USACH

Enabling Low Cost SiC Boule Fabrication – Lower Cost/Wafer

Thursday, April 18, 2024

Agenda

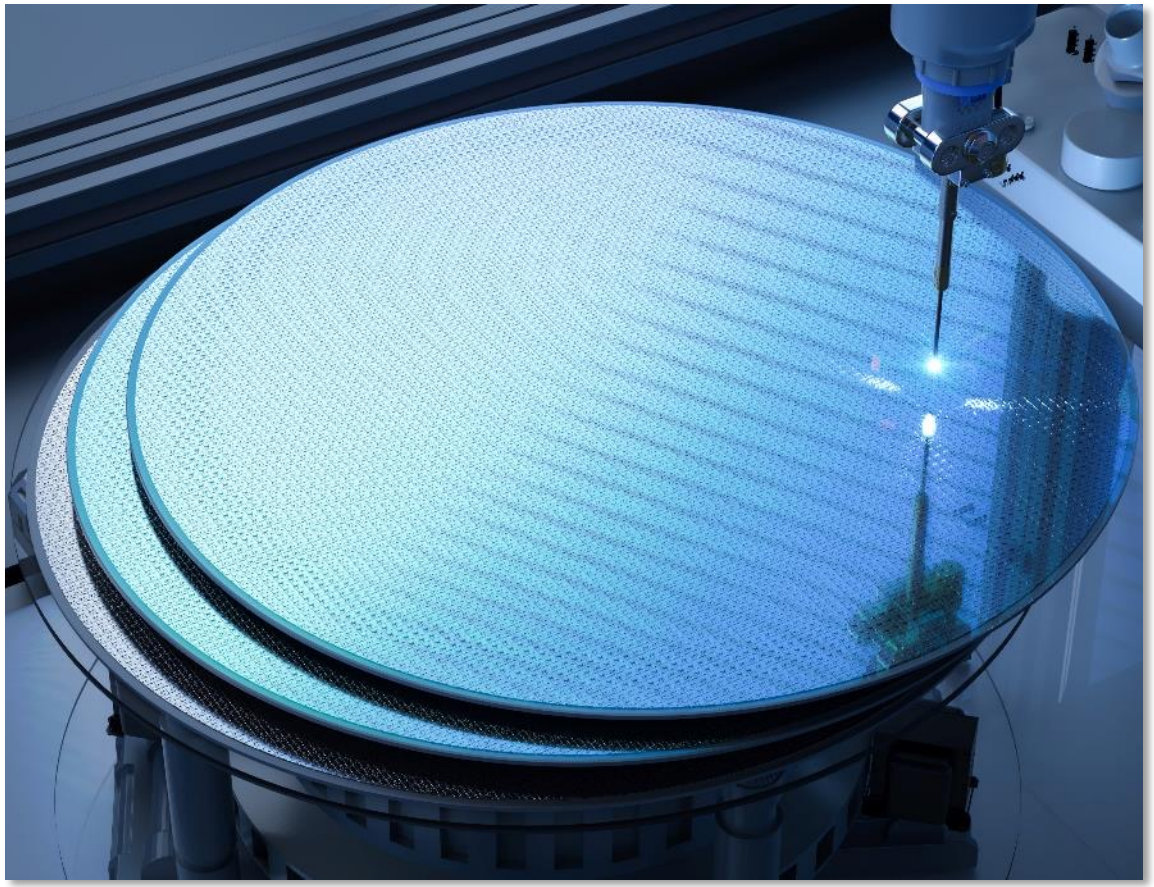
- Who is USACH?
- Semiconductor experience
- Entry into SiC space
- BoulePro 200AX update
  - Technical
  - Commercial
- Pro Series machines
  - Custom solutions
  - Capabilities

Who is USACH?

Part of the Hardinge family of brands with a long history of supplying custom machining solutions to the semiconductor space

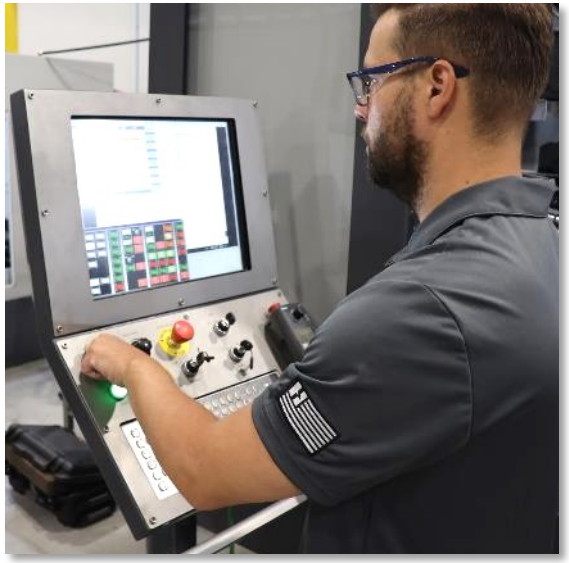
Semiconductor Experience

- For the last decade, USACH has supplied several fully automated solutions into the silicon wafer processing space, specifically an assortment of spare parts made from materials such as silicon, alumina and silicon carbide for semiconductor processing chambers.
- USACH has provided nearly 100 of these machining solutions with full automation from raw part storage to machine center to ultrasonic cleaning stations to final part storage and transfer.
- Familiar with semiconductor supply chain requirements, semi standards, and communication protocols such as SECS/GEM.



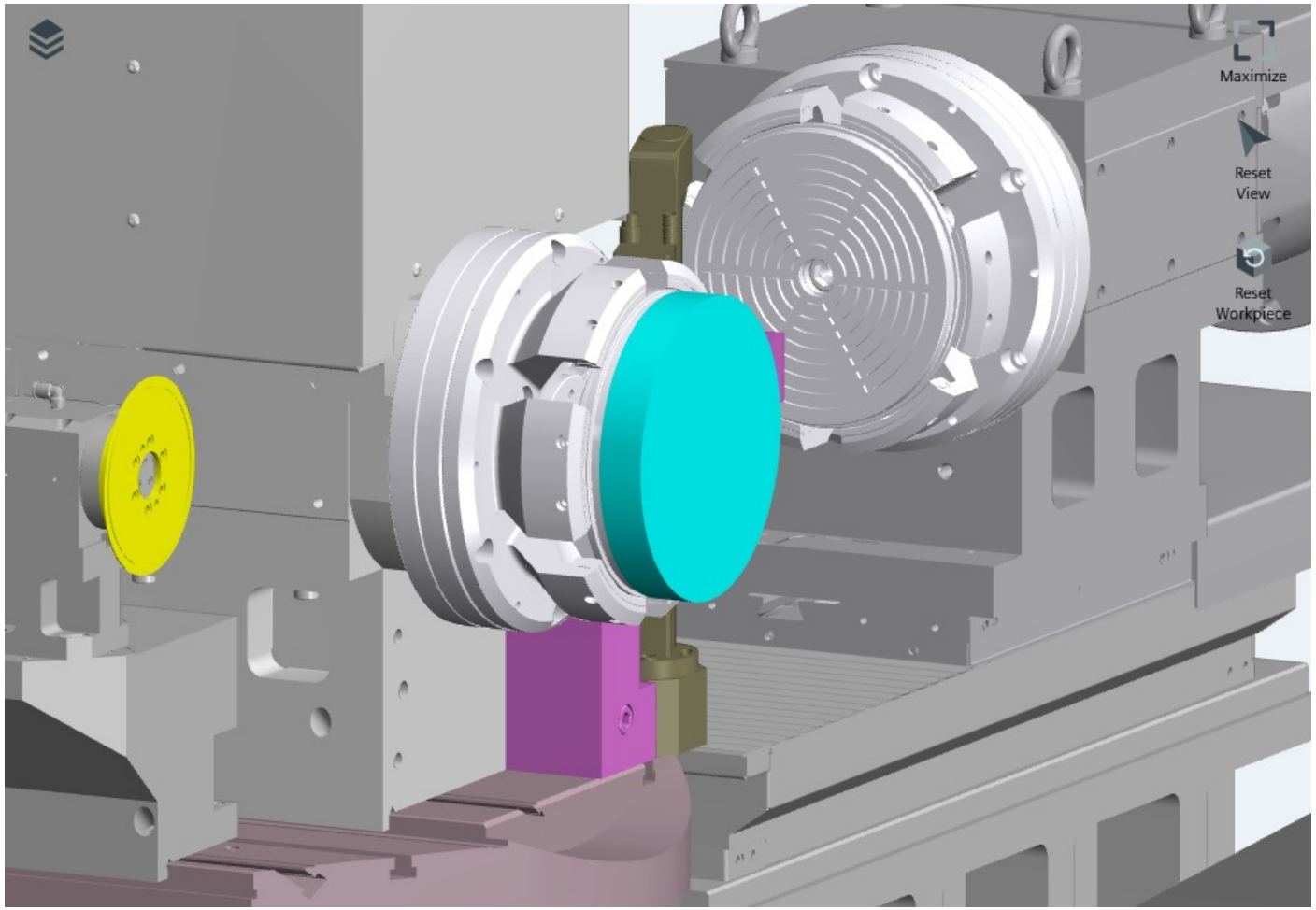
Entry into SiC Space

- Experience supplying the semiconductor industry machining solutions
- Several levels of management, engineering, and sales coming from a SiC substrate manufacturer (GT Advanced Technologies acquired by onsemi in 2021)
- Understand the challenge associated with machining as grown SiC boules to wafer-ready pucks
- USACH / Hardinge was in perfect position to create a solution for boule fabrication for the rapidly growing SiC market.



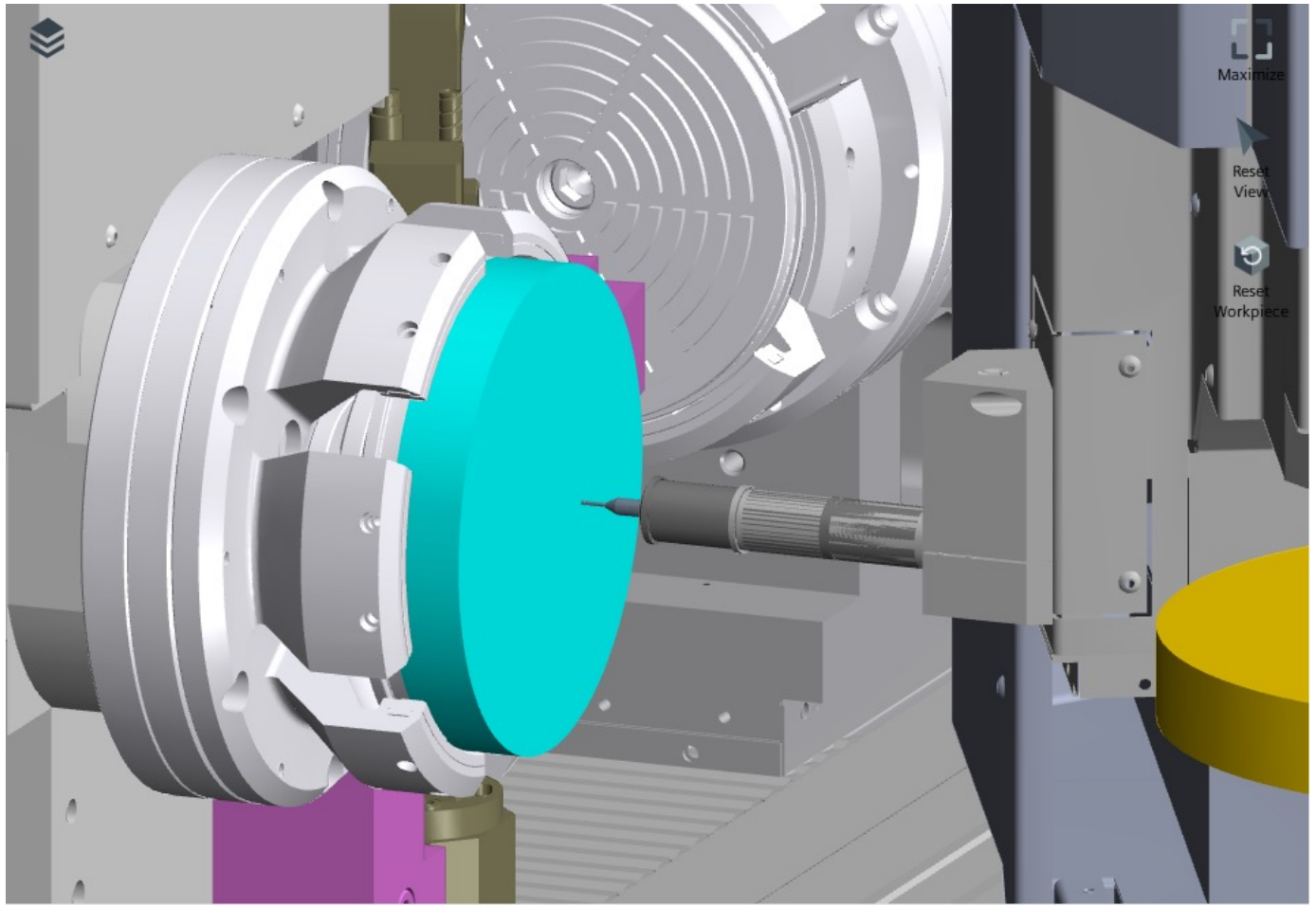
BoulePro 200AX Update - Technical

Process Flow – Part Loading on the Vacuum Plate



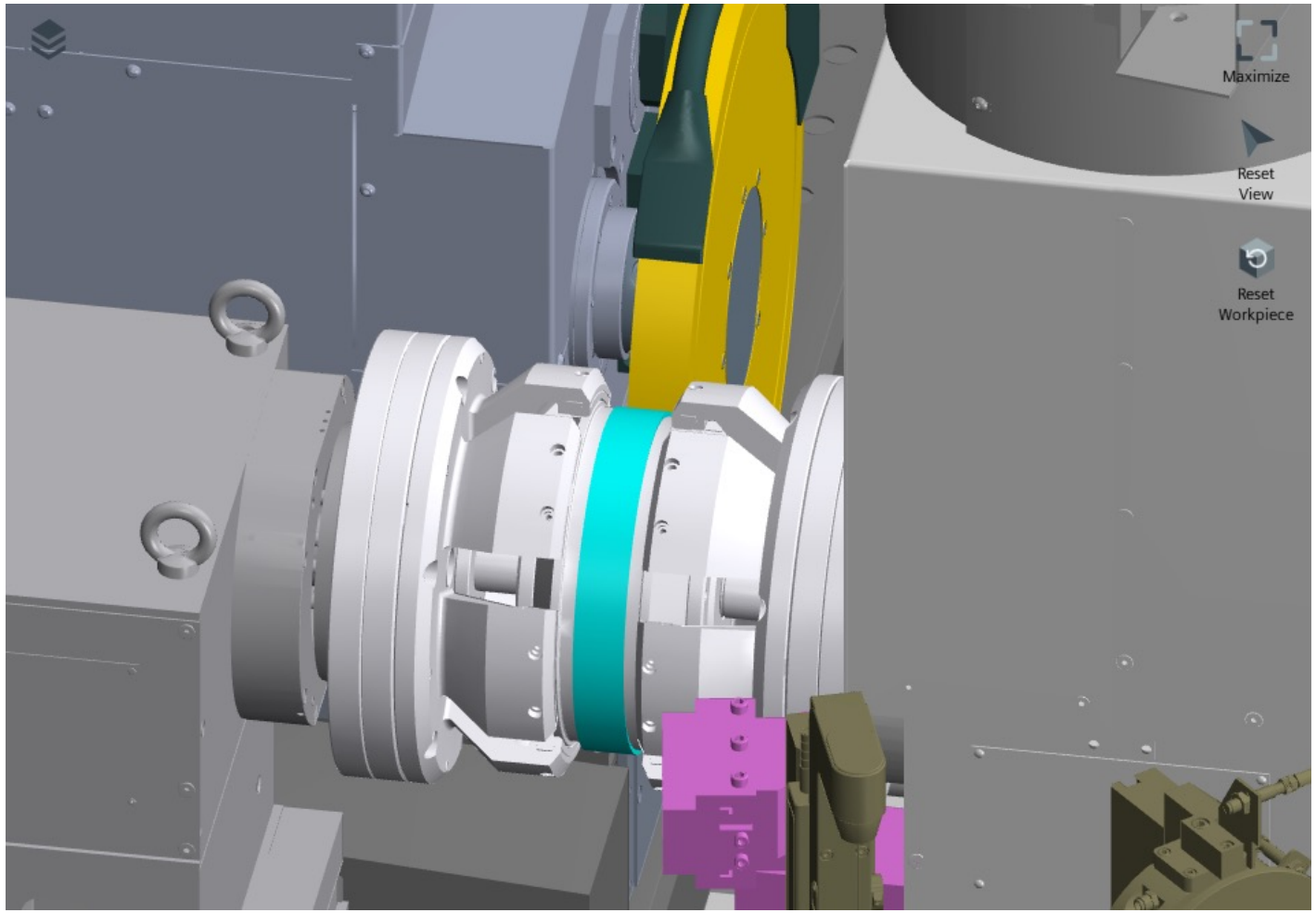
BoulePro 200AX Update - Technical

Process Flow – Part Probing / Dimensional Analysis



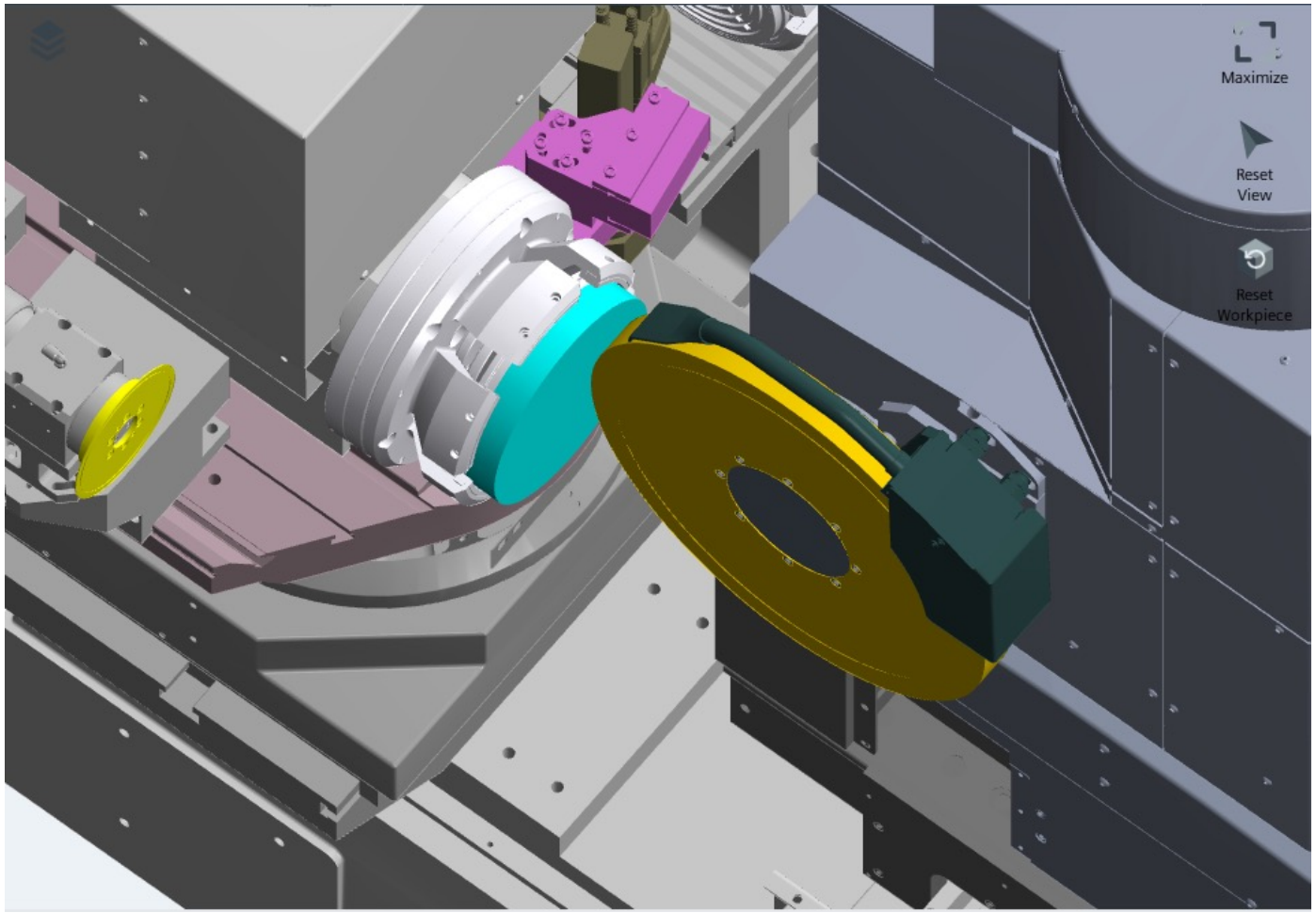
BoulePro 200AX Update - Technical

Process Flow – Part Pinched Between Centers / Initial OD Grind



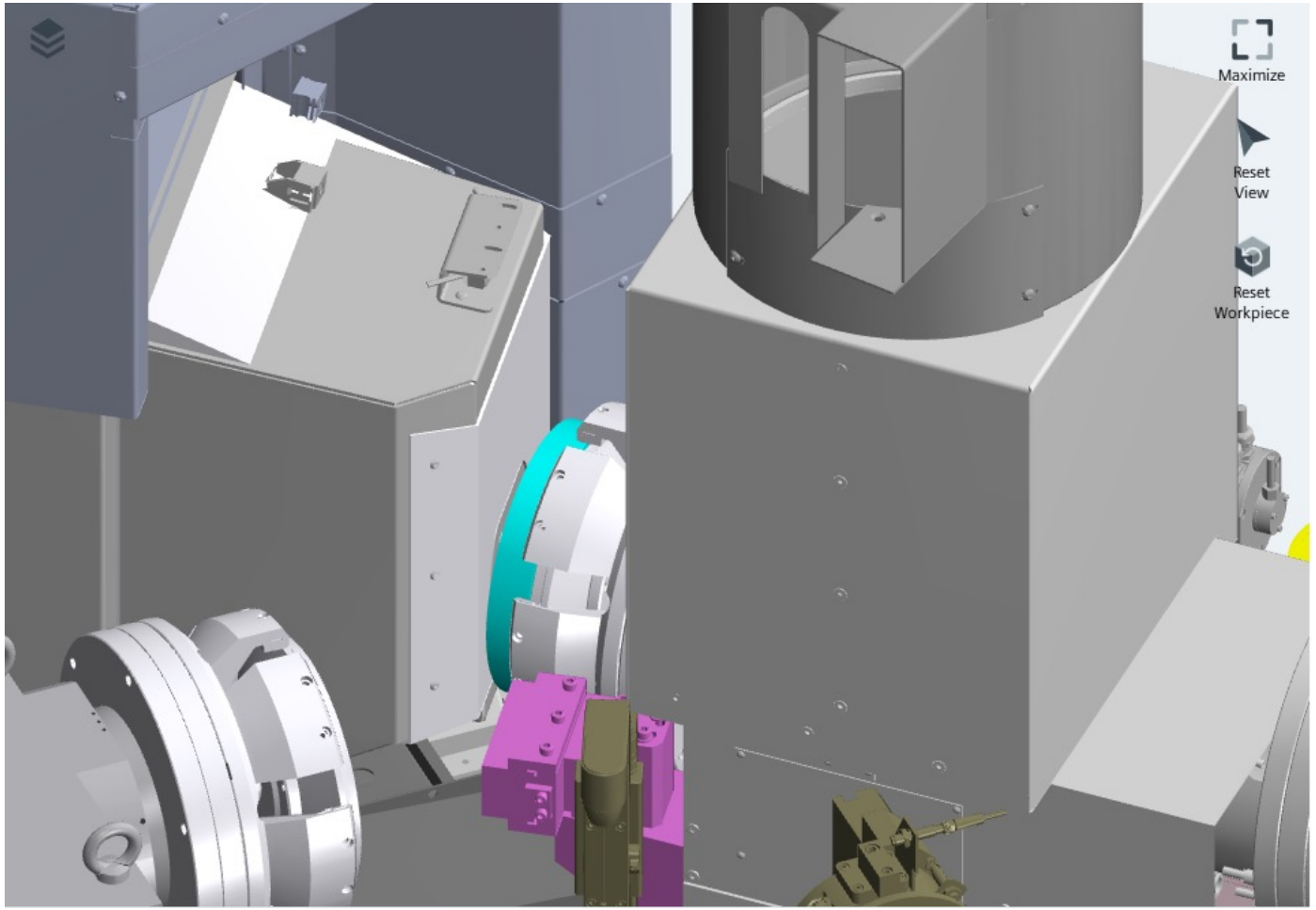
BoulePro 200AX Update - Technical

Process Flow – Initial Dome Grind, If Needed



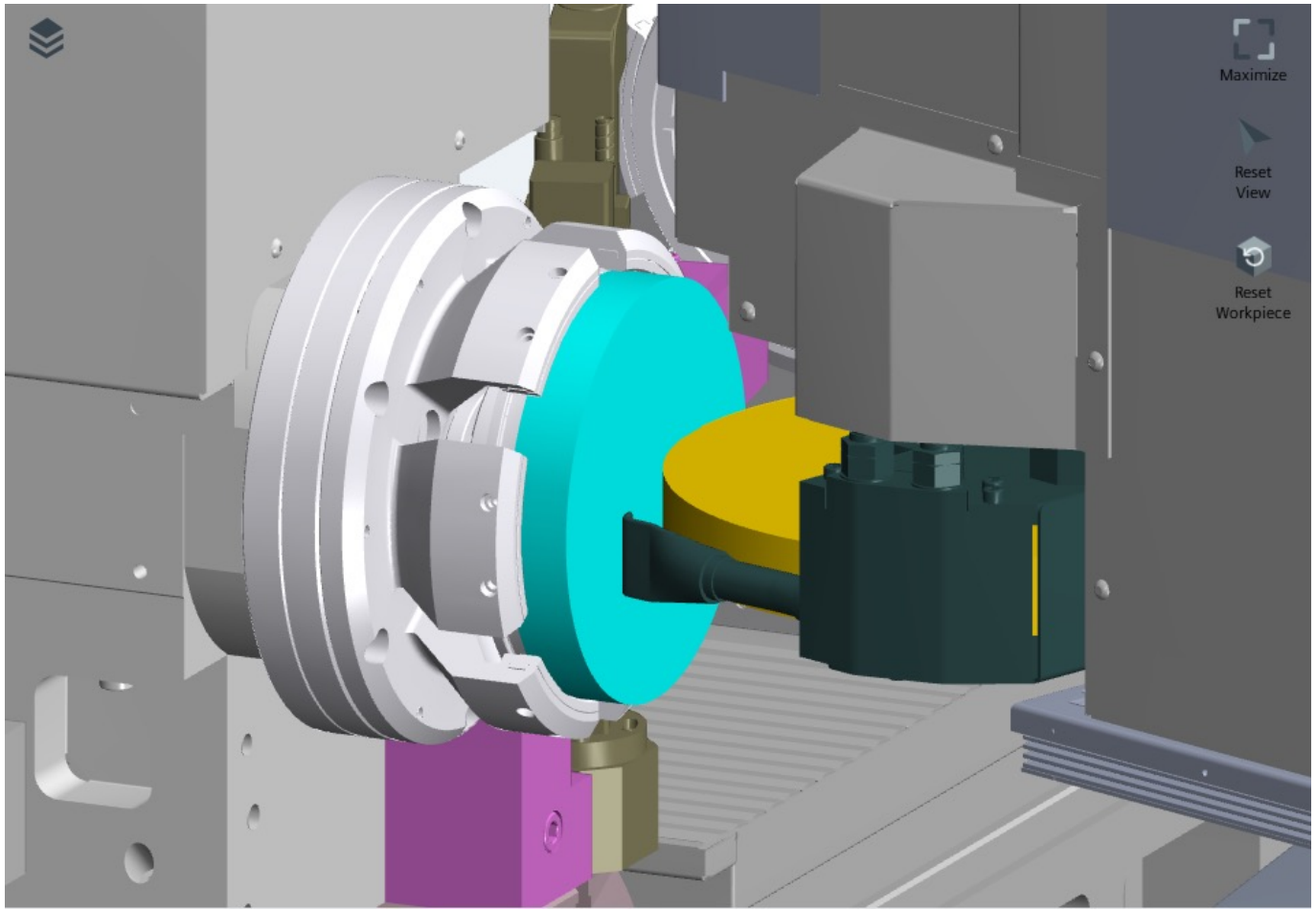
BoulePro 200AX Update - Technical

Process Flow – XRD to Determine Crystal Orientation



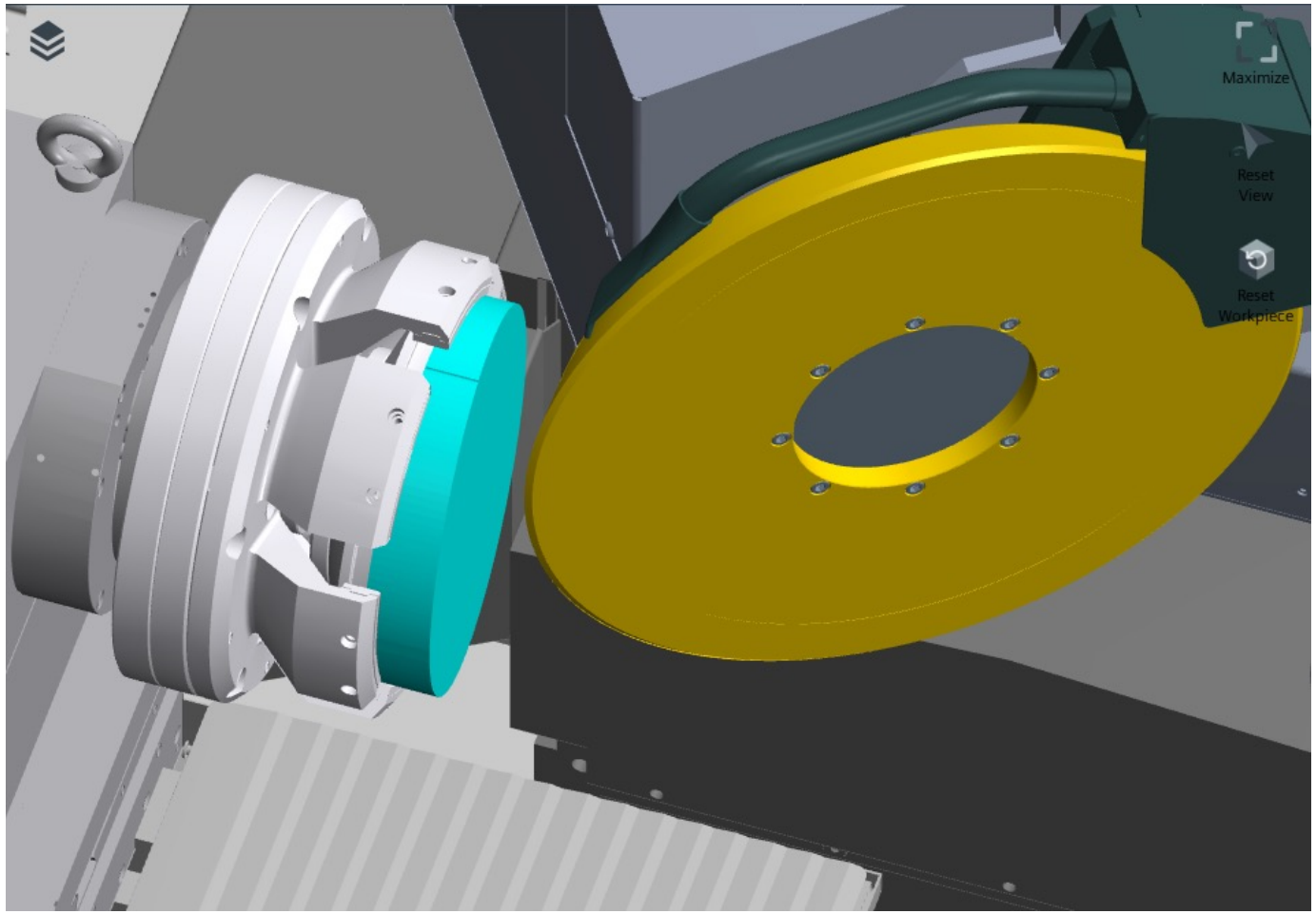
BoulePro 200AX Update - Technical

Process Flow – Surface Grinding to Correct Crystal Orientation



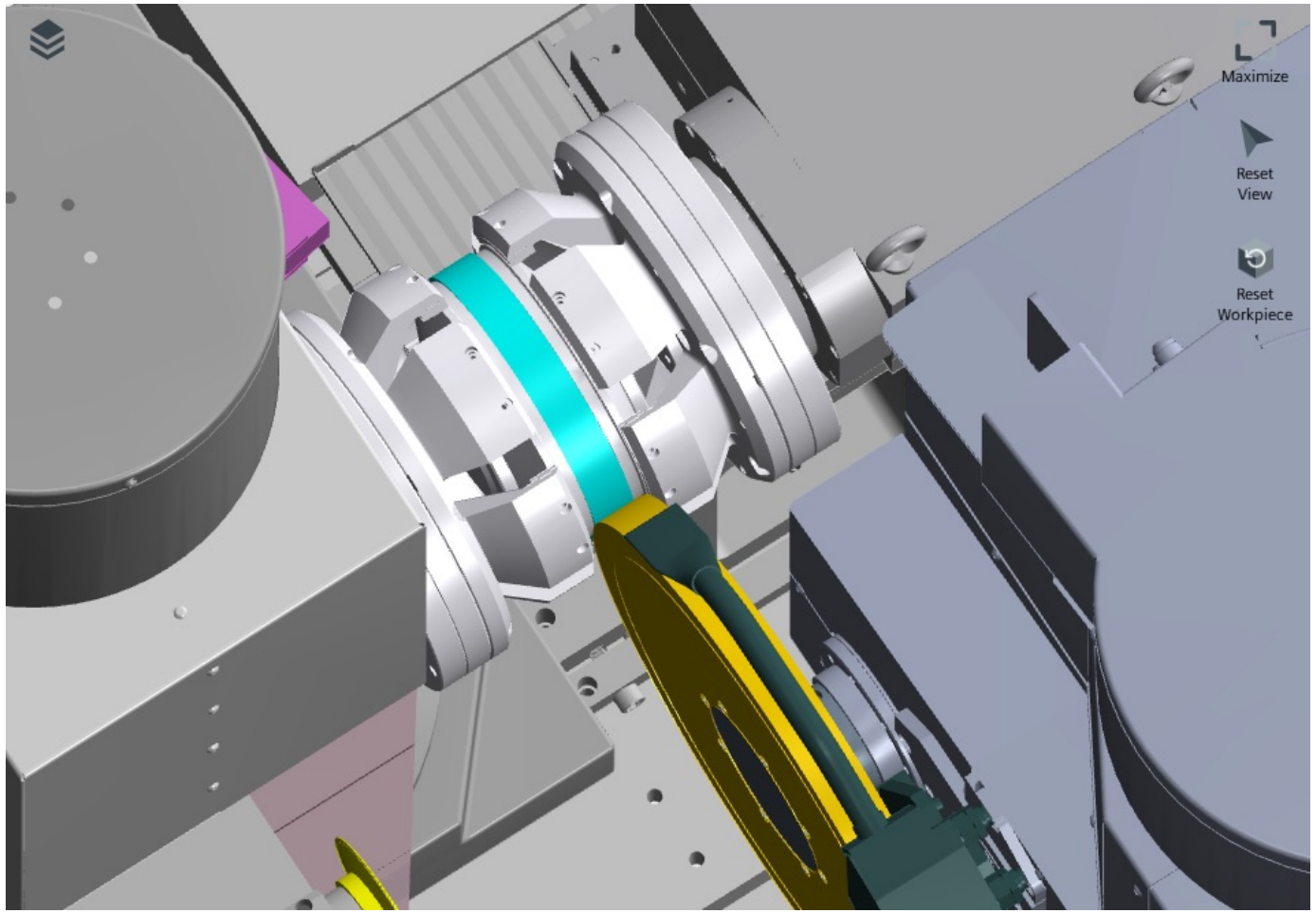
BoulePro 200AX Update - Technical

Process Flow – Part Transfer to C2 and Seed Side Rotary Grind



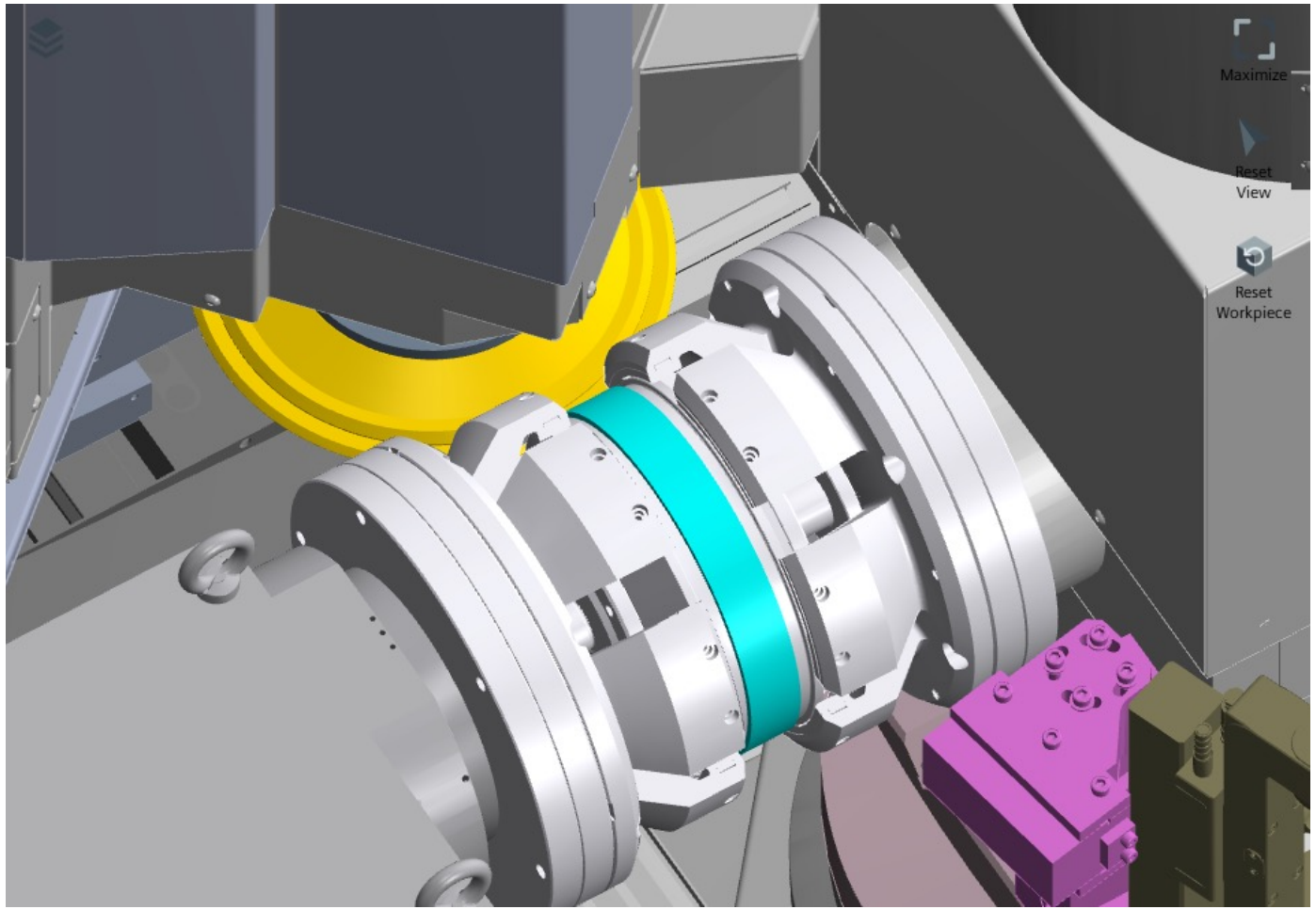
BoulePro 200AX Update - Technical

Process Flow – Finish OD Grind and Flat Grind for 150mm



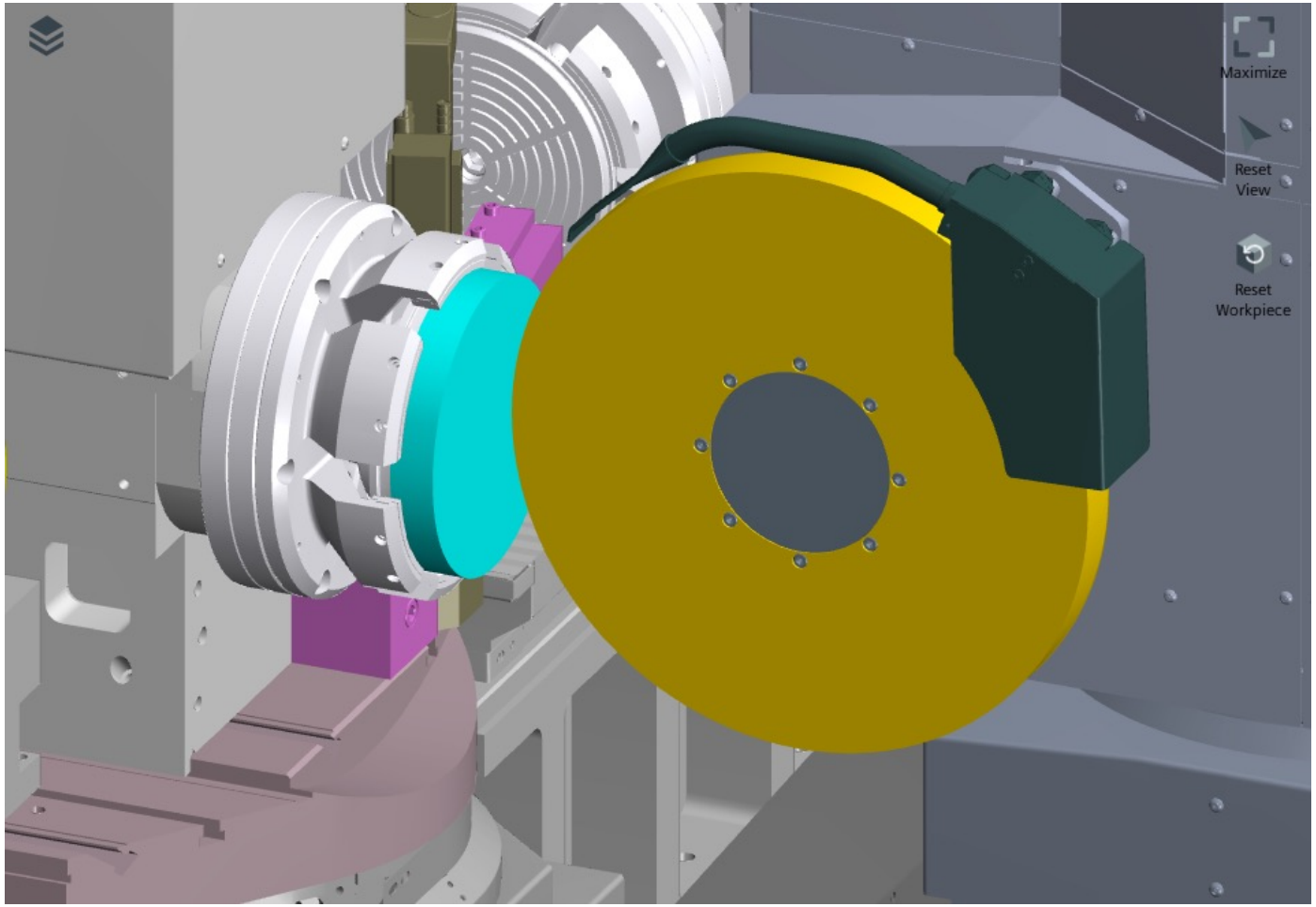
BoulePro 200AX Update - Technical

Process Flow – Finish OD Grind and Notch Grind for 200mm



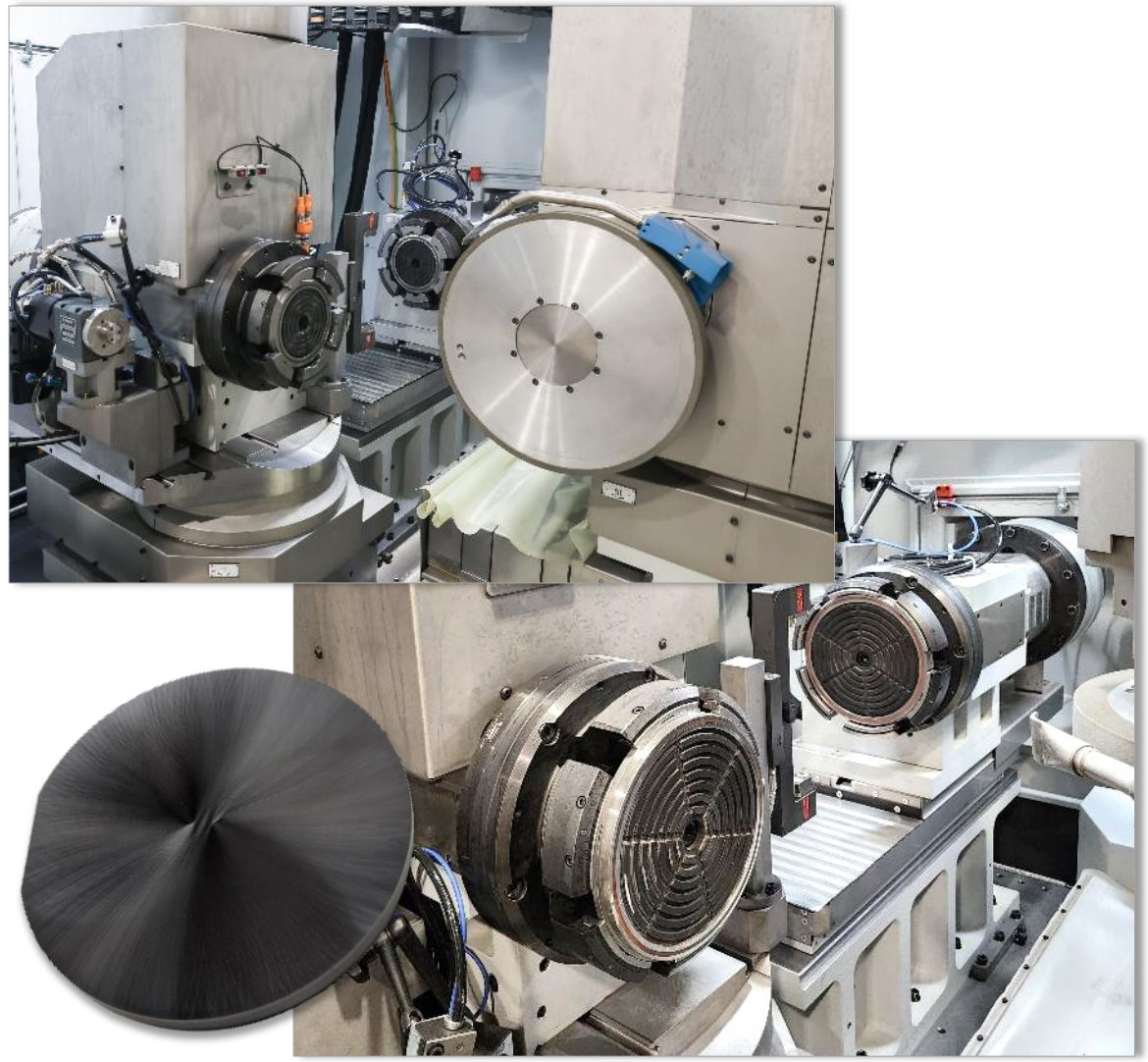
BoulePro 200AX Update - Technical

Process Flow – Additional Rotary Surface Grinding for Laser Wafering



BoulePro 200AX Update - Technical

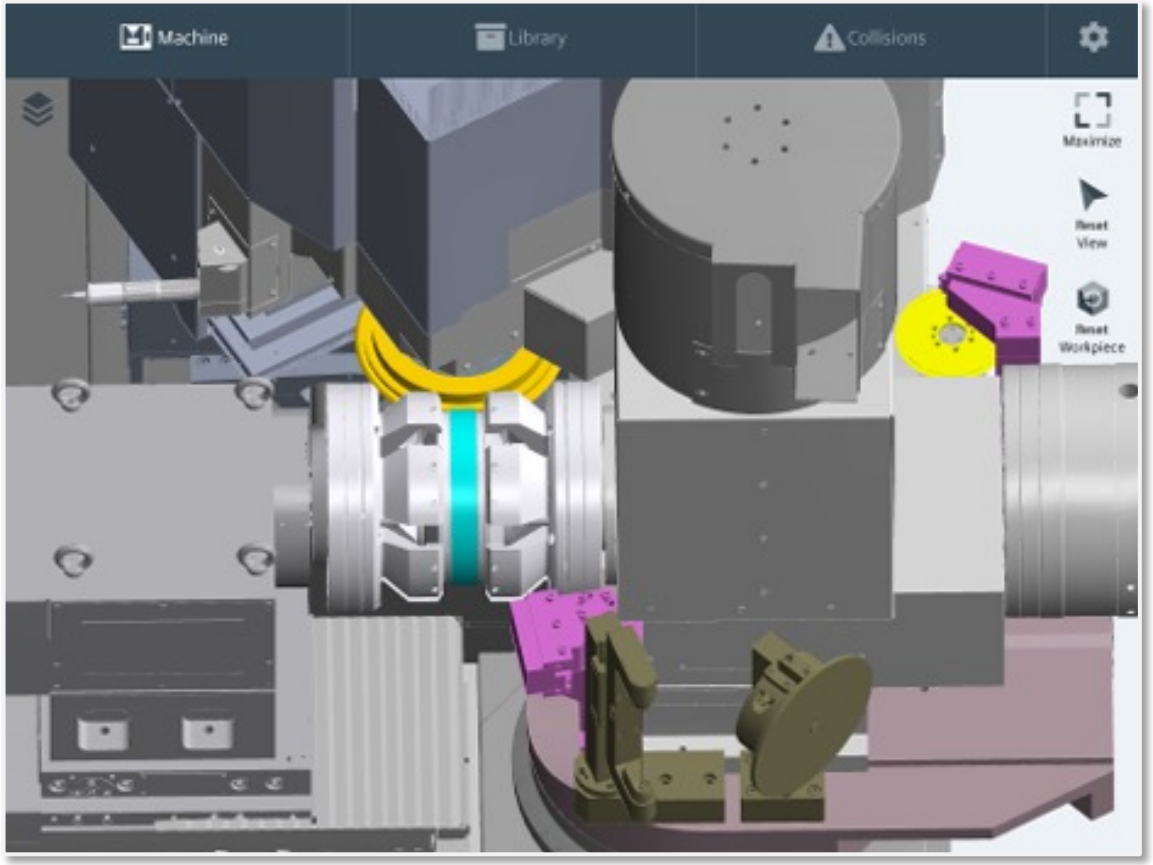
- 150mm Process
  - Fully developed and in use at customer sites currently
  - Feedback extremely positive
  - Wide range of crystal geometry and orientation corrections performed
- 200mm Process
  - Fully developed and FAT complete for first customer
  - Soon to ship to customer site for SAT



BoulePro 200AX Update - Technical

Digital Twin

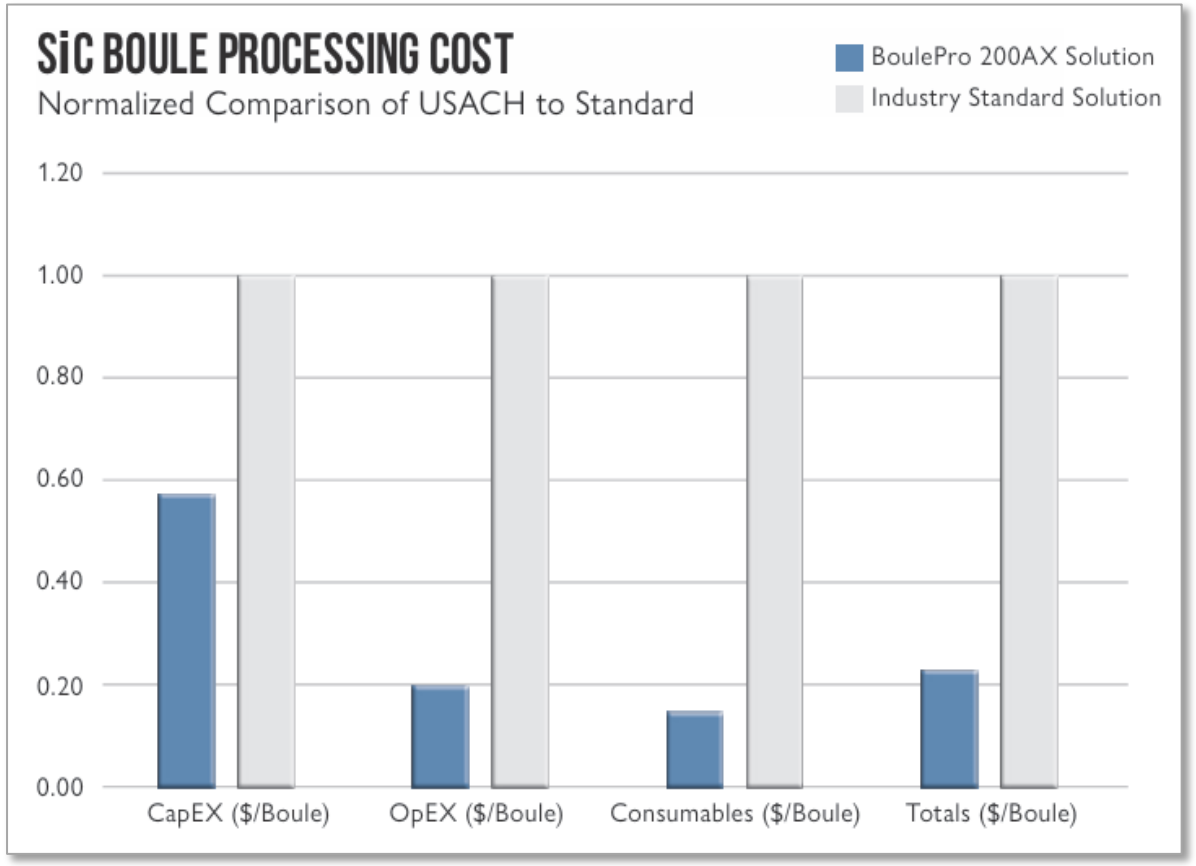
- Identical replica of the actual machine
- Time is 1:1 on digital twin and reality making this a useful tool for cycle time calculations for different geometry boules
- Proven to match real time on actual machine using customer feedback
- Available for customer to purchase module for machine to perform further fine tuning and development in house
- If dimensions are provided, we can run the digital twin per customer request



BoulePro 200AX Update - Technical

Advantages

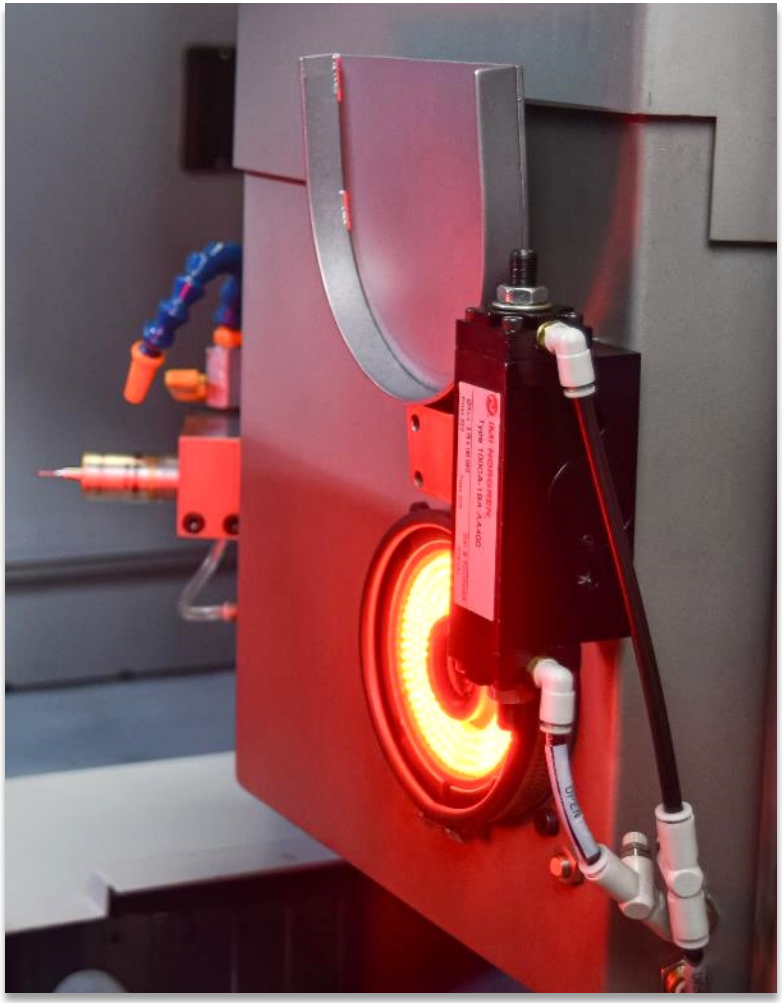
- 85% reduction in labor cost
- 80% reduction in manufacturing footprint
- One machine tool accomplishes all the required steps in a fully automated process that typically takes one – three hours
- Advanced degree of automation provides for improved process repeatability
- Total cost (CapEx, OpEx, consumables) reduction of nearly 80% compared to today's industry standard



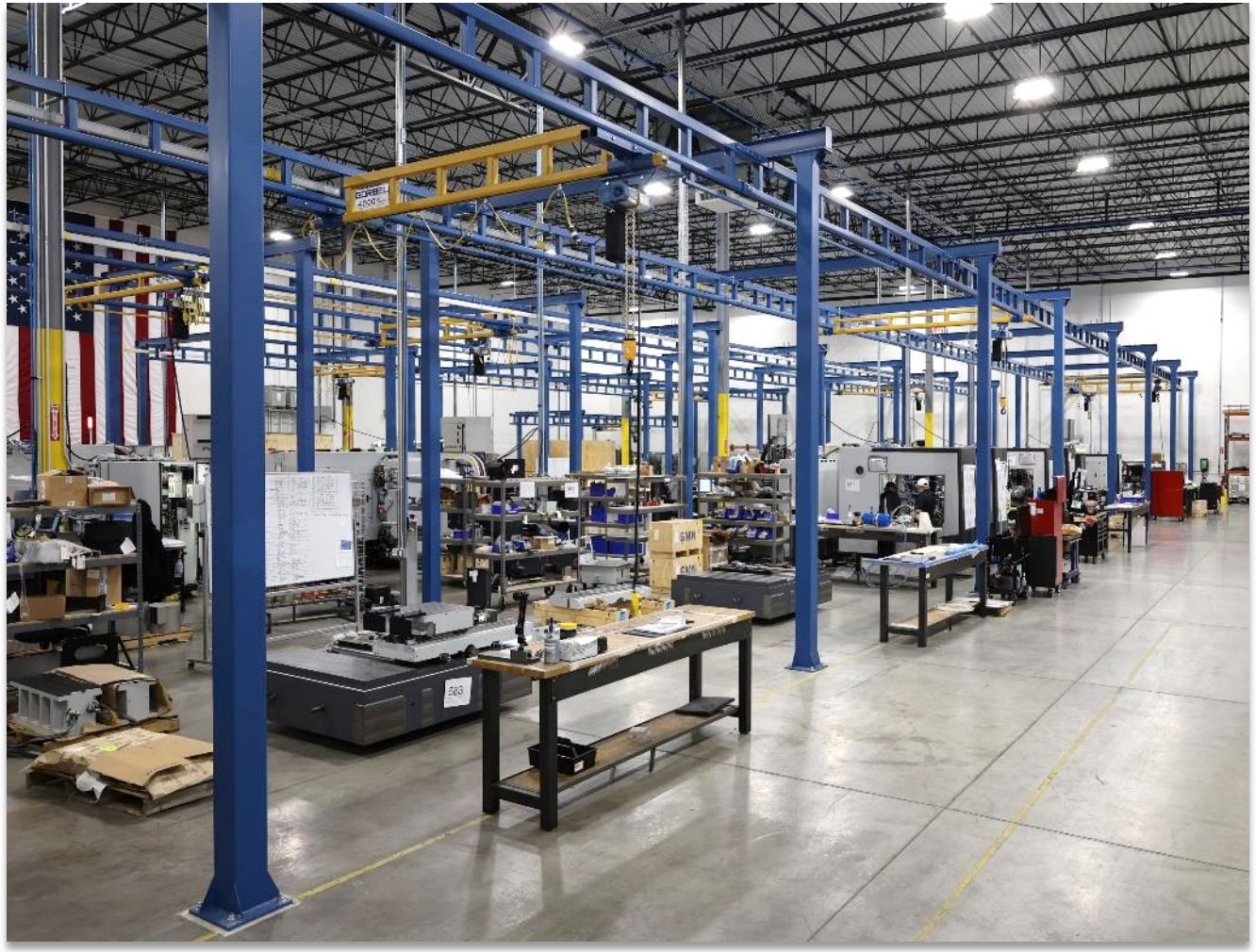
BoulePro 200AX Update - Technical

R&D Initiatives

- Working with two different types of as grown boule and/or puck level metrology to evaluate integrating quality analysis prior to grinding and/or prior to wafering respectively
- UV light detection: optional system in the BoulePro that is able to see foreign polytype and send back to the grinding process in order to completely remove that polytype to optimize the yield from the boule
- Vision system: optional system in the BoulePro that can capture photos and / or videos of the boule in any phase of the process - mature technology we have used in other semiconductor applications
- Laser scribing: optional system in the BoulePro that can apply a laser scribe to the finished puck for material tracking purposes



BoulePro 200AX Update - Commercial



Factory Upgrades

- Additional production space
  - 10K ft^2 dedicated space
  - 11 new production bays
- New demo/showroom
- Customer café
- Customer conference room
- ~$720K invested in upgrades

BoulePro 200AX Update - Commercial

- Several production units shipping continuously throughout this year as FAT's are completed
- 1 production unit ready in early May not being shipped until a later date and have customer permission to run demonstrations on this machine with other SiC producers
- 5 customers currently committed to demonstrations in May / June timeframe and are ready to support others in July / August
- Well positioned to support the growing SiC industry through cost down efforts and being an enabling technology for 200mm

Pro Series Machines

Custom solutions for all your semiconductor material needs

PRO SERIES MODELS INCLUDE:

USACH BOULE PRO 200AX

The USACH BoulePro 200AX is your choice for the Silicon Carbide Semiconductor market

USACH SAPPH PRO

The USACH Sapph Pro is your choice for the Sapphire Materials market

USACH CER PRO

The USACH Cer Pro is your choice for the Ceramics market

USACH Si PRO

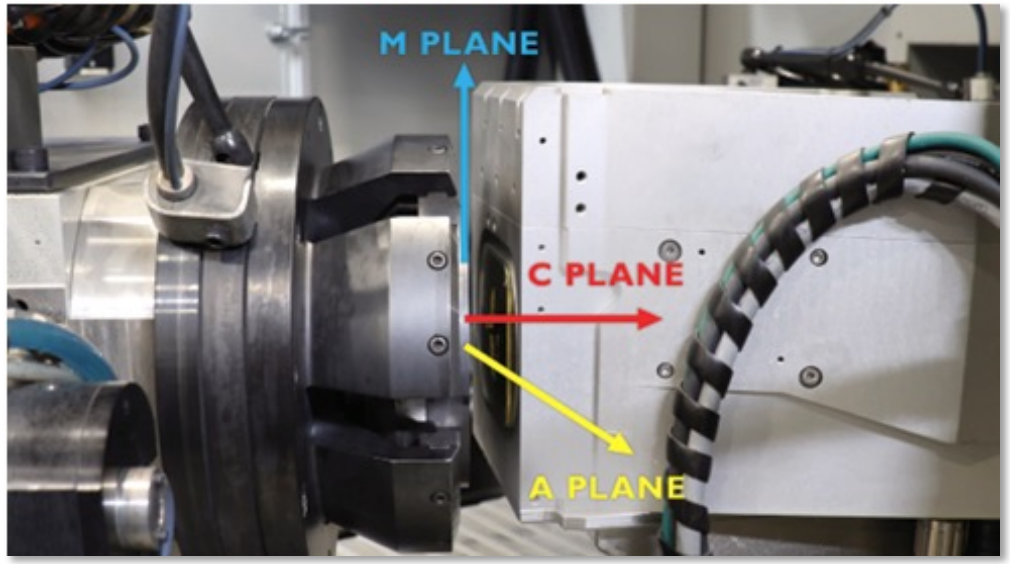
The USACH Si Pro is your choice for Silicon machining in the semiconductor & photovoltaic market

USACH BoulePro 200AX

Pro Series Machines

Custom solutions for all your semiconductor material needs

- Advantages:
  - Setup reduction
  - Labor reduction
  - Automation capability
  - Scrap elimination
  - Tooling reduction
  - TCO reduction
- Technology:
  - Vision systems
  - Metrology integration
  - Probing
  - Tool changers
  - 6-axis grinding
  - B-axes



Thank You