Inkjet Printing Mechatronics

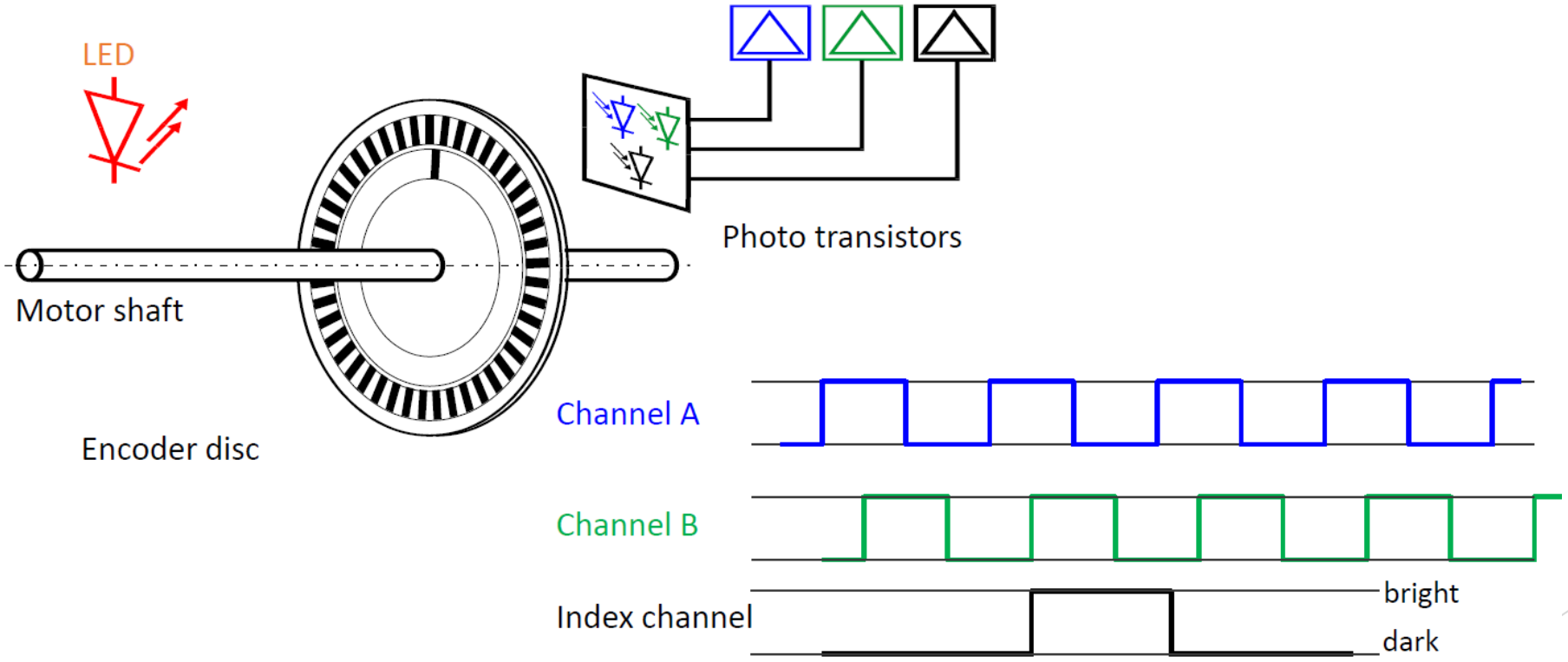
Part 2 of 2 Printer Mechatronics

Encoders

Encoders are used to determine exact positions on the axis for velocity or position control.

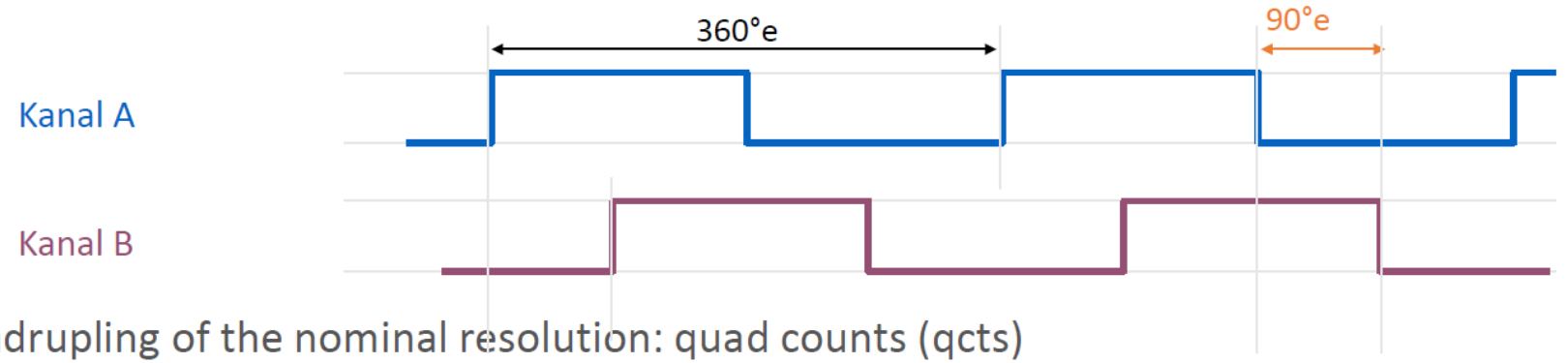
- Incremental encoder
- Absolute encoder

Incremental Encoder

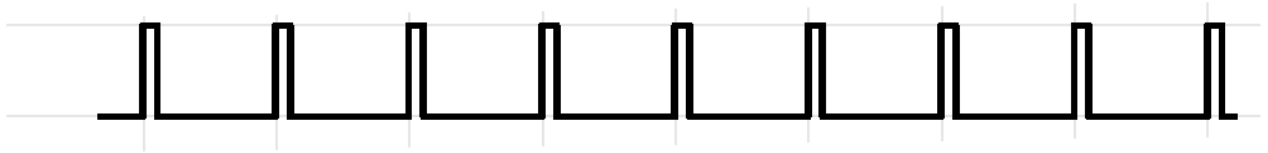


Encoder Signals

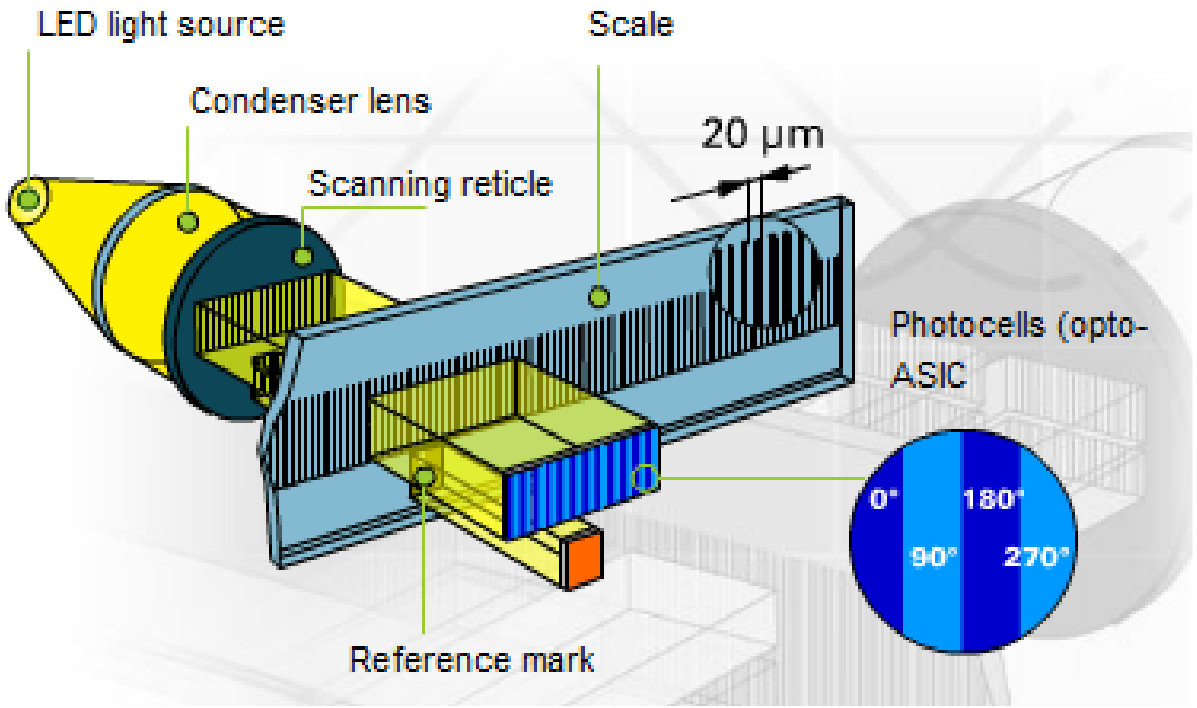
- 2 channels A and B with **N** pulses each per revolution
- Direction of rotation (signal A or B is leading)



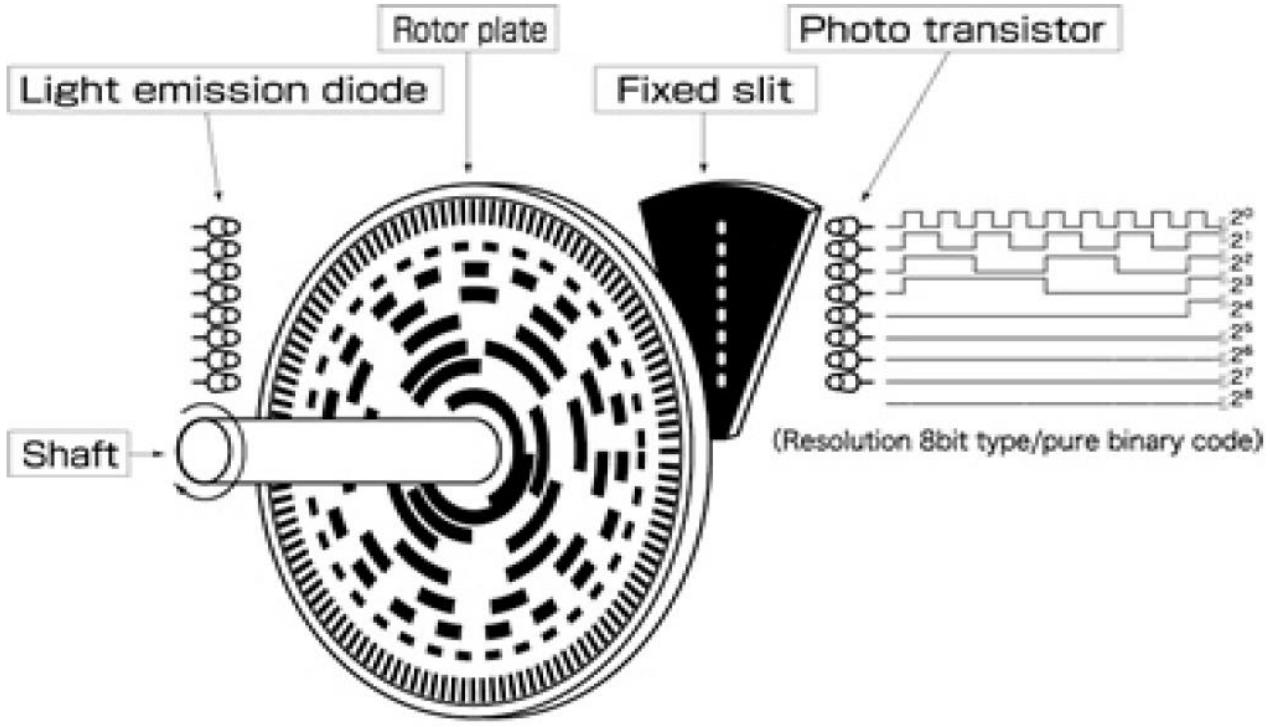
- Quadrupling of the nominal resolution: quad counts (qcts)
  - 500 pulses = 2000 qcts = 0.18°



High Resolution Encoder



Absolute Encoder



Absolute Encoder Simplified Structure

Sensors

- Axis encoders for print synchronization
- Print reference
- Substrate presence and positioning
- Inline print image control (camera)
- Axis end stop
- Ink fill sensor
- Pressure sensor
- …

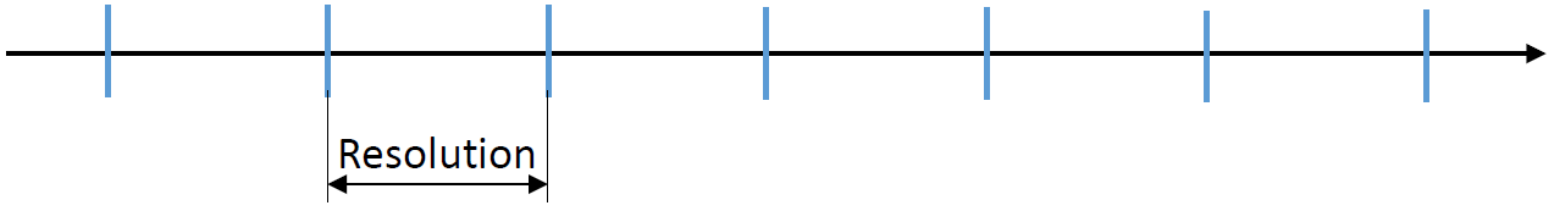
Dynamics

- Dynamic parameters:
  - Acceleration
  - Velocity

- •Print heads are sensible to high acceleration
- •Constant velocity is important for reliable printing (see quality issues)

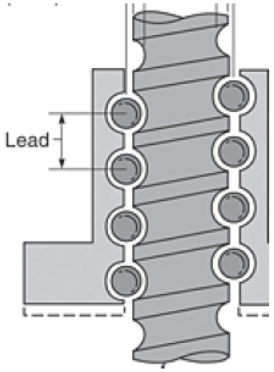
Resolution

Resolution is the shortest distance between two possible positions based on the used position sensor:



Example of a ball screw drive with incremental encoder on the motor:

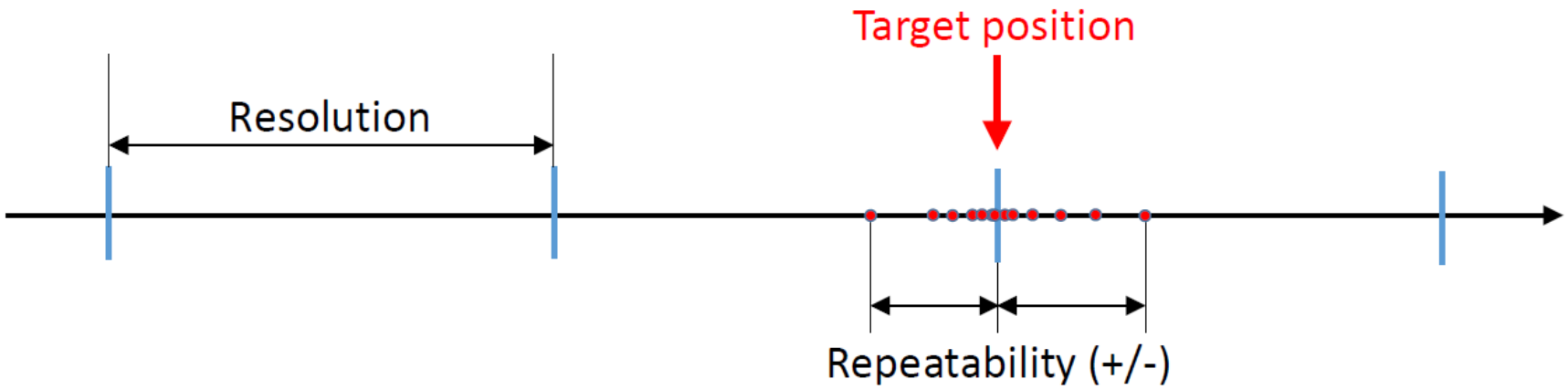
- Incremental encoder: n=512 increments (per turn)
- Ball screw lead: s=5 mm (linear displacement per turn)
- Resolution r=?



r=s/n ≈10µm (or ≈2.5µm with the use of quad counts)

Repeatability / Precision

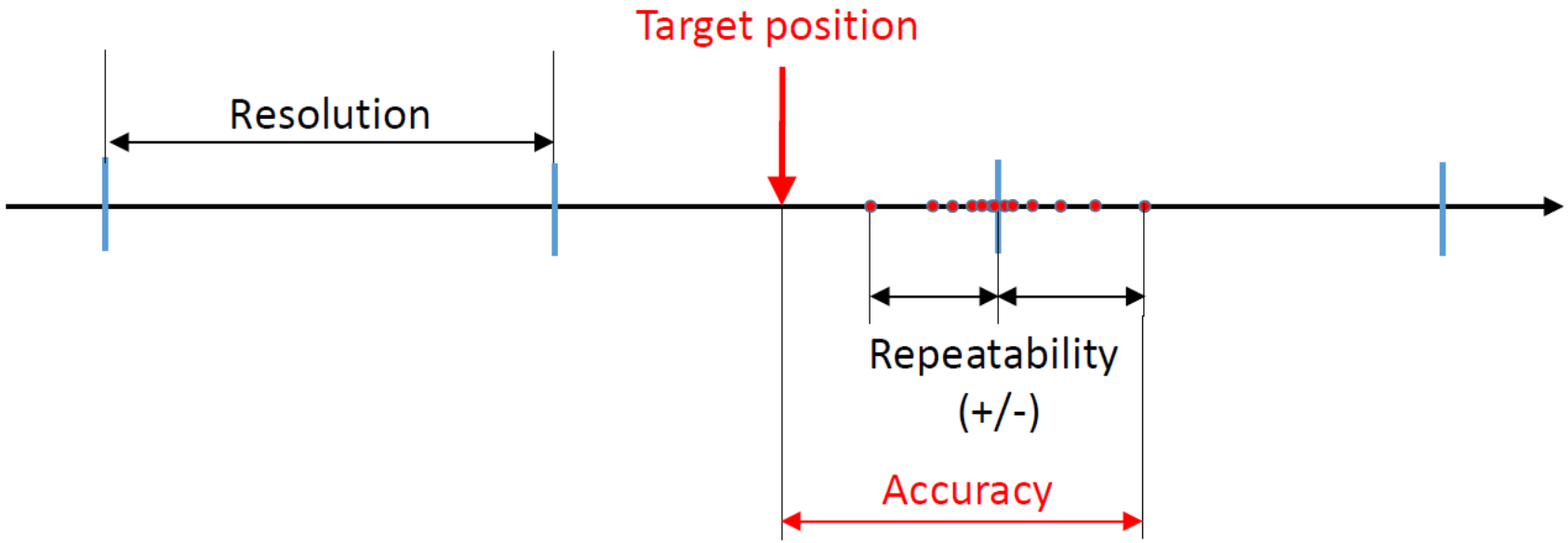
Repeatability (also named precision) is the maximal position error, when positioning several times to the same position.



Repeatability can be much higher than the resolution!

Accuracy

The accuracy of an axis is linked to it's resolution and repeatability:



Accuracy as worst case value is 50% of the resolution + the repeatability!

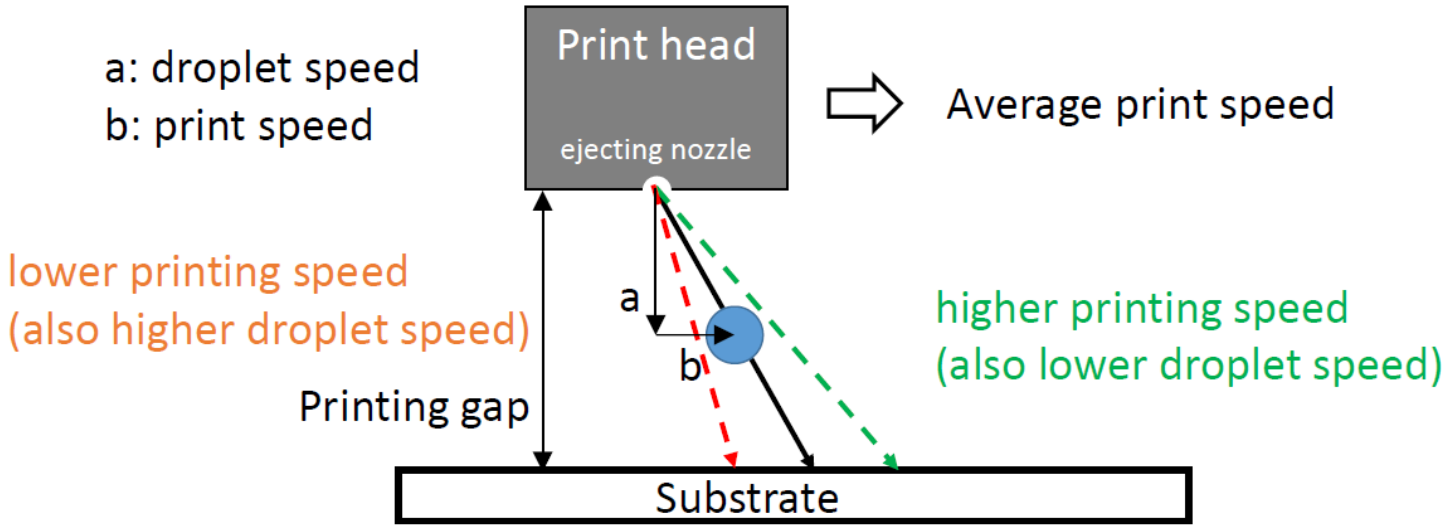
Quality Issues

- What can affect the quality of the printed image from the point of view mechatronics?
- Vibrations
- Linearity of axis (nonlinearity is visible in the printed image)
- Variable axis speed
- Backlash

Variable Axis Speed

The influence is depending on printing gap and droplet speed:

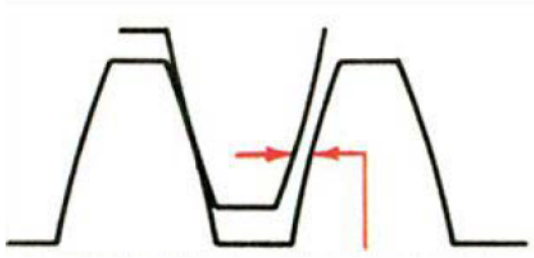
a: droplet speed
b: print speed



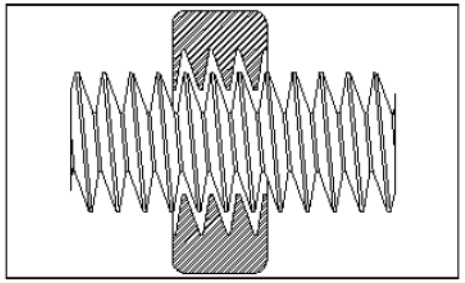
- Easiest and best for print quality is therefore always a constant axis speed !
- If printing during acceleration and deceleration is needed, the effect can be compensated.

Backlash

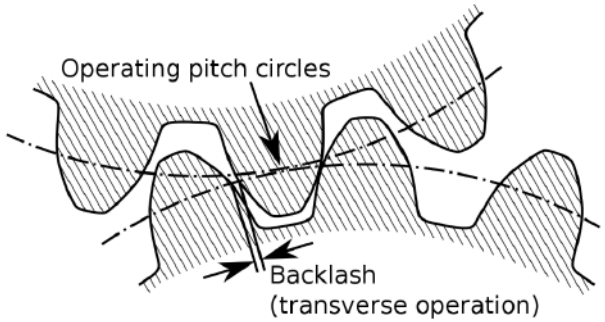
Timing belt



Ball screw



Rack and pinion



Linear drive has no backlash !