Metal additive manufacturing applied to accelerators

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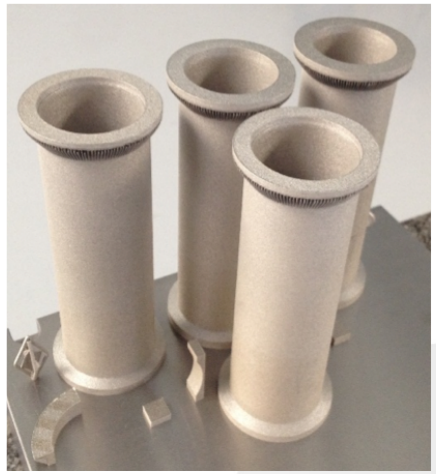
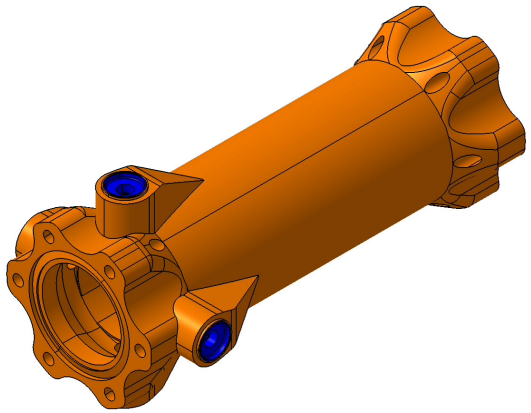
History





- IJCLab (LAL) has been a pioneer in the application of additive manufacturing to accelerators (AM)
- Demonstration of UHV compatibility
- Demonstration of an accelerator component (BPM)

Next step: High power RF

- High power Radio frequency components are among the most challenging (mechanically) in accelerator.
- Can we use AM to build RF components?
- Several challenges to solve:
  - Surface quality
  - Effect of high power on material
  - Material conductivity
  - …
- But possible advantages:
  - Better cooling
  - Manufacturing of difficult shapes…

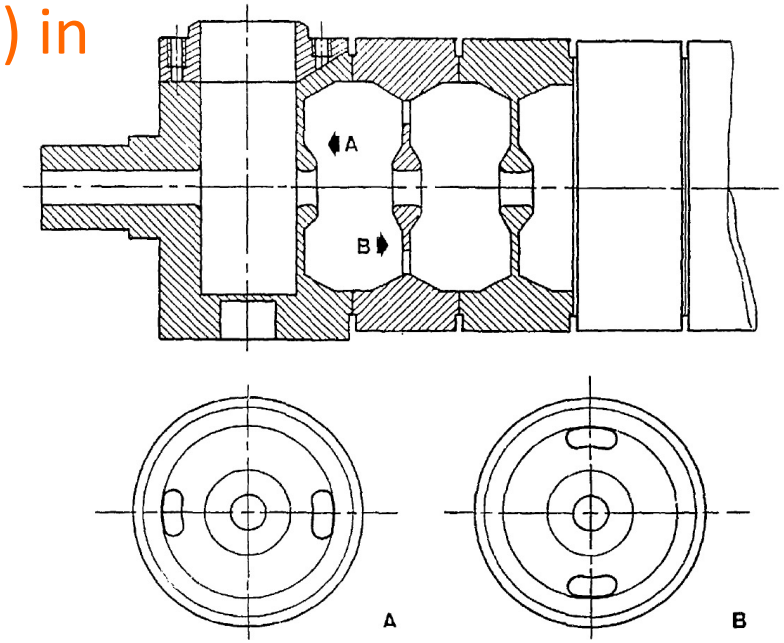


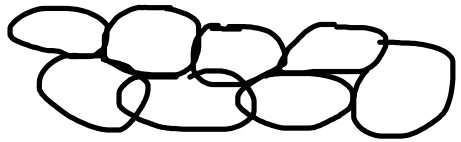
FIG.V.2 Géométrie de l'entrée de la section accélératrice

Source: Pascal Giraud's thesis 1984

Defects in AM surfaces

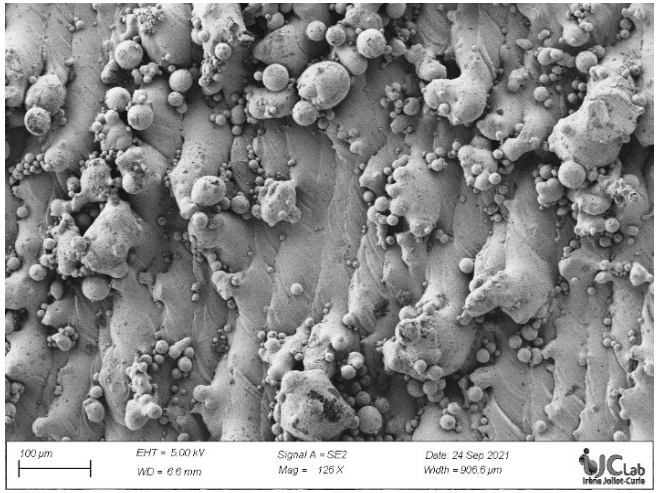
In traditional manufacturing metal are cut by sharp objects, hence the surface will have grooves due to the cutting process.

In additive manufacturing, objects are built by adding droplets of metals.

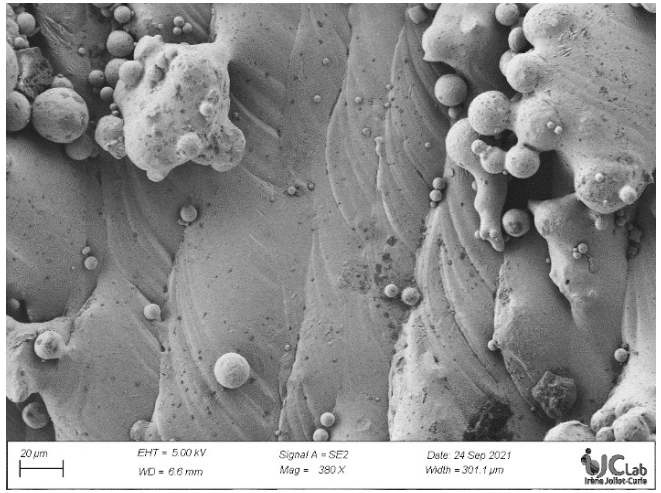


AM Copper samples

Picture by Quentin Ponchon



x 125

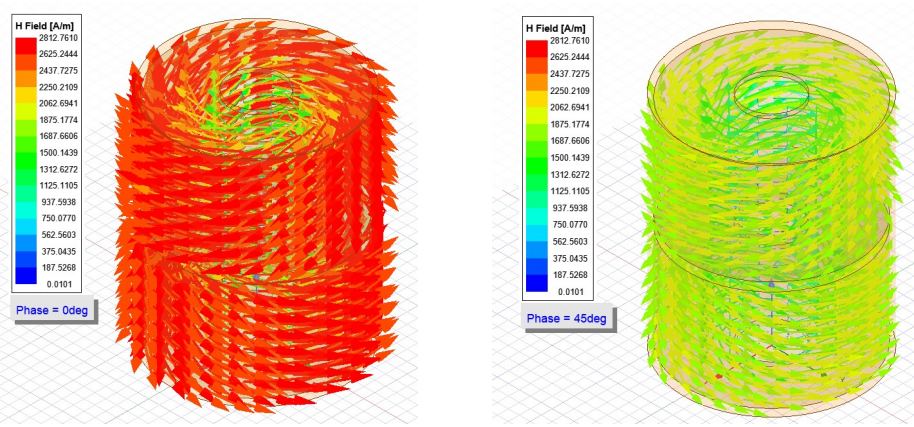


x 380

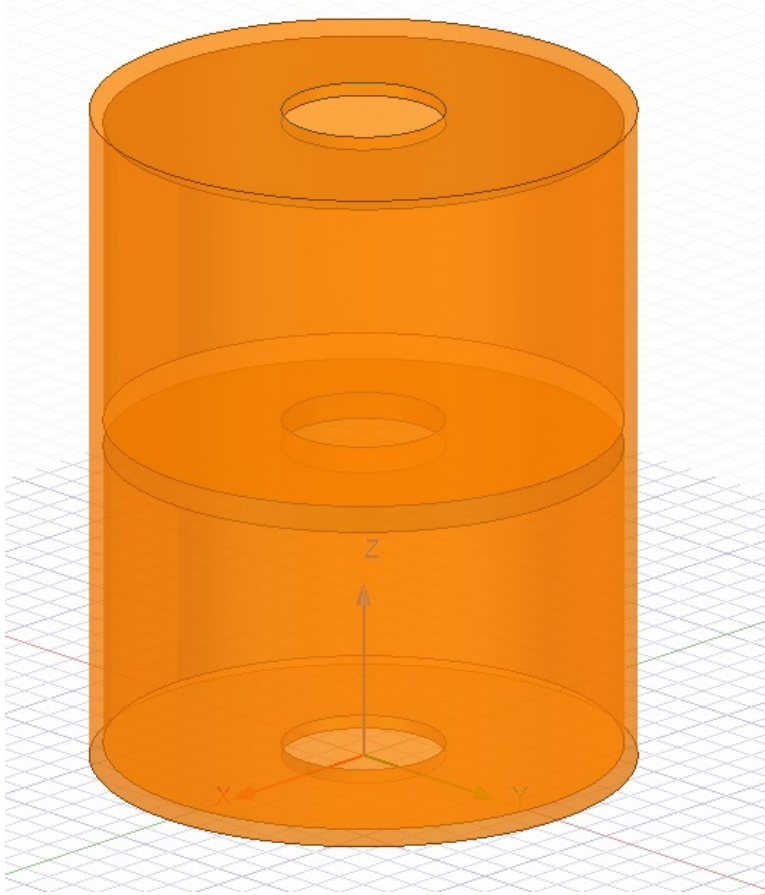
Very different from traditional manufacturing surfaces.

Work by Yevhenii Slaston

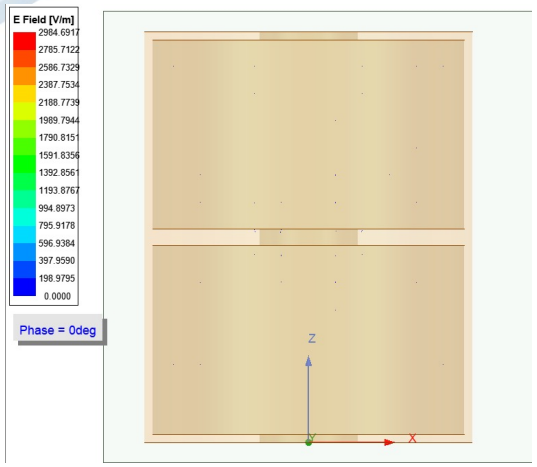
- Simulation of a double pillbox cavity
- Addition of defects to understand their impact.

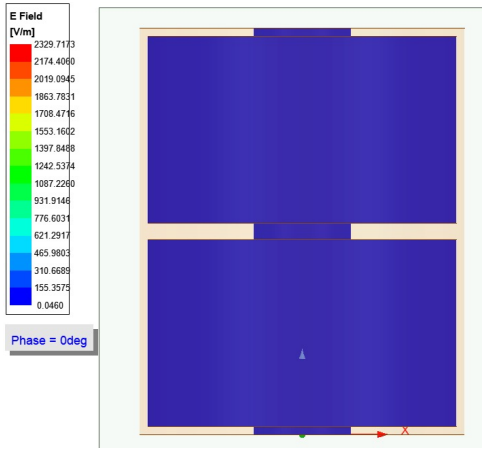


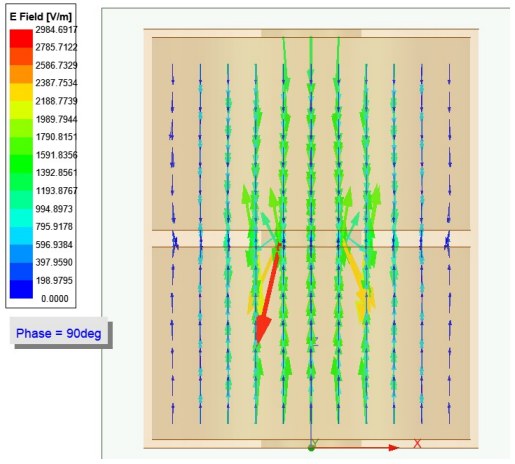
Magnetic field

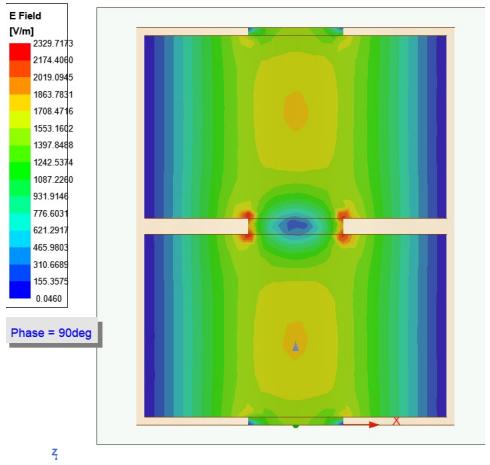


Simulations





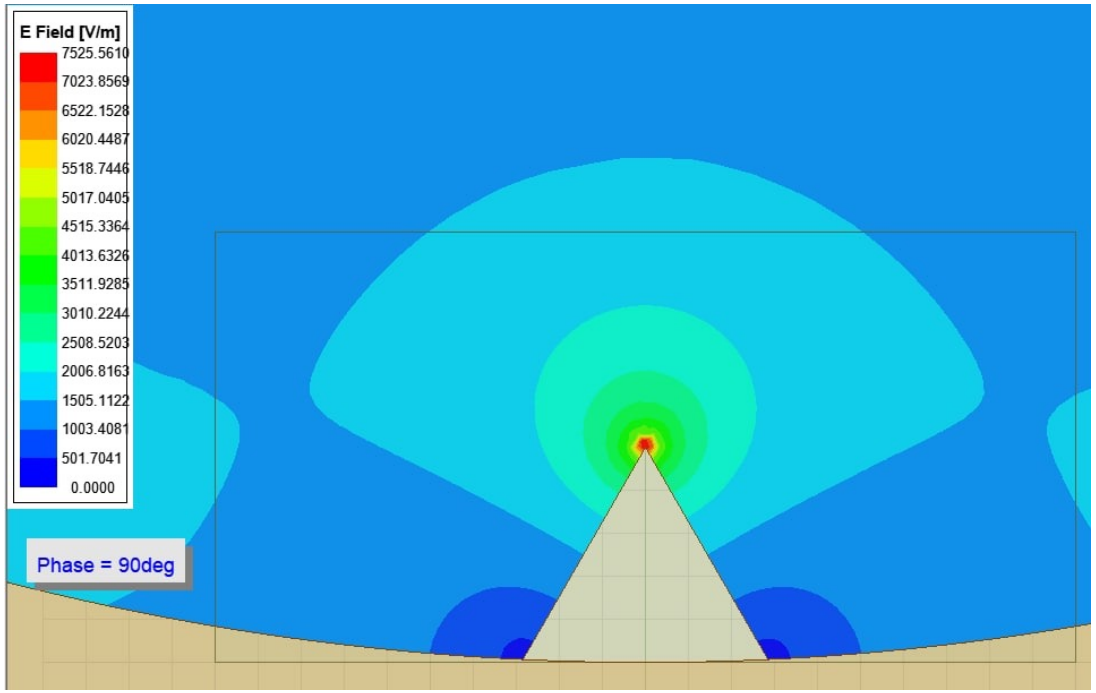




Work by
Yevhenii Slaston

Electric field

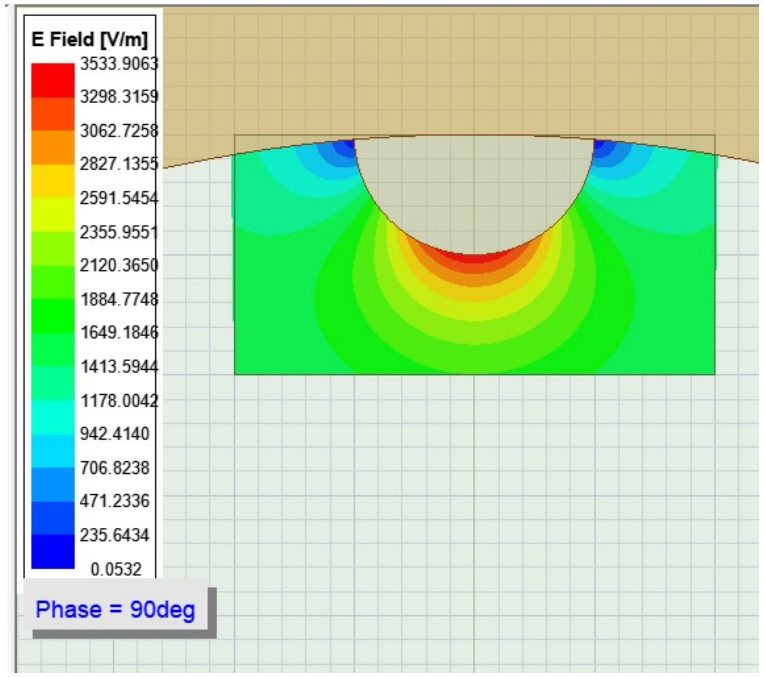
Simulations



Work by
Yevhenii Slaston

Electric field
on a sharp tip

Simulations



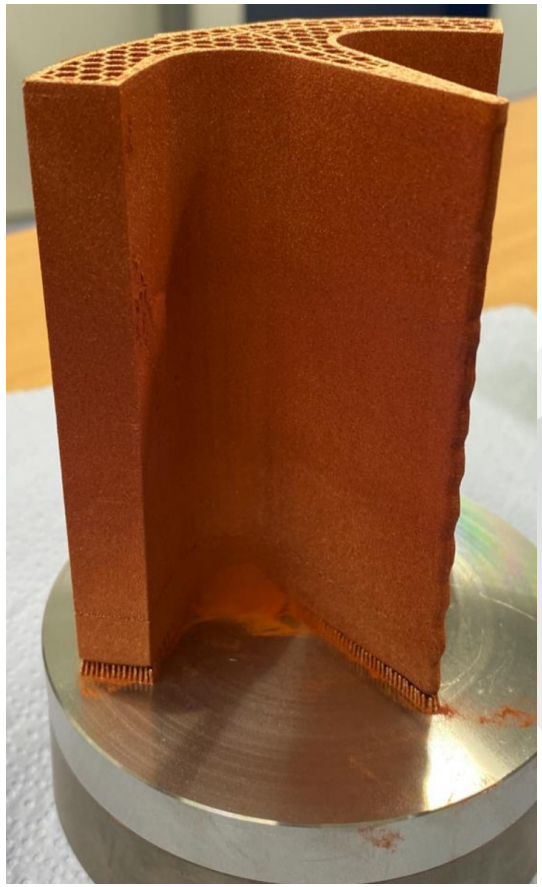
Work by
Yevhenii Slaston

Electric field
on a cylinder

Simulation results

- As expected, the smoother surfaces produced by AM should be less prone to EM breakdowns.
- However, postprocessing is very important.
- Next step: build a small test device (for example a thermionic electron gun).
- But: we are also part of the AM work package in the European project I.FAST.

AM made RFQ



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FIRST PROOF-OF-CONCEPT PROTOTYPE OF AN ADDITIVE-MANUFACTURED RADIO FREQUENCY QUADRUPOLE

- Impressive progress on the manufacturing of a RFQ.
- The project also involves work on other type of accelerator components such as accelerating cavittues.

Outlook

- Additive manufacturing has the potential to improve accelerators components.
- UHV compatibility and mechanical suitability have already been demonstrated.
- One of the next step is to demonstrate the feasability of high power RF structures.
- Several groups are working on this.
- Thanks to Stéphane Jenzer, Quentin Ponchon, Yevhenii Slaston, Emma Toffin,…