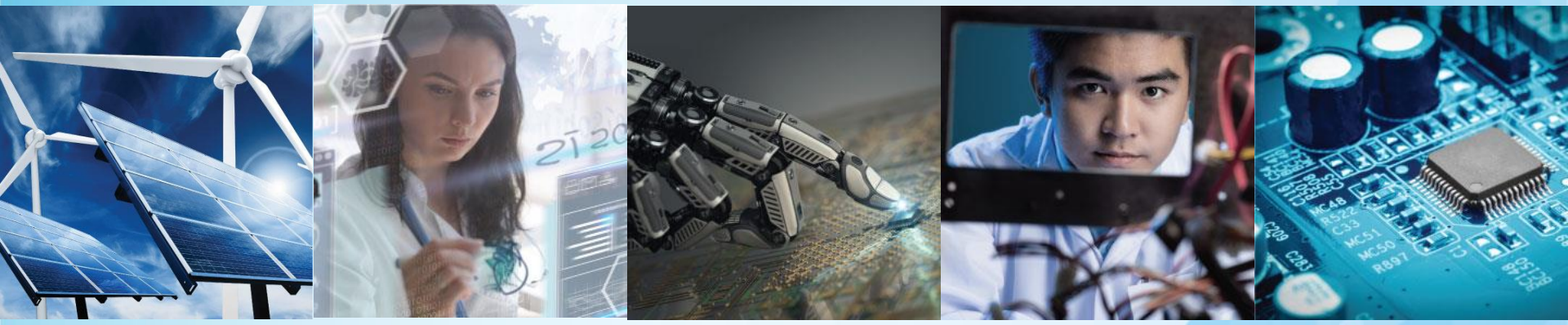


IEEE AP-S/MTT-S Egypt Section Chapter

RFID Systems and Applications

Prof. Atef Z. Elsherbeni

IEEE Fellow (2007) - ACES Fellow (2008)

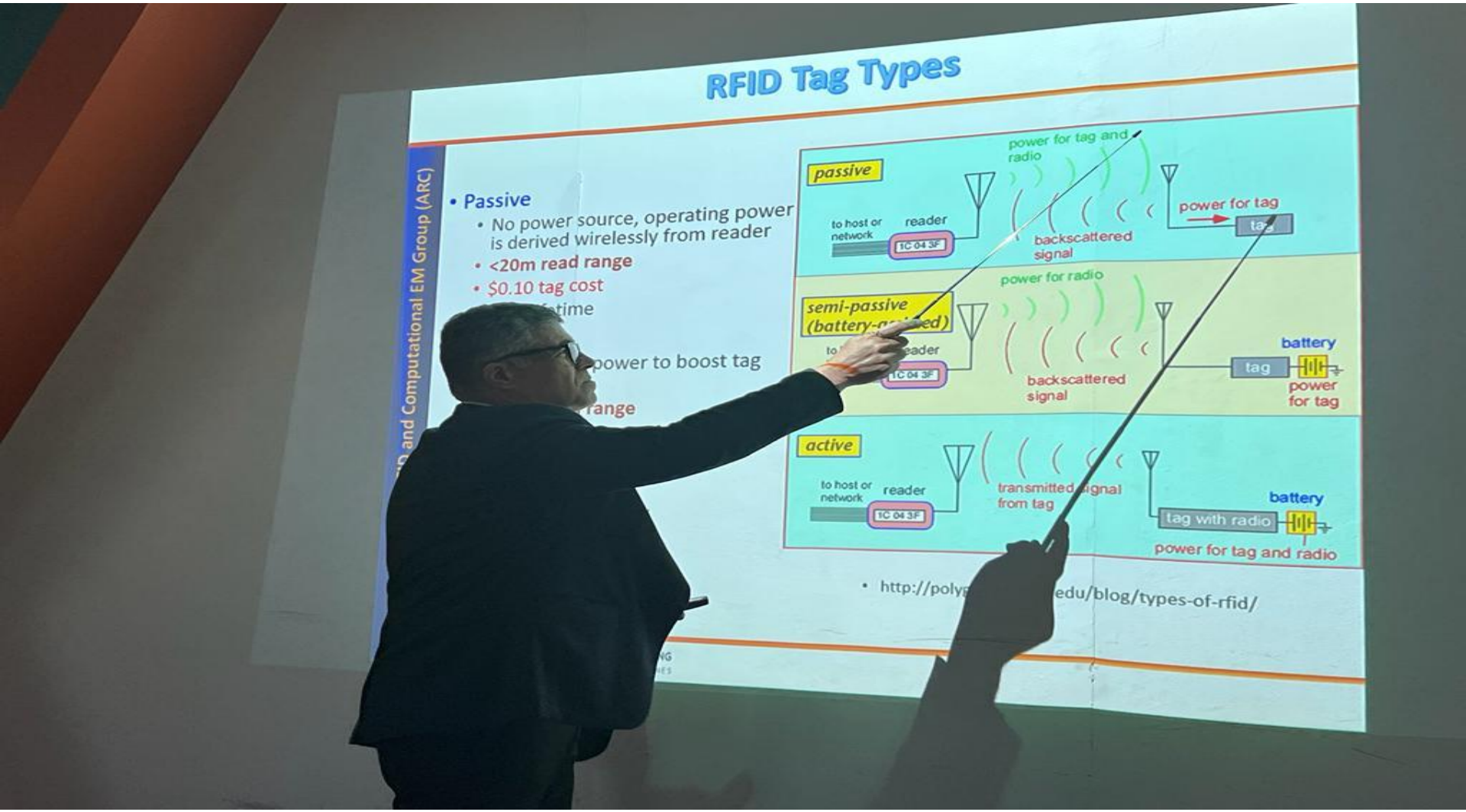
IEEE APS Distinguished Lecturer (2020-2023)

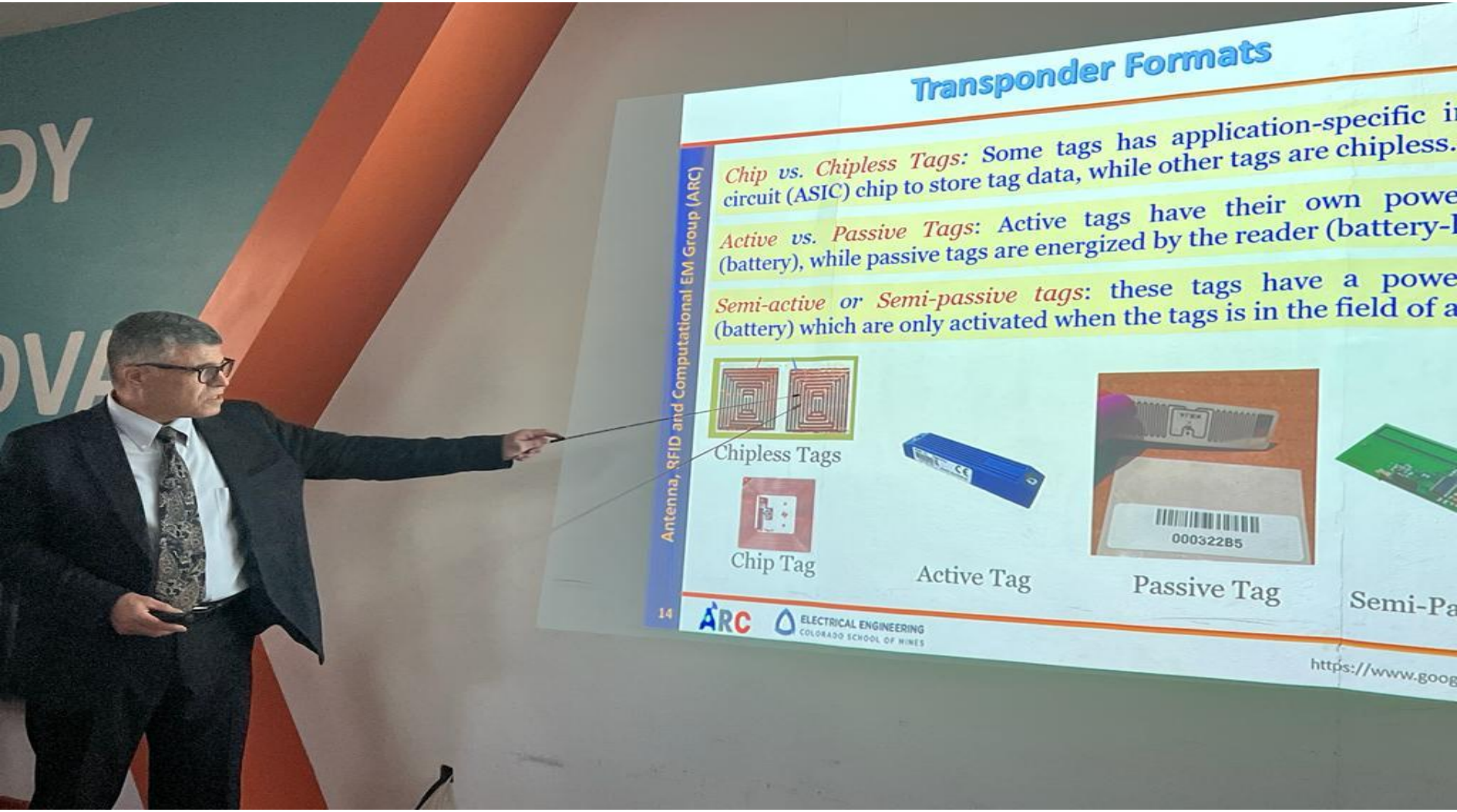
Electrical Engineering Department, Colorado School of Mines

Date: 1 Dec 2022 | Time: 11:00 AM to 01:00 PM

Agenda

- Introduction
- RFID Technologies
- UHF RFID Systems and Operation
- New Designs of UHF RFID Reader Antennas
- UHF RFID Applications
- Discussion and questions.


RFID Tag Types
and Computational EM Group (ARC)
• Passive
• No power source, operating power is derived wirelessly from reader
• <20m read range
• $0.10 tag cost
power to boost tag
range
passive
power for tag and radio
to host or network
reader
1C 04 3F
backscattered signal
power for tag
tag
semi-passive
power for radio
battery
tag
backscattered signal
power for tag
active
to host or network
reader
1C 04 3F
transmitted signal from tag
battery
tag with radio
power for tag and radio
edu/blog/types-of-rfid/


Transponder Formats
Chip vs. Chipless Tags: Some tags has application-specific i
circuit (ASIC) chip to store tag data, while other tags are chipless.
Active vs. Passive Tags: Active tags have their own powe
(battery), while passive tags are energized by the reader (battery-
Semi-active or Semi-passive tags: these tags have a powe
(battery) which are only activated when the tags is in the field of a
Antenna, RFID and Computational EM Group (ARC)
Chipless Tags
Chip Tag
Active Tag
Passive Tag
00032285
Semi-Pa
14
ARC
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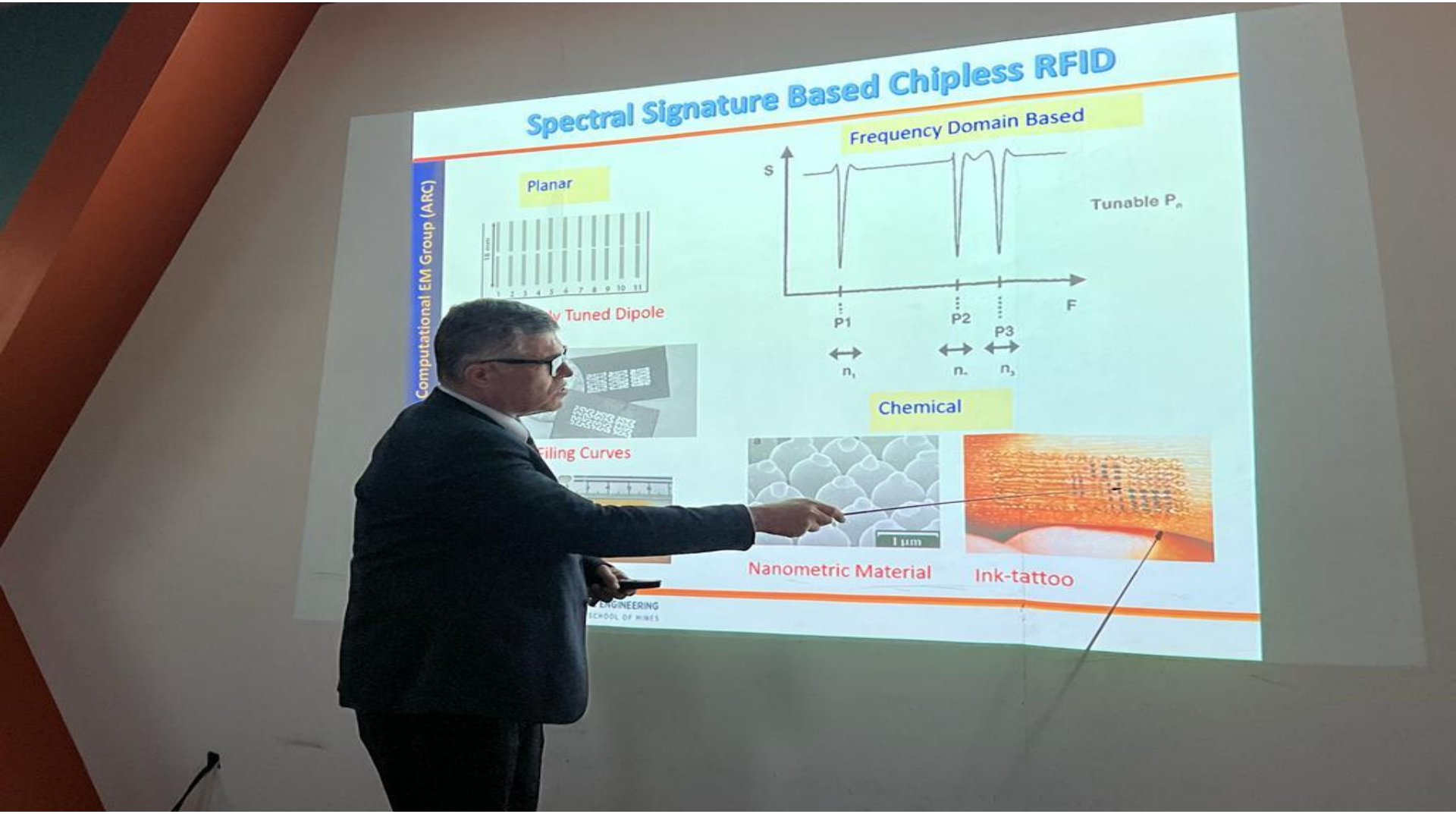
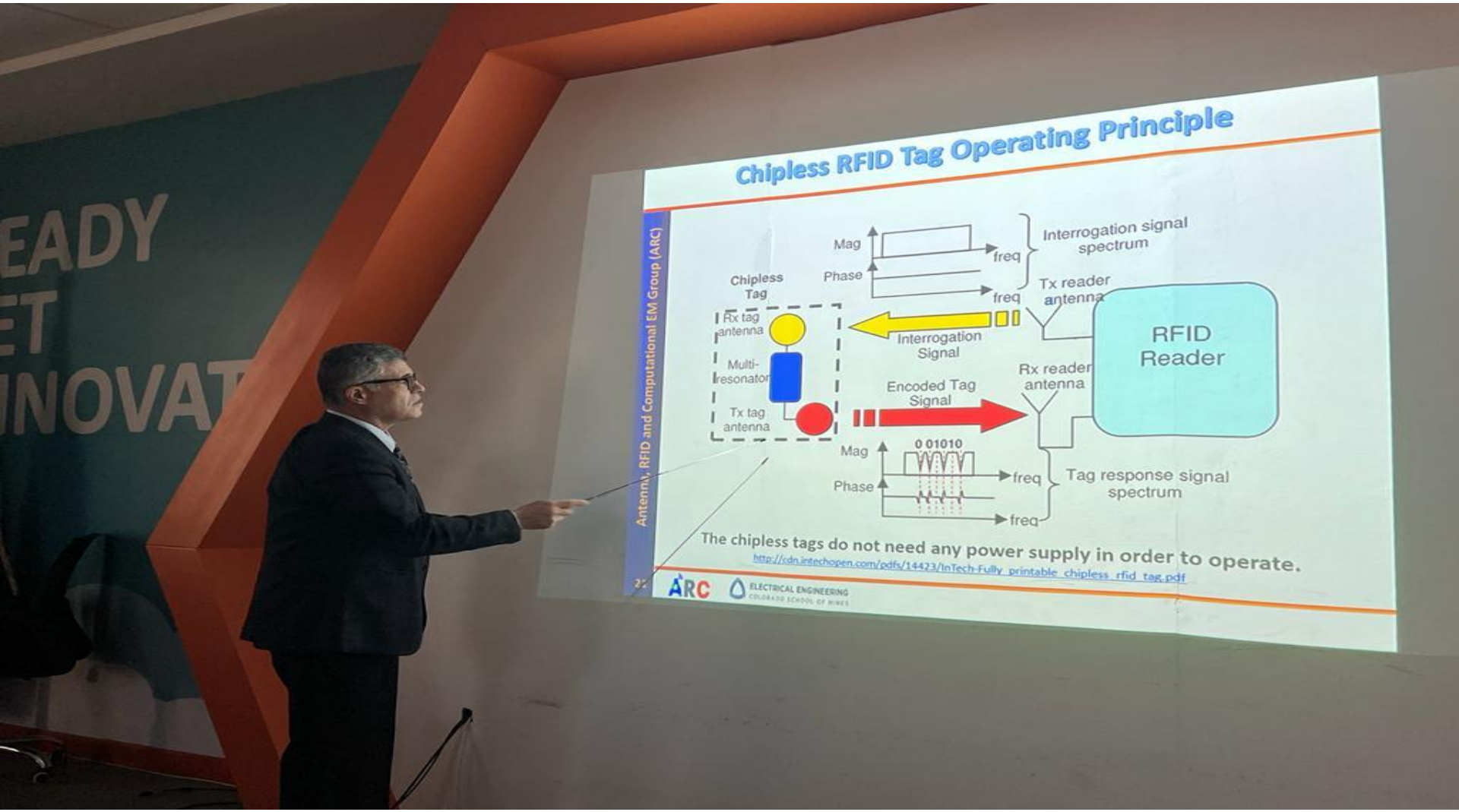
https://www.goog


Spectral Signature Based Chipless RFID
Computational EM Group (ARC)
Planar
Tuned Dipole
Filing Curves
Frequency Domain Based
S
F
P1
P2
P3
Tunable P
Chemical
Nanometric Material
Ink-tattoo


Chipless RFID Tag Operating Principle
Antenna, RFID and Computational EM Group (ARC)
Mag
Phase
freq
freq
Interrogation signal spectrum
Chipless Tag
Rx tag antenna
Multi-resonator
Tx tag antenna
Tx reader antenna
Interrogation Signal
RFID Reader
Rx reader antenna
Encoded Tag Signal
0 01010
Mag
Phase
freq
freq
Tag response signal spectrum
The chipless tags do not need any power supply in order to operate.
http://cdn.intechopen.com/pdfs/14423/InTech-Fully_printable_chipless_rfid_tag.pdf
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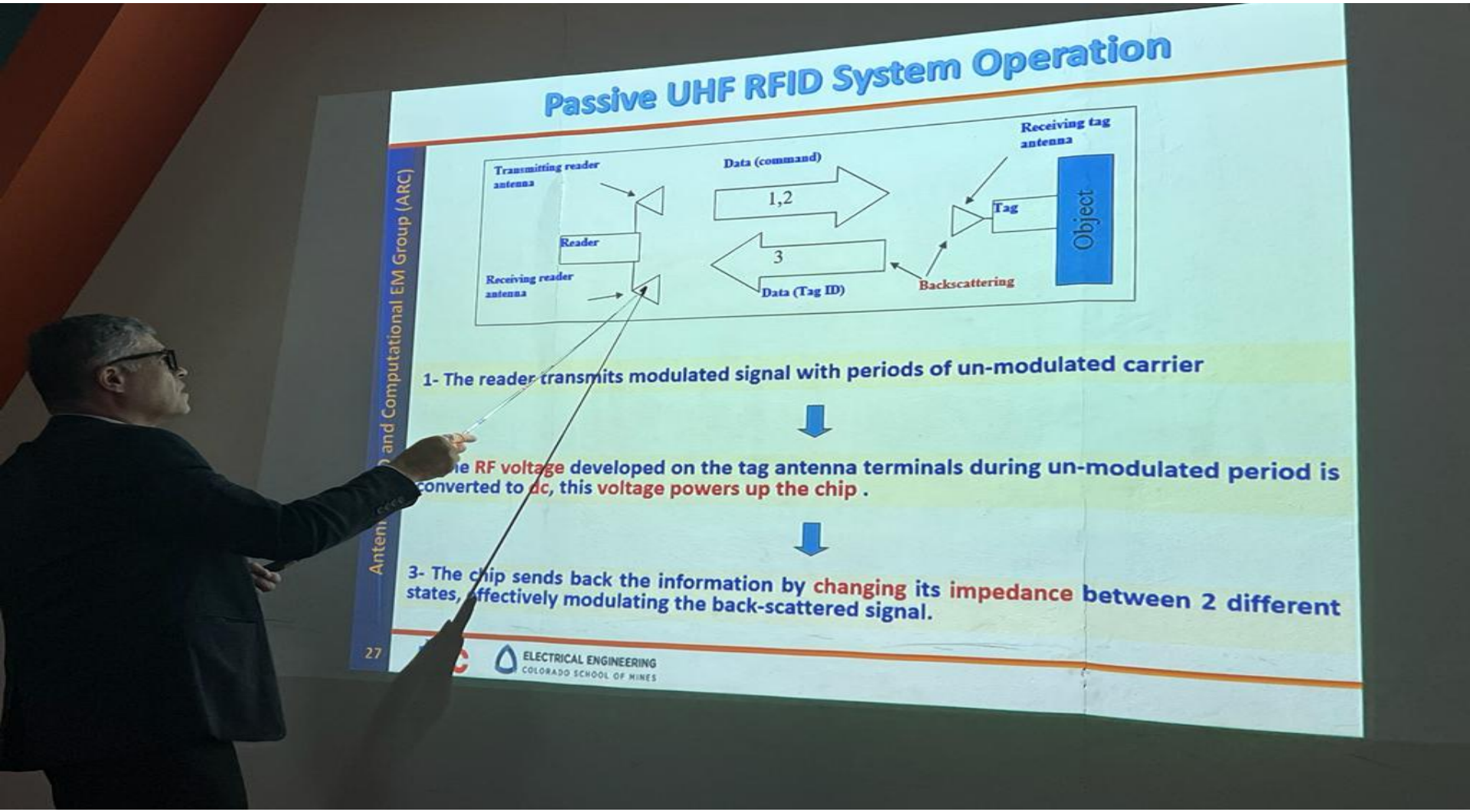
Passive UHF RFID System Operation
Transmitting reader antenna
Data (command)
1,2
Receiving tag antenna
Tag
Object
Reader
3
Receiving reader antenna
Data (Tag ID)
Backscattering
1- The reader transmits modulated signal with periods of un-modulated carrier
RF voltage developed on the tag antenna terminals during un-modulated period is converted to dc, this voltage powers up the chip .
3- The chip sends back the information by changing its impedance between 2 different states, effectively modulating the back-scattered signal.
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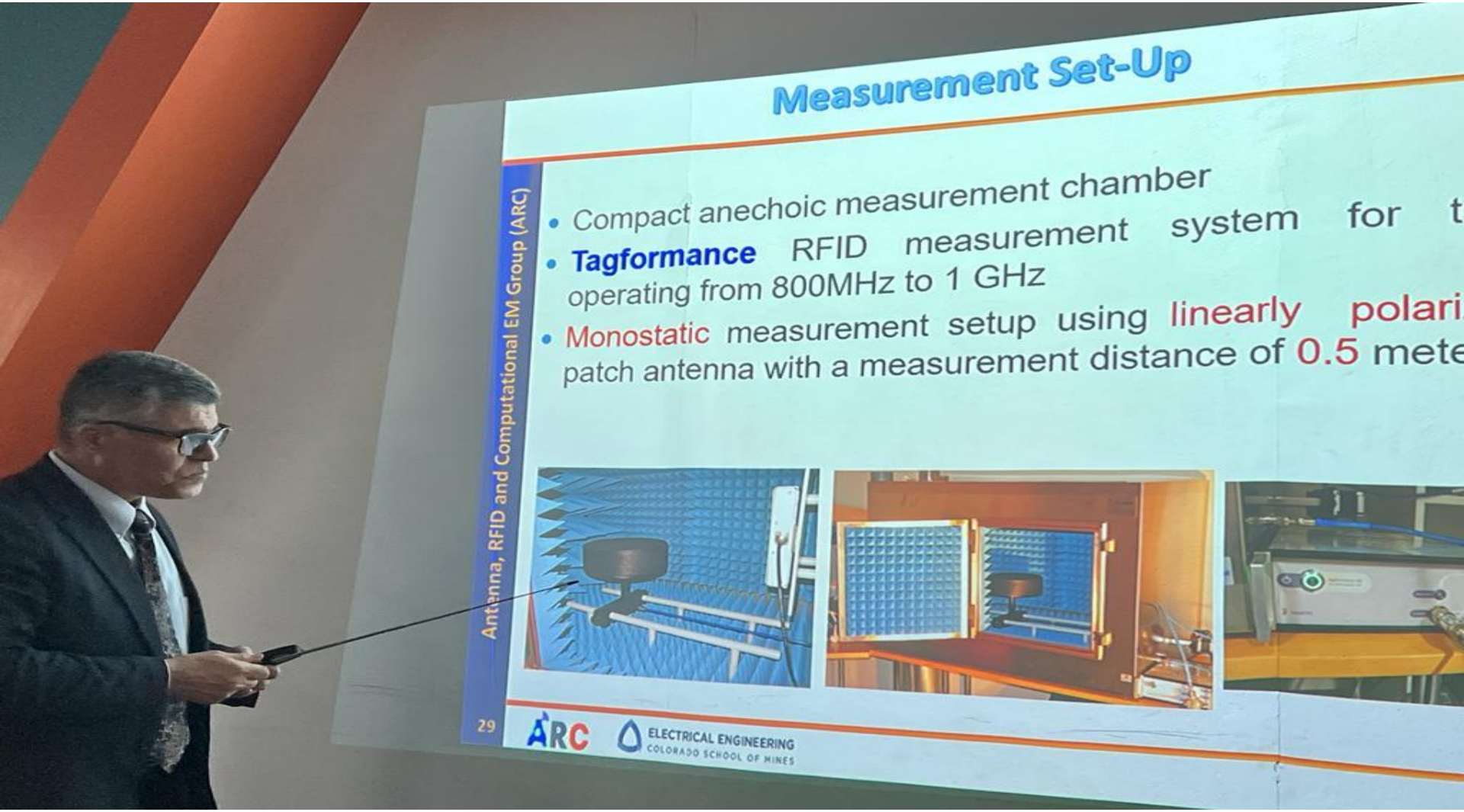
and Computational EM Group (ARC)


Measurement Set-Up
Compact anechoic measurement chamber
Tagformance RFID measurement system for t
operating from 800MHz to 1 GHz
Monostatic measurement setup using linearly polari
patch antenna with a measurement distance of 0.5 mete
Antenna, RFID and Computational EM Group (ARC)
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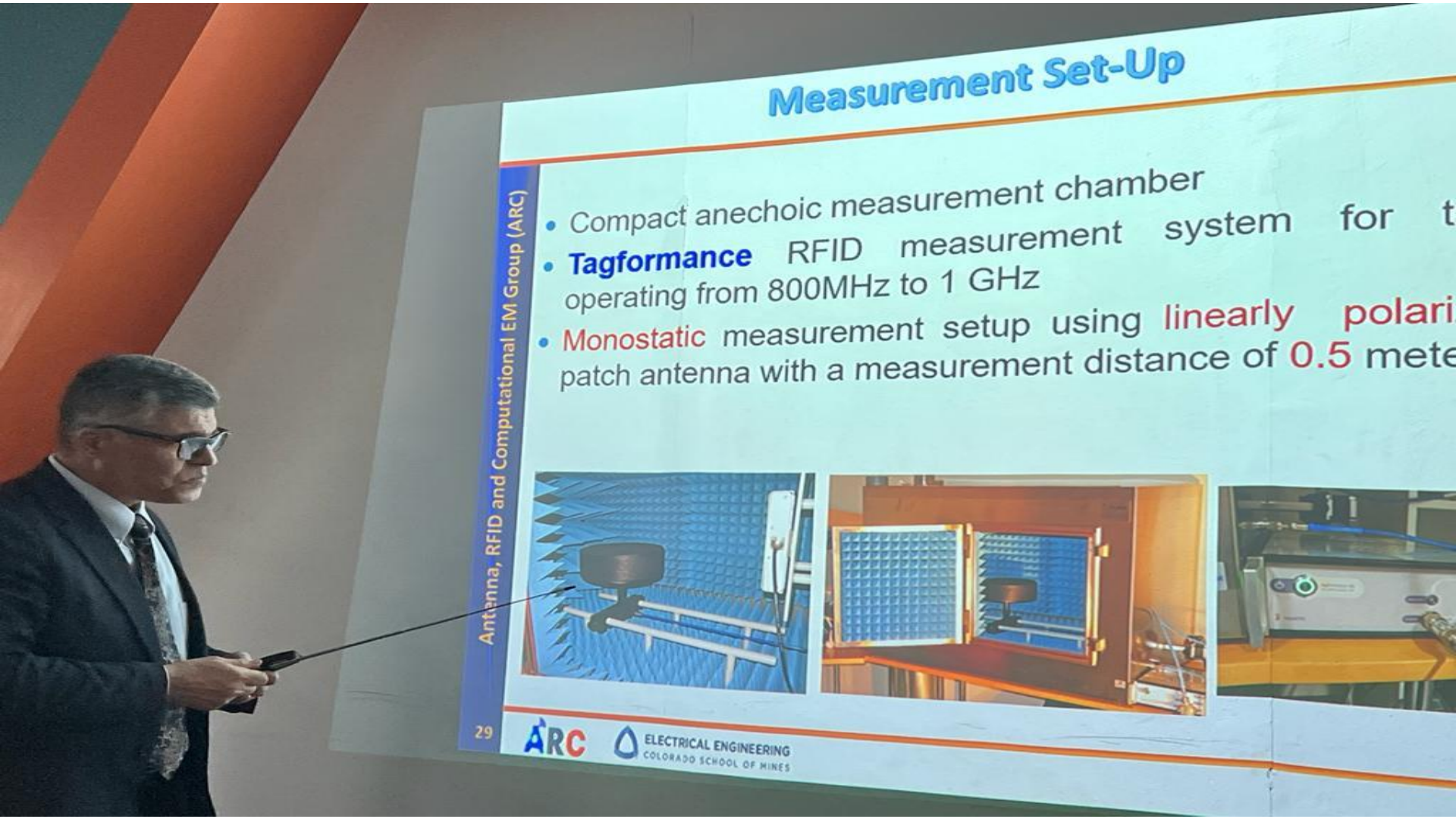
Measurement Set-Up
Antenna, RFID and Computational EM Group (ARC)
• Compact anechoic measurement chamber
• Tagformance RFID measurement system for t
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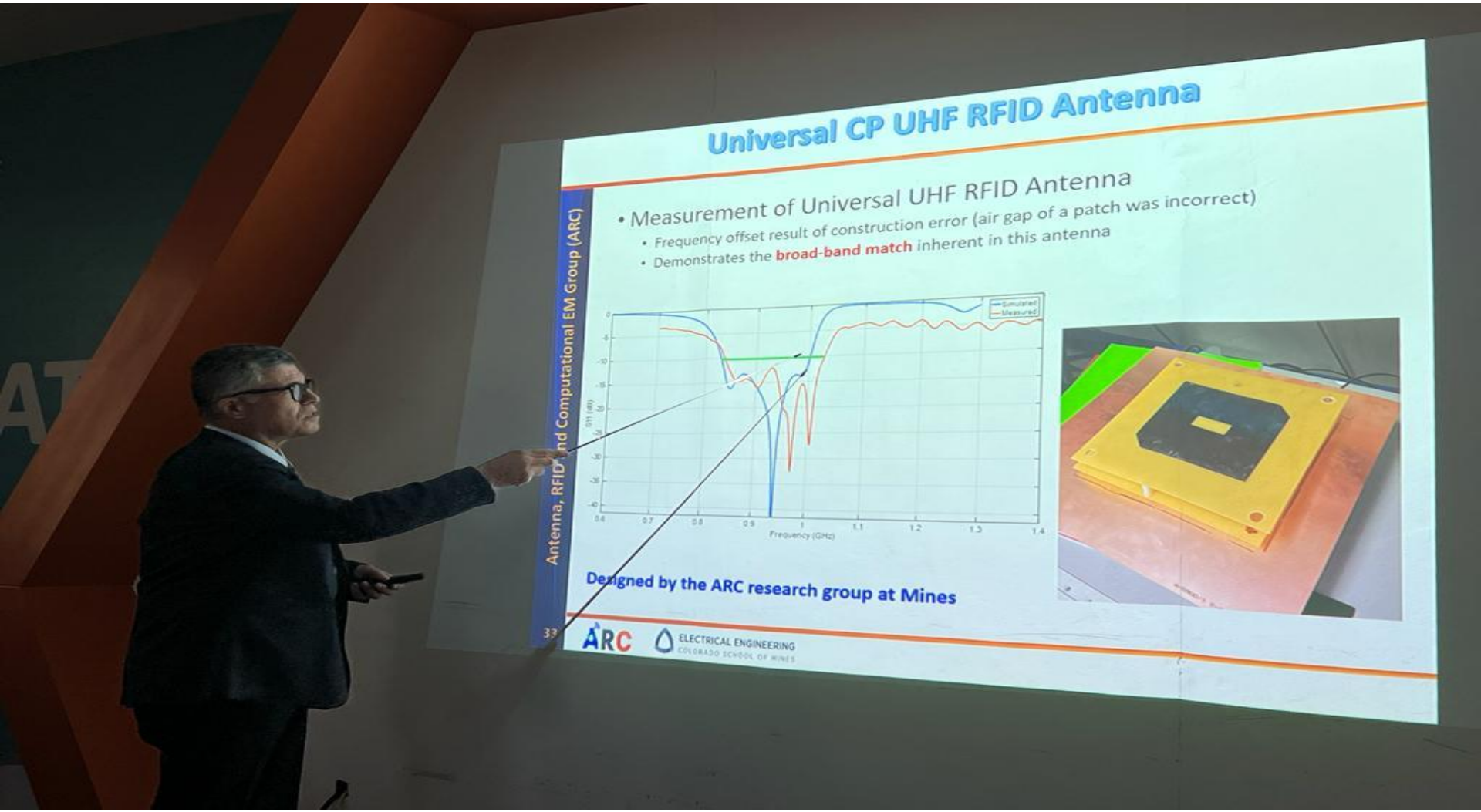
Universal CP UHF RFID Antenna
Measurement of Universal UHF RFID Antenna
Frequency offset result of construction error (air gap of a patch was incorrect)
Demonstrates the broad-band match inherent in this antenna
Frequency (GHz)
Designed by the ARC research group at Mines
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Antenna, RFID and Computational EM Group (ARC)
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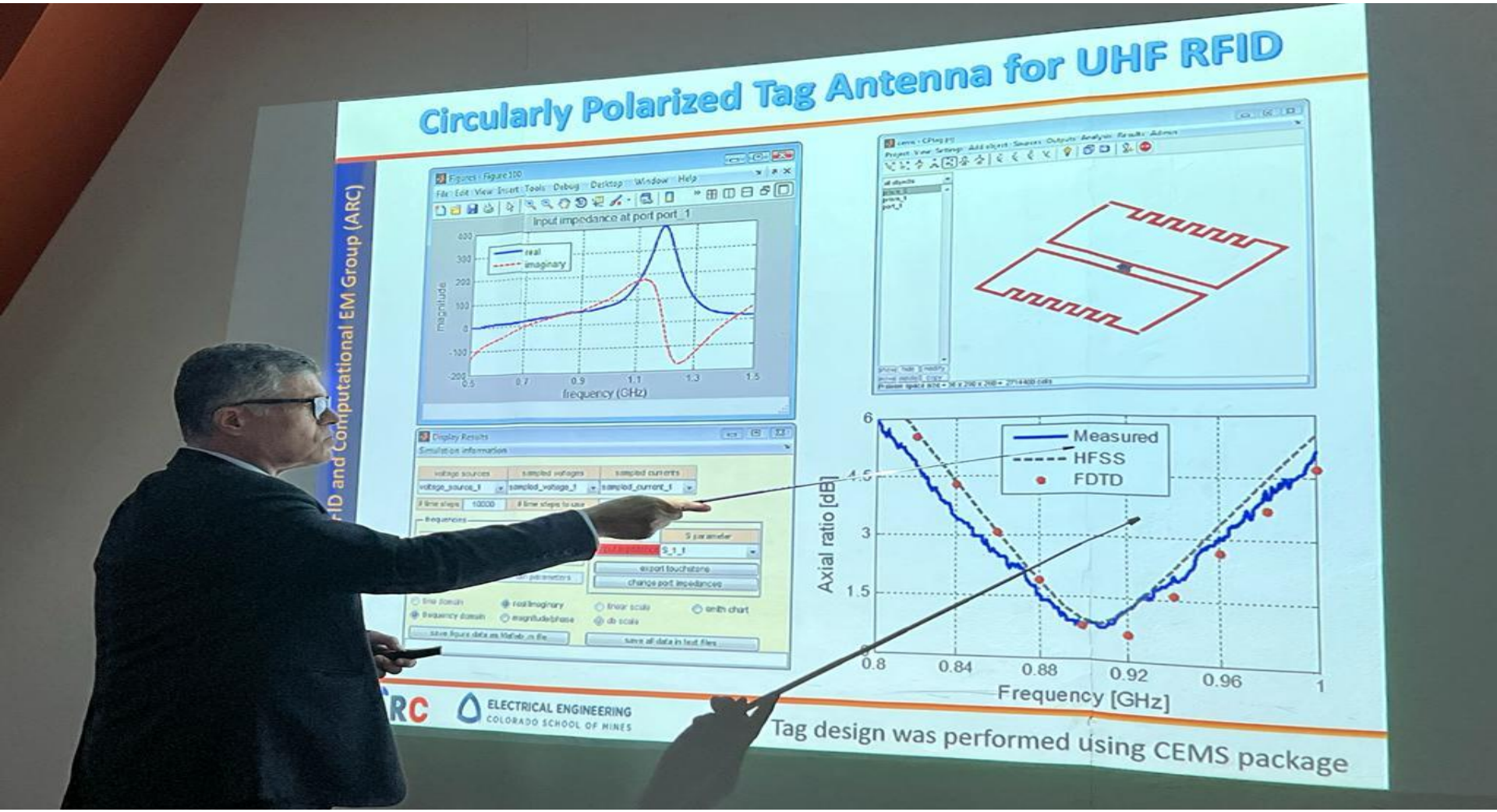
Circularly Polarized Tag Antenna for UHF RFID
ID and Computational EM Group (ARC)
Input impedance at port port_1
real
imaginary
magnitude
frequency (GHz)
Measured
HFSS
FDTD
Axial ratio [dB]
Frequency [GHz]
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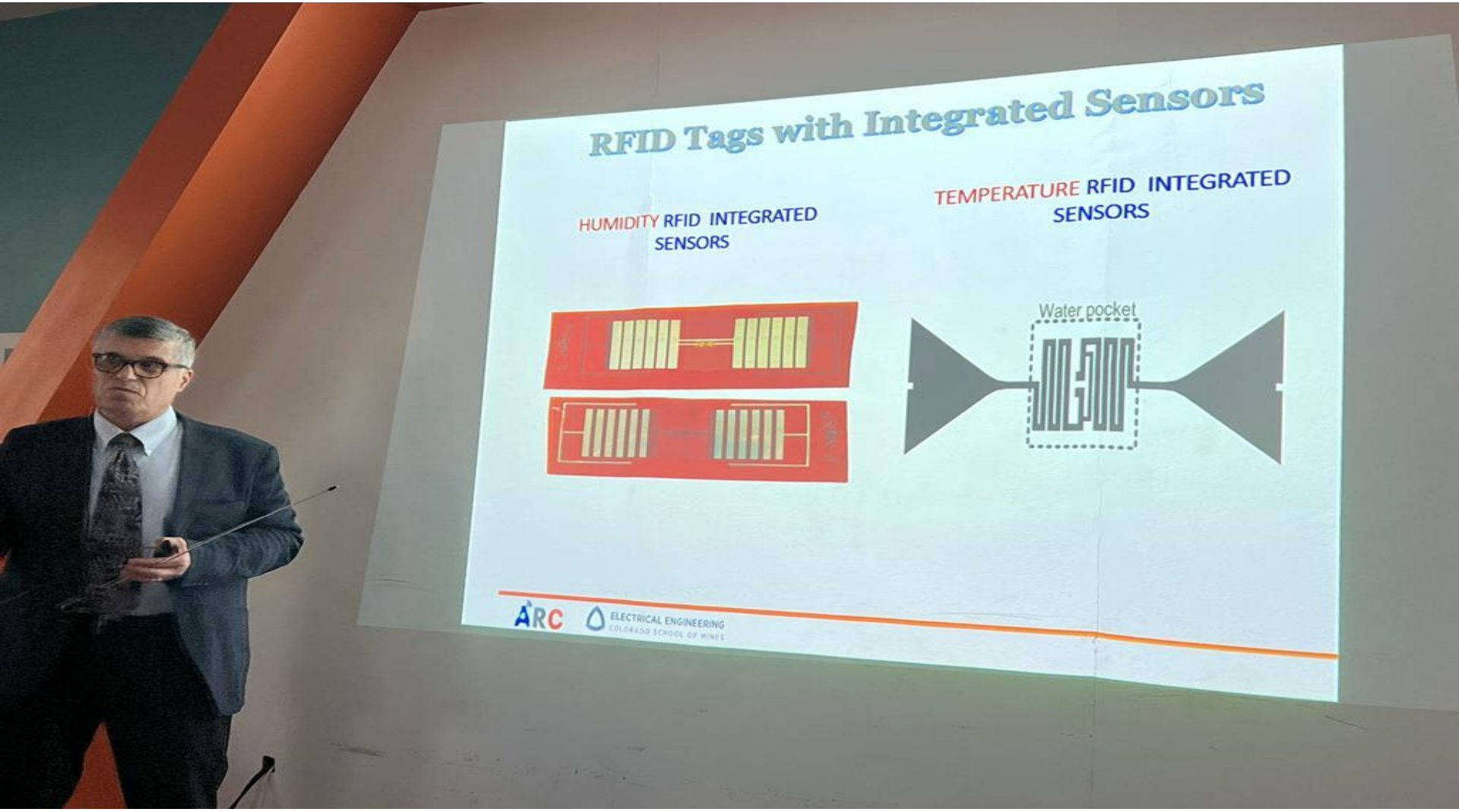
Tag design was performed using CEMS package


RFID Tags with Integrated Sensors
HUMIDITY RFID INTEGRATED SENSORS
TEMPERATURE RFID INTEGRATED SENSORS
Water pocket
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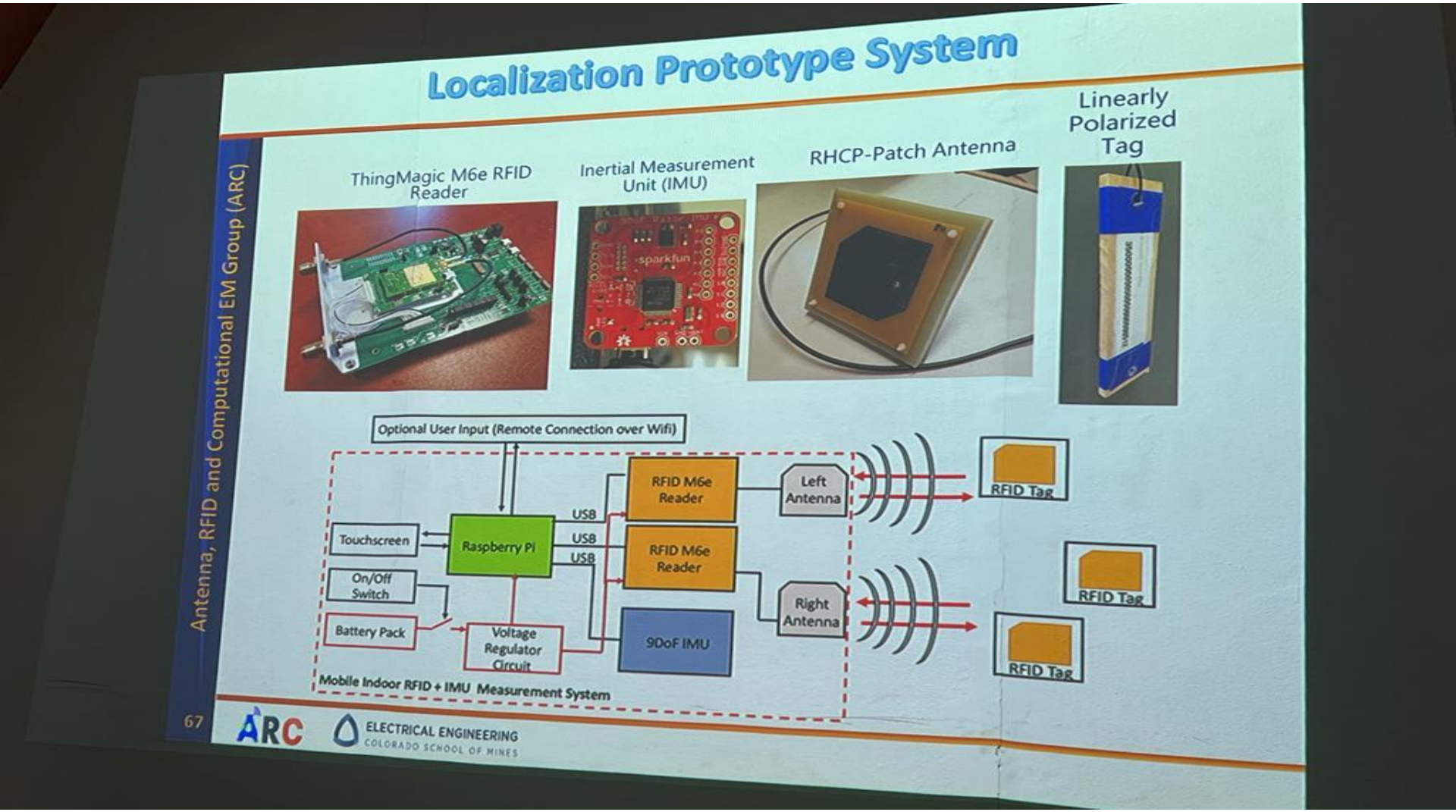
Localization Prototype System
Antenna, RFID and Computational EM Group (ARC)
ThingMagic M6e RFID Reader
Inertial Measurement Unit (IMU)
RHCP-Patch Antenna
Linearly Polarized Tag
sparkfun
Optional User Input (Remote Connection over Wifi)
Touchscreen
On/Off Switch
Battery Pack
Raspberry PI
Voltage Regulator Circuit
USB
USB
USB
RFID M6e Reader
RFID M6e Reader
9DoF IMU
Left Antenna
Right Antenna
RFID Tag
RFID Tag
RFID Tag
Mobile Indoor RFID + IMU Measurement System
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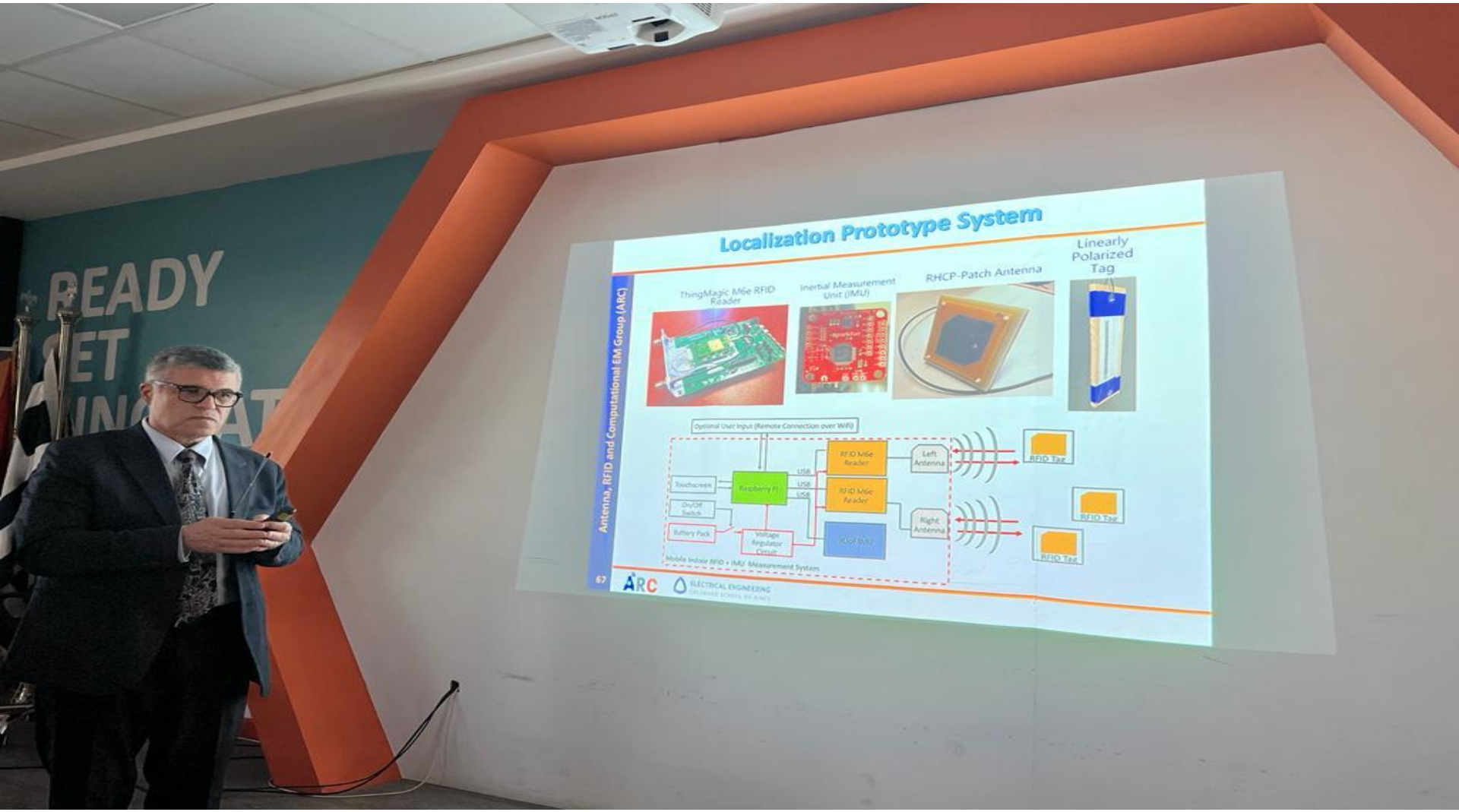
READY
Localization Prototype System
Antenna, RFID and Computational EM Group (ARC)
ThingMagic M6e RFID Reader
Inertial Measurement Unit (IMU)
RHCP-Patch Antenna
Linearly Polarized Tag
Optional User Input (Remote Connection over WiFi)
Touchscreen
On/Off Switch
Battery Pack
Raspberry Pi
Voltage Regulator Circuit
USB
USB
USB
RFID M6e Reader
RFID M6e Reader
IMU
Left Antenna
Right Antenna
RFID Tag
RFID Tag
RFID Tag
Mobile Indoor RFID + IMU Measurement System
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ARC
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Thank You