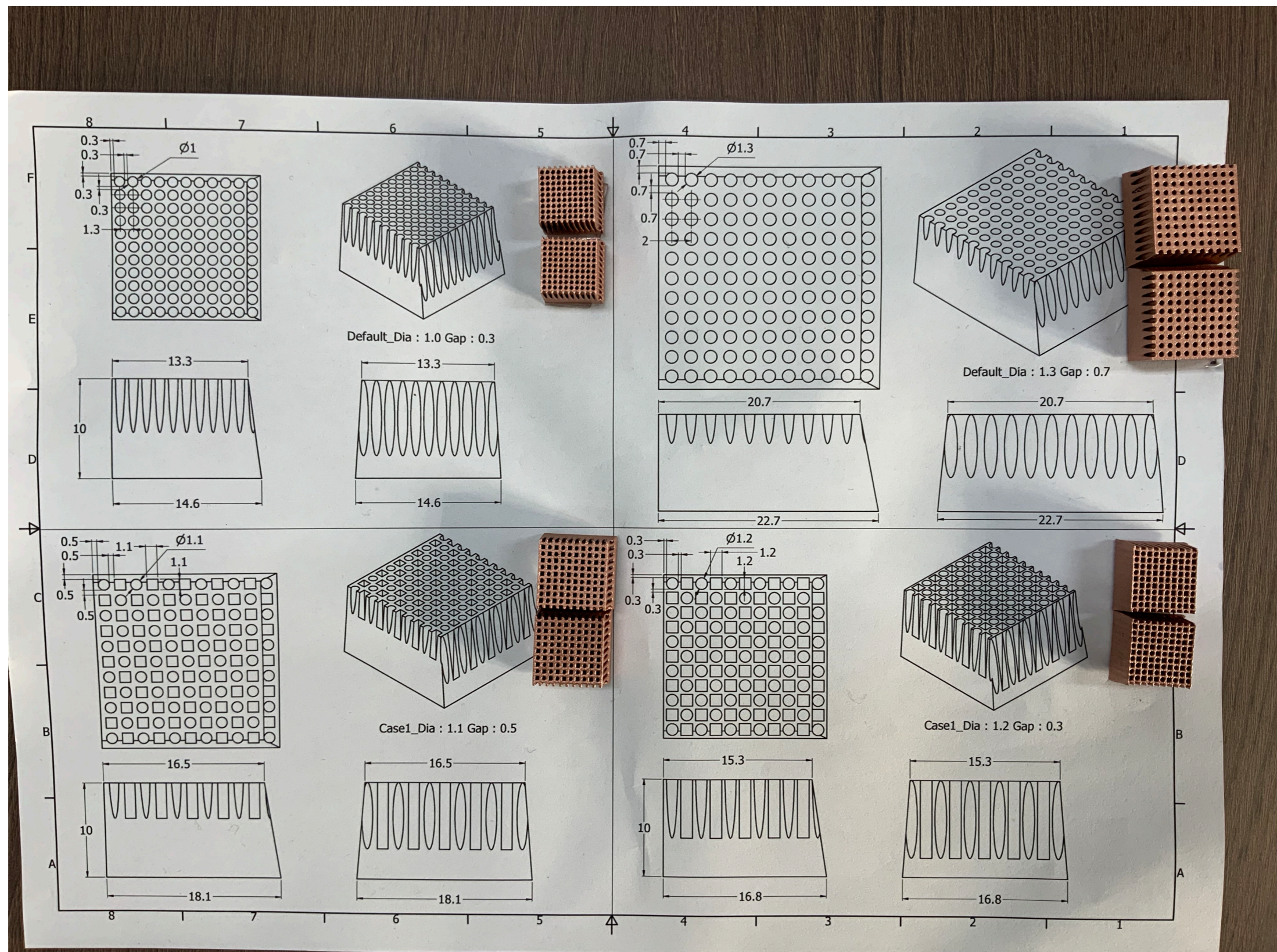


	Samples	1	2	3	4	5	6	7	8	9	10
Diameter (mm)	Designed	1.0	1.1	1.2	1.1	1.0	1.3	1.1	1.2	1.2	1.1
	Outcome	0.9-0.95	0.9-0.95	1.0-1.05	0.8-0.85	0.8-0.85	1.1-1.15	0.9-0.95	1.0-1.05	1.0-1.05	0.9-0.95
Wall thickness (mm)	Designed	0.5	0.5	0.5	0.4	0.3	0.7	0.5	0.3	0.5	0.4
	Outcome	0.52	0.6	0.62	0.5	0.45	0.81	0.6	0.4	0.65	0.52

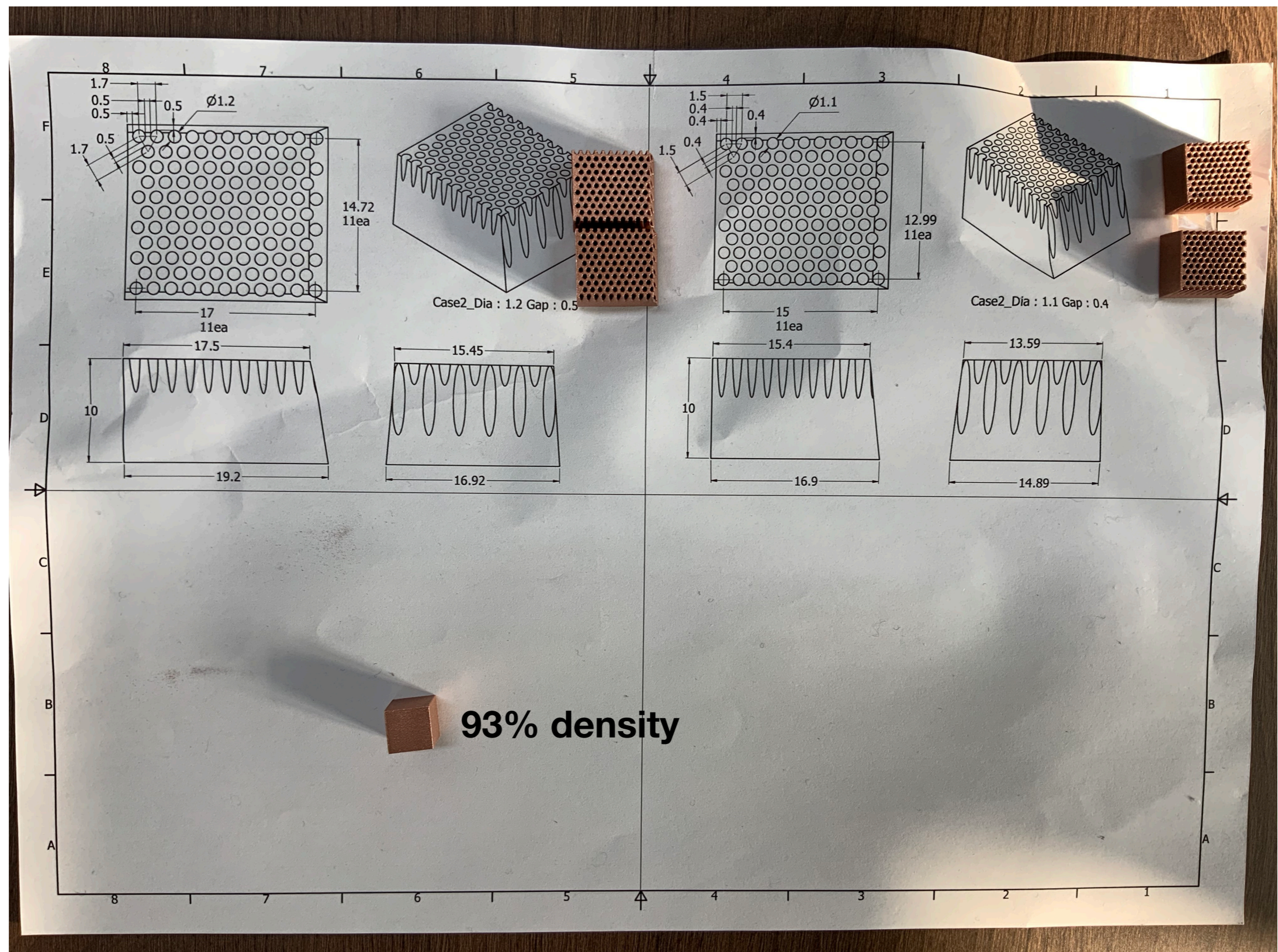
Sample 1 - 4



Sample 5 - 8



Sample 9 - 10



Back Up