Assembling Gigapixel Panoramas

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The Real Scenario

- Complete Pipeline

MTF

- System MTF
  - Lens + Sensor + etc.. + (Human Eye)
Atmospheric Limitations

- Turbulence *(Heat)*
- Aerosols *(Distance)*

![Image of atmospheric conditions](image1)

Sensor Formats

- FX - Full Frame
- DX - Digital Camera

![Image of sensor formats](image2)

Lens MTF Parameters

- Sagital / Meridional Patterns
- Distance from Image Center

![Image of lens MTF parameters](image3)
Lens Performance

- the good and the bad ;-

MTF-50
- sharpness perception

Aperture x Pixel Size

- Optimal Aperture

The Sweet Spot

- Why?
  - Large Apertures (light aberrations) **
  - Small Apertures (diffraction effect)
Sensor Resolution

- Bayer Pattern
- Demosaicing
- Moire Artifacts

Lens Vignetting

- Radial Falloff

- 4 types:
  - Natural
  - Pixel
  - Optical
  - Mechanical

Vignetting Correction

- Venice panorama
Motion Blur

- Object Movement
- Camera Motion

De-blurring...

The Camera Sensor

- Noise
- Quantization

Sensor Noise

- ISO / Sensor Size
- Long Exposure
- Other Factors
  Noise Reduction...
Sensor Quantization

- Response Curve

- Analog - Digital (8 to 14 bits)

Camera Processing

- Photosites (photons to electrons)
- ISO (amplification)
- A/D (quantization)
- Demosaicing
- [denoising]
- [color conversion]
- Response Curve
- Gamma Encoding
- JPEG

Stitching

- Alignment
  - Projective Transformation
- Blending
  - Linear
  - Multiband
  - GraphCut
  - Poisson
The Future

- Terapixel Imaging Systems
- Metalens
- Super-resolution

The End?