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# AVIOR M-300

## Vacuum coating system for high-performance optical filters


Dr. Antun Peić, M.Sc. Lukas Hell

## Introduction

## Part I: The AVIOR M-300 Platform - Ultra high-precision Coating on up to 300 mm

- AVIOR M-300 Overview
- Main Configuration
- Configuration Options
- Flexible Turntable Design for Universal Substrate Loading
- Run-to-Run Stability
- AVIOR M-300 Key Facts and Features

## Part II: AVIOR M-300 - Process Technology

- a-Si:H/$SiO_2$ NIR Bandpass Filter
- High-performance NIR Bandpass Filter: X39 Filter
- SOLAYER “Zero Bow” Technology: X41 Filter
- CWDM Filter Development

# Global Locations

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With our HQ near Frankfurt, a research and development site near Dresden and subsidiaries in the USA, China, Taiwan and Singapore, SOLAYER is globally positioned to serve customers all over the world.




- Located near Frankfurt within the Material Valley
- D&E of vacuum deposition equipment & components

- HQ near Dresden in Silicon Saxony
- R&D for precision thin-films and filter technologies

# POSITIONING & STRATEGY

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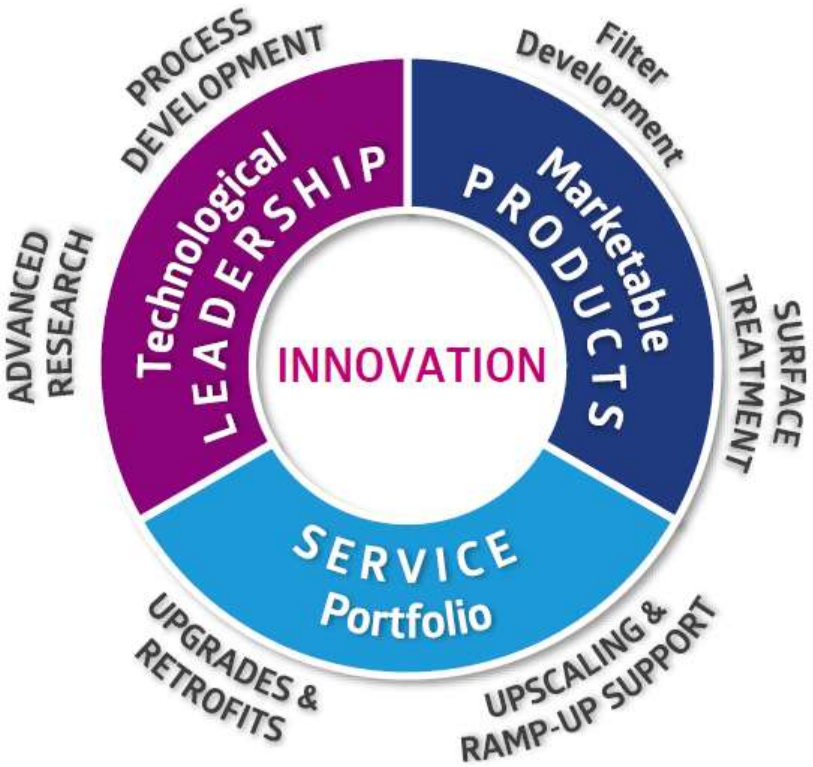


## MISSION

"With a clear focus on the development & applications of the innovative thin film technologies - We support our customers in a highly competitive market"

- **Technological Leadership**
  Transforming innovation into processes and products
- **Marketable Products**
  Most versatile product platform enables ultra high-precision optical coatings with extraordinary film quality combined with filter and process development that highly benefit customers
- **Service Portfolio**
  Offering specialized support to help customers succeed in a very competitive market with upgrade & retrofits, process development, product development and thin film services

# Market Activities & Competences

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## Technology Expertise

- High Precision Thin Film Coating
- Sputtering Technologies
- Functional & Optical Layers

## Equipment & Tools

- AVIOR Optical Coating
- ALASCO Flexible Coating
- ALITH Inline Coating

## Customer Support

- Equipment Service
- Technology Service
- Consulting Service

## Market Focus

- Precision Optics
- Opto Electronics
- Sensors

# Driven by Photonics Megatrends Demand

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**Autonomous mobility**
IR, LiDAR filter

**Mobile/consumer**
IR, TOF/LiDAR filter
ambient sensors

**Data Center**
CWDM, DWDM filter

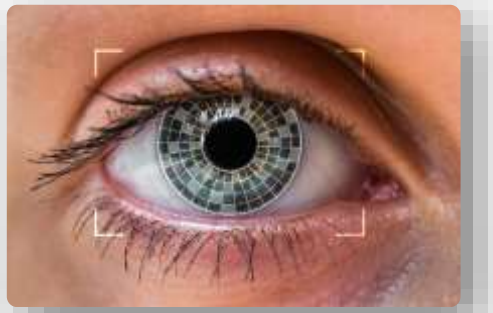
**5G**
CWDM, DWDM filter

**Industry 4.0**
IR, TOF/LiDAR, BP filter
CWDM, DWDM filter

**Machine learning**
IR, TOF/LiDAR filter
BP sensor filter

**AR/VR**
IR, TOF filter

**Health care**
IR filter, low/high pass,
BP filter



Source: YOLE Development, Gartner, PWC

# HIGH-PRECISION OPTICAL COATING PLATFORMS

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ALIOTH

AVIOR

ALASCO

## HIGH THROUGHPUT INLINE COATING



## ULTRA HIGH-PRECISION COATING


## FLEXIBLE & MULTI-FUNCTIONAL COATING

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# AVIOR M-300 HIGH-PRECISION COATING ON 300 MM

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- Flexible and modular platform
- Excellent process stability
- High-precision thin-film coatings
- Outstanding productivity
- Ready for future demands

# AVIOR M-300 Main Components

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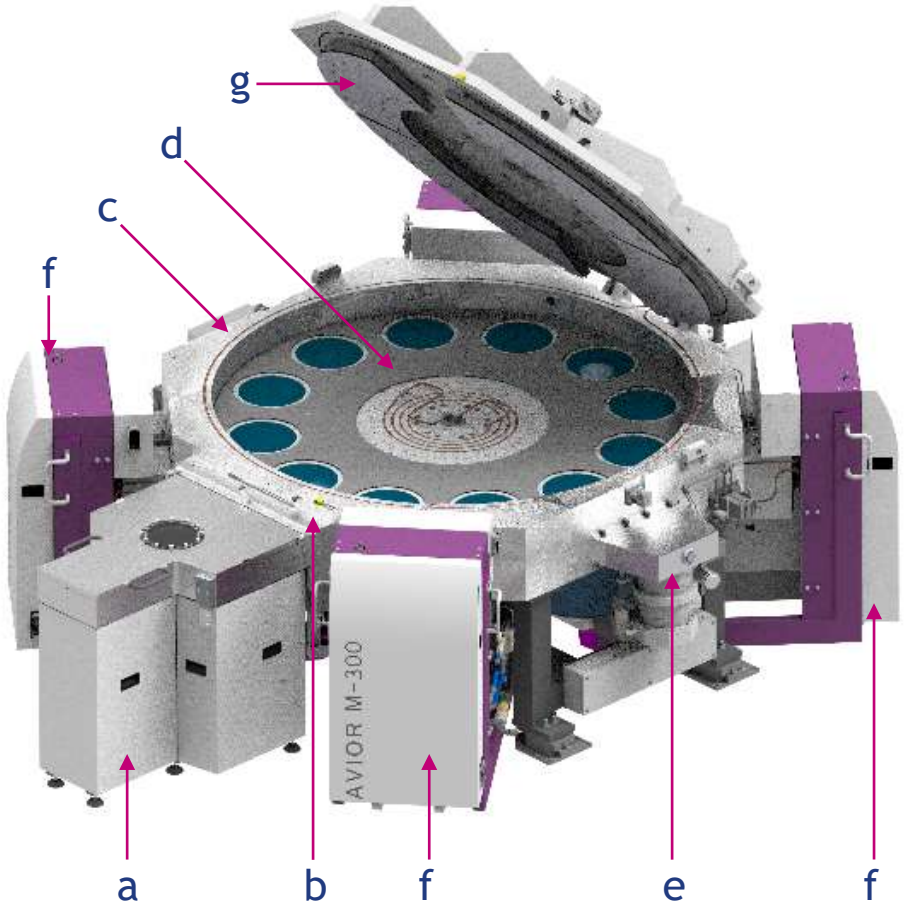


a) Load/unload handling
(automatic or manual)

b) Gate valve

c) Process chamber

d) Turn table
(12 x ∅ 300 or 24 x ∅ 200 or 48 x ∅ 150)

e) Plasma source # 1-2

f) Sputter magnetrons # 1-4
(dual rotary magnetrons)

g) Substrate heating (option)

# AVIOR M-300 OPTIONS

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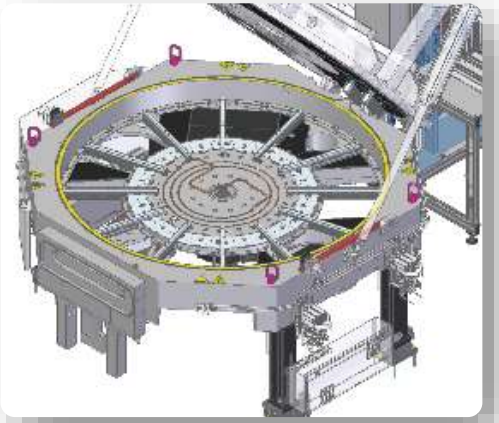
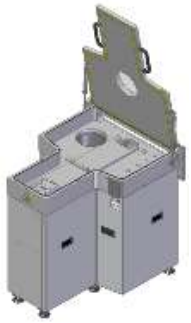
## Base System

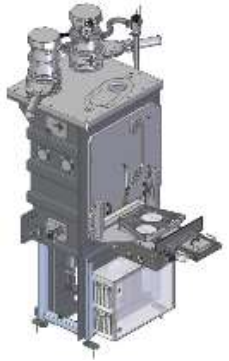


- Modular design
- Future-proof
- Upgradable

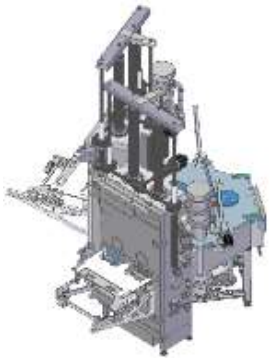
## Loading



Semi-manual single loading
Automatic turntable loading
Load/unload cycle ~ 105 min



Segment single batch stacker
Automatic turntable loading
Load/unload cycle ~ 38 min

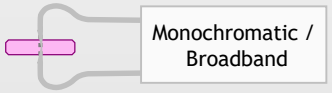


Customized Solutions
Various formats & handling concepts

## Process Options

Sputter #1-4

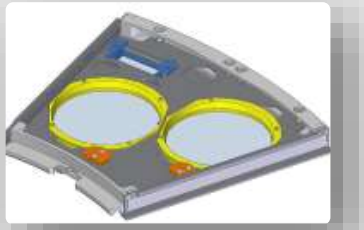

Highspeed temperature




Optical monitoring

Plasma #1-2

Gas Supply $H_2$ $O_2$ $N_2$
Top/bottom heater



Witness glass exchange

# AVIOR M-300 UNIVERSAL CONFIGURATION

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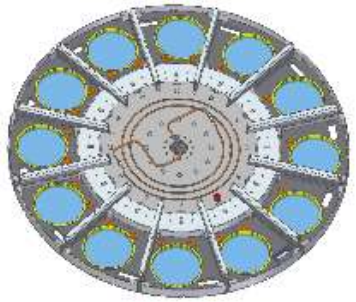
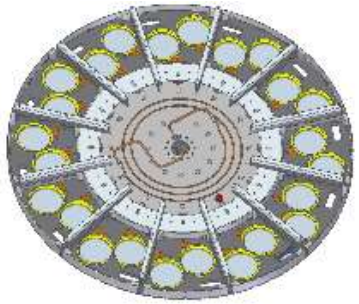
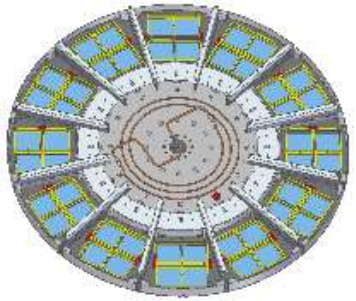
12 x 300 mm

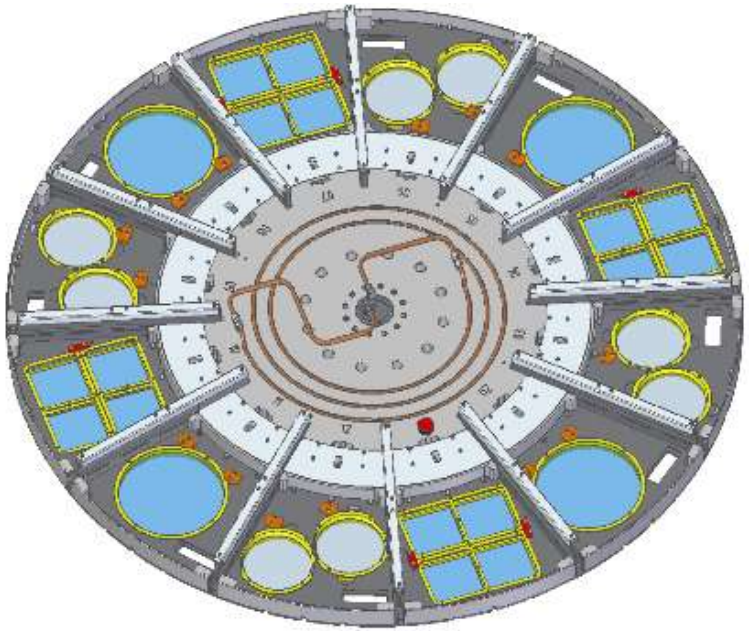


24 x 200 mm



48 x 150 mm





Various sizes and shapes possible

- Universal substrate loading
- One turntable covers all substrate sizes
- No mechanical modification needed
- Economic equipment utilization

# AVIOR M-300 RUN-2-RUN

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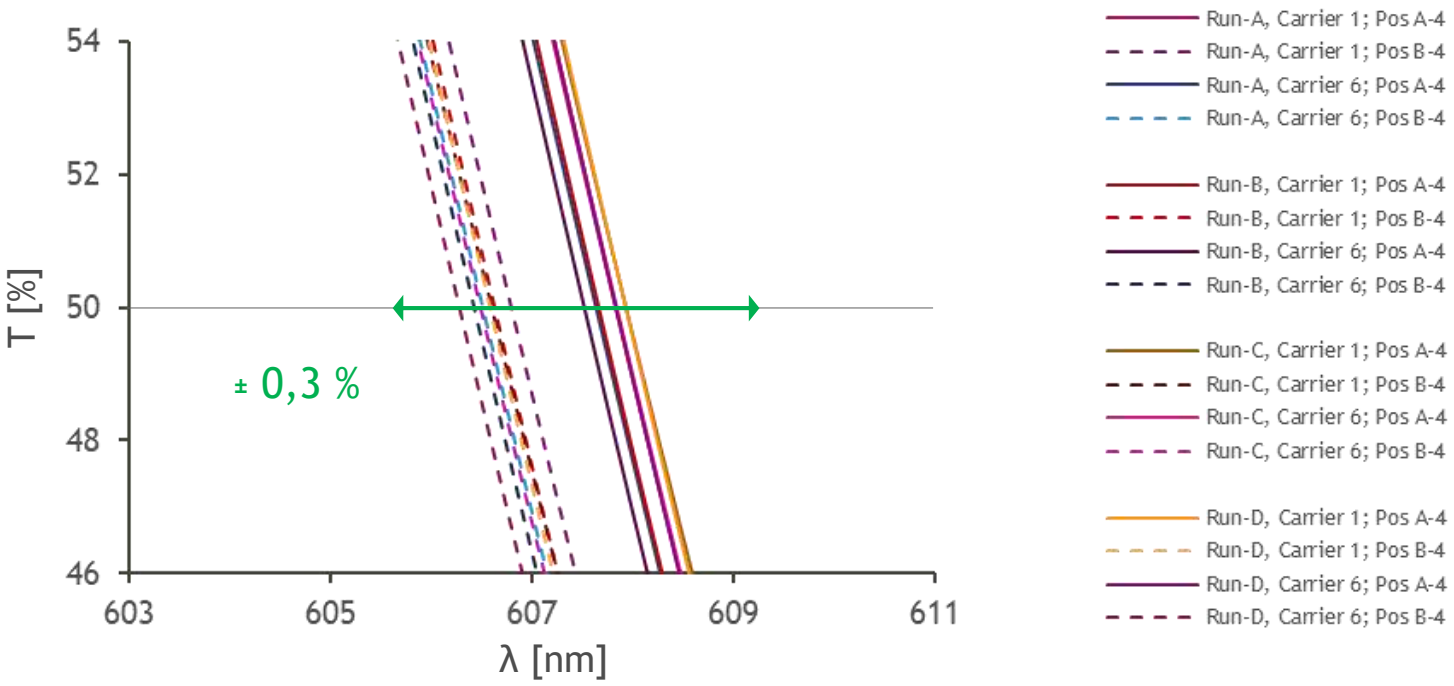
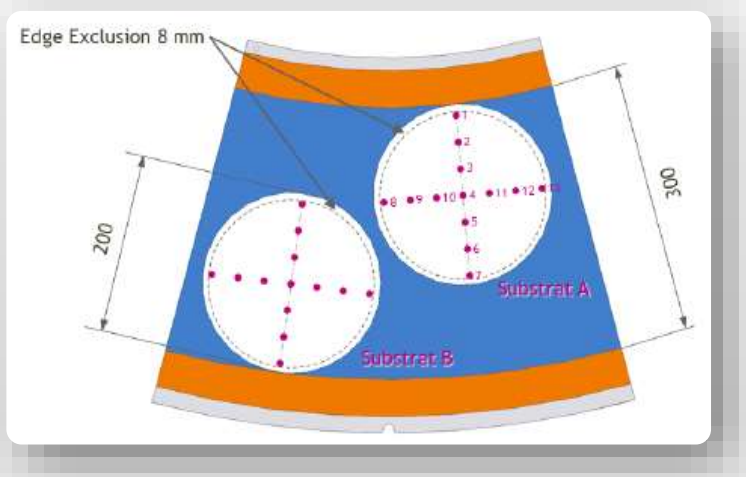



- Run A-D, Carrier 1 & 6, Pos A4 & B4




- 26L low-pass
- $SiO_2/Nb_2O_5$
- 2.488 µm
- **Time controlled**

# AVIOR M-300 Key Facts

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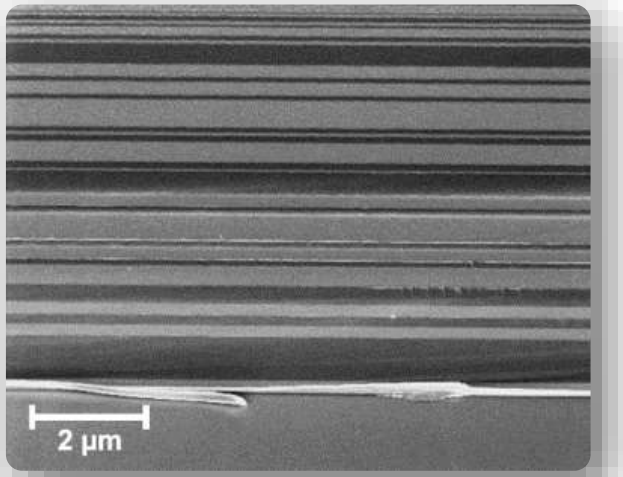
## Film Quality




- Uniformity ≤ ± 0.2 %
- Dense, stable, low defect → shift-free films
- In-situ process automation & optical monitoring

## Process


- Compound assisted reactive sputtering (CARS)
- Sputter-Up configuration
- Dual-Rotatable Cathode arrangement

## Productivity

- Fully automated loading system
- High deposition rates up to 0.6 nm/s (~2 µm/h)
- Fast process adaptions, no test runs needed

## Flexibility

- Wide variety of film materials available
- Up to 4 materials with out any exchange
- Convertible substrate carrier for up to ∅ 300

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## Part II: AVIOR M-300 - Process Technology

- a-Si:H/$SiO_2$ NIR Bandpass Filter
- High-performance NIR Bandpass Filter: X39 Filter
- SOLAYER “Zero Bow” Technology: X41 Filter
- CWDM Filter Development

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## What products/processes can you achieve with the AVIOR M-300?

### NIR bandpass filter for many applications in the infrared wavelength region

- Key components for optical measurements, distance measurement applications or specific systems for gesture recognition
- The special characteristic of these filters allows:
  - Accurate distance measurements at low light intensity conditions
  - Measurements with higher sensitivity
  - Higher precision at normal signal light levels

### CWDM filter

- Wavelength division multiplexers (WDM) are used to combine or separate optical signals with different wavelengths
- CWDM (C - Coarse) are multiplexers or demultiplexers for separating or merging signals with a channel spacing of 20 nm
- Applications: CWDM transmission systems, cable television networks, … etc
- CWDM filter development is SOLAYERS´s intermediate step on the way to 5G capable filter solutions up to DWDM (D – Dense) with significantly smaller channel spacings

# A-Si:H NIR Bandpass Filter

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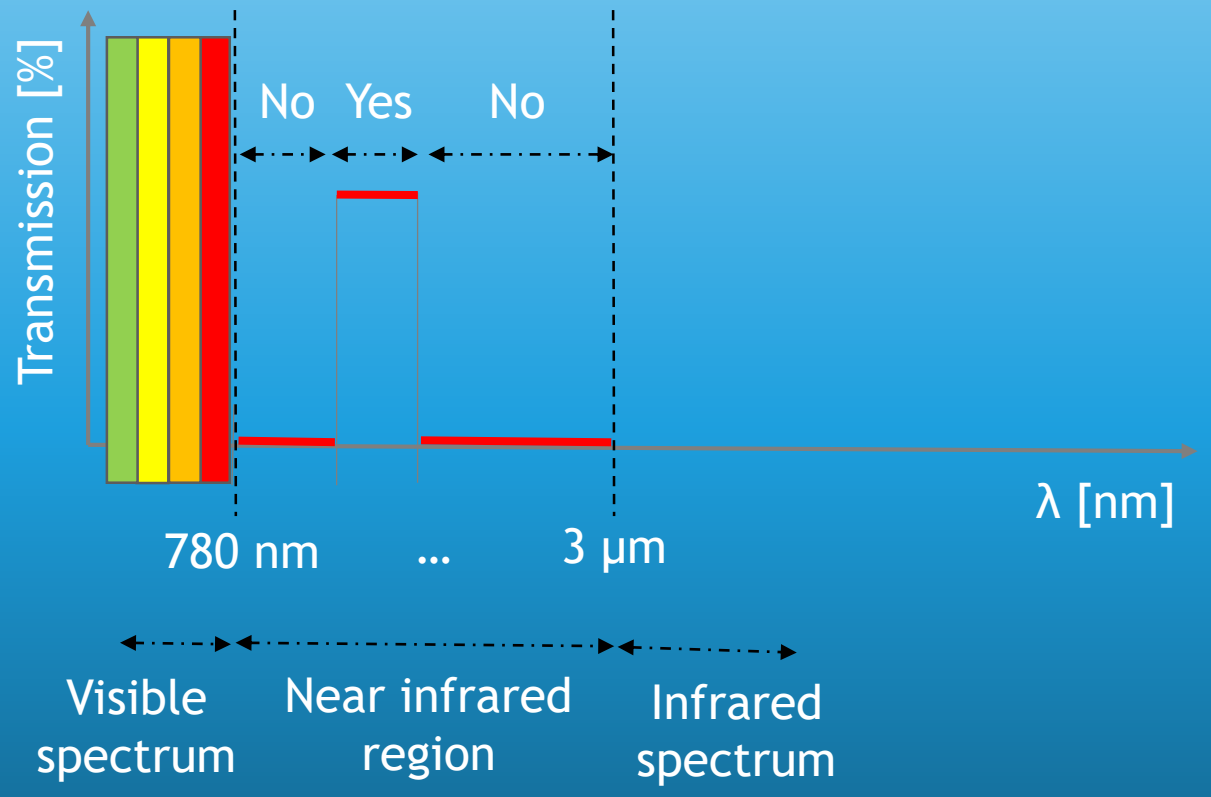
- **What is a NIR bandpass filter?**
- How can that be realized?
- Which properties are important/critical?



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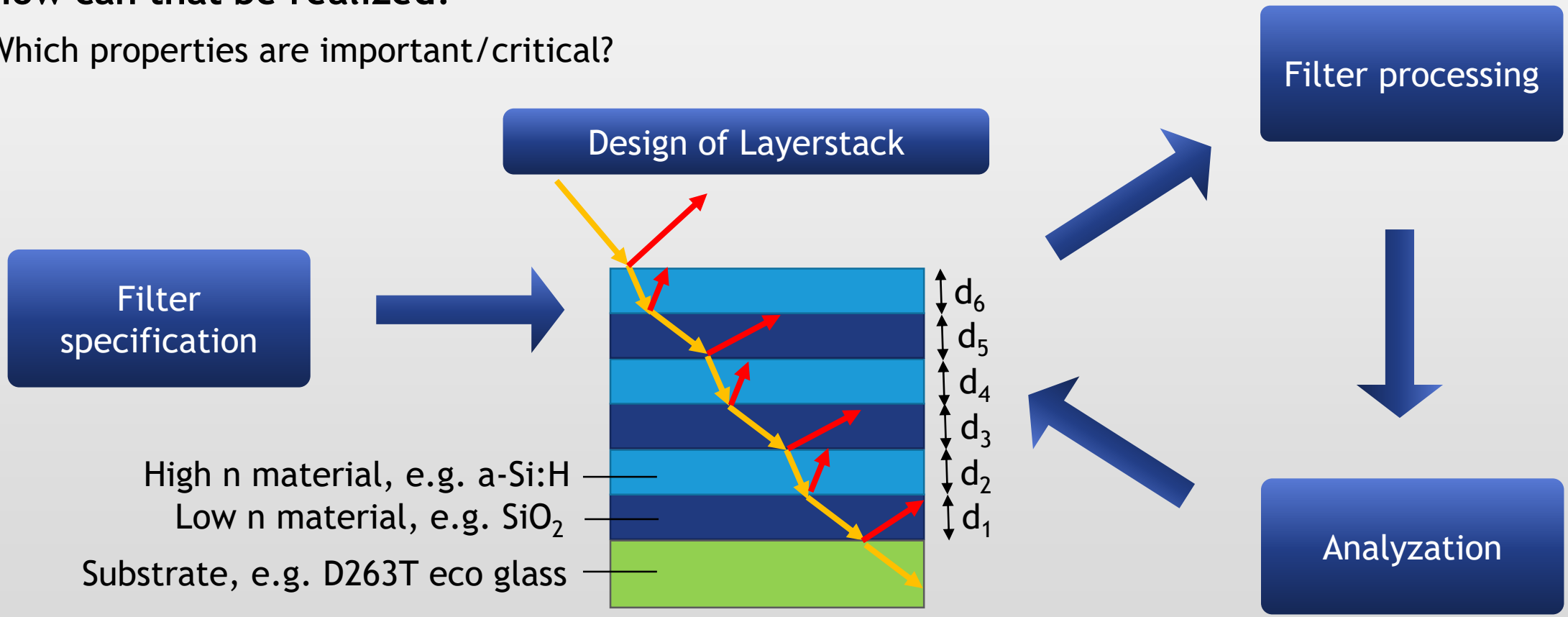

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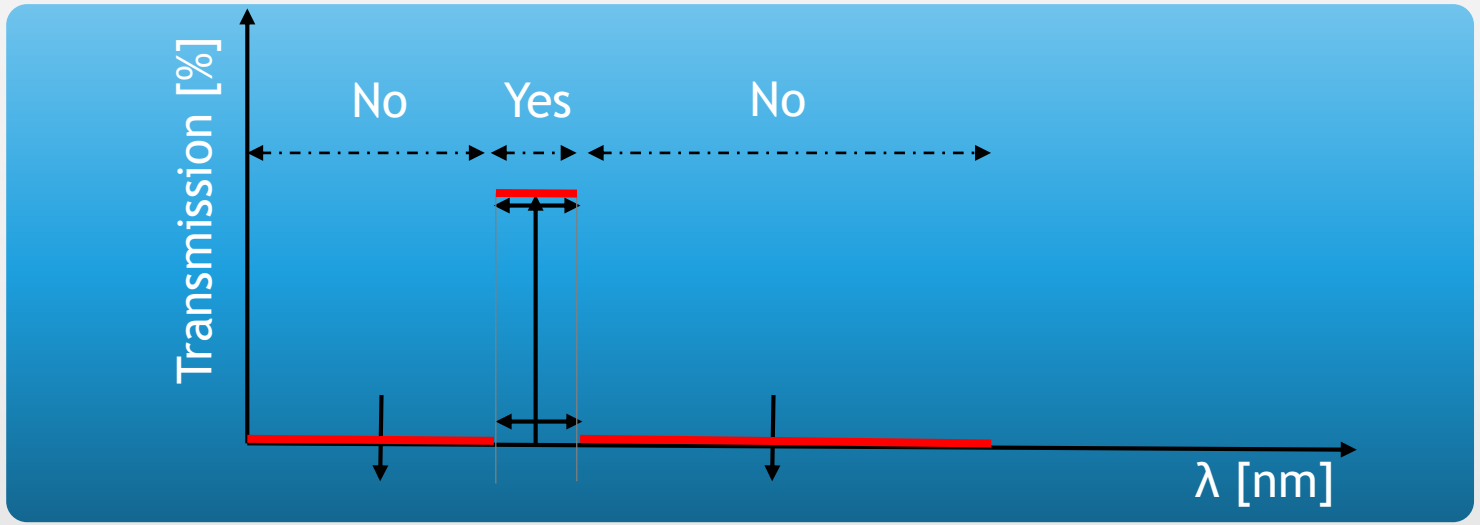


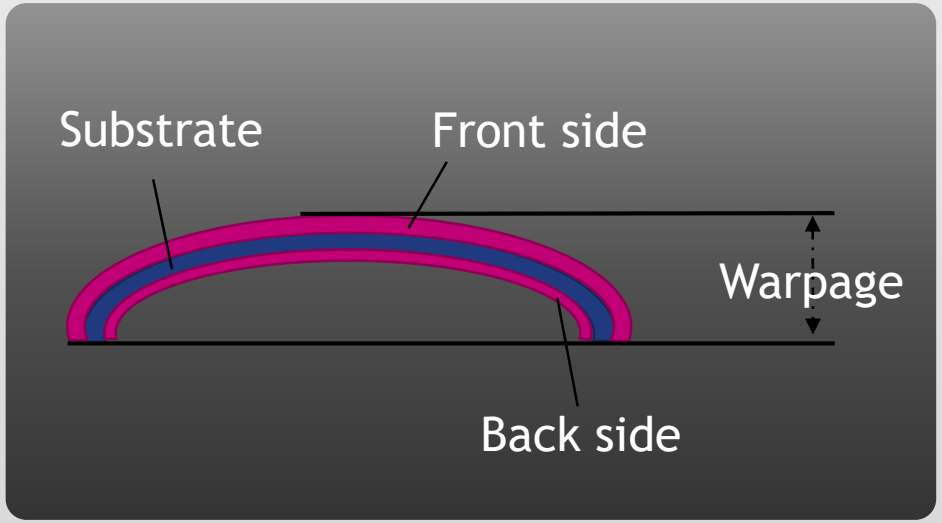


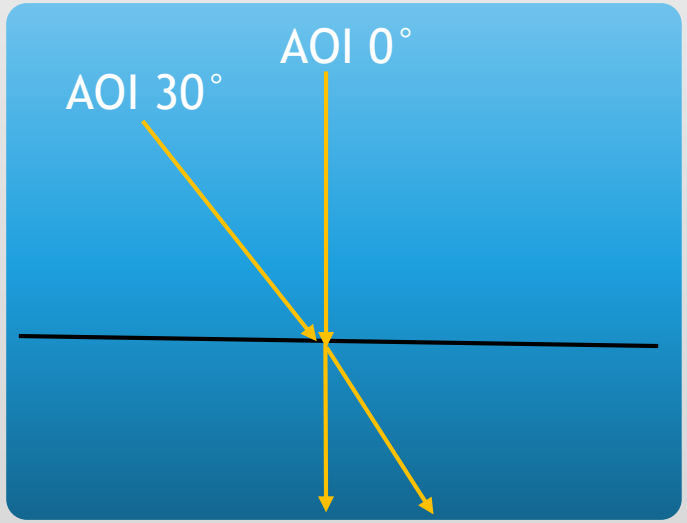


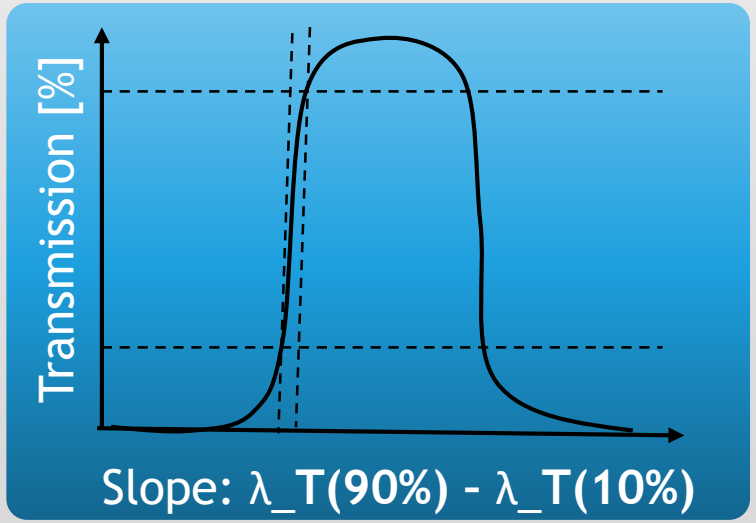

# A-Si:H NIR Bandpass Filter

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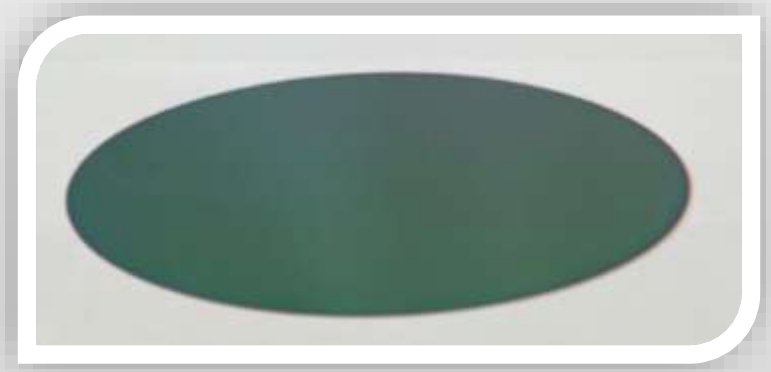
## Solutions with AVIOR M-300: X39 and X41 Technology

- 20-40 layer a-Si:H/$SiO_2$ filter systems
- Layerstack is designed with „OptiLayer“
- Deposition rates of nearly 0.6 $\frac{nm}{s}$ for a-Si:H and 0.8 $\frac{nm}{s}$ for $SiO_2$
- Ø 200 mm glass substrates with 0.2 mm thickness
- Process stability: time controlled
- **X39 → High-performance NIR bandpass filter**
  - Standard NIR bandpass filter
  - High transmission values
- **X41 → „Zero Bow“ Technology**
  - Excellent blocking properties
  - Simplified and enabled post-processing, e.g. transport handling, waferbonding, … etc.
  - Adjustable filter shape for high-end LiDAR applications

**SOLAYER X39 Technology**



**SOLAYER „Zero Bow“ X41 Technology**

# A-Si:H NIR Bandpass Filter X39

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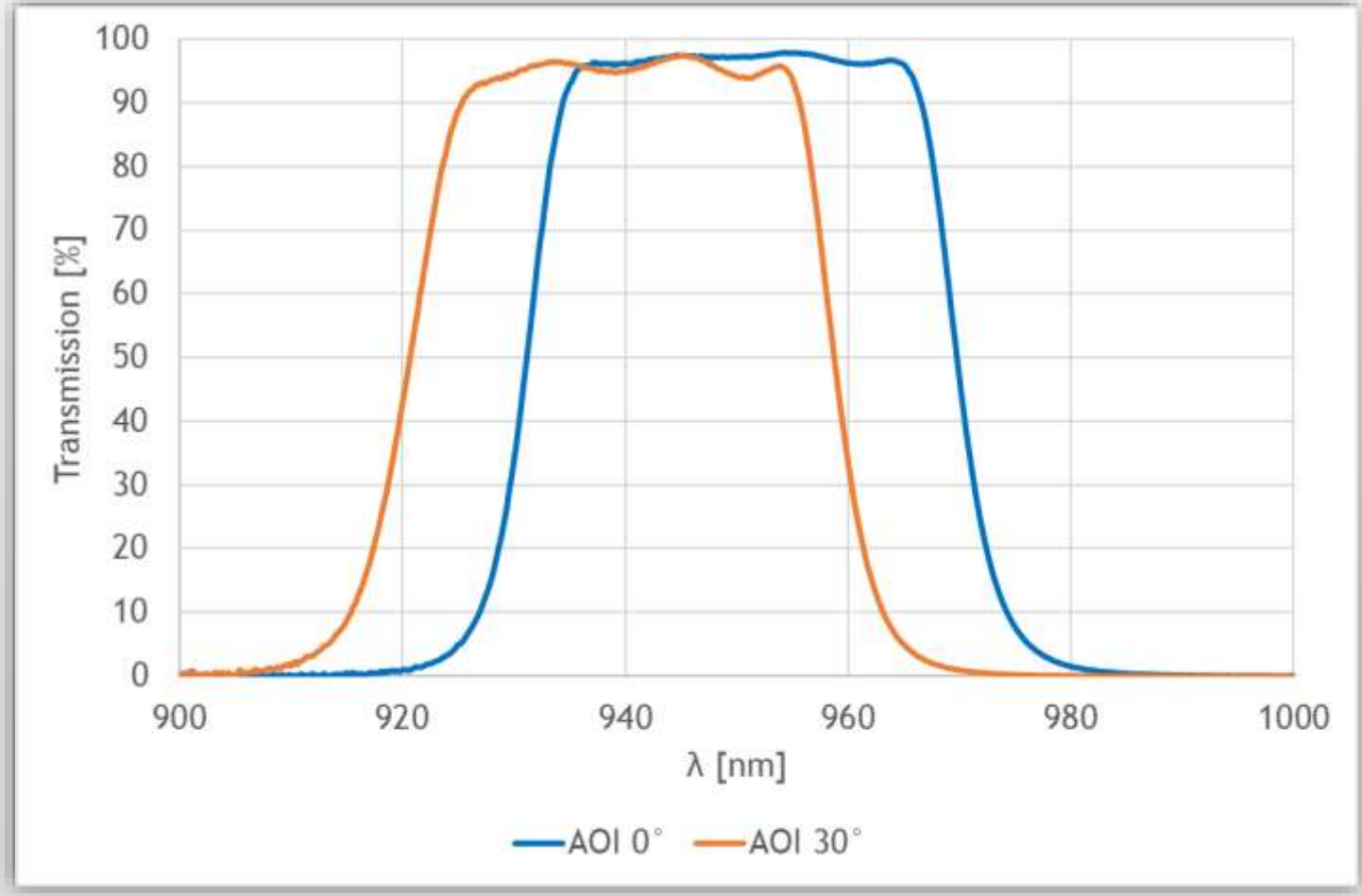
## Filter Performance

| Central wavelength | 950.5 nm |
|---|---|
| Bandpass length | 32.15 nm |
| Transmittance in the bandpass | $T_{avg}$ in PB > 96.0 %<br>$T_{min}$ in PB > 93.0 % |
| Blocking in cut off bands | OD > 5 avg (UV – 900 nm)<br>OD > 5 avg (1000 – 1100 nm)<br>OD > 4 abs (UV – 900 nm)<br>OD > 3 abs (1000 – 1100 nm) |
| Angle of Incidence (AOI) - Shift | < 10.5 nm |
| Slope | < 9 nm |
| Substrate size | Ø 200 mm |
| Substrate thickness | 0.2 mm |
| Warpage | < 11 mm |



# A-Si:H NIR Bandpass Filter X41

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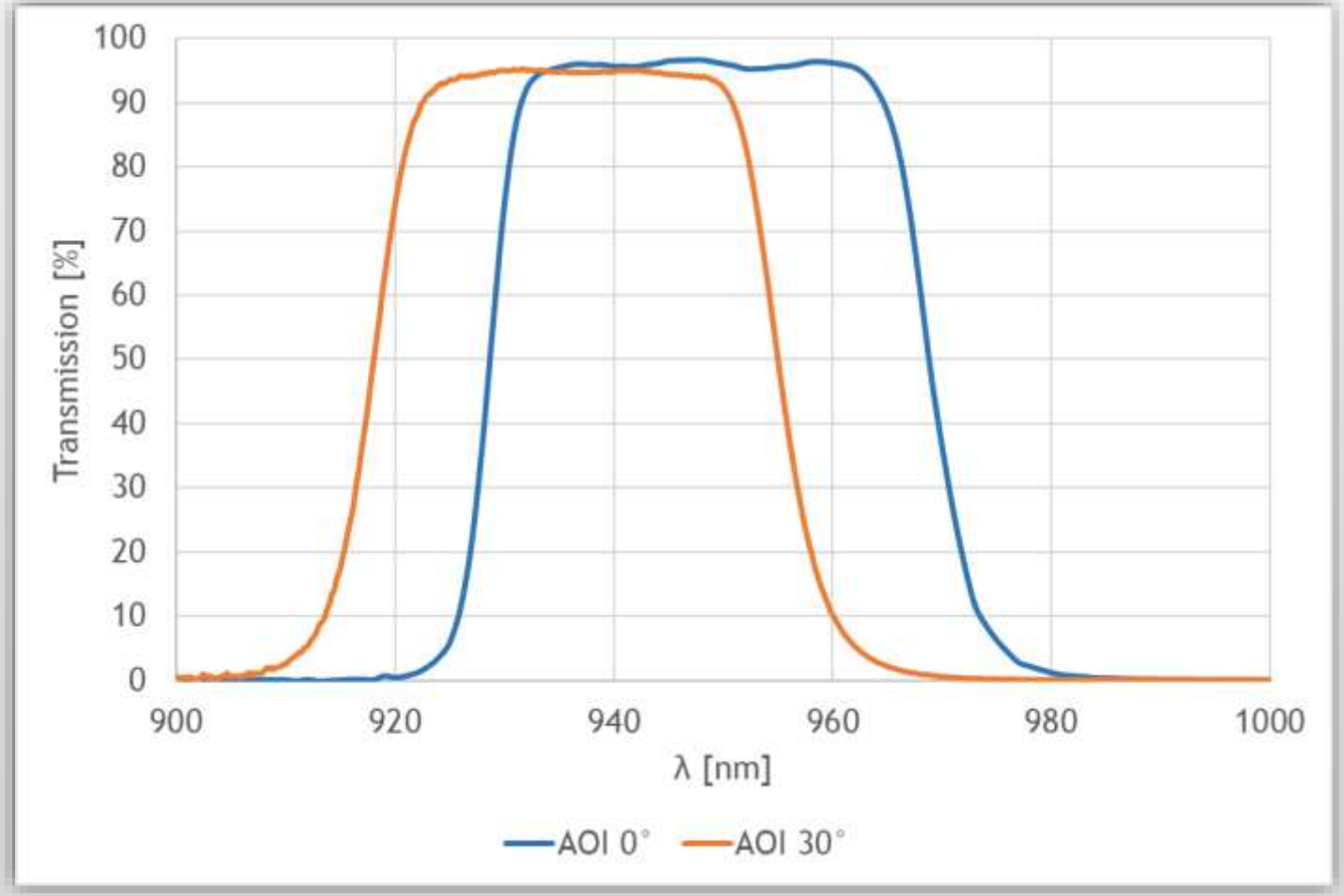
## Filter Performance

| Central wavelength | 948.2 nm |
|---|---|
| Bandpass length | 32.90 nm |
| Transmittance in the bandpass | $T_{avg}$ in PB > 96.0 %<br>$T_{min}$ in PB > 92.0 % |
| Blocking in cut off bands | OD > 5 avg (UV – 900 nm)<br>OD > 5 avg (1000 – 1100 nm)<br>OD > 4 abs (UV – 900 nm)<br>OD > 4 abs (1000 – 1100 nm) |
| Angle of Incidence (AOI) - Shift | < 11 nm |
| Slope | < 9 nm |
| Substrate size | Ø 200 mm |
| Substrate thickness | 0.2 mm |
| Warpage | 0 mm |



# A-Si:H NIR Bandpass Filter X41

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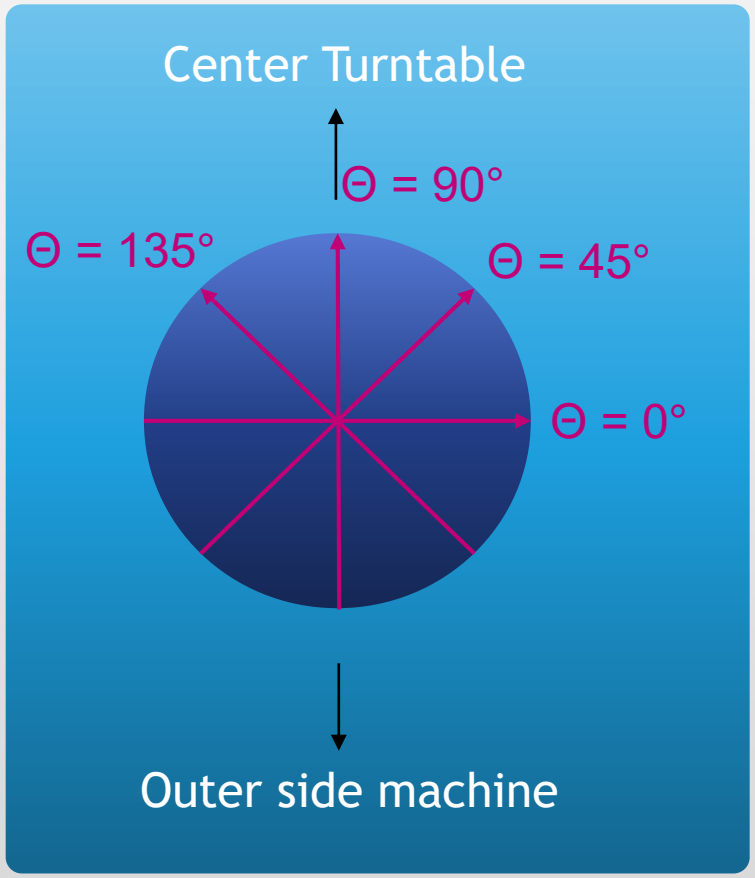
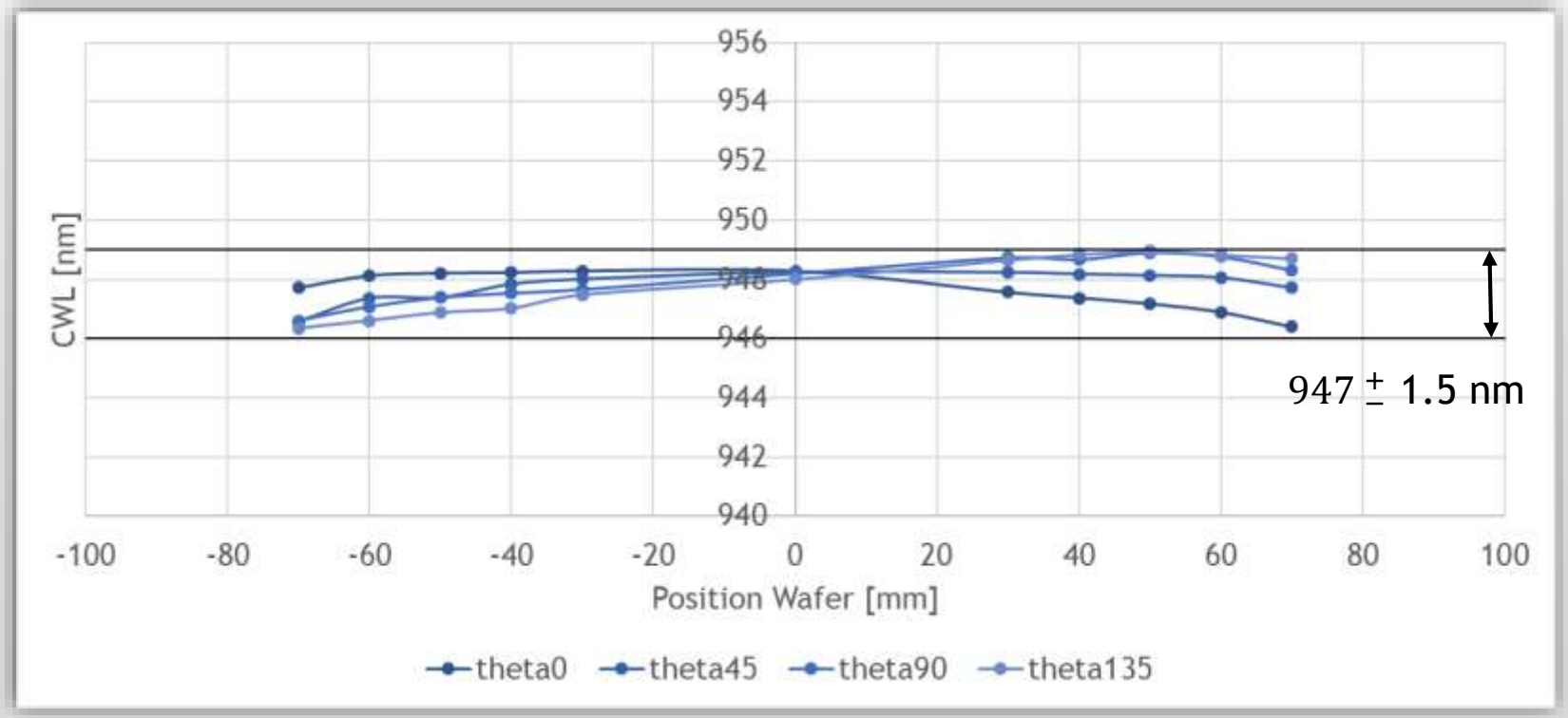
- **Uniformity**



# A-Si:H NIR Bandpass Filter X41

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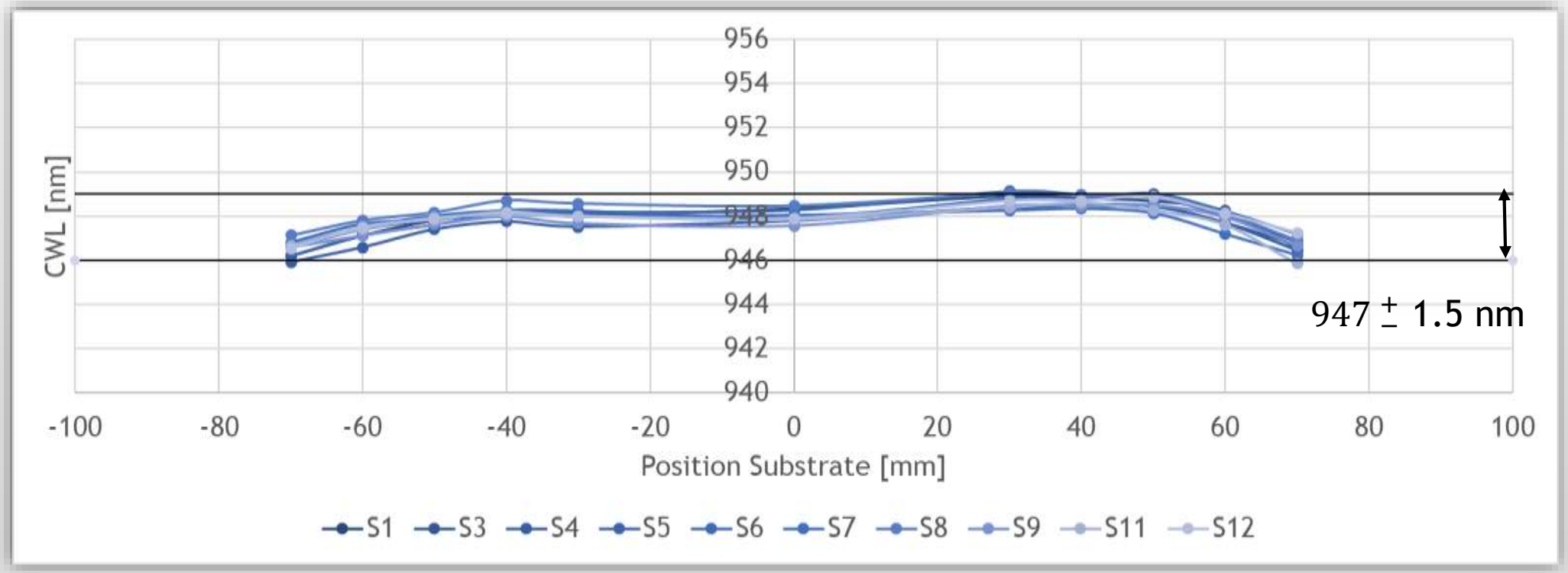
- **Radial Uniformity Position to Position**



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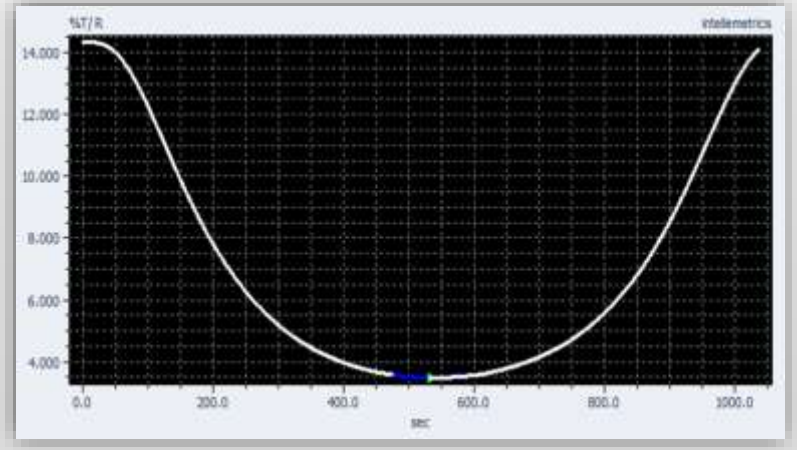
## Basic parameters of CWDM process

- 120-140 layer $Ta_2O_5/SiO_2$ filter system
- Layerstack is designed with „Macleod“
- Deposition rates of nearly 0.7 $\frac{nm}{s}$ for $Ta_2O_5$ and 0.6 $\frac{nm}{s}$ for $SiO_2$
- Ø 150 mm BK7 glass substrates with 10 mm thickness
- Process stability: Monochromatic Monitoring System (Intellemetrics)



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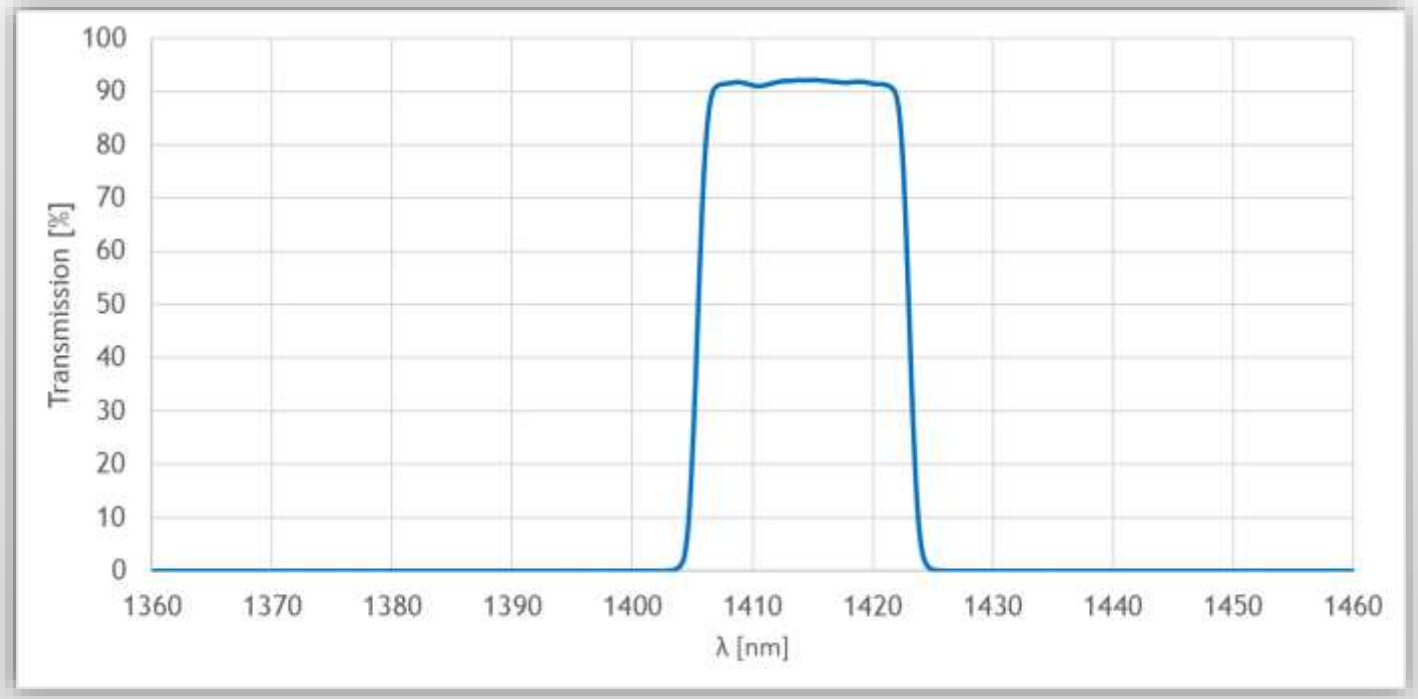
## Filter Performance

w/o Backside Coating

| Central wavelength | 1414.2 nm |
|---|---|
| Max. Insertion Loss in Passband without backside AR | < 0.48 dB |
| Passband width @-0.25dB | 15.37 nm |
| Stopband width @-30dB | 22.4 nm |
| Transmission variation in Passband | 0.12 dB |
| Substrate size | Ø 150 mm |
| Substrate thickness | 10 mm |



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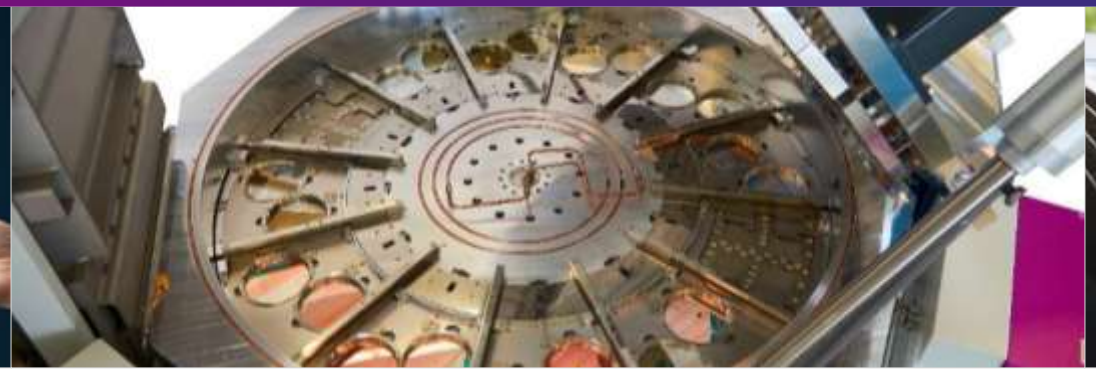


# Thank You for your Attention!

For more Information and Inquiries please Contact: ANTUN.PEIC@SOLAYER.COM