JAIN UNIVERSITY
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Centre for Emerging Technologies ™

SSTDM 2014
International workshop on Small Satellite and Sensor Technology for Disaster Management

L-BAND ICE-PENETRATING RADAR ON BOARD A SMALL SATELLITE

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OUTLINE

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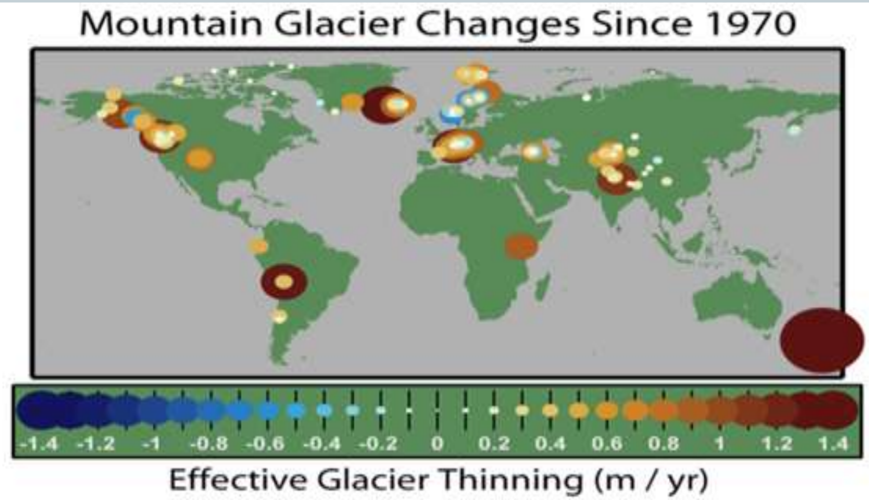
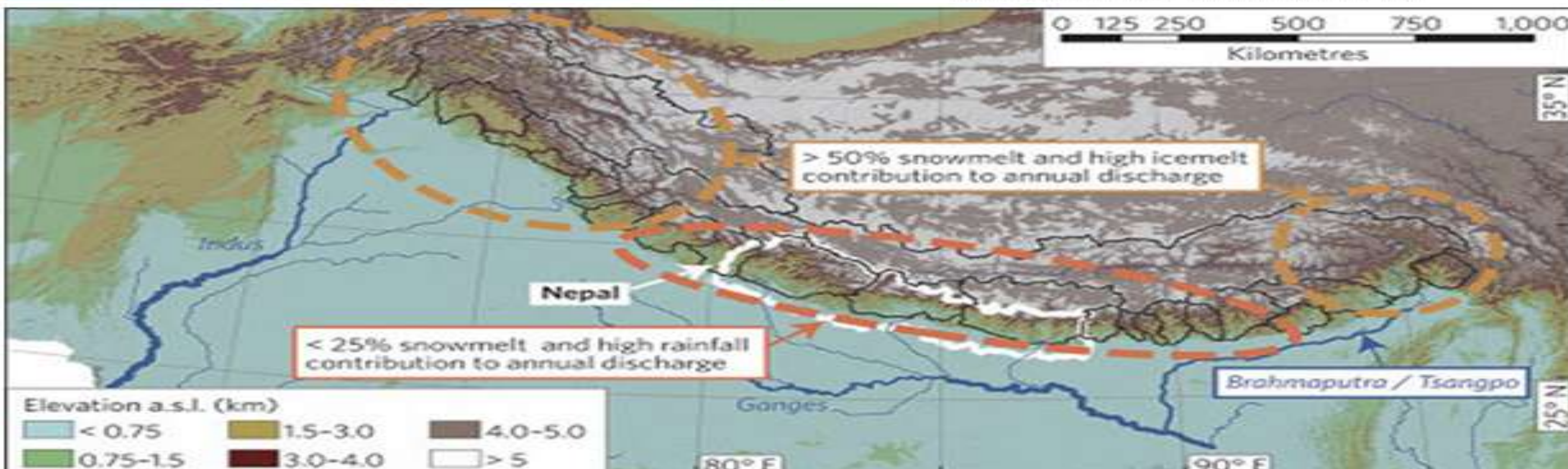
- **ABSTRACT**
- INTRODUCTION
- INSTRUMENT CONFIGURATION
- BLOCK DIAGRAM
- DESCRIPTIVES
- IMPLEMENTATION SPECS
- CONCLUSION
  - TIMELINE / REVIEWS

ABSTRACT

- Payload instrument, viz., an L-band ice-penetrating radar on board a small satellite system.
- The application focus is on monitoring snow/ice extent and detecting melting phase globally and over the Himalayas, in particular.
- The microwave radar has unique capability to penetrate ice/snow and has shown its capability at RF frequencies.
- It has a strong merit to contribute in monitoring water and mass balance in the Himalayan region.

PROJECT FOCUS





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INTRODUCTION

- Climate Change
  - Remote Sensing Sensors
  - Space Missions
- The scientific results have focused on understanding and quantifying such phenomena like:
  - global warming
  - sea-level rise
  - global water and mass balance
  - occurrences of El Nino and La Nina events

- & relating them to natural disasters such as cyclones, flash floods, droughts, tsunamis…

INTRODUCTION

- Results and conclusions were discussed among a number of agencies around the world.

- No reliable data in terms of both quality and quantity, thus leading to fierce debates and contradictions on the results reported.

- It is therefore of paramount importance to design appropriate remote sensing instruments, use them on suitable platforms and apply and use the data along with complementary in situ data for establishing an operational configuration.

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INSTRUMENT CONFIGURATION

- The proposed radar instrument is Unfocused/Focussed Synthetic-Aperture Radar (SAR)
  - capable of operating from
    - ground-based mobile platforms
    - aircraft and spacecraft

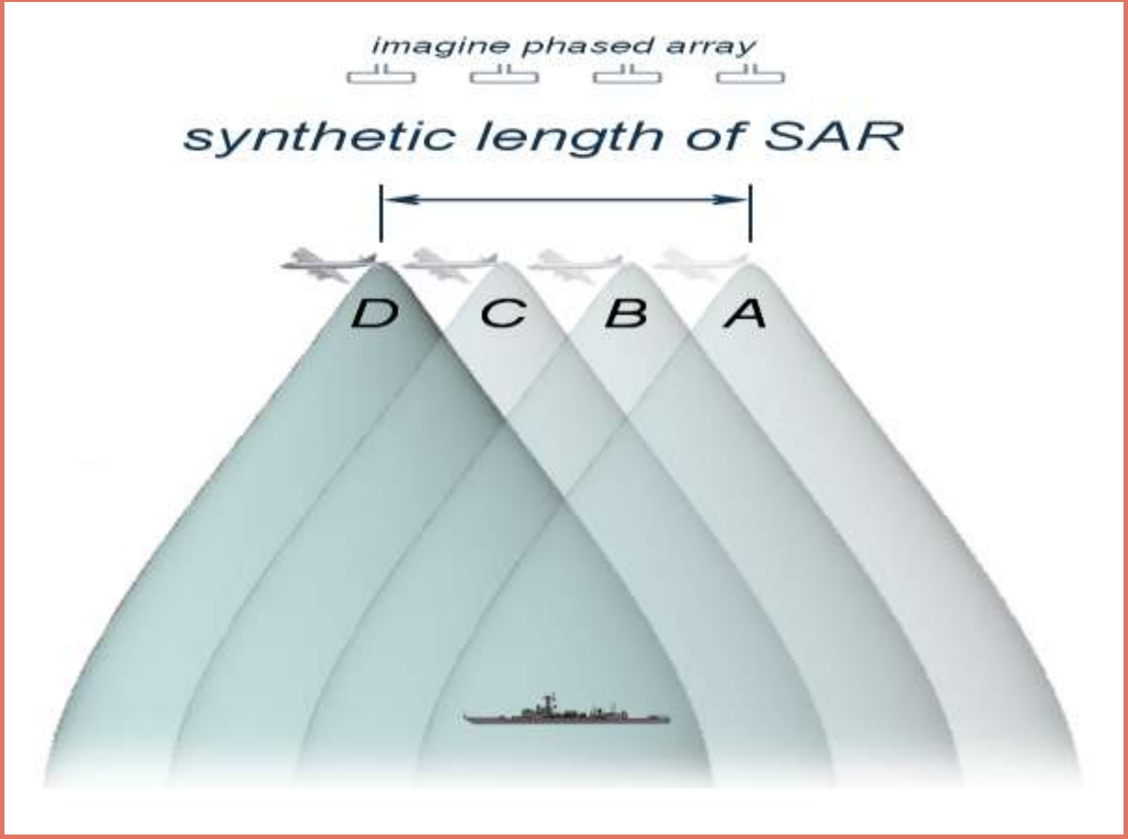
  - with appropriate modifications in the power transmitted, pulse repetition frequency, antenna configuration and signal processing.

INSTRUMENT CONFIGURATION

- SYNTHETIC-APERTURE RADAR (SAR)
  - Mostly Airborne or Space-borne Radar system which utilizes the flight path of the platform to simulate electronically, an extremely huge antenna, generating high resolution remote sensing imagery.
    - The individual receive/transmit cycles are completed and the data observed over each individual cycle is stored electronically.
    - For the signal processing, phase and the magnitude of the received signals over successive pulses from elements of the synthetic aperture.
    - After a particular number of cycles, the stored data is combined to generate a high resolution image of the region scanned over.

INSTRUMENT CONFIGURATION

- SYNTHETIC-APERTURE RADAR (SAR)



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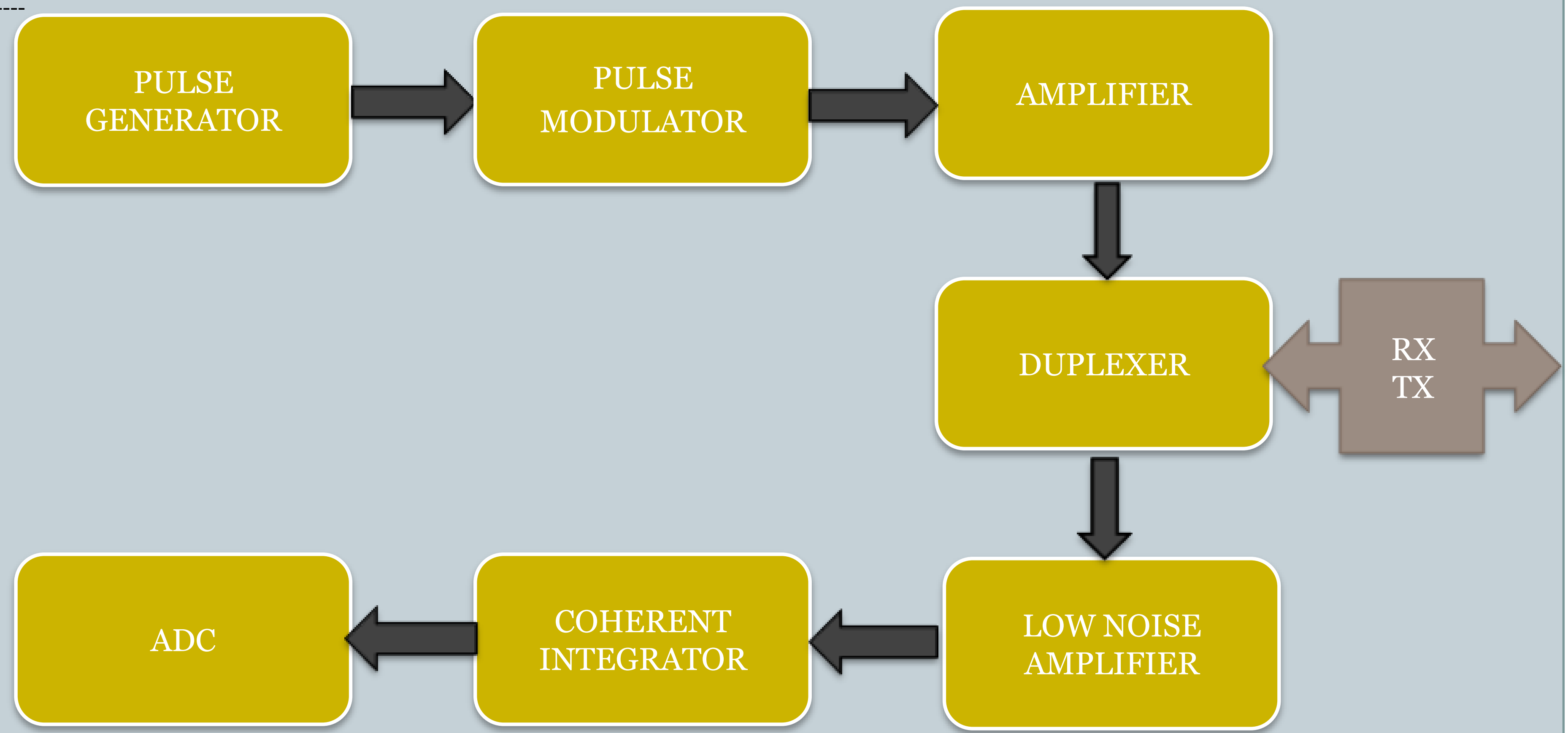
BLOCK DIAGRAM



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DESCRIPTIVES

- PULSE GENERATOR

  Continuous wave, RF Source

- PULSE MODULATOR

  Linear FM Chirp System

- AMPLIFIER

  Power Amplifier

- DUPLEXER
- LOW NOISE AMPLIFIER
- COHERENT INTEGRATOR
- ANALOG TO DIGITAL CONVERTER

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IMPLEMENTATION SPECS

AIRBORNE Version

Transmitter-Receiver: Pulsed chirp radar configuration

DC Power: 5 to 10 W

RF Pulse power: 10 W peak (TBC)

Pulse width: 60 ns

Depth Resolution: < 3 m (goal)

Antenna: Linear Micro-strip patch array (Goal to design a phased array for electronic steering for better area coverage)

Swath: (Instantaneous) 200 – 400 m (Unfocused); switchable with phased array antenna for more coverage up to 2 km to 4 km.

Depth of sensing: 100 m nominal

IMPLEMENTATION SPECS

SMALLSAT Version

Transmitter-Receiver: Pulsed chirp radar configuration

DC Power: 5 to 10 W

RF Pulse power: 30 W peak (TBC)

Pulse width: 60 ns

Depth Resolution: < 3 m (goal)

Antenna: Linear Micro-strip patch array (Goal to design a phased array for electronic steering for better area coverage)

Swath: (Instantaneous) 200 – 400 m (Unfocused); switchable with phased array antenna for more coverage up to 2 km to 4 km.

Depth of sensing: 100 m nominal

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TIMELINE

MONTHS	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
FEASIBILITY STUDY																				
DESIGN																				
REALIZATION																				
TESTING																				
FIELD OPERATIONS																				

REVIEWS

Internal Reviews:	Weekly to Monthly – as per requirements
External Reviews with experts:	Quarterly / Completion of milestone

Project Structure: (Students)

Project Manager:	One main + One back-up
Engineers:	4 (Antenna, Tx., Rx. and Processing)
Integration:	All
Testing:	All
Field Operations:	All + External support
Data Analysis:	Two: (One Applications Scientist)

Principal Investigator:	Assistant Professor (RF/Microwave design, implementation)
Advisor:	Senior Professor (schedule, progress review, budget)
Overall	Director: SET, Jain University, Bangalore.

BUDGET

- Currently working on the component-pricing part of the project.
- Waiting for the lowest-quotation from the Vendors.
- Estimates are mentioned in the paper submitted.

REFERENCES

- Y. K. Chan and S. Y. Lim; "Design and Development of a Low Cost Chirp Generator for Airborne Synthetic Aperture Radar“
- Sun-Ryoul Kim, Hyuk Ryu, Keum-Won Ha, Jeong-Geun Kim and Donghyun Baek; "20 MHz-3 GHz Programmable Chirp Spread Spectrum Generatorfor a Wideband Radio Jamming Application"
- M. P. Vasudha, School of Engineering and Technology, Jain University; “A low-earth orbit satellite with microwave sensors in snow-ice studies over himalayas as inputs for disaster monitoring”
- http://www.himalaya2000.com/himalayan-facts/himalayan-glaciers.html
- http://www.npr.org/2012/04/24/151206843/melt-or-grow-fate-of-himalayan-glaciers-unknown.
- http://en.wikipedia.org/wiki/Retreat_of_glaciers_since_1850.

Thank You