Gyrotron Technology, Inc.

Gyrotron Solar Processing Technologies

Confidential

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What is the Gyrotron Beam?

The Gyrotron Beam is a high-performance industrial heating source, far superior to Gas, Infrared, or Laser.

The Gyrotron heats …

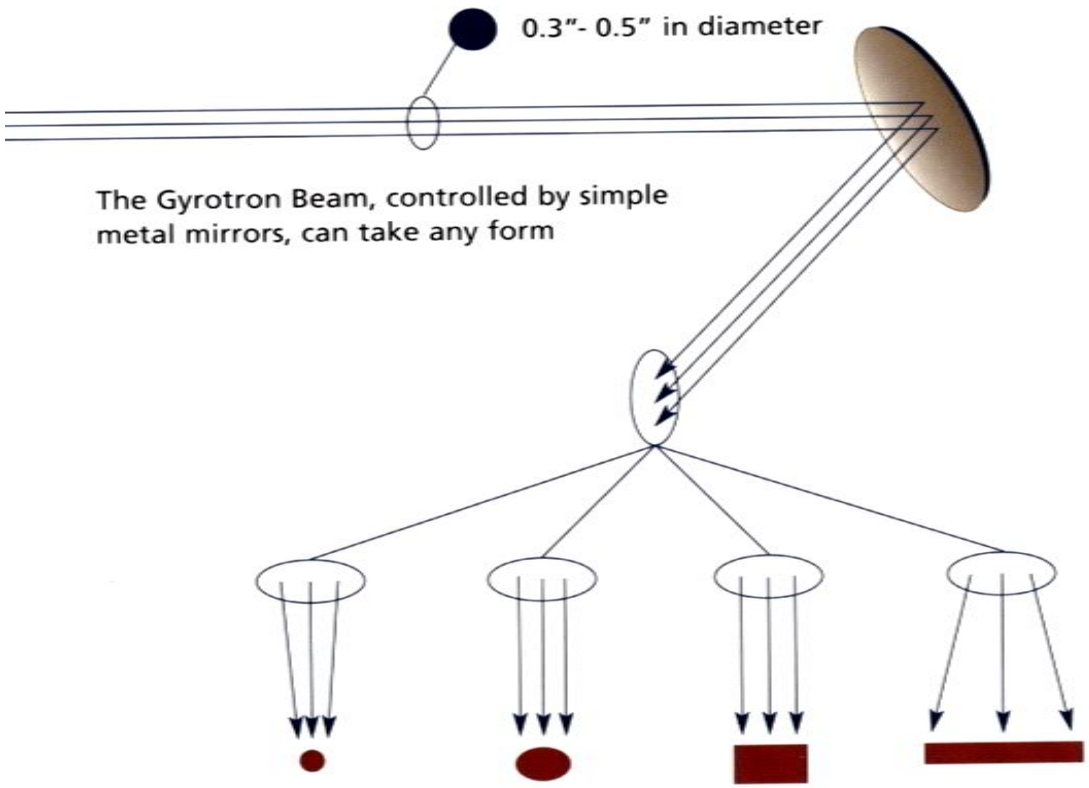
- **Large or small objects ultra rapidly, with a heating rate of thousands of degrees per second;**

- **To any temperature up to over 3,000^{0}C with high repeatability and accuracy of better than 1%;**

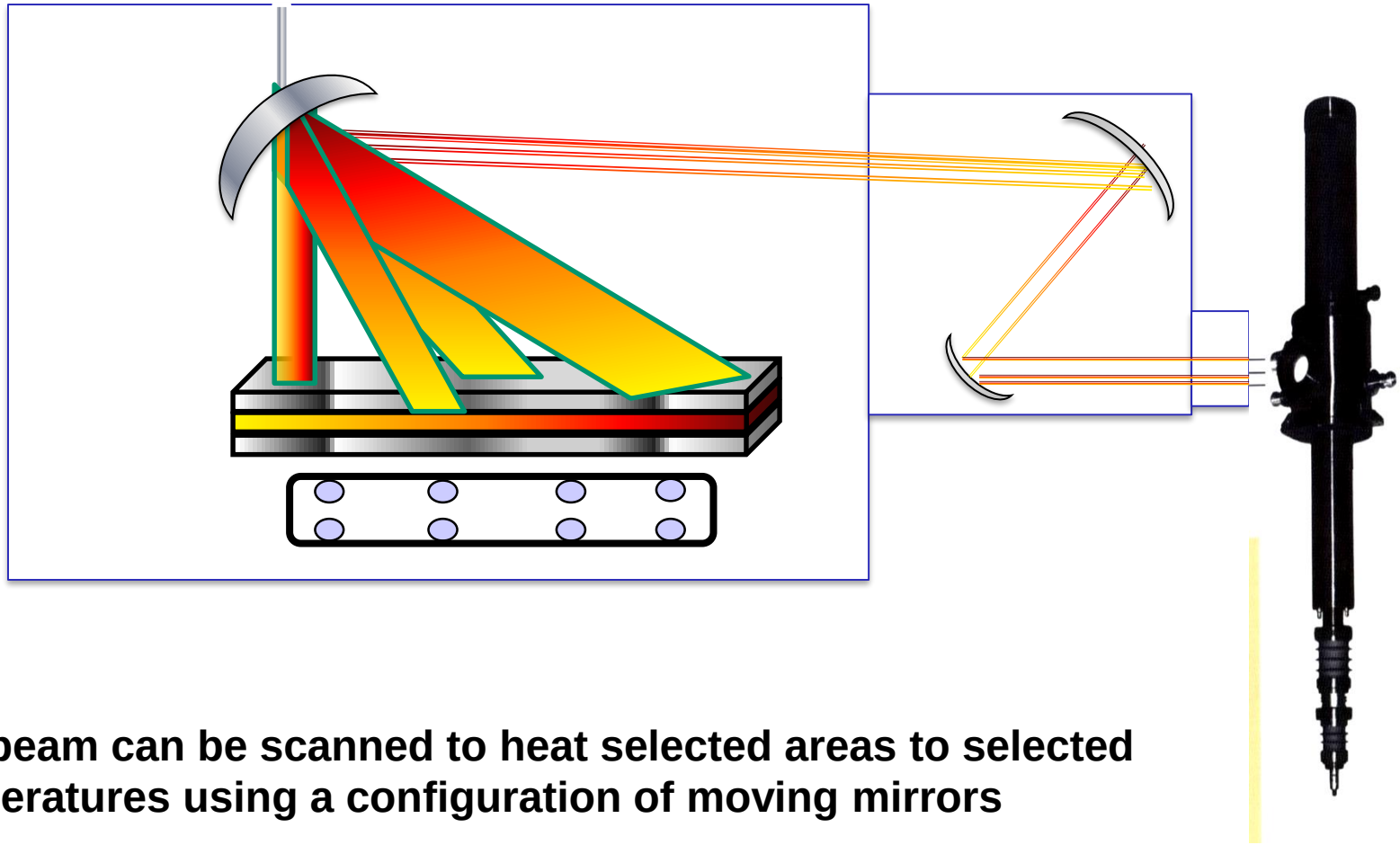
- **With precise and controllable temperature distribution.**

Gyrotron Beam Shape Can be Controlled

The bean can be shaped into any form – circular, strip, square, etc by using simple metal mirrors, greatly increasing processing possibilities

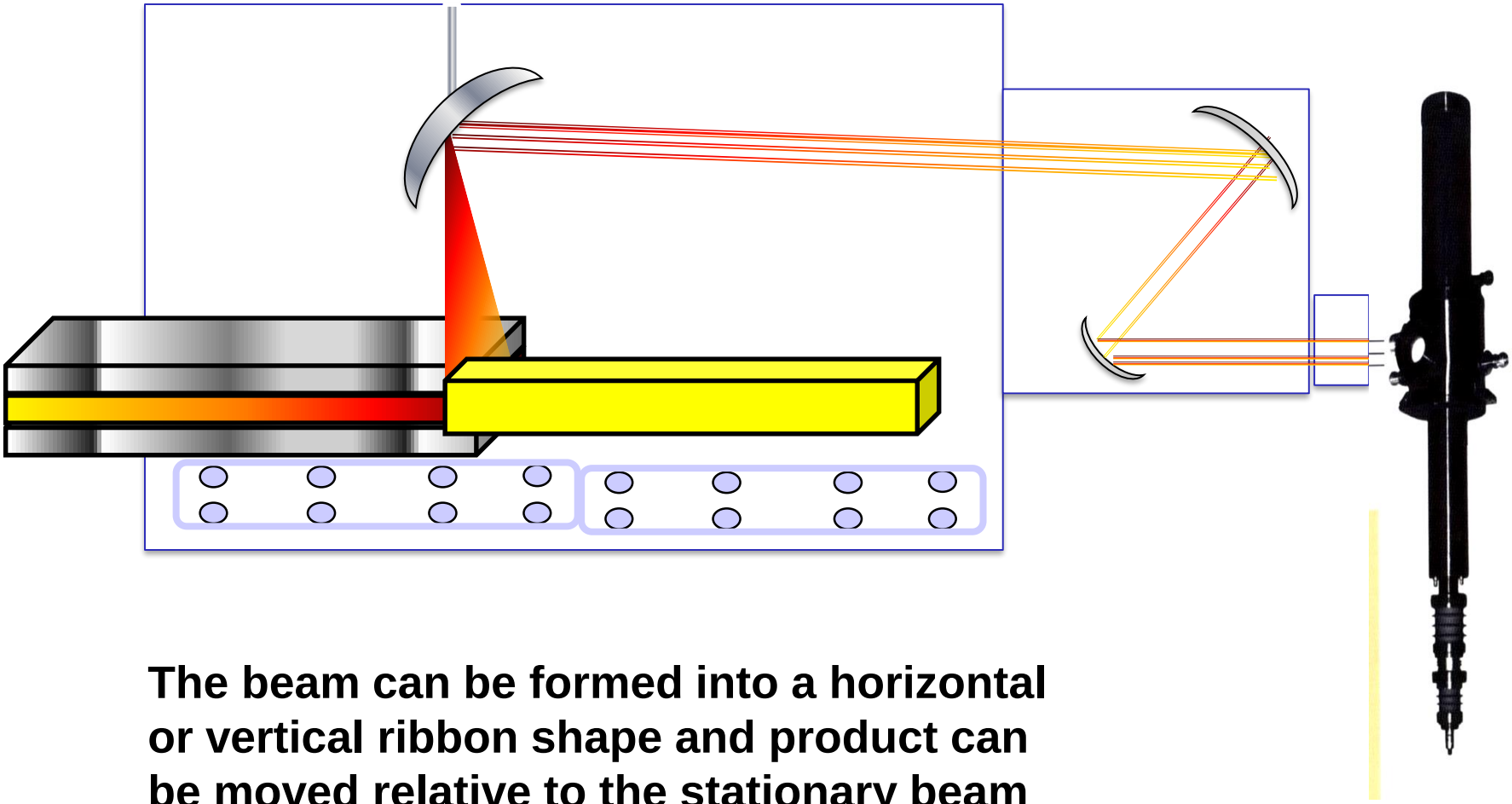


It Can be Scanned



The beam can be scanned to heat selected areas to selected temperatures using a configuration of moving mirrors

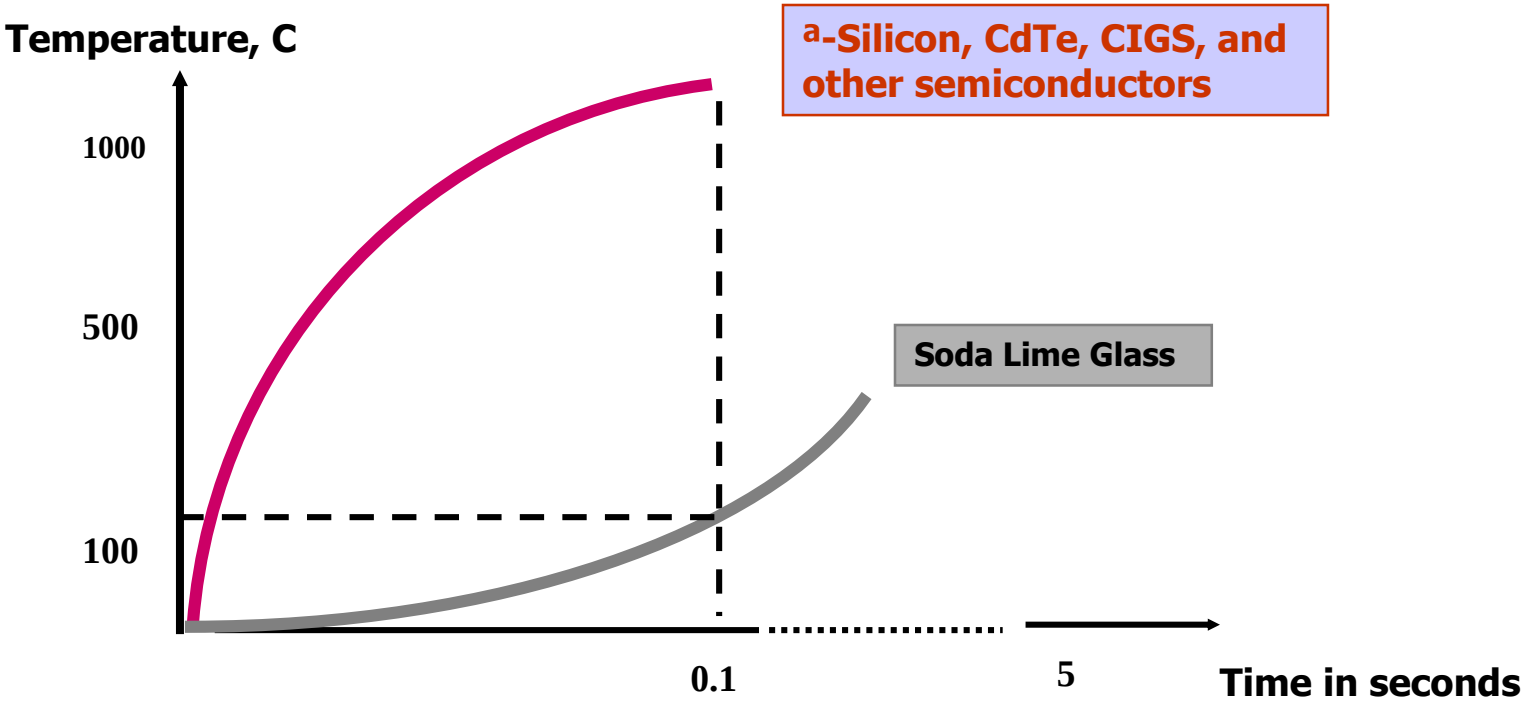
Heating Options - Ribbon



The beam can be formed into a horizontal or vertical ribbon shape and product can be moved relative to the stationary beam

Gyrotron material heating capability

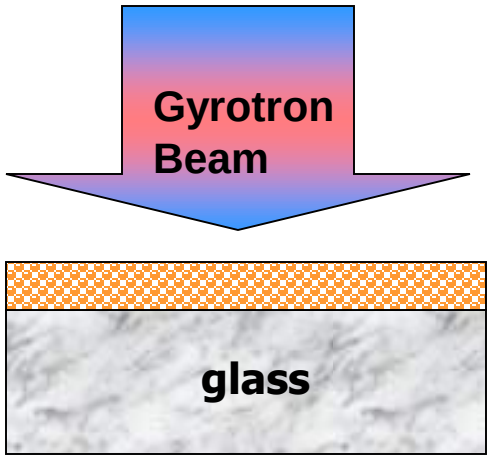
Semiconductors absorb gyrotron microwave energy to a significantly greater extent than glass.

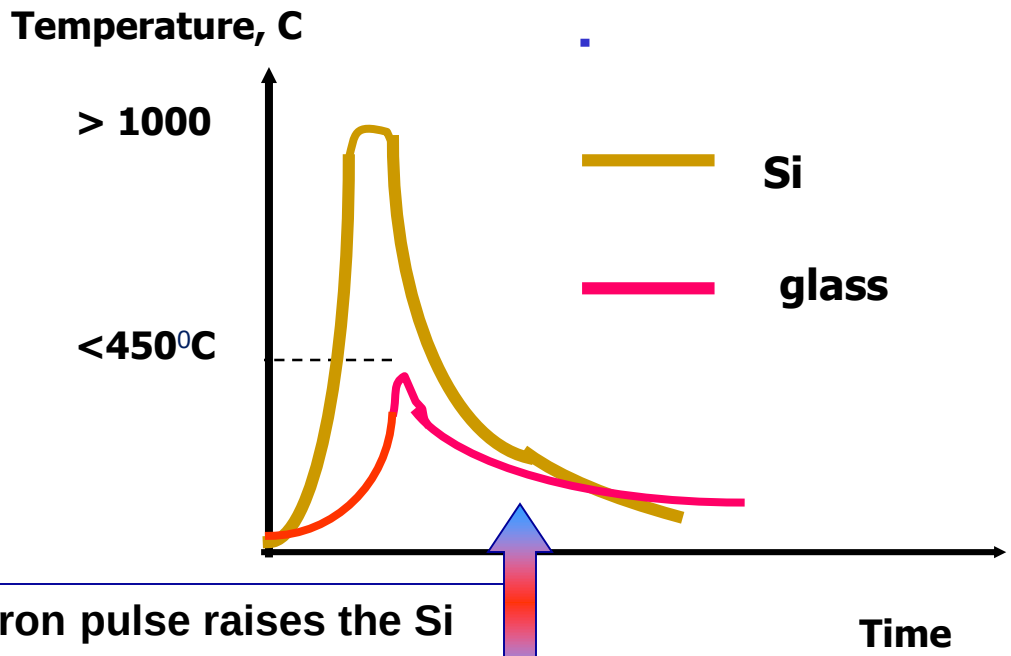


Thin Film on Glass

Annealing

A semiconductor layer can be heated to very high temperature in a short time while keeping glass temperature low. This results in better semiconductor quality, higher productivity, and allows use of inexpensive soda lime glass.



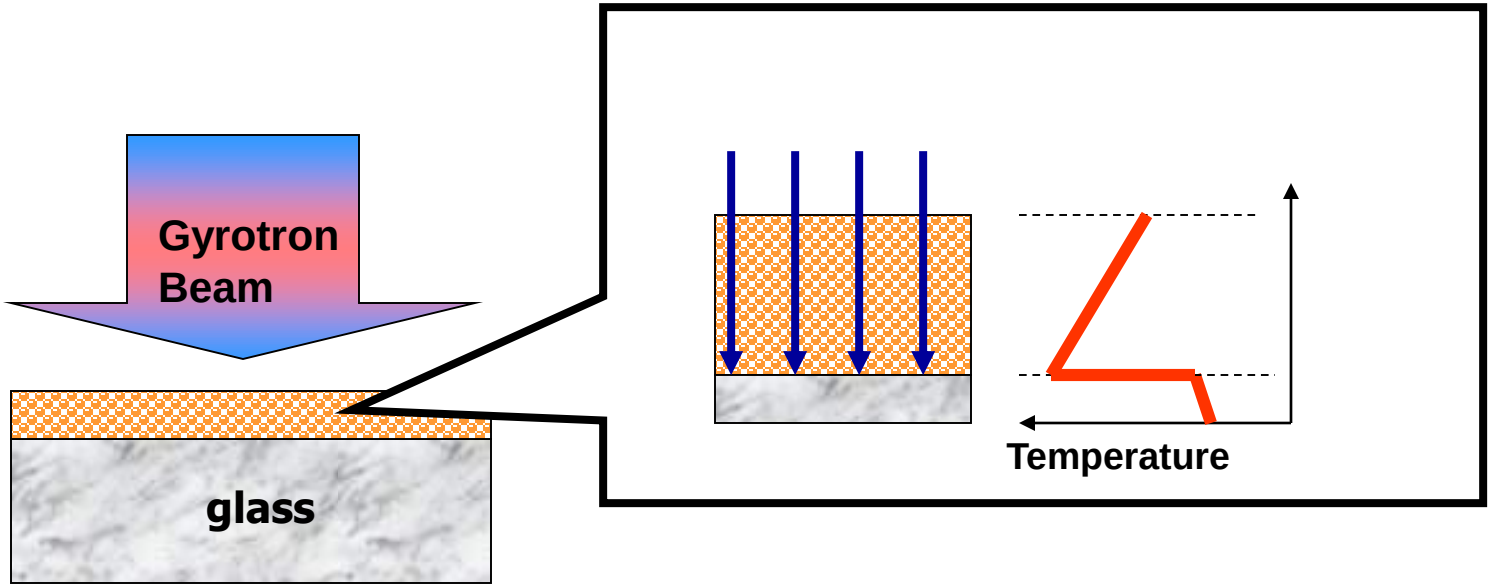


The applied gyrotron pulse raises the Si to a higher temperature than the glass because Si absorbs the gyrotron beam better than glass.

Thin Film on Glass

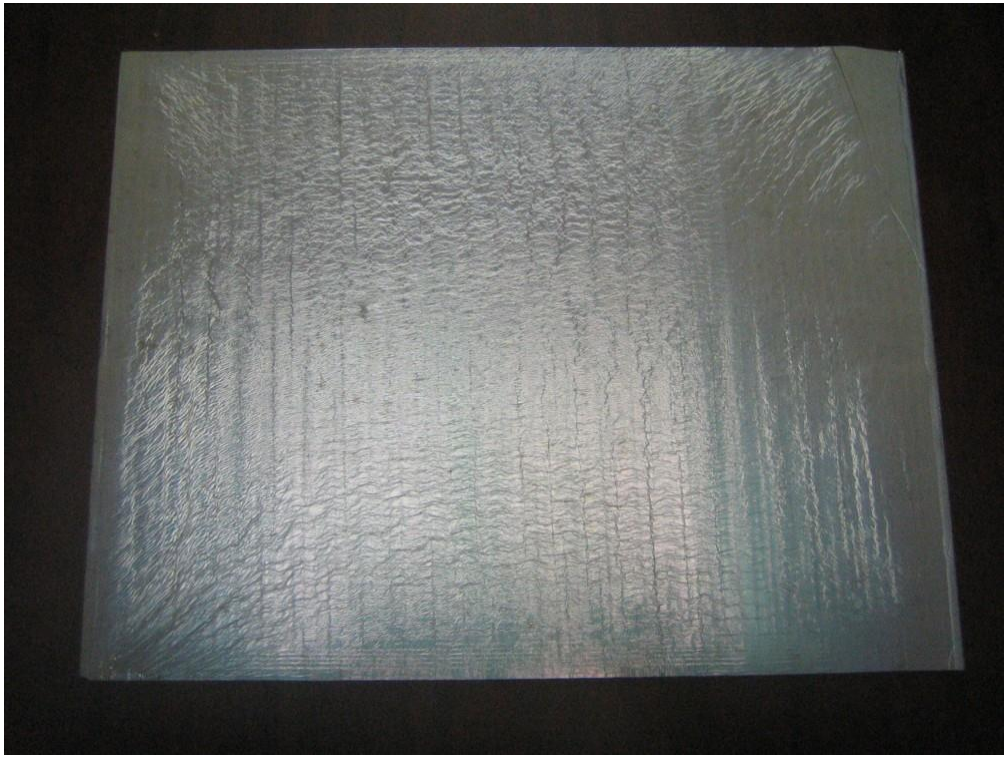
Annealing

The gyrotron not only reduces processing time but also creates better crystals because oriented crystallization can be realized. The necessary temperature distribution across the system can be achieved due to the gyrotron's ability to heat rapidly and selectively.



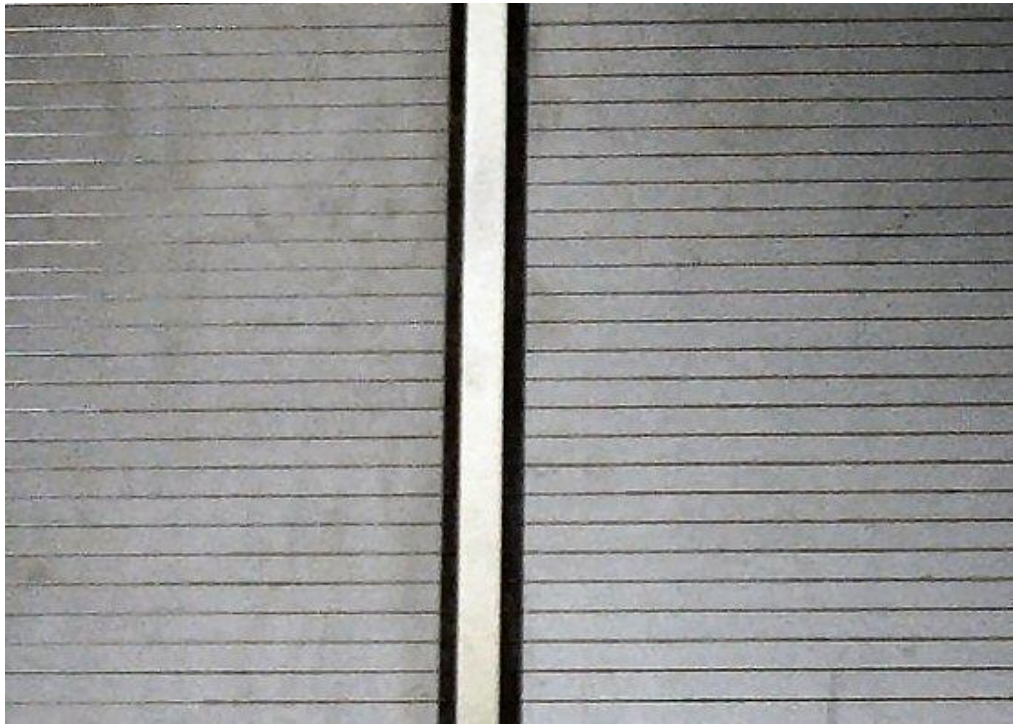
Annealing of Solar Cells

The efficiency of solar cells can be increased as a result of the high temperature annealing made possible by the gyrotron. Productivity can be 10 sq ft (1m^2)/sec or more.



Low Temperature Annealing of Solar Cells

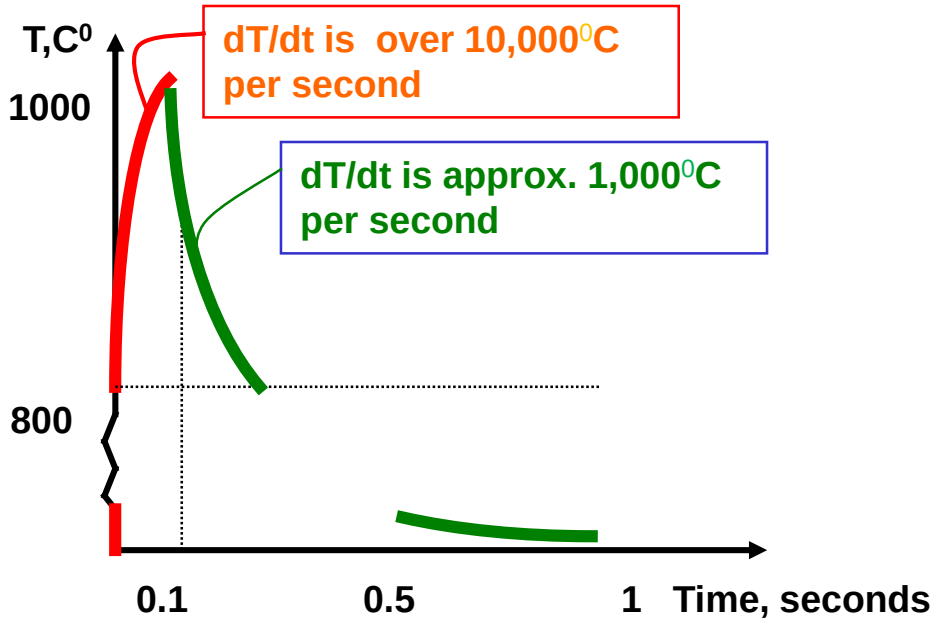
The efficiency of solar cells that require low temperature annealing (600^{0}C and less) is also increased as a result of the heating made possible by the gyrotron. Productivity can be 20 sq ft (2m^2)/sec or more.

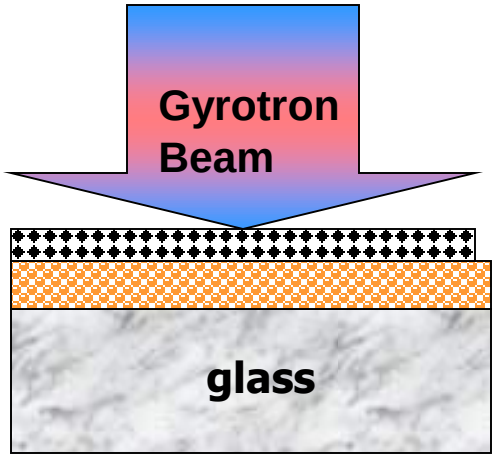


Thin Film on Glass

Activating

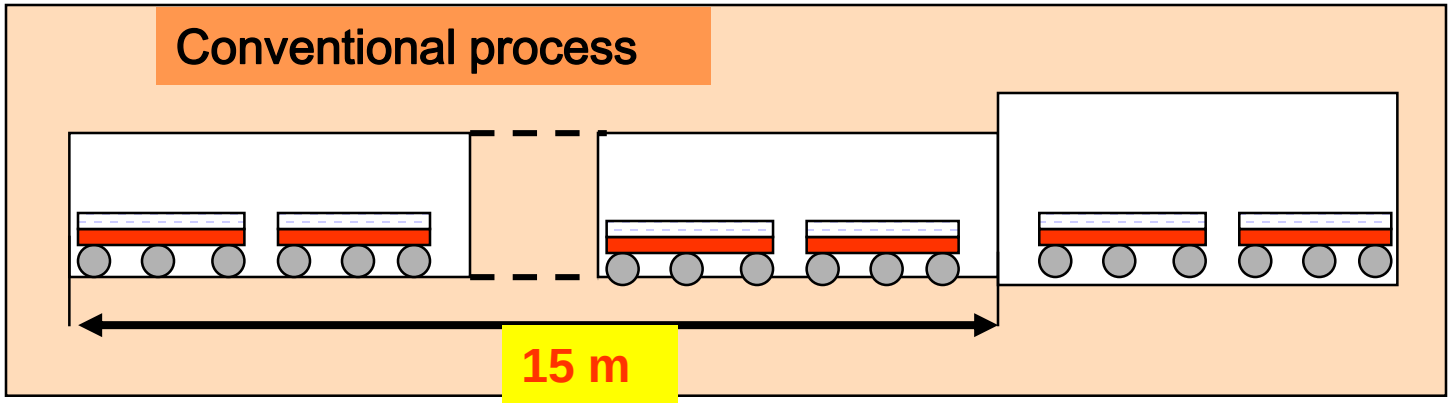
The gyrotron's sharp and powerful heat pulse provides a very efficient activating process for any dopants and semiconductor materials.

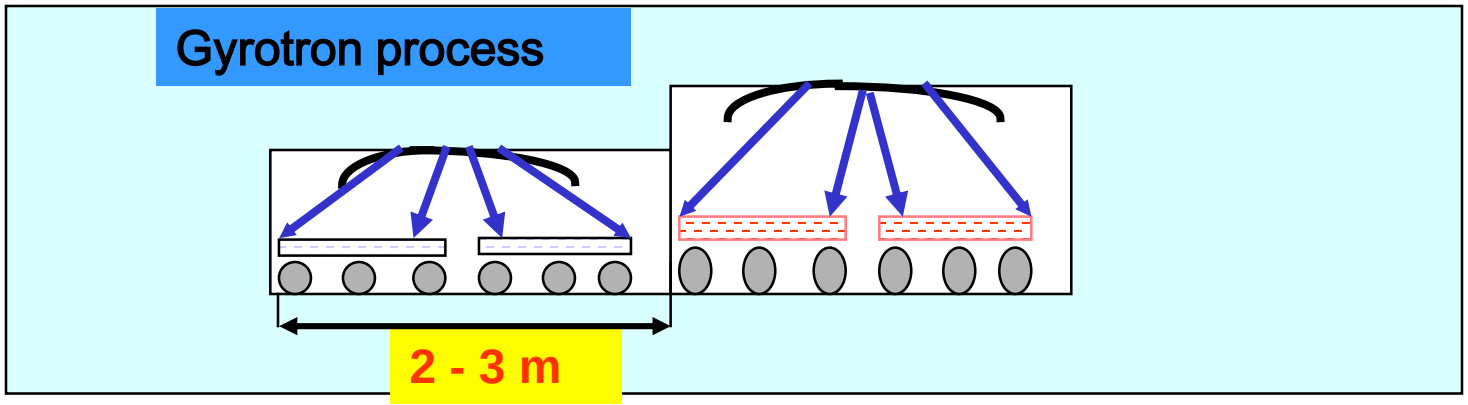




Gyrotron Use in Deposition

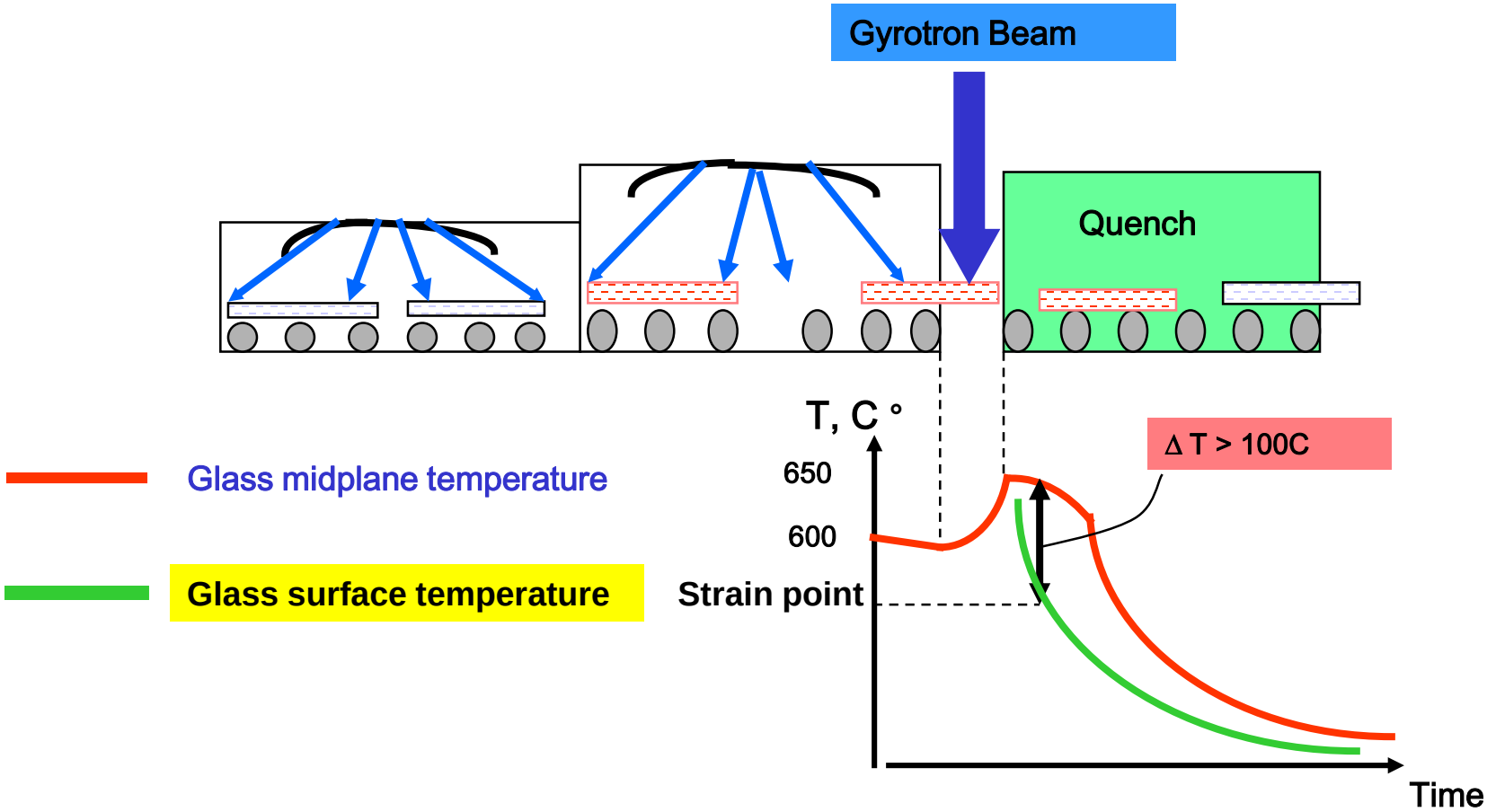
The gyrotron beam can preheat glass before and during sputtering. Long vacuum preheat lines are cut to a minimum: 0.5-1.5 glass lengths, and energy is saved. The use of the gyrotron inside the sputtering chamber eliminates the need for heaters and reduces processing time





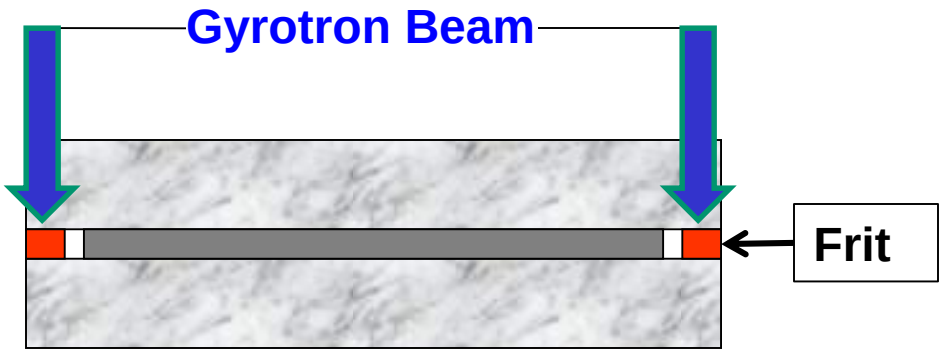
Gyrotron Use after Deposition (Tempering)

The gyrotron beam raises (or keeps) the glass midplane temperature to 650C after it leaves the sputtering vacuum chamber creating conditions for full tempering of glass.

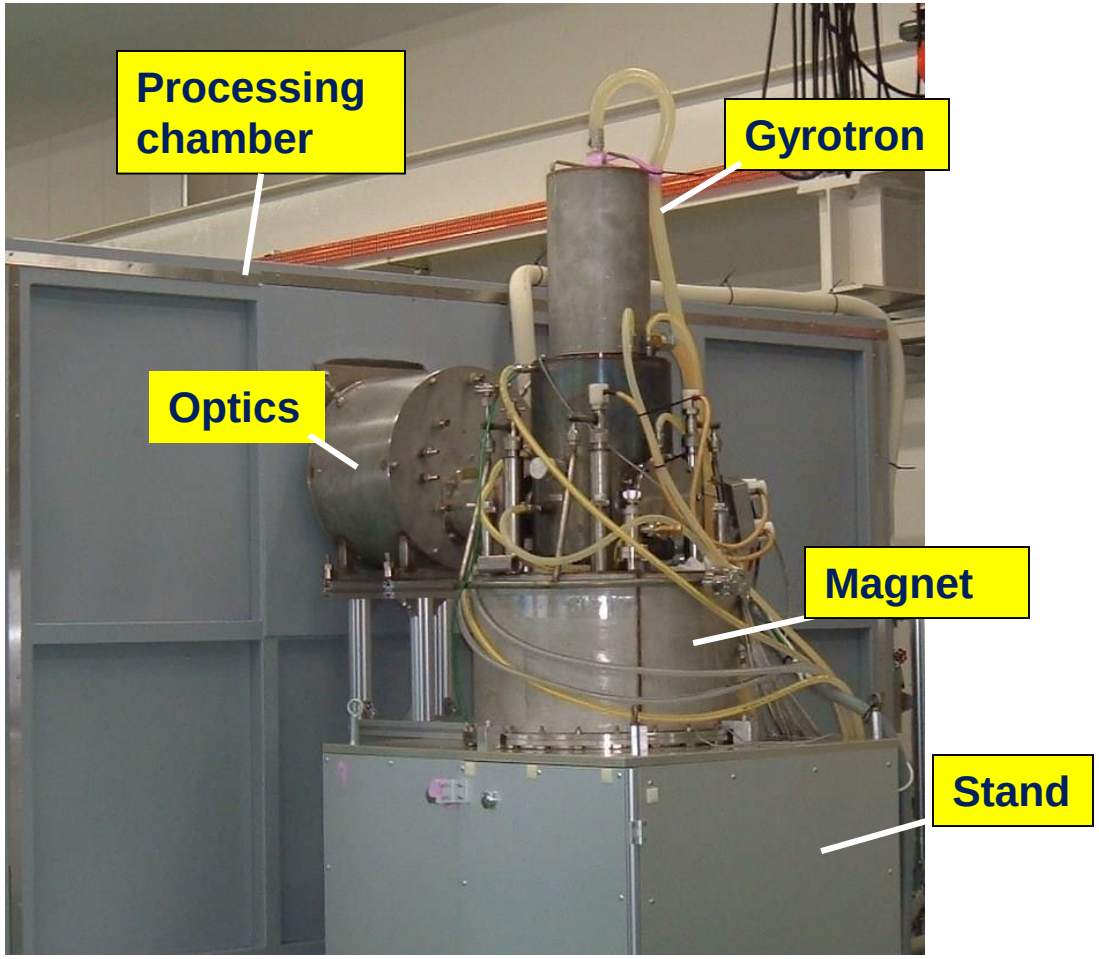


Sealing Solar Modules

The sealer/frit is selectively and rapidly heated. Glass remains cooler, and temper as well as solar properties are protected. No remained stress



Gyrotron Beam Installation



Example of the gyrotron set