THIN ABSORBING FILMS & MULTI-SAMPLE ANALYSIS

SESSION 5

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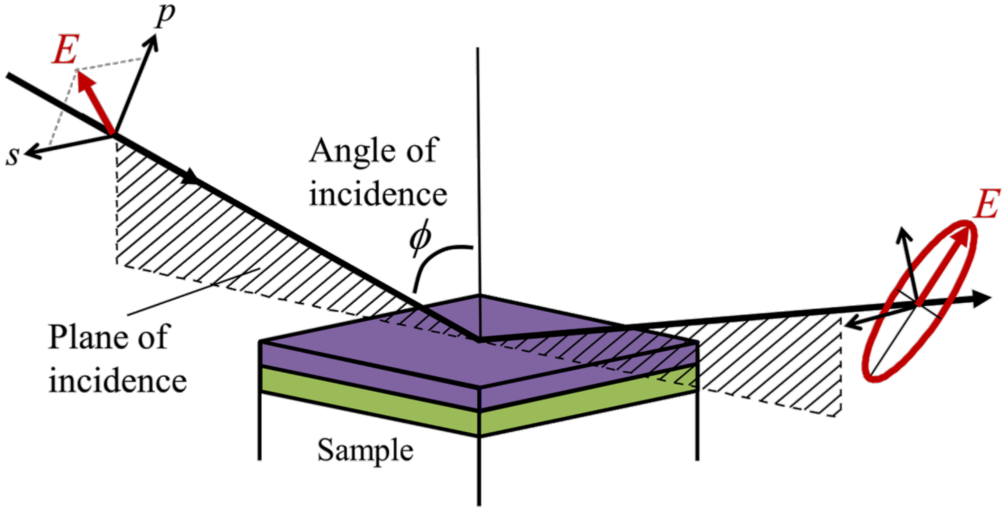
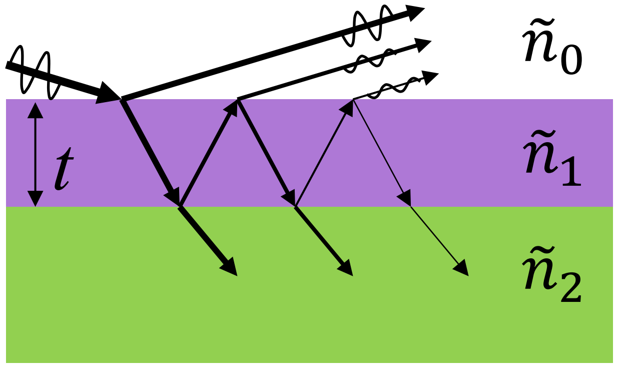
COURSE OUTLINE

- Session 1: Substrates
- Session 2: Transparent Films
- Session 3: Absorbing & Semi-Absorbing Films (B-Spline)
- Session 4: Semi-Absorbing Films (Gen-Osc)
- **Session 5: Thin Absorbing Films and Multilayers**
- Session 6: Advanced Topics



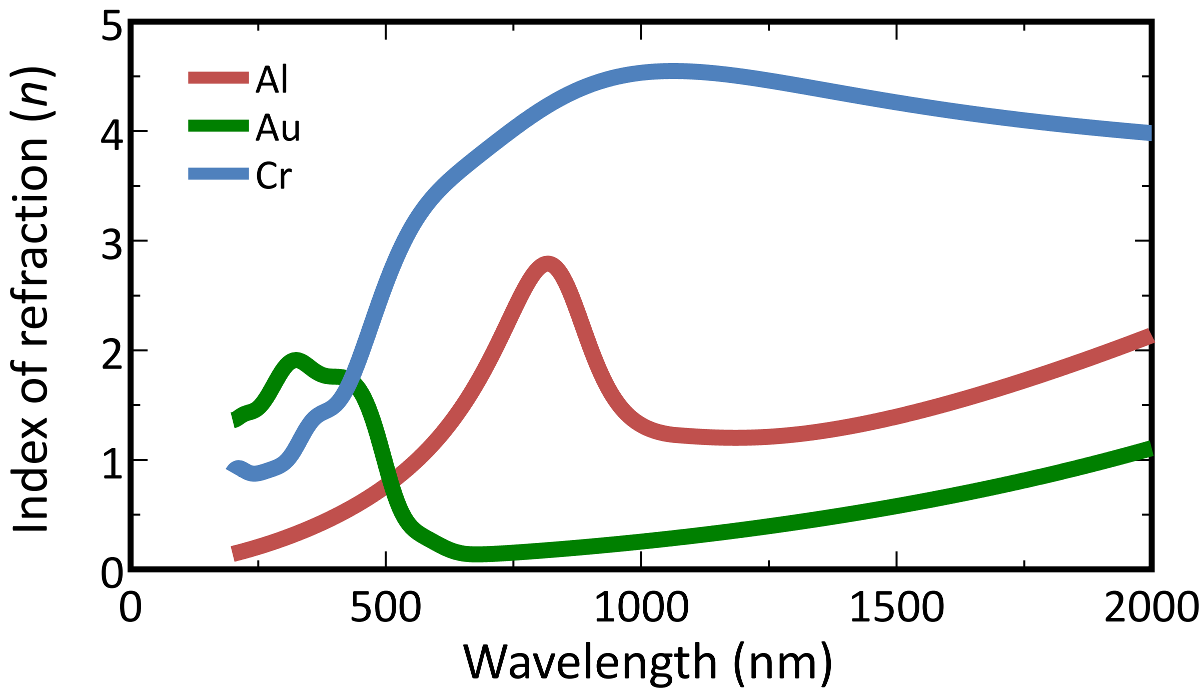


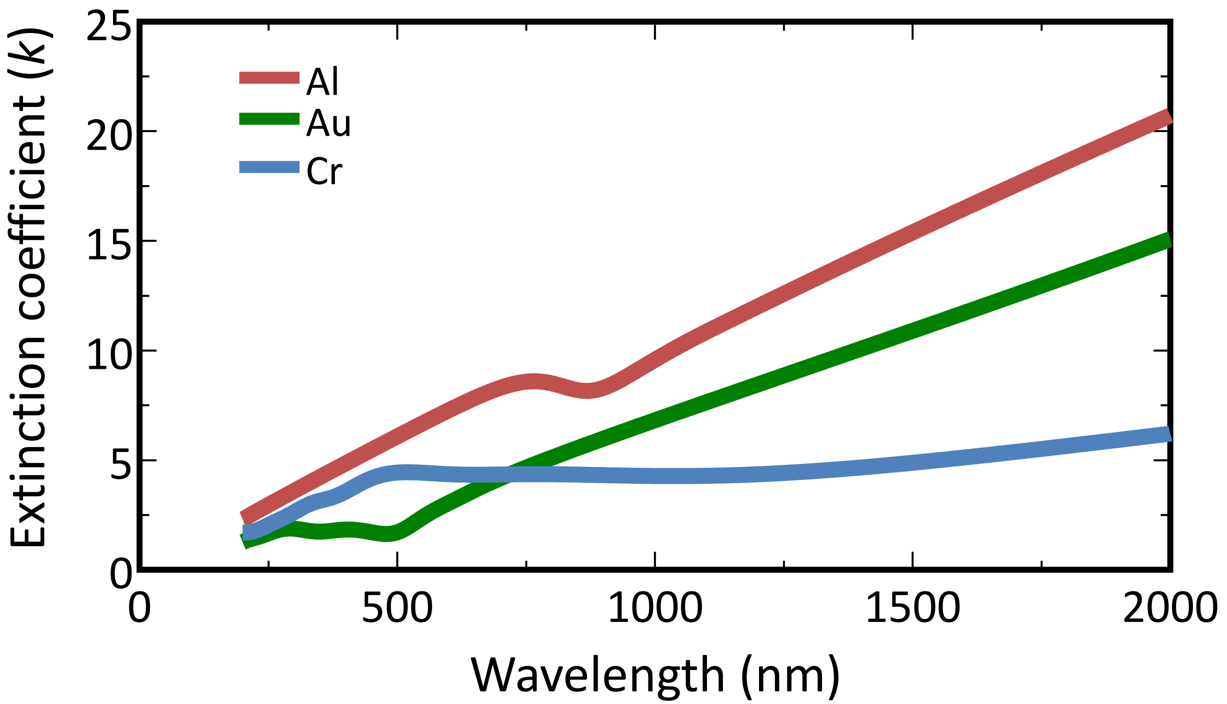
SESSION 5 OUTLINE

- Thin Absorbing Film Methods
  - Interference Enhancement
  - SE + Transmission Intensity
- Multilayers

ABSORBING MATERIALS (METALS)

- No regions of transparency, so need to determine both n & k.

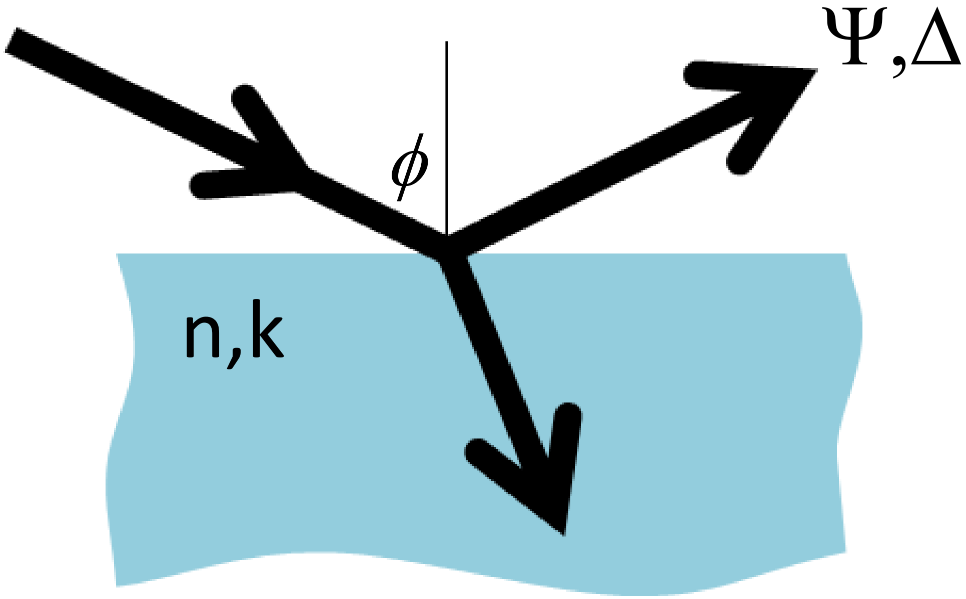


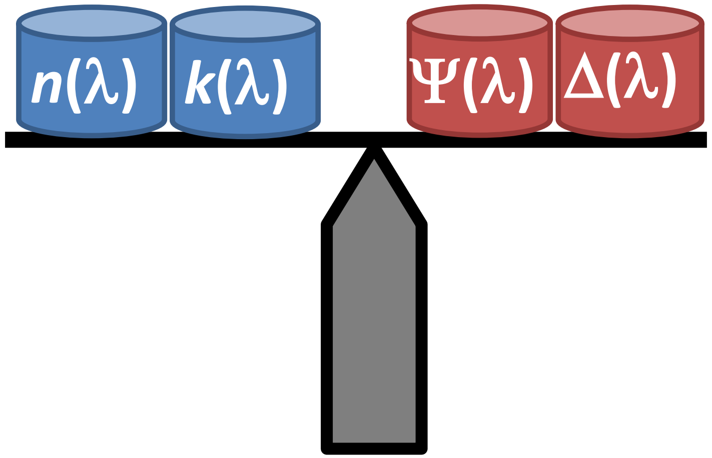


OPAQUE LAYERS

- Treat metal as "substrate" if no light returns from bottom of layer. Typically 50-150nm thick.

Absorbing

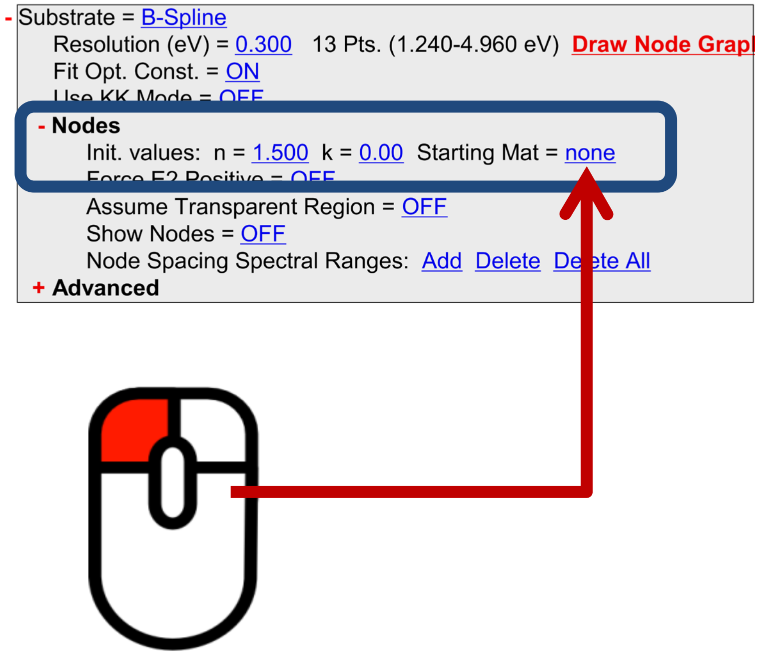




2 Measured Data (Ψ,Δ)
2 Unknowns (*n*,*k*)

OPAQUE METAL PROCEDURE (SESSION 3)

Preparing the B-spline



Expand the **Nodes** section, click on “Starting Mat = none”
Select a new material file from Library

Add B-Spline as Substrate in Model

⇩

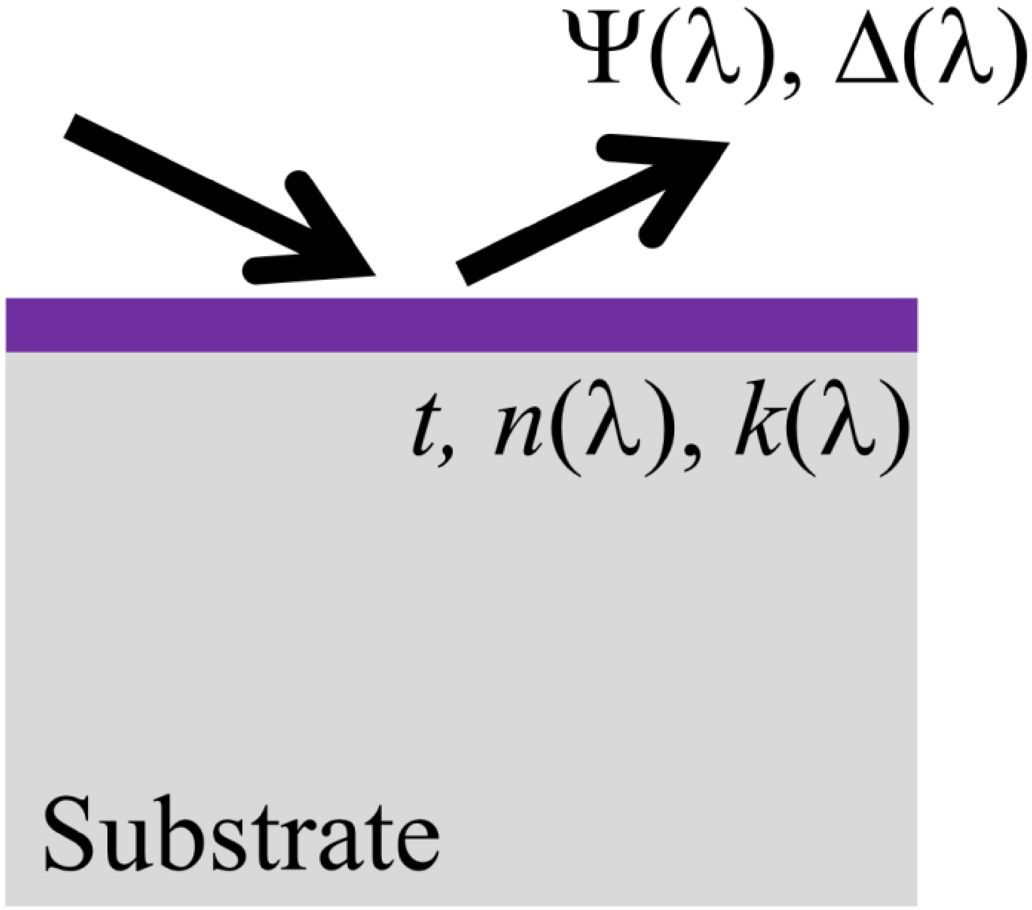
Expand Nodes: Add Metal as “Starting Mat”

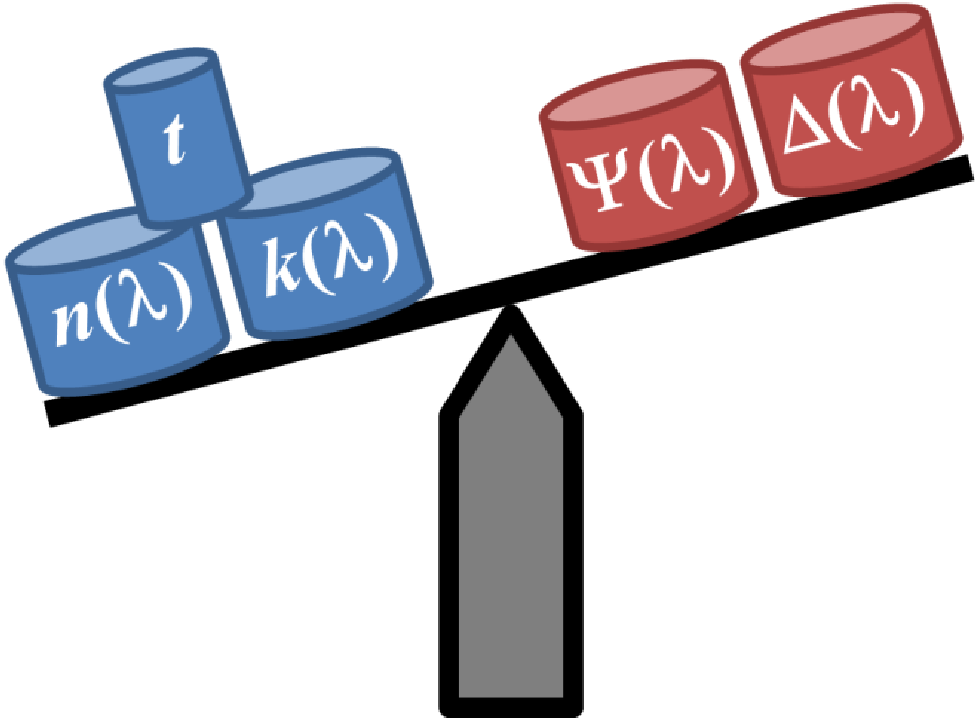
⇩

Press Fit, Optimize Node Resolution

THIN METAL CHALLENGE

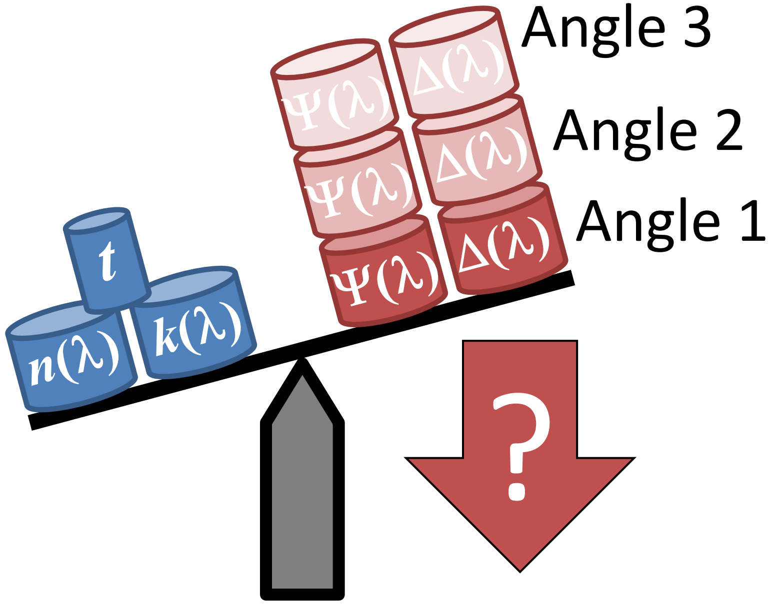
- Need to determine thickness, *n* and *k*!





MULTIPLE ANGLES ???

- Ψ and Δ data curves are different at each angle of incidence
- Can we use multiple angles to increase the data “content” and solve for both thickness and optical constants of thin metals???

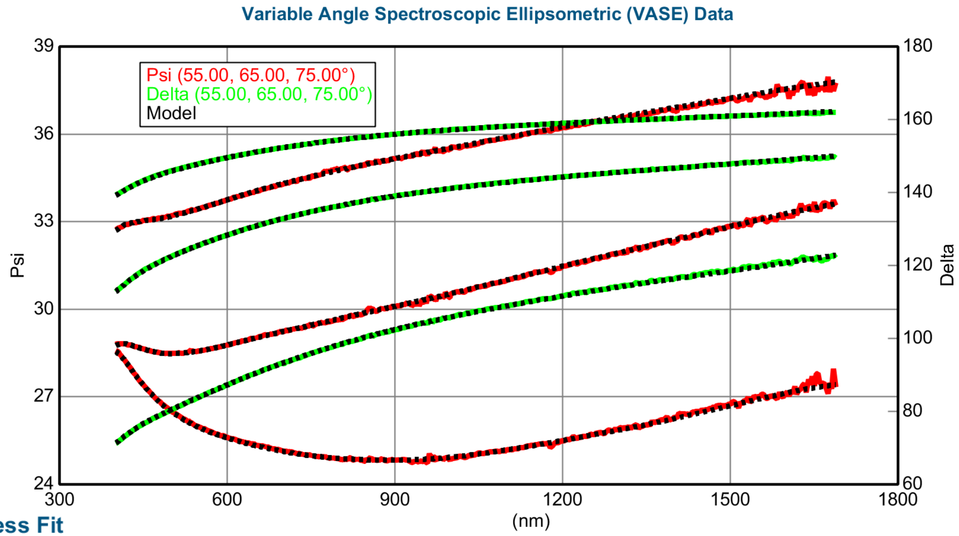


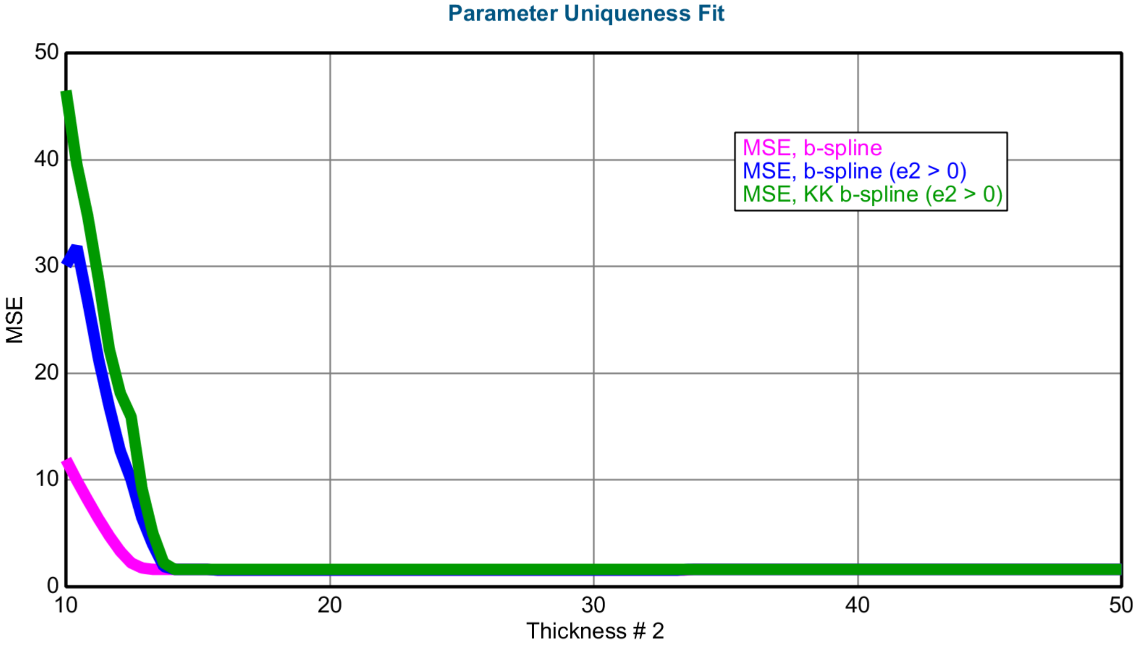
THIN METAL ON SI (MULTIPLE ANGLES)

- Layer # 2 = B-Spline Thickness # 2 = **20.00 nm** (fit)
  - Resolution (eV) = 0.150 16 Pts. (0.734-3.091 eV) **Draw Node Graph**
  - Fit Optical Constants = ON
  - Use KK Mode = ON (In Use)
  - + **Kramers-Kronig**
  - - **Nodes**
    - Init. Values: n = 1.500 k = 0.00 Starting Mat. = Ti
    - Force E2 Positive = ON
    - Assume Transparent Region = OFF
    - Show Nodes = OFF
    - Node Spacing Spectral Ranges: Add Delete Delete All
  - + **Advanced**

Layer # 1 = NTVE_JAW Thickness # 1 = 1.50 nm

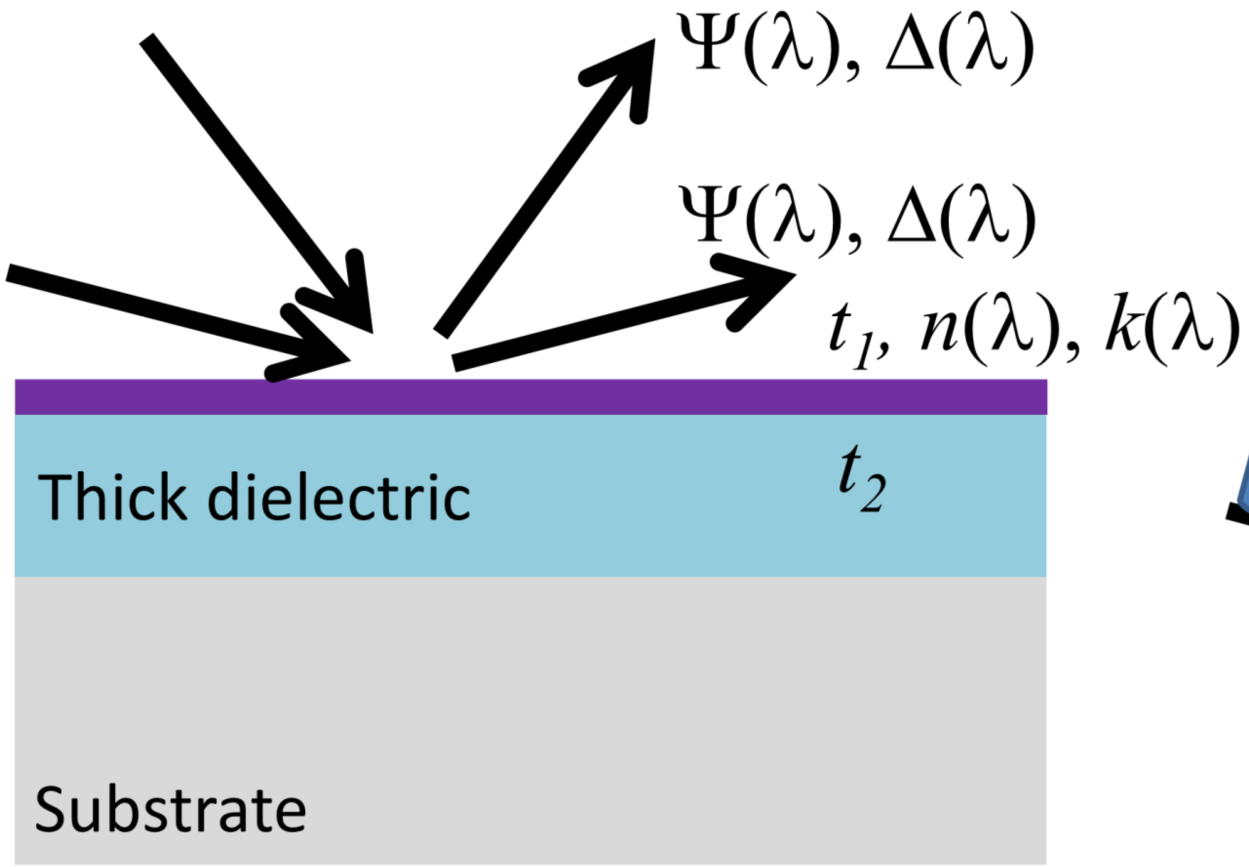
Substrate = Si_JAW

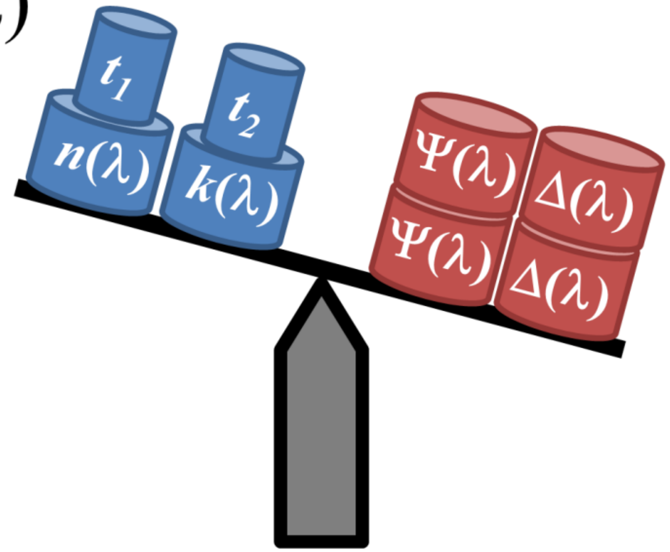




STRATEGY #1: INTERFERENCE ENHANCEMENT

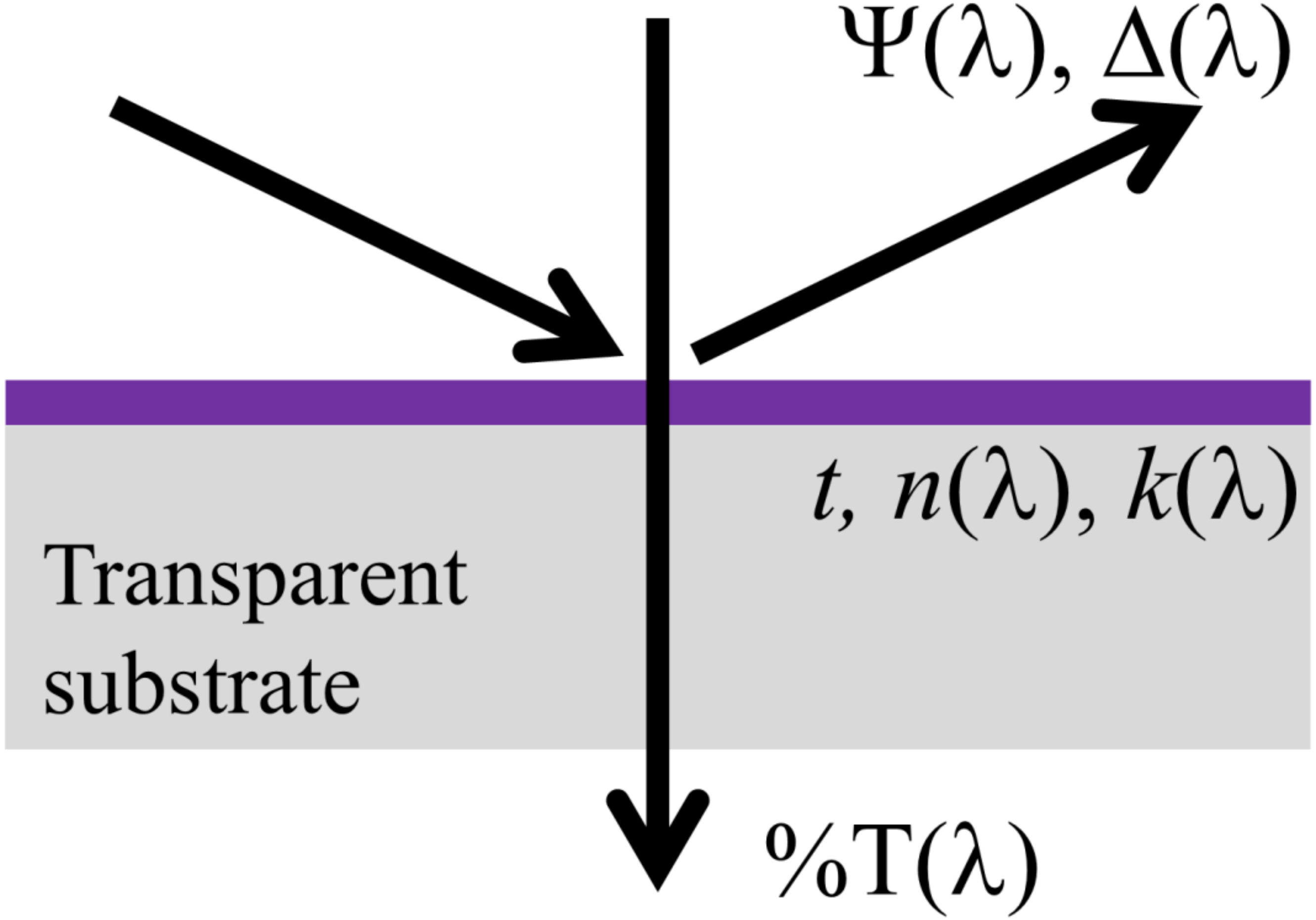
- Thick dielectric under absorbing film produces "NEW" information about absorbing film versus angle.

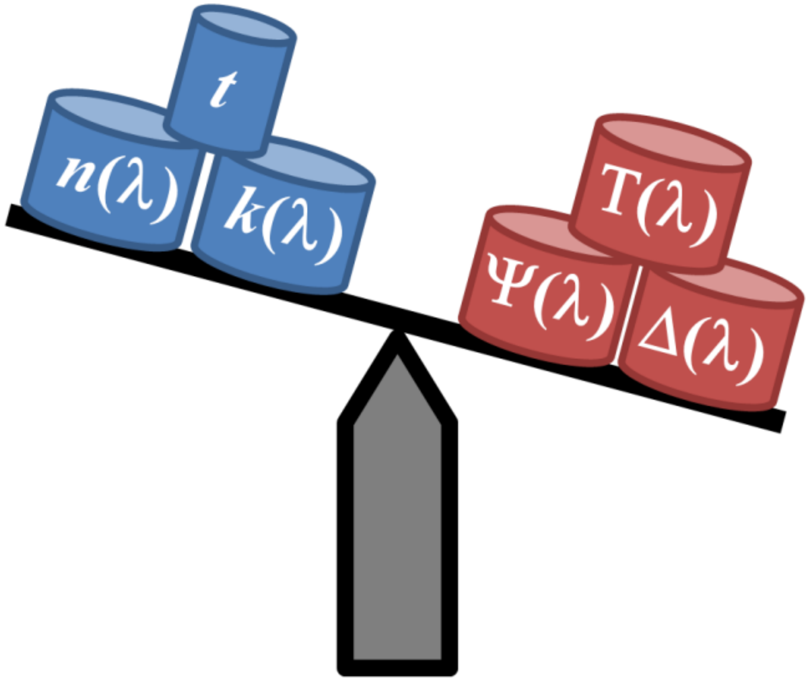




STRATEGY #2: SE + INTENSITY

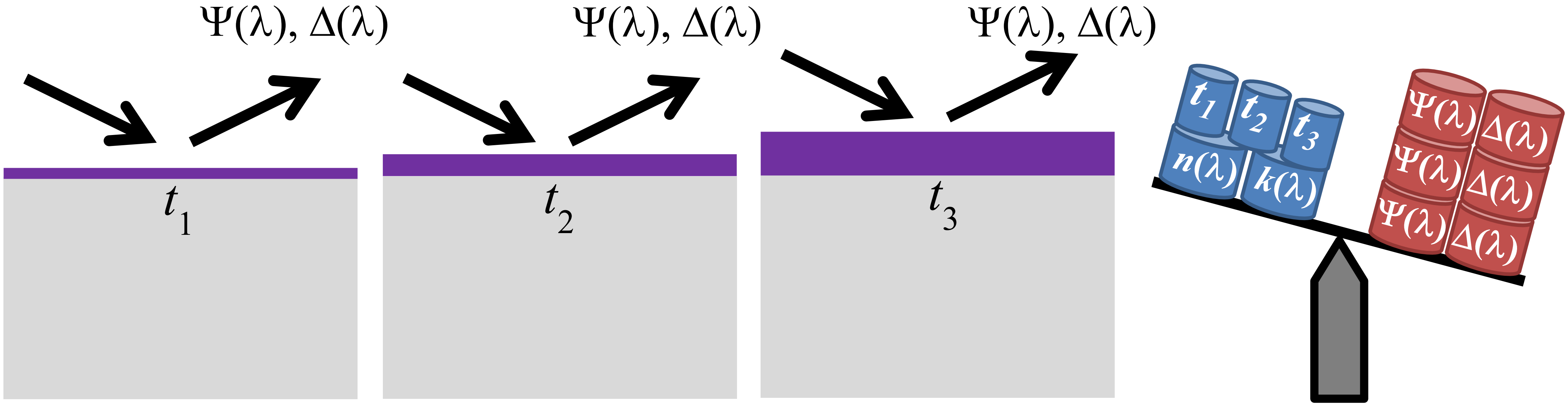
- Transmitted intensity adds new data content.





STRATEGY #3: MULTI-SAMPLE ANALYSIS

- New information from multiple samples with same *n,k* but different thickness for new path length.

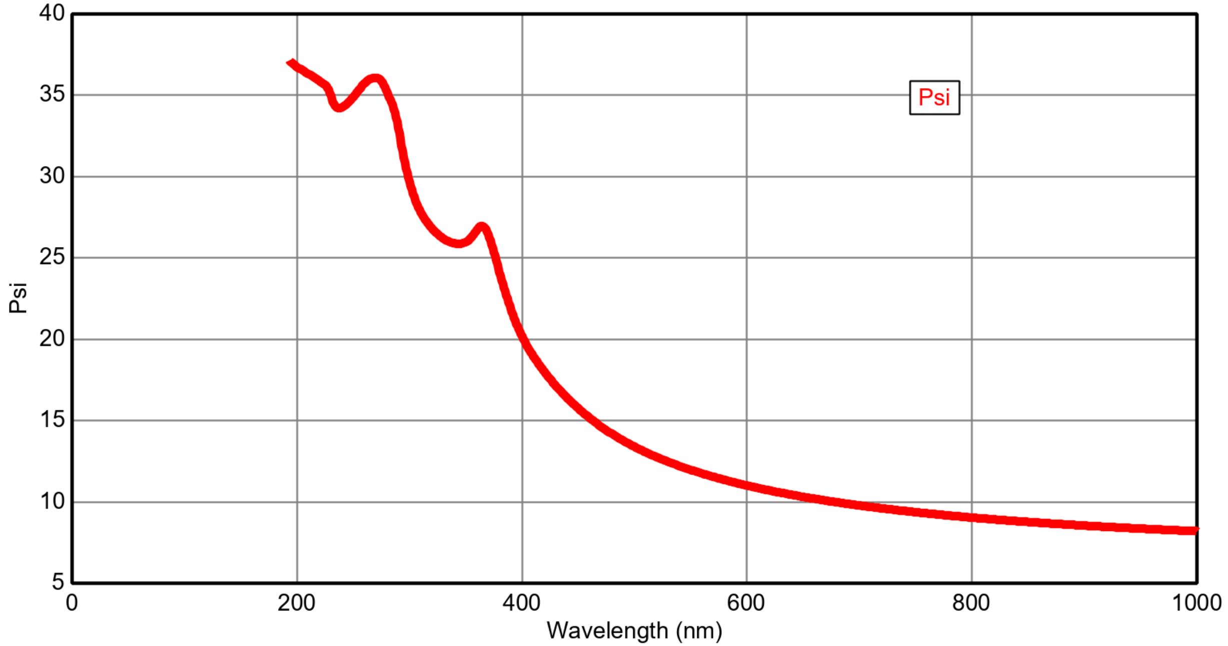


INTERFERENCE ENHANCEMENT

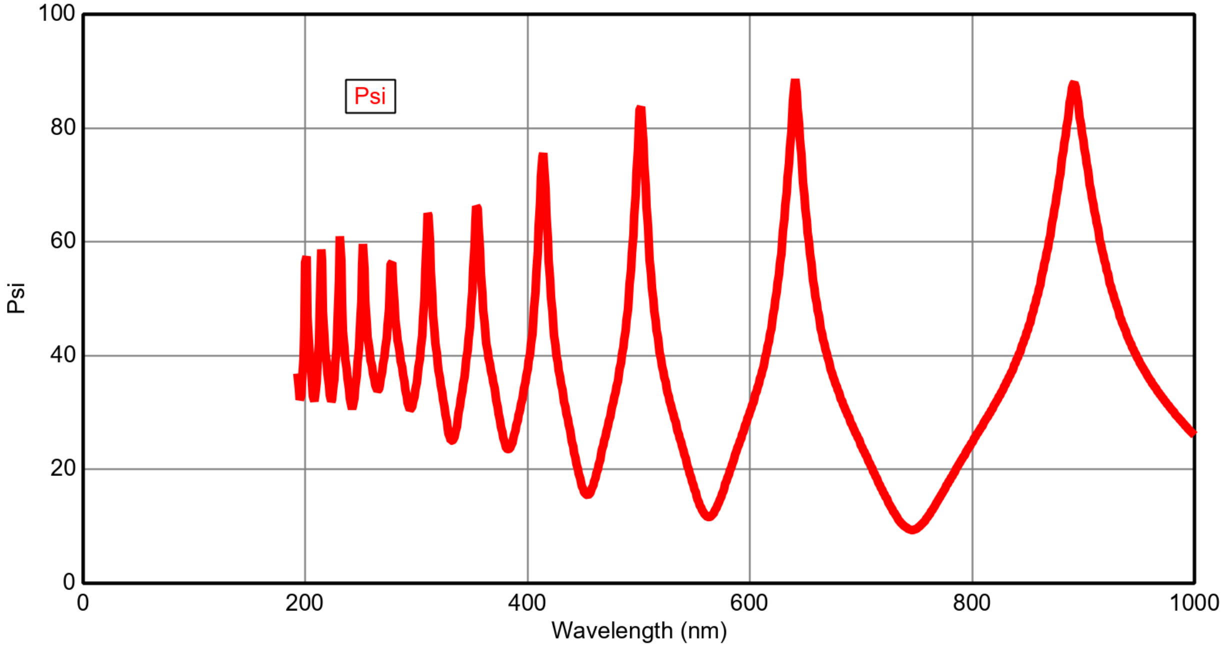
ARTIFACT MINIMIZATION

- Correct film thickness when there are no "artifacts" in our thin film optical constants from the underlying sample "structure"

Native Oxide on Si



1µm Oxide on Si

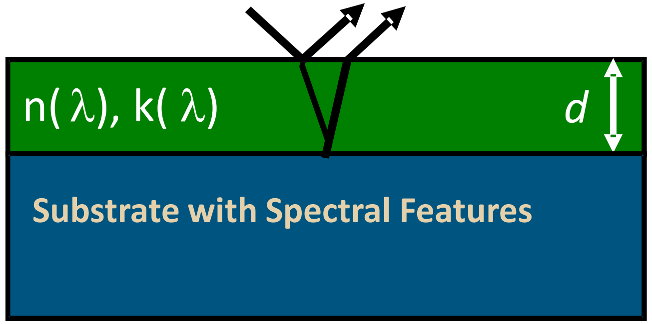


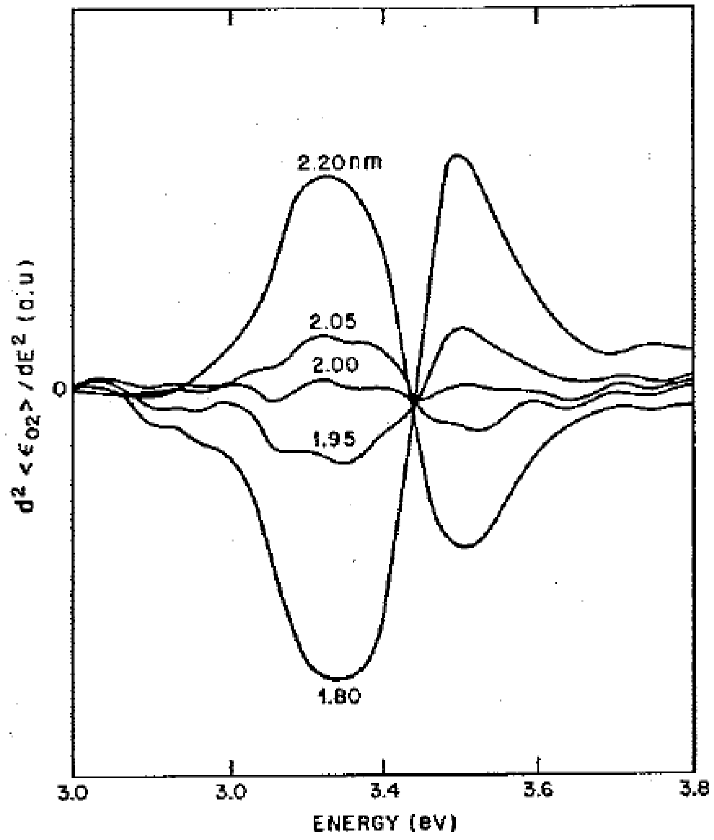
"ARWIN-ASPNES" EFFECT

- Identify correct thickness when substrate "features" do not appear in film n,k.

Also referred to as "Artifact Minimization"

  - Sharp substrate spectral features are preferred
  - Film can't have same features as substrate
    - B-spline forces metal film to have "smooth" n,k so it can't follow the substrate features

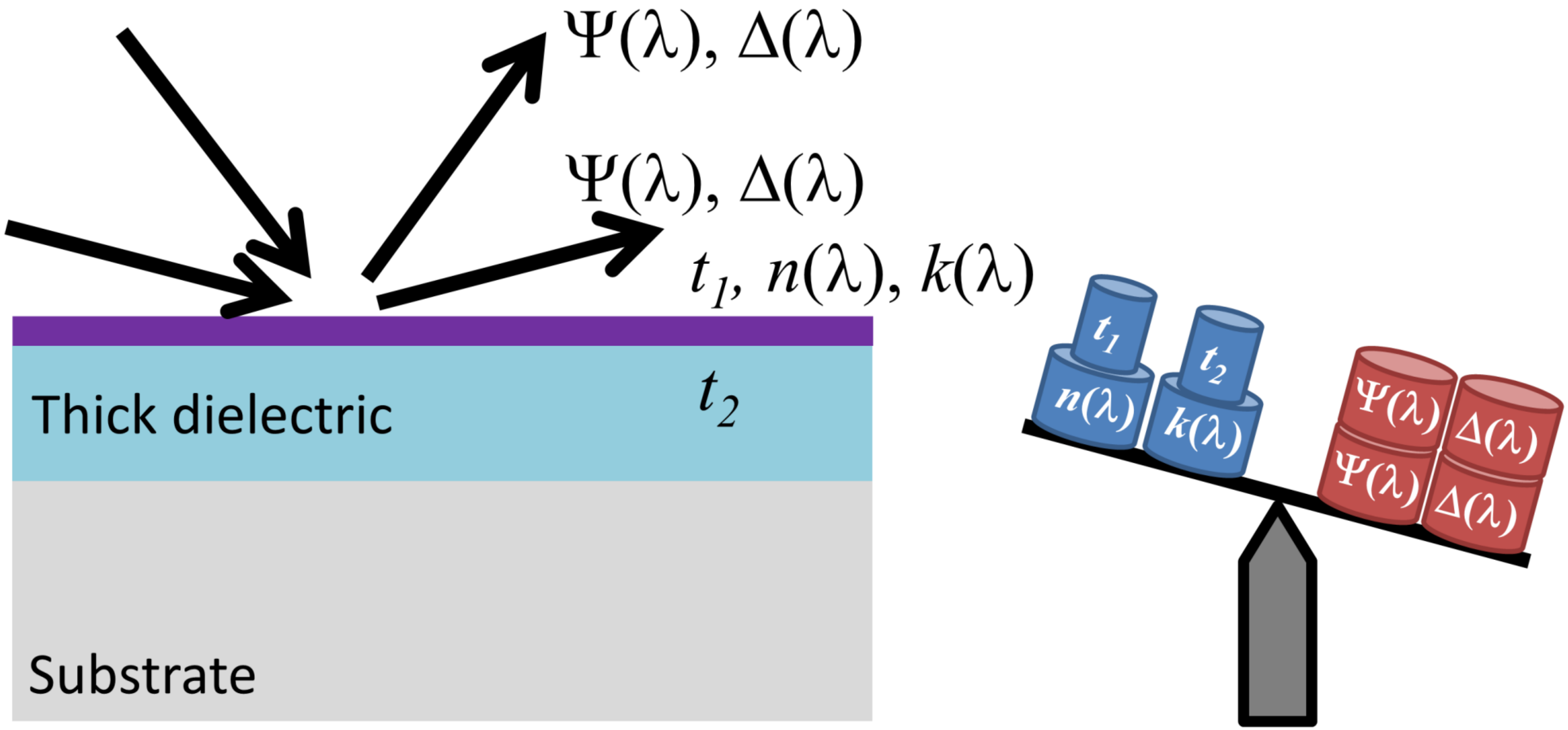




H. Arwin and D.E. Aspnes "Unambiguous Determination of Thickness and Dielectric Function of Thin Films by Spectroscopic Ellipsometry", *Thin Solid Films*, **113** (1984) 101.

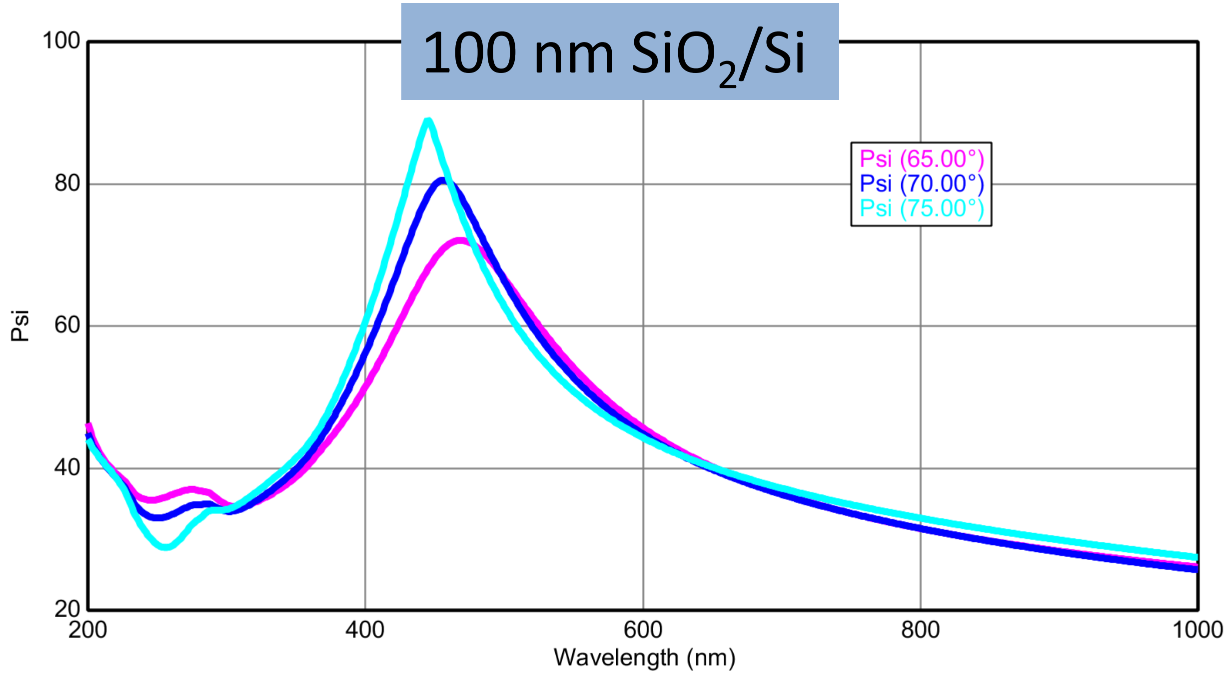
STRATEGY: INTERFERENCE ENHANCEMENT

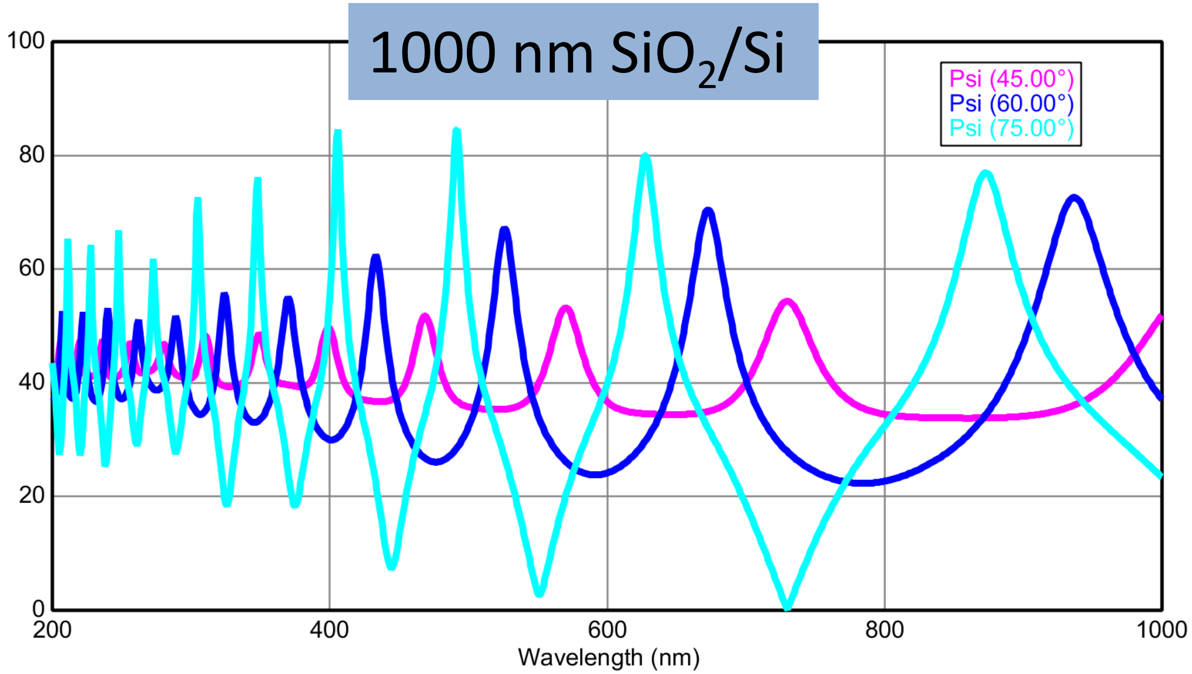
- Thick dielectric under absorbing film produces “NEW” information about absorbing film versus angle.



WHY MULTIPLE ANGLES?

- Changing angle shifts spectral location for the "artifacts"





Thicker dielectric has more "artifacts"

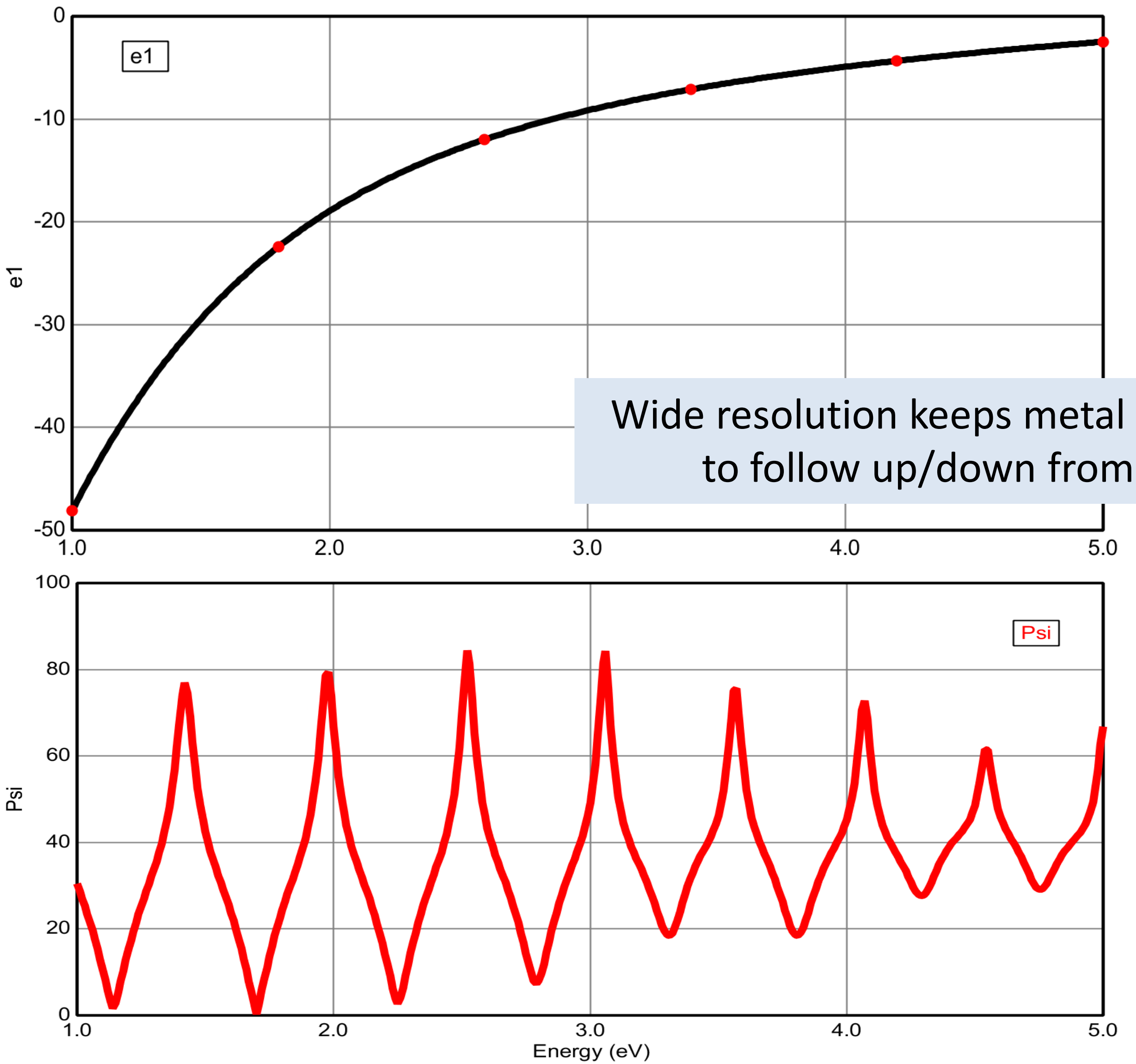
Wide angle separation also spreads "artifacts"

INTERFERENCE ENHANCEMENT PROCEDURE

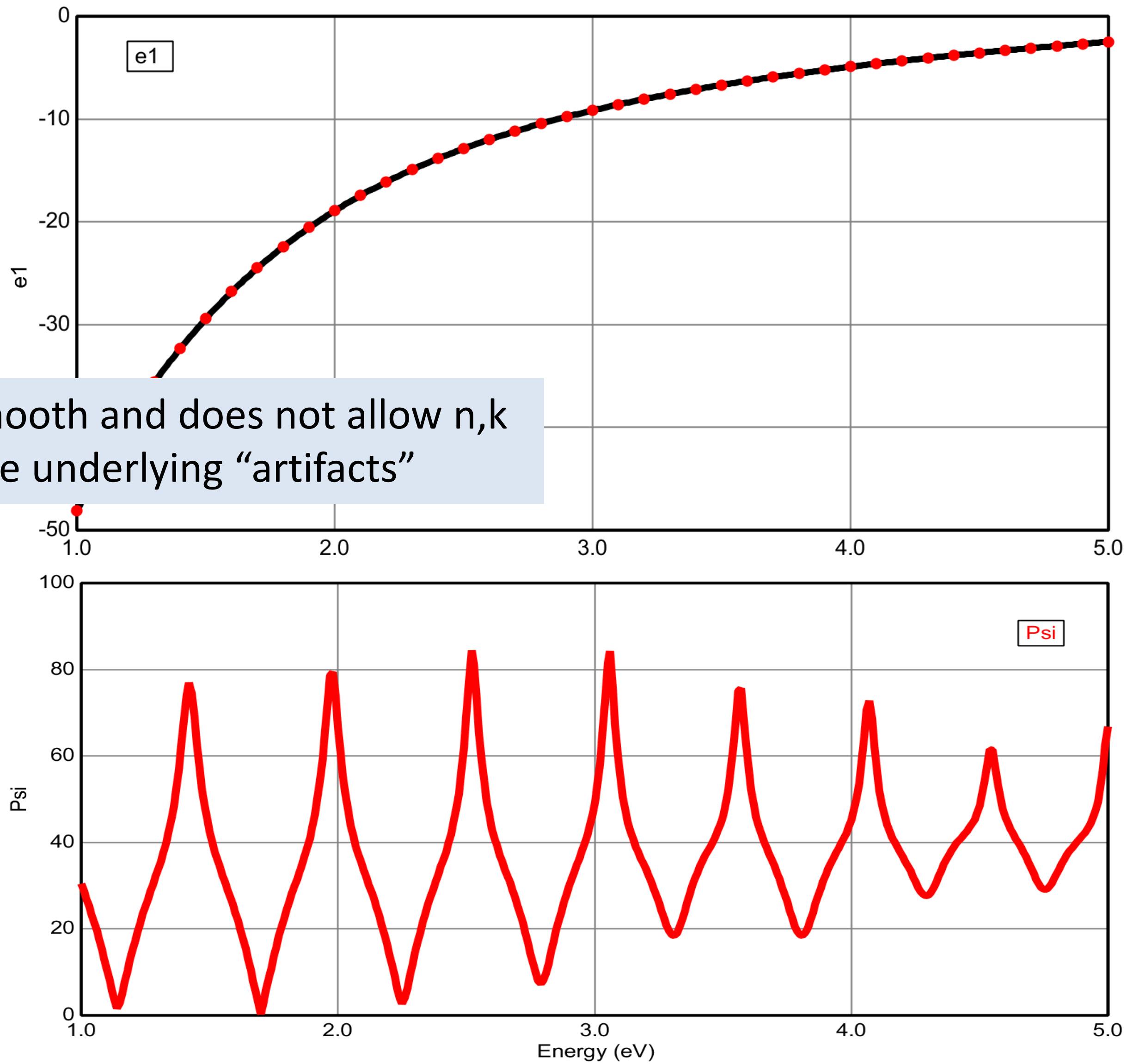
1. Build model. Include all layers and nominal thicknesses.
   - Start with published values if available.
   - Use B-spline or GenOsc to parameterize the absorbing film.
2. Adjust thicknesses iteratively
   - Adjust dielectric to match interference pattern.
   - Adjust absorbing layer to match amplitude…“dampening”.
   - Consider Global Fit as needed
3. Fit absorbing layer optical constants and both thicknesses
4. Check Results and Uniqueness.

B-SPLINE NODE RESOLUTION

0.75 eV resolution

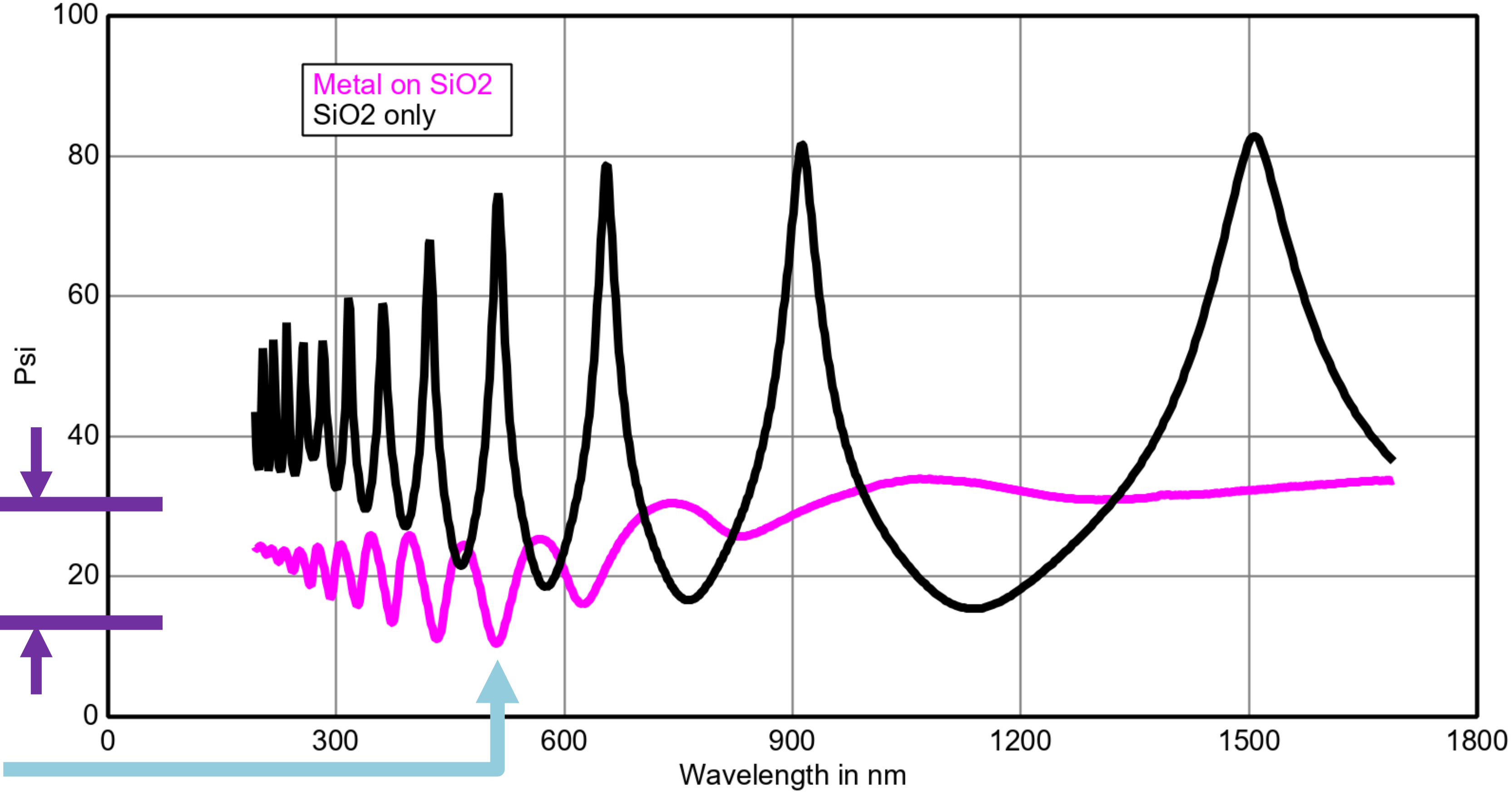


0.1 eV resolution

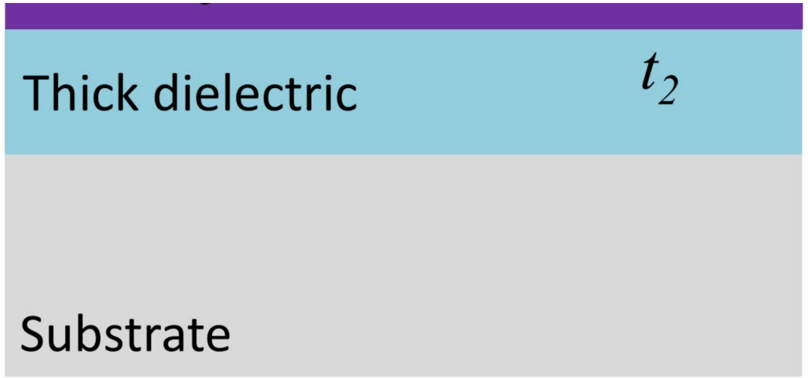


Wide resolution keeps metal smooth and does not allow n,k to follow up/down from the underlying “artifacts”

DATA FEATURES (INTERFERENCE ENHANCEMENT)



Compression of oscillations caused by the metal absorption

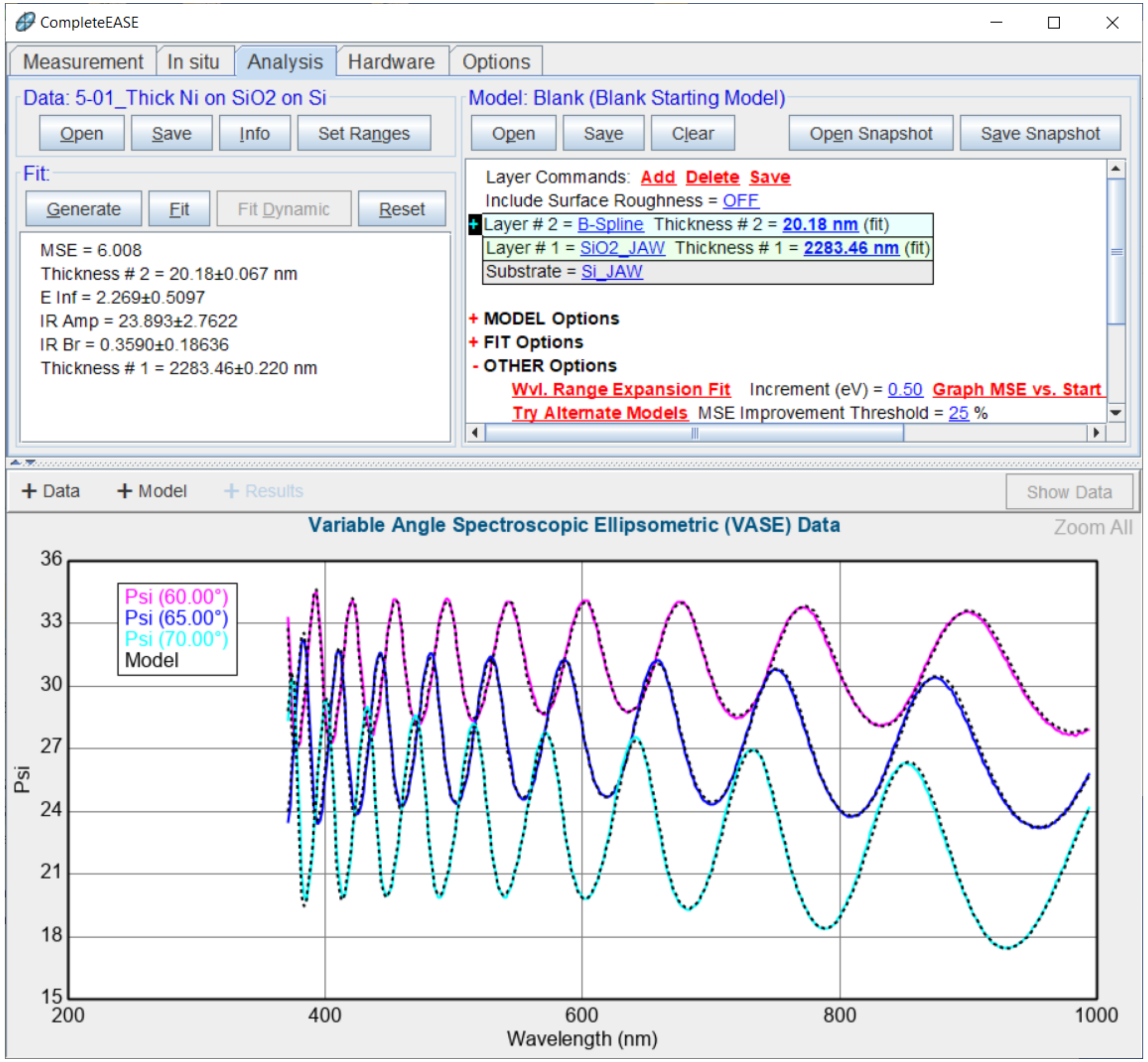


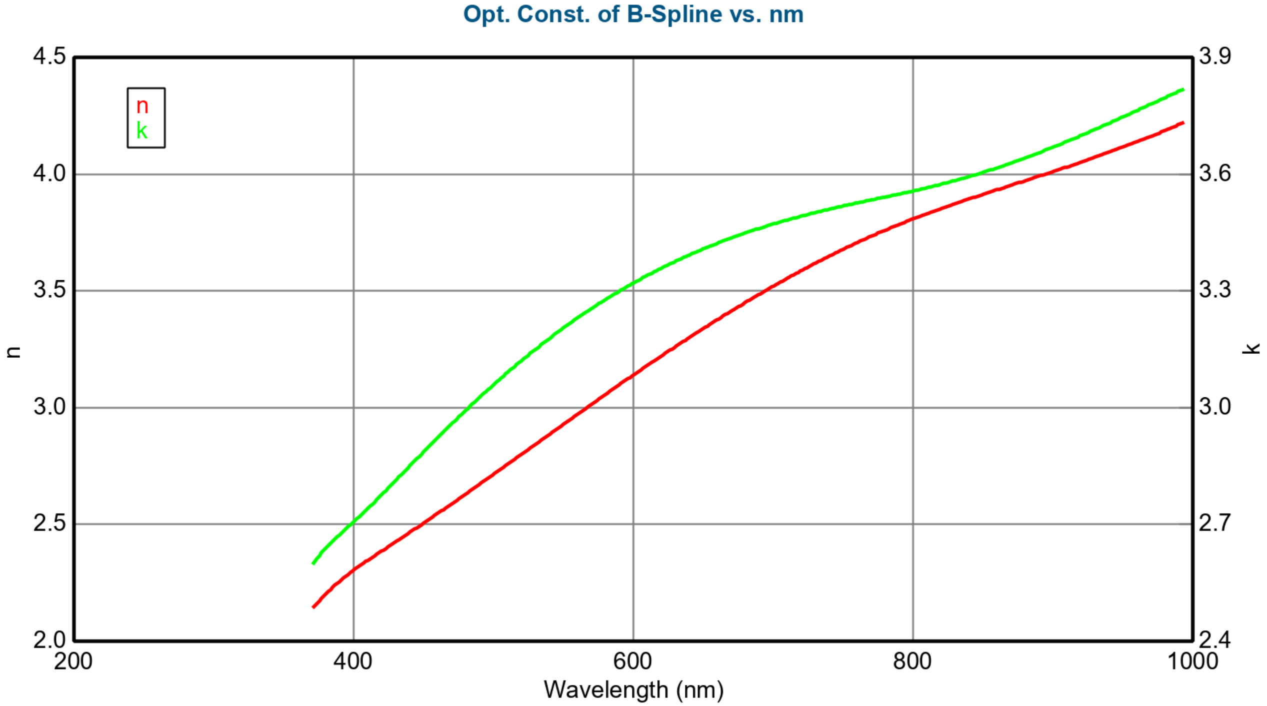
Large number of oscillations due to thick dielectric

5-01 Ni on SiO_2 on Si

- Determine Ni optical constants for thin film on SiO_2-coated silicon substrate.

Ni on SiO_2 on Si: Results

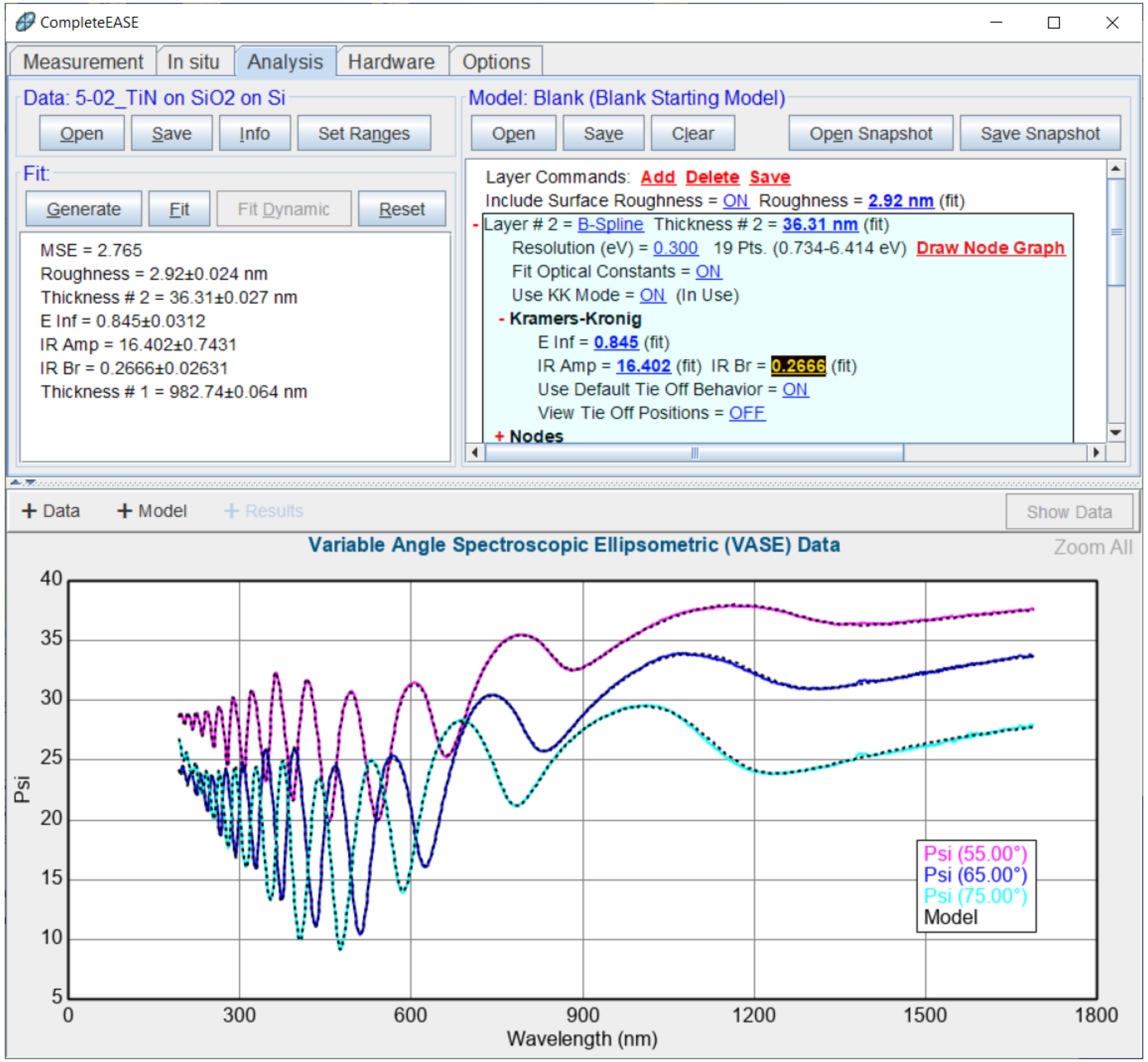


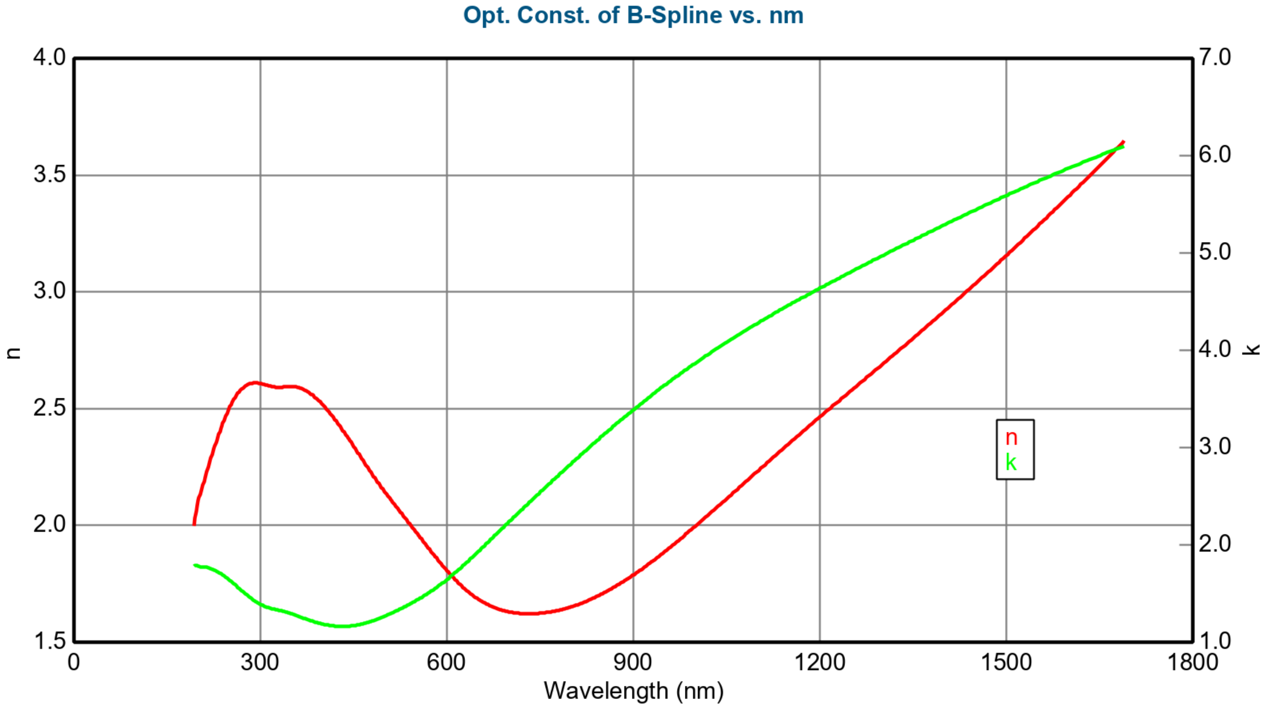


5-02 TiN on SiO_2 on Si

- Try to determine TiN optical constants for thin film on SiO_2-coated Silicon substrate.

TIN ON SIO_2 ON SI: RESULTS

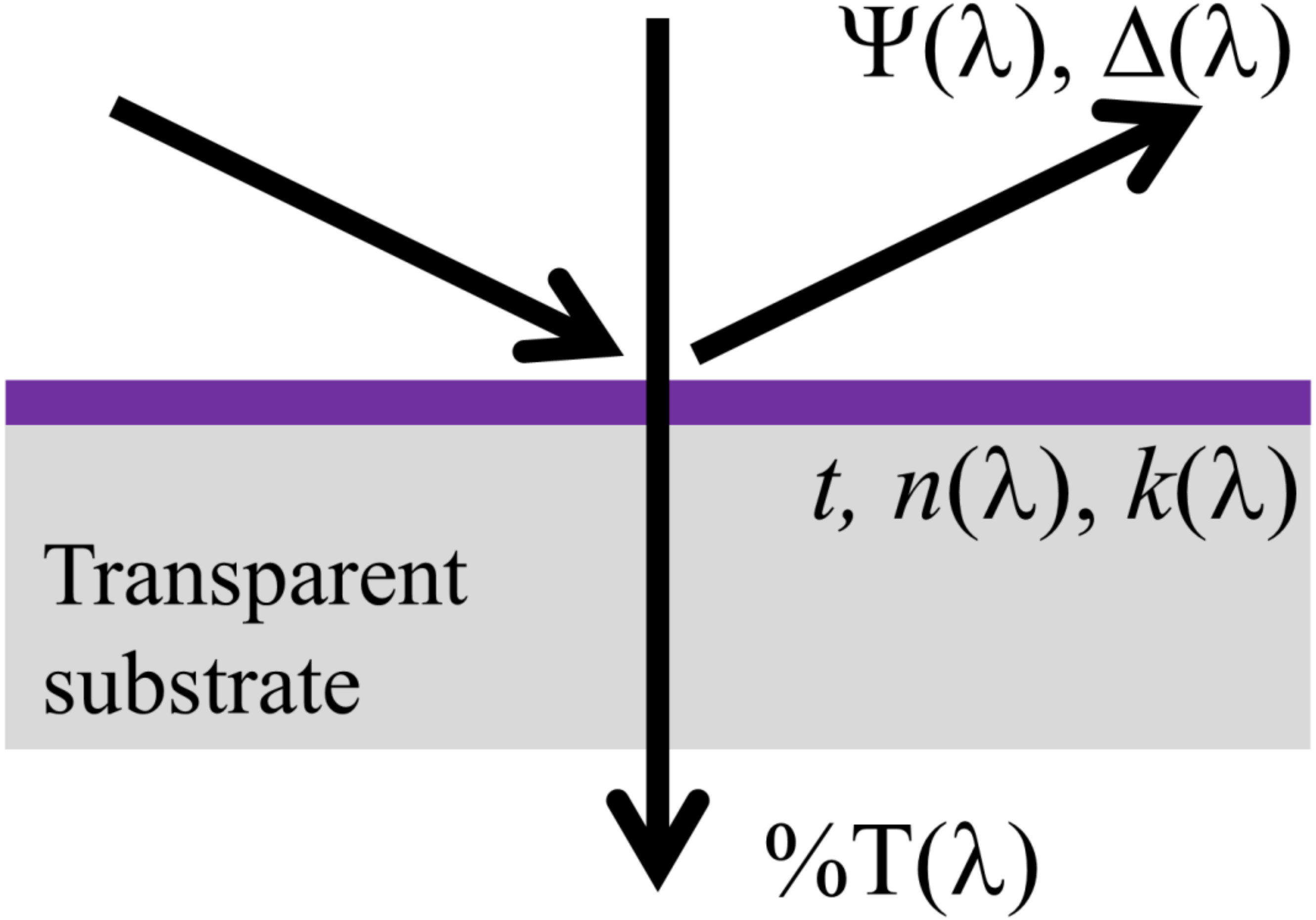


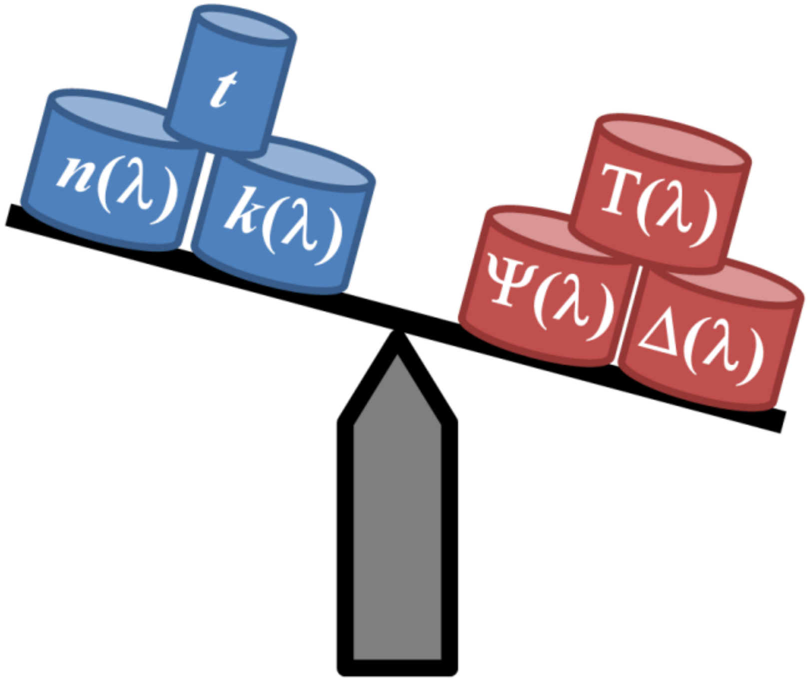


SE + TRANSMISSION

STRATEGY: SE + INTENSITY

- Transmitted intensity adds new data content.

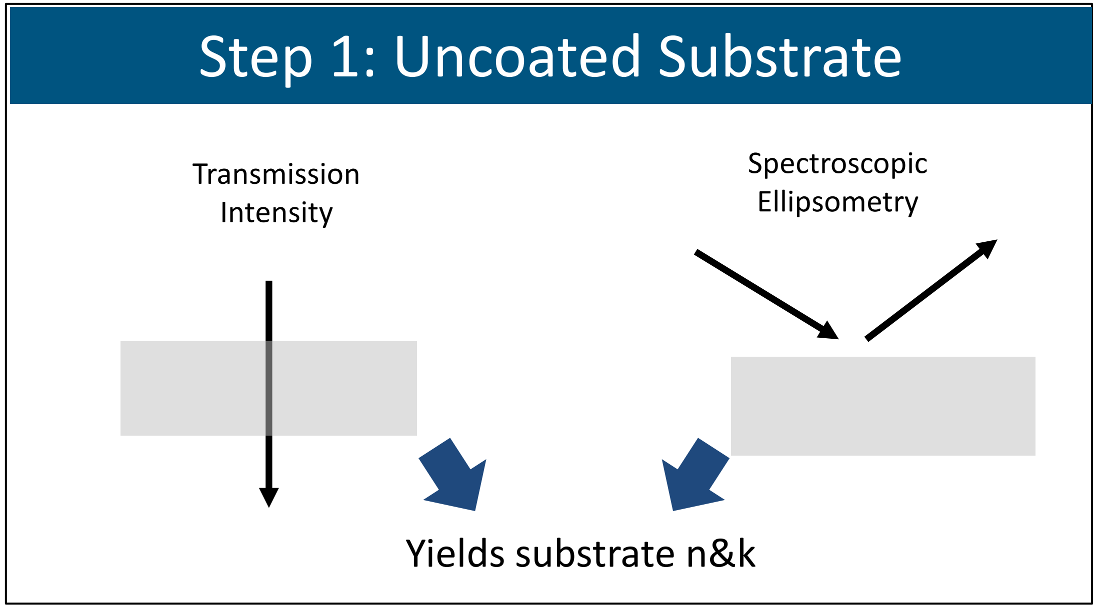


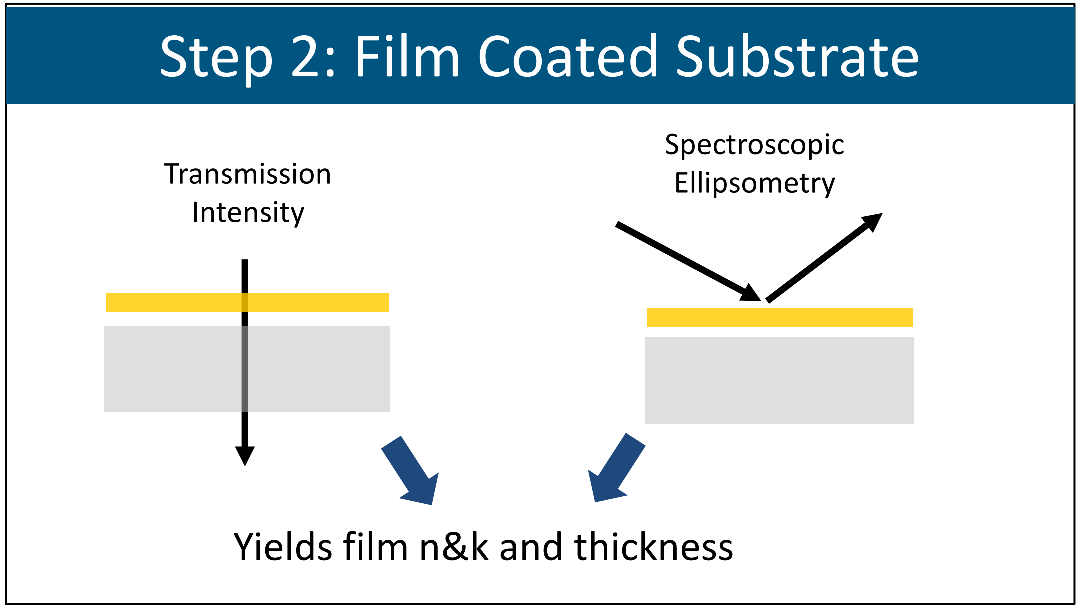


SE + TRANSMISSION ON THIN ABSORBING FILMS

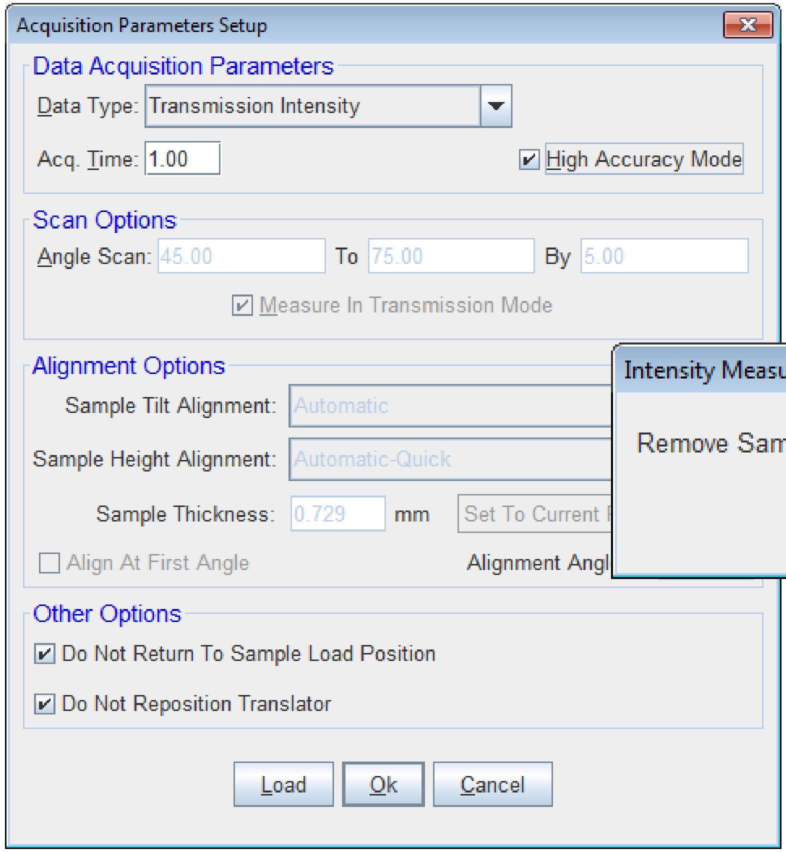
Step 1: Measure and analyze bare reference substrate

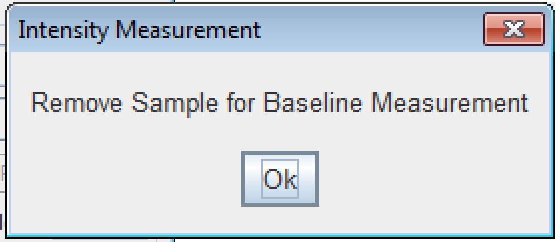
Step 2: Measure and analyze thin absorbing films



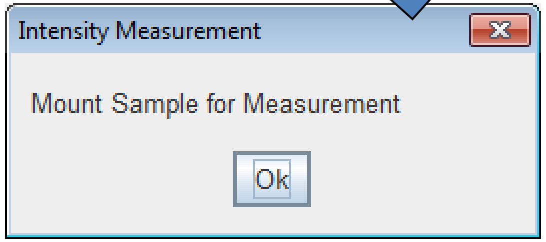


TRANSMISSION INTENSITY IN COMPLETEEASE

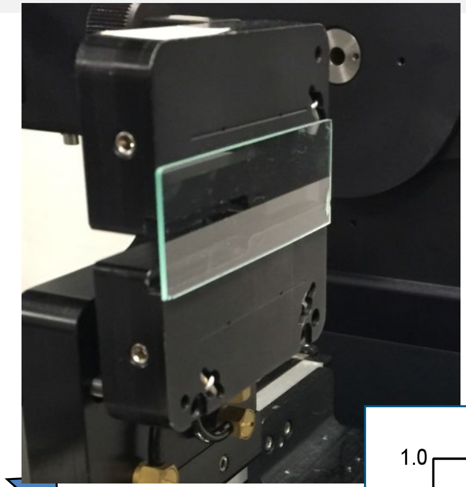


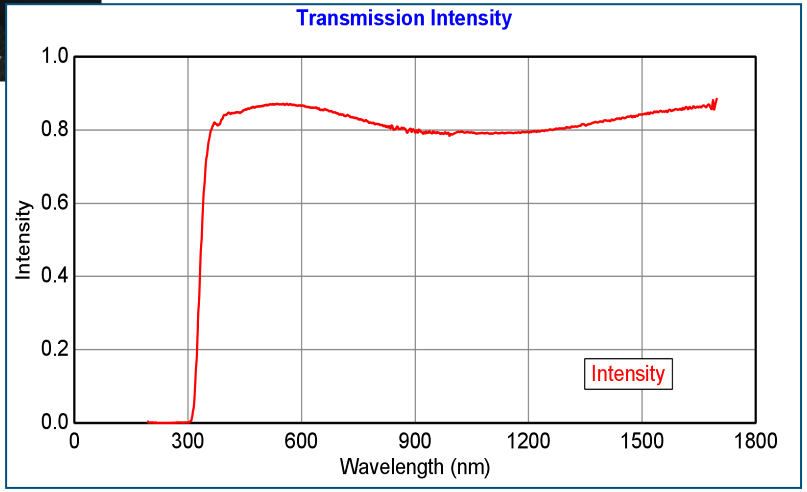


I.



II.





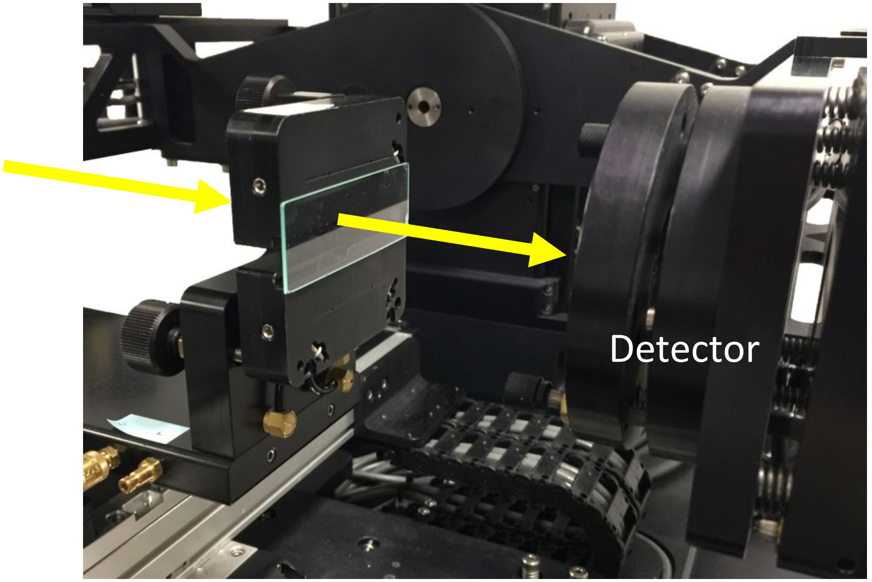
I. Perform baseline measurement without sample (I_0)

II. When prompted, hold sample perpendicular to beam path (I_1)

$$T = \frac{I_1}{I_0}$$

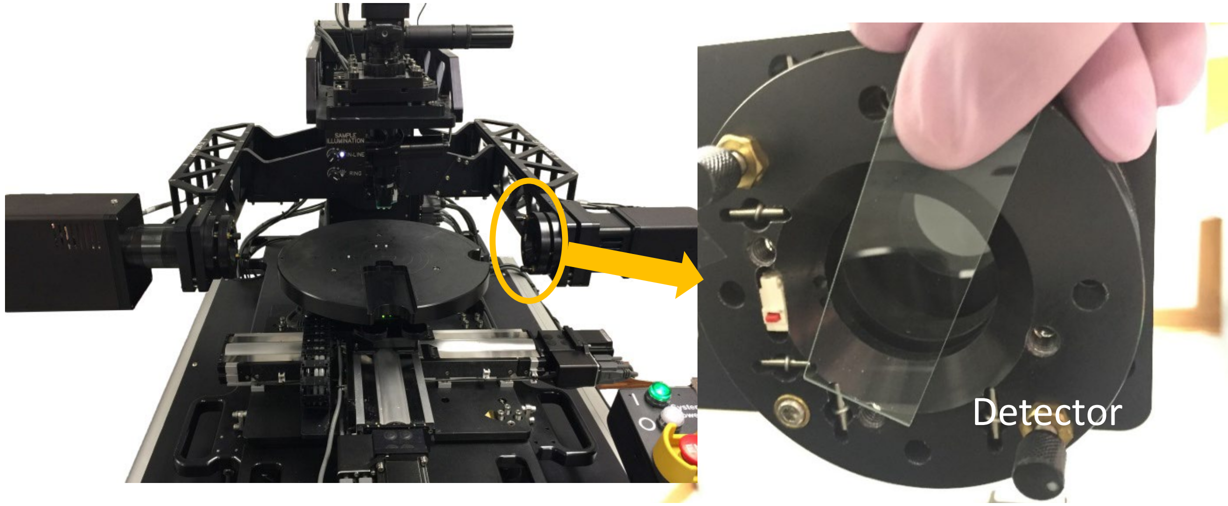
TRANSMISSION SAMPLE MOUNT ON HORIZONTAL BASE

- Transmission Stage



- Offers tip-tilt alignment
- Accommodates a range of sample sizes

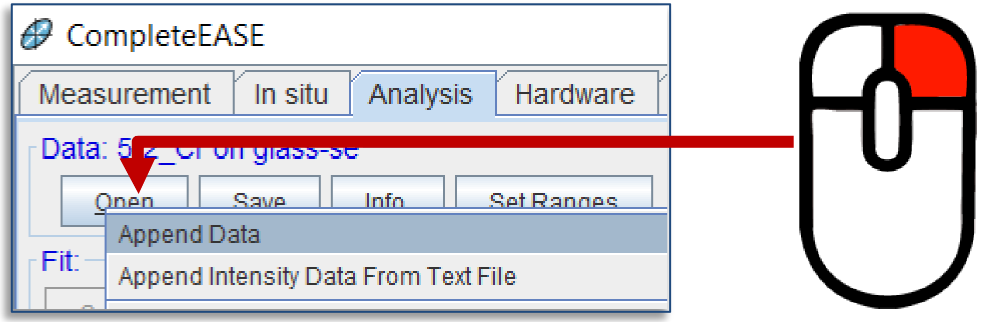
- Manual Position



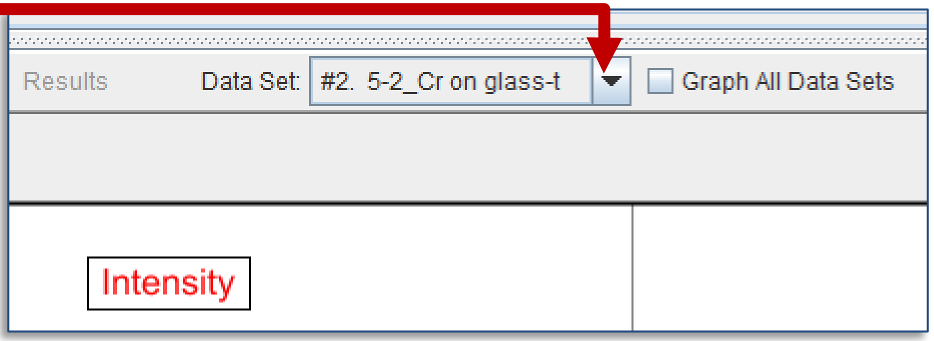
- No stage needed (or swapping of stages)
- Approximate alignment
- Limited sample sizes

MULTIPLE DATA SETS IN COMPLETEEASE

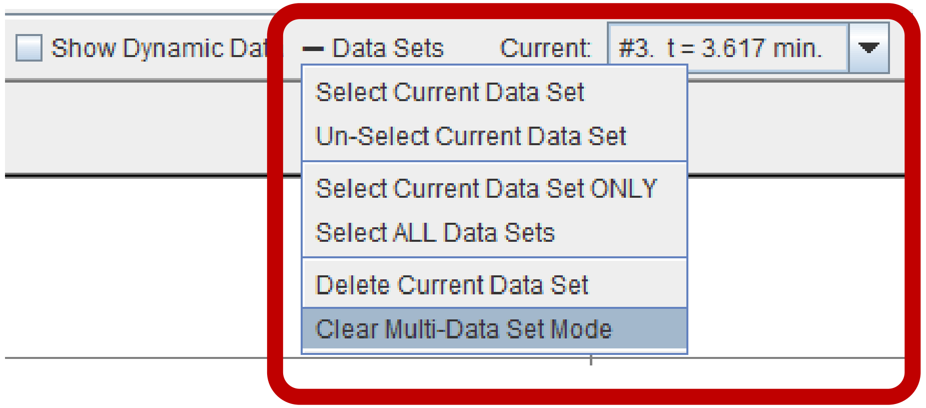
- Right-Click on ‘Open’ to APPEND Data.



- Move between data sets with drop-down menu.
  (Alt-#, toggles between data sets)



- +Data Sets to Select, Un-select, Delete Data Sets

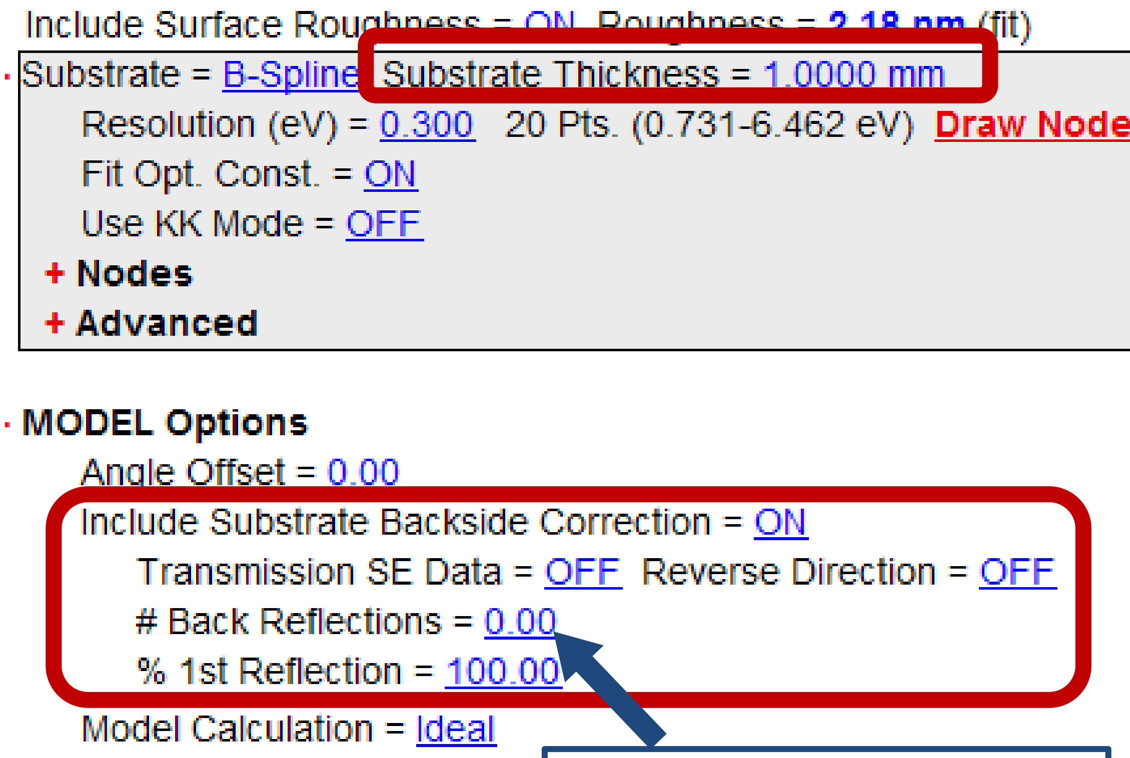


WORKING WITH TRANSMISSION DATA

1. “Include Substrate Backside Correction” = ON
   (in Model Options)

2. Set Substrate Thickness to nominal value
   (use caliper to measure)

3. Set # Back Reflections



= 0 if reflection SE data does not collect back reflection.

NOTE: “Transmission SE Data” is used to inform that measurement was collected from transmitted rather than reflected beam.

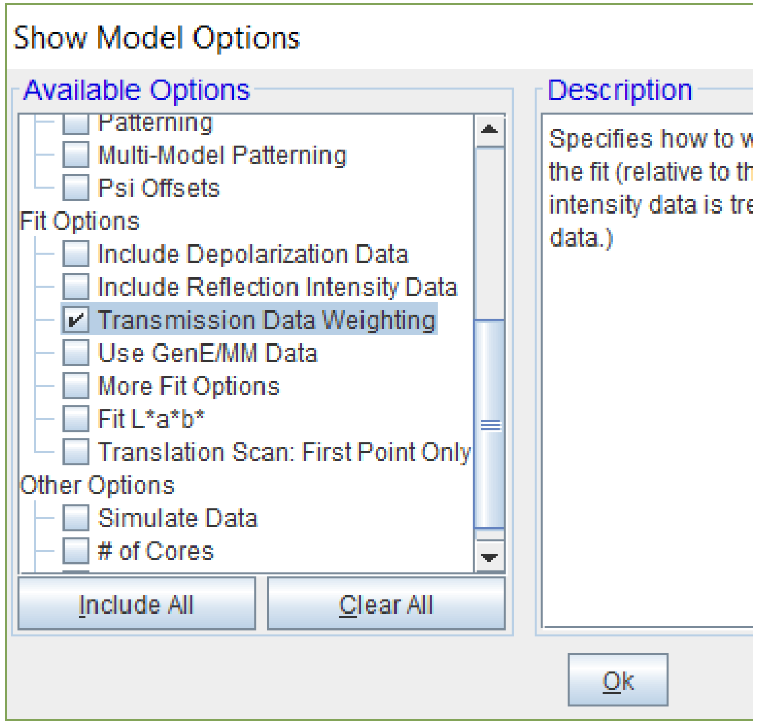
SETTING TRANSMISSION WEIGHTING

1

+ MODEL Options
+ FIT Options
+ OTHER Options

Configure Options

Turn Off All Fit Parameters



- When SE data set contains many angles of incidence, the FIT is biased towards SE over Transmission Data.
- Can increase Transmission Data weighting to compensate

2

- FIT Options

Perform Thickness Pre-Fit = OFF

Use Global Fit = OFF

Fit Weight = N,C,S

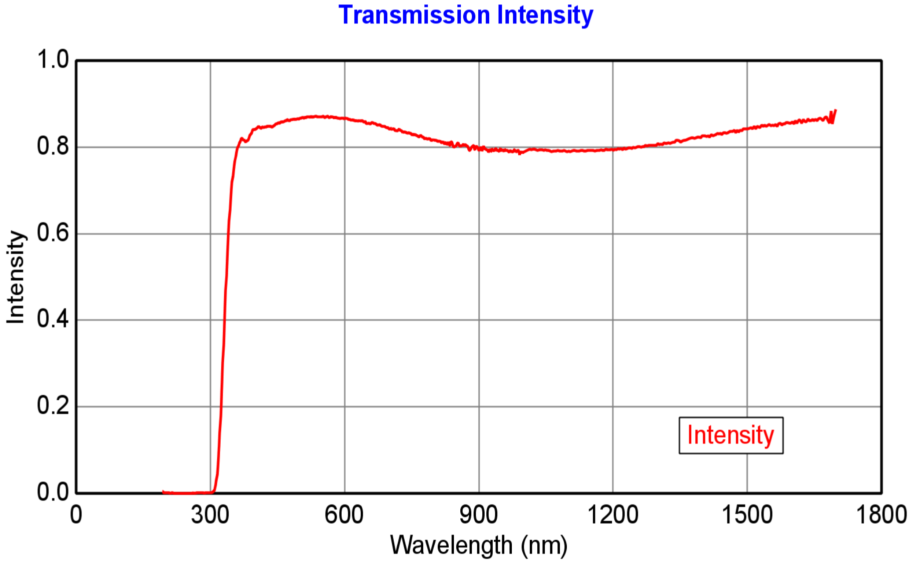
Transmission Data % Weight = 100.00

Limit Wvl. for Fit = OFF

Include Derived Parameters = OFF

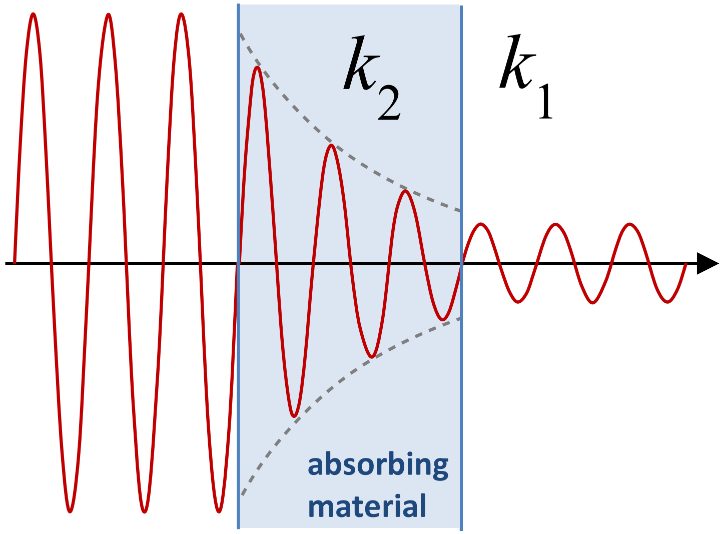
100% sets Transmission curve equal to 1 SE data curve. If you collect 5 angles, may want to increase to 500%

ABSORPTION IN GLASS SUBSTRATE



- Glass may have small absorptions in UV or in NIR
- SE not sensitive to "very small" absorption (k < 0.001) in substrate.
- Transmission intensity is sensitive to small k-values in substrate due to long path length.

*no sensitivity to substrate thickness (use nominal value)



$$I(z) = I_o e^{-\alpha z}$$

$$\alpha(\lambda) = \frac{4\pi k(\lambda)}{\lambda}$$

Add Transmission to characterize k.

GLASS SUBSTRATES (STRATEGIES)

SE data only

- Cauchy/Sellmeier for *n* (match Ψ)
- Roughness (match Δ)
- # of Backside Reflections when applicable (shift in Ψ with angle)

SE + T

- Cauchy/Sellmeier for *n* (match Ψ)
- Roughness (match Δ)
- # of Backside Reflections when applicable (shift in Ψ with angle)
- B-spline or Genosc for *k* (match T)

- Hybrid Layer???
  - Cauchy/Sellmeier for *n* (ε_1)
  - B-spline for *k* (ε_2)

HYBRID LAYER

- Allows different dispersion equations for *n*,*k* (or $\varepsilon_1,\varepsilon_2$)

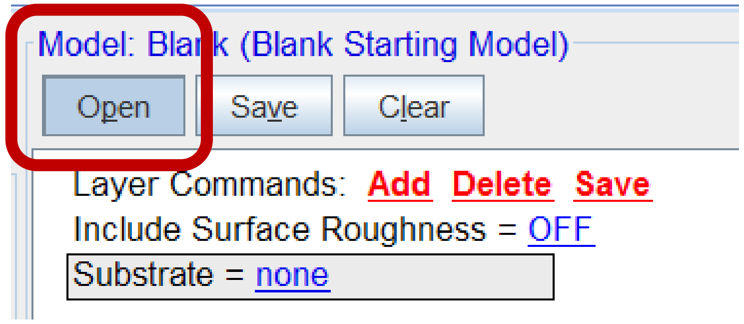
$$\tilde{\varepsilon} = \varepsilon_1 - i\varepsilon_2 = \tilde{n}^2 = (n - ik)^2 = n^2 - 2ink - k^2$$

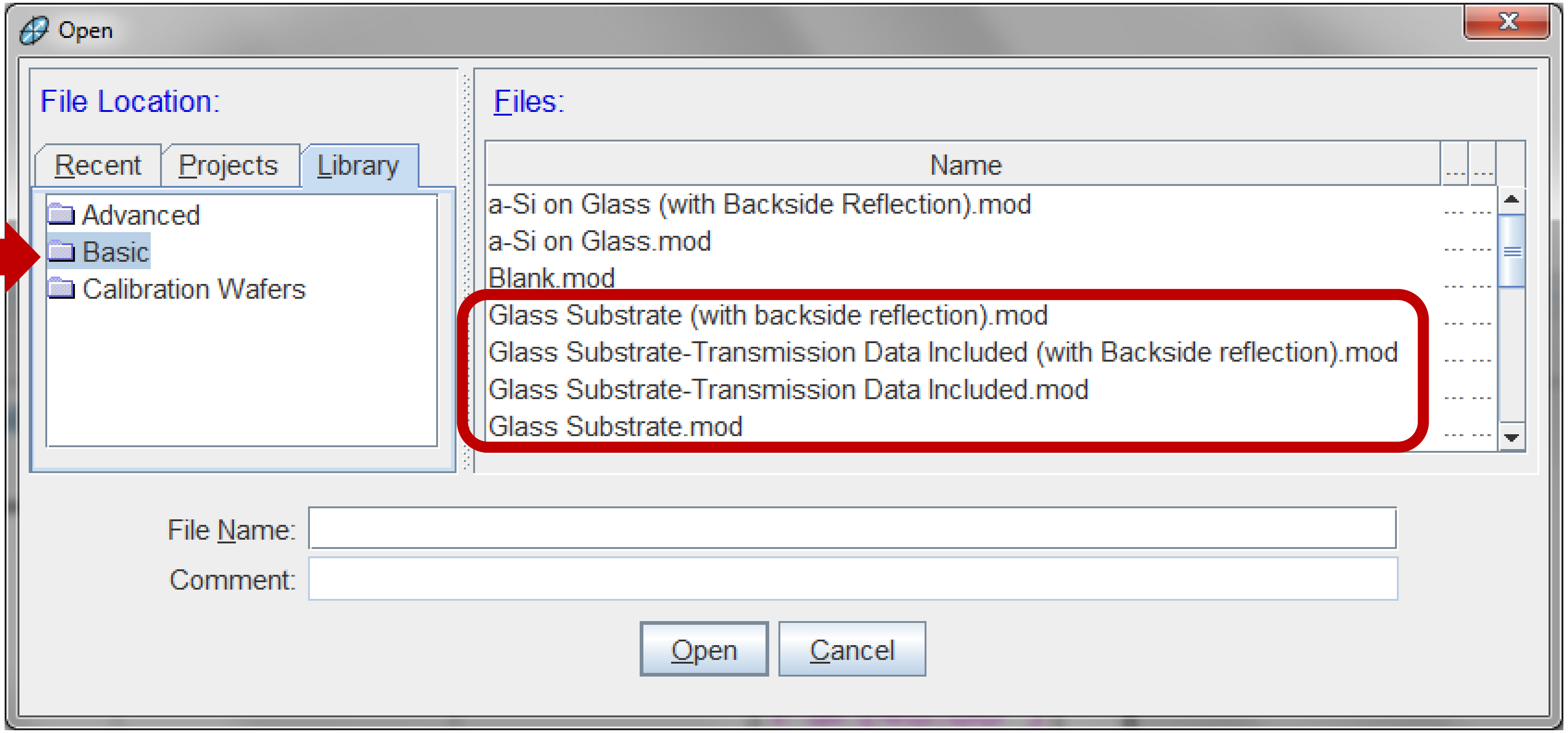
$$\varepsilon_1 = n^2 - k^2 \qquad \varepsilon_2 = 2nk$$

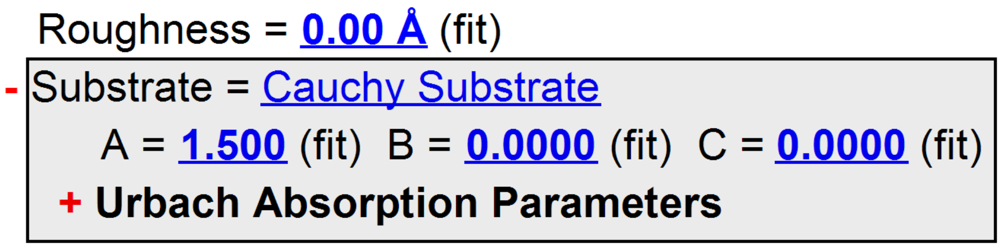
- Advantage:
  – Smooth *n*, match small *k*
- Disadvantage:
  – Lose KK consistency

- Substrate = Hybrid Substrate Thickness = 3.0000 mm
  Optical Constants = e1 & e2
  + e1 Function = Gen-Osc
  + e2 Function = B-Spline

AUTOMATED MODELS







CE built-in Models: Substrate SE+T

Glass substrate-Transmission data included.mod

Layer Commands: Add Delete Save
Include Surface Roughness = ON Roughness = **0.00 nm** (fit)
- Substrate = B-Spline Substrate Thickness = 1.0000 mm
  Resolution (eV) = 0.300 20 Pts. (0.731-6.462 eV) **Draw Node Graph**
  Fit Opt. Const. = ON
  Use KK Mode = OFF
  + **Nodes**
  + **Advanced**

- **MODEL Options**
  Angle Offset = 0.00
  Include Substrate Backside Correction = ON
    Transmission SE Data = OFF Reverse Direction = OFF
    # Back Reflections = 0.00
    % 1st Reflection = 100.00
  Model Calculation = Ideal
- **FIT Options**
  Perform Thickness Pre-Fit = OFF
  Use Global Fit = OFF
  Fit Weight = N,C,S
  Transmission Data % Weight = 100.00
  Limit Wvl. for Fit = OFF
  Limit Angles for Fit = OFF
  Max. Acceptable MSE = 100.000

Note: this refers to #Back reflection in reflection SE data.

Glass substrate-Transmission data included (with backside reflection).mod

Layer Commands: Add Delete Save
Include Surface Roughness = ON Roughness = **0.00 nm** (fit)
- Substrate = B-Spline Substrate Thickness = 1.0000 mm
  Resolution (eV) = 0.300 20 Pts. (0.731-6.462 eV) **Draw Node Graph**
  Fit Opt. Const. = ON
  Use KK Mode = OFF
  + **Nodes**
  + **Advanced**

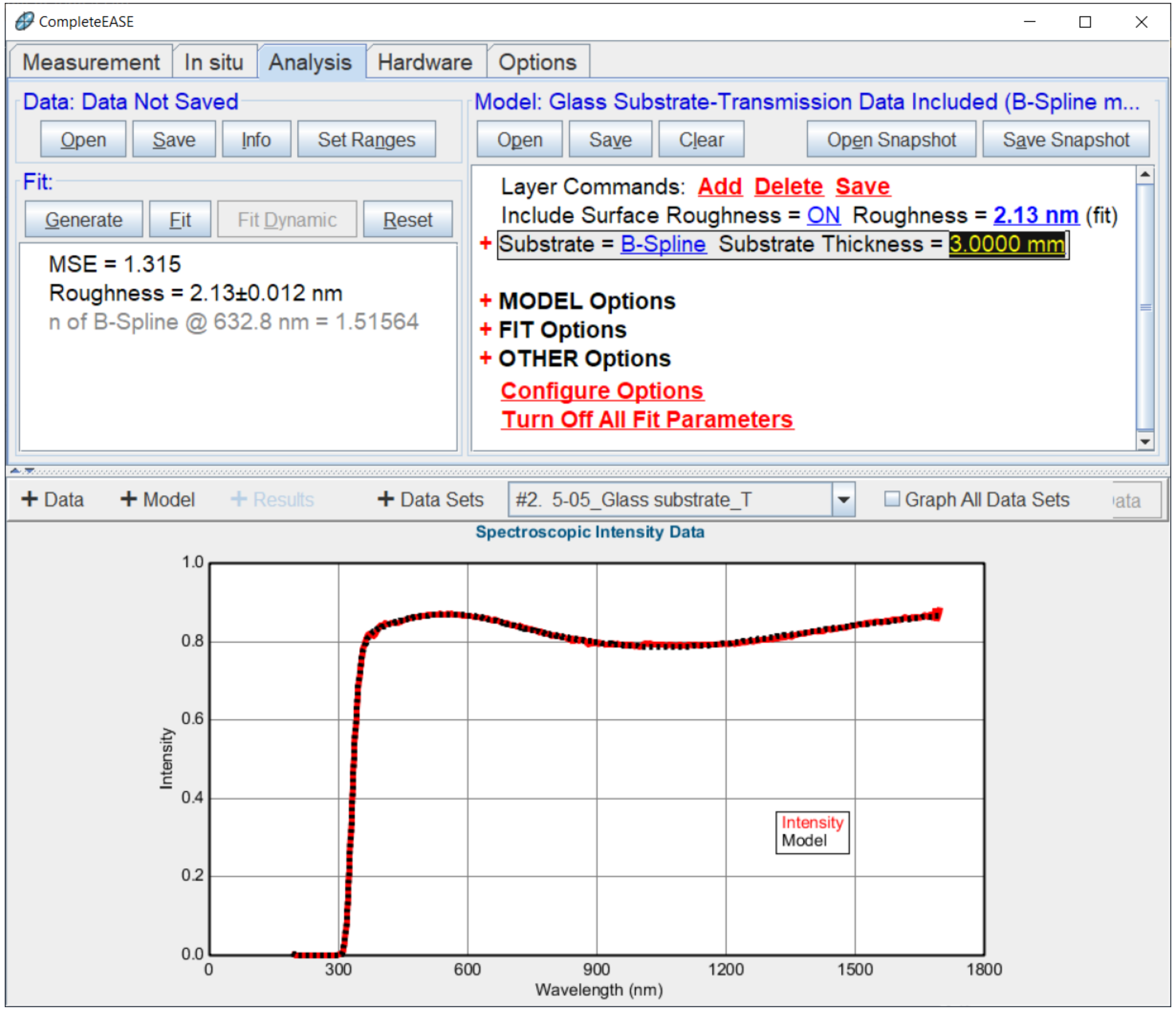
- **MODEL Options**
  Angle Offset = 0.00
  Include Substrate Backside Correction = ON
    Transmission SE Data = OFF Reverse Direction = OFF
    # Back Reflections = 5.000
    % 1st Reflection = 100.00
  Model Calculation = Ideal
- **FIT Options**
  Perform Thickness Pre-Fit = OFF
  Use Global Fit = OFF
  Fit Weight = N,C,S
  Transmission Data % Weight = 100.00
  Limit Wvl. for Fit = OFF
  Limit Angles for Fit = OFF
  Max. Acceptable MSE = 100.000

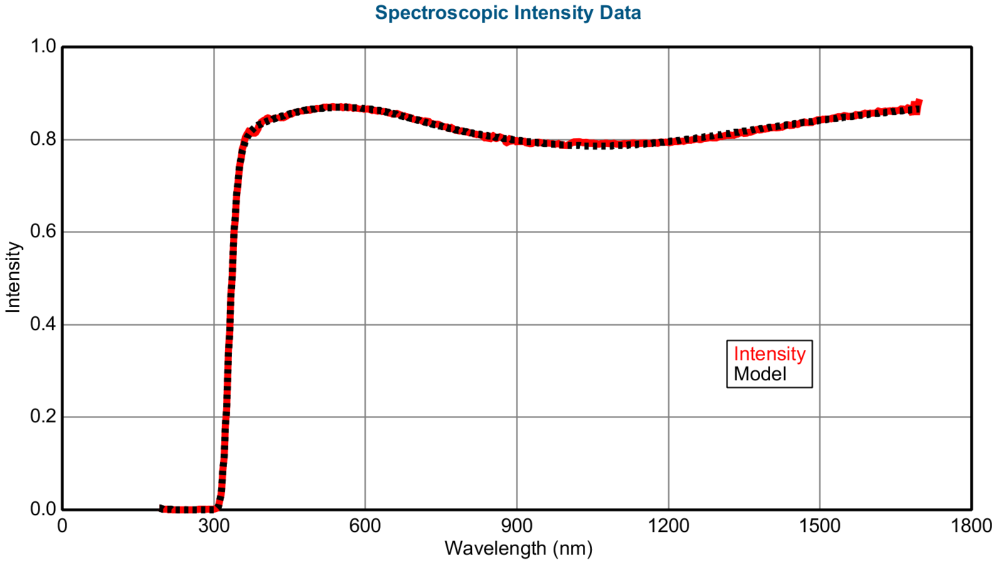
Tip: Save substrate nk for film analysis!

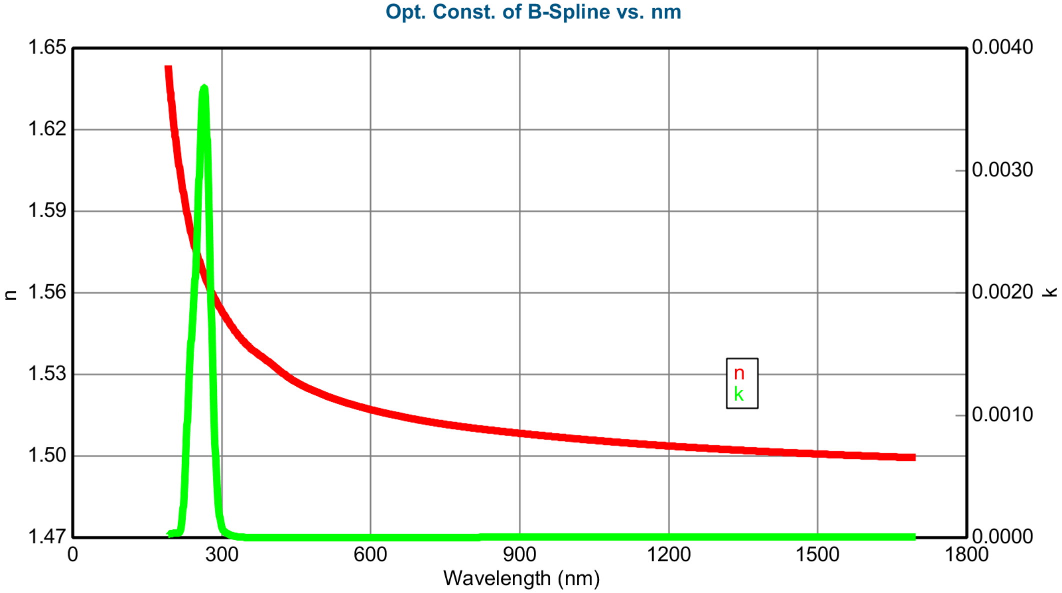
5-03 Glass Substrate (with Transmission)

- Use both data sets (SE + Transmission) to determine the substrate optical constants for this **3 mm** thick glass substrate

GLASS SUBSTRATE: RESULTS





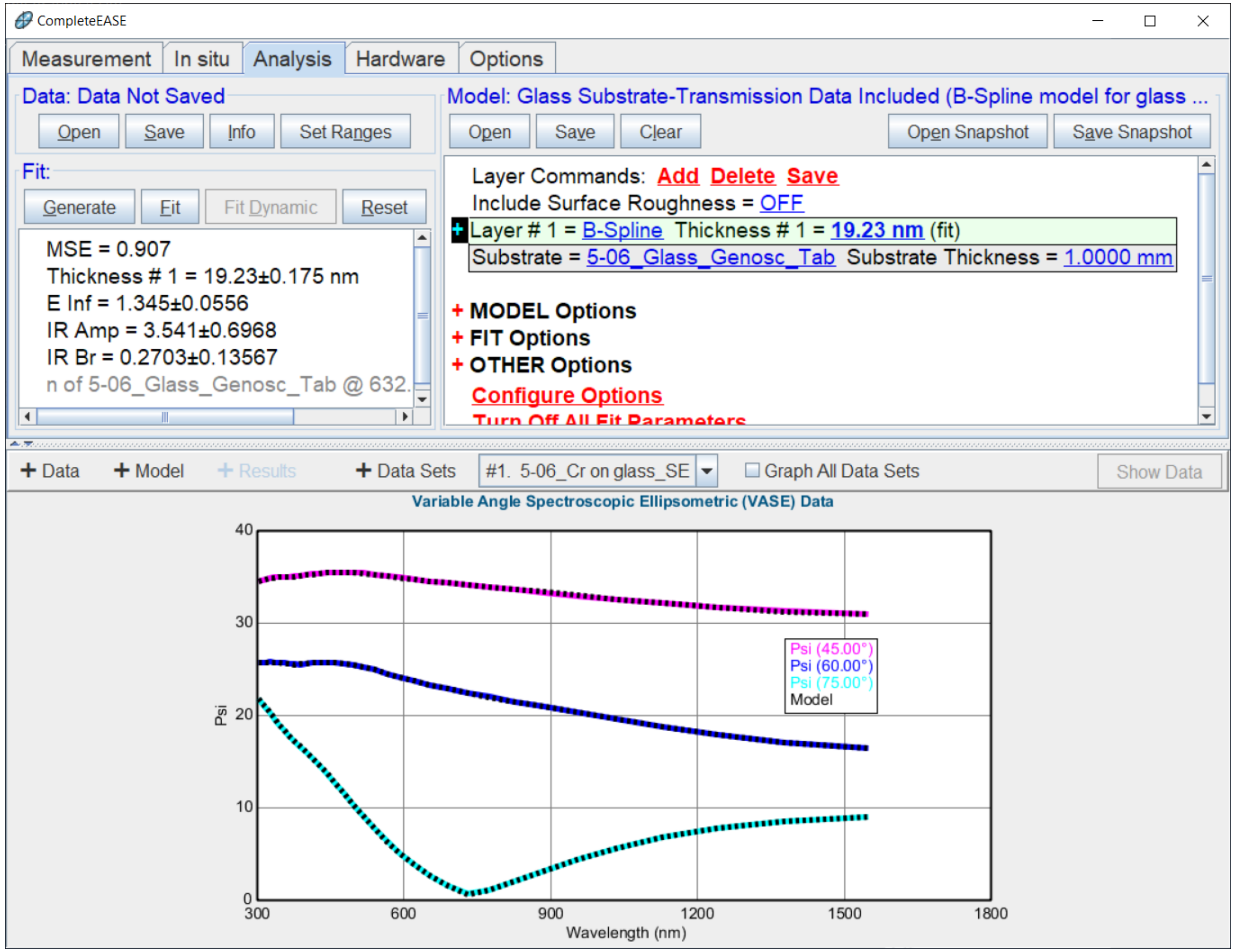


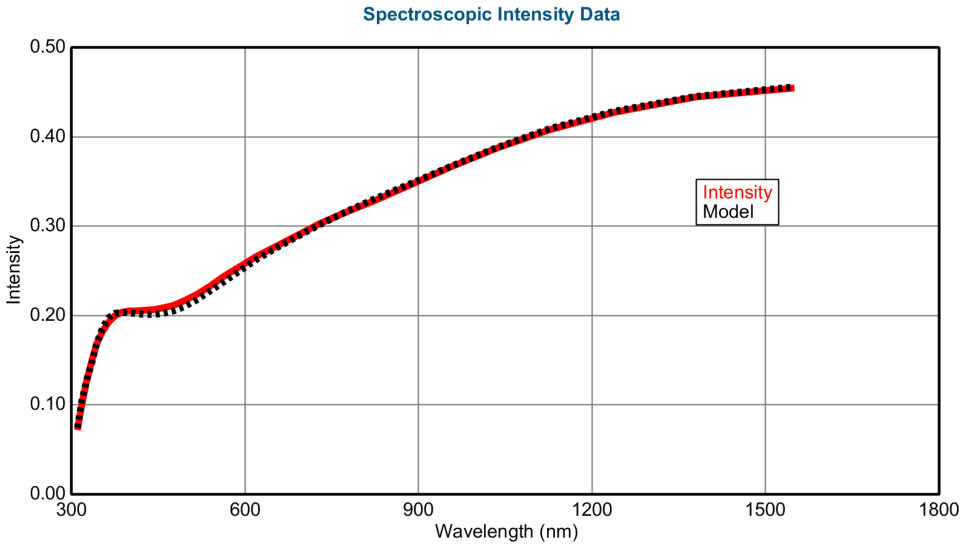
5-04 Cr on Glass Substrate (SE + T)

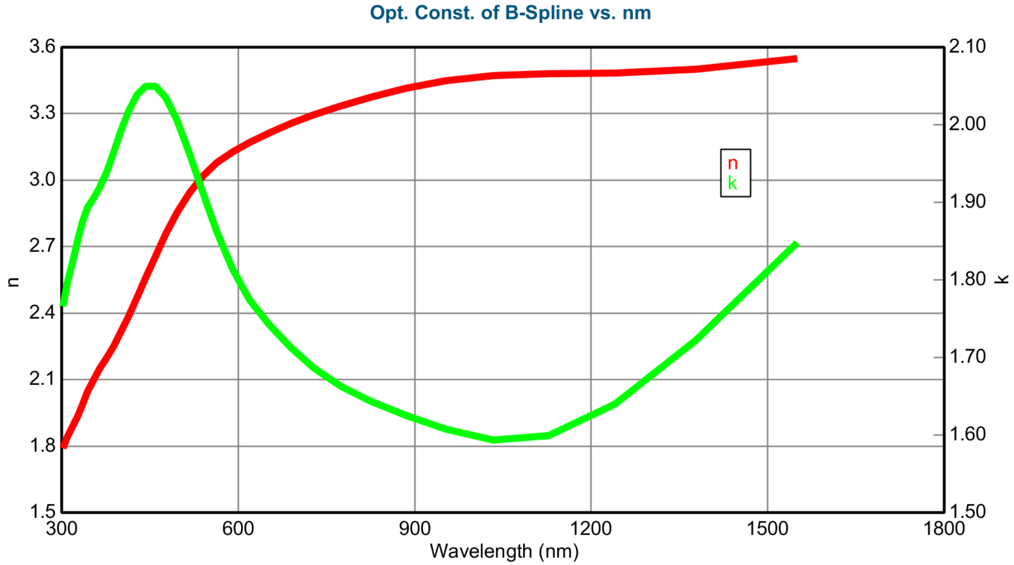
- Use both data sets (SE + Transmission) to determine the Cr optical constants for this thin layer on **1 mm** thick glass substrate (use 5-04_Glass_Genosc_Tab.mat)

NOTE: This is not the same glass substrate as previous example

CR ON GLASS: RESULTS



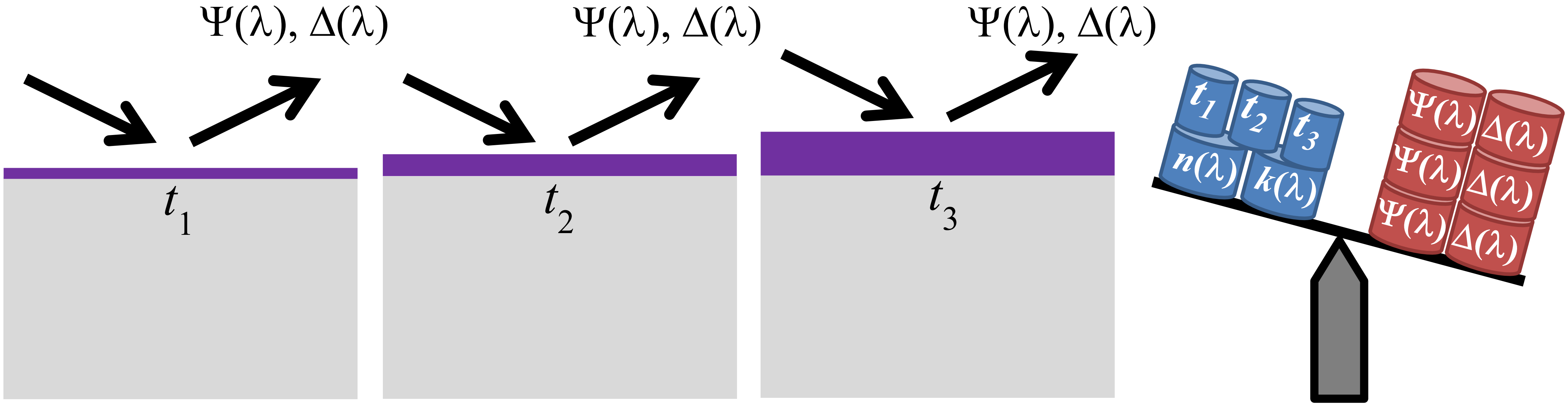




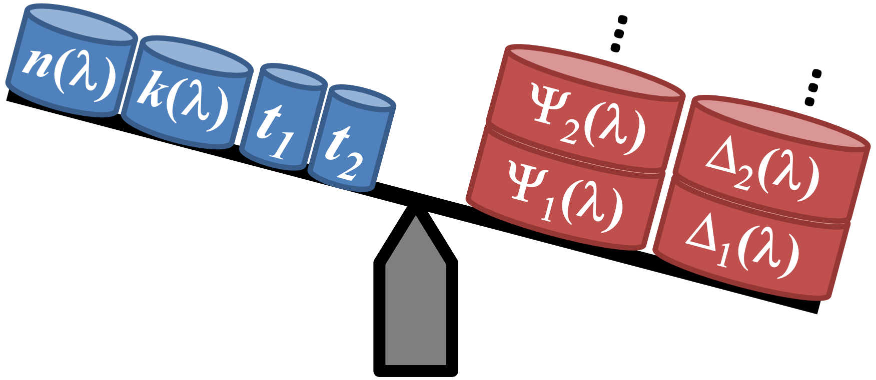
MULTI-SAMPLE ANALYSIS

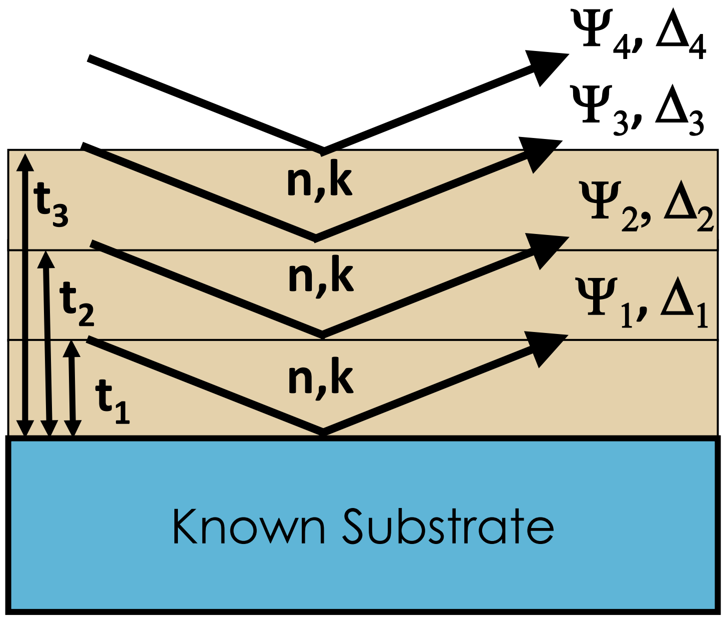
STRATEGY #3: MULTI-SAMPLE ANALYSIS

- New information from multiple samples with same *n,k* but different thickness for new path length.



Multi-Sample Analysis & In-Situ Analysis





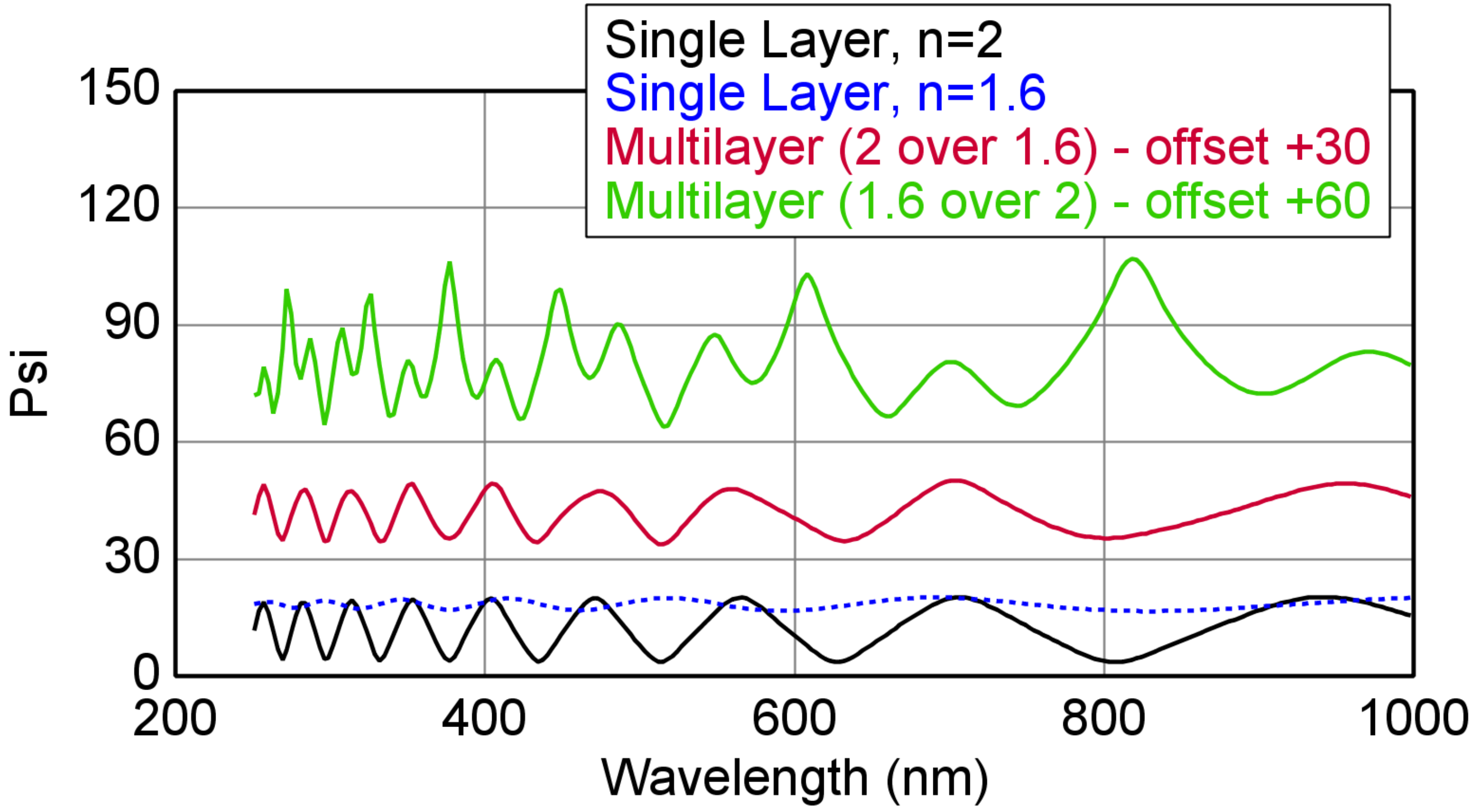
Method	Advantages	Disadvantages
Multi-Sample and in-situ Analysis	▪ More information about same material. ▪ Easy to achieve from map of non-uniform sample.	▪ Requires consistent optical constants. ▪ In-situ requires ellipsometer integration into system.

C.M. Herzinger et al. "Determination of AlAs optical constants by variable angle spectroscopic ellipsometry and a multisample analysis" *J. Appl. Phys. 77* (9) 1995, p. 4677-4687.

MULTILAYERS

MULTI-LAYER COATINGS

- Interference pattern is a “mixture” of the oscillations from each layer – multiple envelopes.



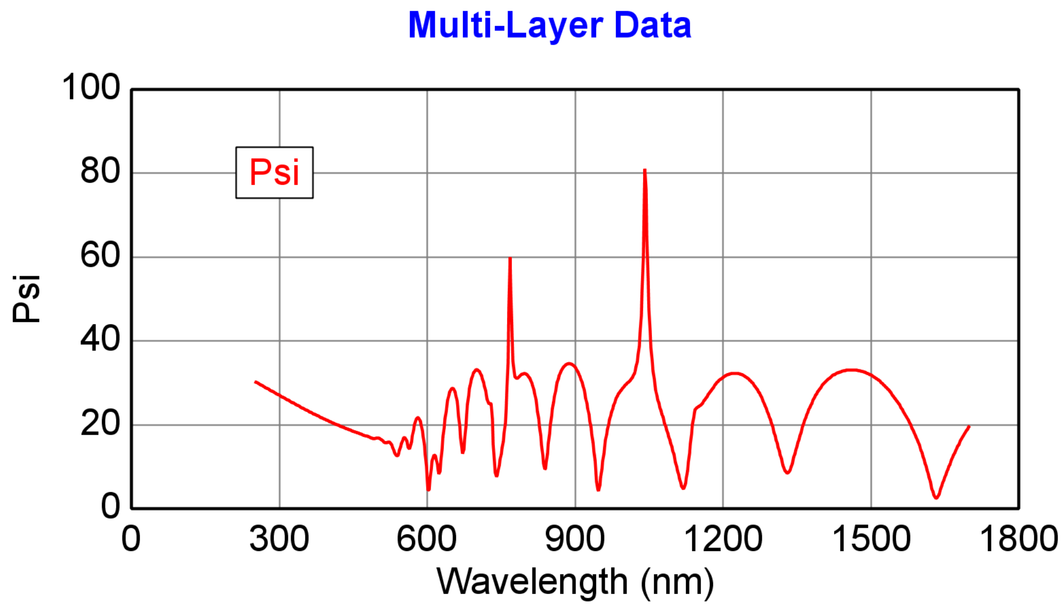
MULTILAYER (ABSORBING-TRANSPARENT)

- If 2 layers, but 1 is absorbing, then the order changes shape.

Which is correct?

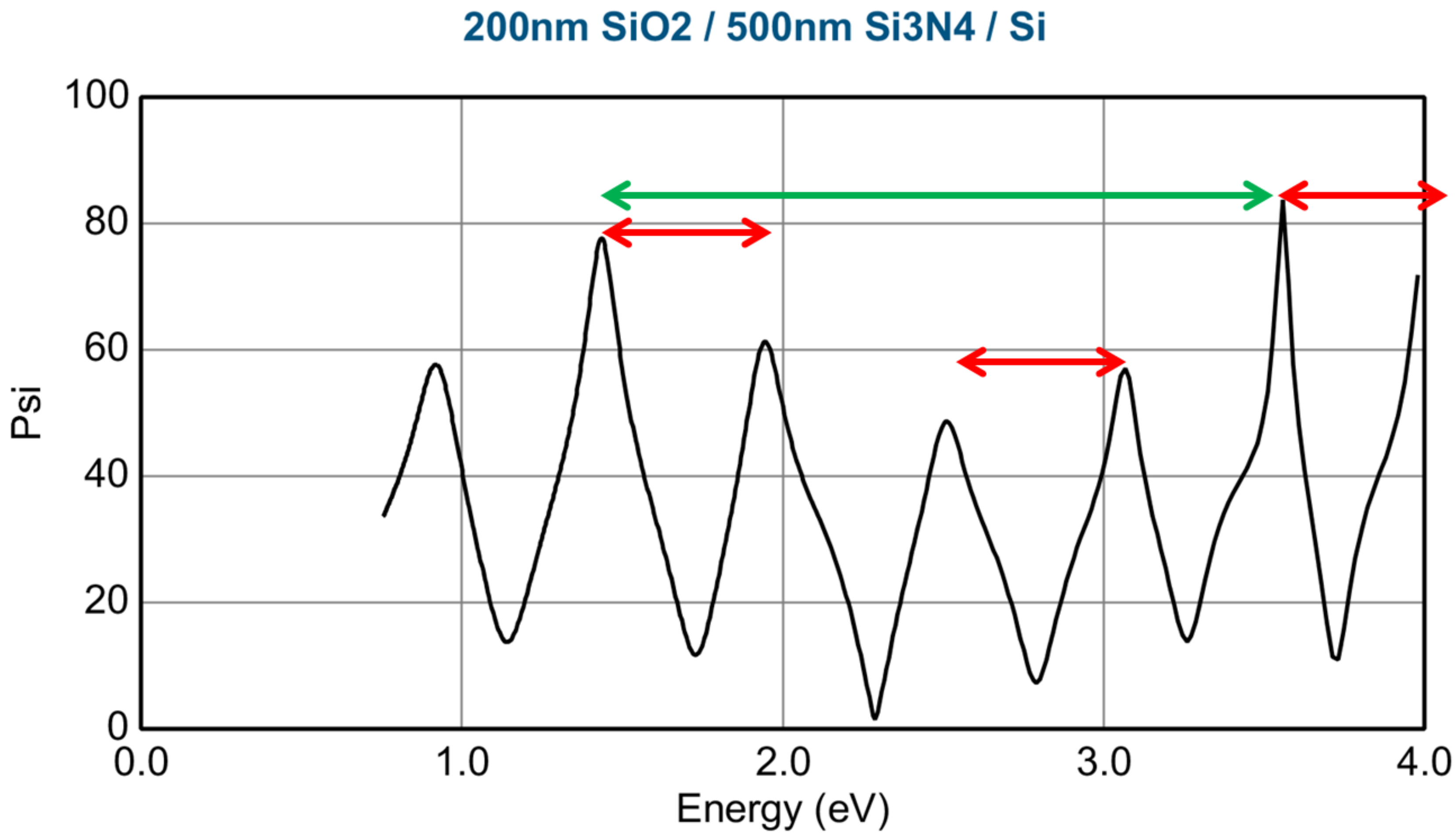
2	a-si	300 nm
1	sio2	3000 nm
0	si	1 mm

2	sio2	3000 nm
1	a-si	300 nm
0	si	1 mm



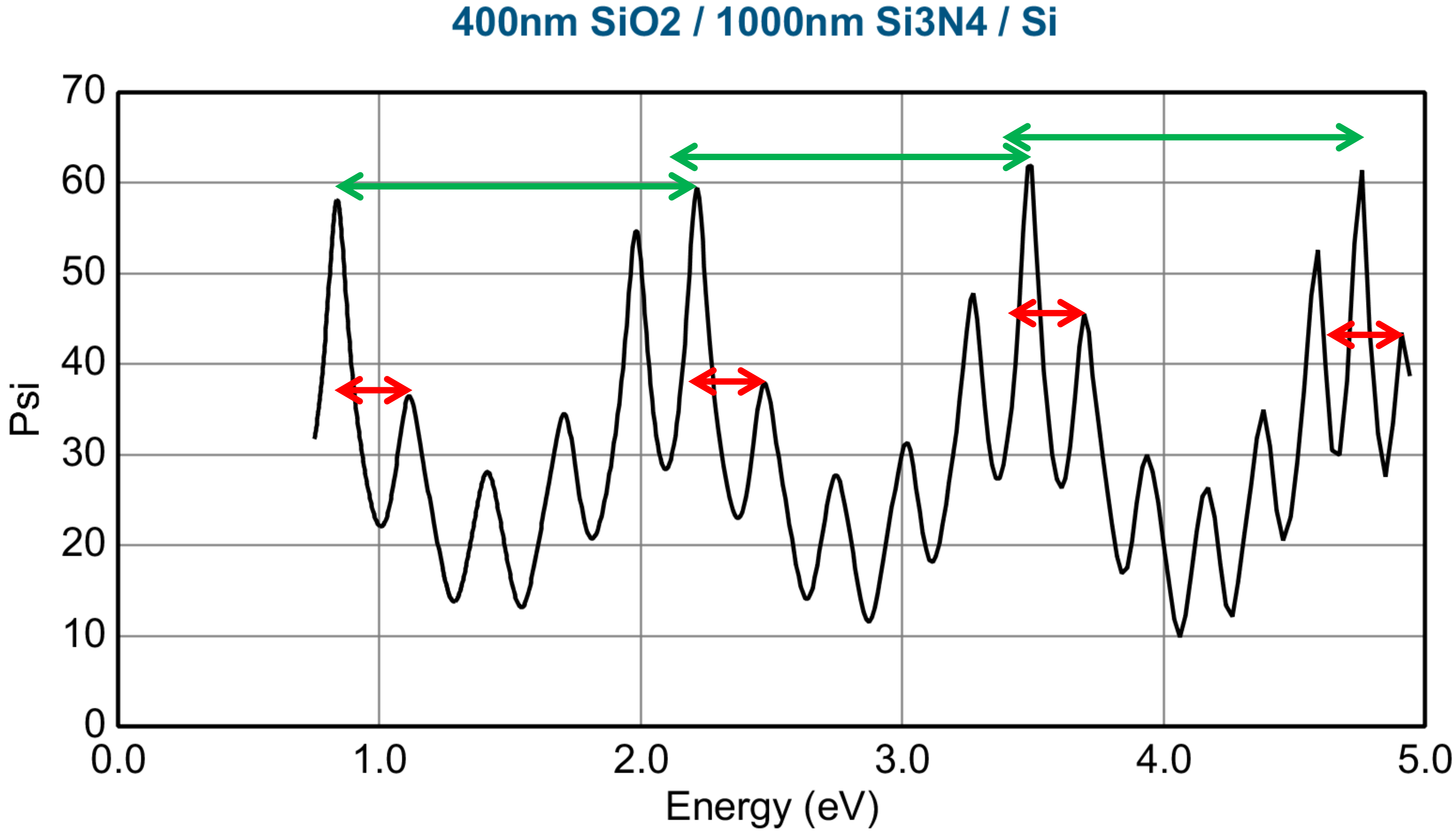
MULTI-LAYER VERSUS EV

- The oscillation periods will be similar to single-layers but with varying heights depending on where the light returned.



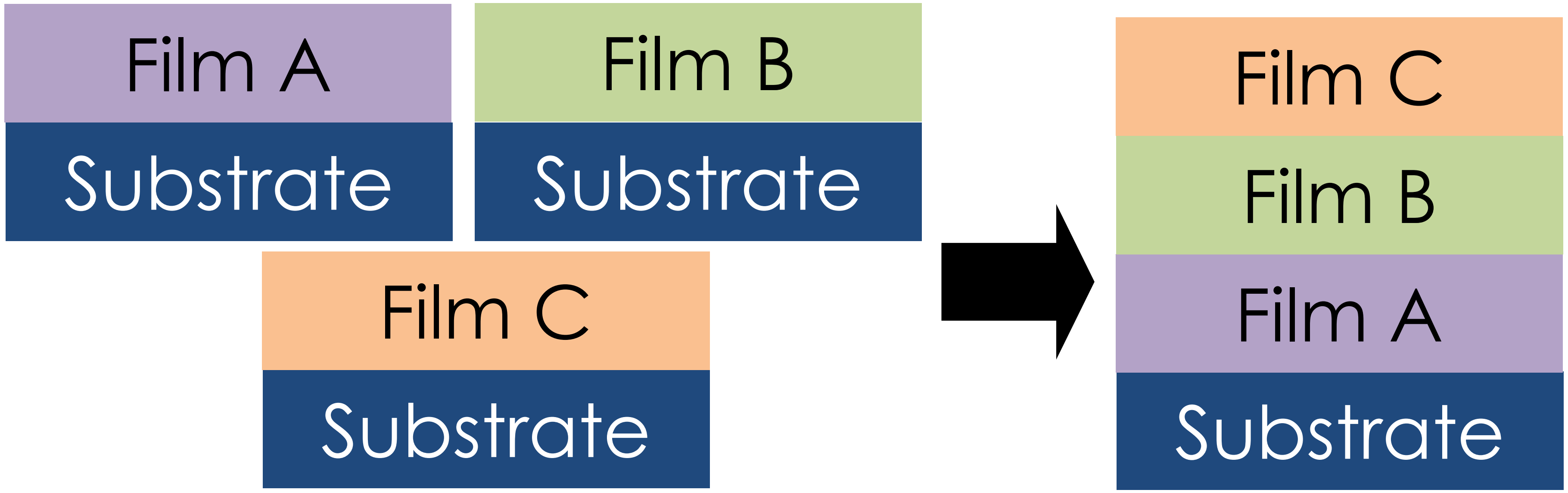
MULTI-LAYERS WITH THICKER FILMS

- Easily identify two separate oscillation frequencies



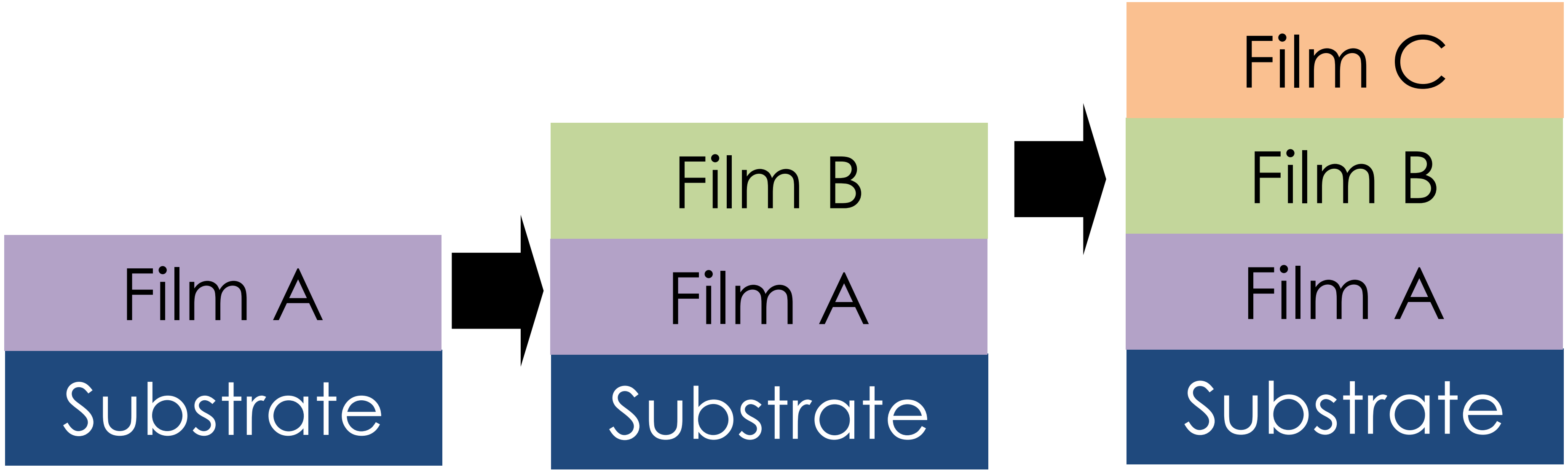
MULTI-LAYER STRATEGIES

- Preferred Method #1
  - Measure n&k from single-layers: use dispersion models.
  - Fit thickness only for multilayer stack.
  - If poor fit, add dispersion parameters for most variable film.

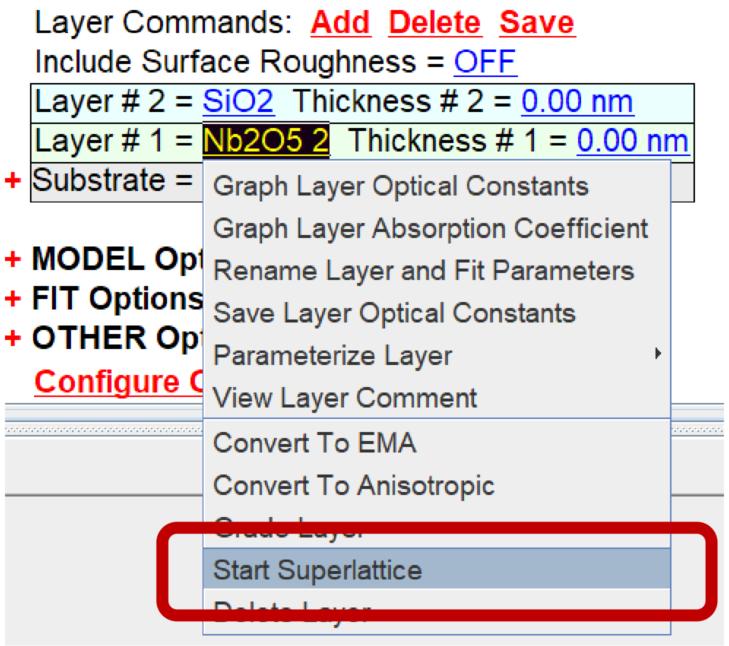


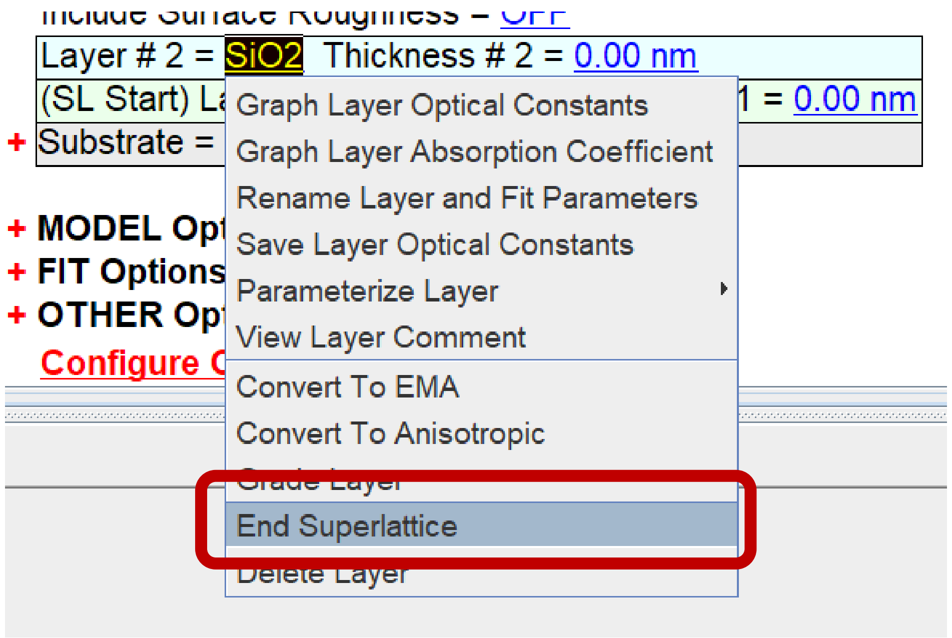
MULTI-LAYER STRATEGIES

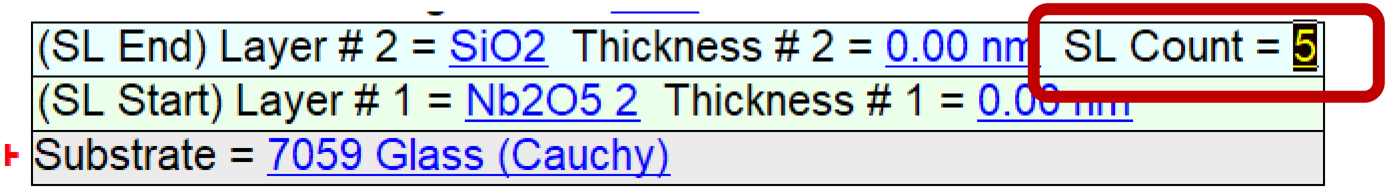
- <u>Preferred Method #2</u>
  - Measure n&k for each "new" layer with previous layers fixed: use dispersion models.
  - If poor fit, add thickness and then dispersion parameters for previous layers.



SUPERLATTICE FOR REPEATING STRUCTURES

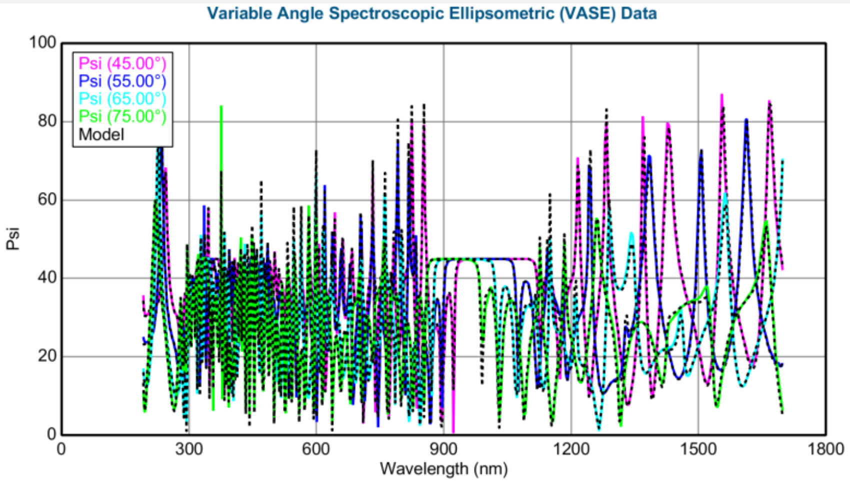


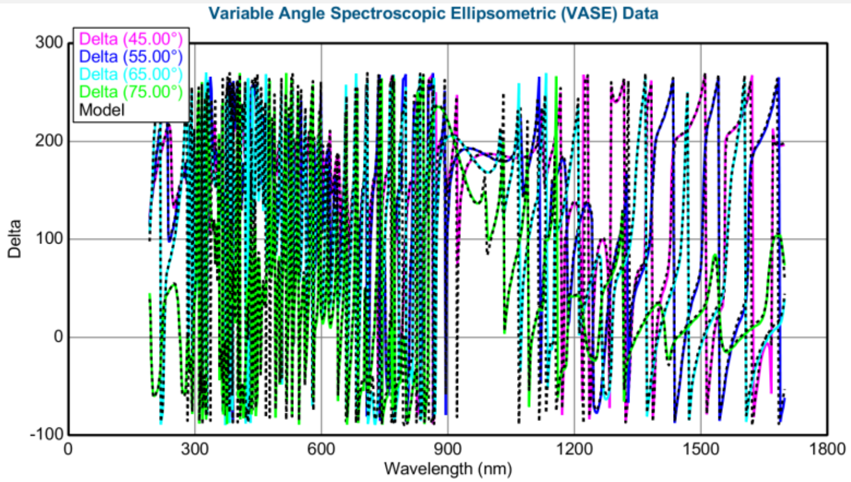


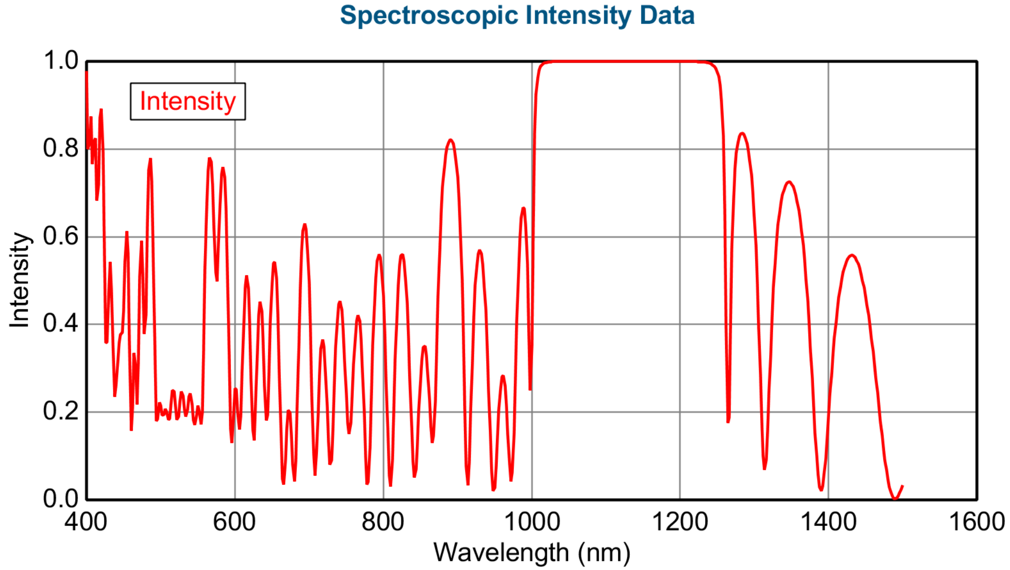


EXAMPLE: HIGH REFLECTION IR MIRROR

-	Layer # 37 = Coupled Thickness # 37 = 2178.27 Å (Coupled) Coupled to Layer # = 1 (Low-N)
-	Layer # 36 = Coupled Thickness # 36 = 1123.46 Å (Coupled) Coupled to Layer # = 2 (High-N)
+	Layer # 35 = Coupled Thickness # 35 = 2173.29 Å (Coupled)
+	Layer # 34 = Coupled Thickness # 34 = 1057.20 Å (Coupled)
+	Layer # 33 = Coupled Thickness # 33 = 2180.22 Å (Coupled)
+	Layer # 32 = Coupled Thickness # 32 = 1331.27 Å (Coupled)
+	Layer # 31 = Coupled Thickness # 31 = 2177.20 Å (Coupled)
+	Layer # 30 = Coupled Thickness # 30 = 1052.14 Å (Coupled)
+	Layer # 29 = Coupled Thickness # 29 = 2174.35 Å (Coupled)
+	Layer # 28 = Coupled Thickness # 28 = 1356.36 Å (Coupled)
+	Layer # 27 = Coupled Thickness # 27 = 1912.56 Å (Coupled)
+	Layer # 26 = Coupled Thickness # 26 = 1172.64 Å (Coupled)
+	Layer # 25 = Coupled Thickness # 25 = 2022.40 Å (Coupled)
+	Layer # 24 = Coupled Thickness # 24 = 1130.44 Å (Coupled)
+	Layer # 23 = Coupled Thickness # 23 = 2115.53 Å (Coupled)
+	Layer # 22 = Coupled Thickness # 22 = 1299.21 Å (Coupled)
+	Layer # 21 = Coupled Thickness # 21 = 2174.35 Å (Coupled)
+	Layer # 20 = Coupled Thickness # 20 = 1175.68 Å (Coupled)
+	Layer # 19 = Coupled Thickness # 19 = 2171.33 Å (Coupled)
+	Layer # 18 = Coupled Thickness # 18 = 1189.74 Å (Coupled)
+	Layer # 17 = Coupled Thickness # 17 = 1672.44 Å (Coupled)
+	Layer # 16 = Coupled Thickness # 16 = 1319.23 Å (Coupled)
+	Layer # 15 = Coupled Thickness # 15 = 2123.35 Å (Coupled)
+	Layer # 14 = Coupled Thickness # 14 = 1298.20 Å (Coupled)
+	Layer # 13 = Coupled Thickness # 13 = 2073.40 Å (Coupled)
+	Layer # 12 = Coupled Thickness # 12 = 1242.93 Å (Coupled)
+	Layer # 11 = Coupled Thickness # 11 = 1717.59 Å (Coupled)
+	Layer # 10 = Coupled Thickness # 10 = 1333.30 Å (Coupled)
+	Layer # 9 = Coupled Thickness # 9 = 1841.11 Å (Coupled)
+	Layer # 8 = Coupled Thickness # 8 = 1155.58 Å (Coupled)
+	Layer # 7 = Coupled Thickness # 7 = 2052.79 Å (Coupled)
+	Layer # 6 = Coupled Thickness # 6 = 1341.28 Å (Coupled)
-	Layer # 5 = Coupled Thickness # 5 = 2060.61 Å (Coupled) Coupled to Layer # = 1 (Low-N)
-	Layer # 4 = Coupled Thickness # 4 = 1260.06 Å (Coupled) Coupled to Layer # = 2 (High-N)
-	Layer # 3 = Coupled Thickness # 3 = 2172.40 Å (Coupled) Coupled to Layer # = 1 (Low-N)
+	Layer # 2 = High-N Thickness # 2 = **1267.03 Å** (fit)
+	Layer # 1 = Low-N Thickness # 1 = **1777.31 Å** (fit)
	Substrate = SI_JAW







J.N. Hilfiker, et al. “Spectroscopic ellipsometry characterization of multilayer optical coatings” Surface & Coatings Technology 357 (2019) 114-121.

CUSTOMIZED GLOBAL FIT

- Use Global Fit = ON
  Parameters: Add Delete All
  x Param. #1 = Thickness # 1
  Min. = 0.00 nm Max. = 1000.00 nm # Guesses = 50
  x Param. #2 = A
  Min. = 1.200 Max. = 4.500 # Guesses = 0

- Customize Global Fit
  # of Data Points = 20 # of Iterations = 5
  Random Search = OFF
  MSE Threshold = OFF
  Include Wvl. Range Expansion Fits = OFF

- Customize Global Fit
  # of Data Points = 20 # of Iterations = 5
  Random Search = ON
  MSE Threshold = ON MSE Threshold Value = 25.0
  Include Wvl. Range Expansion Fits = OFF

of Data Points

Reduce selected wavelengths for initial search

of Iterations

Fit steps performed at each parameter combo.

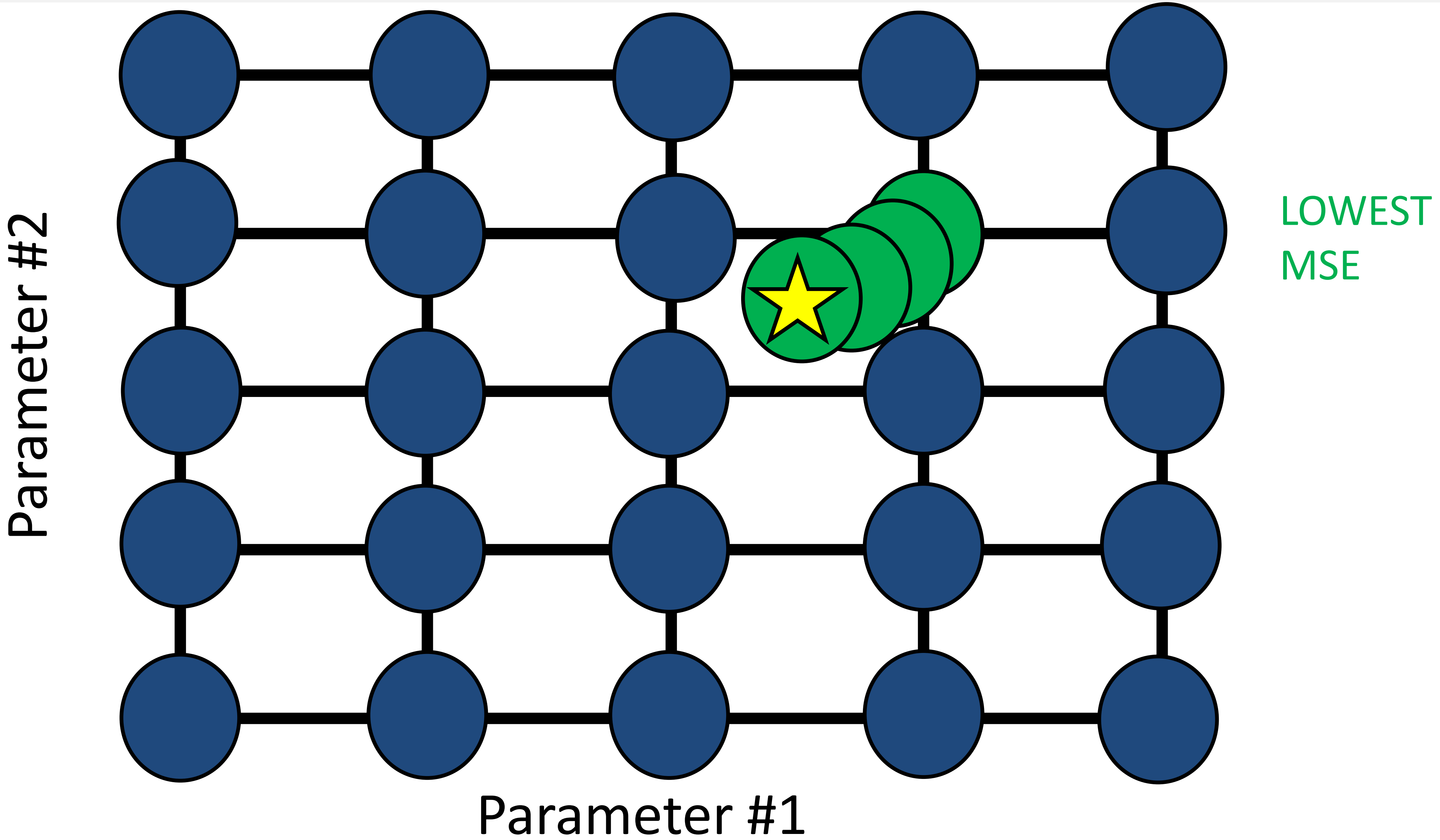
Random Search

Jump through each parameter combo in random order with no repeats.

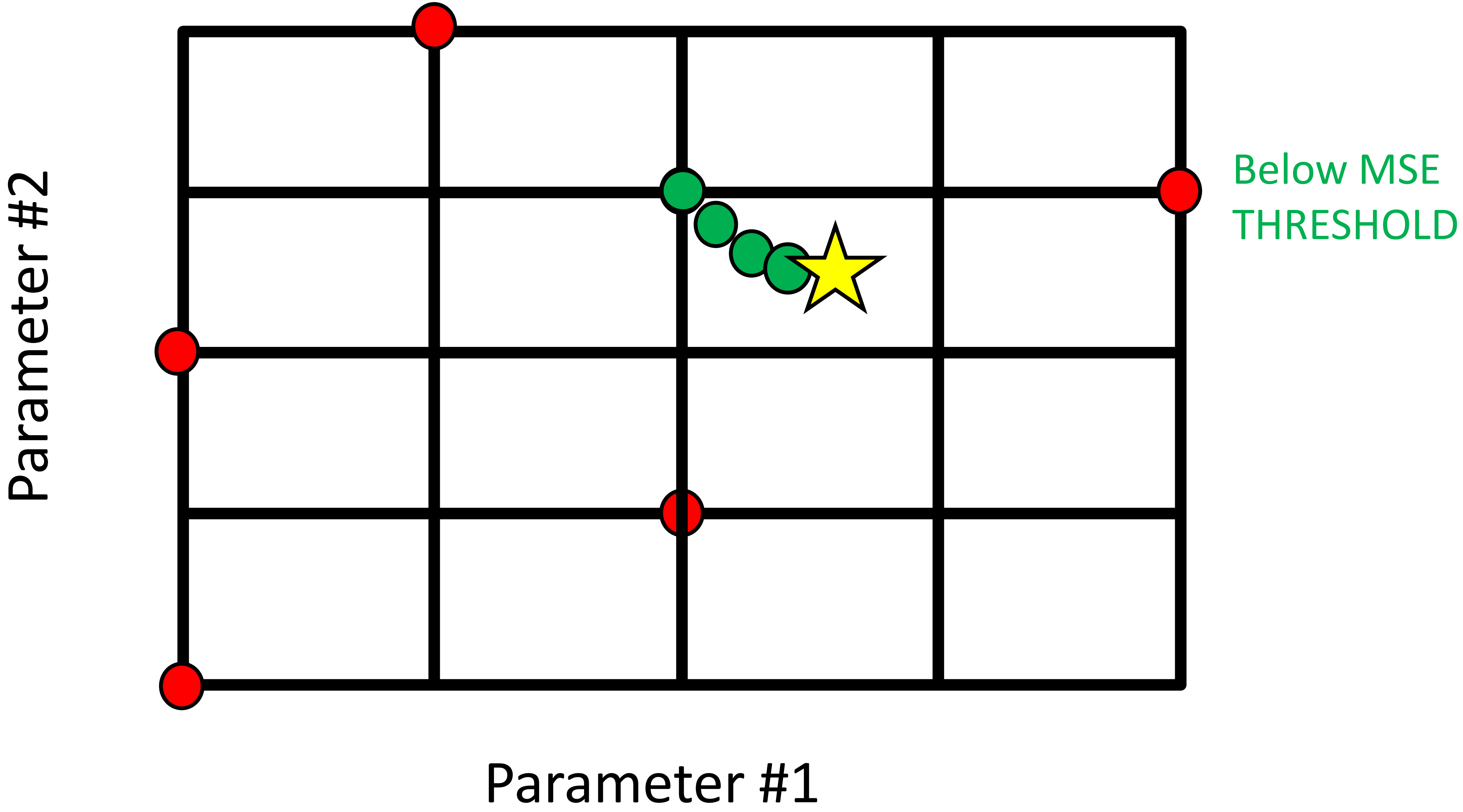
MSE Threshold

Stop Global Fit step if MSE is below this value

GLOBAL FIT



RANDOM GLOBAL FIT



5-05 Silicon on Insulator (SOI)

- Using tabulated optical constants from the library, find the thickness of the silicon and oxide layers.

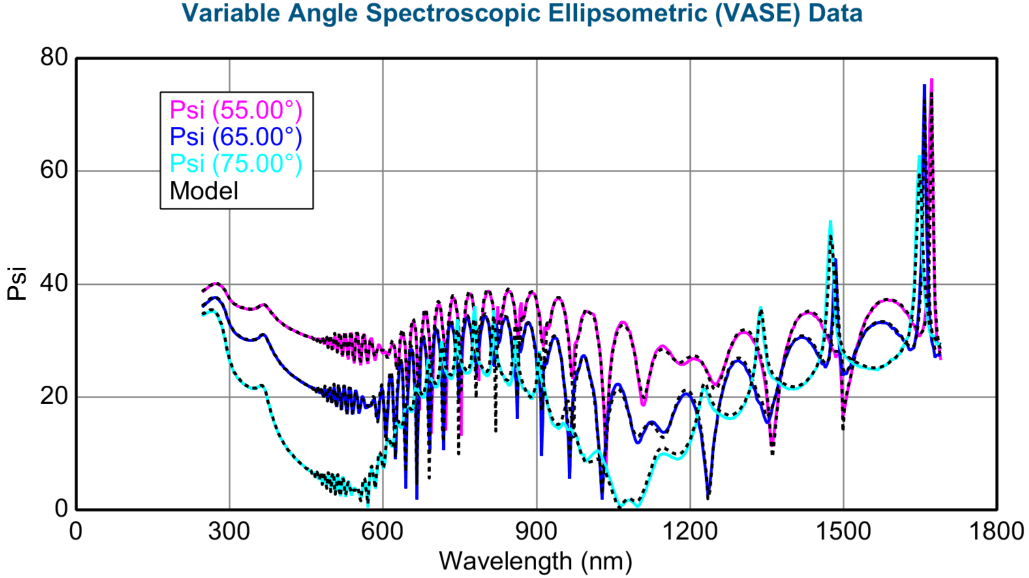
5-05: SOI #1 RESULTS

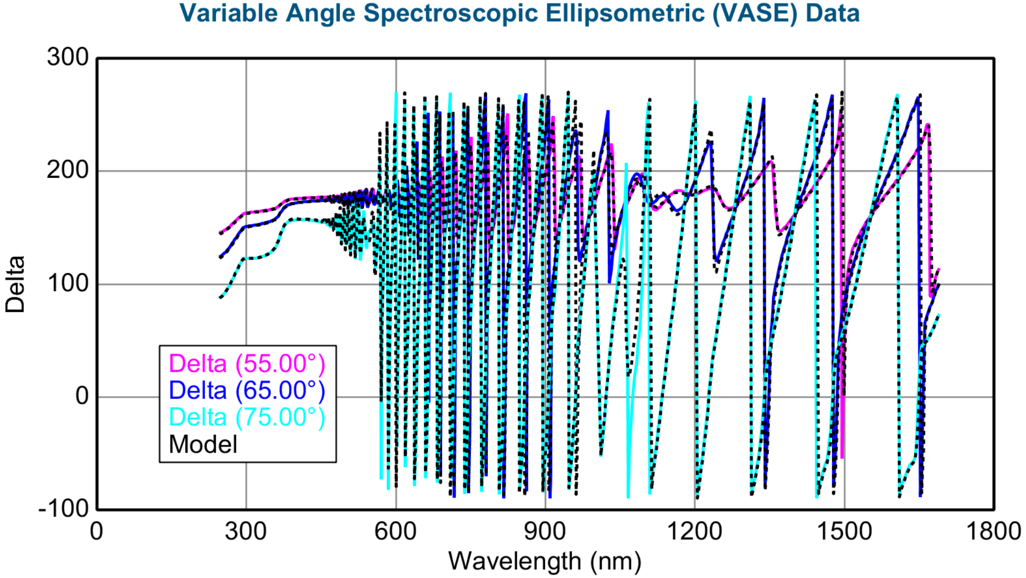
Layer Commands: **Add** **Delete** **Save**

Include Surface Roughness = OFF

Layer # 3 = NTVE_JAW	Thickness # 3 = **2.24 nm** (fit)
Layer # 2 = Si_JAW	Thickness # 2 = **1965.95 nm** (fit)
Layer # 1 = SiO2_JAW	Thickness # 1 = **493.17 nm** (fit)
Substrate = Si_JAW	

- **MODEL Options**
  - Angle Offset = 0.00
  - Include Substrate Backside Correction = OFF
  - Model Calculation = Include Thickness Non-uniformity and Bandwidth(nm)
    - % Thickness Non-uniformity = **0.50** (fit) Bandwidth (nm) = **4.101** (fit)
    - # of Pts = 9





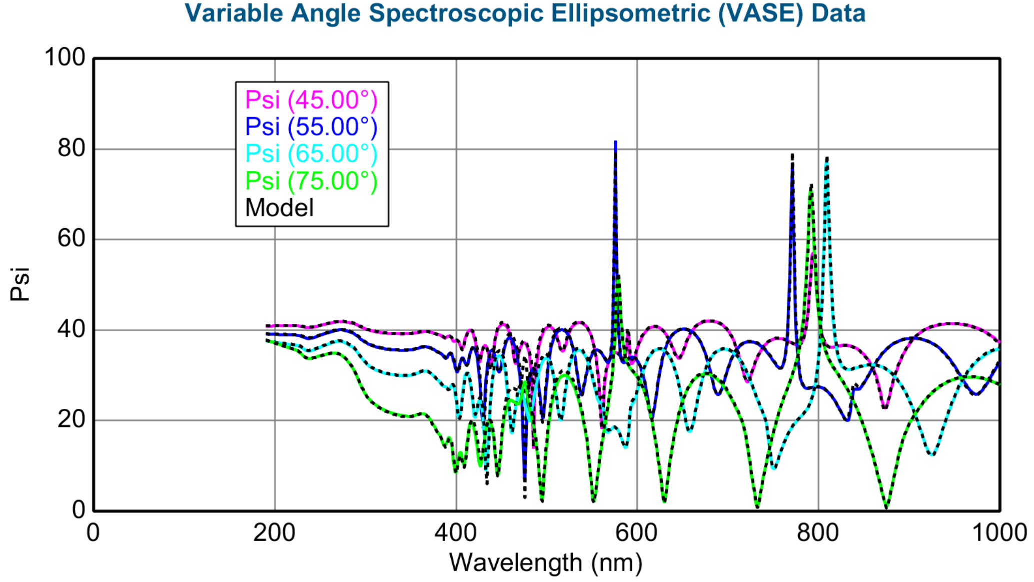
5-05: SOI #2 RESULTS

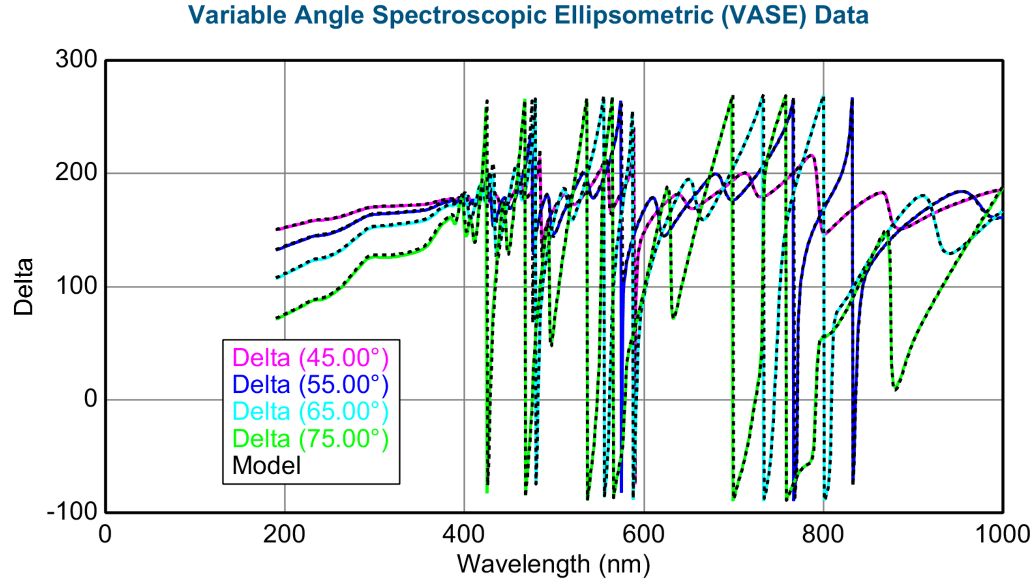
Layer Commands: **Add** **Delete** **Save**

Include Surface Roughness = OFF

Layer # 3 = NTVE_JAW	Thickness # 3 = 1.24 nm
Layer # 2 = Si_JAW	Thickness # 2 = **221.13 nm** (fit)
Layer # 1 = SiO2_JAW	Thickness # 1 = **2007.12 nm** (fit)
Substrate = Si_JAW	

- **MODEL Options**
  - Angle Offset = 0.00
  - Include Substrate Backside Correction = OFF
  - Model Calculation = Include Bandwidth (nm)
    - Bandwidth (nm) = **3.152** (fit)
    - # of Pts = 9





5-06 4-layer Optical Stack on Si

- This 4-layer stack is made up of SiO_2 and Ta_2O_5, which have already been measured for you (material files provided in Session 5 directory).

- Which layer is on the top?
- Fit using Superlattice Approach and then compare to 4-layers fit separately.

5-06: 4-LAYER MULTILAYER RESULTS

Layer Commands: **Add** **Delete** **Save**

Include Surface Roughness = OFF

+	Layer # 4 = Ta2O5_Session5 Thickness # 4 = **404.84 nm** (fit)
+	Layer # 3 = SiO2_Session5 Thickness # 3 = **597.83 nm** (fit)
+	Layer # 2 = Ta2O5_Session5 Thickness # 2 = **404.54 nm** (fit)
+	Layer # 1 = SiO2_Session5 Thickness # 1 = **600.02 nm** (fit)
	Substrate = Si_JAW

- MODEL Options

Angle Offset = 0.00

Include Substrate Backside Correction = OFF

Model Calculation = Include Bandwidth (nm)

Bandwidth (nm) = **4.552** (fit)

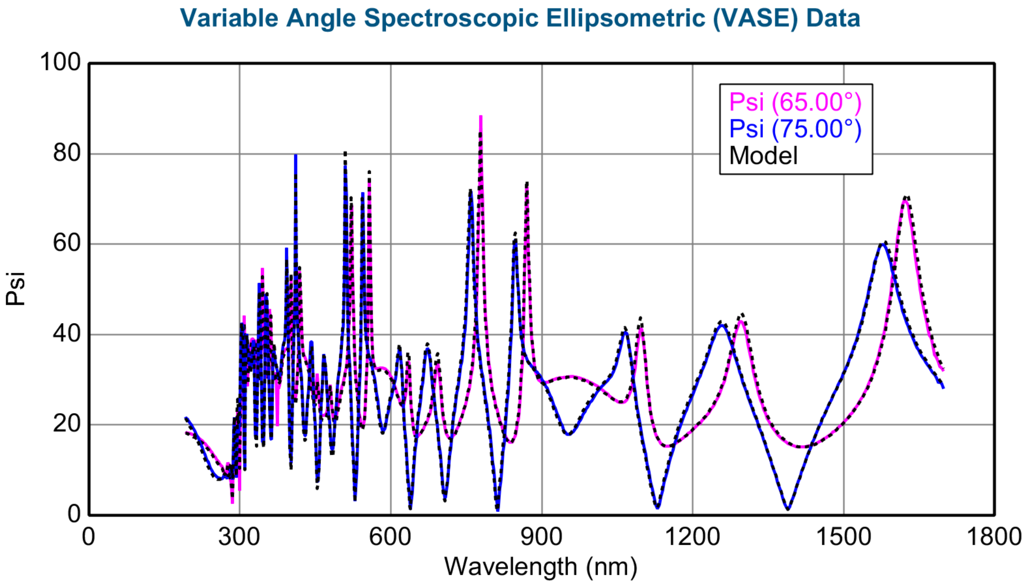
# of Pts = 9

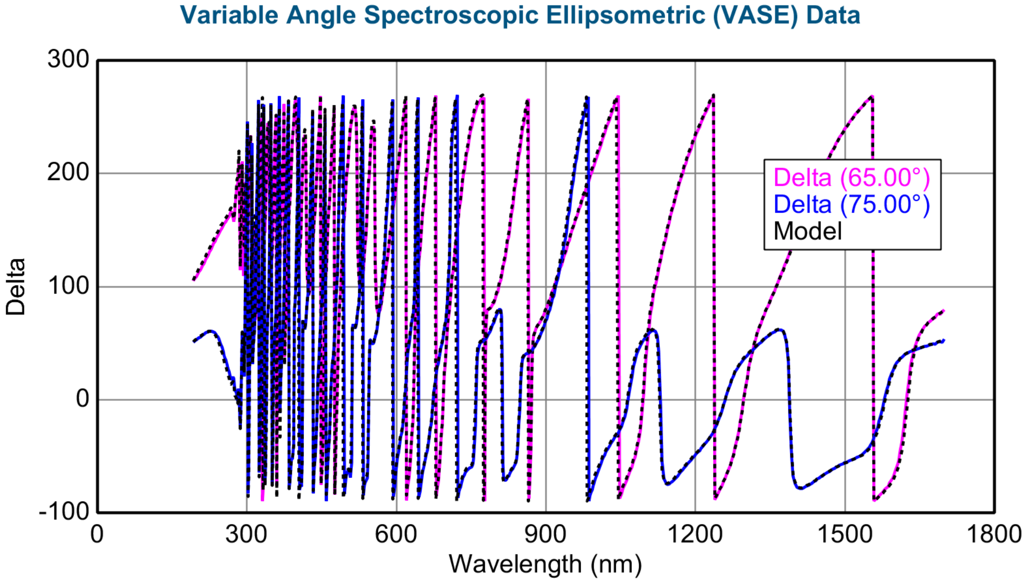
+ FIT Options

+ OTHER Options

Configure Options

Turn Off All Fit Parameters



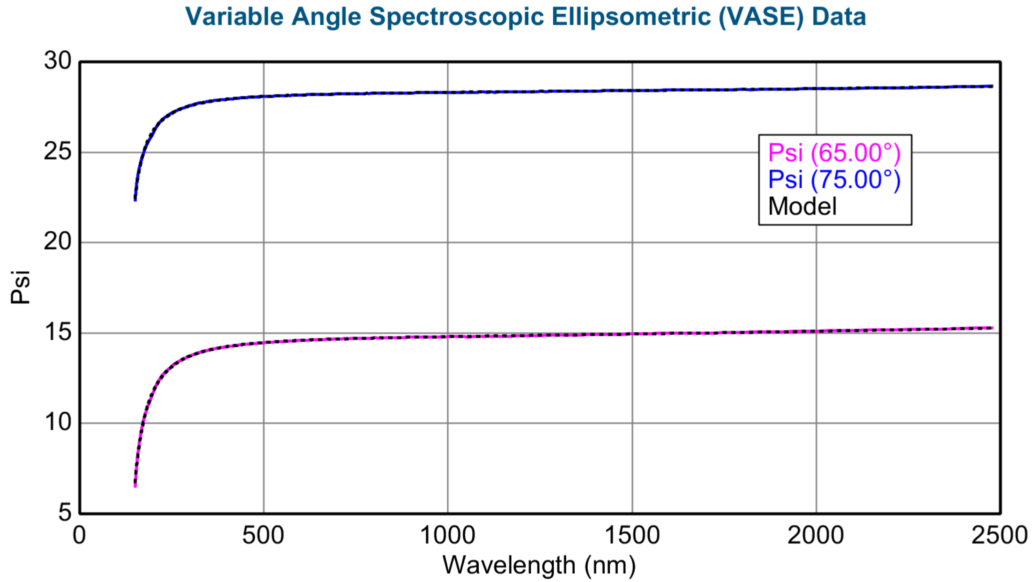


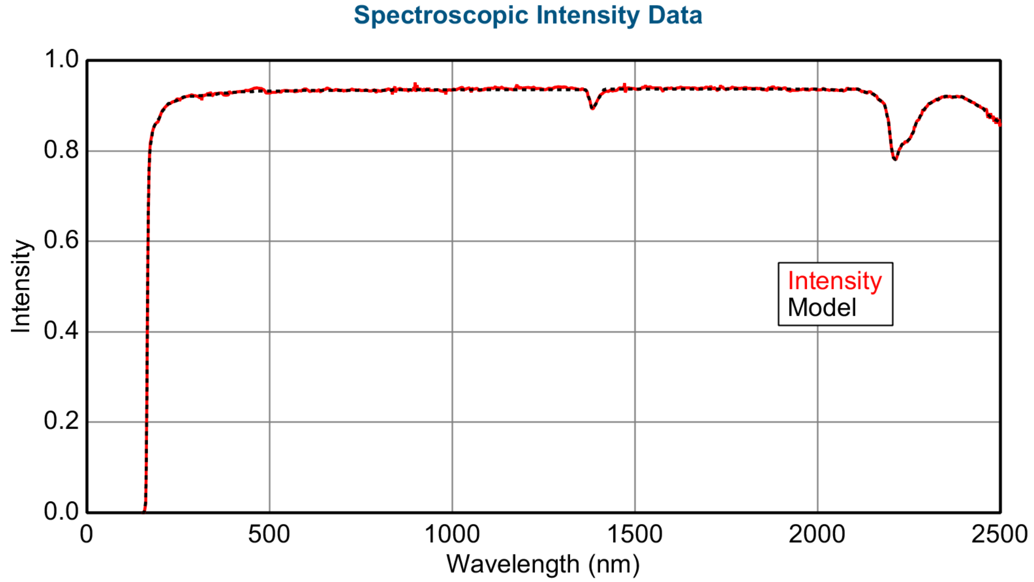
5-07 Glass Substrate (with Transmission)

- Use both data sets (SE + Transmission) to determine the substrate optical constants for this **3 mm** thick fused silica substrate

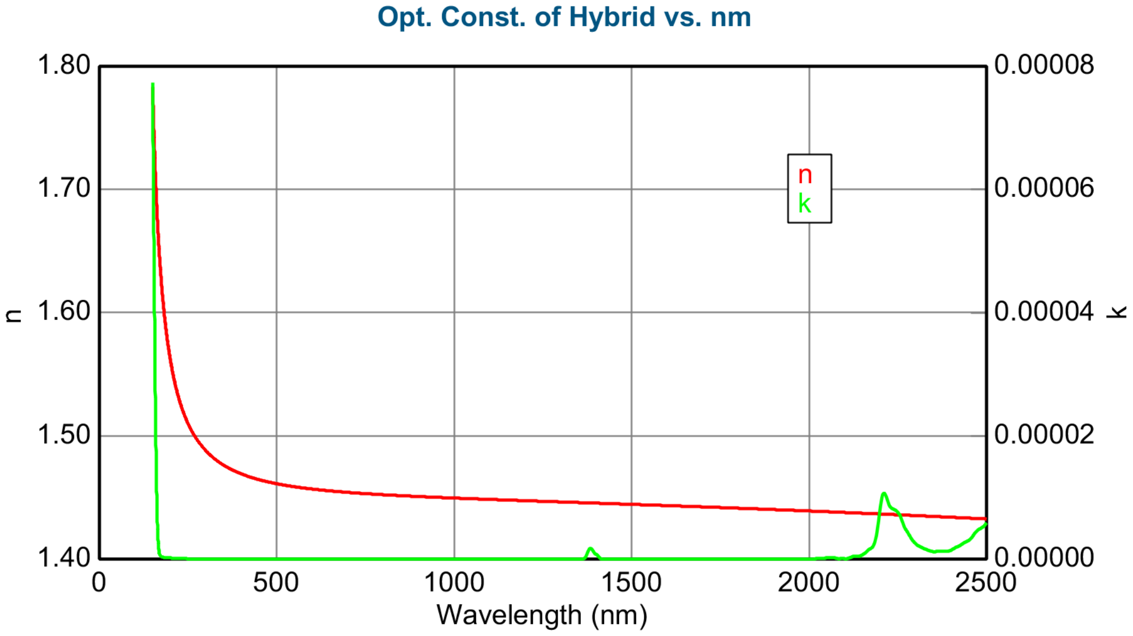
- Try using the Hybrid layer.

5-07: Fused Silica Substrate Results





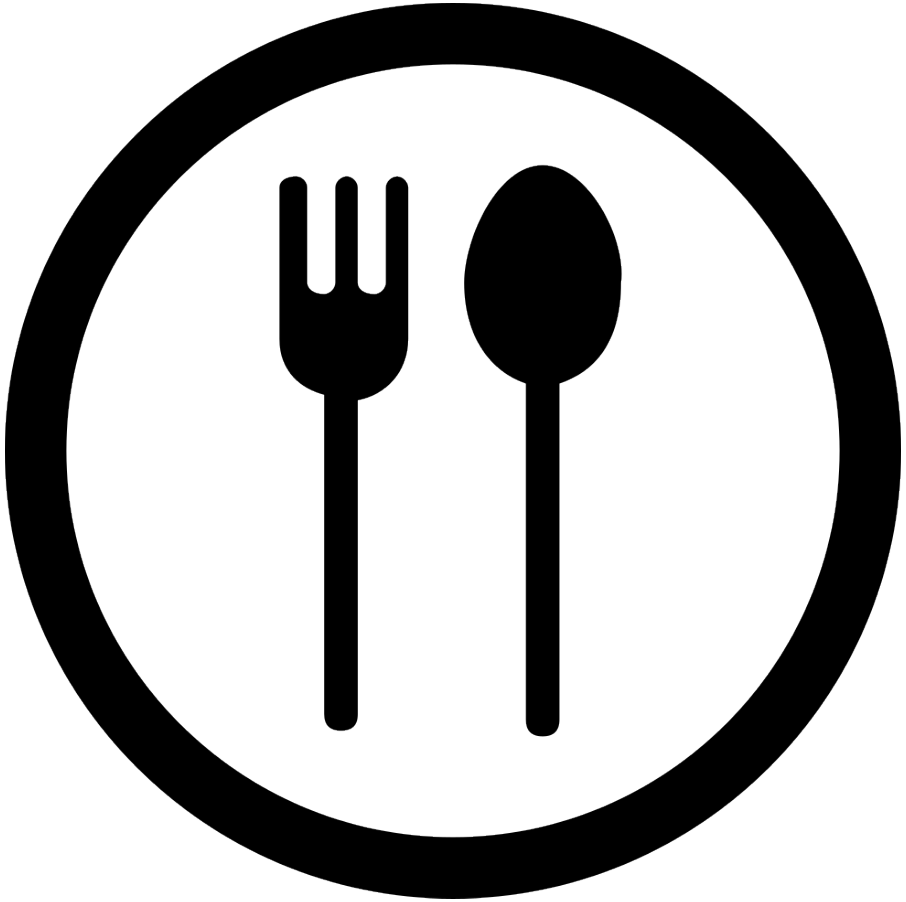
- Substrate = Hybrid Substrate Thickness = 3.0000 mm
  Optical Constants = e1 & e2
  + e1 Function = Gen-Osc
  + e2 Function = B-Spline



SESSION 5 OUTLINE

- Thin Absorbing Film Methods
  - Interference Enhancement
  - SE + Transmission Intensity
- Multilayers

LUNCH TIME

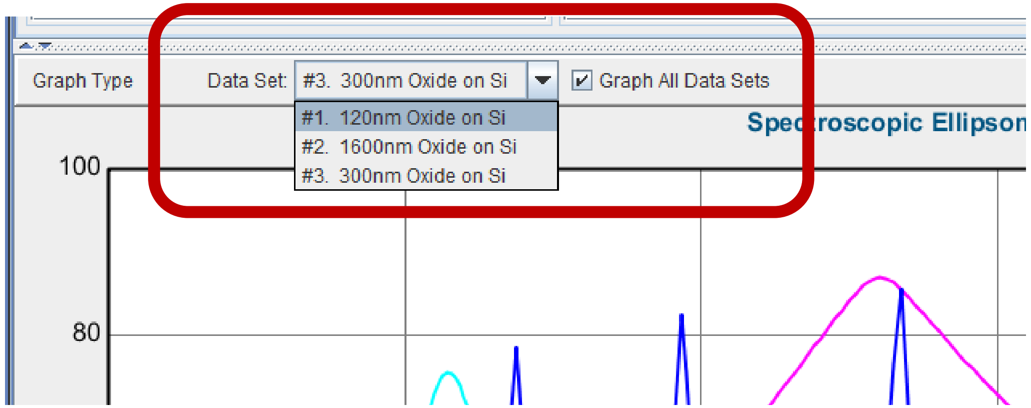


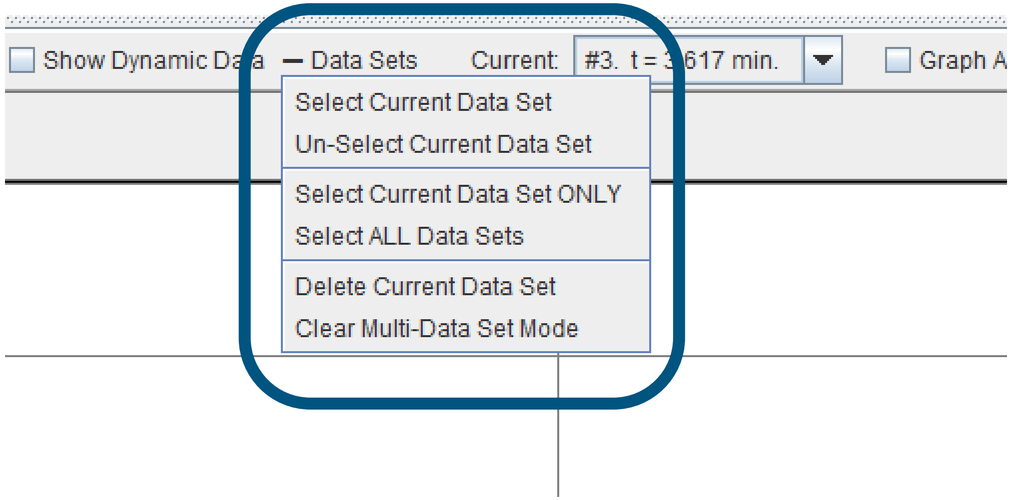
Additional Slides beyond this Point

MULTI-DATA SETS IN CE

- Graphing and Handling

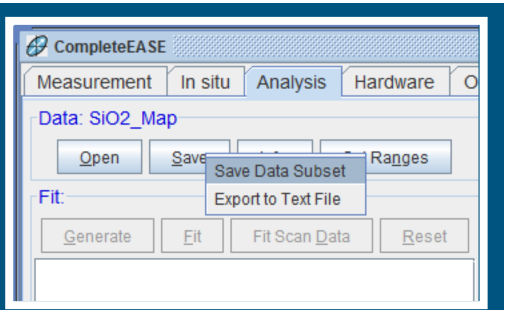
Drop Down Menu for Data Sets



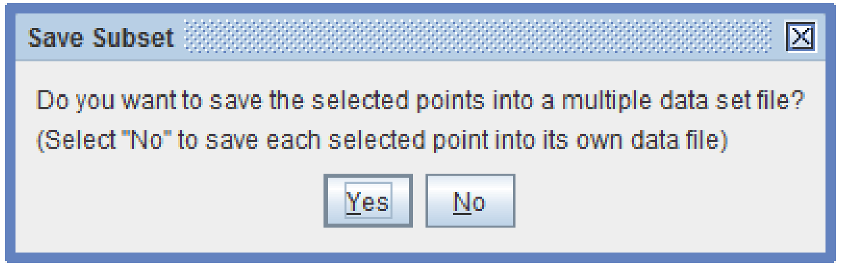


- Saving

Right-click over Data 'Save' button and press "Save Data Subset"



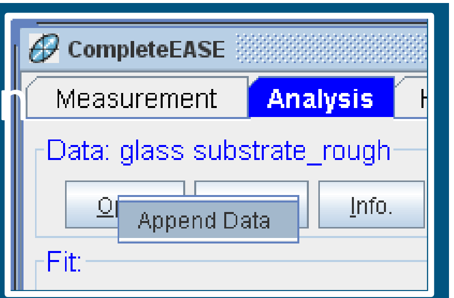
Save Data Subset as Individual or Multi-Data Set file



HOW DO WE GET MULTI-DATA SETS?

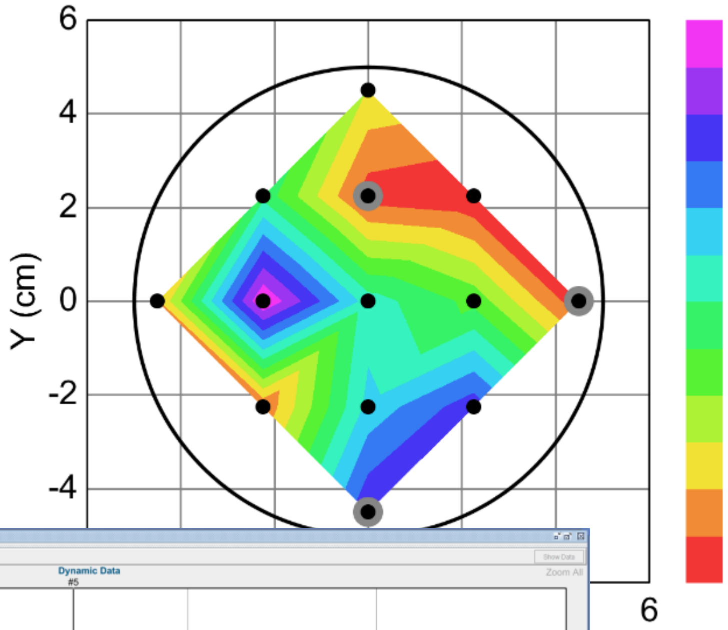
- Multiple single Measurements
  - Append Data

Right-click on Data ‘Open’ button



- Mapping Data

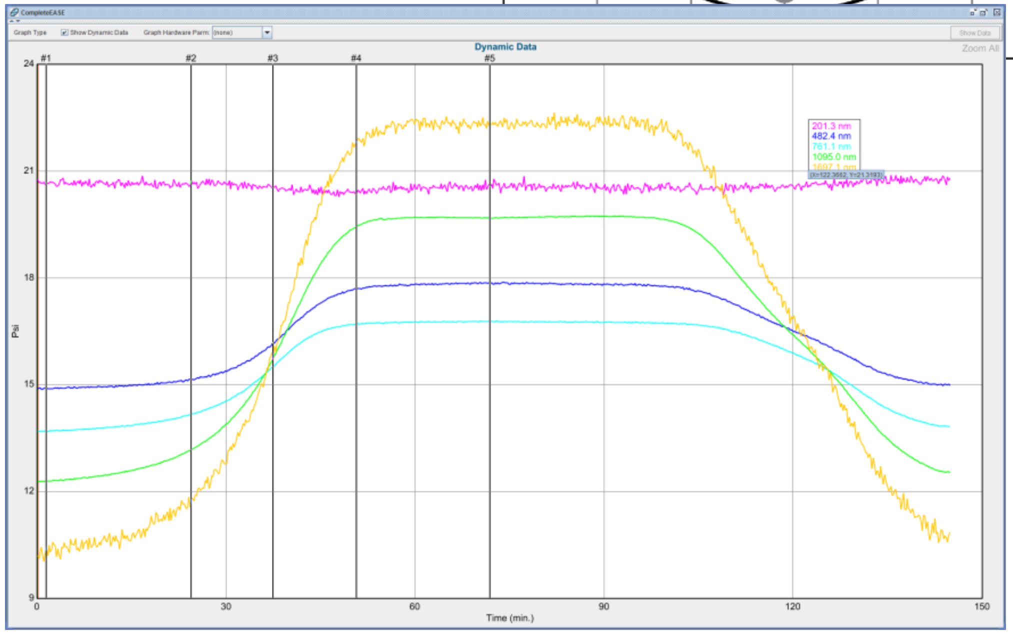
CTRL-CLICK to select multiple points



- Dynamic Data
- Rotation Scans

CTRL-CLICK to select multiple points

CTRL-Drag Mouse to select “range” of Data points

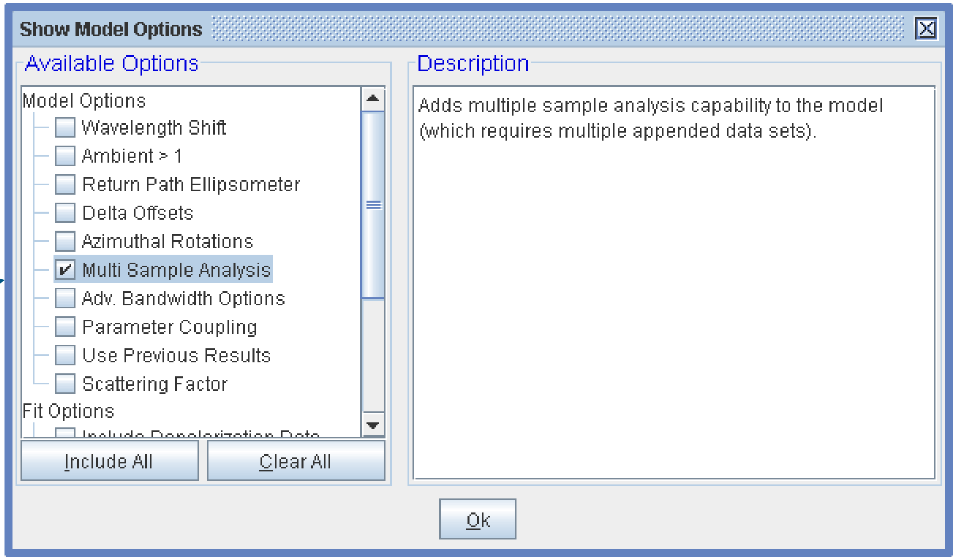


SETTING UP MSA IN CE

- Need to tell CompleteEASE which parameters to vary between multiple data sets

Configure Options

Layer Commands: Add Delete Save
Include Surface Roughness = OFF
Substrate = none
Angle Offset = 0.000
+ MODEL Options
+ FIT Options
+ OTHER Options
Configure Options
Turn Off All Fit Parameters



Add Fit Parameter

- MODEL Options
Include Substrate Backside Correction = OFF
Model Calculation = Ideal
- Multi Sample Analysis
Add Fit Parameter Delete All Parms

Data Set	Thickness # 1
#1	100.00 nm
#2	100.00 nm
#3	100.00 nm

Roll Mouse over each Fit Parameter and choose which to fit

MSA IN CE

- Model parameters are the same for "selected" data sets
- Parameters added to "Multi Sample Analysis" section can vary between data sets
- Select, Unselect, and Delete Data Sets