

From Sensor to System; Sensor Architecting

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Abstract

Researchers of sensors, typically focus on a set of critical characteristics of the sensors. However, do we know what is critical from a broader perspective, such as a device builder, a subsystem builder, the system, or the user of the system?

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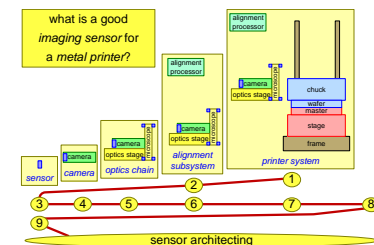
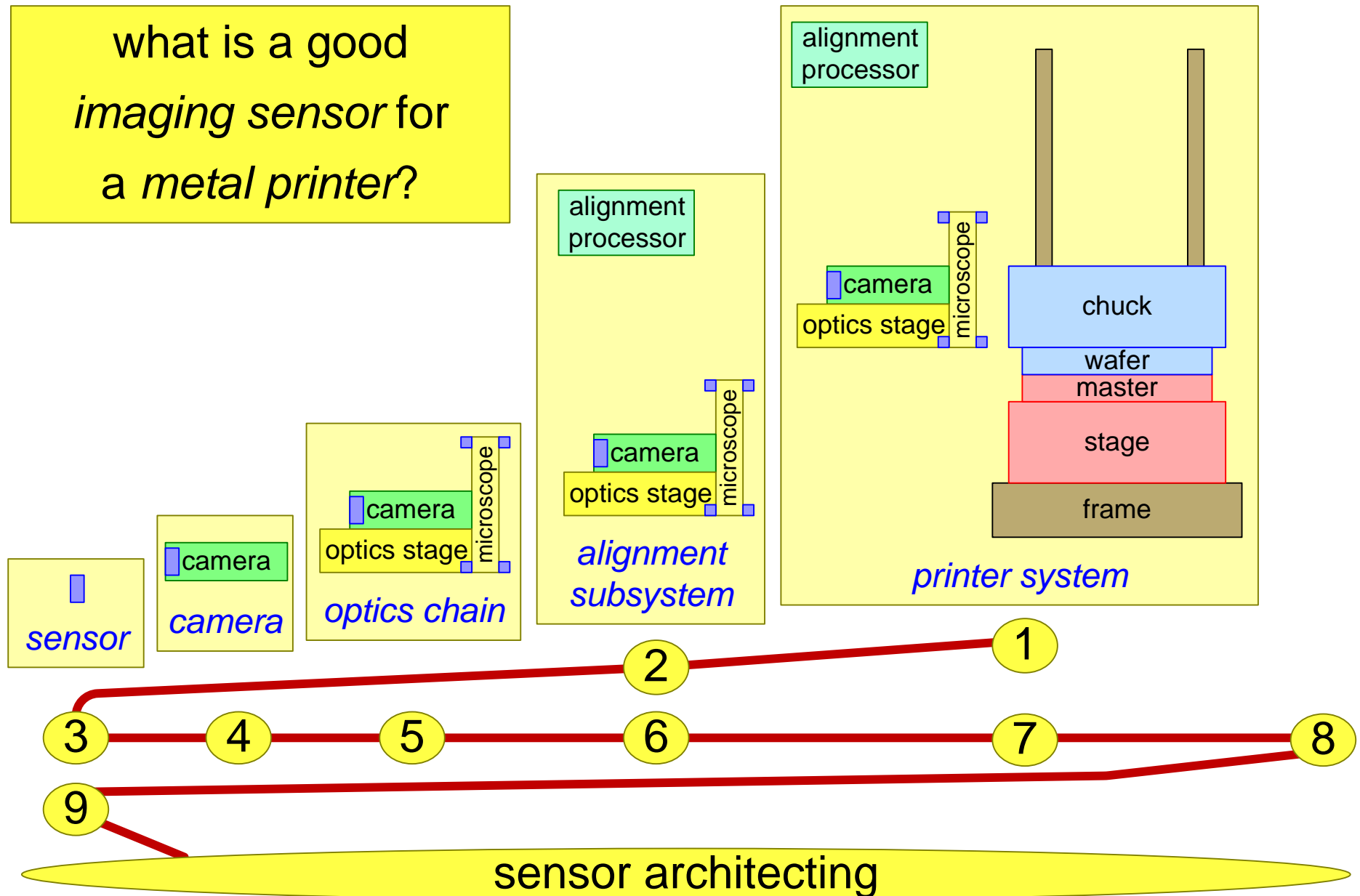
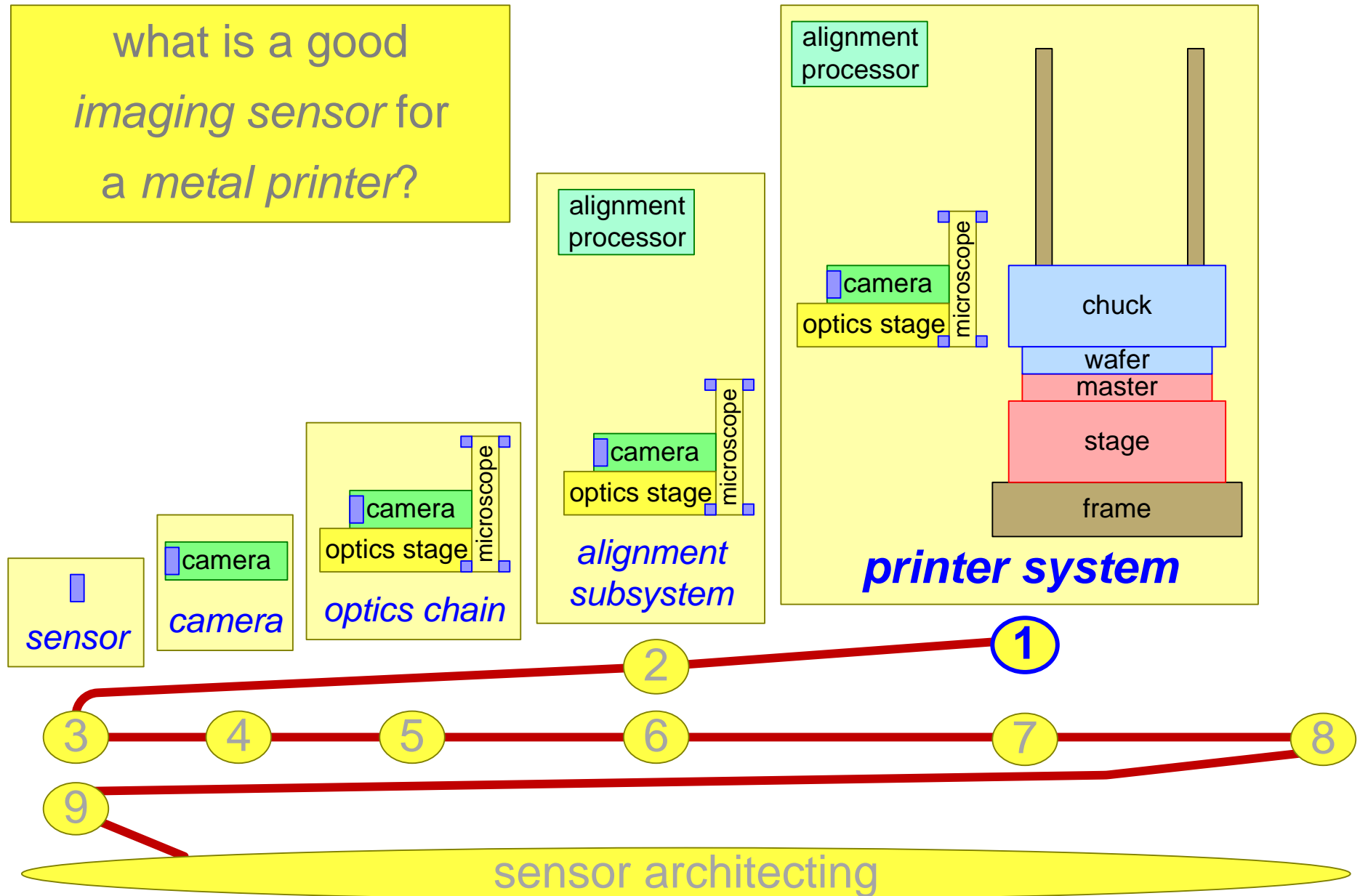


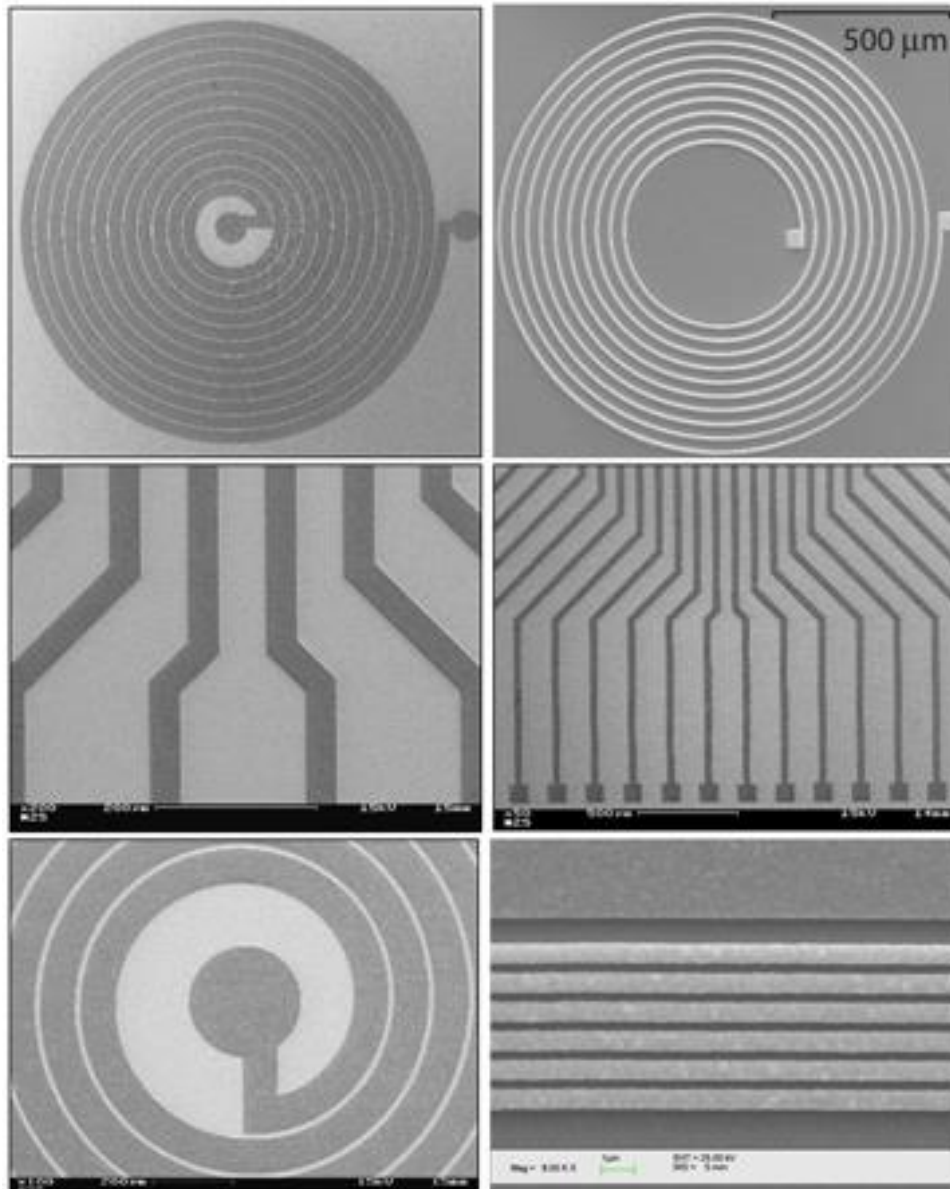
Figure of Contents™



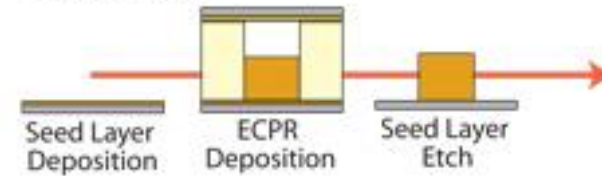
The System: a Metal Printer



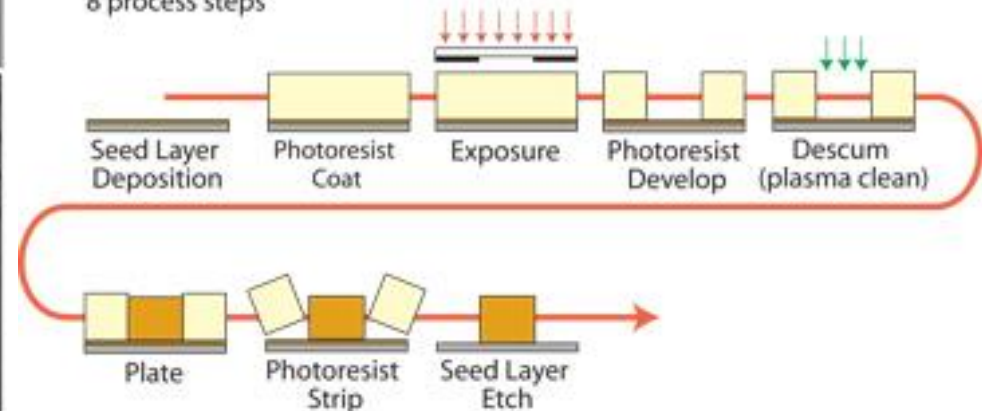
Application of the System



ECPR - ElectroChemical Pattern Replication 3 process steps



Conventional lithography based metallization 8 process steps



A metal printer
replaces 6 process step by 1 process step.
It prints an entire wafer at once.

Where will your Sensor be used?

Indicate the equivalent levels for your sensor or actuator

sensor

imaging sensor

device

camera

component

optics chain

subsystem

alignment

system

printer

application

metal printing

Worksheet: Note 3..5 KPPs for your Sensor

sensor

imaging sensor

device

camera

component

optics chain

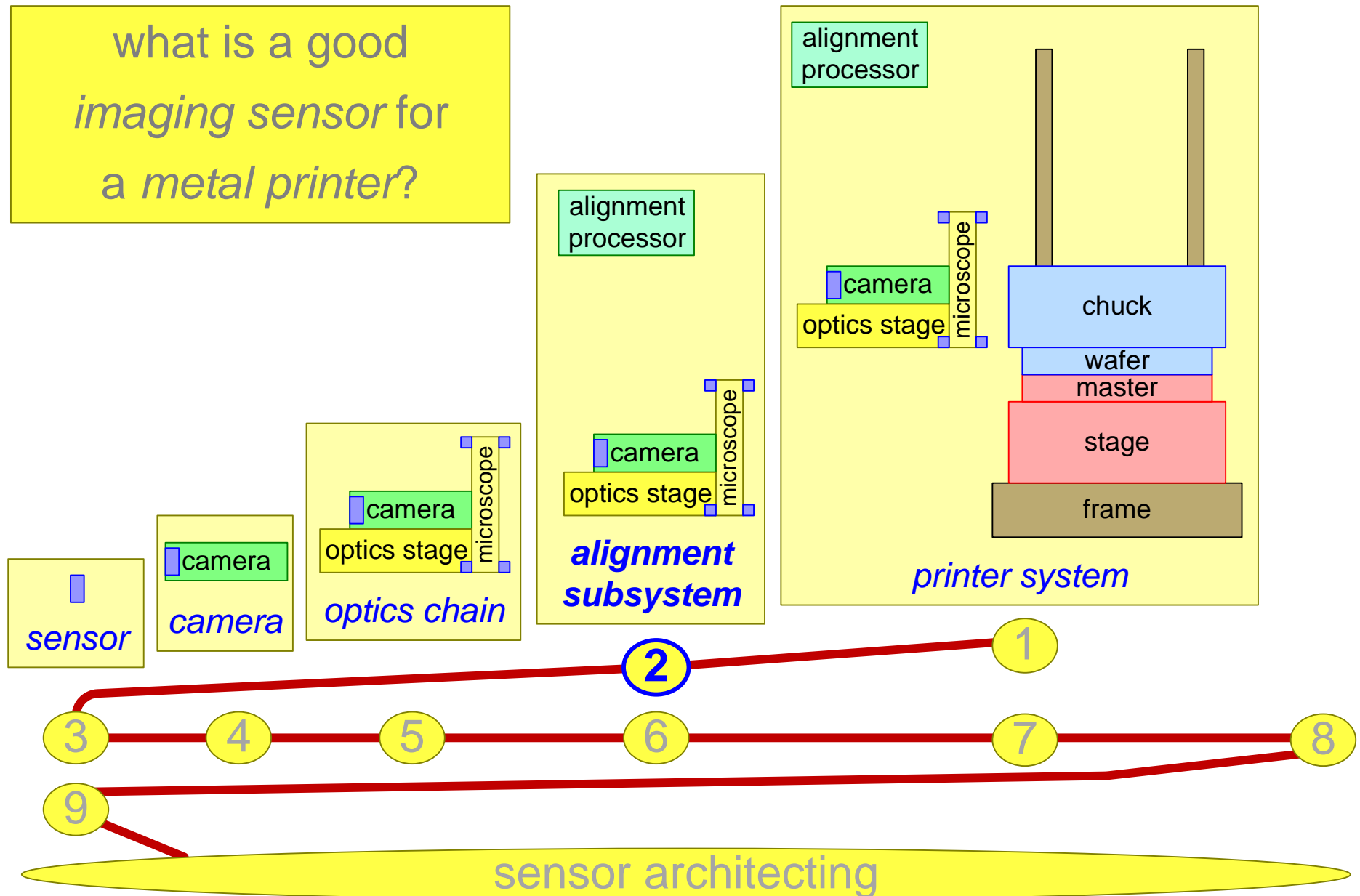
subsystem

alignment

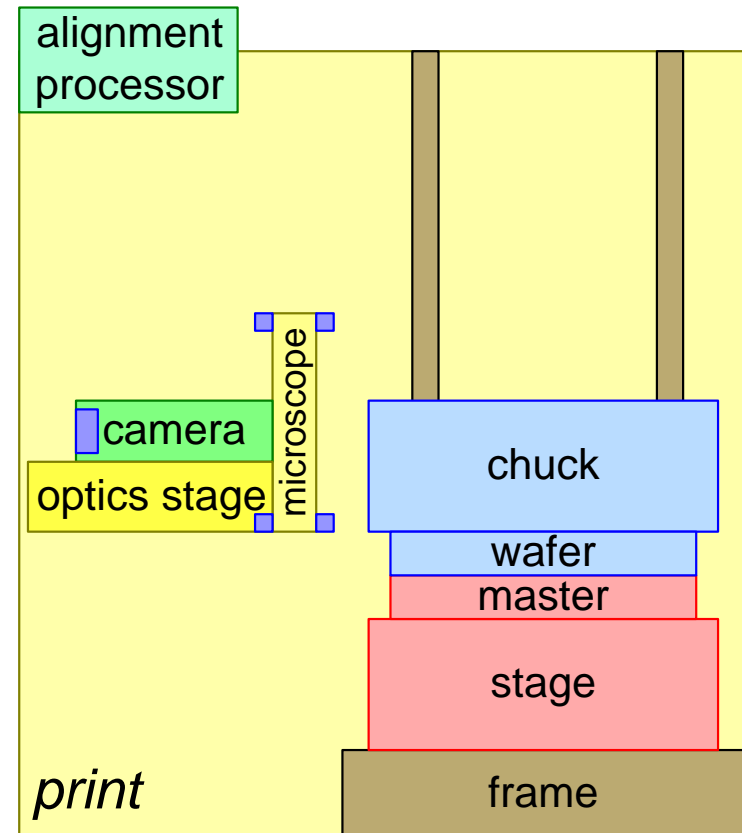
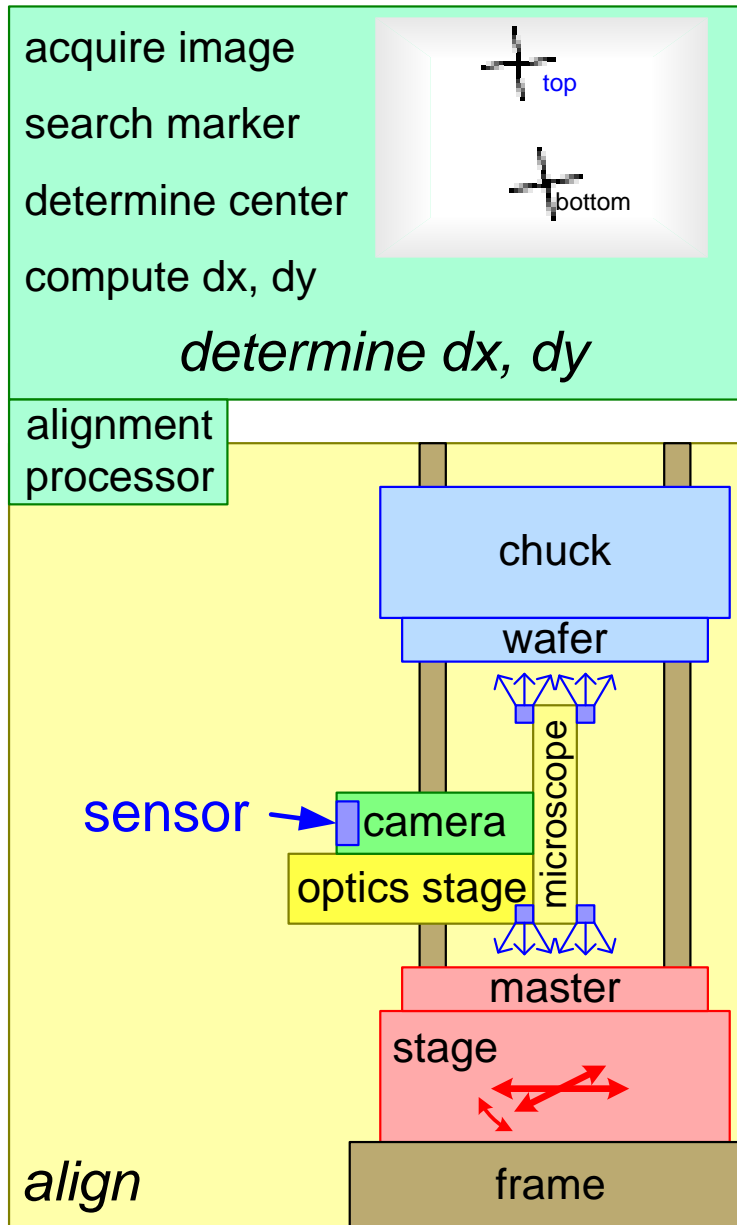
system

printer

The Subsystem: Alignment

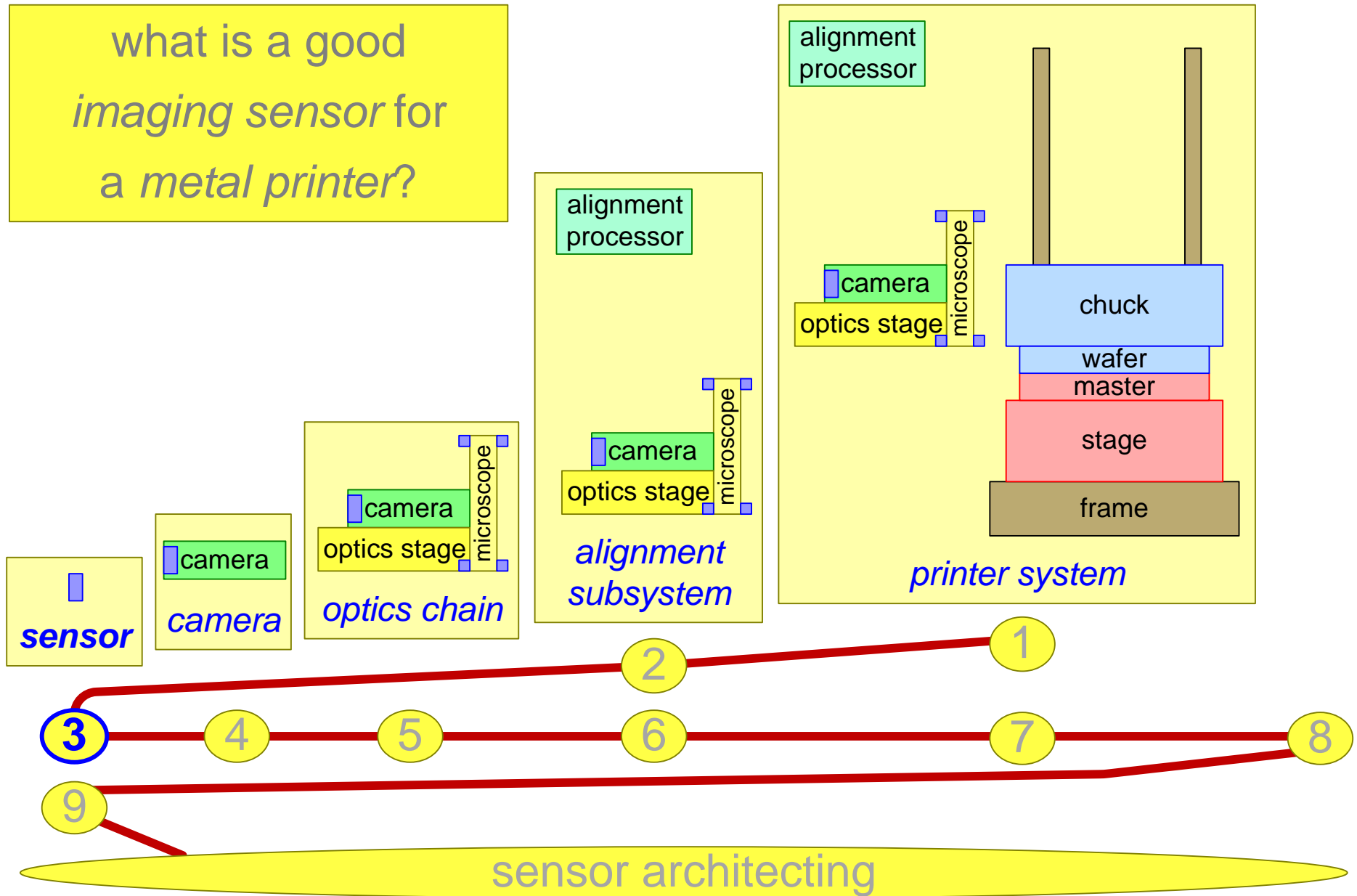


Basics of Alignment Function

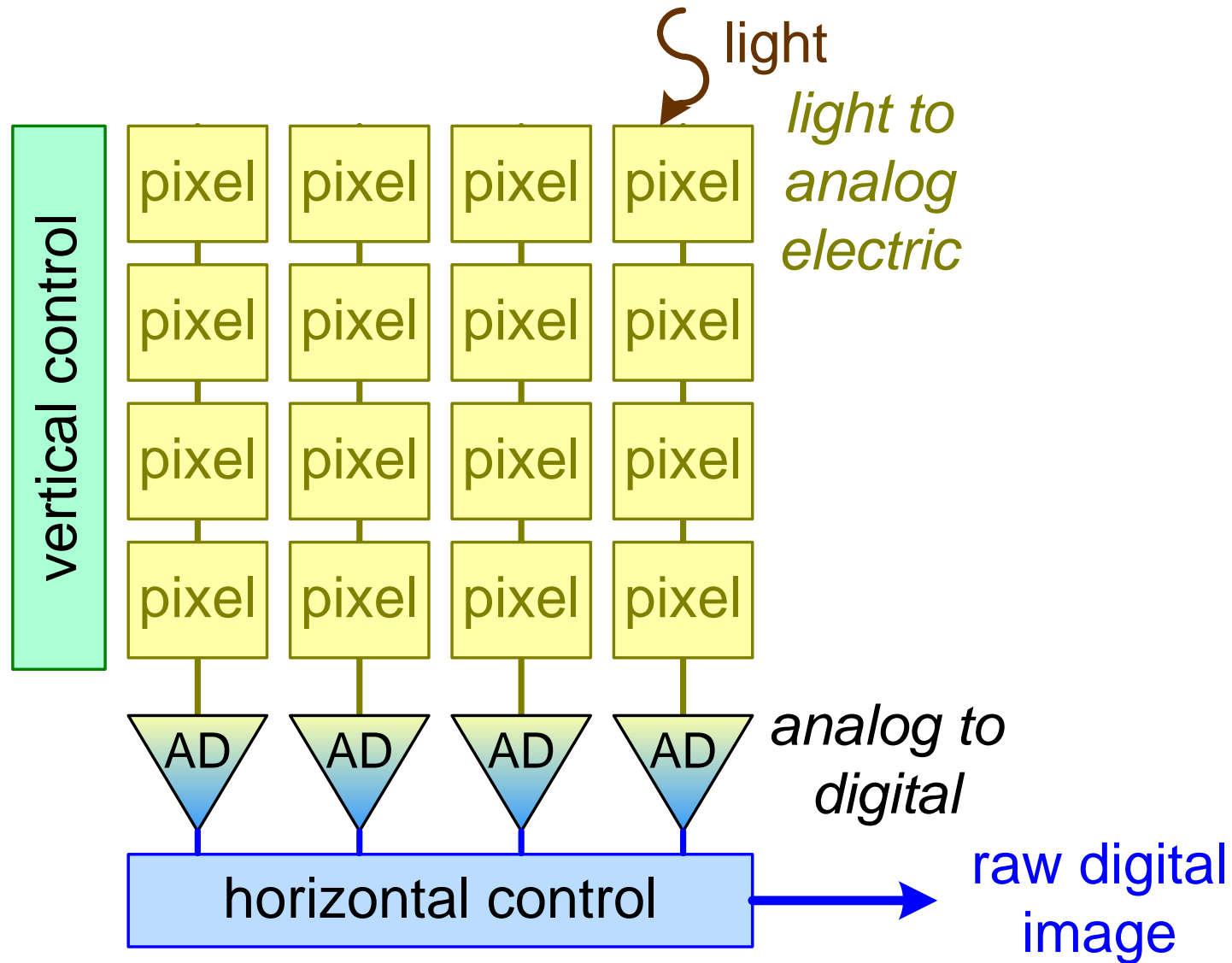


The Sensor

what is a good *imaging sensor* for a *metal printer*?



Sensor Block Diagram



What are the 3 to 5
Key Performance Parameters
of the sensor?

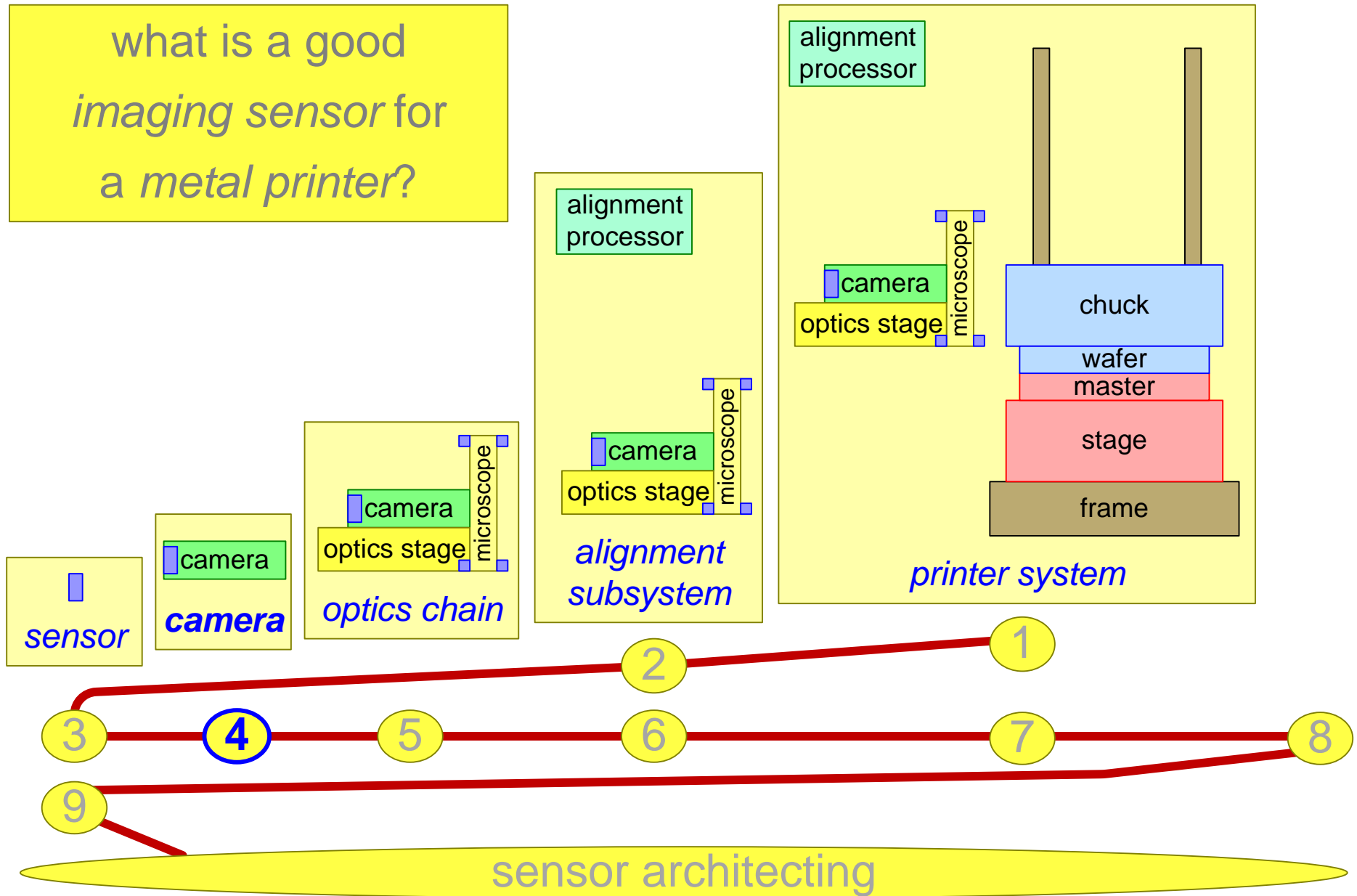
What are the 3 to 5
Key Performance Parameters
of your sensor?

Possible *Key Performance Parameters* of the sensor

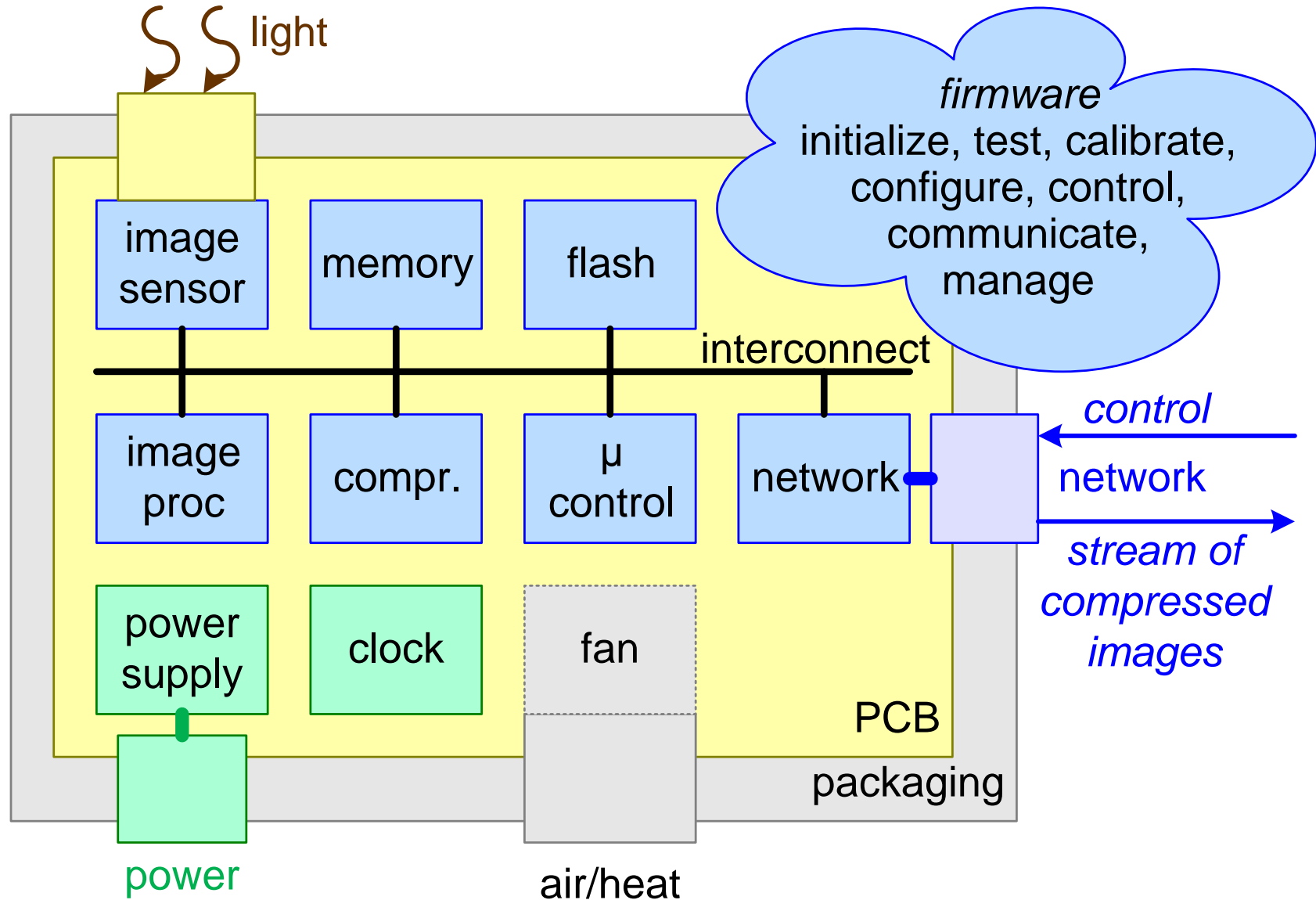
- spatial resolution
- contrast resolution
- frame rate
- image acquisition time
- image uniformity
- sensor size
- energy consumption
- cost price
- color range
- sensitivity

The Camera

what is a good
*imaging sensor for
a metal printer?*



Camera Block Diagram



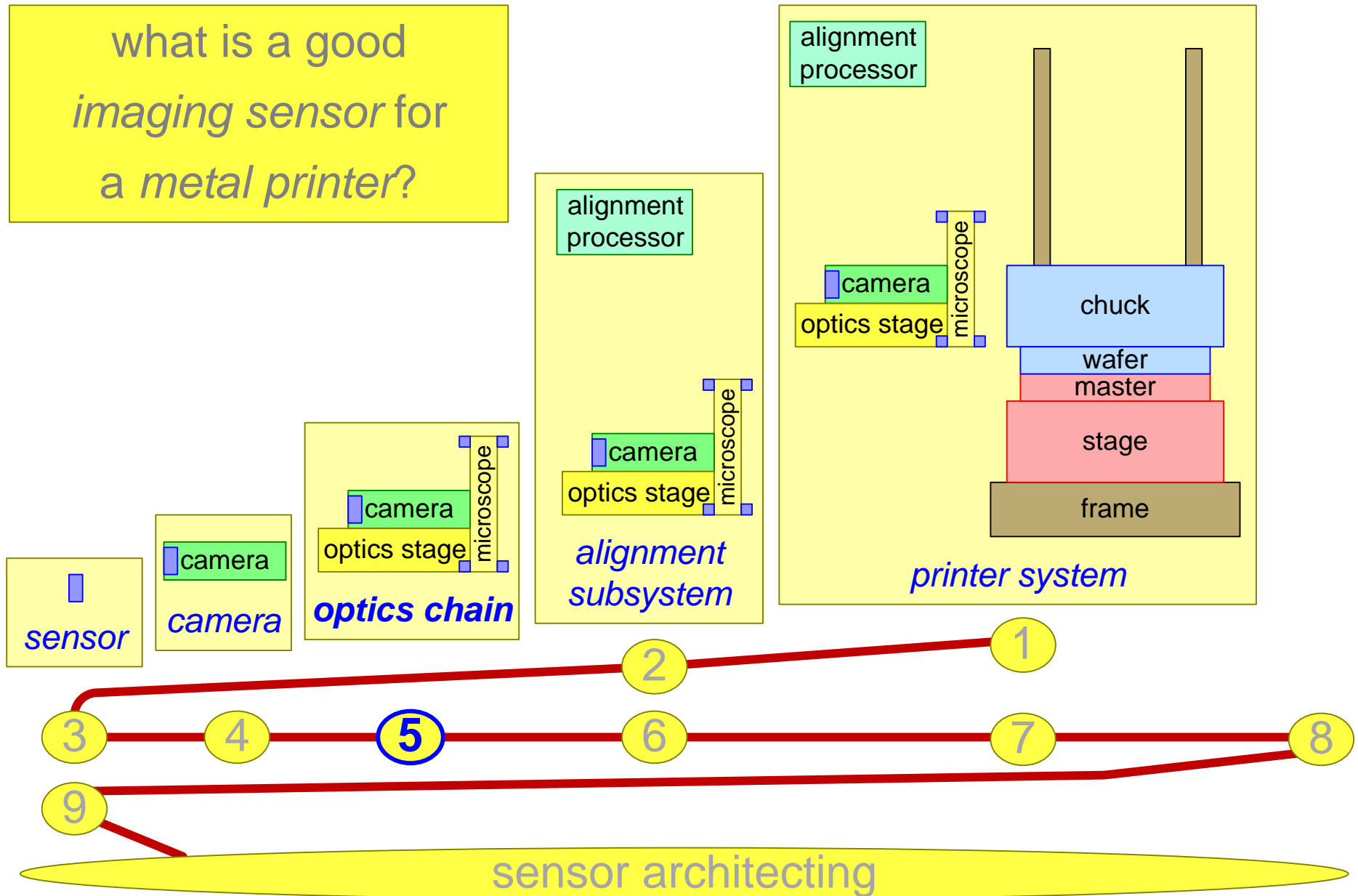
What are the 3 to 5
Key Performance Parameters
of the camera?

What are the 3 to 5
Key Performance Parameters
of the device incorporating your
sensor?

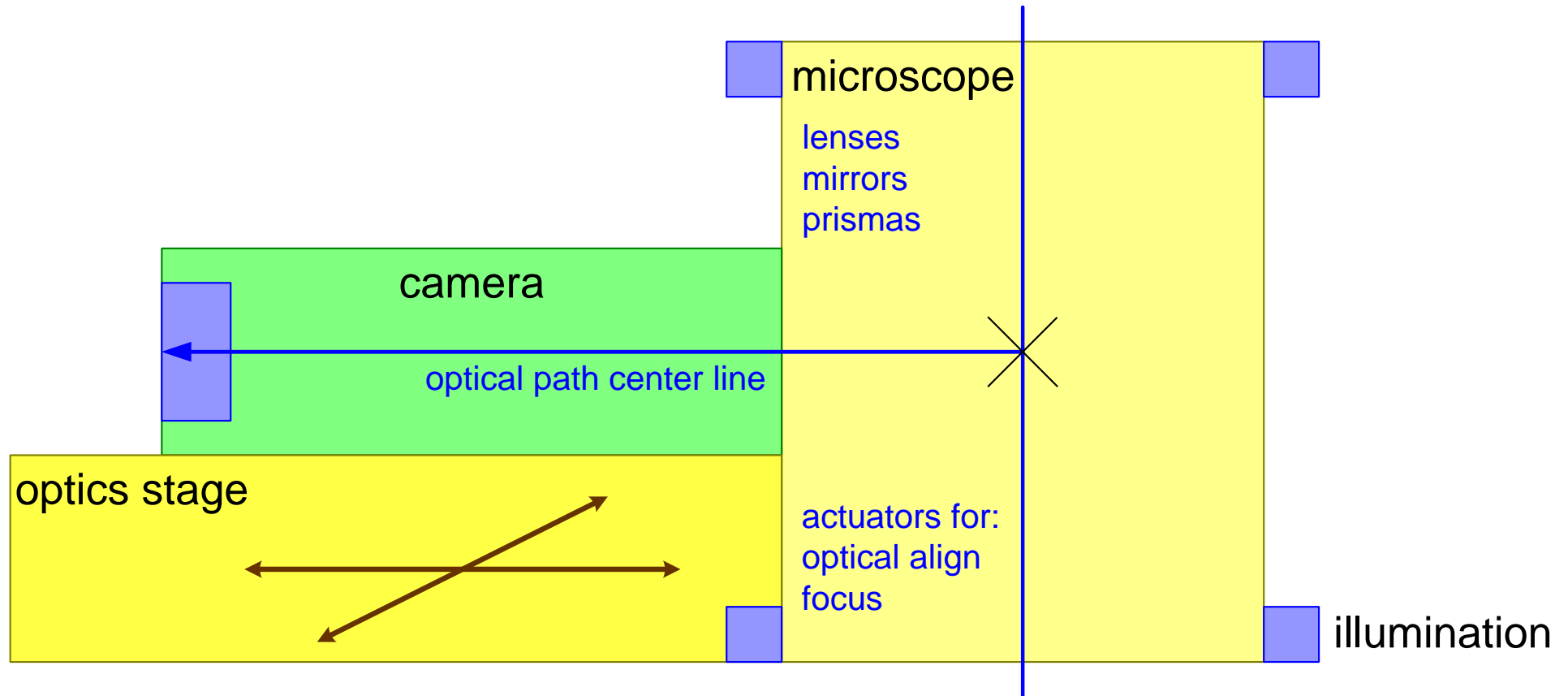
Possible
Key Performance Parameters
of the camera

- image quality (resolution, uniformity, color range)
- acquisition performance (frame rate, acquisition time)
- camera size, weight
- camera energy consumption, thermal stability
- camera cost price
- storage capacity
- compression rate and quality
- communication performance

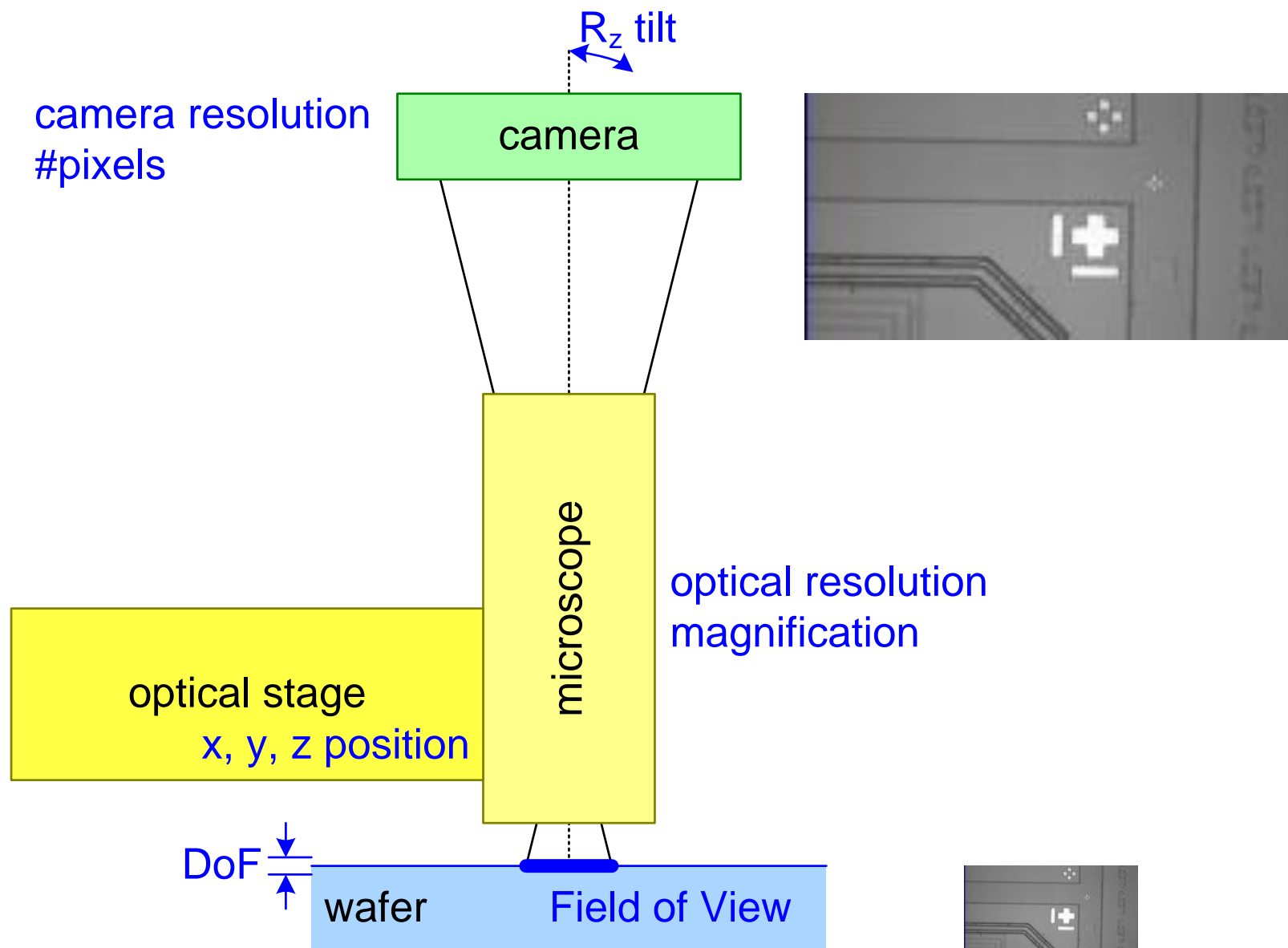
The Optics Chain



Optics Chain Block Diagram



Optics Chain



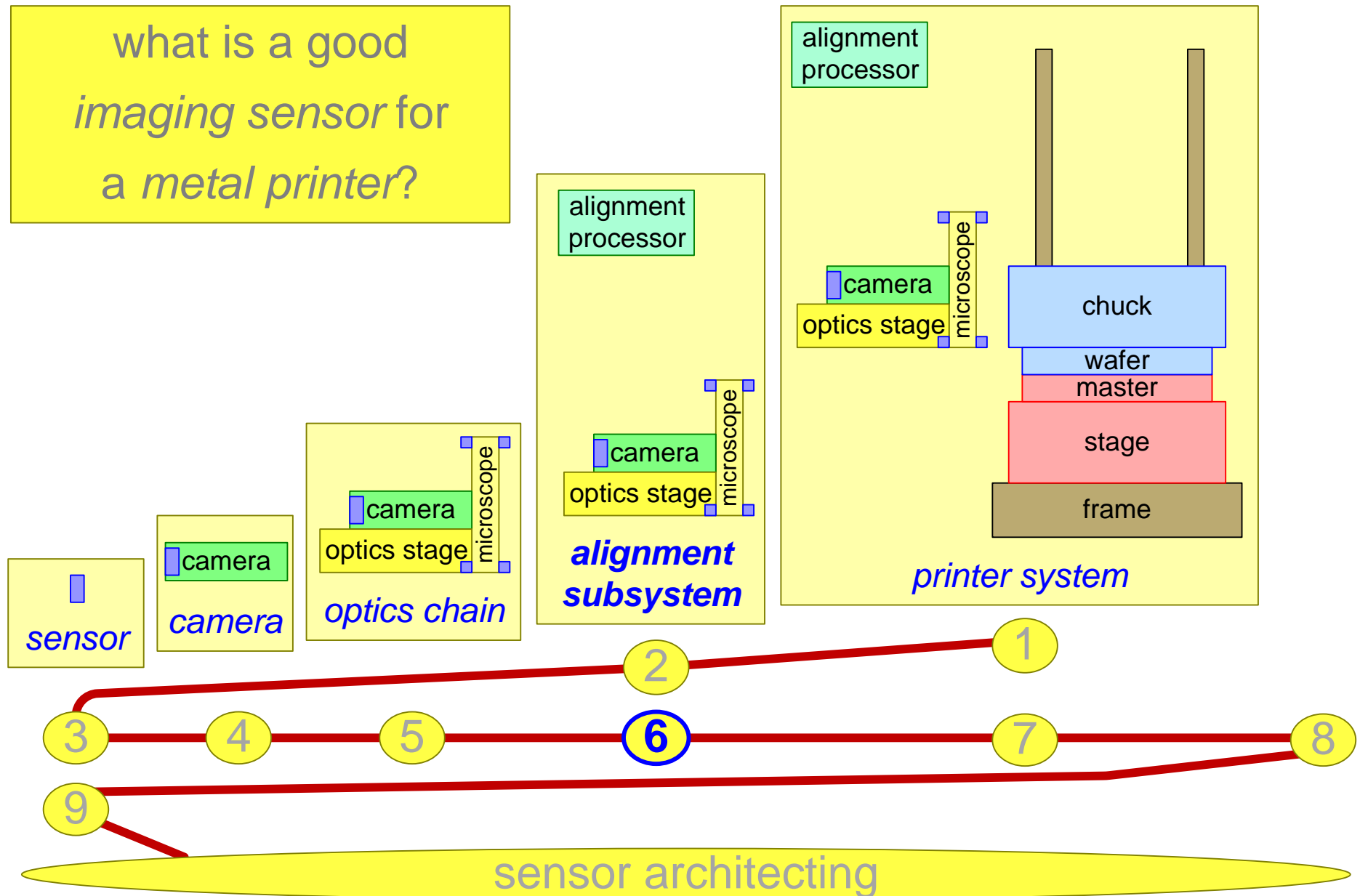
What are the 3 to 5
Key Performance Parameters
of the optics chain?

What are the 3 to 5
Key Performance Parameters
of the component incorporating your
sensor?

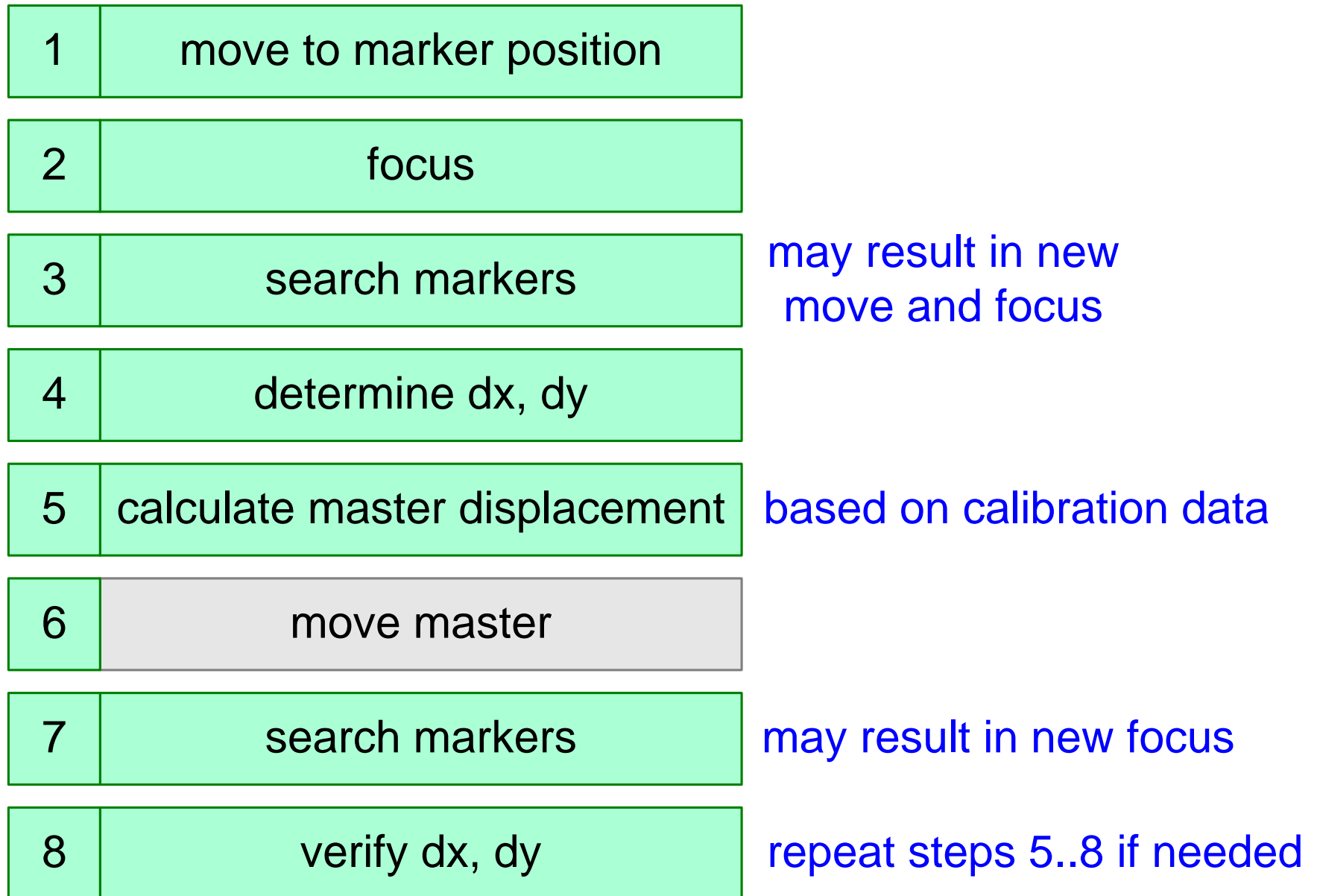
Possible *Key Performance Parameters* of the optics chain

- position and angle stability
- wafer-to-sensor image quality (resolution, uniformity, color range)
- vertical size
- acquisition performance (frame rate, acquisition time)
- stage performance (speed, stability, reproducibility)
- focus performance
- x, y range
- thermal stability
- cost, weight, size stage+optics

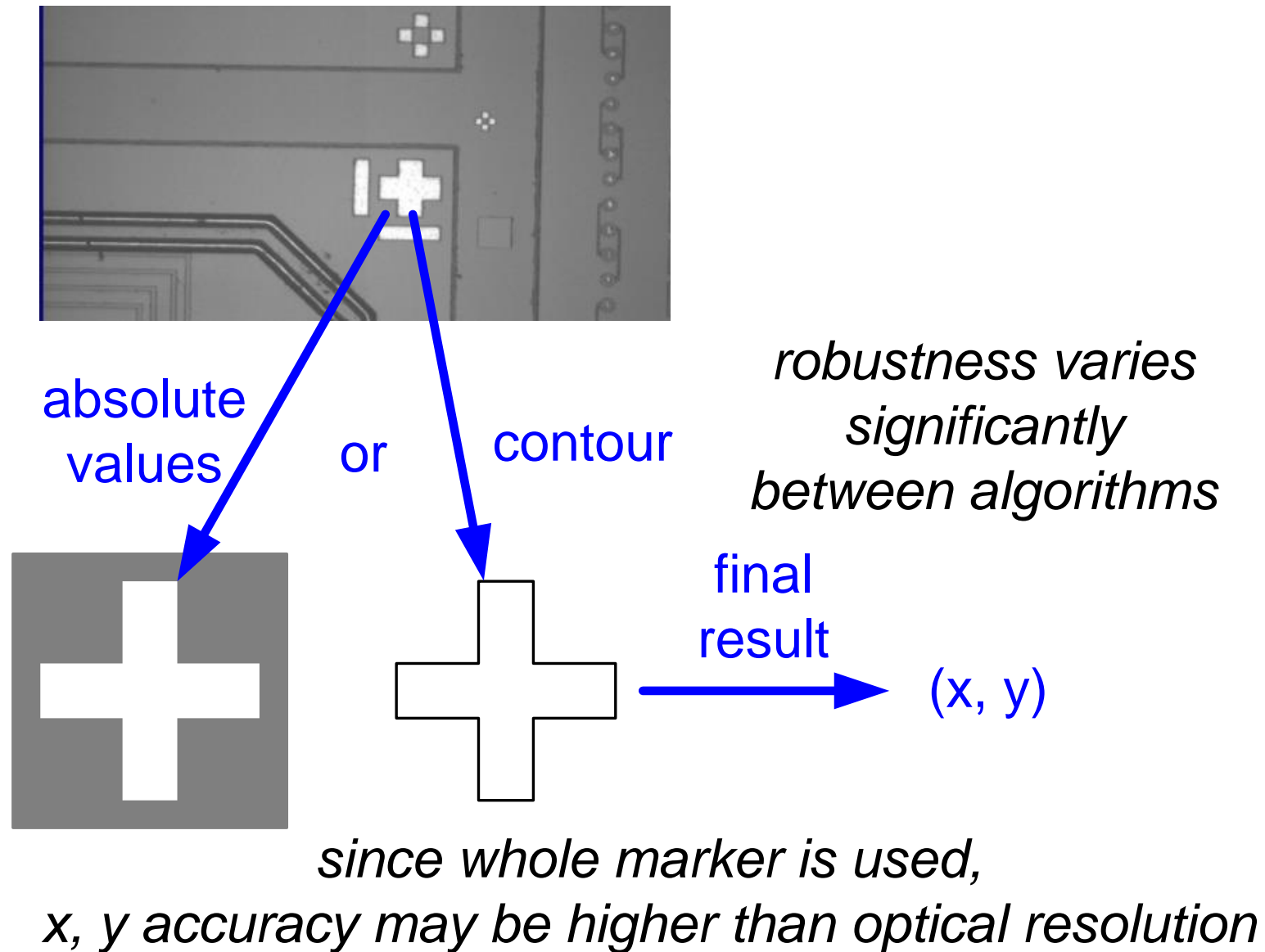
The Alignment Subsystem



Alignment Workflow



Alignment Algorithm



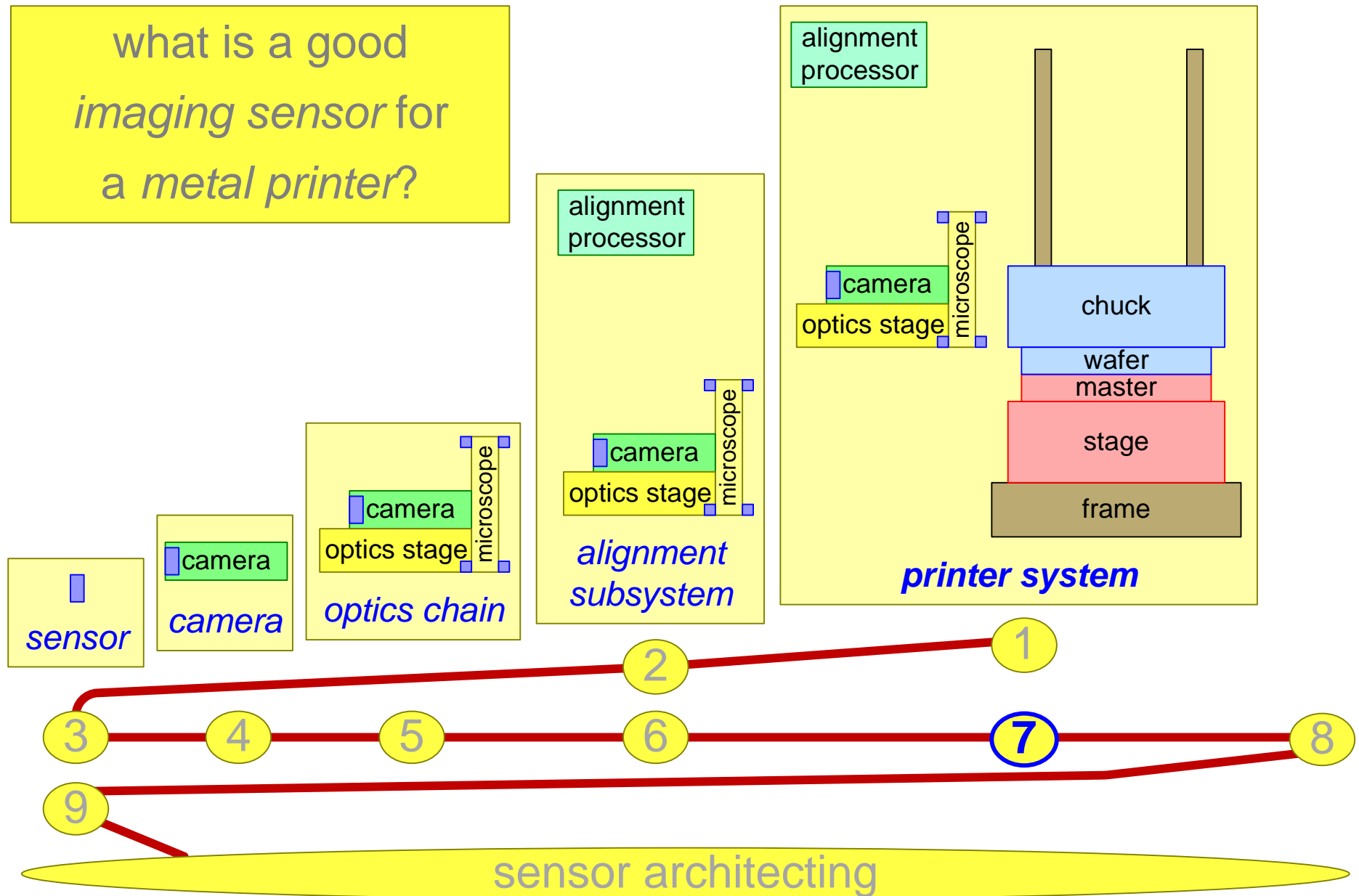
What are the 3 to 5
Key Performance Parameters
of the alignment subsystem?

What are the 3 to 5
Key Performance Parameters
of the subsystem incorporating your
sensor?

Possible
Key Performance Parameters
of the alignment subsystem

- dx, dy after alignment
- alignment cycle time
- robustness for markers, patterns, wafers, temperature
- cost, weight, size subsystem

The Printer System



What are the 3 to 5
Key Performance Parameters
of the printer system?

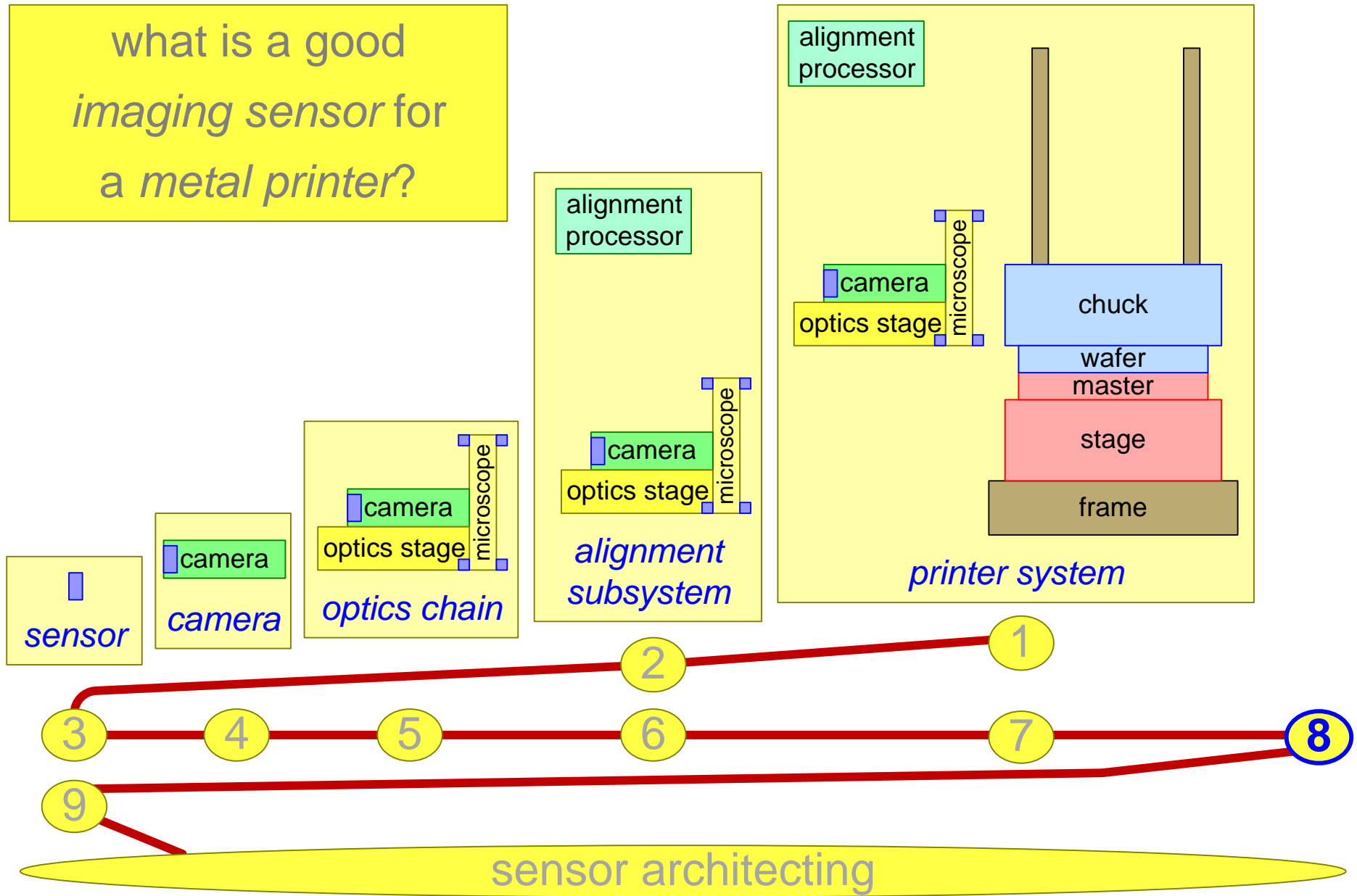
What are the 3 to 5
Key Performance Parameters
of the system incorporating your
sensor?

Possible
Key Performance Parameters
of the printer system

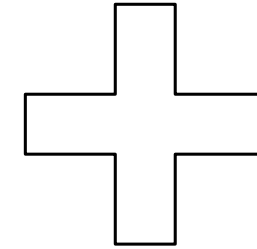
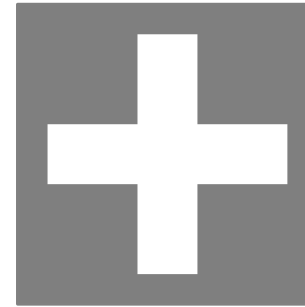
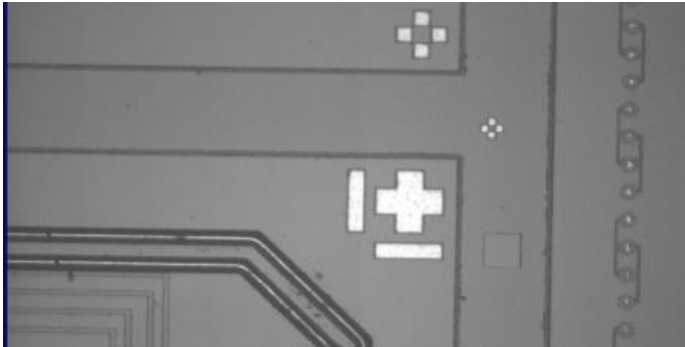
- print quality (pattern resolution, cross section control)
- overlay (=positioning accuracy)
- throughput
- reliability (uptime, high MTBF)
- robustness for markers, patterns, wafers, temperature
- integral costs (system cost, operational costs)
- consumables and waste
- fab interoperability (wafers and information)
- footprint

The Context

what is a good
*imaging sensor for
a metal printer?*



How Process can Influence Alignment



Context: process influence on alignment

what if little contrast



what if slow transition



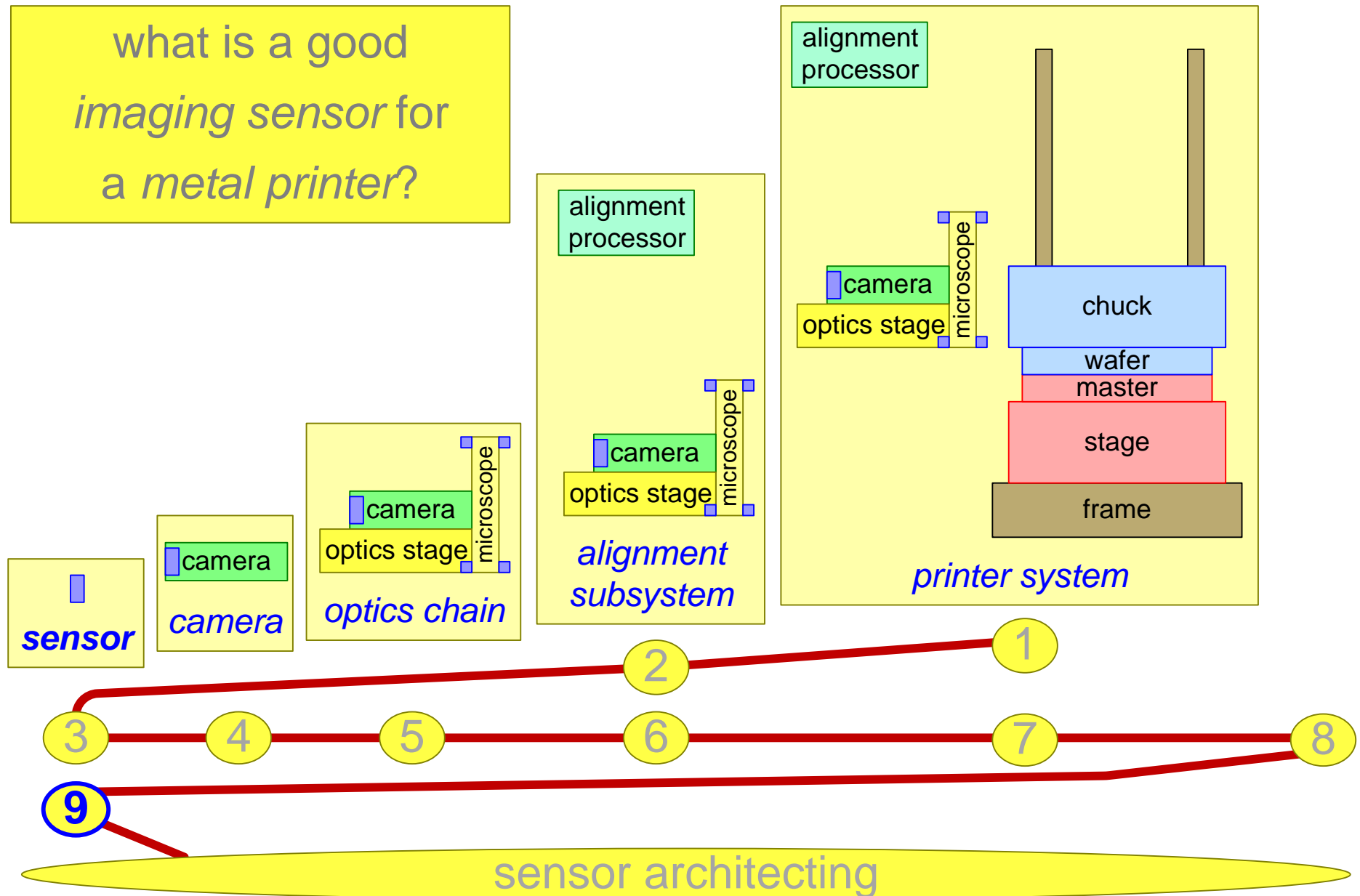
what if wafer surface height varies



what if shadows

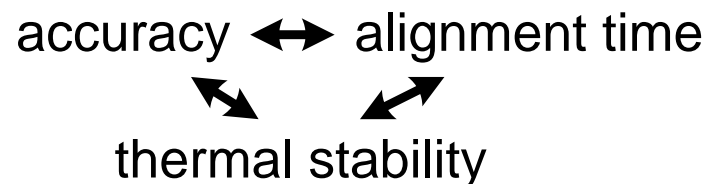
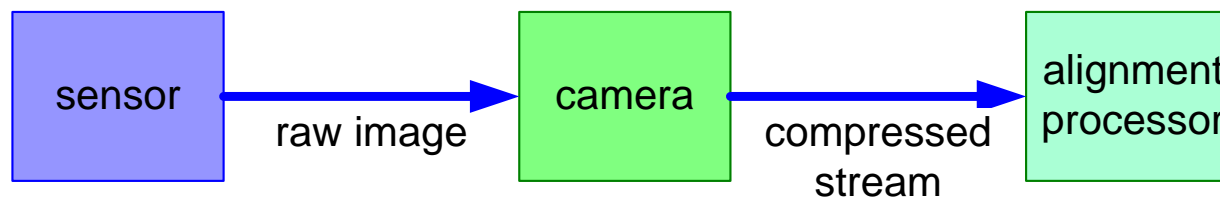
what if marker is damaged

Revisiting the Sensor

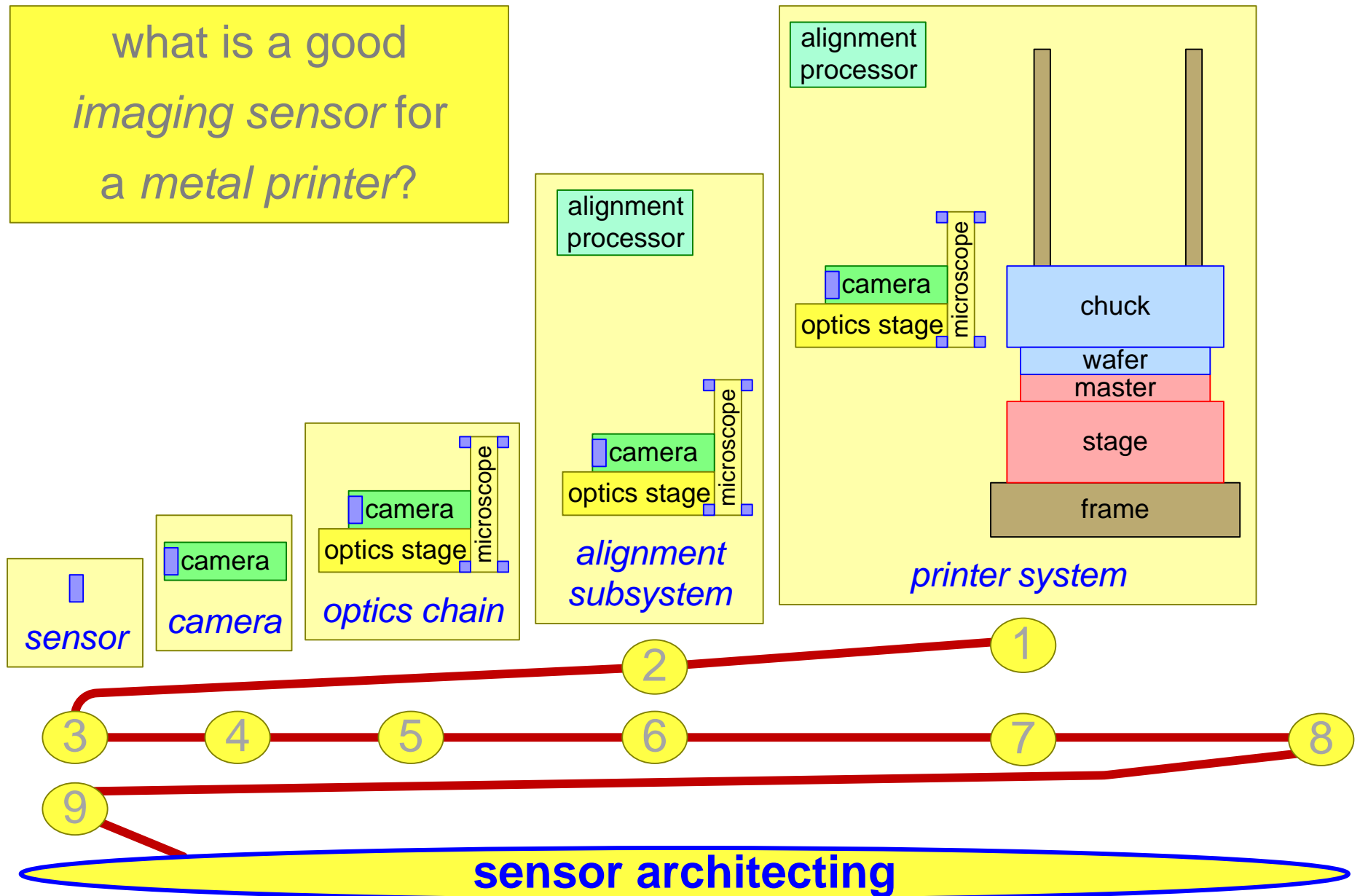


Part of the Design Space

	<i>benefits</i>	<i>disadvantages</i>
high resolution	accurate dx, dy	long acq time long transfer time long calculation time high energy consumption
large FoV	easy to find markers	long acq time long transfer time high energy consumption
red light	visibility marker	low optical resolution
blue light	high optical resolution	poor visibility marker
continuous on	thermal steady state	requires continuous cooling



Sensor Architecting



Sensor Architecting: 8 Orders Zoom in-out

