

[EPSC2026-709]

# First Quasi-Global Lunar Polarimetric Map from Danuri/PolCam Using a Calibration Pipeline with Smear Correction

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# What is the Danuri?



- **Payloads**

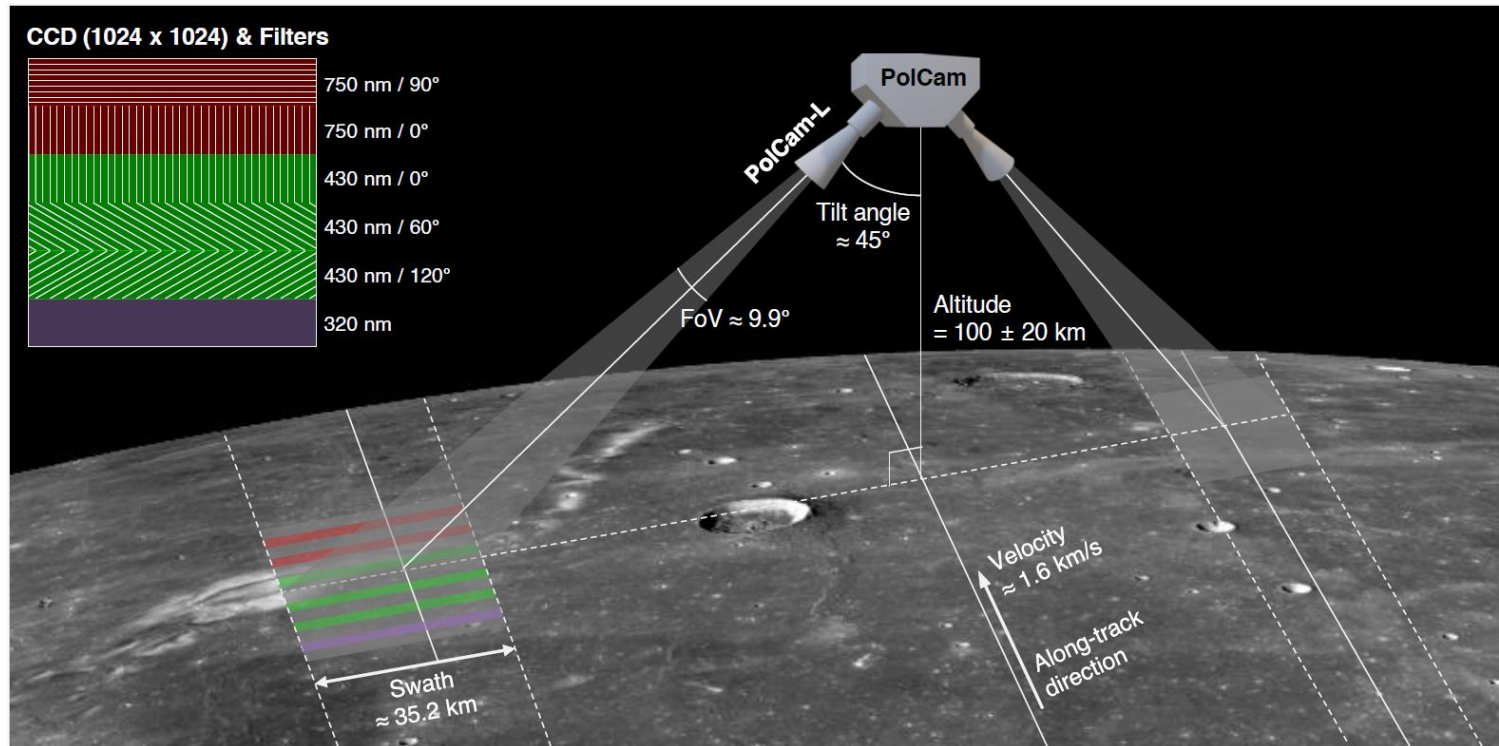
- LUTI (KARI)
- KGRS (KIGAM)
- KMAG (KHU)
- **PolCam** (KASI & KHU)
- ShadowCam (NASA & ASU)

- **PolCam Observation Status (As of July 2026)**

- Cumulative Observations: **13,785** out of 15,563 polar orbits
- Nominal Mission (100-km Orbit): **7,856** orbits over 746 days
- Extended Mission (60-km Orbit): **2,477** orbits over 218 days
- Extended Mission (Frozen Orbit): **3,065** orbits completed

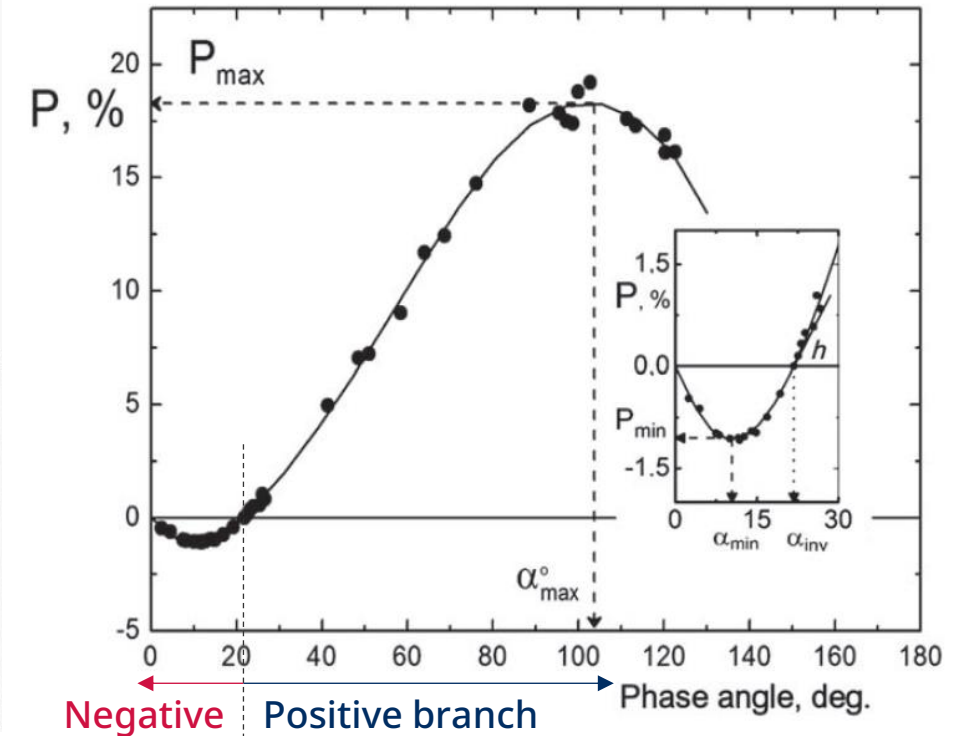
# What is PolCam?

Baek et al. (2025) JKAS



- First polarimetric survey mission ever conducted from lunar orbit.
- Two cameras tilted 45-degree from the nadir direction.
- 6 channels: 3 spectral bands + 5 polarizer for each camera.
- Utilized only 6 lines out of 1,024 lines with one line per a channel.

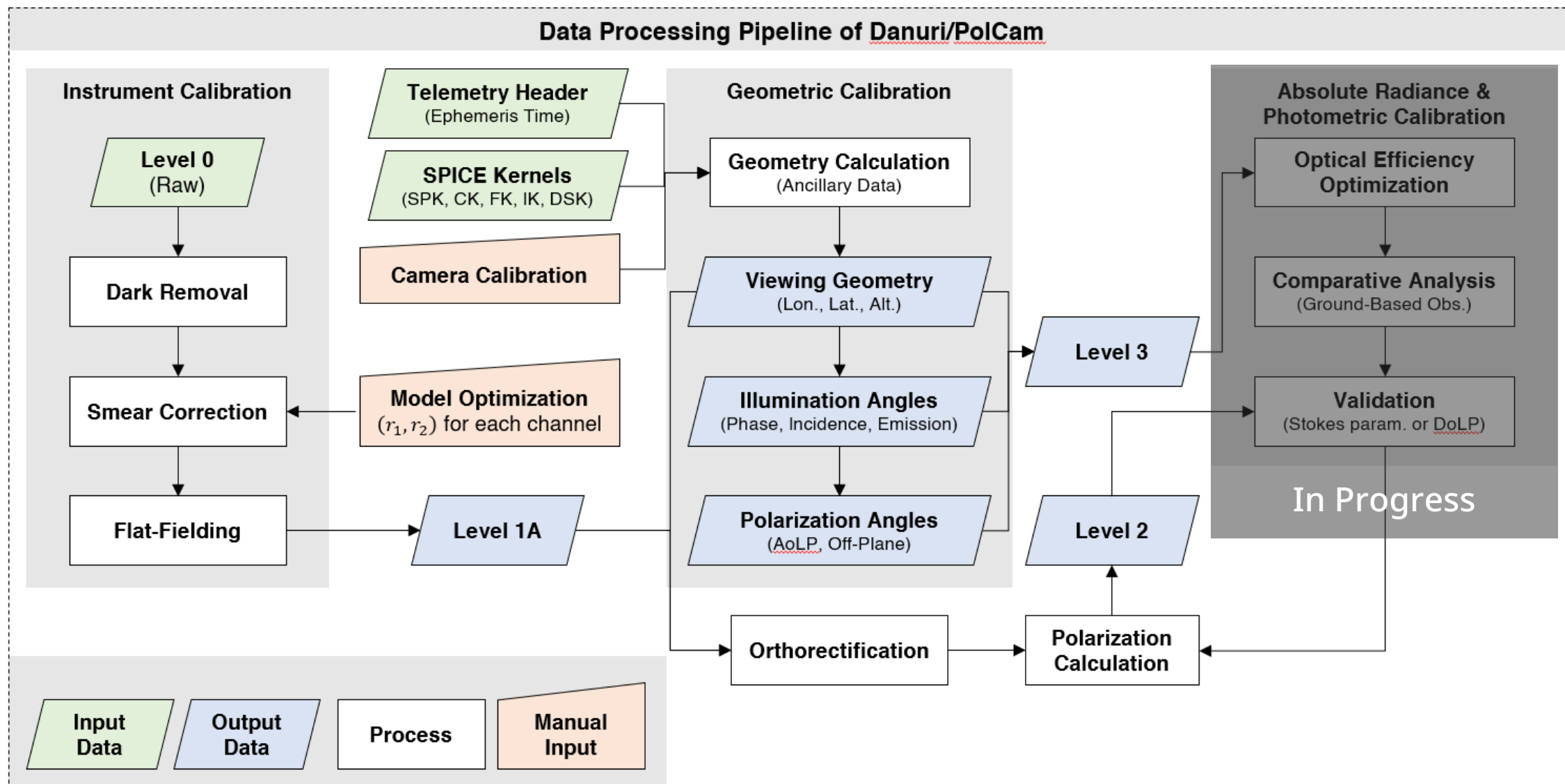
Kvaratskhelia (1988) AbaOB



Umov's law:  $b = a \log P_{\max} + \log A$

(particle size)  $\propto b \propto P_{\max}^a A$

# Data Processing Pipeline



# Geometric Calibration

※ Camera Calibration → 3D Georeferencing → Projection → Mosaicking ([Baek et al. 2025, JKAS](#))

- Raw Data (distorted)



- (Left) Leaned central peak of Copernicus crater.
- (Right) Elongated or dented small craters.

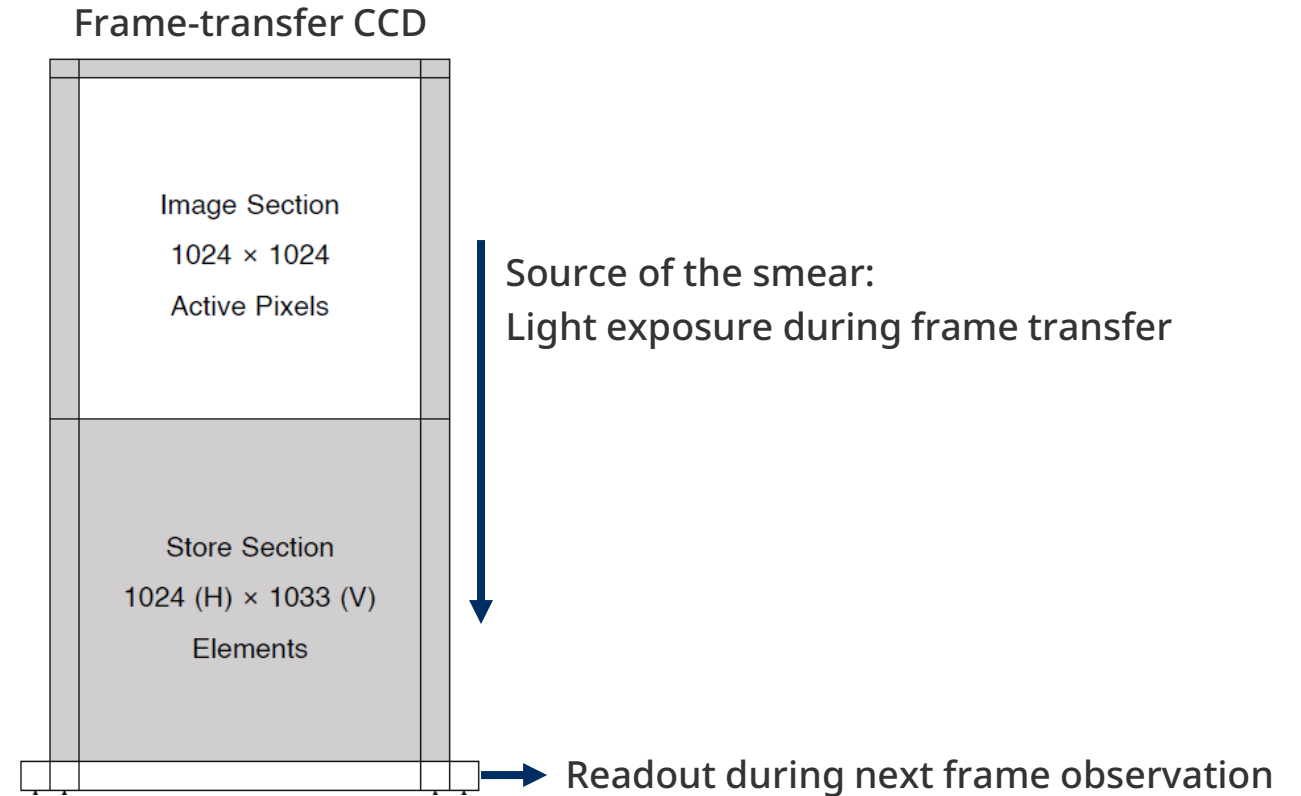
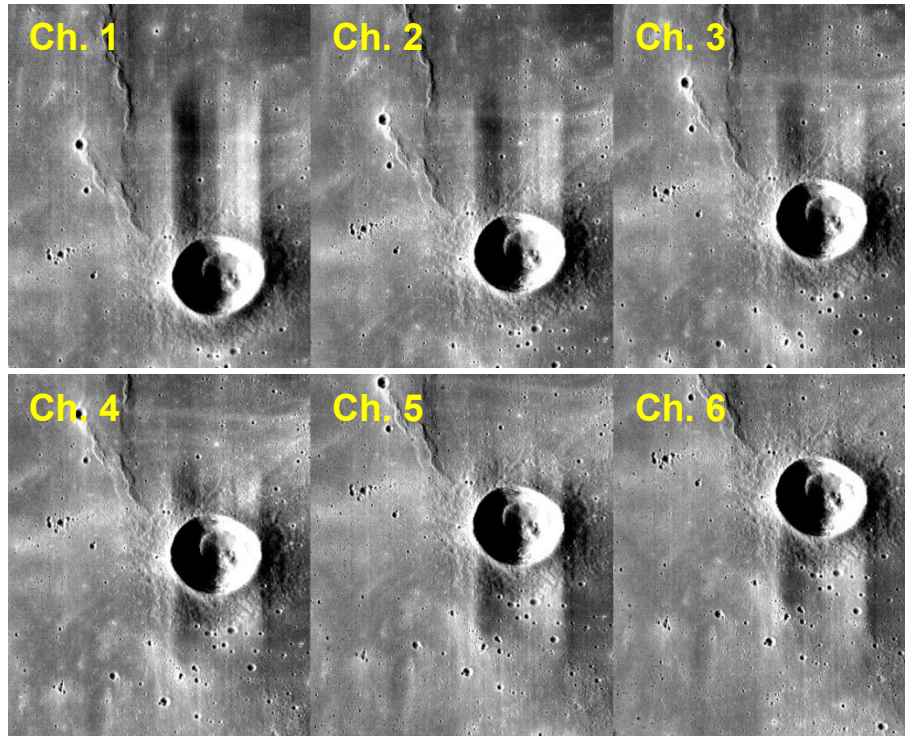
- Calibrated Data (onto equirectangular coord.)



- (Left) Corrected to appear as if observed from the nadir direction.
- (Right) Restored to their original circular shape.

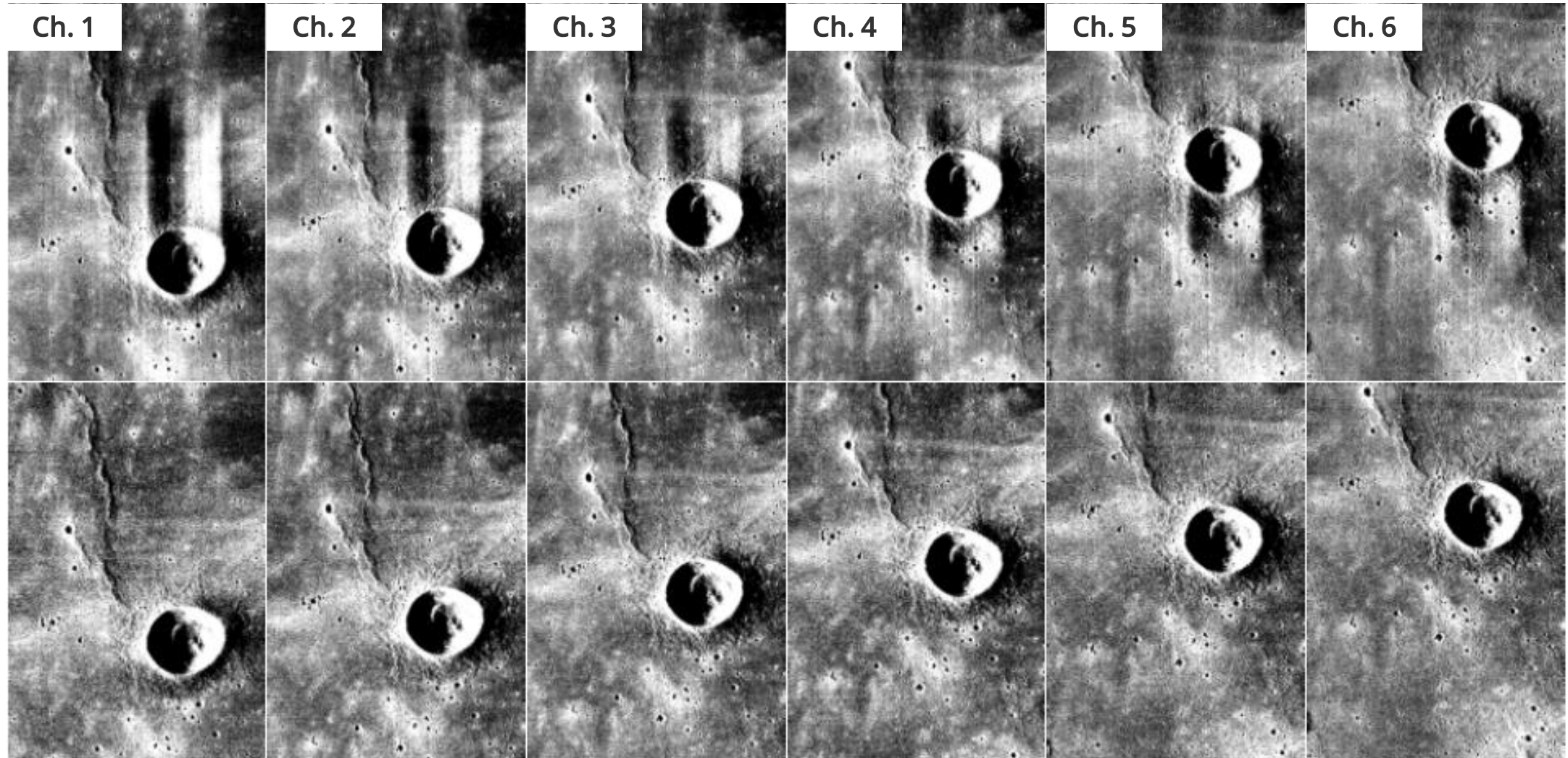
# Instrument Calibration

- ※ Dark Current Removal → Smear Correction → Flat-Fielding (Baek et al., accepted to *PASP*)
- ※ Basic theoretical model for smear correction described in Iglesias et al. (2015) *ApOpt*



# Smear Correction

- Typical case before and after smear correction



# Smear Correction

Stokes  $I$

DoLP

Stokes  $I$

DoLP



- Before smear correction
  - Their feature in polarization were unrecognizable.
  - This data would be practically unusable.
- After smear correction
  - The smear artifacts are effectively mitigated.
  - We can see an inverse relationship between brightness and polarization.

**Curious about our main result, quasi-global polarimetric map?**  
**Join my talk this Friday at 11:12 AM in Room Earth!**

# Summary

- **Geometric Calibration:** Corrected geometric **image distortions**.
- **Instrument Calibration:** Mitigated comprehensive sensor noise, including **smear correction**.
- **Quasi-Global Map:** Generated an **initial lunar polarimetric map**.
- **Limitations:**
  - **Quantitative analysis is restricted** prior to absolute radiance calibration.
  - Current study is limited to **qualitative, localized comparisons** within adjacent regions.
  - 3D georeferencing at 512 PPD is **highly time-consuming** (processed at 128 PPD for rapid verification).
- **Publications with PolCam Data**
  - Baek et al. (2025) *JKAS*: Geometric Calibration
  - Baek et al., accepted to *PASP*: Image Artificial Correction (Instrument Calibration)
  - Shkuratov et al. (2026a,b,c) *Icarus*: Irregular Mare Patches (Ina, Maskelyne, Sosigenes)
  - Farrand et al. in review: A Regional Pyroclastic Deposit in Komarov Crater on the Lunar Farside

# Future Work

- **Absolute Radiance Calibration:** Cross-calibration using LROC WAC off-nadir data.
- **Photometric Calibration:** Applying the Hapke model and empirical phase functions.
- **Validation:** Comparison with fully calibrated data and Earth-based polarimetric data.
- **Software Porting:** Pipeline migration (IDL/Python to C++) for speed and USGS ISIS3 compatibility.
- **Parallel Computing:** Cluster server-based acceleration for 512 PPD data processing.
- **Seeking Postdoc Opportunities**
  - Available from Mar. 2027 (Expect Ph.D. in Feb., 2027).
  - Open to postdoc positions in the Europe and US.
  - Contact: [kilho.baek@gmail.com](mailto:kilho.baek@gmail.com) (or [kilho.baek@khu.ac.kr](mailto:kilho.baek@khu.ac.kr))

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## Thank you for listening!