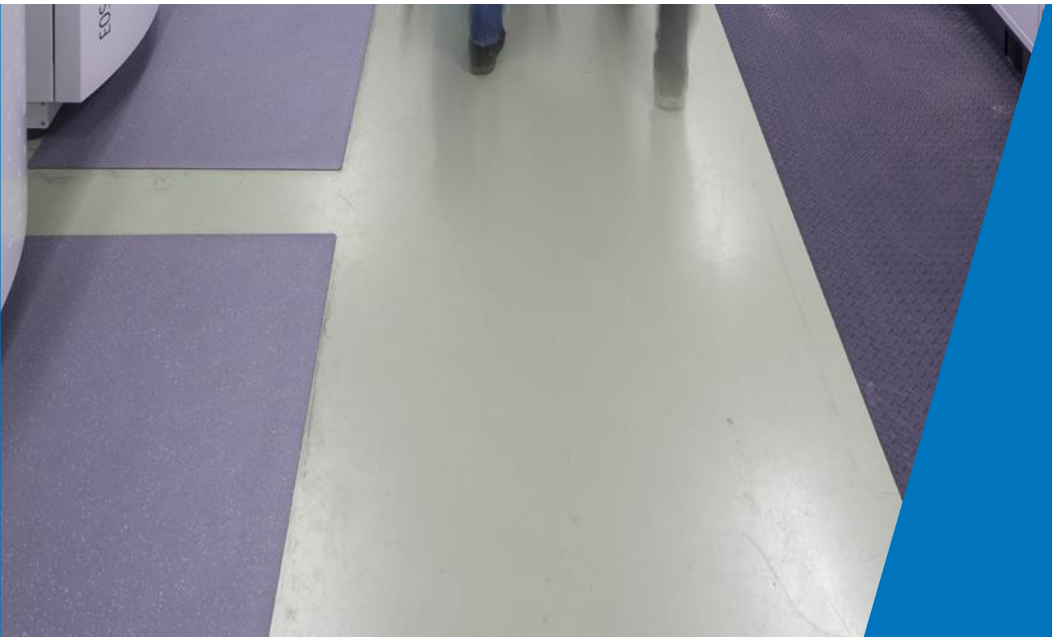
DUNLEE PHILIPS

DMLS at Philips

Implementation of Large-Scale Production of Antiscatter Grids for Medical Applications



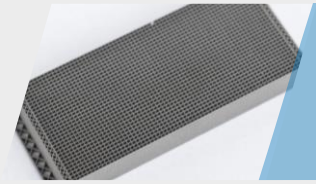
The challenges of high volume AM

Carbone Nicola

Engineer in Additive Design & Manufacturing

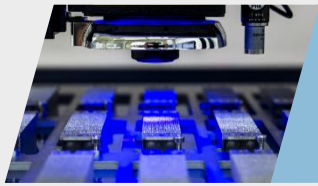
25 September 2024

1. Philips & Dunlee



2. Application meets technology

3. Developing into a large scale Factory



4. AM production

High quality components for diagnostic imaging

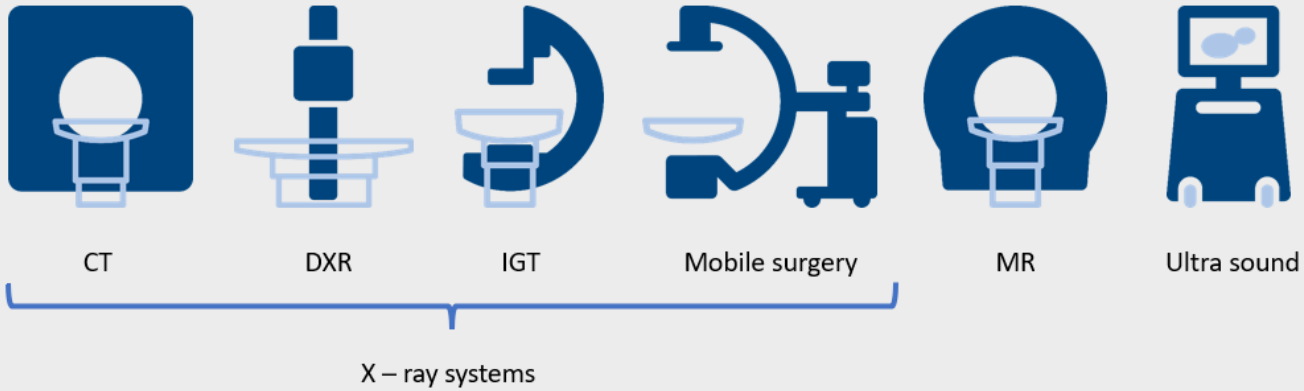
Philips medical equipment portfolio

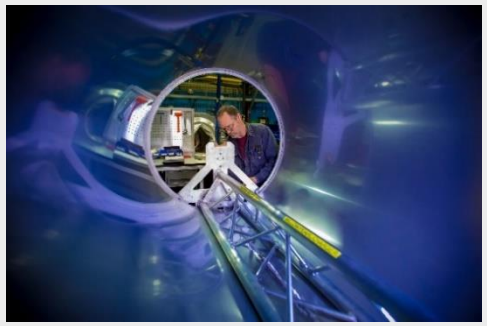
- More than 2000 experts
- Operations in Europe, USA, Middle-East, Asia

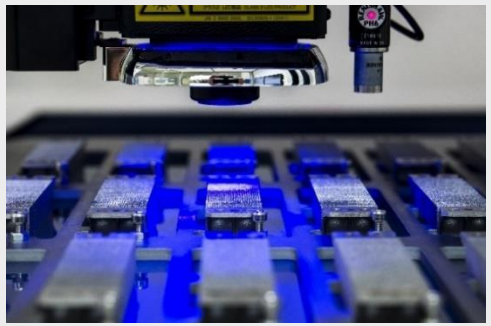
Dunlee - Core Competence:

- Manufacturing of x-ray tubes for CT, radiography and interventional imaging
- MRI components
- Complete component groups for CT scanners
- **Grid solutions for all x-rays systems**

100+ years of experience in the production and optimization of imaging solutions







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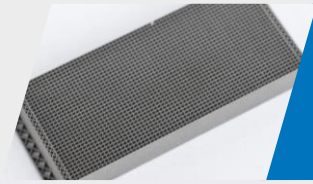

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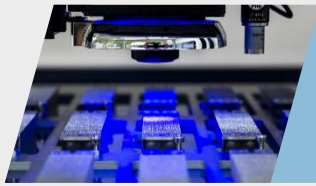
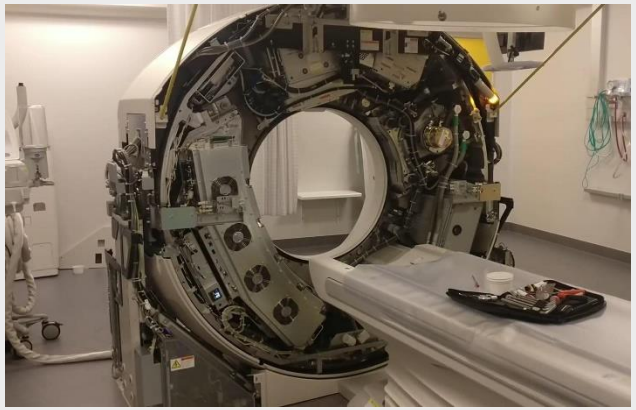
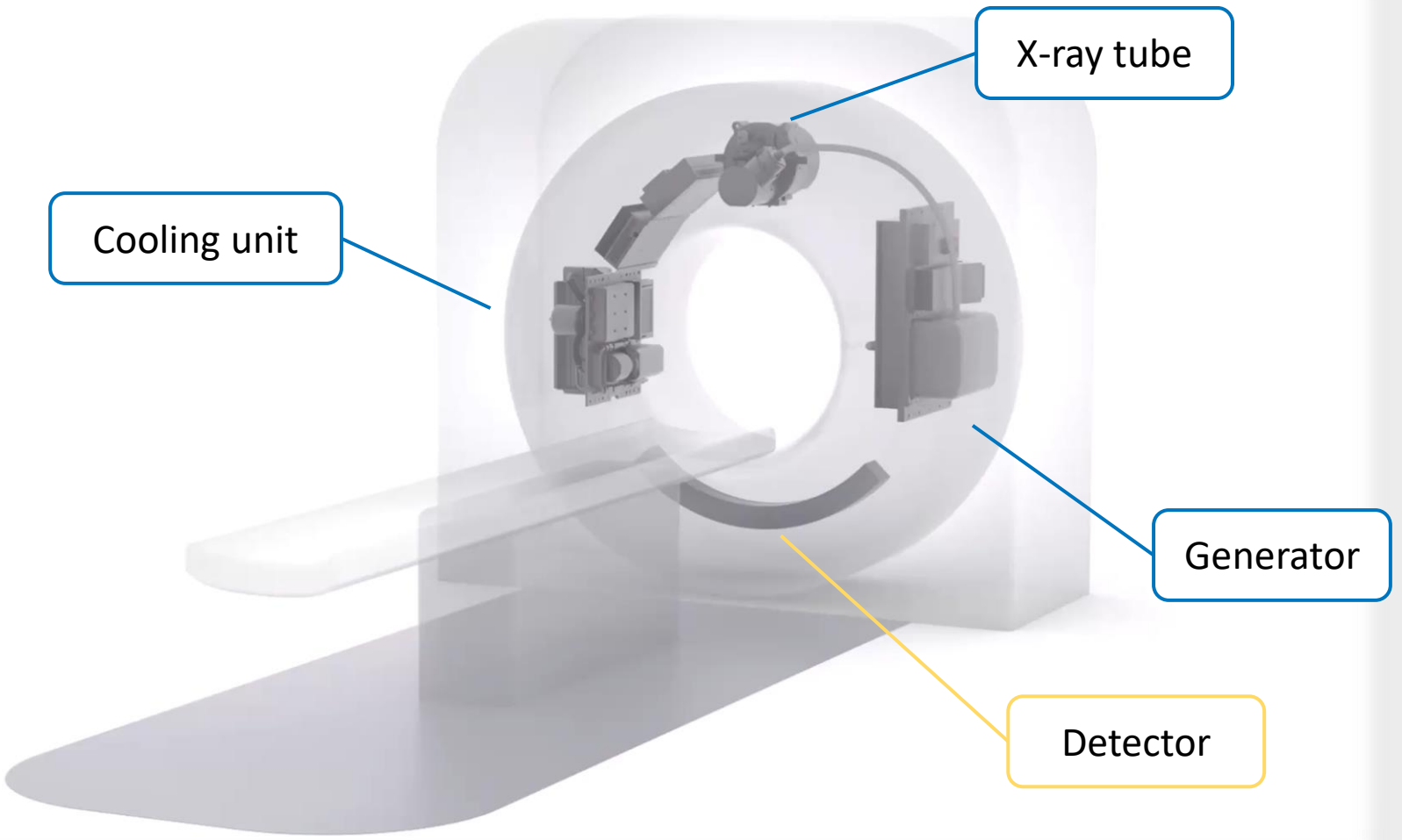


4. AM production

Application meets technology

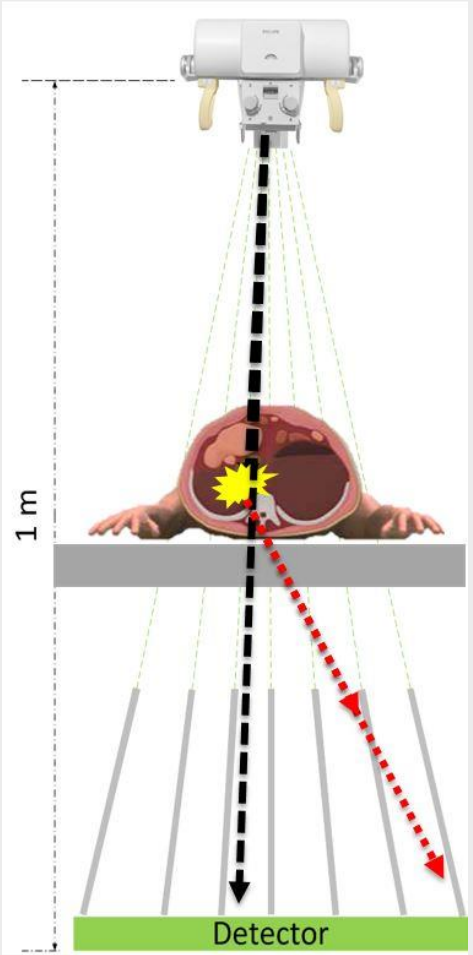
CT and its components



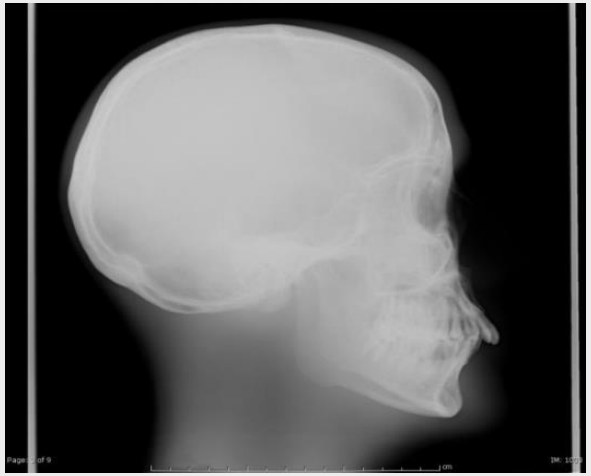


Application meets technology

X-ray scatter absorption in an **A**nti **S**catter **G**rid (ASG)



Scattered X-rays are absorbed by an ASG



*X ray image **without** ASG*

*X ray image **with** ASG*

Advantages of applying an ASG:

1. Higher Image Quality
2. Less artifacts
3. Improved contrast resolution
4. Lower X-ray dosage and contrast fluids

Cross section of an ASG

Application meets technology

Material requirements

X-ray stopping power:
- Best stopping power against radiation (Density: 19,2 g/cm³)

Price:
- Best price for stopping power per volume

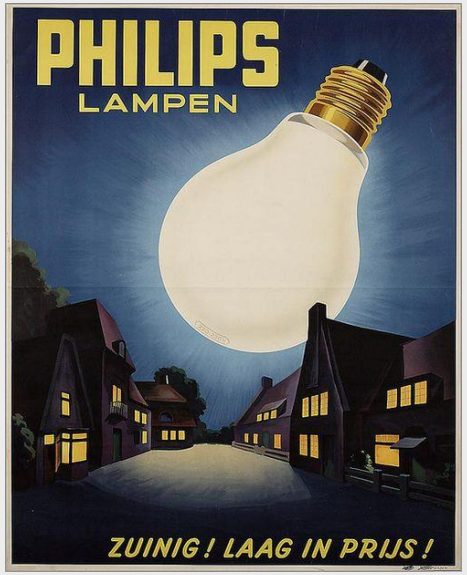
Mechanical properties:
- Fatigue and elastic modulus under CT conditions (up to 20 G acceleration)

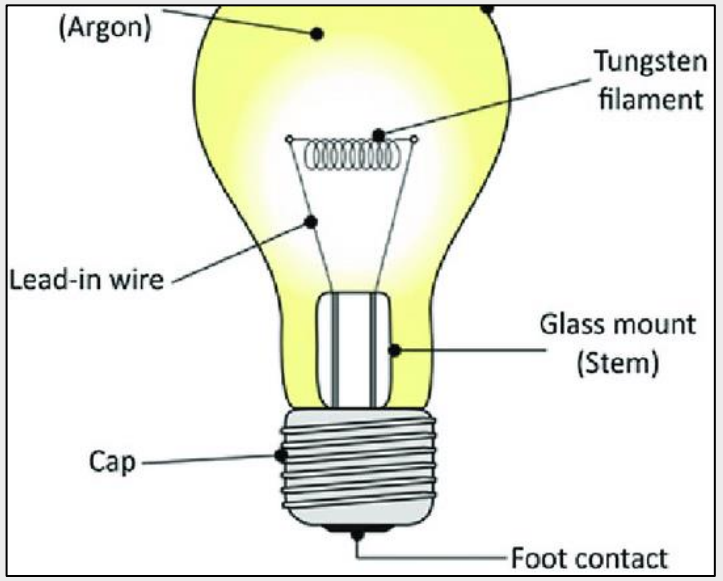
Other distinguished material characteristics:

Heat:
- Resistance against high temperatures (3422°C)

Magnetic compatibility:
- Non-magnetic characteristics (e.g. MRI)

Lifetime:
- Highest resistance against wear → reusability



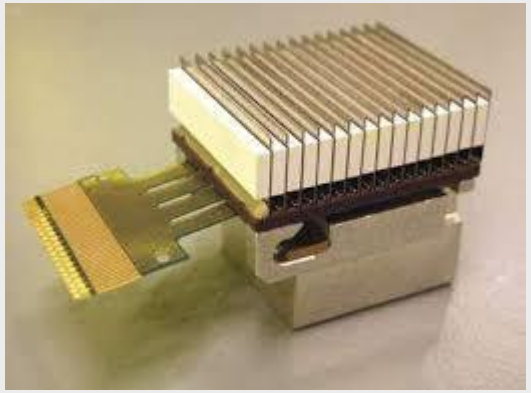


Material	% X-rays absorbed @ 120 kV in 0.1 mm solid wall	Price (€/kg)	Price (€/cm3)
Tungsten	62	120(1)	2.31
Molybdenum	31	130(2)	1.33
Copper	12	50(3)	0.45
Palladium	44	25000(3)	144
Tantalum	59	1200(2)	19.92

(1) Powder price in 2008
(2) Quote in 2008
(3) Estimated from 2008 materials price from internet

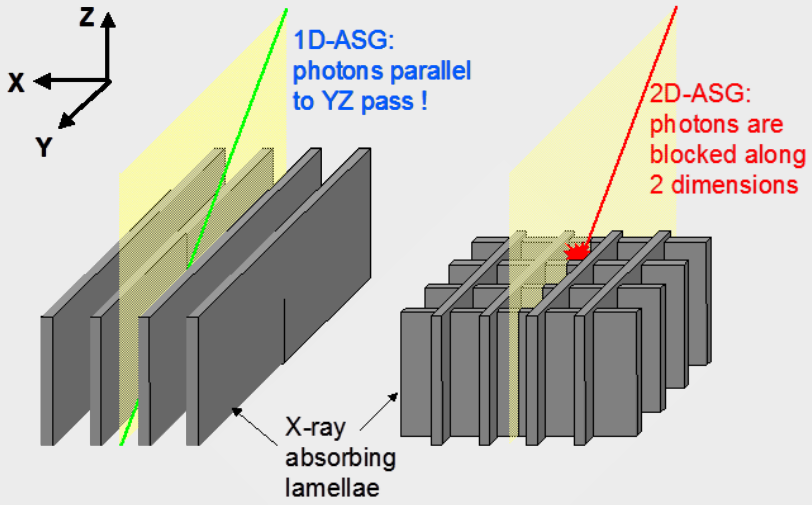
Application meets technology

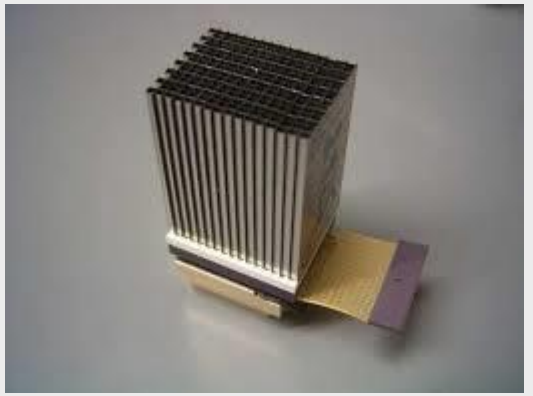
Re-Design for AM – from 1D to 2D in 3D



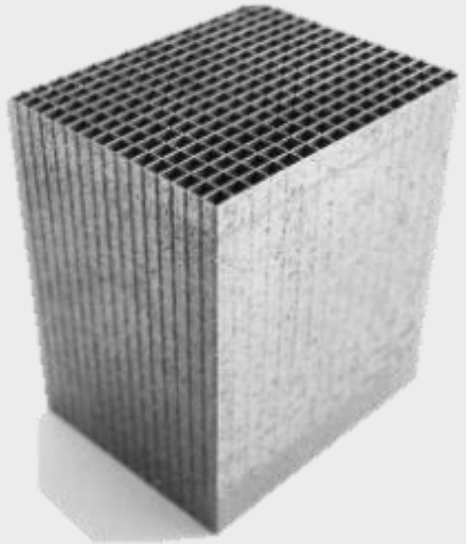
1D Molybdenum Grid

1D Assembly Molybdenum Grid





Folded 2D Molybdenum Grid



3D printed tungsten 2D Grid

Application meets technology

Requirements for a Tungsten 2D grid

1

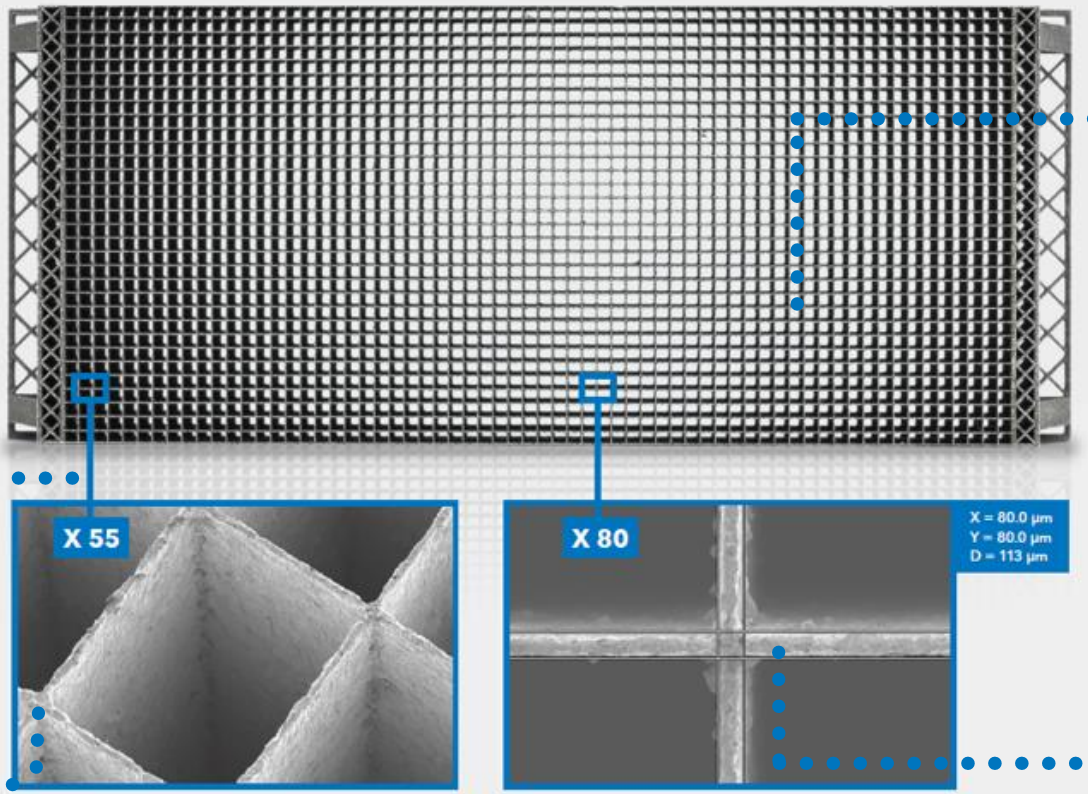
Positional accuracy of 25 um

The application requires precise positioning of the lamellae/walls

2

Small feature size of 100um

Thin wall thicknesses allow for high utilization of primary X-rays due to less shadowing of walls on the detector.



3

Freedom of design

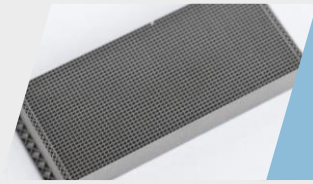
3D additive manu-facturing allows full scale-ability

4

Better absorption of scattered x-ray

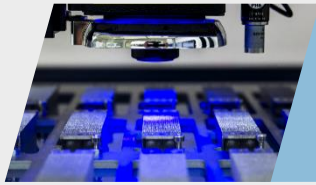
High density of pure-Tungsten offers best absorption

1. Philips & Dunlee



2. Application meets technology

3. Developing into a large scale Factory



4. AM production

Developing into a large scale Factory

The history Additive Manufacturing of Tungsten Grids

First 3D metal printers start Operation: a custom M270 FDR

Capable of building highly accurately positioned tiny features in Tungsten

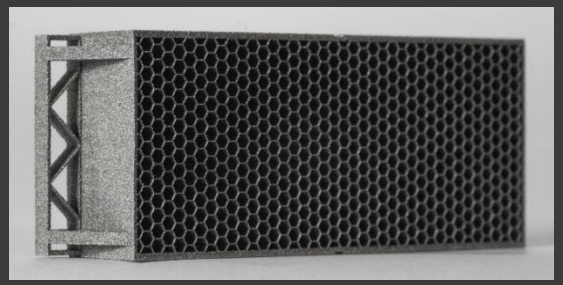
Ready for large volume production

Philips is ready to print in high volumes

2007 2008 2012 2014 2016 2021

Start of 2D Grid R&D

Motivation: find alternatives to current grids that offer premium image quality & simplify design and processing

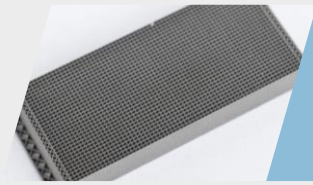


First industrial customer for 2D ASG

Officially designed into a new CT system

±120.000 ASG's sold in a year

1. Philips & Dunlee



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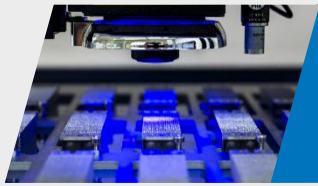


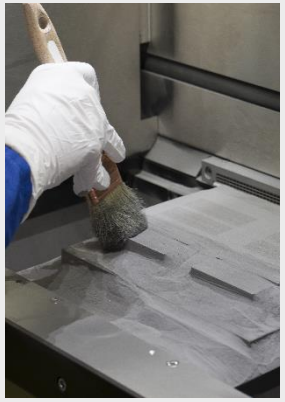
4. AM production

AM production

A complete production flow

Design
Redesign for AM/ CAD preparation/

Build
Machine preparation /calibration

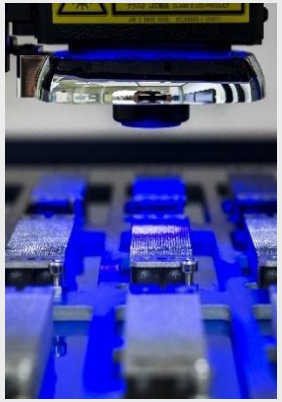


Marking
Full product traceability

EDM
Separation/ Feature machining

Post processing
Surface finishing

Quality inspection
Measure-ments and evaluation



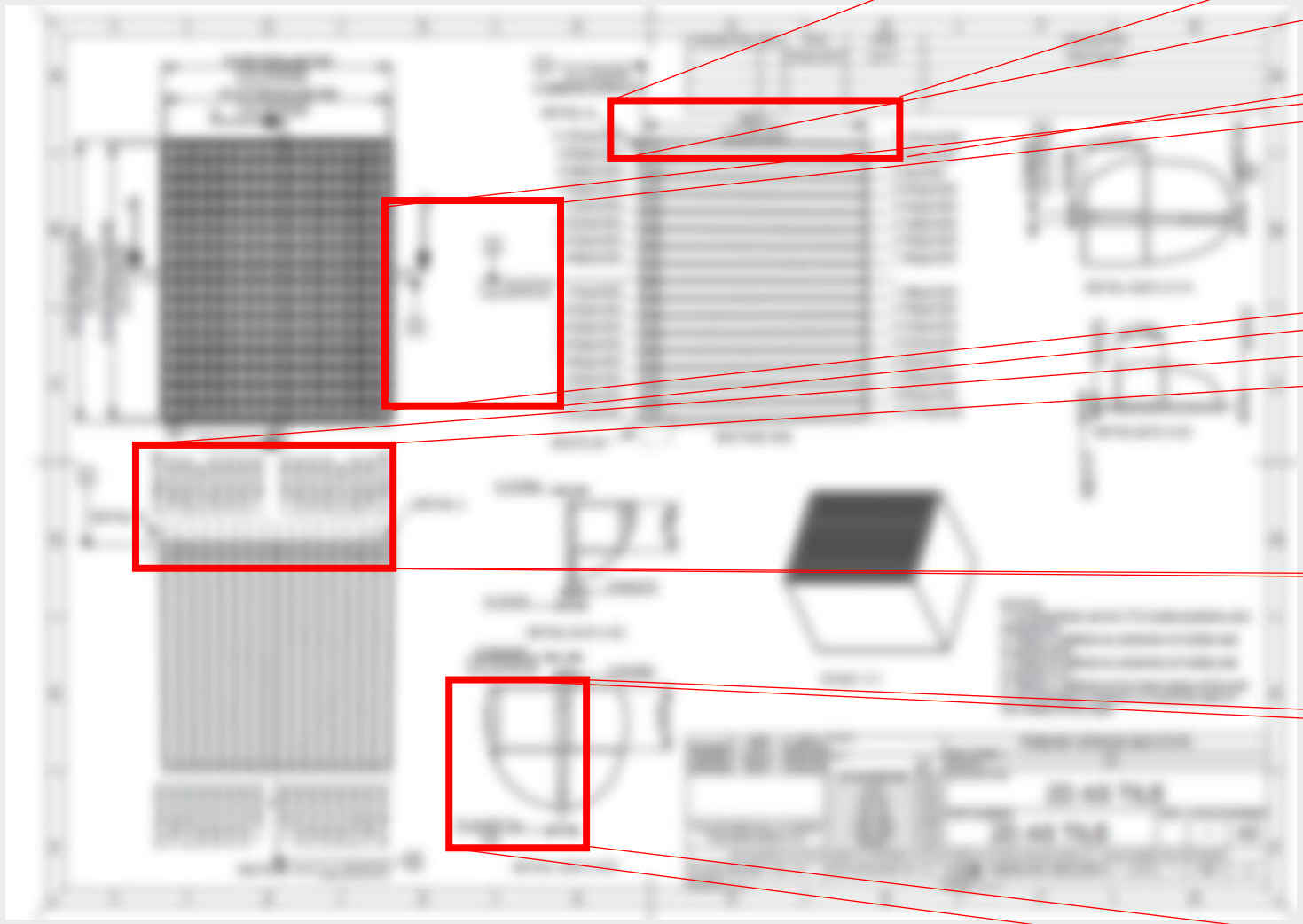
Packaging

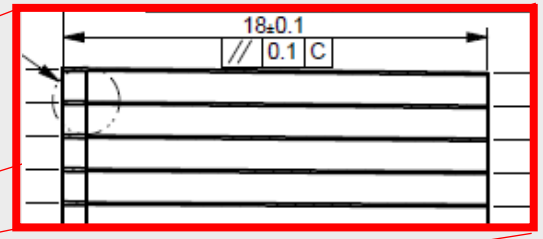
Specific foams for every ASG

Manufacturing on a large scale is the art of repeatability

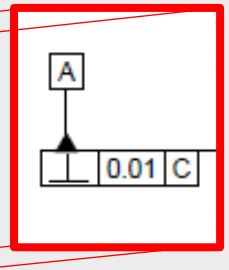
AM Production

Design – Re design for AM/CAD preparation



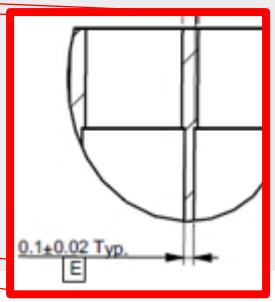


Parallelism top and bottom plane



Perpendicularity of mid-wall to bottom surface

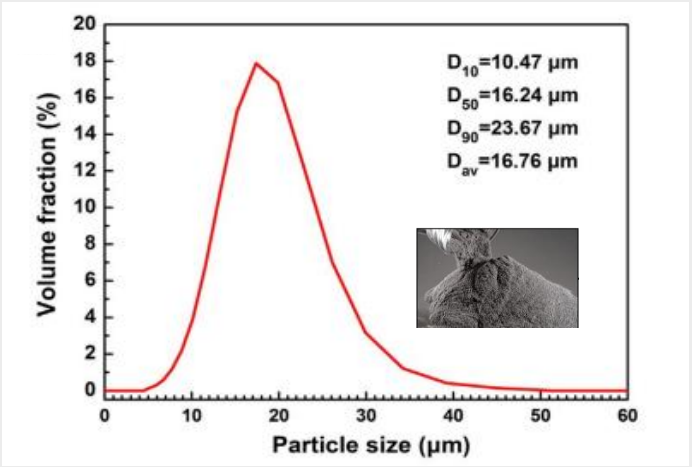
Position tolerance of every wall in relation to mid-wall



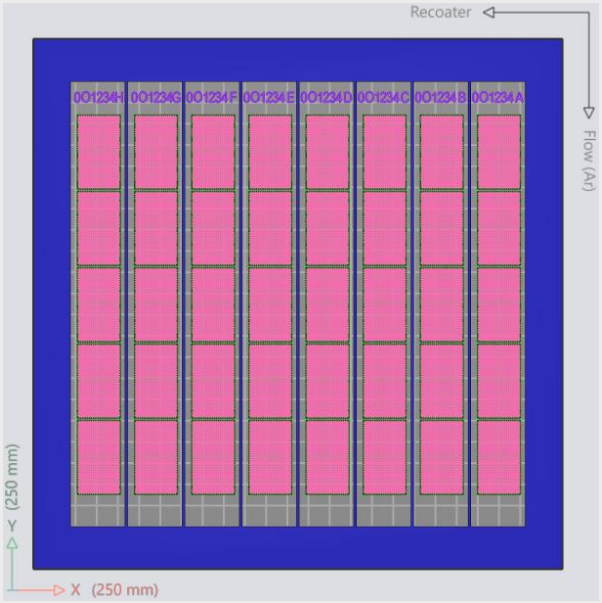
Feature size tolerance

AM production

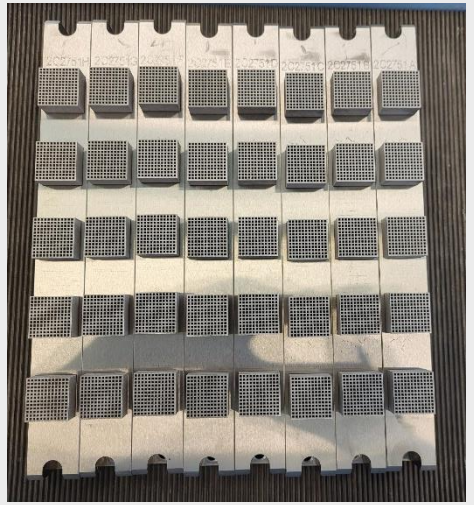
Customized build preparation



- Fine powder for fine features



- A unique preparation of models and print files to obtain high quality details



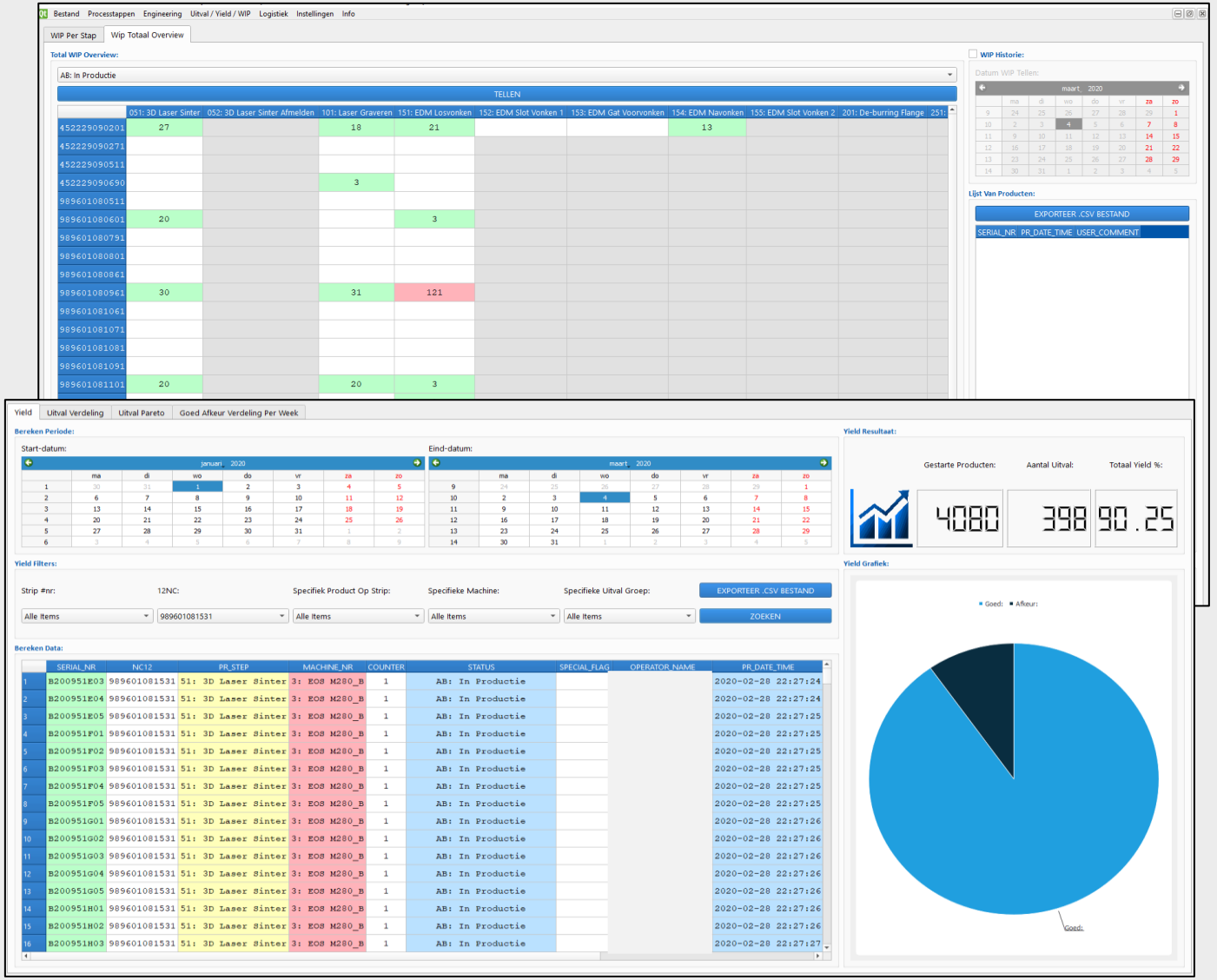
- Customized strips for every single product on build plate for improved quality and traceability

AM production challenges

Marking for full product traceability

AMaDa

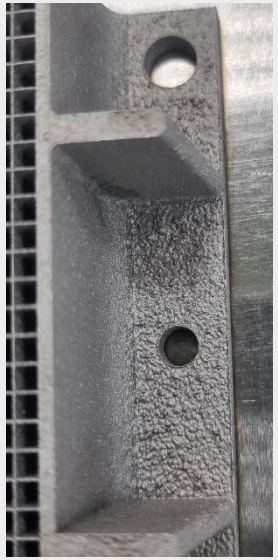
Additive Manufacturing Database

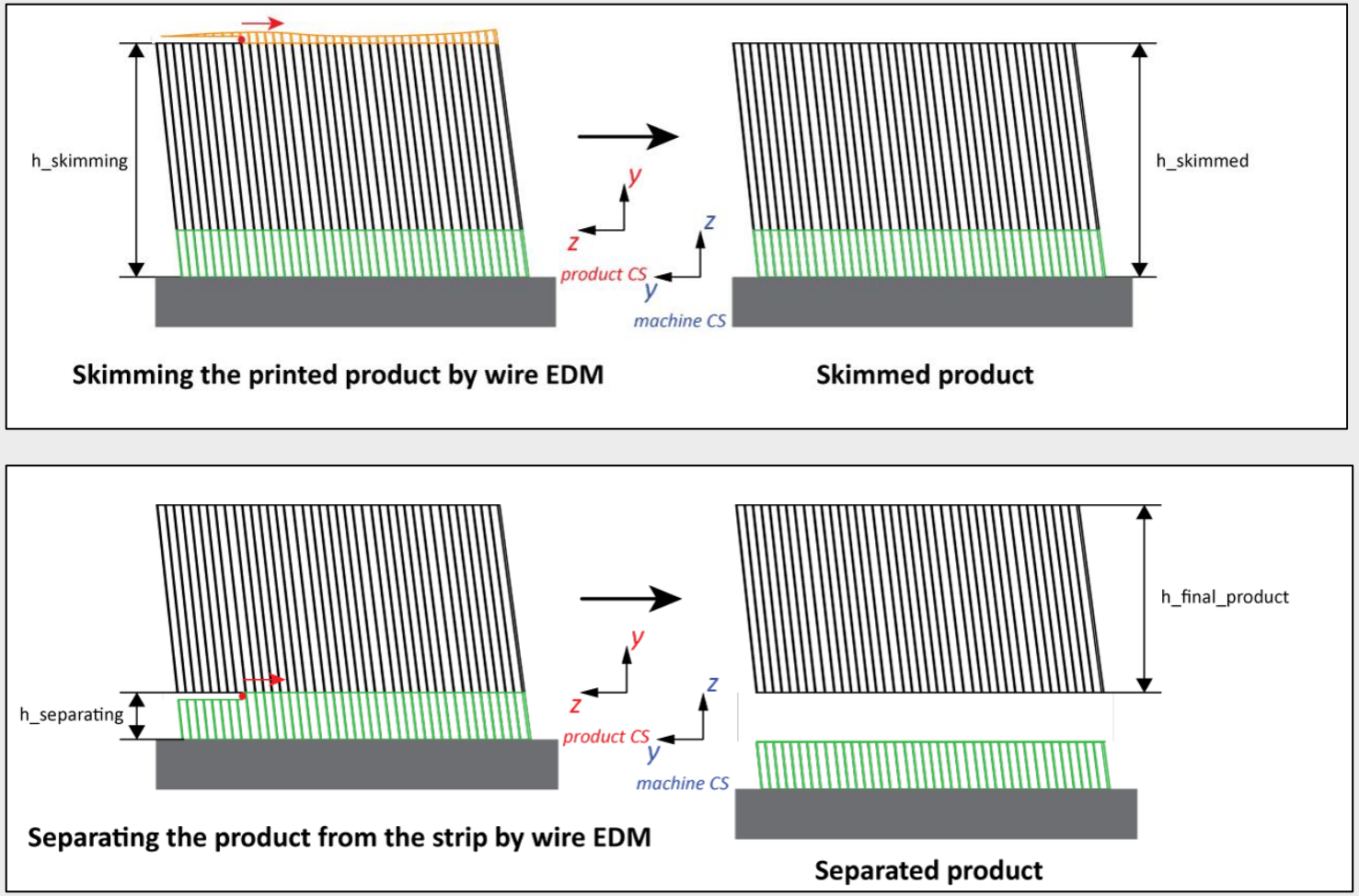


AM production challenges

Feature machining through wire EDM

- Part separation and skimming
- Machining of slots/holes of flanges



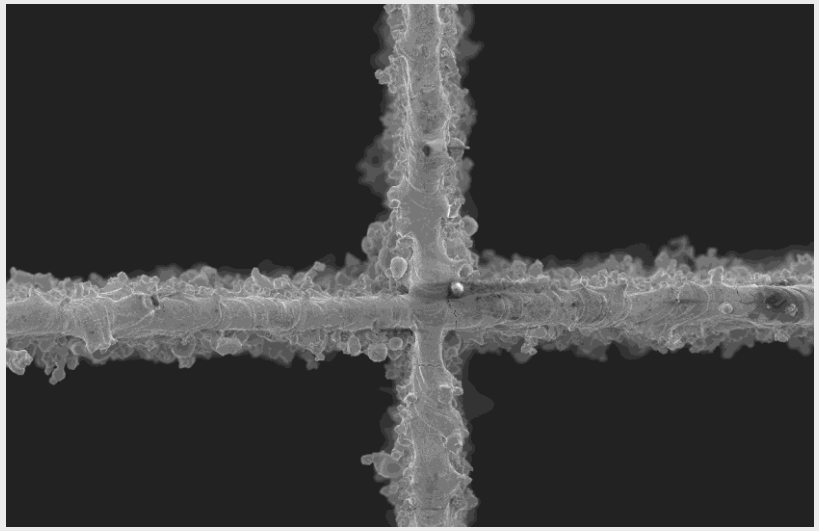


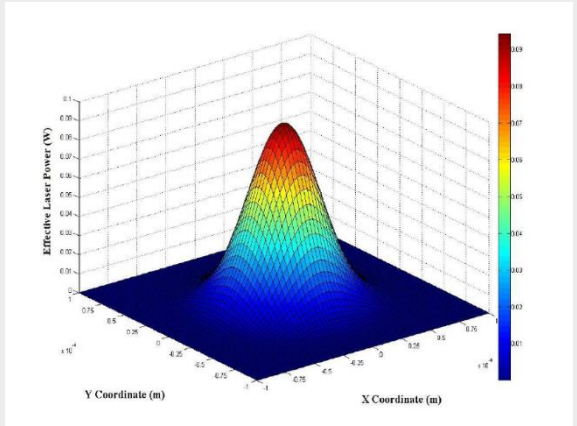
Schematic side view of ASG being skimmed and separated from its strip by EDM

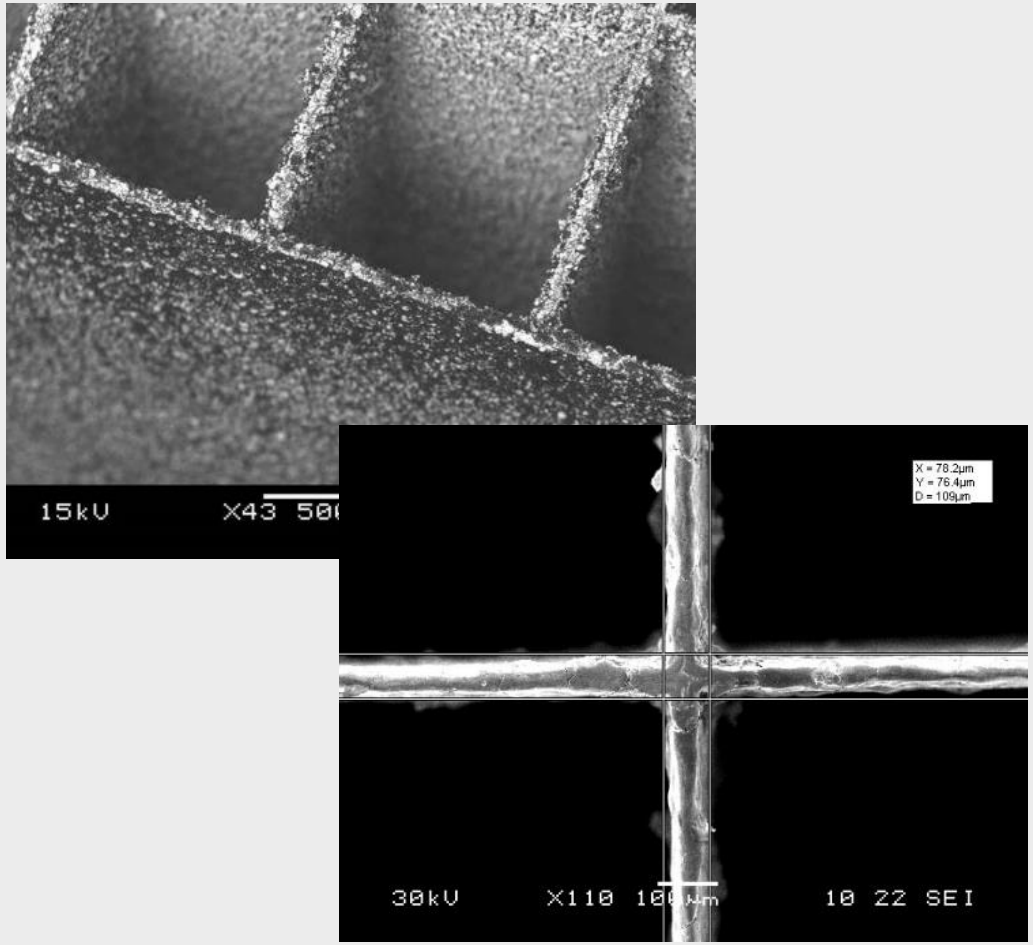
[Left image courtesy: https://www.manufacturingguide.com/en/wire-edm]

AM production

Additional treatments for highest surface accuracy







AM production

Quality – Measurements and evaluation

Rigorous quality control:

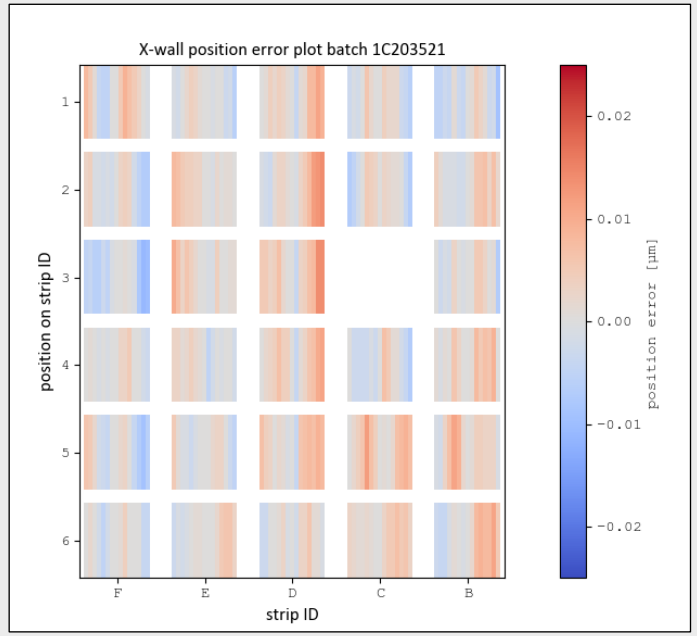
- 100% quality control: e.g. dimensions

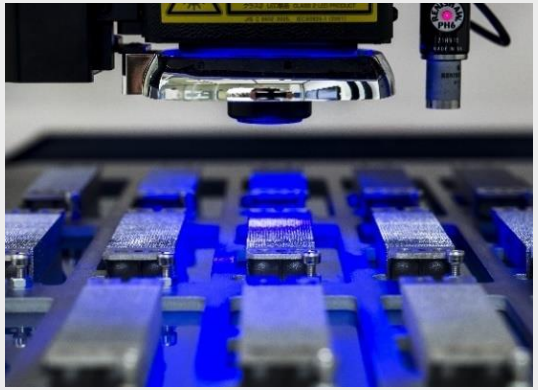
Certified:

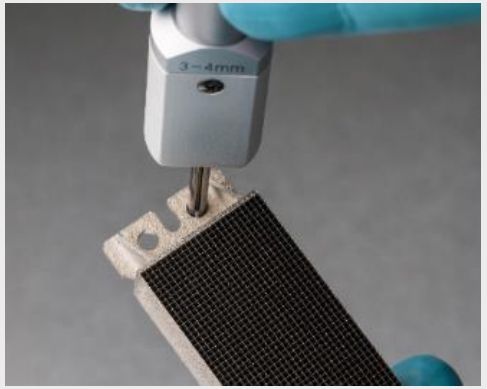
- ISO 13485 certified (certification for medical procedures)

Recycling and low environmental impact:

- Rejected parts recycled







Marketing Campaigns

Content Strategy

1 Medical Expertise

We create custom designs that are not universally applicable under highest quality standards. We are focusing on medical ASGs.

2 Non-medical applications

Our experience with this metal is guaranteeing us new customers in new sectors – semiconductors, fusion…

3 Advocate Innovation

Expand expertise to other industries
Fusion: together with the complexity of shape in this, tungsten - with the highest melting point of all the metals - has been chosen as the armor material to be a key part of the fusion technology

4 Encourage Research Collaboration

Encourage research collaborations on tungsten parts and use the content of white papers and openness to collaboration in communication. Target KoLs and universities and support them in their research by providing latest technology

Thank you for your attention

Nicola Carbone –
Design for Additive&Manufacturing Engineer
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