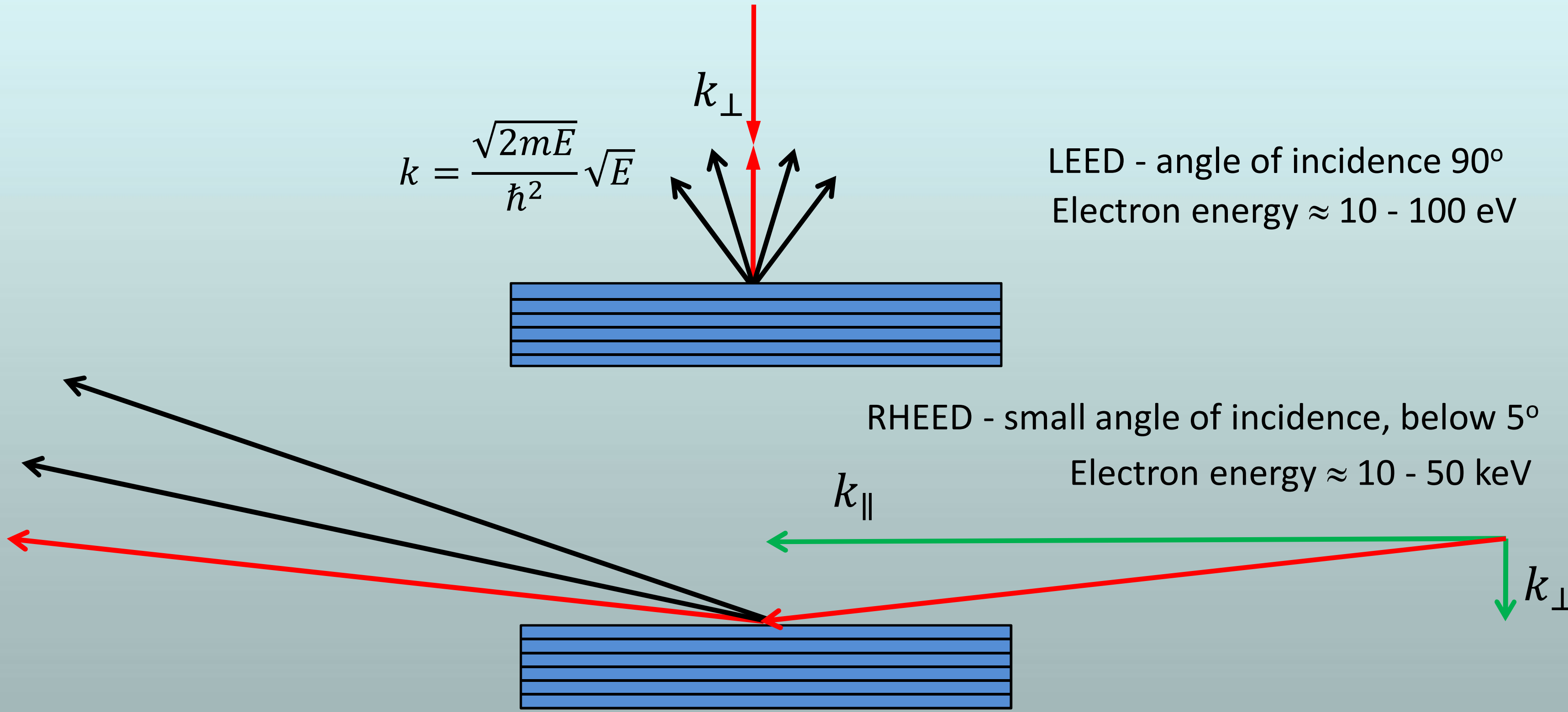
LEED and RHEED geometry

$$k = \frac{\sqrt{2mE}}{\hbar^2}\sqrt{E}$$

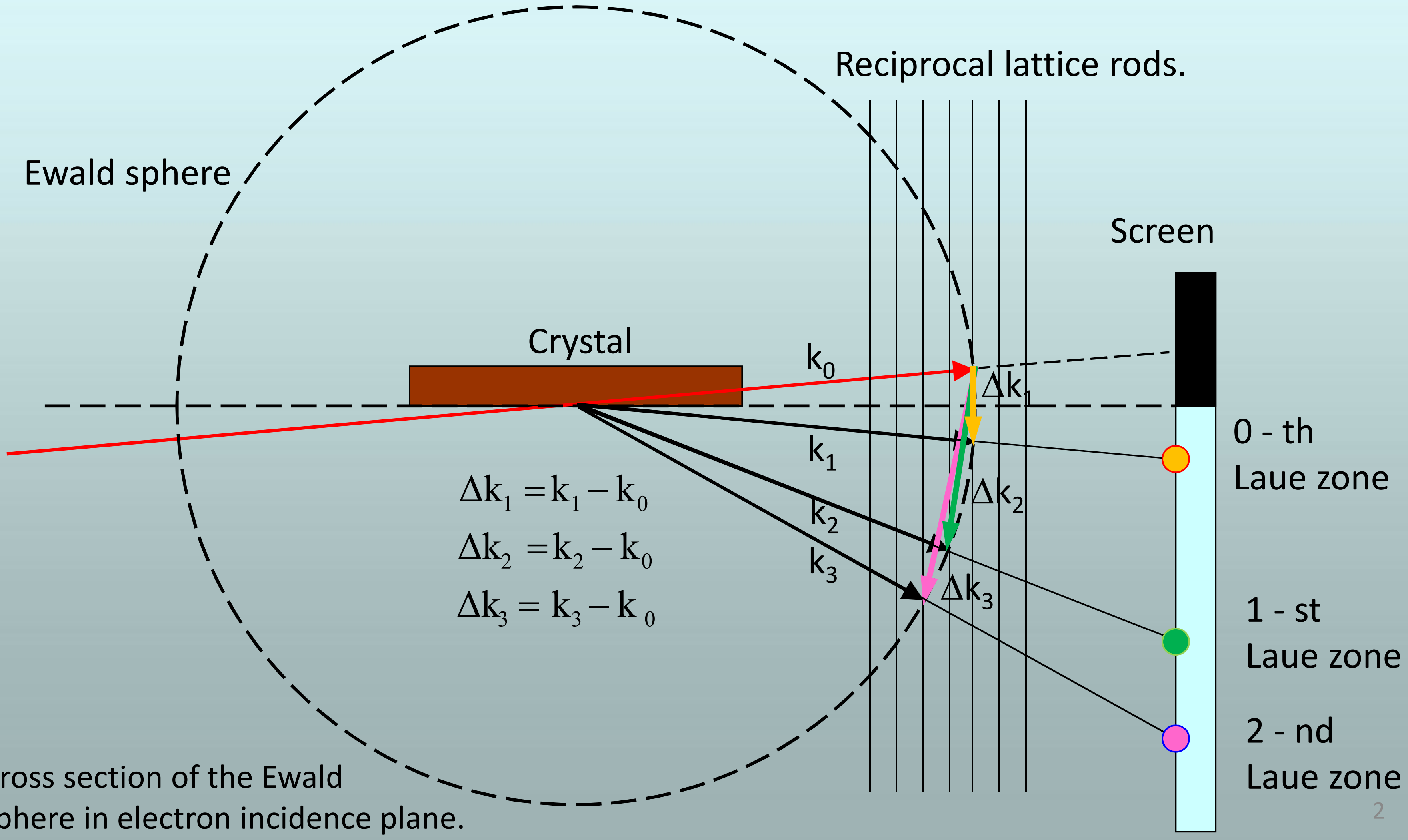
LEED - angle of incidence 90°
Electron energy ≈ 10 - 100 eV

RHEED - small angle of incidence, below 5°
Electron energy ≈ 10 - 50 keV



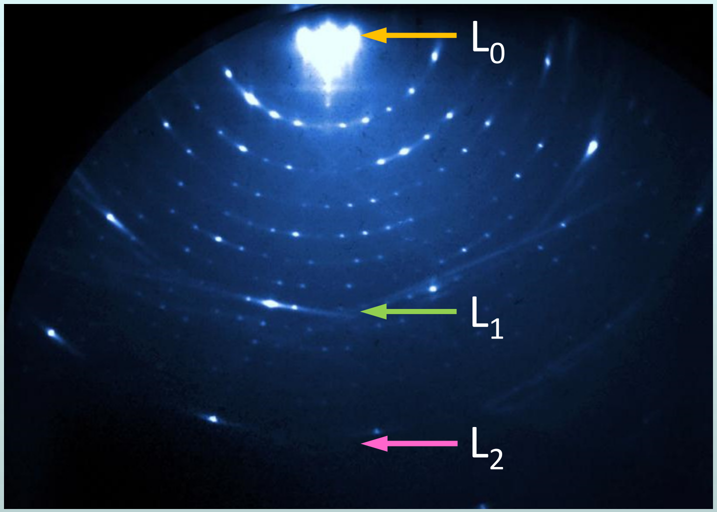
In RHEED, due to small angle of incidence, is the perpendicular component of the electron wavevector of the same range as in LEED.

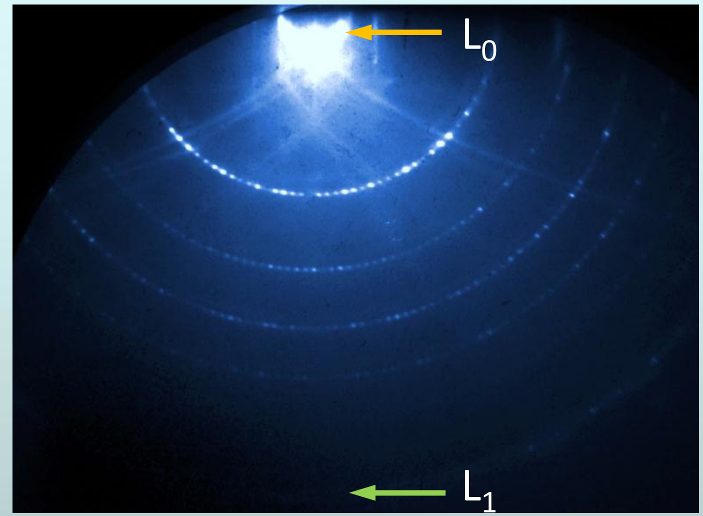
Ewald construction

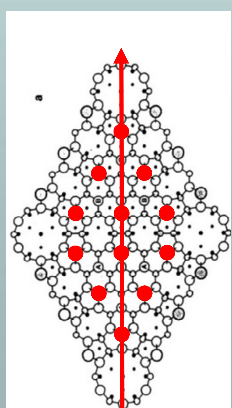


Cross section of the Ewald sphere in electron incidence plane.

Laue Zones - Si(111)-7x7 RHEED pattern example

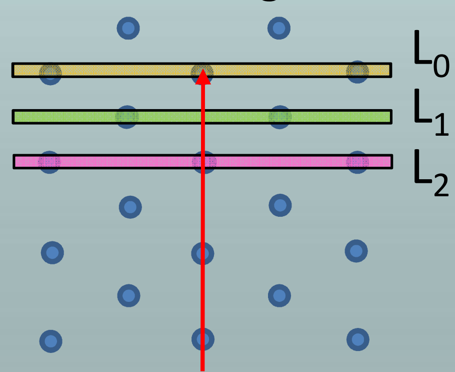




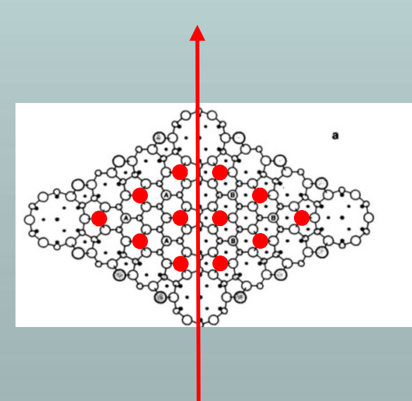


Si(111)-7x7
real space

$\mathrm{e-beam\ along\ Si}[11\bar{2}]$

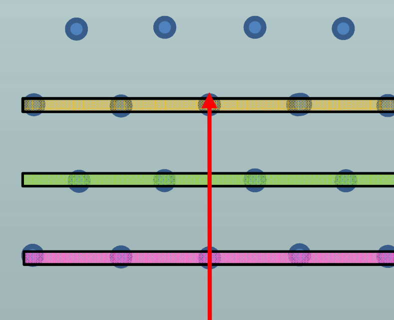


Si(111)-1x1
reciprocal space



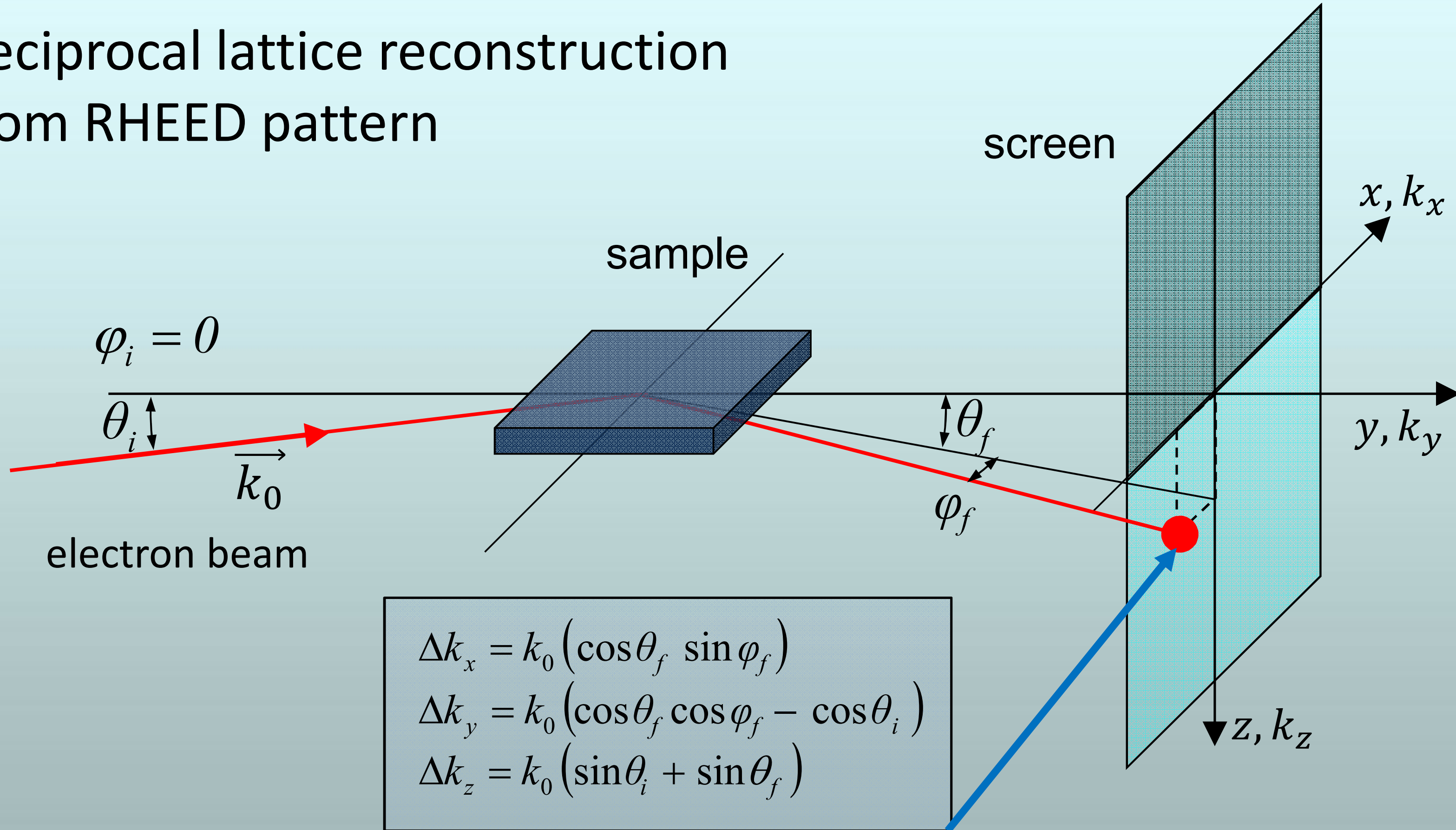
Si(111)-7x7
real space

$\mathrm{e-beam\ along\ Si}[1\bar{1}0]$



Si(111)-(1x1)
reciprocal space

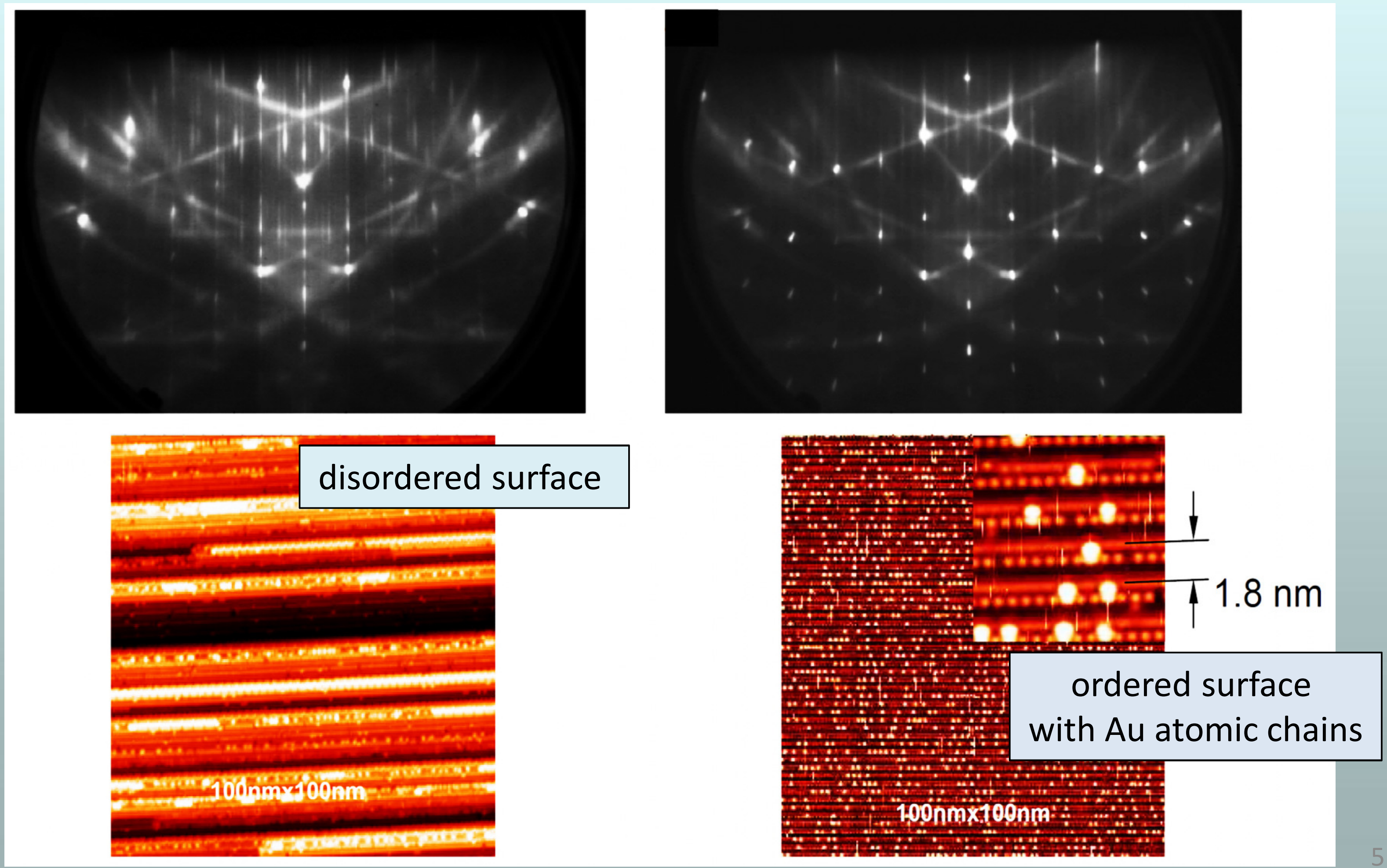
Reciprocal lattice reconstruction from RHEED pattern



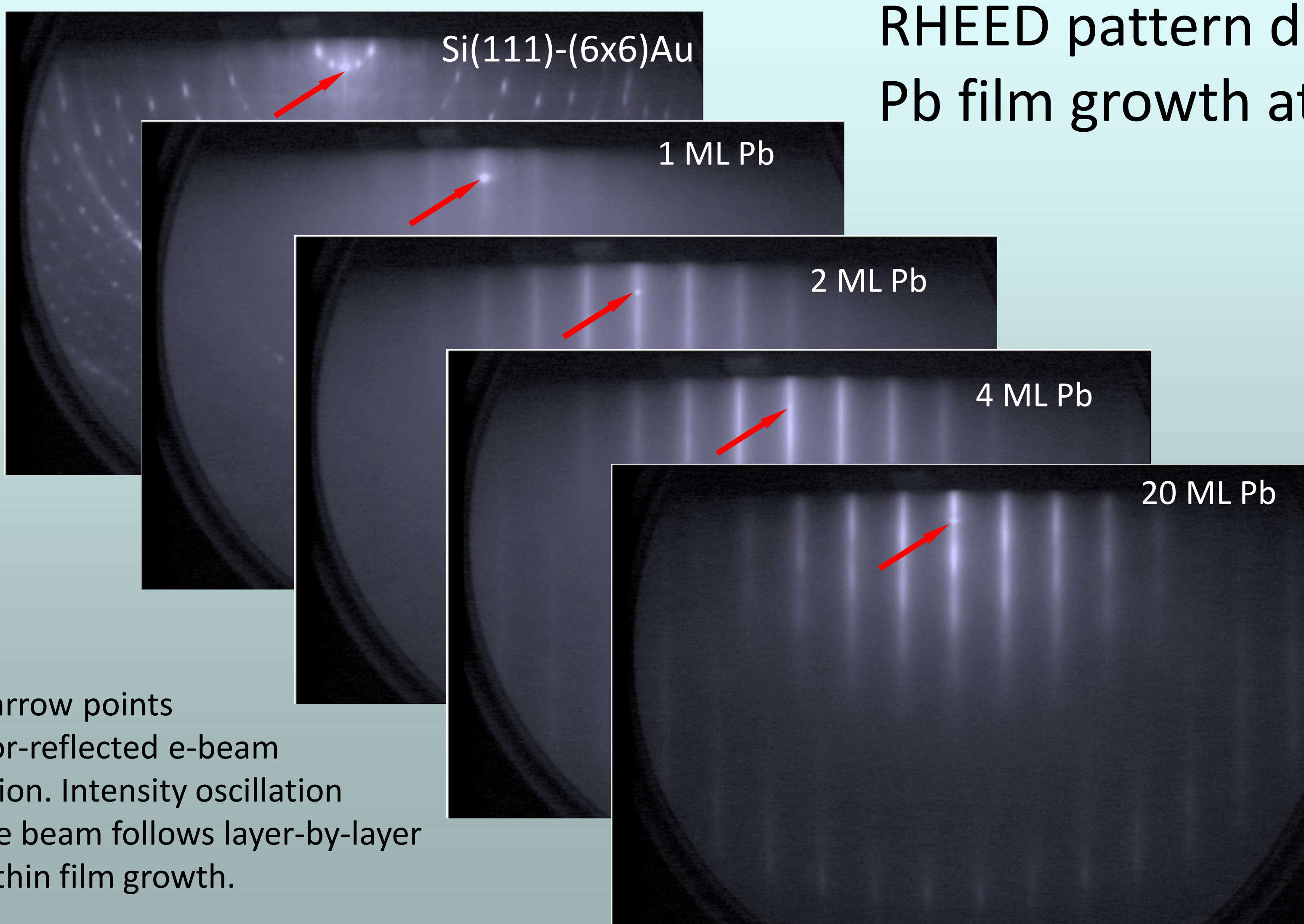
$$\Delta k_x = k_0 \left(\cos\theta_f \ \sin\varphi_f \right)$$
$$\Delta k_y = k_0 \left(\cos\theta_f \cos\varphi_f - \cos\theta_i \right)$$
$$\Delta k_z = k_0 \left(\sin\theta_i + \sin\theta_f \right)$$

To every point of the screen a reciprocal space coordinate may be prescribed

RHEED and STM images of Si(557) surface



RHEED pattern during Pb film growth at 80K



The arrow points mirror-reflected e-beam position. Intensity oscillation of the beam follows layer-by-layer ultrathin film growth.

RHEED oscillations

RHEED mirror-reflected electron beam intensity oscillations measurd durnig Pb ultrathin film growing on Si(111)-(6x6)Au surface in UHV conditions.

This experimental method allows precise control of the film thickness and its unformity, thus enables fabrication of metallic quantum wells.

See more details in:

M. Jałochowski, E. Bauer, *Quantum size and surface effects in the electrical resistivity and high-energy electron reflectivity of ultrathin lead films*, Phys. Rev. **B38**, 5272 (1988).

M. Jałochowski, E.Bauer, *Reflection high-energy electron diffraction intensity oscillations during the growth of Pb on Si(111)*, J. Appl. Phys. **63**, 4501 (1988)