ENOUGH (DATA) ALREADY!
ADVENTURES IN CAPTURING APPEARANCE

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INTRODUCTION

METHODS TO GENERATE DIGITAL MATERIALS

TOTAL APPEARANCE CAPTURE

IS THE DIGITIZATION OF MATERIALS
WITH TRUE, FULL
APPEARANCE MEASUREMENT.

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COMMUNICATE

THE APPEARANCE EXCHANGE FILE FORMAT

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v-ray | Maya

Fabric sample measured with a TAC7

COMMUNICATE

THE APPEARANCE EXCHANGE FILE FORMAT

THE **AxF FILE** IS THE **DIGITAL TWIN OF A PHYSICAL MATERIAL SAMPLE** COMPRISING, FULL APPEARANCE MEASUREMENT INFORMATION PLUS METADATA.

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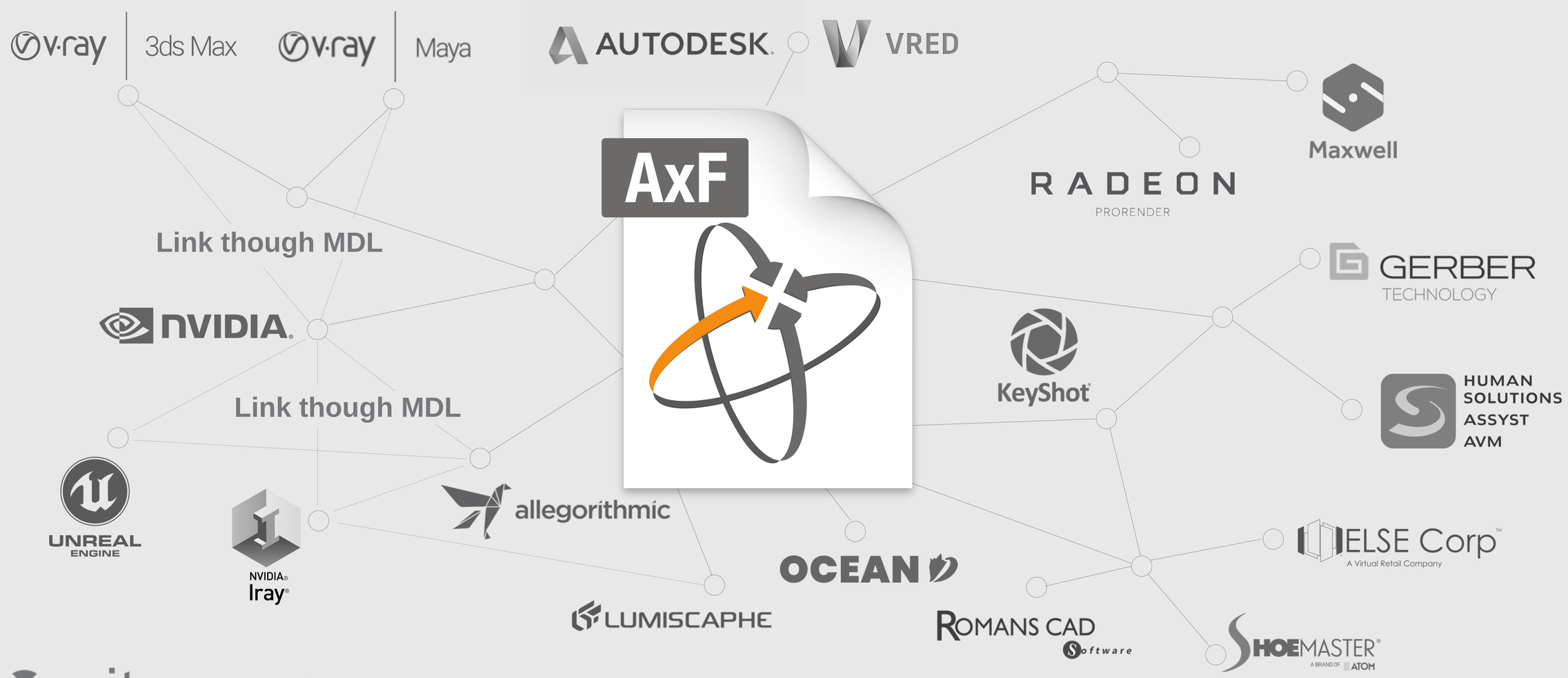
PARTNER NETWORK

THE APPEARANCE EXCHANGE FILE FORMAT - H2/2018



APPEARANCE CAPTURE
THE TAC TECHNOLOGY

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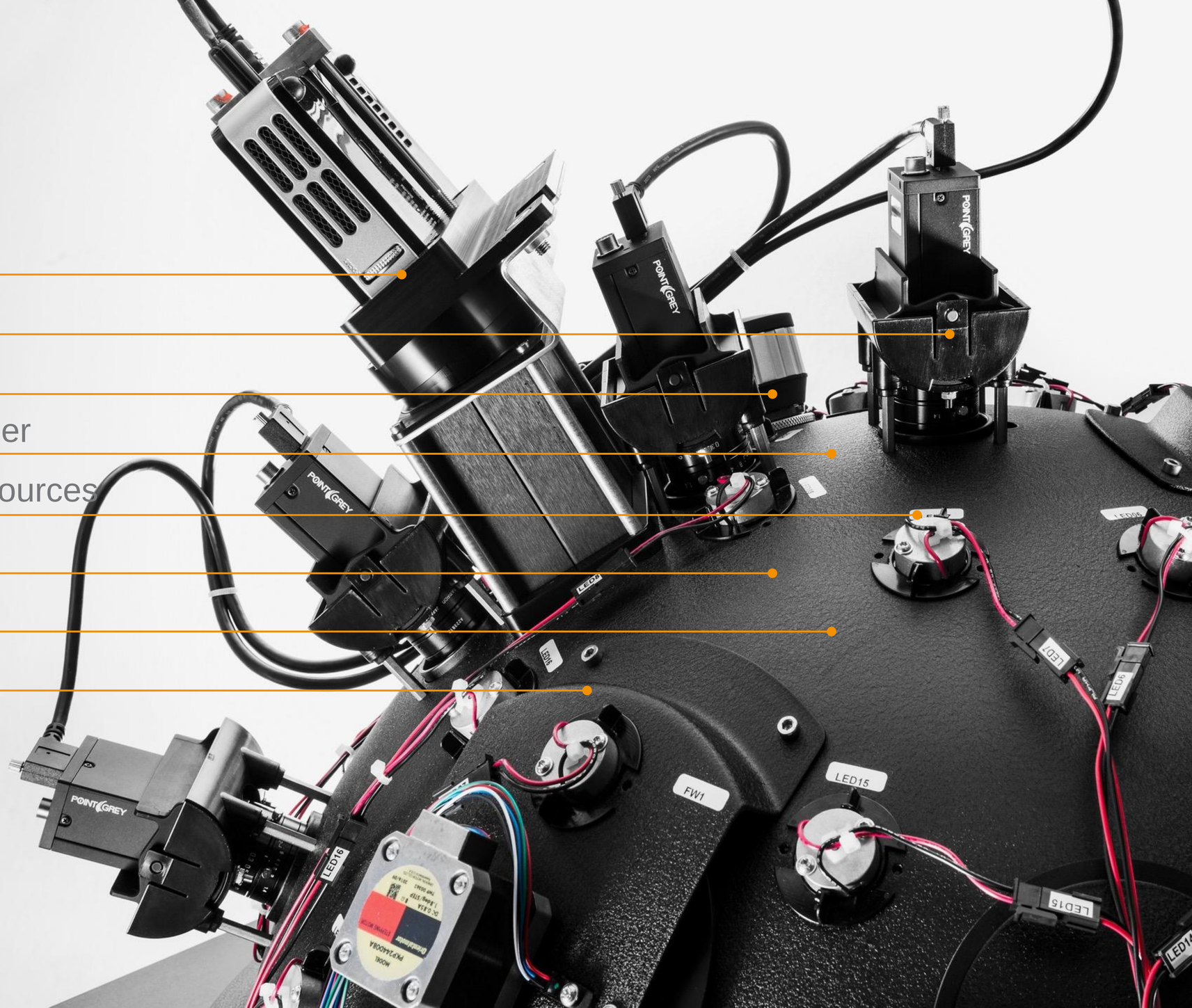
CAPTURE

MEASUREMENT TECHNOLOGY

- Structured light projector
- 4 industry-grade cameras
- Spectrophotometer
- Variable linear light scanner
- 32 white LED point-light sources
- Backlight module
- Rotation stage
- 8 spectral light sources



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CAPTURE
MEASUREMENT TECHNOLOGY

Measurement spot:
130 mm diameter,
±3 mm depth of field

Sample specification:
up to 22 cm x 30 cm x 3 cm
up to 5,45 kg

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CAPTURE

THE TAC7 SCANNER

- Measurement time: typical 15 - 120 minutes
- Measurement data size 20 - 120 GB raw data
- Post-processing time: typical 15 - 120 minutes
- Final size of AxF files: 1 – 200 MB

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WAIT! WHAT?

TAC7 DATA

Measurement time: typical 15 - 120 minutes

Measurement data size 20 - 120 GB raw data

Post-processing time: typical 15 - 120 minutes

Final size of AxF files: 1 – 200 MB

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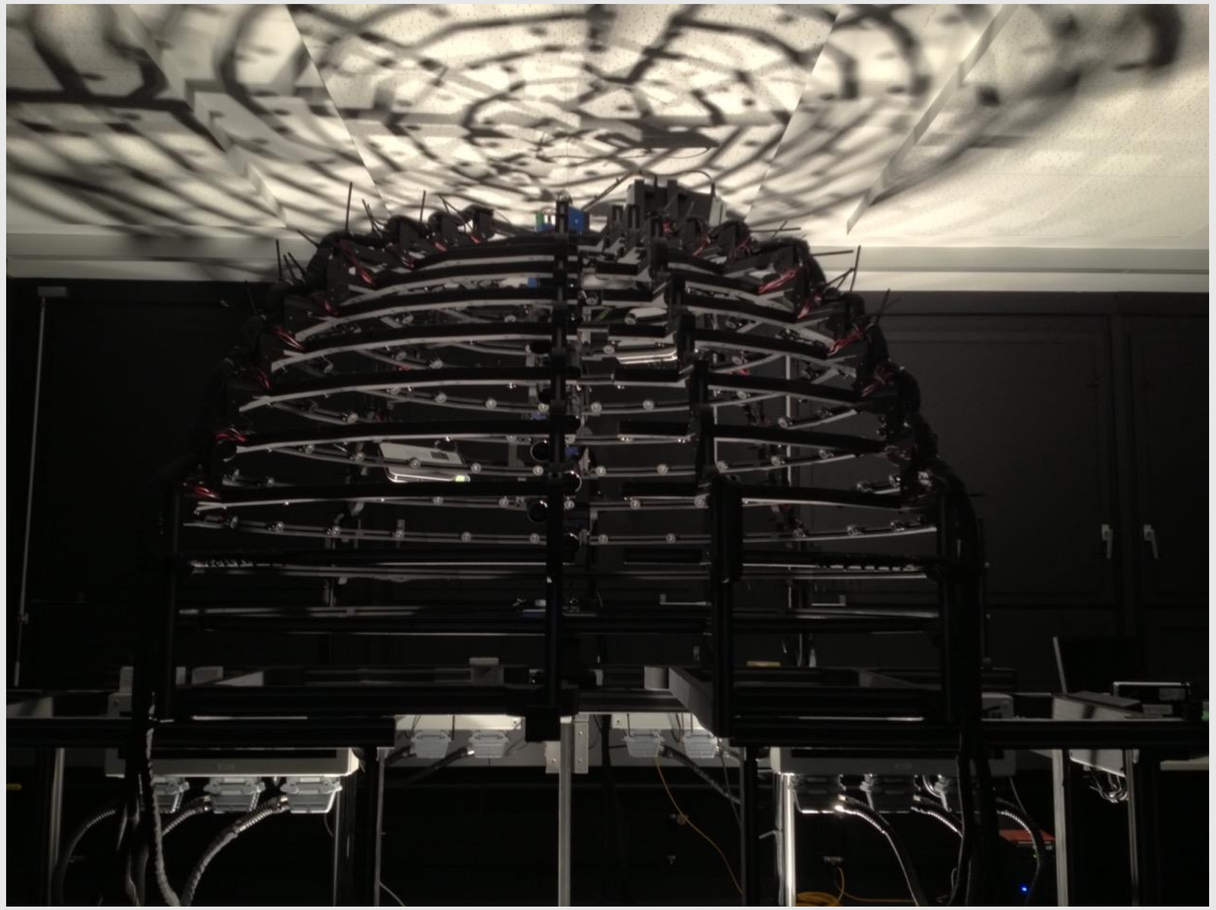
THAT’S NOT THE WORST OF IT

THE DOME – OUR FIRST GENERATION APPEARANCE SCANNER

- Measurement time: typical 2 – 4 hours
- Measurement data size 200 GB – 1.2 TB raw data
- Post-processing time: 2 - 36 hours
- Final size of AxF files: 20 – 200 MB



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THE MAIN POINTS

TAC7 DATA

- Know the target
- Know the data
- Organize the data

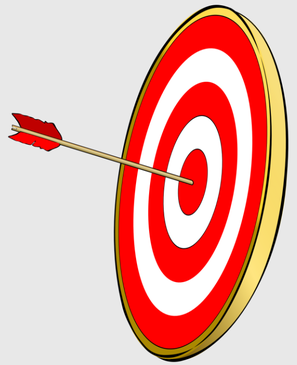
THE INFORMATION HIGHWAY

TAC7 DATA

AI

AI / Error Analysis / Heuristics

Categorization → Measurement → Fitting → Modeling



Information is gathered or added or organized at each step

$$f_s(\mathbf{i},\mathbf{o}) = \rho_s \frac{F(\mathbf{i},\mathbf{h})\,G(\mathbf{i},\mathbf{o},\mathbf{h})\,D(\mathbf{h})}{4\,|\mathbf{i}\cdot\mathbf{n}|\,|\mathbf{o}\cdot\mathbf{n}|}$$

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Survivor Illustration: Gathering data can seem like attempting to keep water in a bucket while throwing it.

MEASURING THE RIGHT DATA

TAC7 DATA

Just when you think you have it all put together…

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THE MORE-IS-BETTER SLIPPERY SLOPE

TAC7 DATA

Does it make sense just to add more images?

Make sure that the additional data adds information not found in existing data

Example: Multiple exposures

MEASURING THE RIGHT DATA

TAC7 DATA

Physical and optical coherence

- Just rotating a stage two degrees does not mean that the data significantly changes
- Feature size determines coherence—you need to find the data!

Drive measurement based on the model

- Identify key properties (one or more variables)
- Determine how they can be differentiated or measured
- Some potential key variables:
    - Gloss (peaks, slopes, angles)
    - Color (and flop)
    - Normals

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ADDING AND MERGING DATA

TAC7 DATA

Similar sources

- Multiple measurements

Issues: Registration, Balance, Resolution

Methodology: Establish a reliable workflow

Different sources

- Different hardware
- User Input
- AI

Issues: All of the above + Compatibility, Fitness, Energy Conservation, Source Reliability

Methodology: Workflow, Testing, Math, More Testing, Training

GOOD DATA VS. BAD DATA

TAC7 DATA

Calibration

The process of providing a framework for understanding the information that you have

- Components: Black, White, Field, Direction, Linearity, Bias, etc.

Methodology: Establish a workflow

Organization

The collection of important information in a form that is usable

- Components: Focus, Resolution, Separability, Repeatability, Model Compatibility

Issues: Cross-talk, Interference

Methodology: Rigorous analysis, attention to detail, study

“I discovered that information is not lost, but it is not returned in a useful way—like burning an encyclopedia but retaining the smoke and ashes.”

– Steven Hawking, Brief Answers to Important Questions

GOOD DATA VS. BAD DATA

TAC7 DATA

Calibration: what do you really know?

Different information is contained in each image.

White Point Adjusted

A D65 CWF

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WHEN DO YOU NEED MORE DATA?

TAC7 DATA

Sampling Theory

- N variables == N inputs
- Nyquist Limit (twice the sample frequency)
- Under-determined, Over-determined, Wrongly-determined

Confidence

How do you know when you’re right?

- Additional data matches the model
- Additional data requires changes in the model
- Visual Verification
- Appearance dE (dA?)

WHEN DO YOU NEED MORE DATA?

TAC7 DATA

More is better when…

- You need to verify model fitness
- The interesting information is hard to find (small features)
- The system is under-determined
- The required accuracy is at risk
- The target information requirement exceeds acquired information (typically related to resolution)

More is NOT better when…

- The model is wrong
- The information is uninteresting (large features)
- You have the time
- You have the space
- You have the speed

i.e. Just because you can!

- Accuracy and repeatability are not issues
- Acquired information exceeds target information requirements

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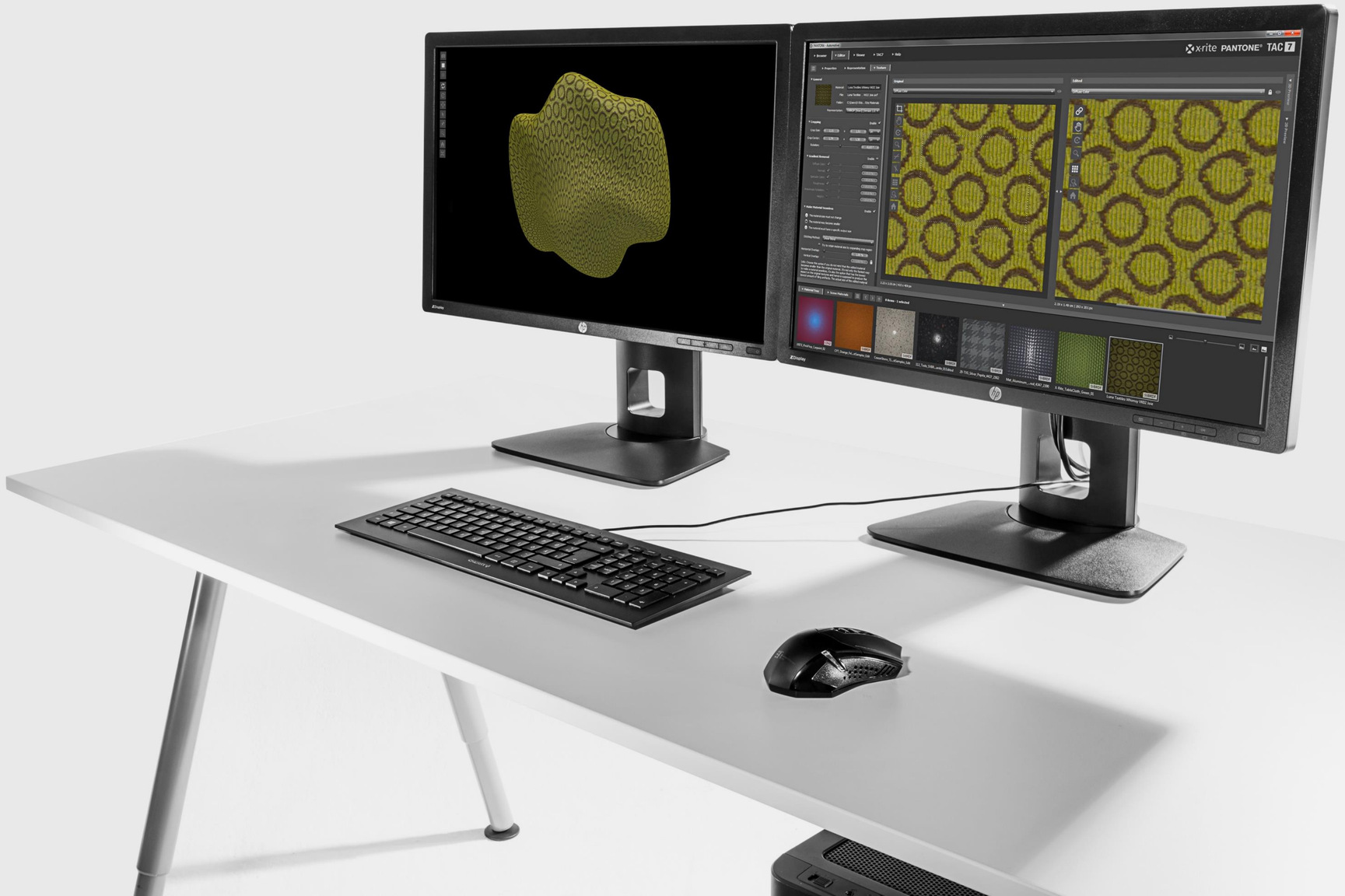
WHERE DO WE GO FROM HERE?

TAC7 DATA

- Better models
- New/Better/More Appropriate Difference Metrics
- Direct Data Acquisition (Acquiring Organized Data)

EDIT AND MANAGE

THE PANTORA DIGITAL MATERIAL HUB



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VISUALIZE

THE VIRTUAL LIGHT BOOTH

- SpectraLight QC Light Booth: D65 Diffuse and D65 LED Spotlight
- High Brightness LCD Display with 5000 cd/m^2
- Position depending closed loop real-time color management engine
- X-Rite OpenGL real-time rendering engine simulating virtual booth

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VISUALIZE
THE VIRTUAL LIGHT BOOTH

- set of embedded motion controllers for body and face tracking
- external X-Rite i1Pro 2 spectrophotometer for system calibration
- embedded X-Rite i1Display Pro colorimeter for closed-loop display calibration
- embedded X-Rite i1Pro 2 spectrophotometer for closed-loop ambient light tracking

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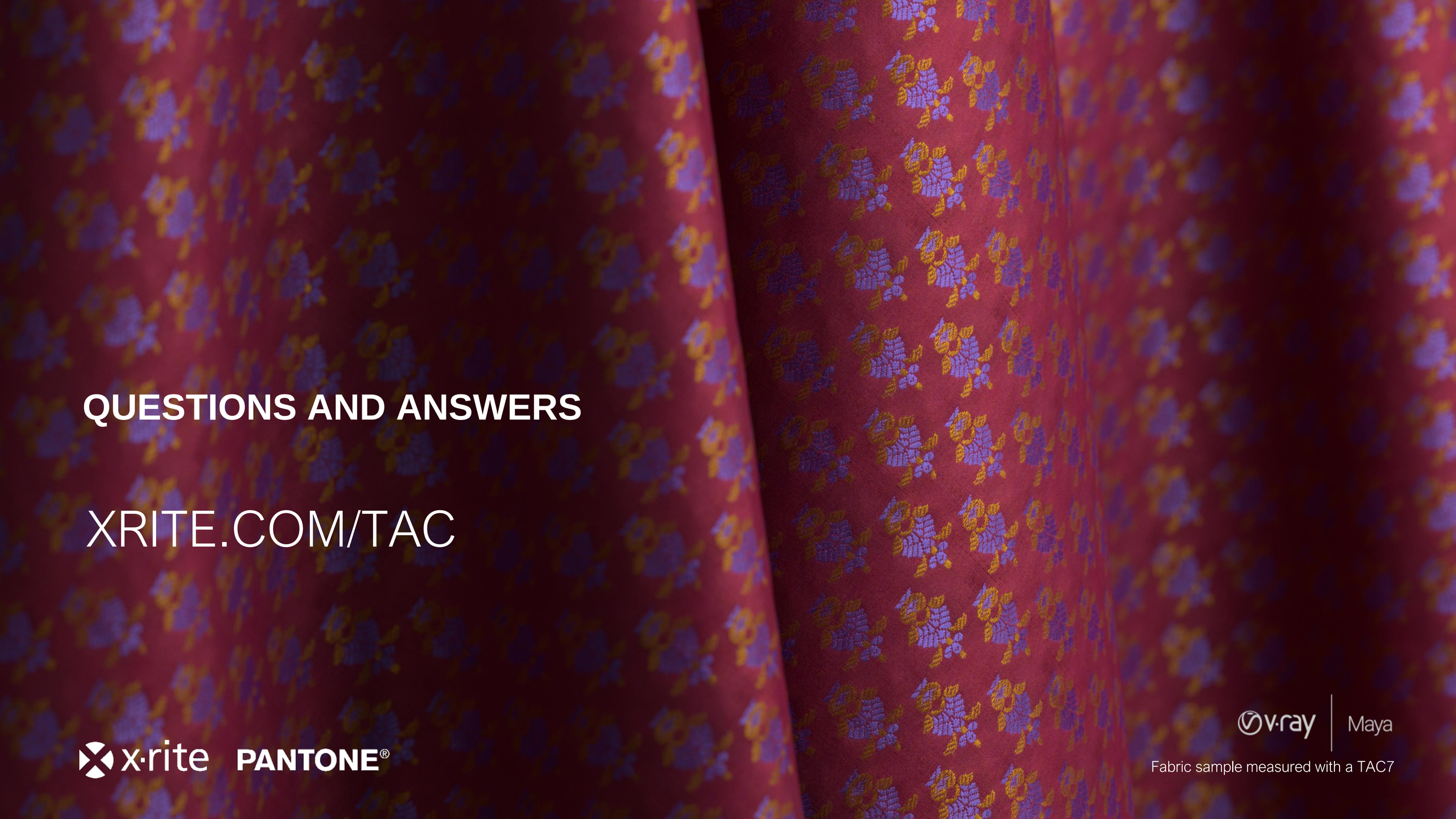

QUESTIONS AND ANSWERS

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