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Increased Sensitivity of Long Period Grating Hydrogen Sensors Through Coupling to Higher Order Cladding Modes

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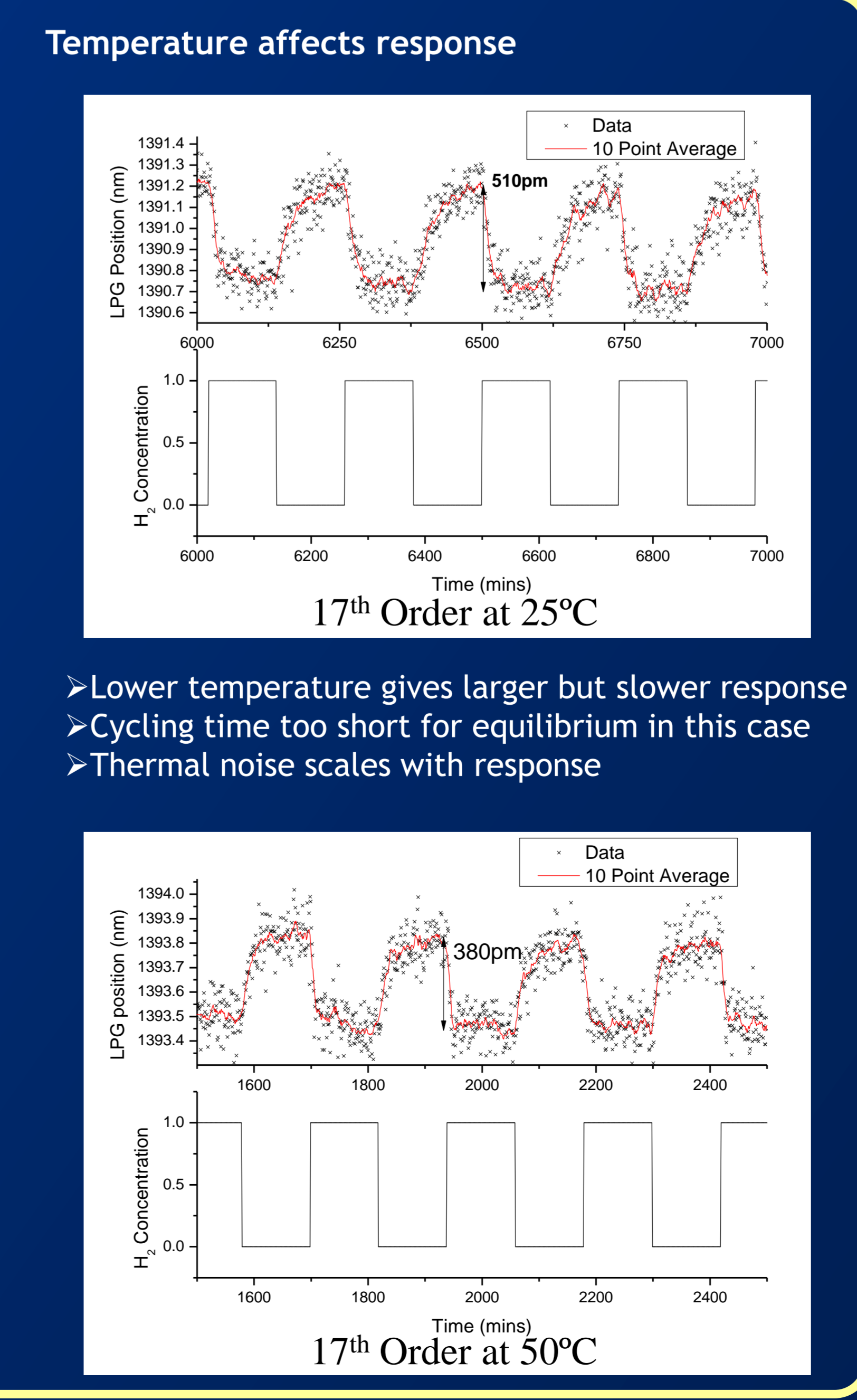
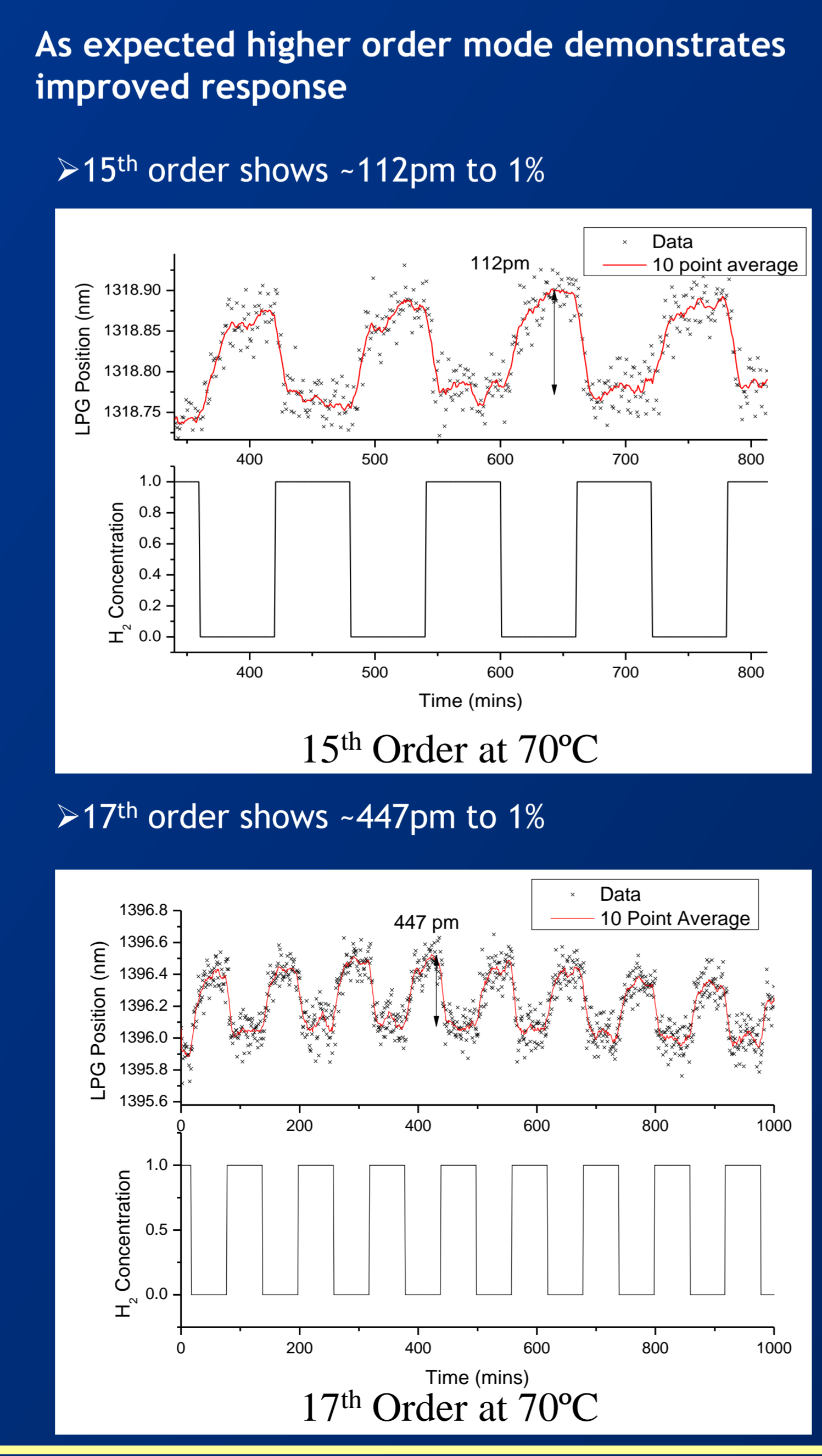
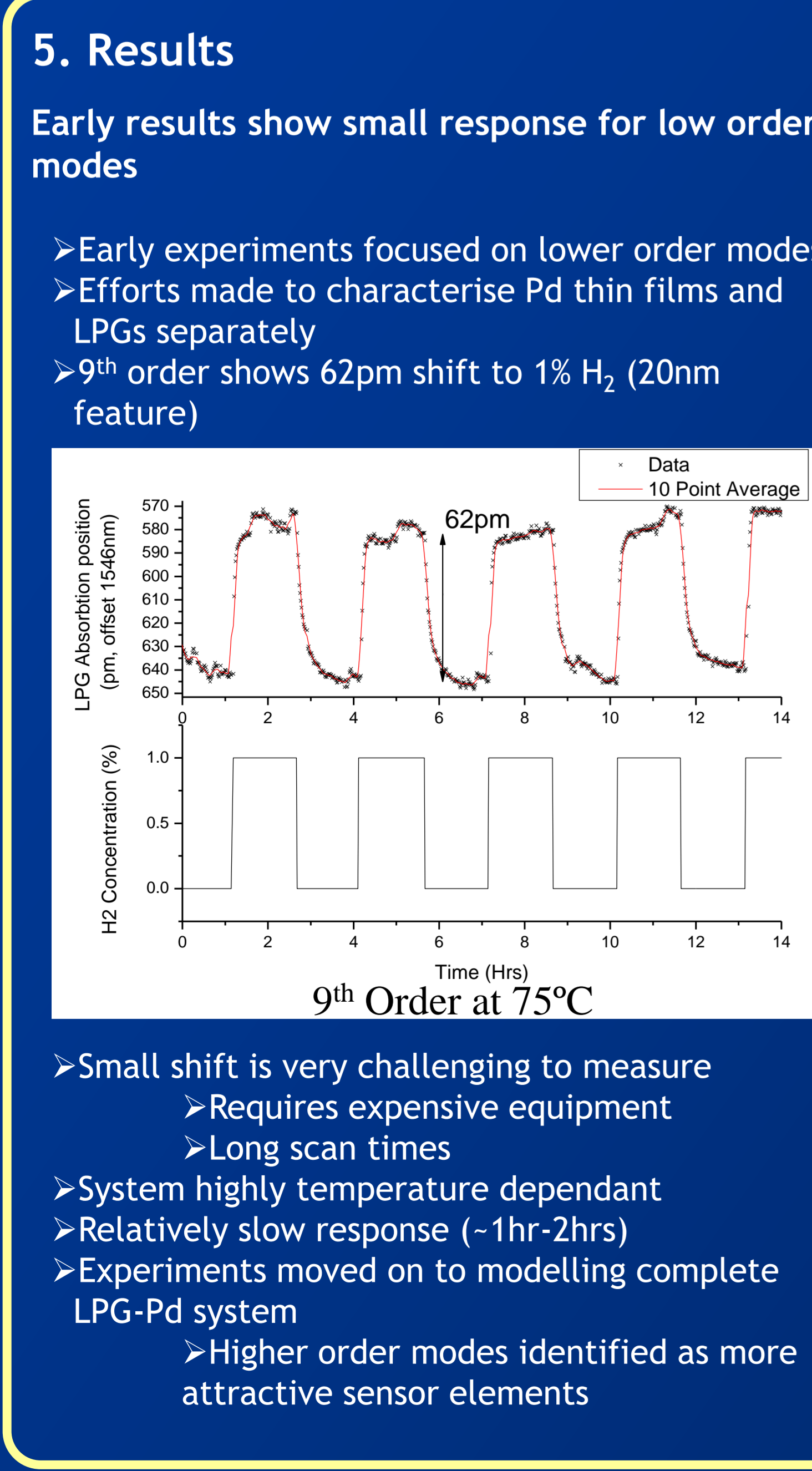
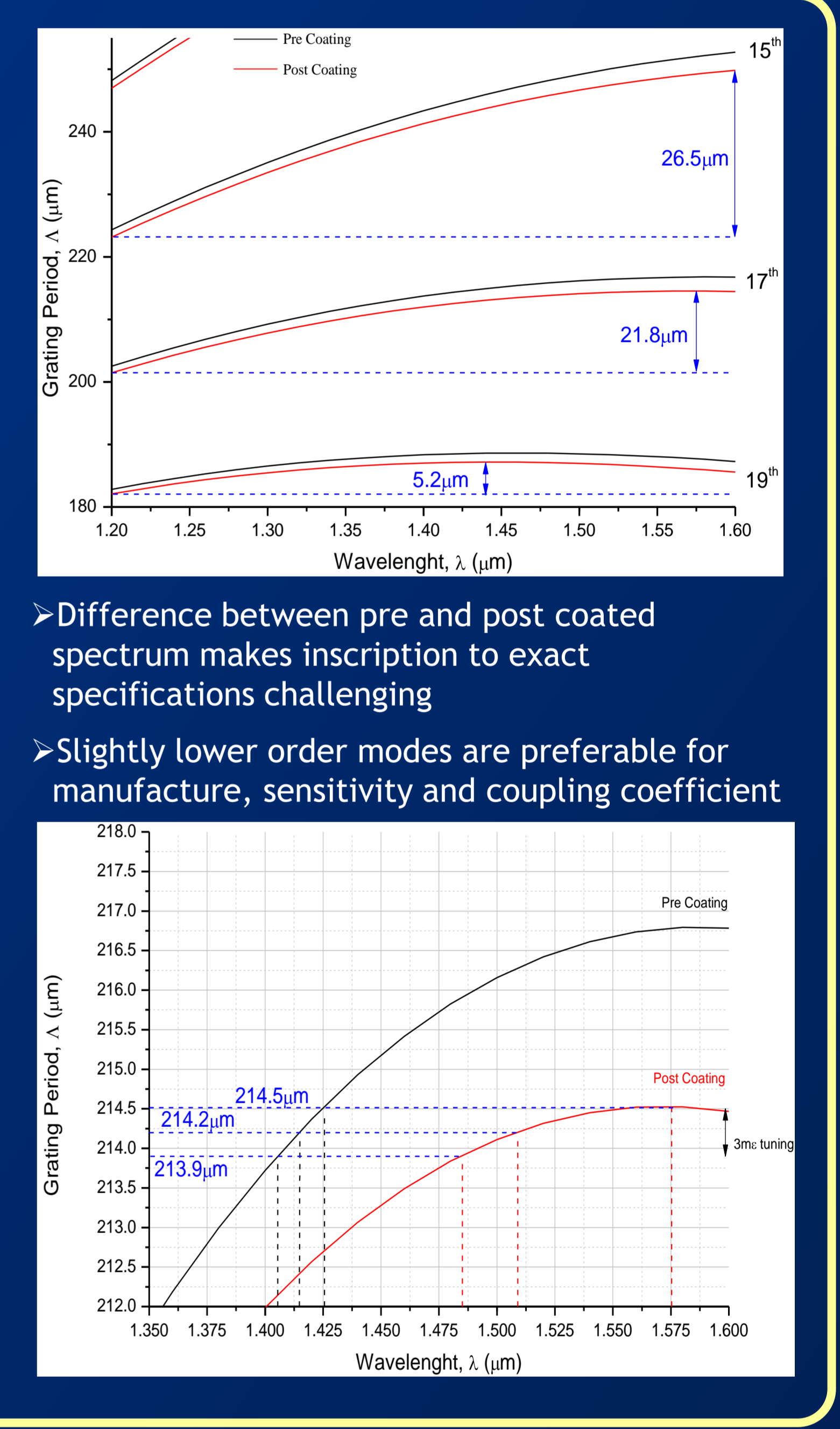
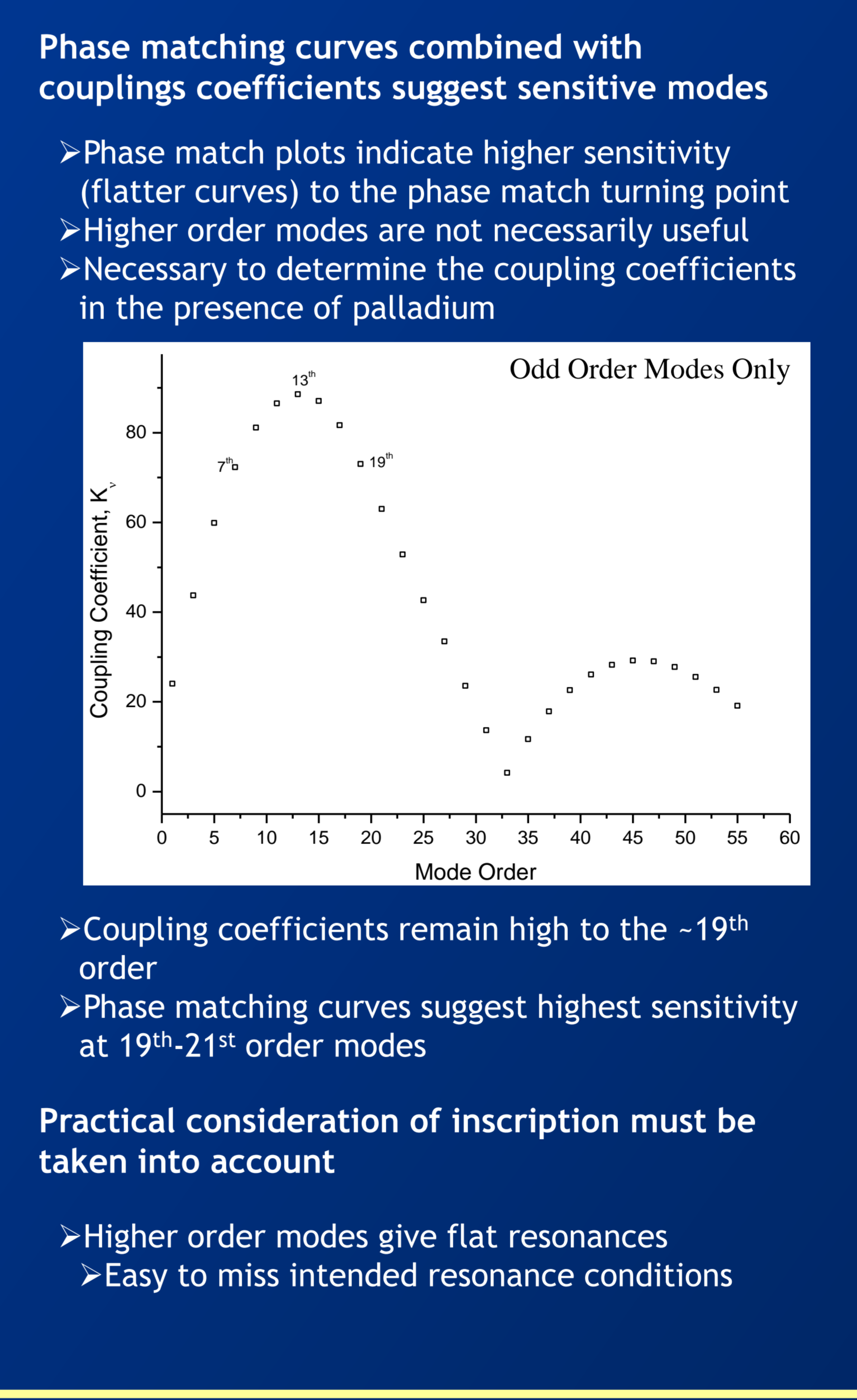
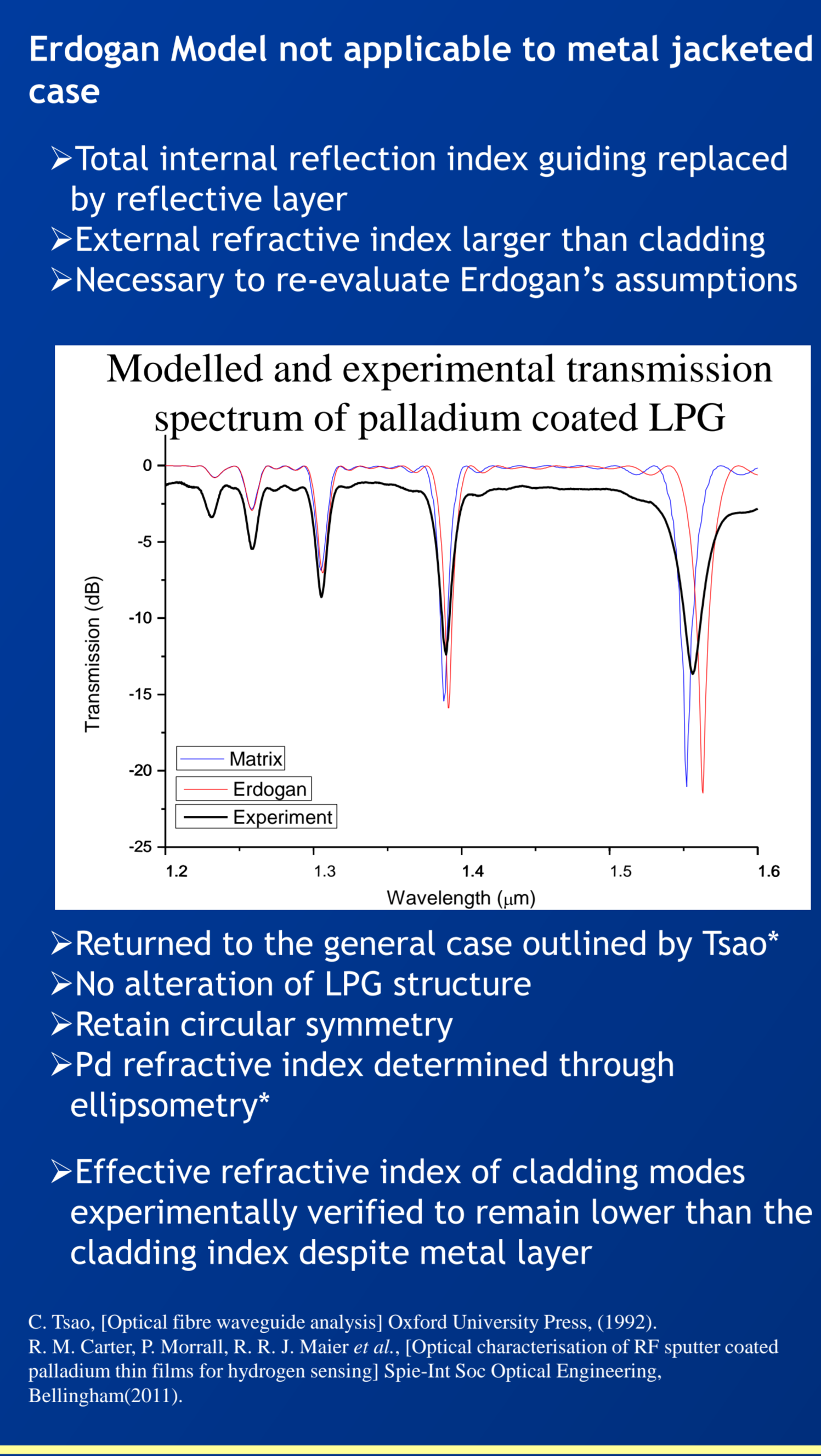
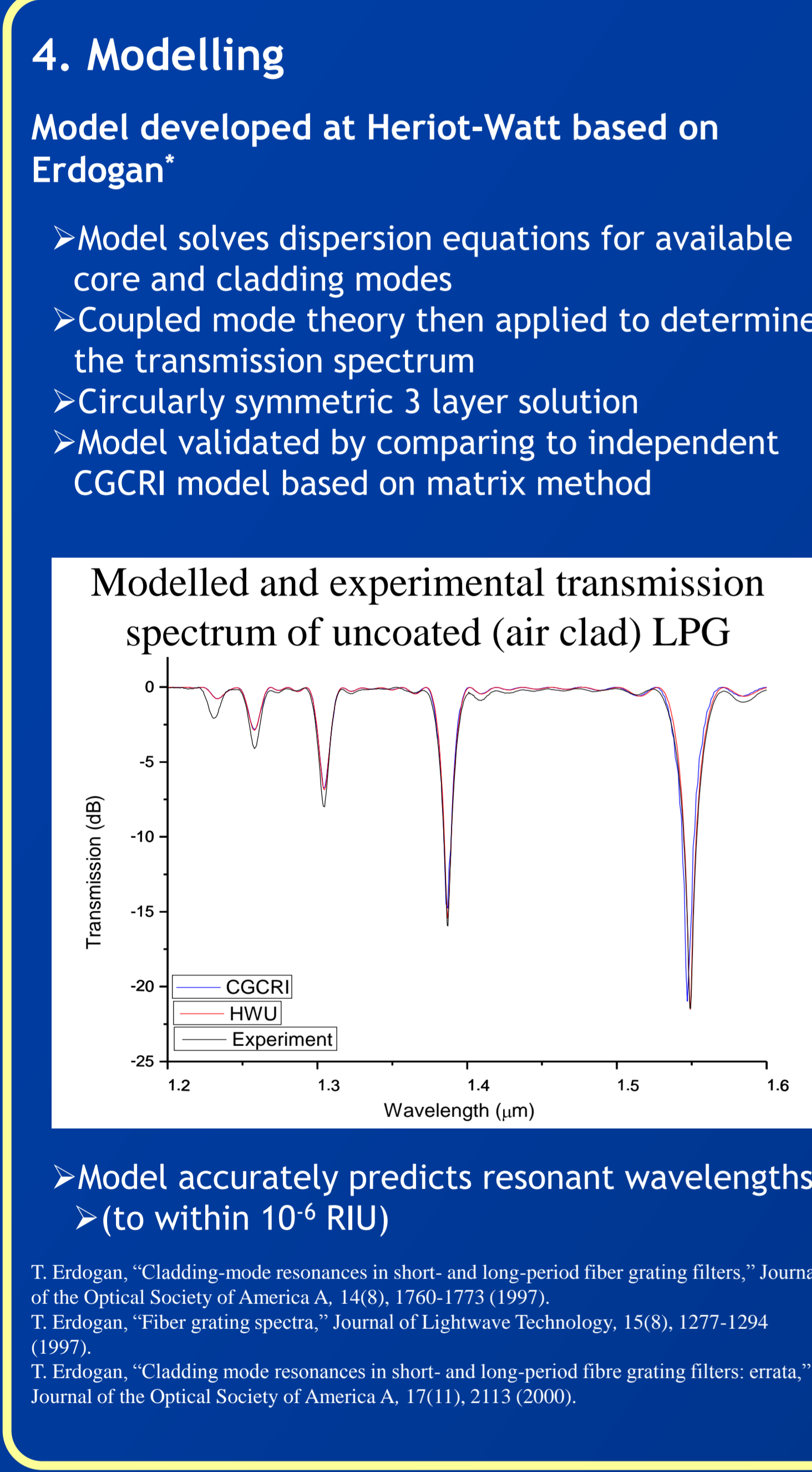
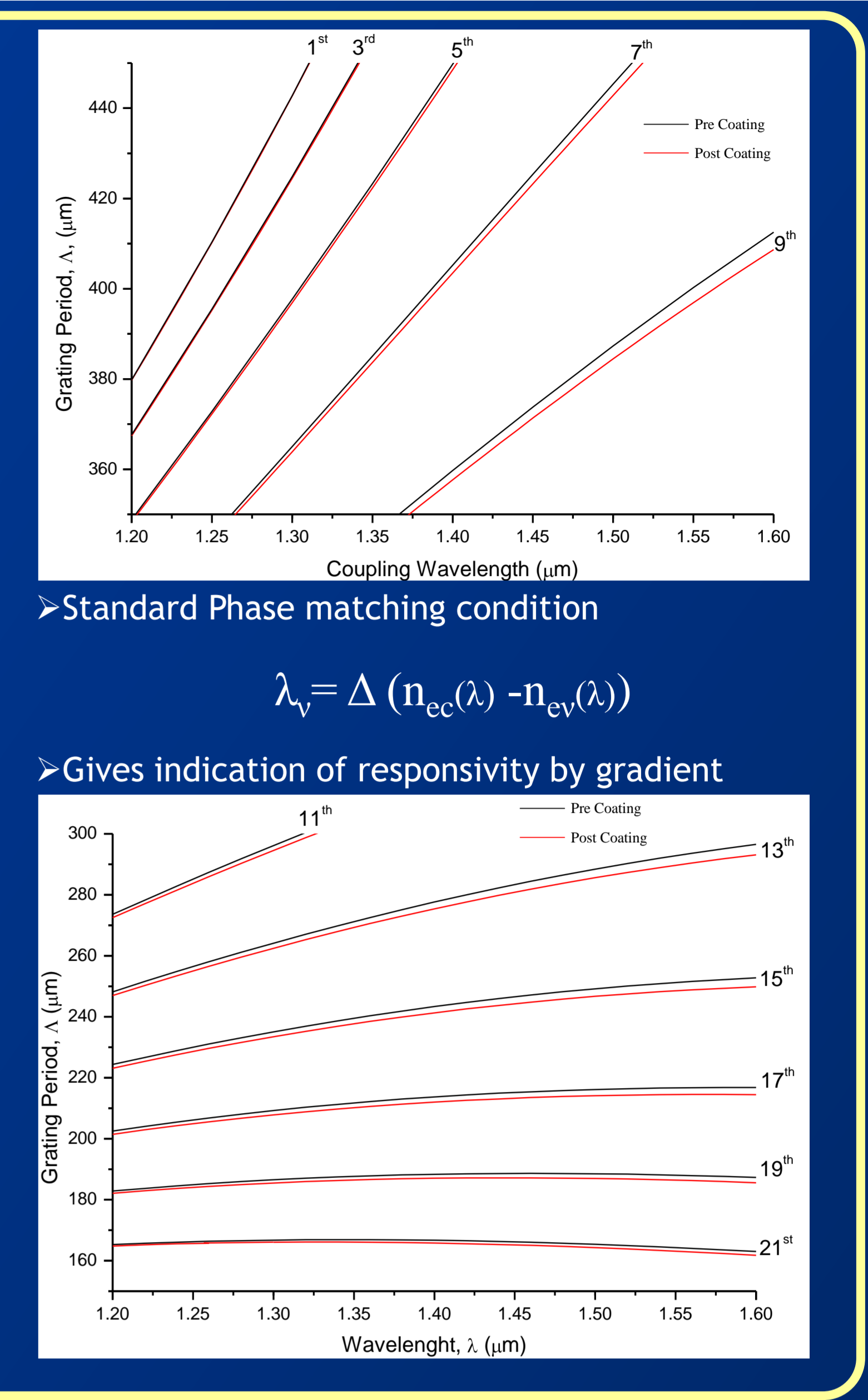
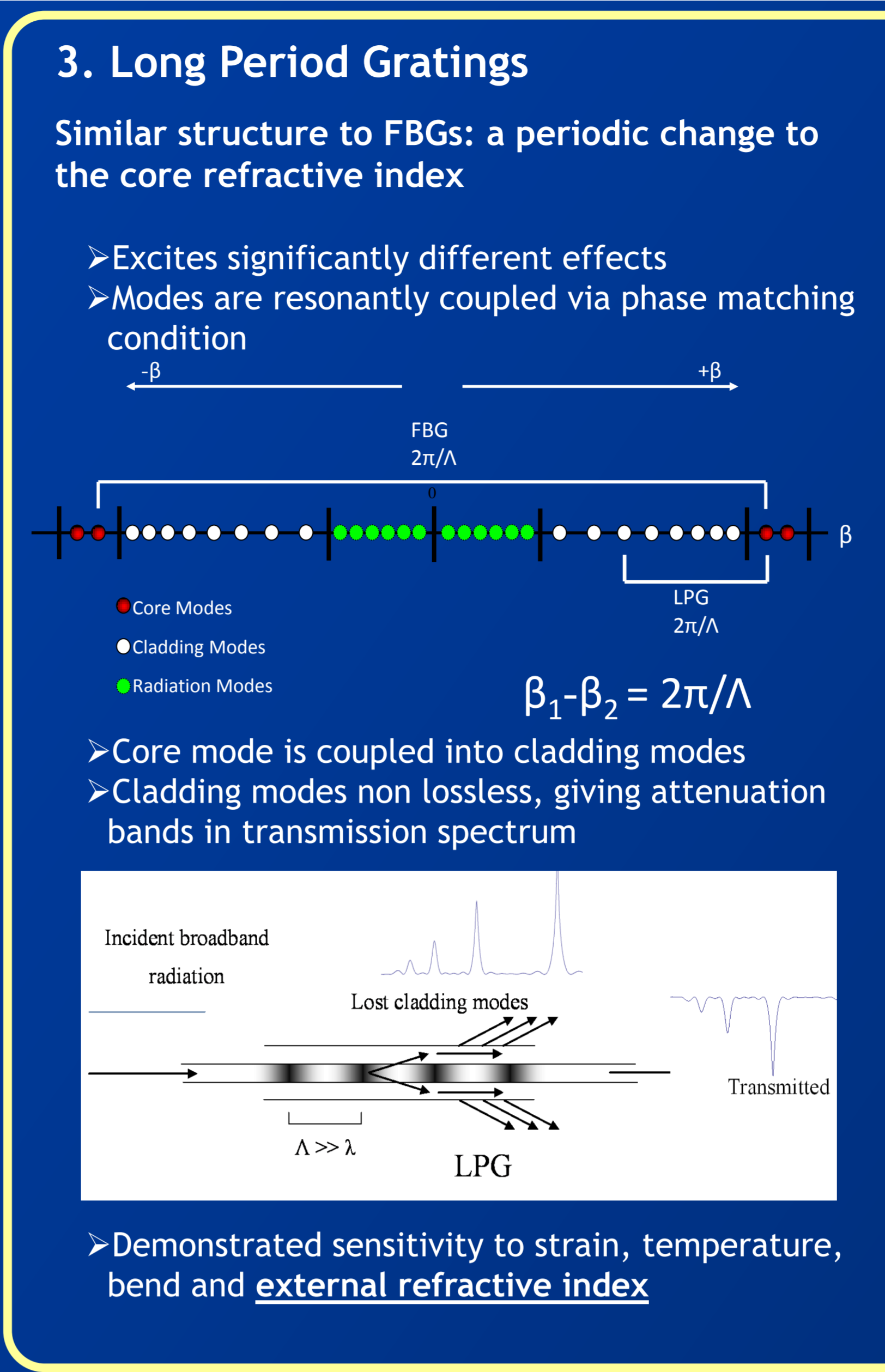
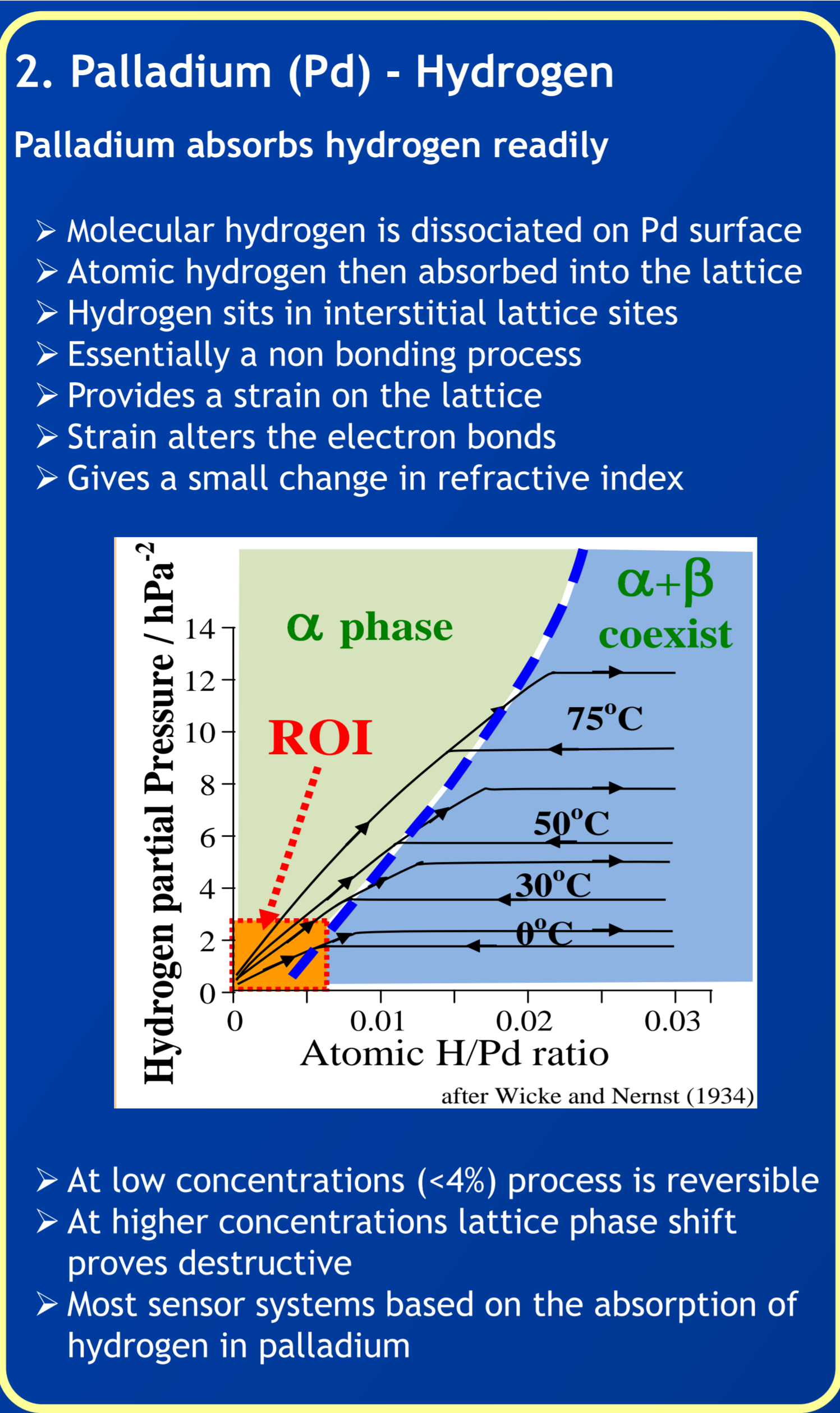
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1. Motivation

Reliable hydrogen detection technologies required for safety applications

- Hydrogen often suggested as future fuel source
- Hydrogen explosive at 4 - 97% in air
- Most systems based on the absorption of hydrogen in palladium
- Optical system preferable for safety reasons
 - No heating
 - No electrical currents
- LPG based hydrogen sensors demonstrated
 - Low responsivity
 - High order modes are more sensitive
- Increase in responsivity leads to decreased equipment cost/requirements
- AWE have a specific requirement:
 - Long term monitoring (>10yrs)
 - Hostile environment
 - Low hydrogen concentrations (<1.5%)
 - Long term fluctuations
 - Remote monitoring system
 - Selective to hydrogen
- Optical solution is preferred



6. Conclusions

High mode order LPG-Pd sensors were investigated

- Analysis of the full dispersive solutions to the modelling of metal jacketed LPGs has been carried out
- High sensitivity and coupling coefficient designs have been calculated
- A range of high mode order LPG elements were manufactured by the CGCRI

High sensitivity sensors have been demonstrated

- 17th order LPG sensor has been demonstrated with 7 times responsivity of 9th order
- Scale and speed of response dependant on temperature
- Thermal sensitivity (noise) scales with sensitivity to external environment
 - No improvement in signal to noise ratio
 - Improvement in absolute response
- Thermal insensitivity/compensation requires further research

