Cs+ Low Temperature Ion Source

A high-brightness, low-energy-spread ion source for SIMS

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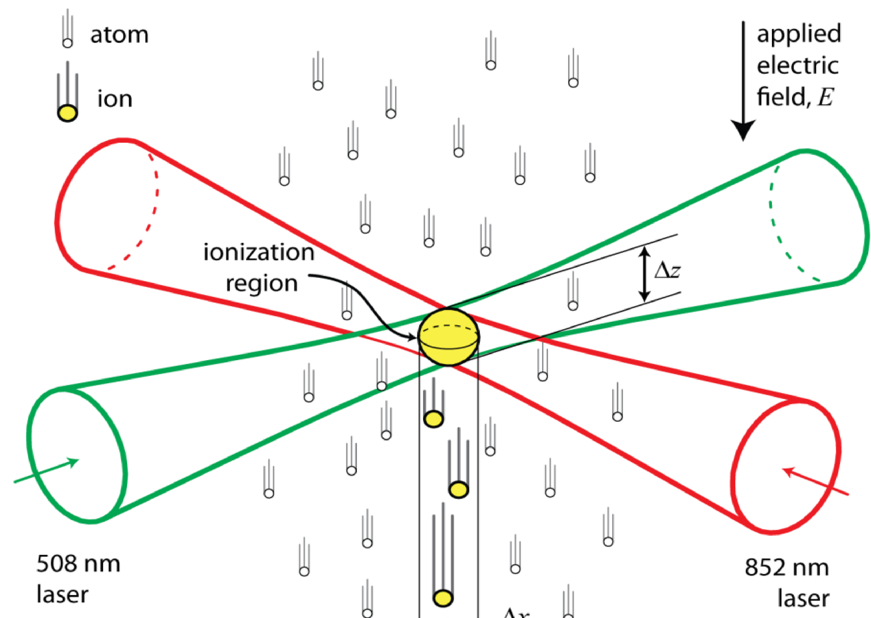
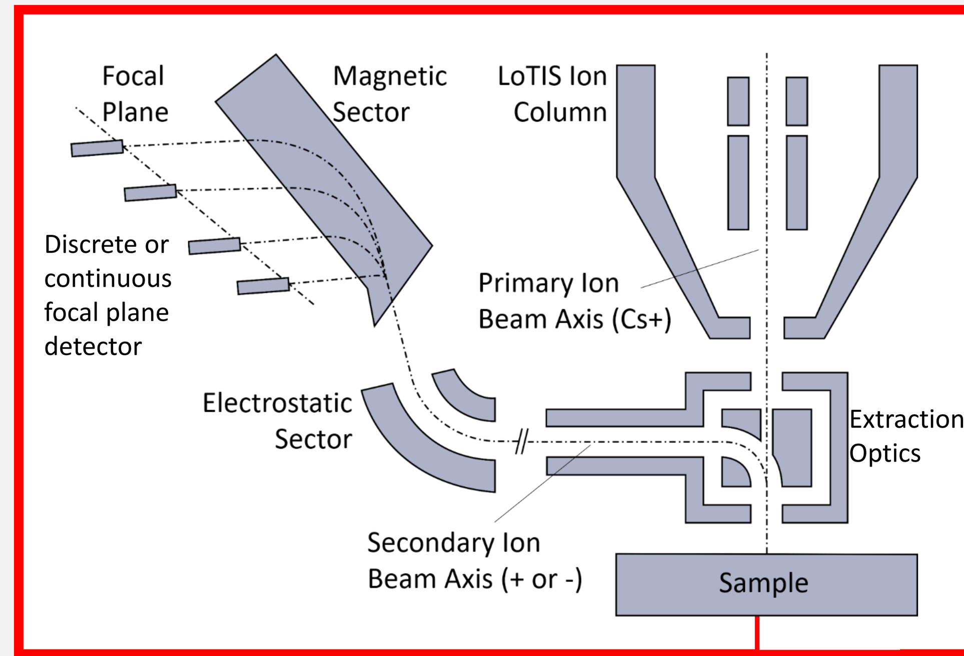
Cs+ LoTIS

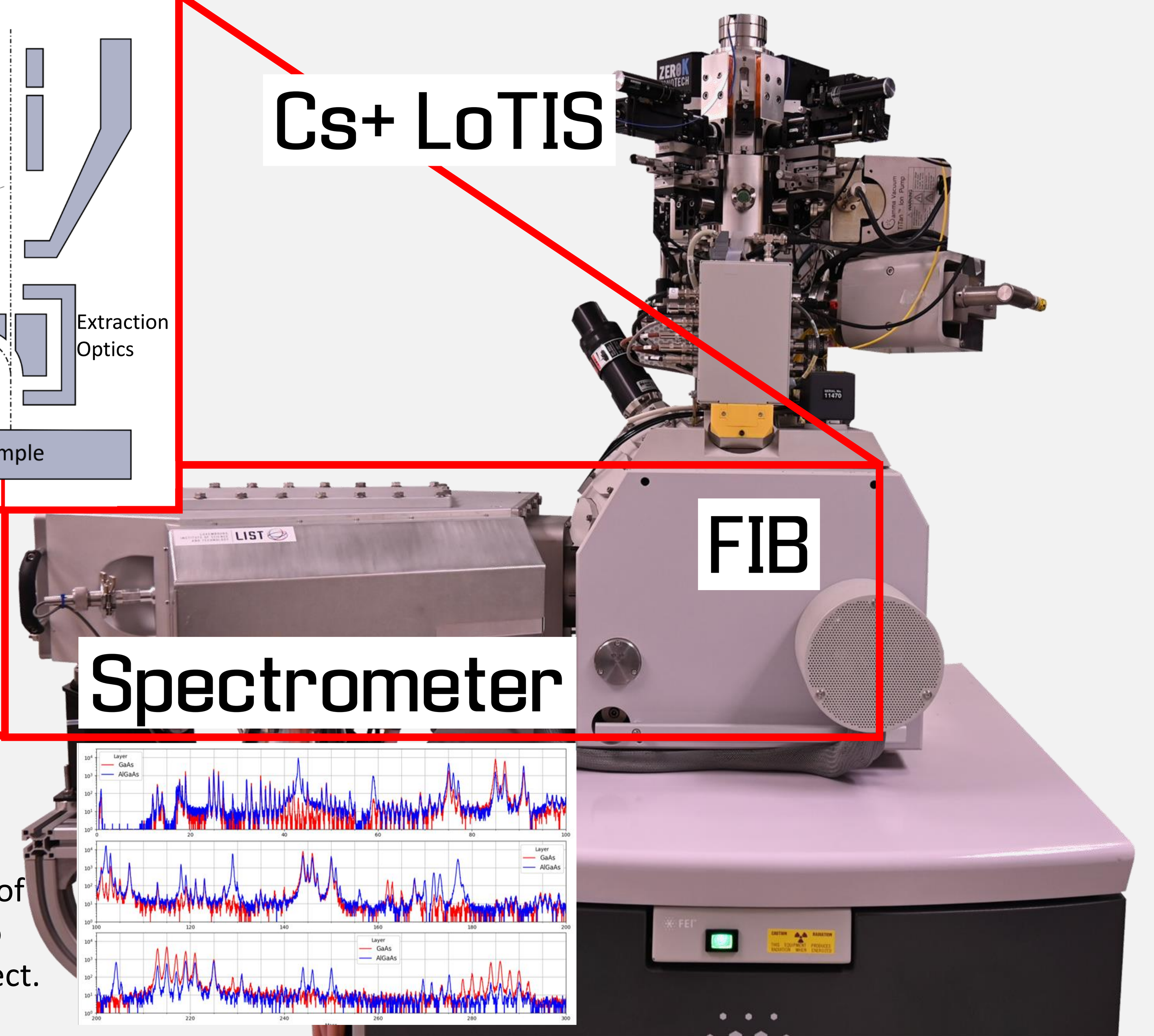


Ions are created in a laser-cooled atomic beam as it flows through the intersection of photoionizing laser beams and accelerated in an applied electric field.

The resulting Cs+ beam has exceptional properties:

< 3 nm spot @ few pA	Energy Spread < 1 eV
< 1 um spot @ 5 nA	Current up to 5 nA





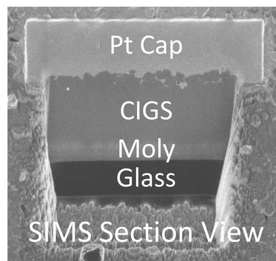
Cs+ LoTIS (zeroK) and SIMS spectrometer (LIST) on a Nova series FIB (FEI)

The magnetic sector spectrometer has $m/\Delta m$ ~400 and is equipped with a continuous focal plane detector capable of acquiring an entire mass spectrum (up to 300 amu) at once with no duty cycle effect.

SIMS Analysis Examples

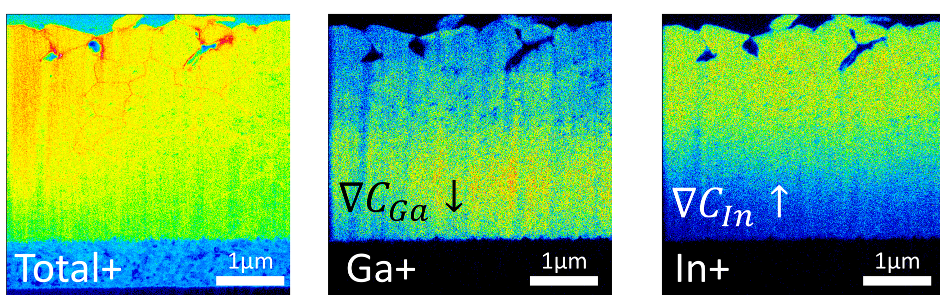
Solar Cell

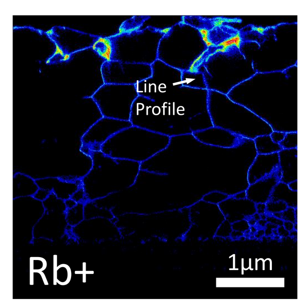
CIGS Cu(In,Ga)Se_2 – Rb doped Absorber



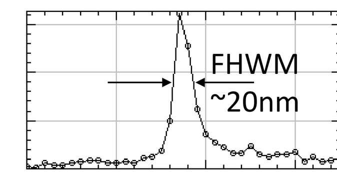
Integrated sample prep and analysis with Cs+ LoTIS ion beam

- Deposit Pt Cap, Machine Section
- Acquire SE and SIMS images



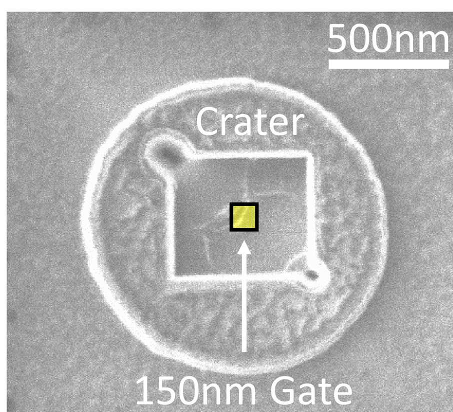


Apparent width of Rb at grain boundary



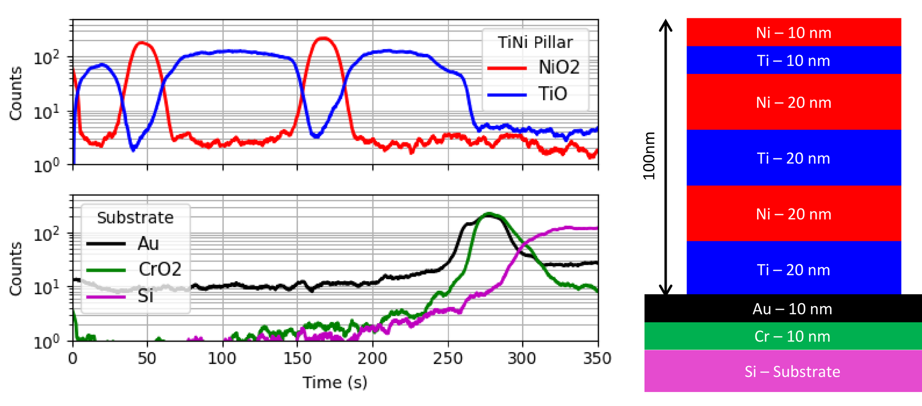
TiNi Pillars

3D movie



Highly localized depth profile performed at 8kV from an square area gate with 150nm sides.

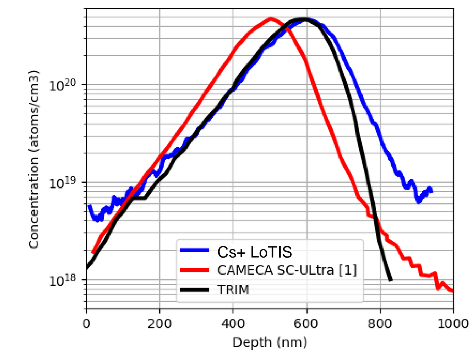
Good SNR, few-nm depth resolution



Boron in Silicon

Implanted B in Si @ 190 kV; dose 10^{16} ions/cm^2

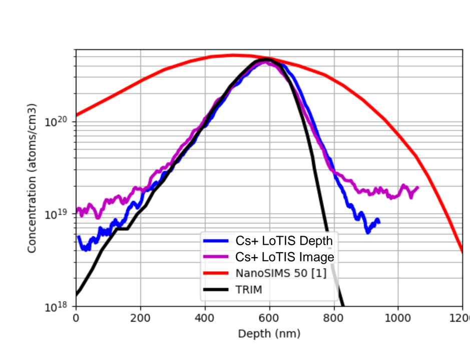
Depth Profile



940nm

	Cs+ LoTIS	SC Ultra
Primary Ion	Cs+	O2+
Energy	16kV	4.5kV
Current	25pA	85000pA
Area	4.2um x 4.2um	?
Secondary Ion	$^{11}BO2-$	$^{11}B+$

Section View Profile



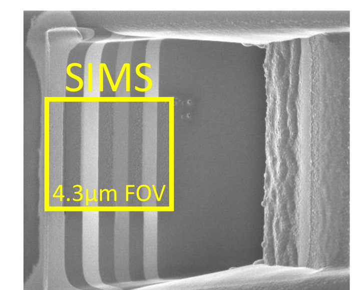
Cs+ LoTIS
NanoSIMS 50 [1]
1 µm

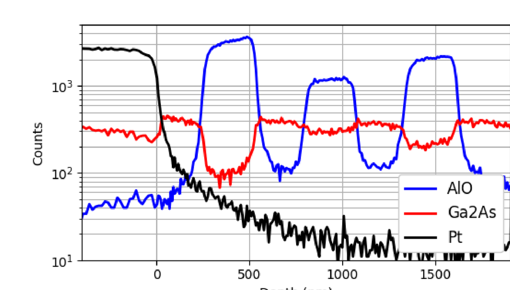
	Cs+ LoTIS	NanoSIMS 50
Primary Ion	Cs+	O-
Energy	16 kV	16 kV
Current	1.6 pA	12 pA
Secondary Ion	$^{11}BO2-$	$^{11}B+$

[1] Eswara, et al. MRS COMMINCATIONS. Volume 9, Issue 3 (2019). 10.1557/mrc.2019.89

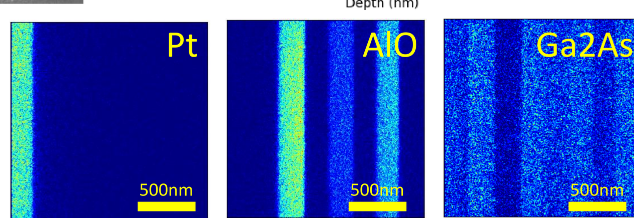
AlGaAs Mutlilayer

Section View Profile

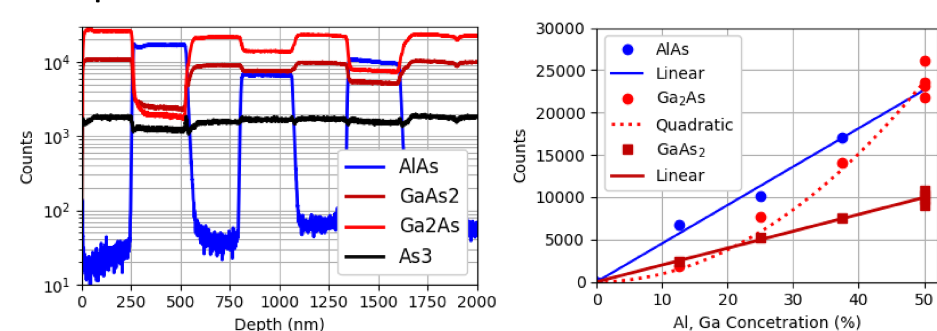




Alternating GaAs / AlGaAs layers with varying Al, Ga concentrations

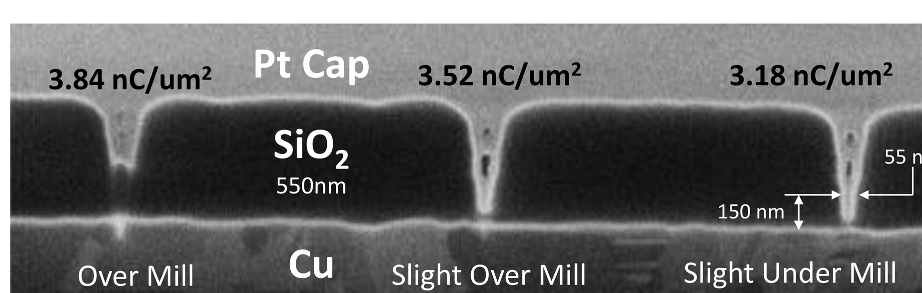


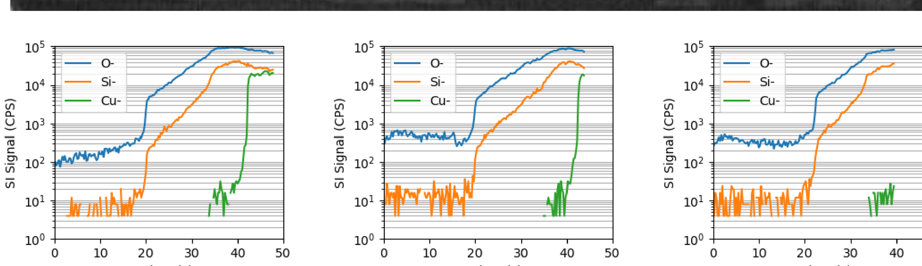
Depth Profile



Nanofabrication Process Control

Endpointing: 50nm wide via, 2.0 pA, 16 kV





Can be difficult to judge transition with SE signals

SIMS signals

- High SNR despite aspect ratio
- Predictive of milling results

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