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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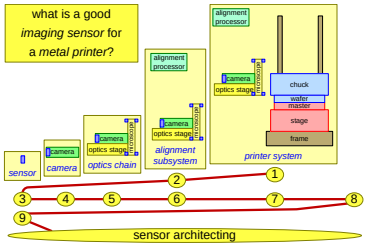
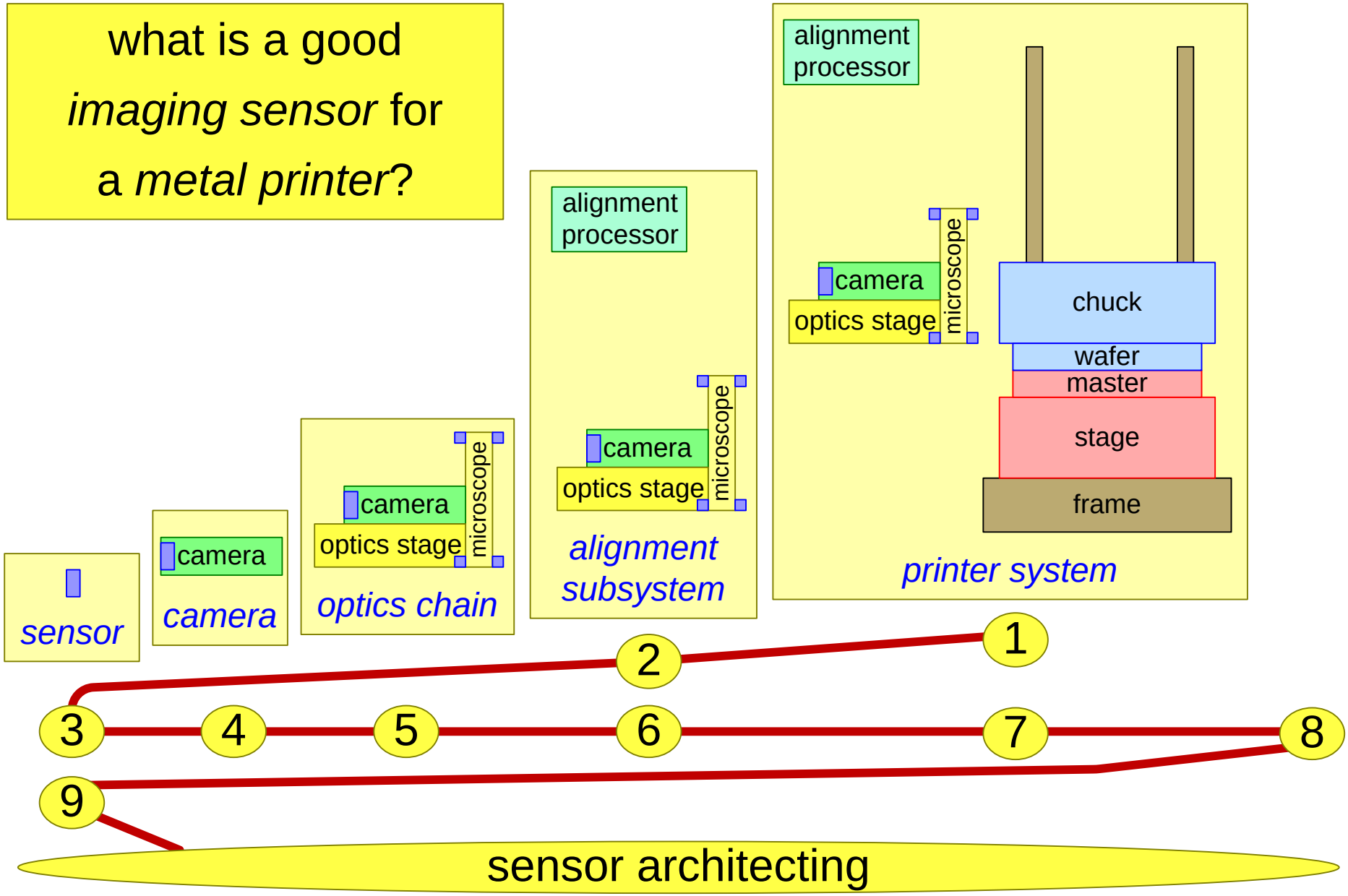
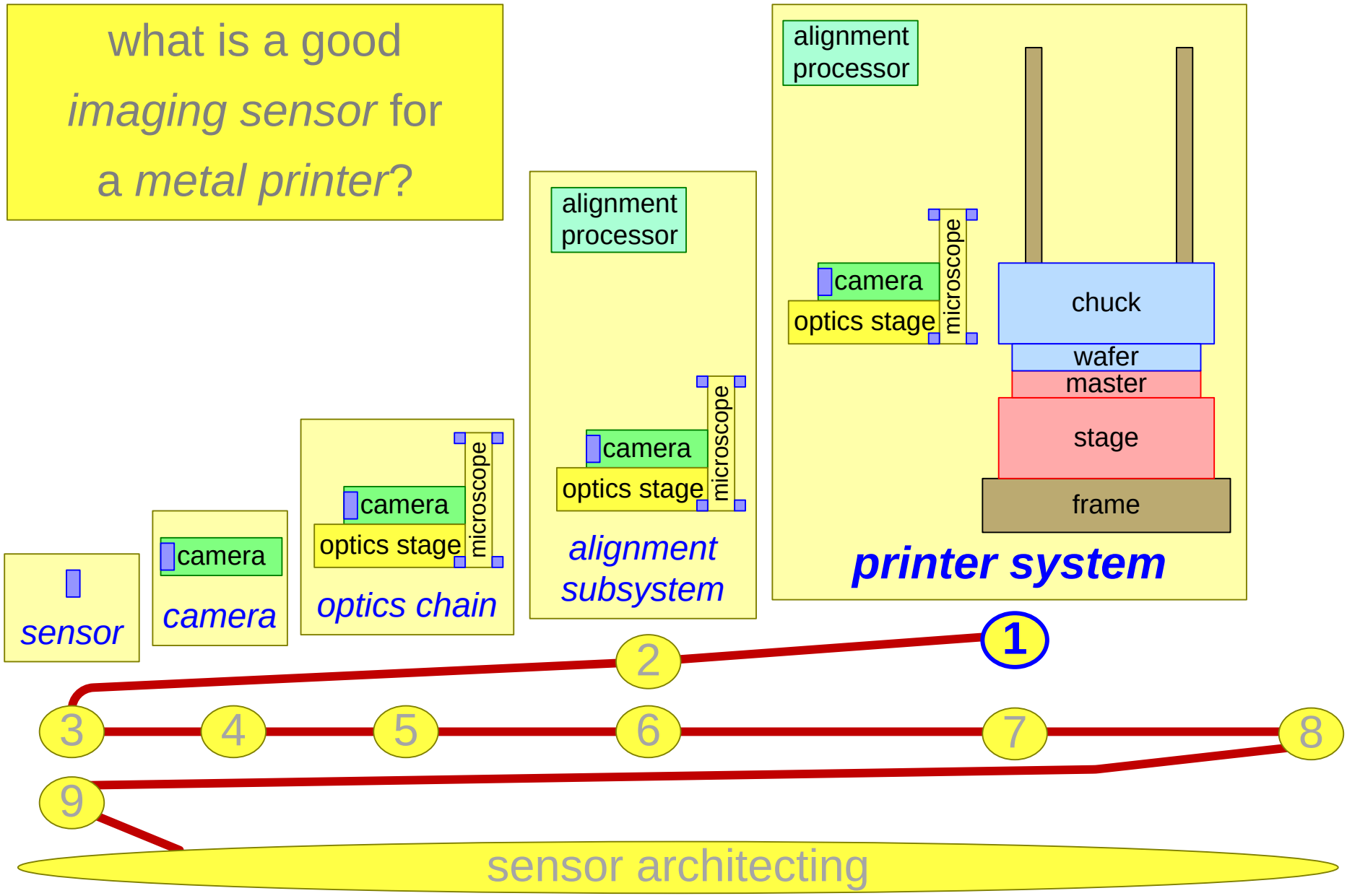


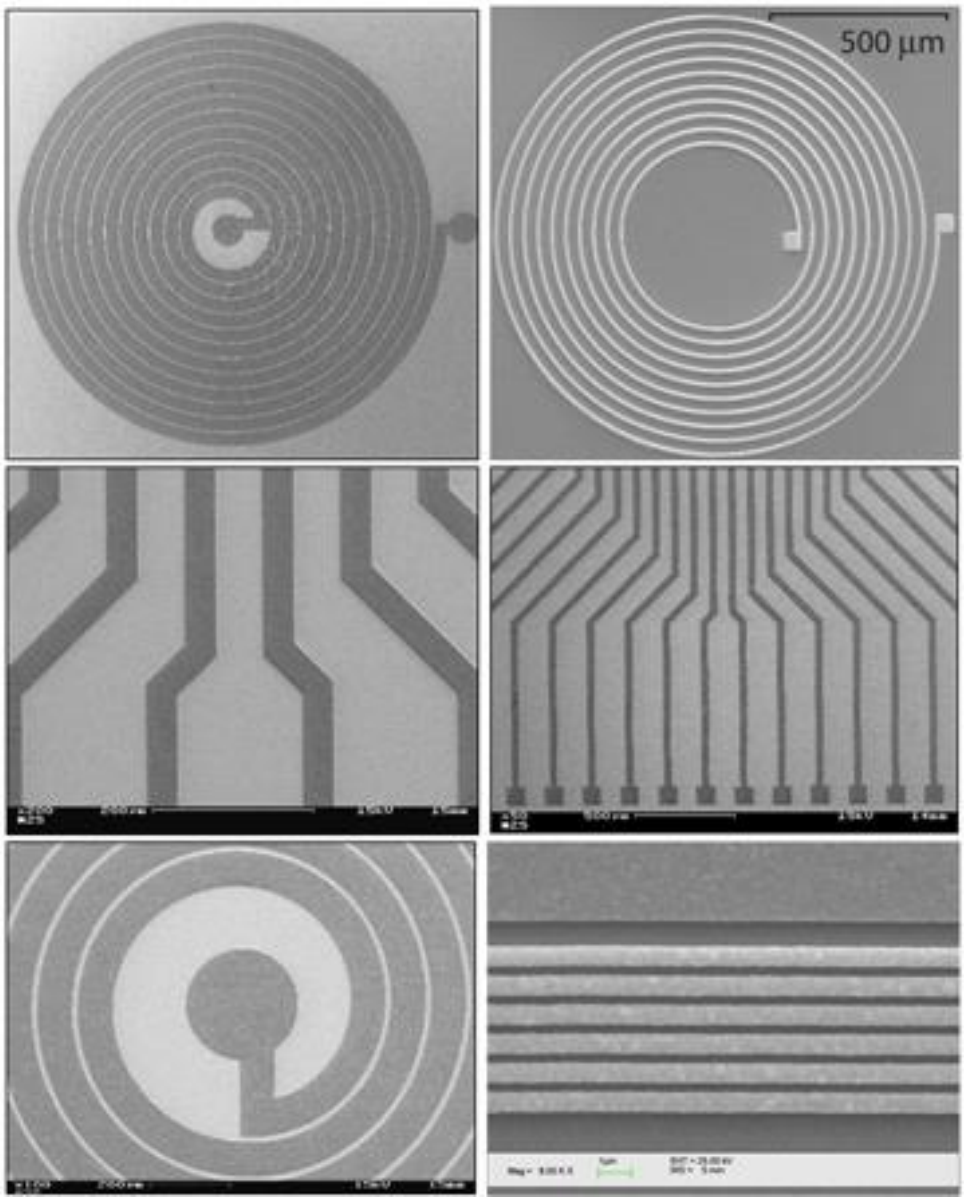
Figure of Contents™

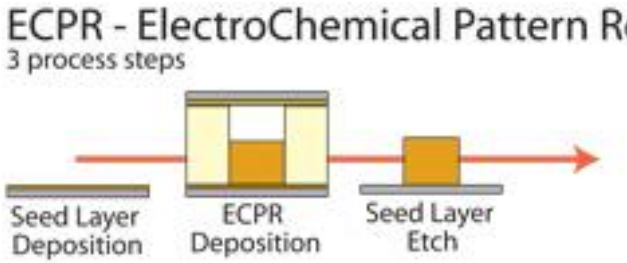


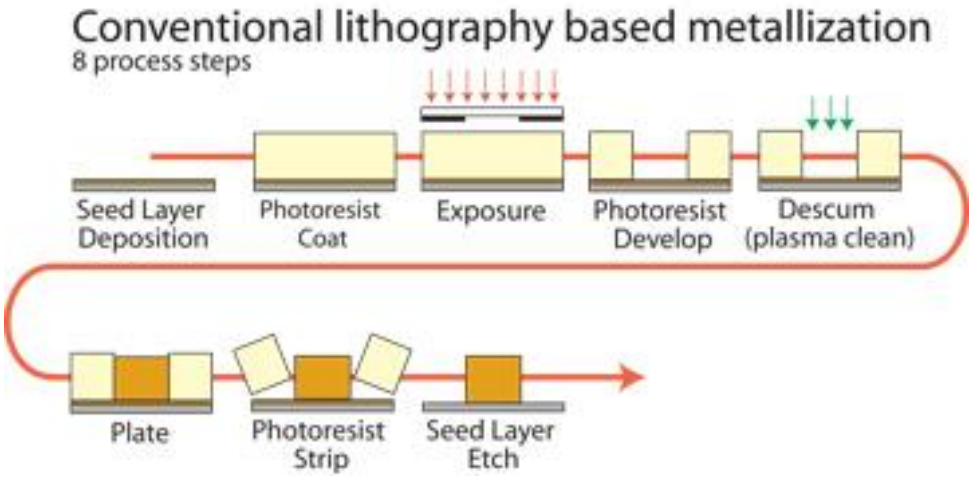
The System: a Metal Printer



Application of the System







A metal printer

replaces 6 process step by 1 process step.

It prints an entire wafer at once.

Where will your Sensor be used?

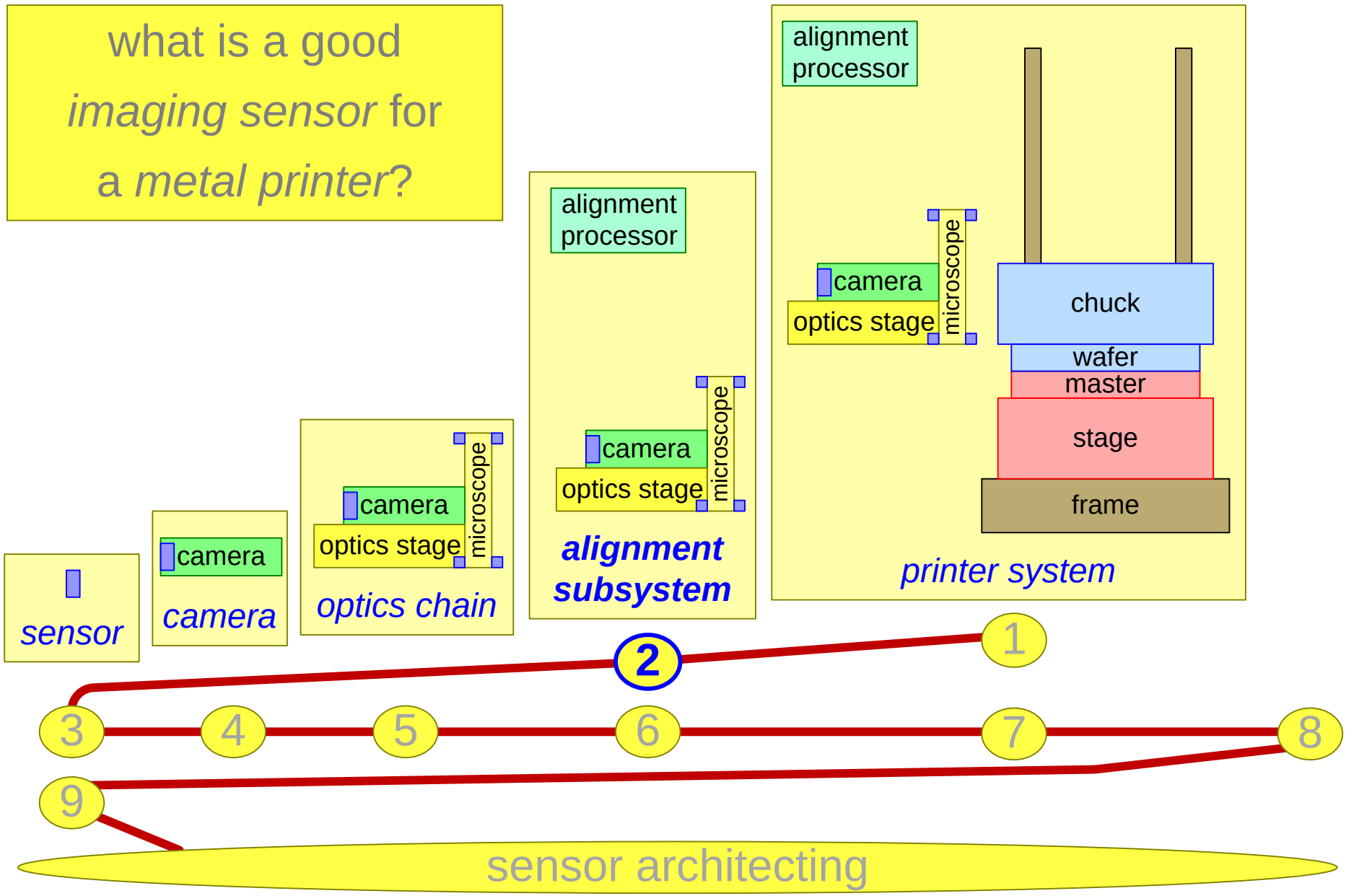
Indicate the equivalent levels for your sensor or actuator

sensor	imaging sensor
device	camera
component	optics chain
subsystem	alignment
system	printer
application	metal printing

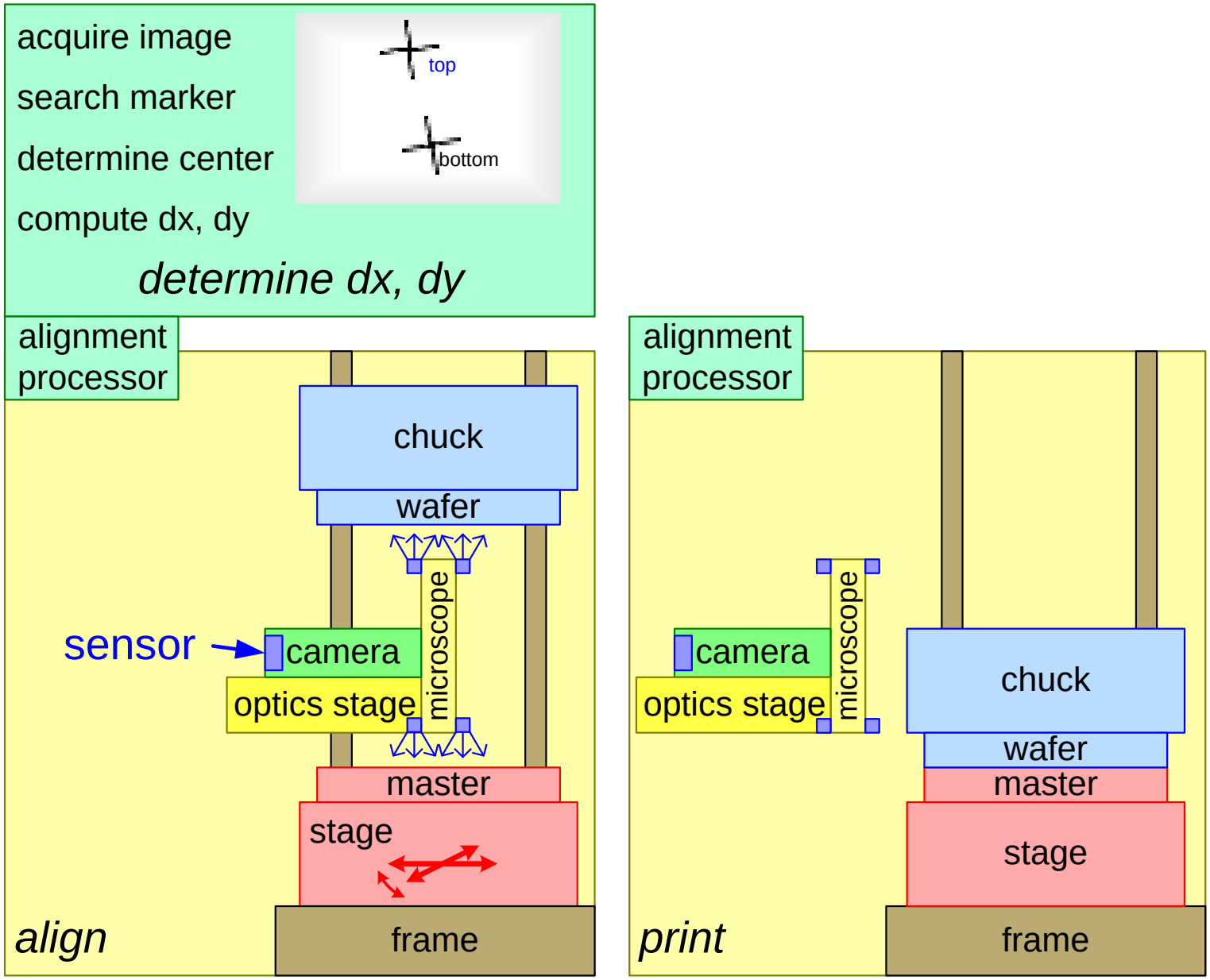
Worksheet: Note 3..5 KPPs for your Sensor

sensor imaging sensor
device camera
component optics chain
subsystem alignment
system printer

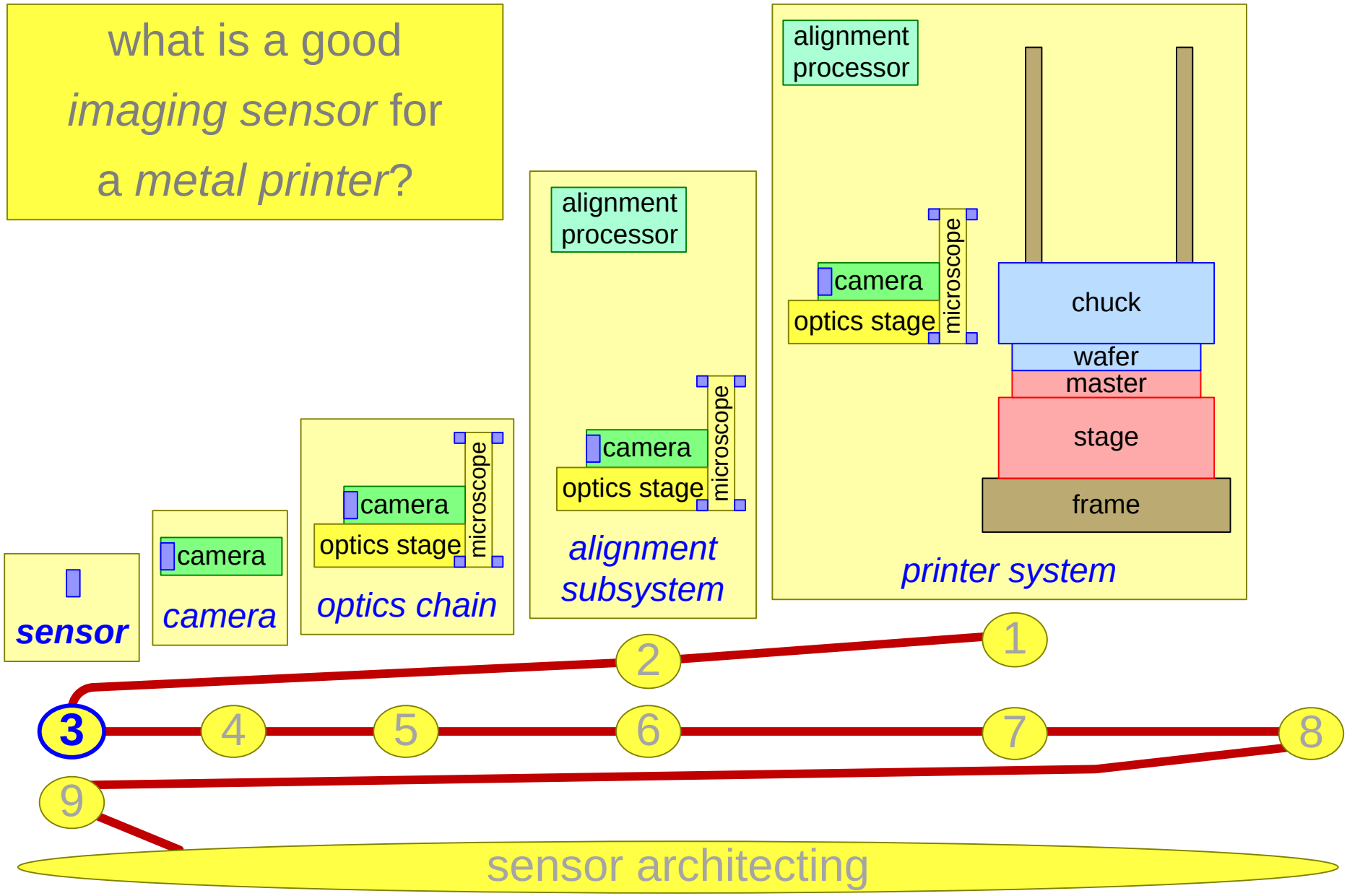
The Subsysem: Alignment



Basics of Alignment Function



The Sensor


what is a good
imaging sensor for
a *metal printer*?
alignment processor
camera
optics stage
microscope
chuck
wafer
master
stage
frame
printer system
alignment processor
camera
optics stage
microscope
alignment subsystem
camera
optics stage
microscope
optics chain
camera
camera
sensor
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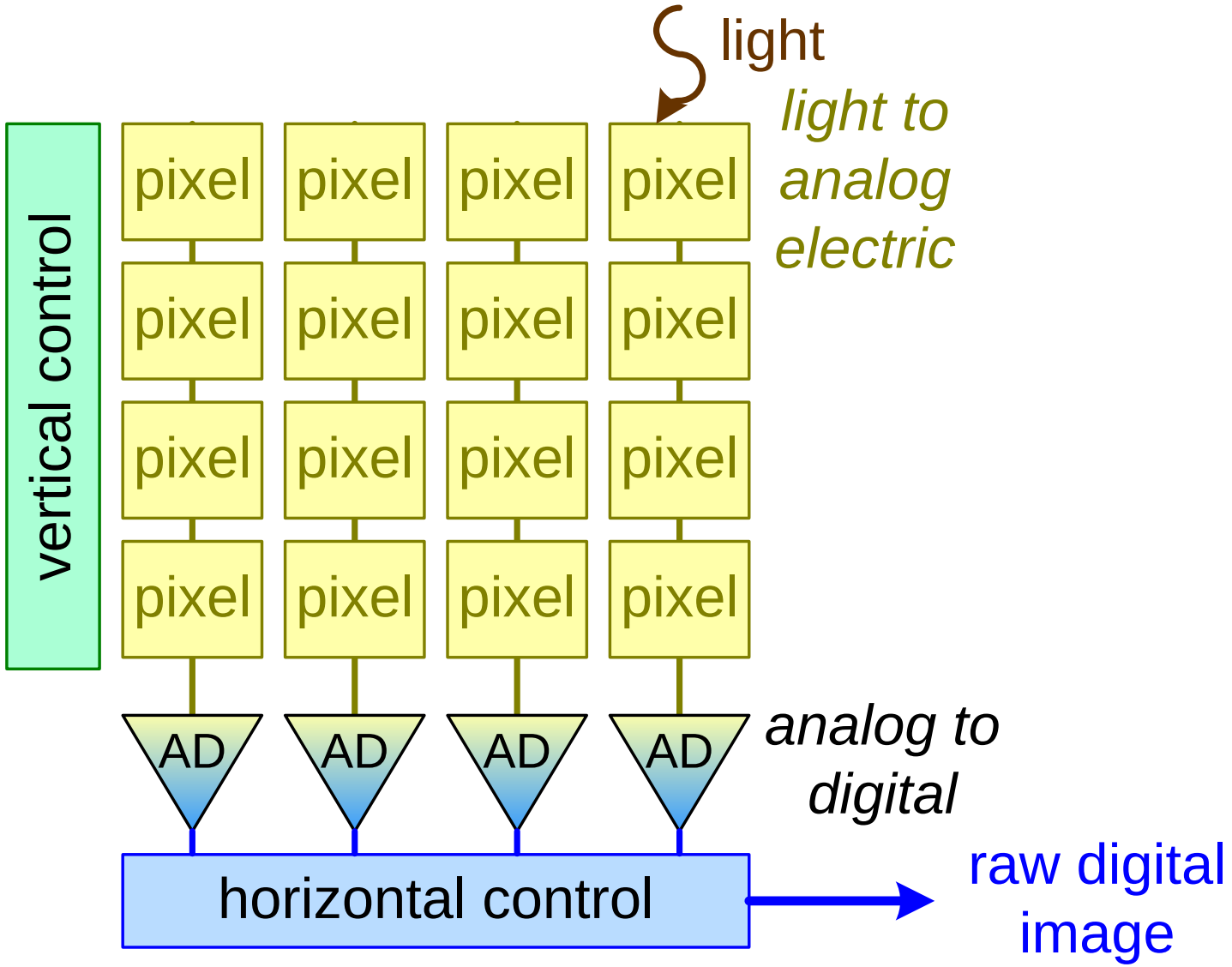
9
sensor architecting

Sensor Block Diagram



Question Sensor Performance

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

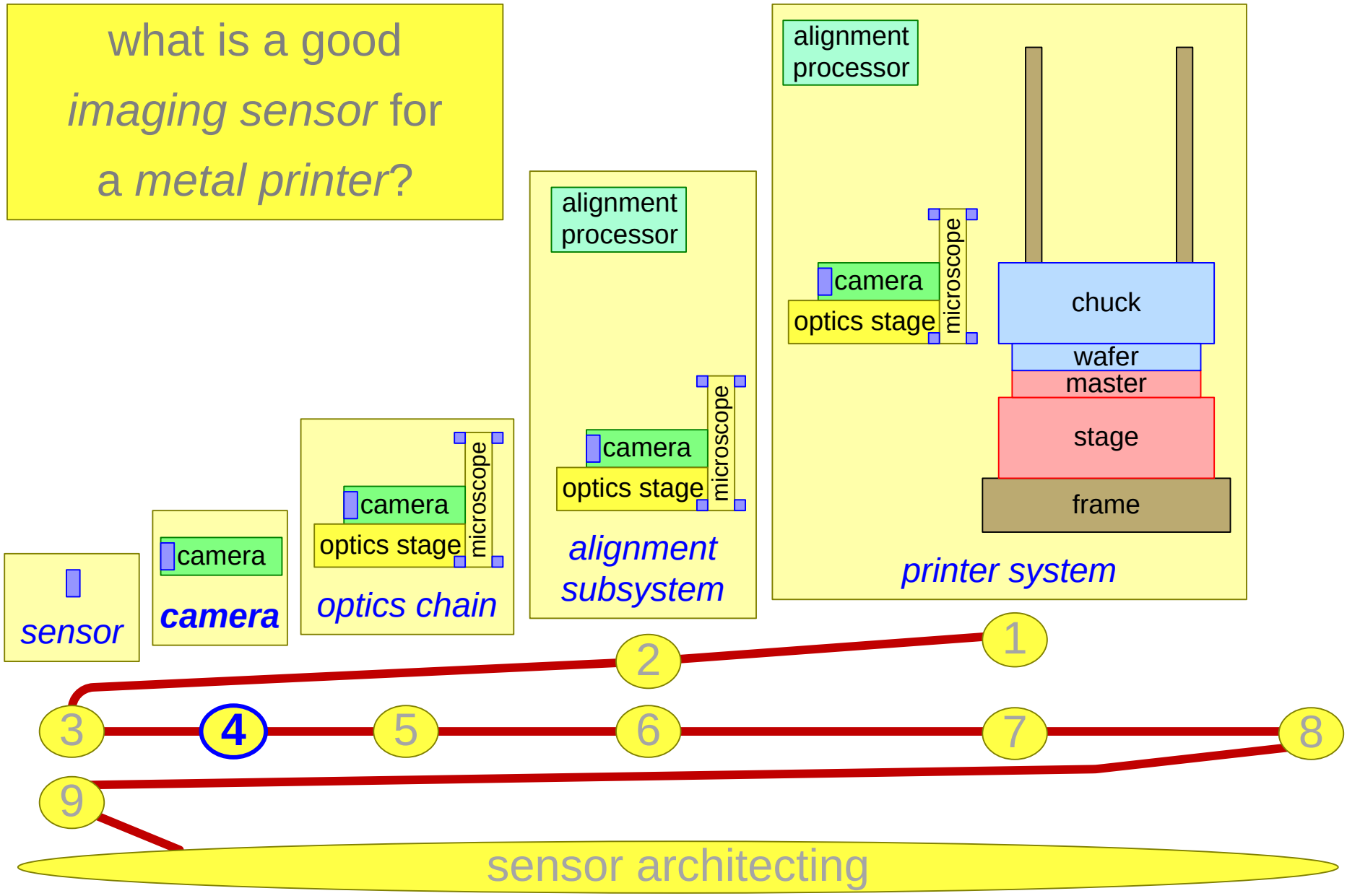
What are the 3 to 5
Key Performance Parameters
of your sensor?

Potential KPPs 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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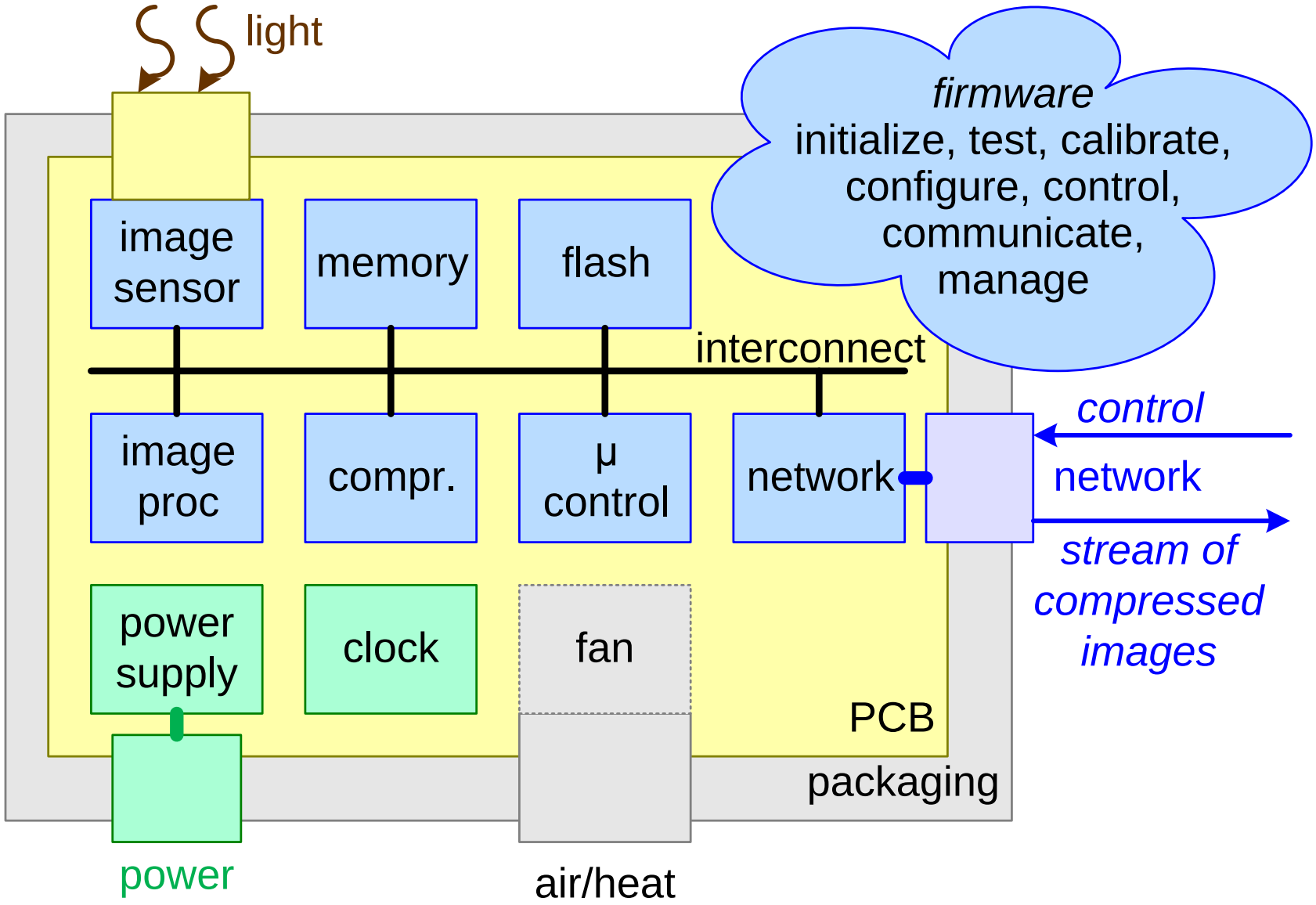
Camera Block Diagram



Question Camera Performance

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

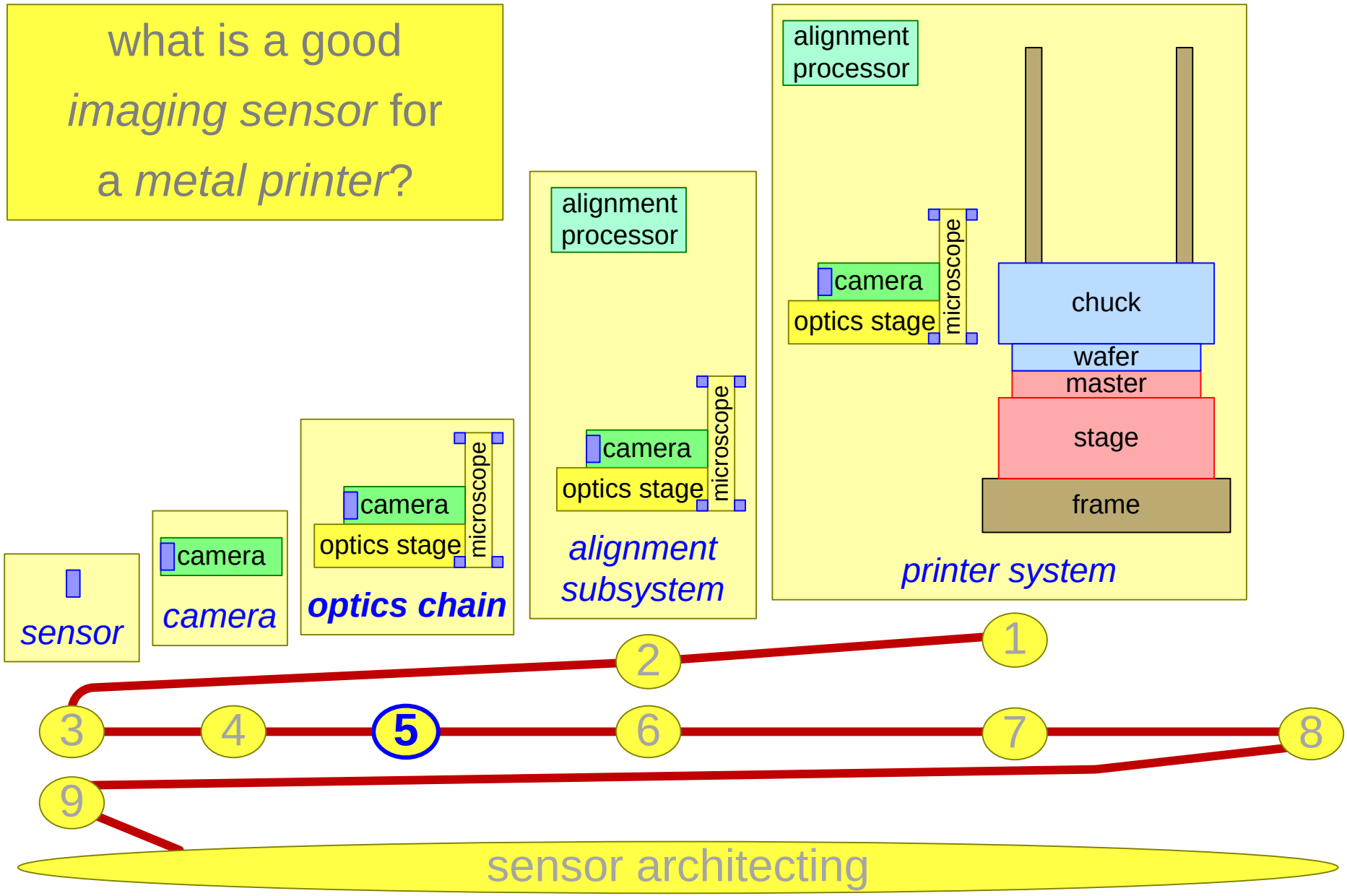
What are the 3 to 5
Key Performance Parameters
of the device incorporating your sensor?

Potential KPPs Camera

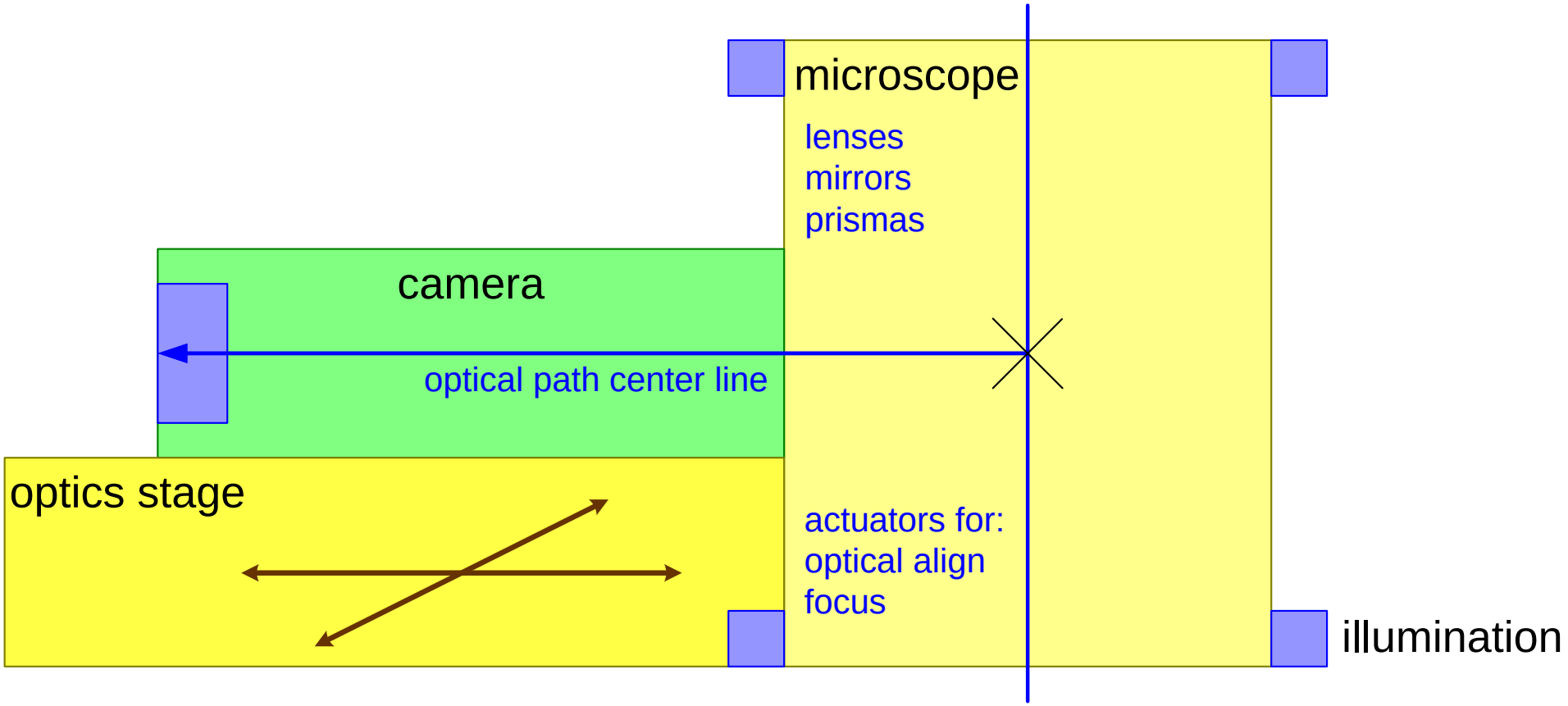
Possible
Key Performance Parameters
of the camera

- 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

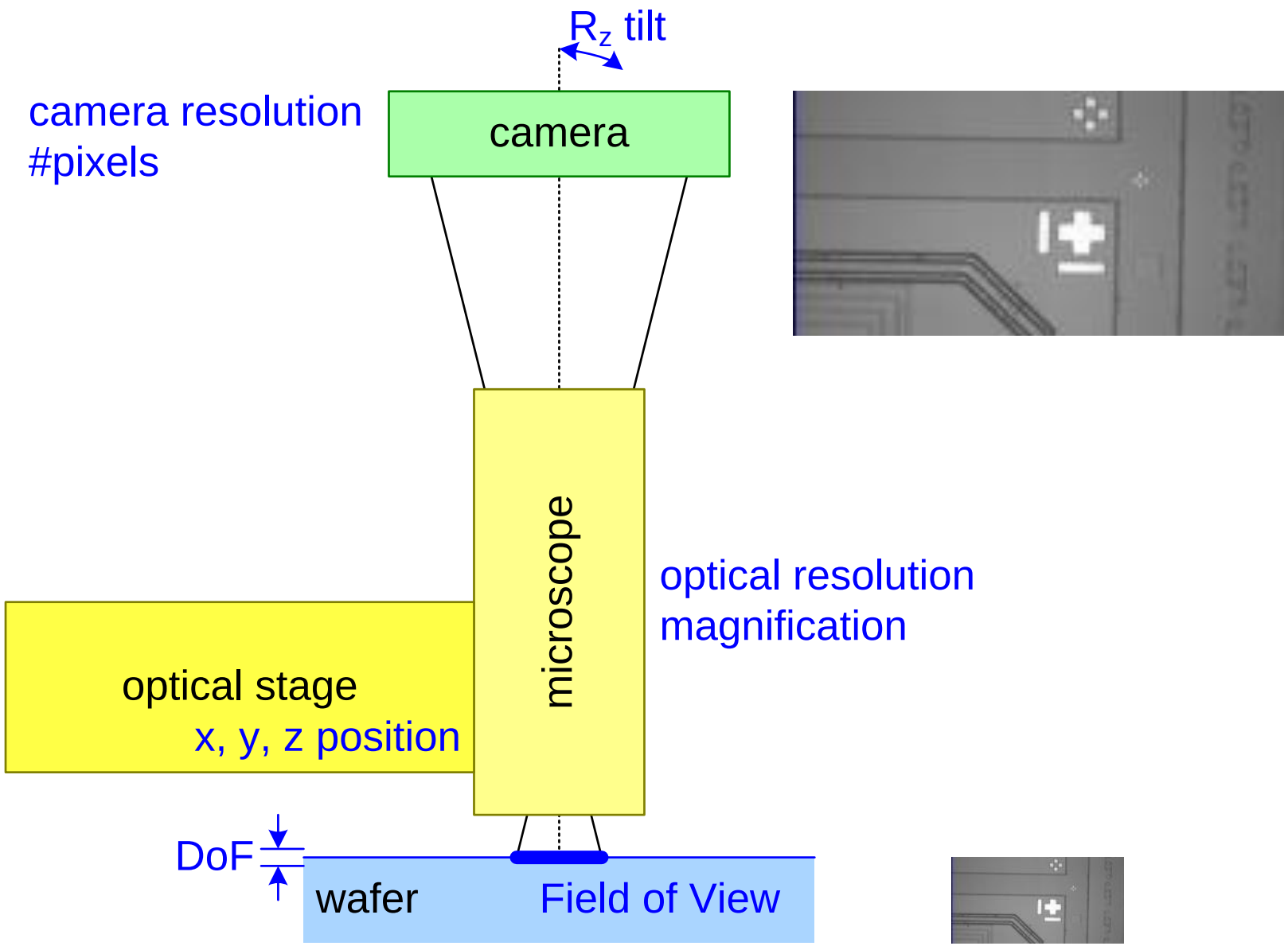
The Optics Chain



Optics Chain Block Diagram



Optics Chain



Question Optics Chain Performance

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

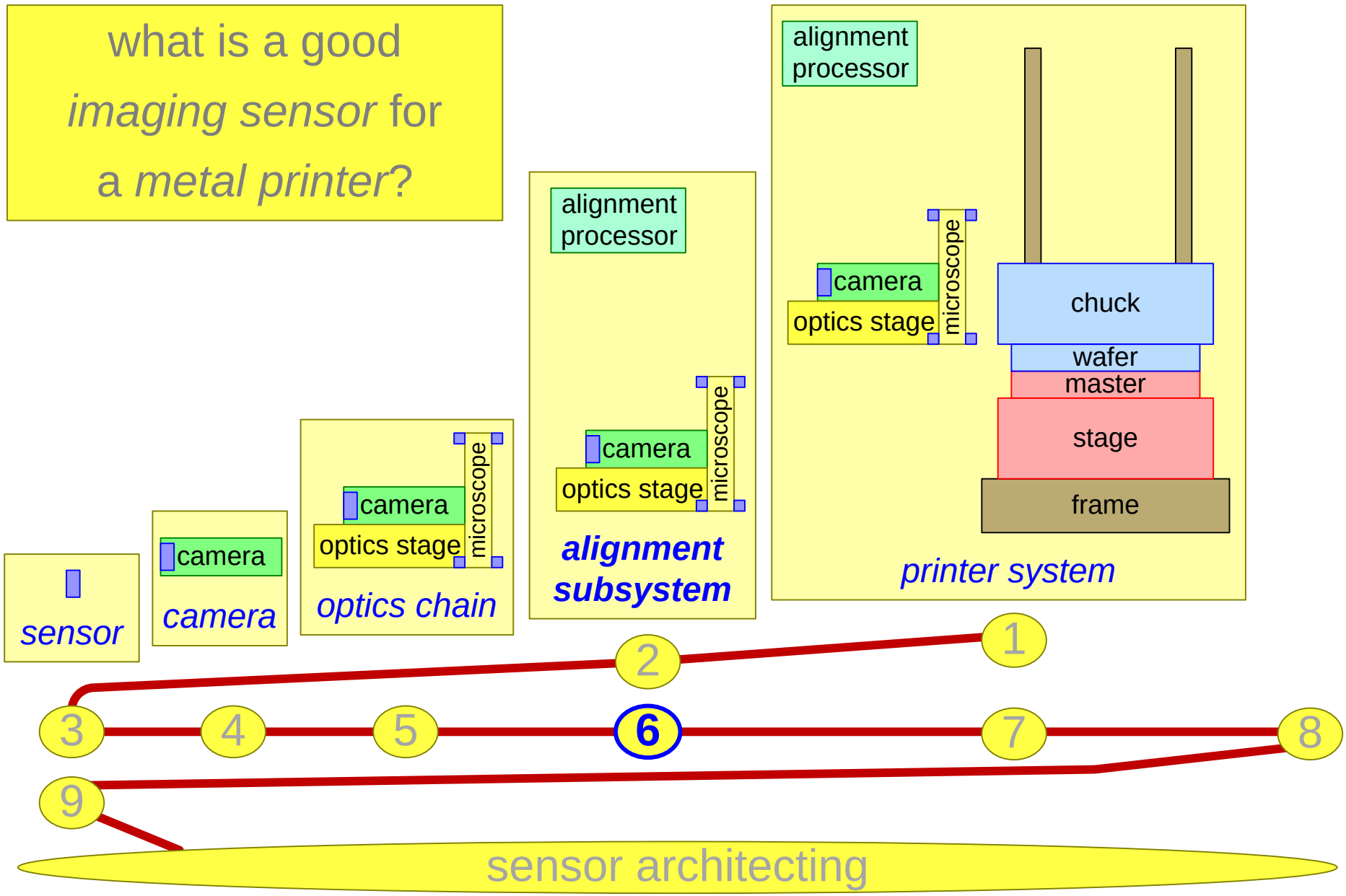
What are the 3 to 5
Key Performance Parameters
of the component incorporating your sensor?

Potential KPPs Optics Chain

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, reproducability)
- focus performance
- x, y range
- thermal stability
- cost, weight, size stage+optics

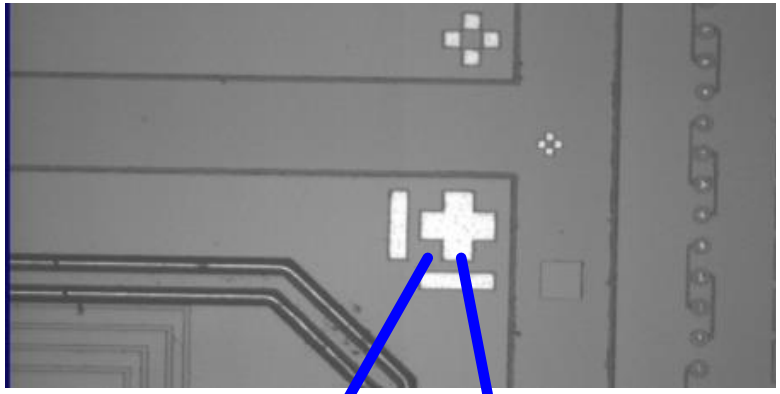
The Alignment Subsystem



Alignment Workflow

1	move to marker position	
2	focus	
3	search markers	may result in new move and focus
4	determine dx, dy	
5	calculate master displacement	based on calibration data
6	move master	
7	search markers	may result in new focus
8	verify dx, dy	repeat steps 5..8 if needed

Alignment Algorithm

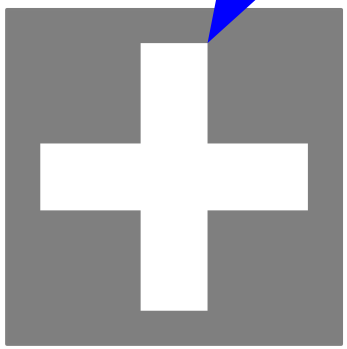


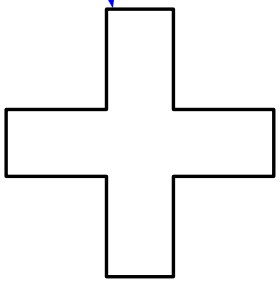
absolute values

or

contour

robustness varies significantly between algorithms





final result

(x, y)

since whole marker is used,
x, y accuracy may be higher than optical resolution

Question Alignment Performance

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

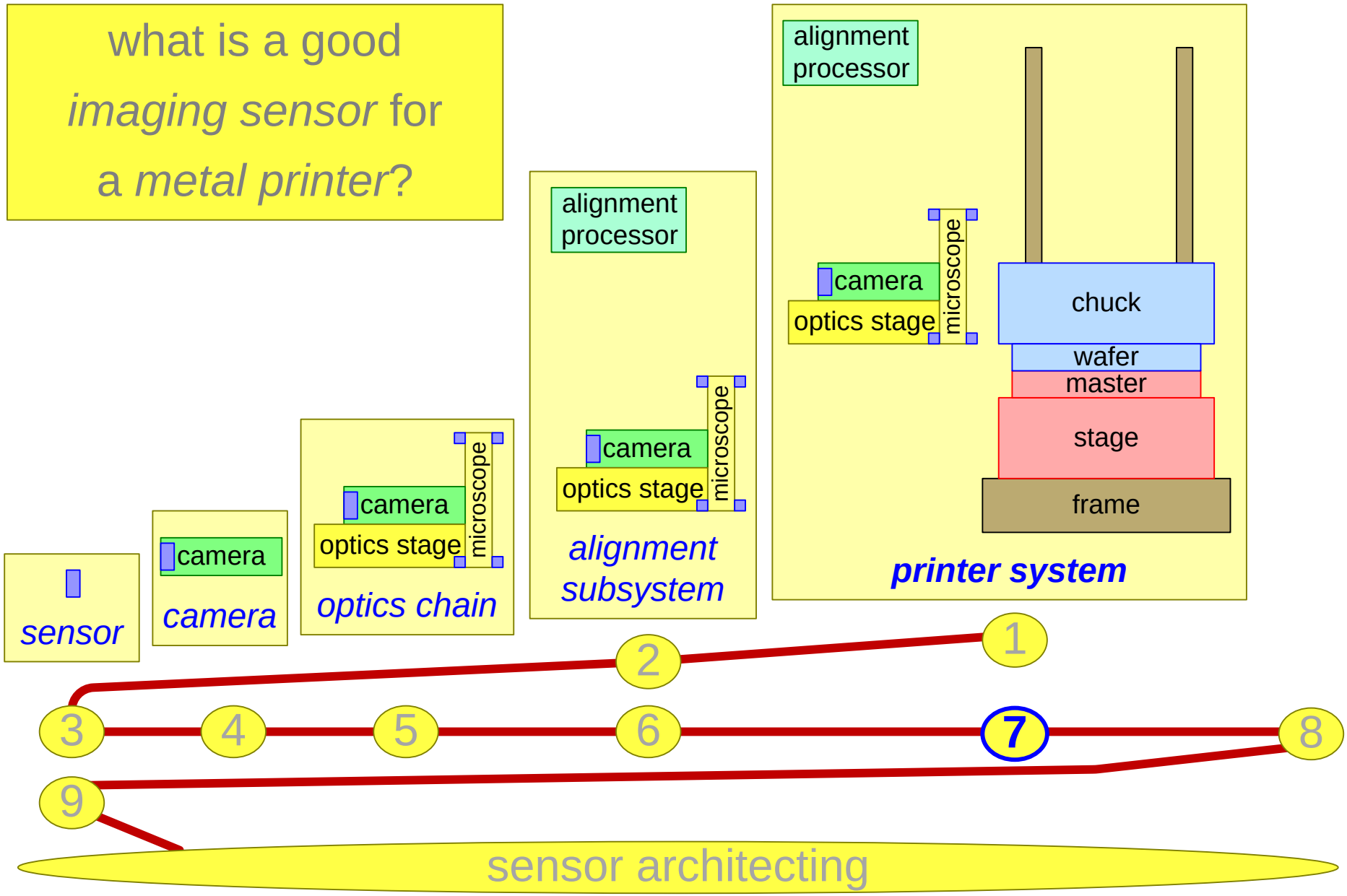
What are the 3 to 5
Key Performance Parameters
of the subsystem incorporating your sensor?

Potential KPPs Alignment

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



Question Printer Performance

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

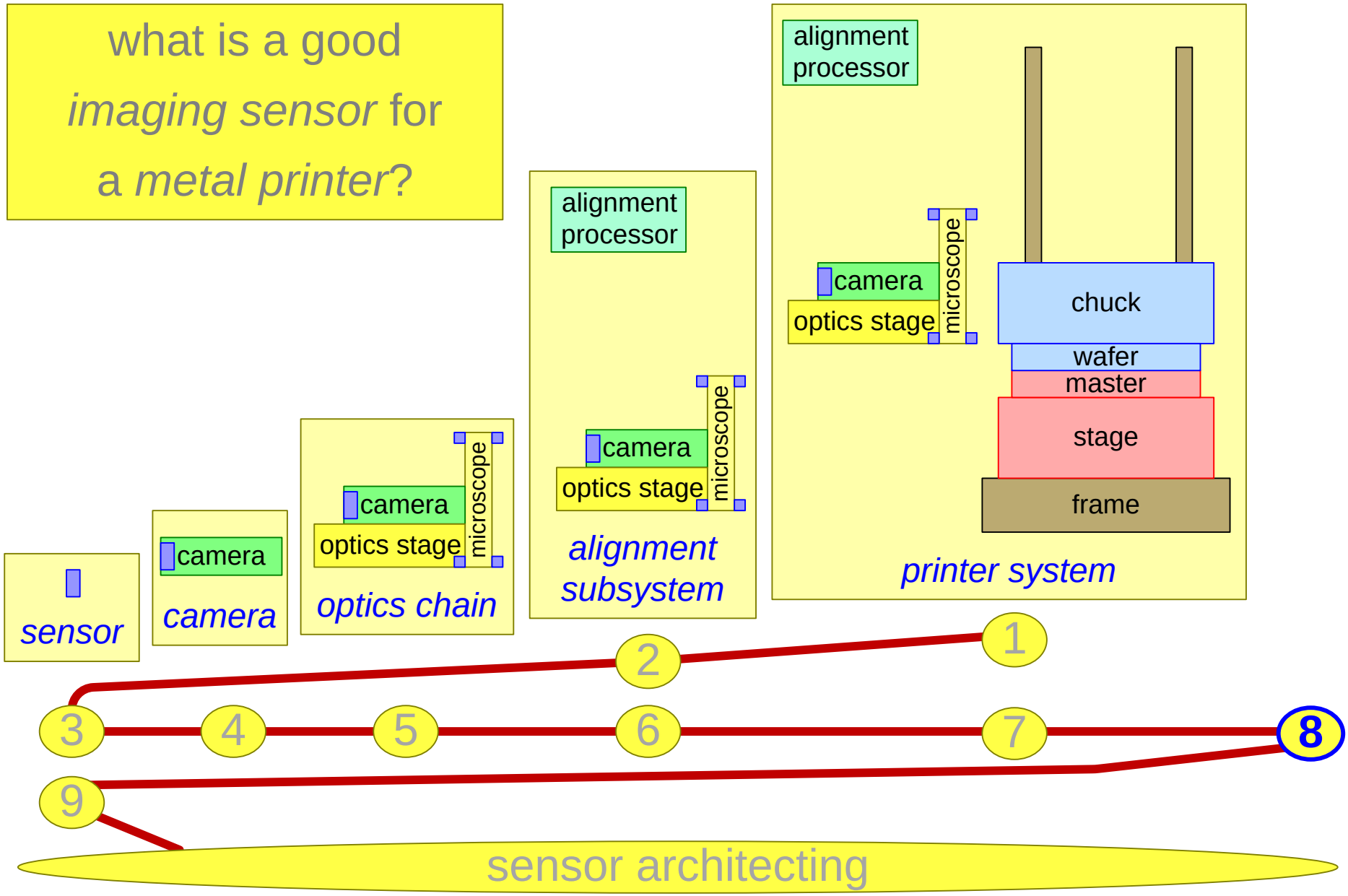
What are the 3 to 5
Key Performance Parameters
of the system incorporating your sensor?

Potential KPPs of the Printer

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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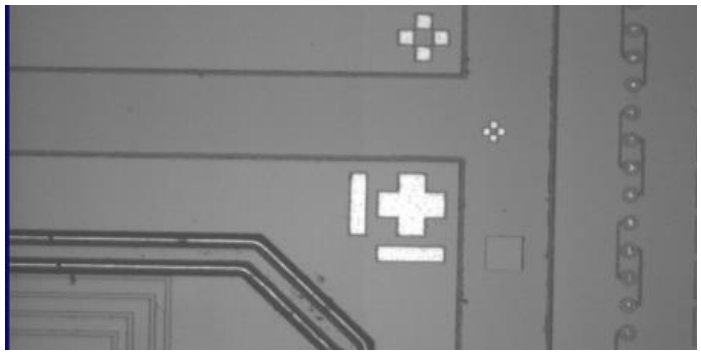
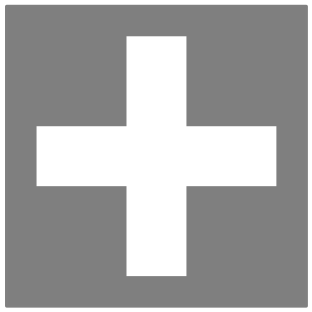
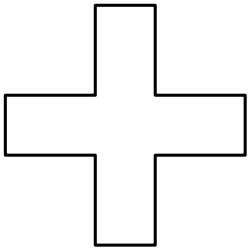
sensor architecting

How Process can Influence Alignment







Context: process influence on alignment

what if little contrast

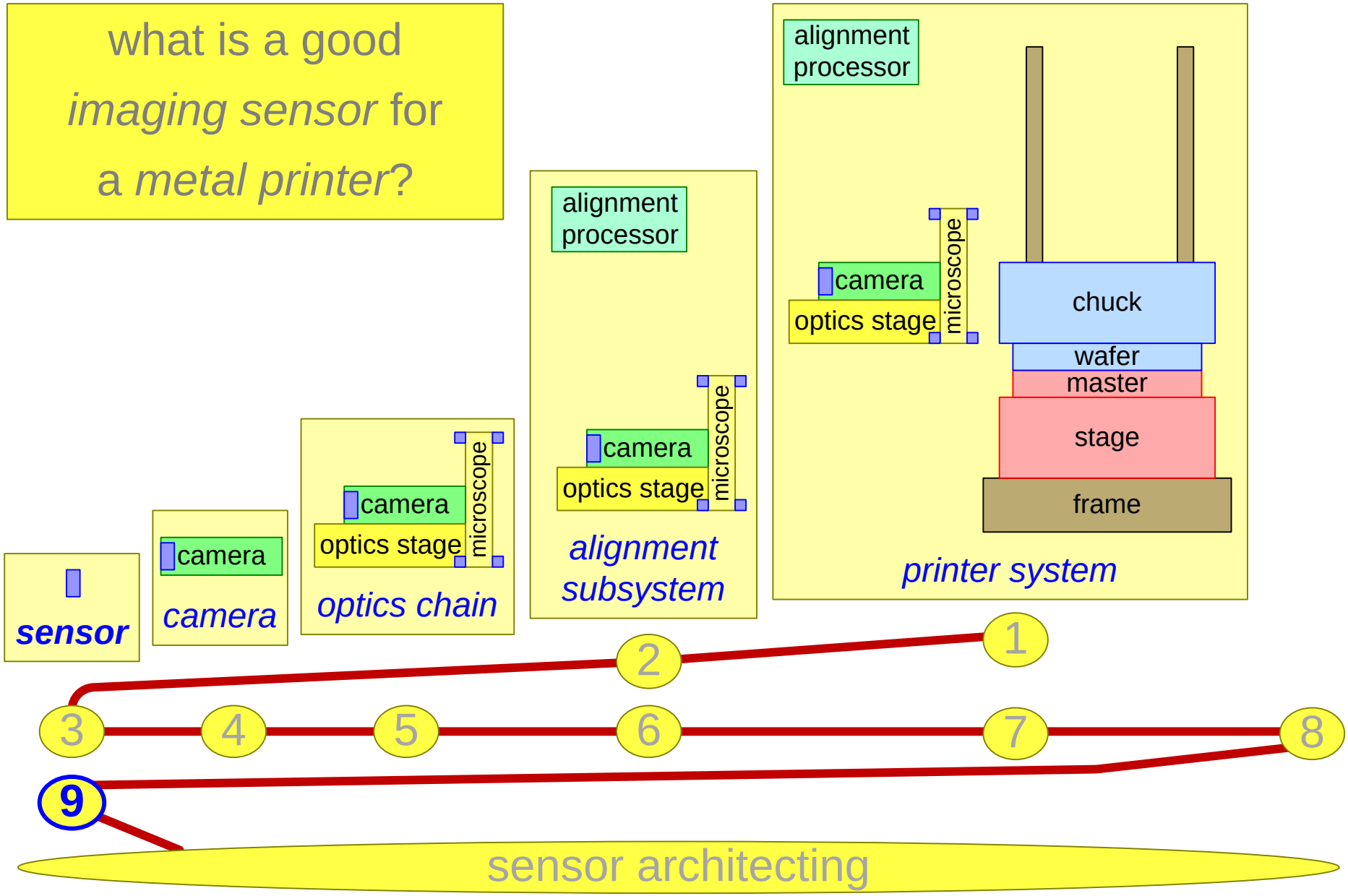
what if slow transition

what if wafer surface height varies

what if shadows

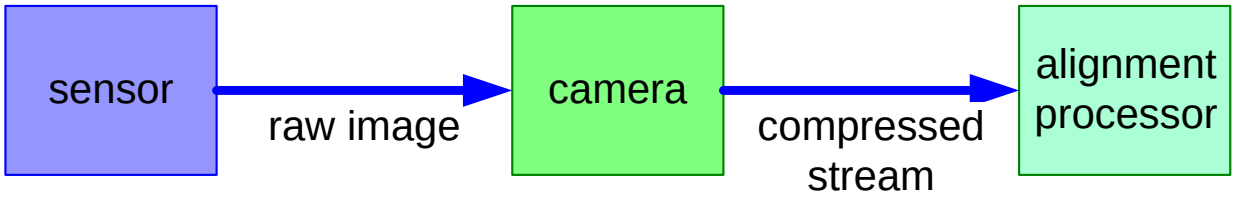
what if marker is damaged

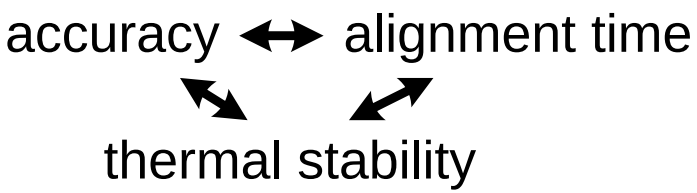
Revisiting the Sensor



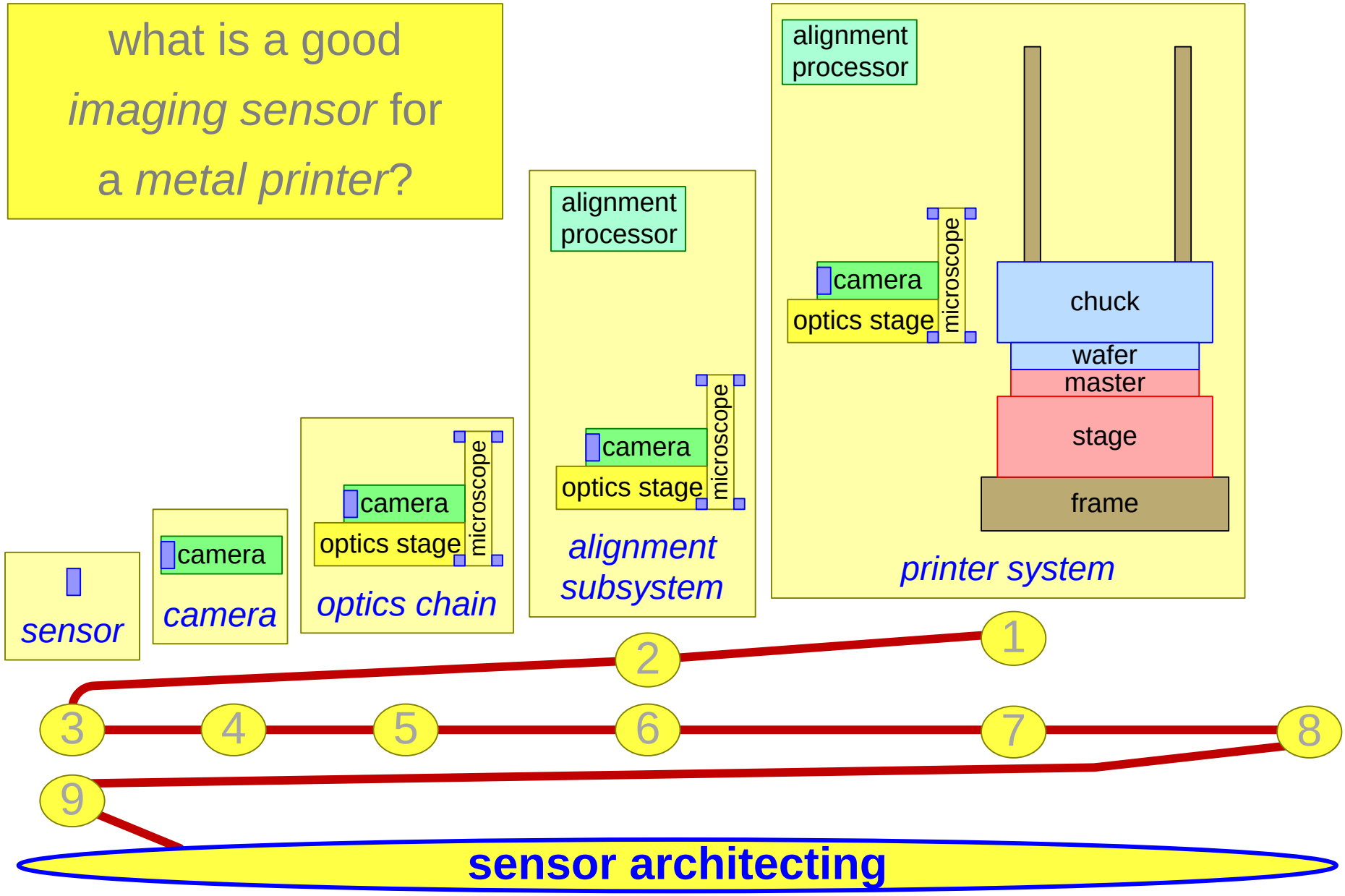
Part of the Design Space

	benefits	*disadvantages*
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