

# Evaluation moderner Wetterradersysteme mittels Zielgeneratoren

M. Schneebeli<sup>1</sup>, A. Leuenberger<sup>1</sup>, D. Schvartzman<sup>2</sup>, B. Cheong<sup>2</sup>, F. Juynent<sup>3</sup>, J. George<sup>3</sup>, V. Chandrasekar<sup>3</sup>, H. Corden<sup>4</sup>, J. Grazioli<sup>4</sup>, A. Berne<sup>4</sup>, S. Kranz<sup>5</sup>, T. Pittorino<sup>5</sup>

<sup>1</sup>Palindrome Remote Sensing GmbH, Landquart, Switzerland

<sup>2</sup>Advanced Radar Research Center, University of Oklahoma, Norman, US

<sup>3</sup>Colorado State University, Fort Collins, US

<sup>4</sup>École Polytechnique Fédérale de Lausanne (EPFL), Lausanne, Switzerland

<sup>5</sup>FH OST, ESA Institut für Elektronik, Sensorik und Aktorik, Buchs, Switzerland

Technologietag OST

11. Juni 2024

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# Radar

RADAR → **RA**dio **D**etection **A**nd **R**anging



# Radar

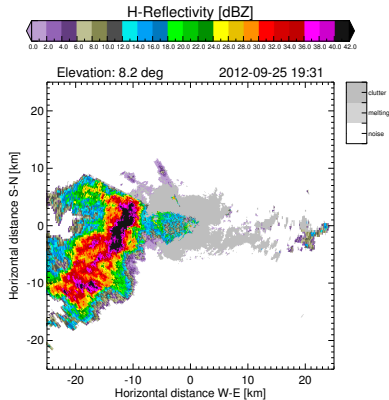
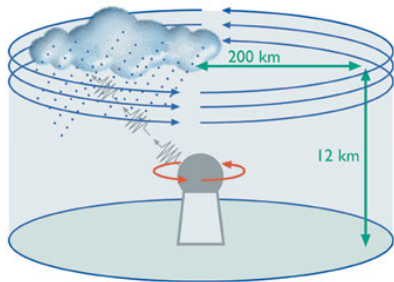
RADAR → **RA**dio **D**etection **A**nd **R**anging

# Radar

RADAR → **RA**dio **D**etection **A**nd **R**anging



# Wetterradar



# Wetterradare in der Schweiz

## Weissfluhgipfel



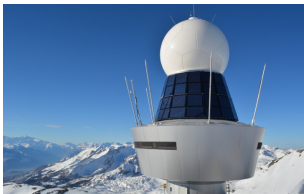
## Albis



## Monte Lema



## Plaine morte



## La Dôle

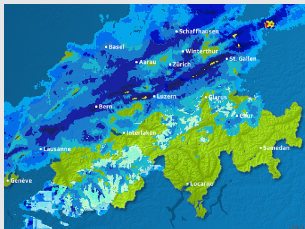


## Übersicht

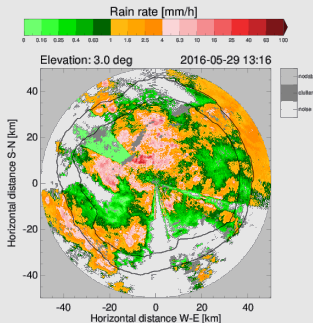


# Bilder vs. Daten

## Unkalibriert: Bilder



## Kalibriert: Daten!



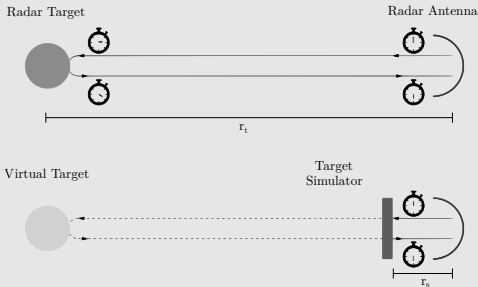
- ▶ Physik
- ▶ Vorhersagen
- ▶ Datenfusion
- ▶ Assimilation
- ▶ Vergleiche

Heutige datengetriebene Wetterapplikationen verlangen genaueste Radardaten!

# Ich sehe was, was du nicht siehst...

## Virtuelles Radarziel

## Prinzip



- ▶ CHILL X-band radar, Colorado





# Palindrome Zielgenerator



## Klein

Halbe Rackbreite  
1U Höhe  
1 kg

## 2-12 GHz

100 MHz Bandbreite  
Kalibrierte Amplituden  
Polarimetrisch

## Sparsam

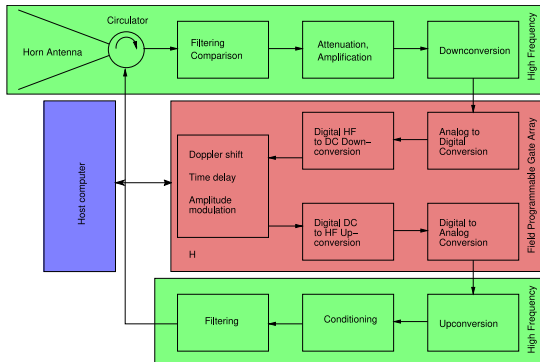
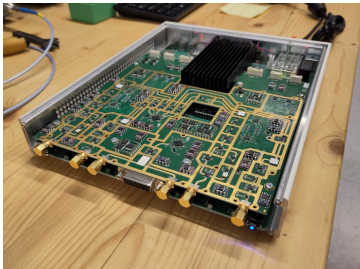
100 W

## SDR basiert

Flexibel konfigurierbar



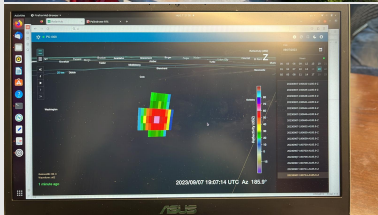
# Unter der Haube



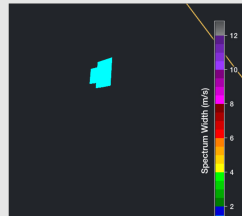
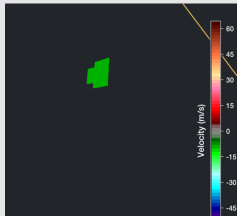
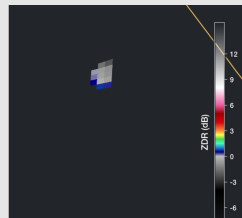
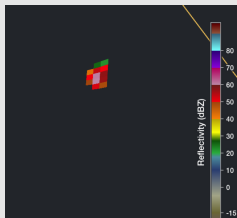
- ▶ Kohärenter Zweikanal Transceiver
- ▶ Integrierte Phasen- und Amplitudenkalibration
- ▶ Hohe Dynamik durch drei separate Empfangspfade

# Advanced Radar Research Center, Norman, US

## Setup



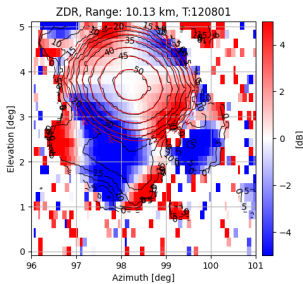
## Resultate in Echtzeit



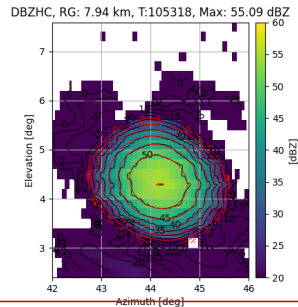
# EPFL Solid State X-band Radar



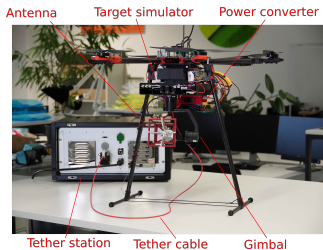
Polaritätsdifferenz



Reflektivität



# Zielgenerator auf Drohne



## Eigenschaften

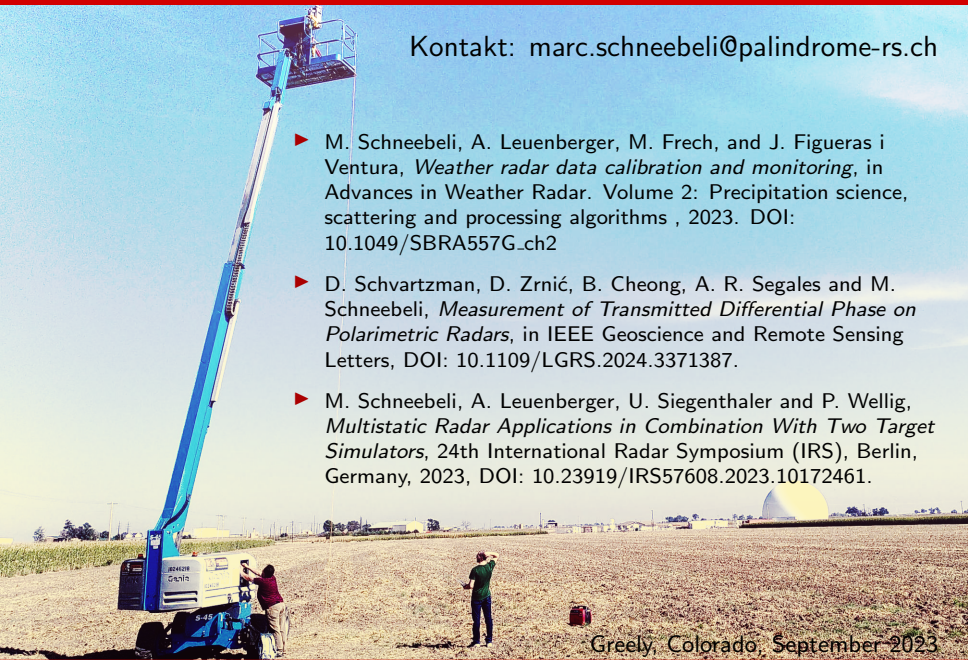
- ▶ Unlimitierte Flugzeit
- ▶ Unlimitierte und schnelle Datenverbindung zum Boden
- ▶ 80 m Flughöhe
- ▶ Jungfernflug am letzten Freitag

## Erweiterte Messmöglichkeiten

- ▶ Antennenmessungen (Fernfeld, polarimetrisch)
- ▶ Komplexe bewegliche Ziele
- ▶ Keine Bodenreflektionen
- ▶ Langzeitmessungen

Kontakt: [marc.schneebeli@palindrome-rs.ch](mailto:marc.schneebeli@palindrome-rs.ch)

- ▶ M. Schneebeli, A. Leuenberger, M. Frech, and J. Figueras i Ventura, *Weather radar data calibration and monitoring*, in *Advances in Weather Radar. Volume 2: Precipitation science, scattering and processing algorithms*, 2023. DOI: 10.1049/SBRA557G\_ch2
- ▶ D. Schwartzman, D. Zrnić, B. Cheong, A. R. Segales and M. Schneebeli, *Measurement of Transmitted Differential Phase on Polarimetric Radars*, in *IEEE Geoscience and Remote Sensing Letters*, DOI: 10.1109/LGRS.2024.3371387.
- ▶ M. Schneebeli, A. Leuenberger, U. Siegenthaler and P. Wellig, *Multistatic Radar Applications in Combination With Two Target Simulators*, 24th International Radar Symposium (IRS), Berlin, Germany, 2023, DOI: 10.23919/IRS57608.2023.10172461.



Greely, Colorado, September 2023