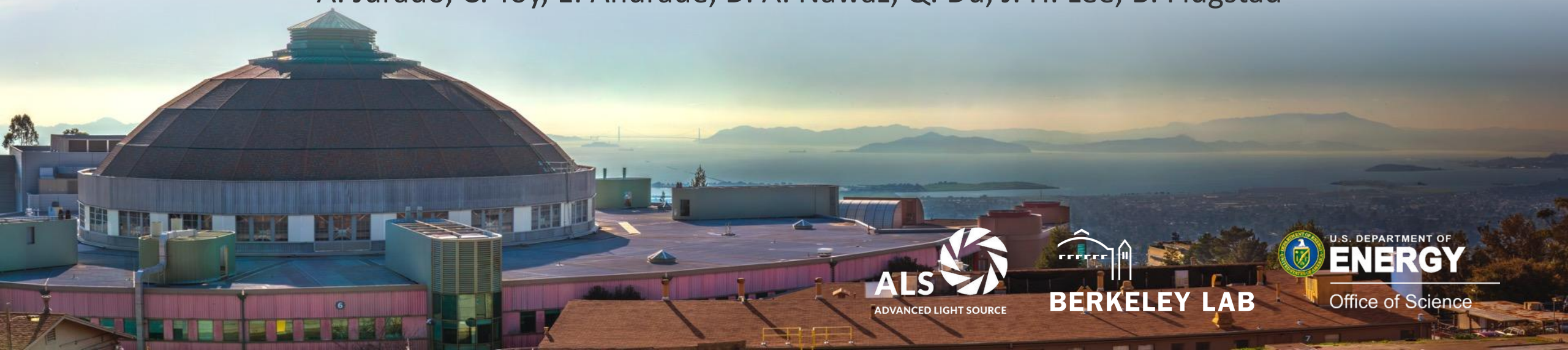


# ALS SR RF Control System Upgrade Plan and Status

Najm Us Saqib  
Control Systems Engineer  
Advanced Light Source Upgrade (ALS-U)

A. Jurado, C. Toy, E. Andrade, D. A. Nawaz, Q. Du, J. H. Lee, B. Flugstad



# Agenda

- Introduction
- Advanced Light Source Storage Ring RF Control System
  - Existing
  - Upgrade Plan
  - Present Status



# Brief Speaker Intro

**Najm us Saqib**

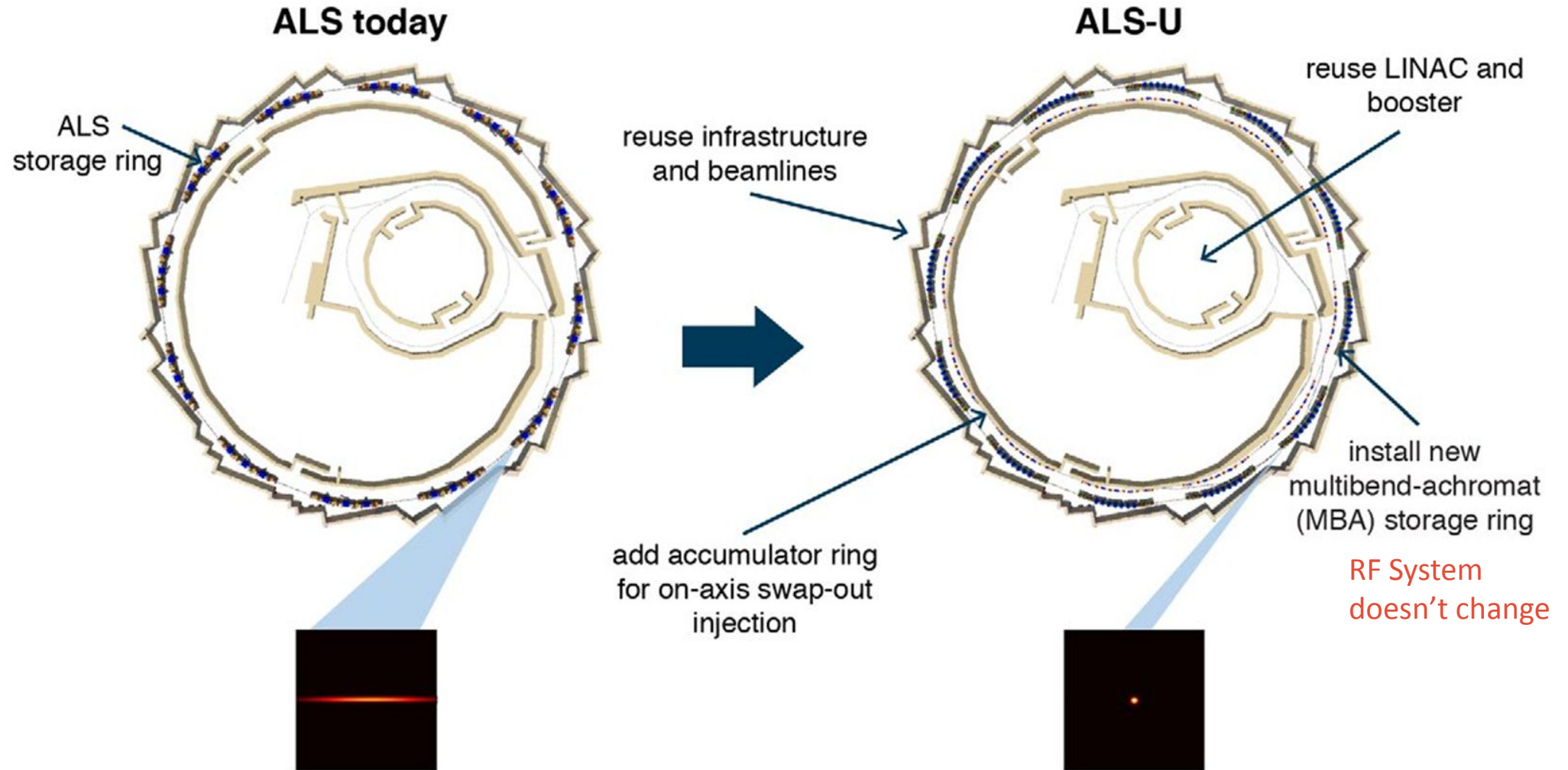
**Control Systems Engineer**

**Advanced Light Source Upgrade Project**

## Experience

- ~3 years synchrotron light source project → ALS-U/ALS
- ~5 years linear accelerator project → LINAC Project Pakistan

# ALS/ALS-U





# SR RF Control System

- Low-level RF
- Cavity Cooling System
  - Relay-based chassis
  - 30 years old
- PLC Controls
  - Horner All-in-one Controllers
  - 7 subsystems: Klystron 1, Klystron 2, Feeder, Master Interlocks, HVPS, HVPAD, Fast Interlock Interface



# SR RF Control System Upgrade

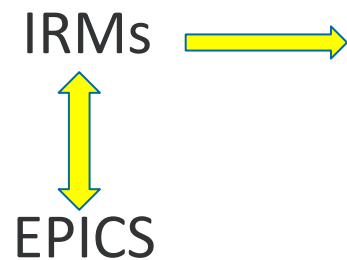
- **Low-level RF (remains same)**
- Cavity Cooling System  Allen Bradley PLC
  - Relay-based chassis
  - 30 years old
- PLC Controls  Allen Bradley PLC
  - Horner All-in-one Controllers
  - 7 subsystems: Klystron 1, Klystron 2, Feeder, Master Interlocks, HVPS, HVPAD, Fast Interlock Interface



# Cavity Cooling System - Existing

Why upgrade:

- 30 years old
- Relay-based
- Difficult to add more functionality



# Cavity Cooling System - Present Status

Before Summer Shutdown 2024



Now



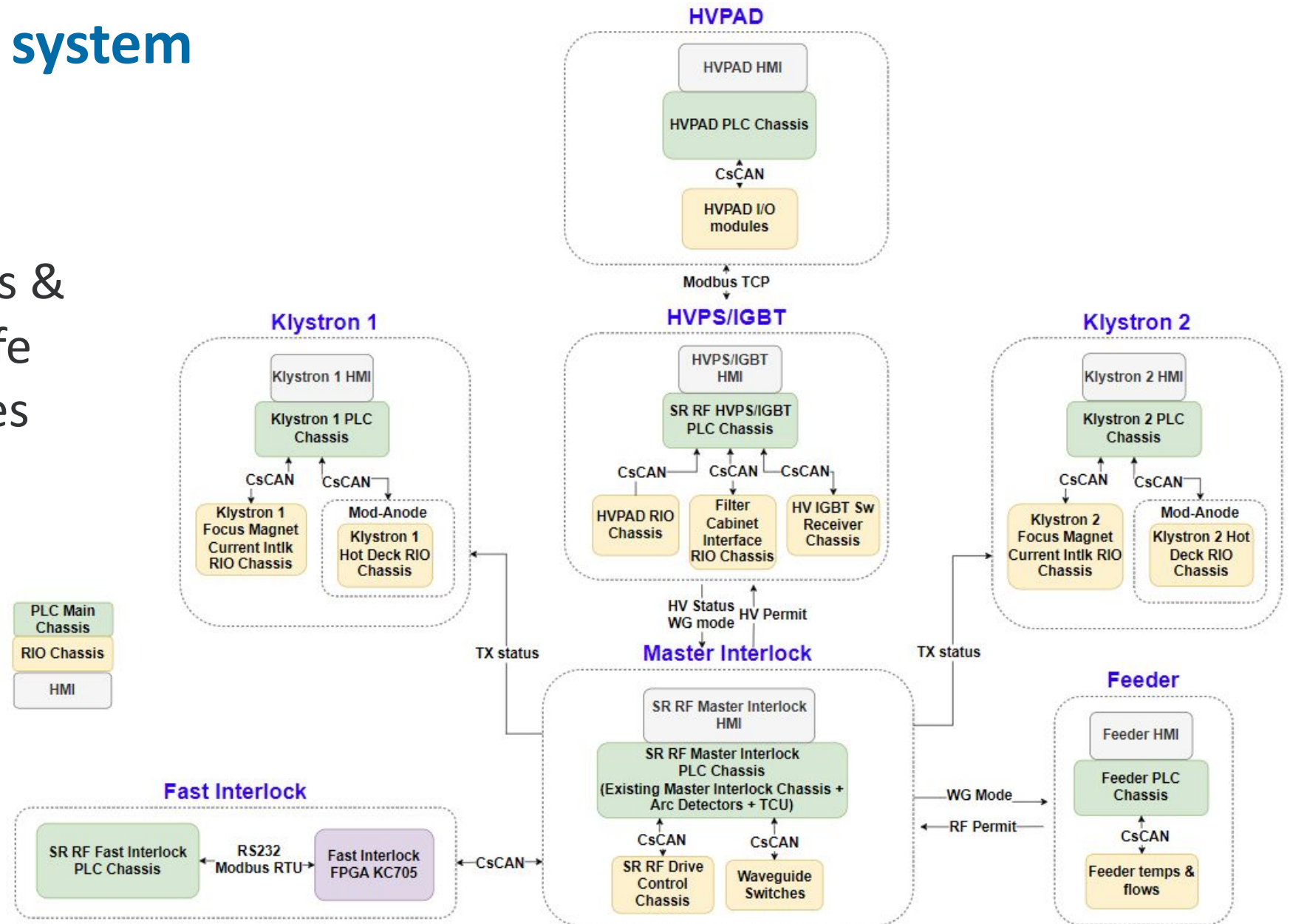
- 1 PLC
- 1 HMI
- ~120U got empty



# Existing SR RF PLC system

Why upgrade:

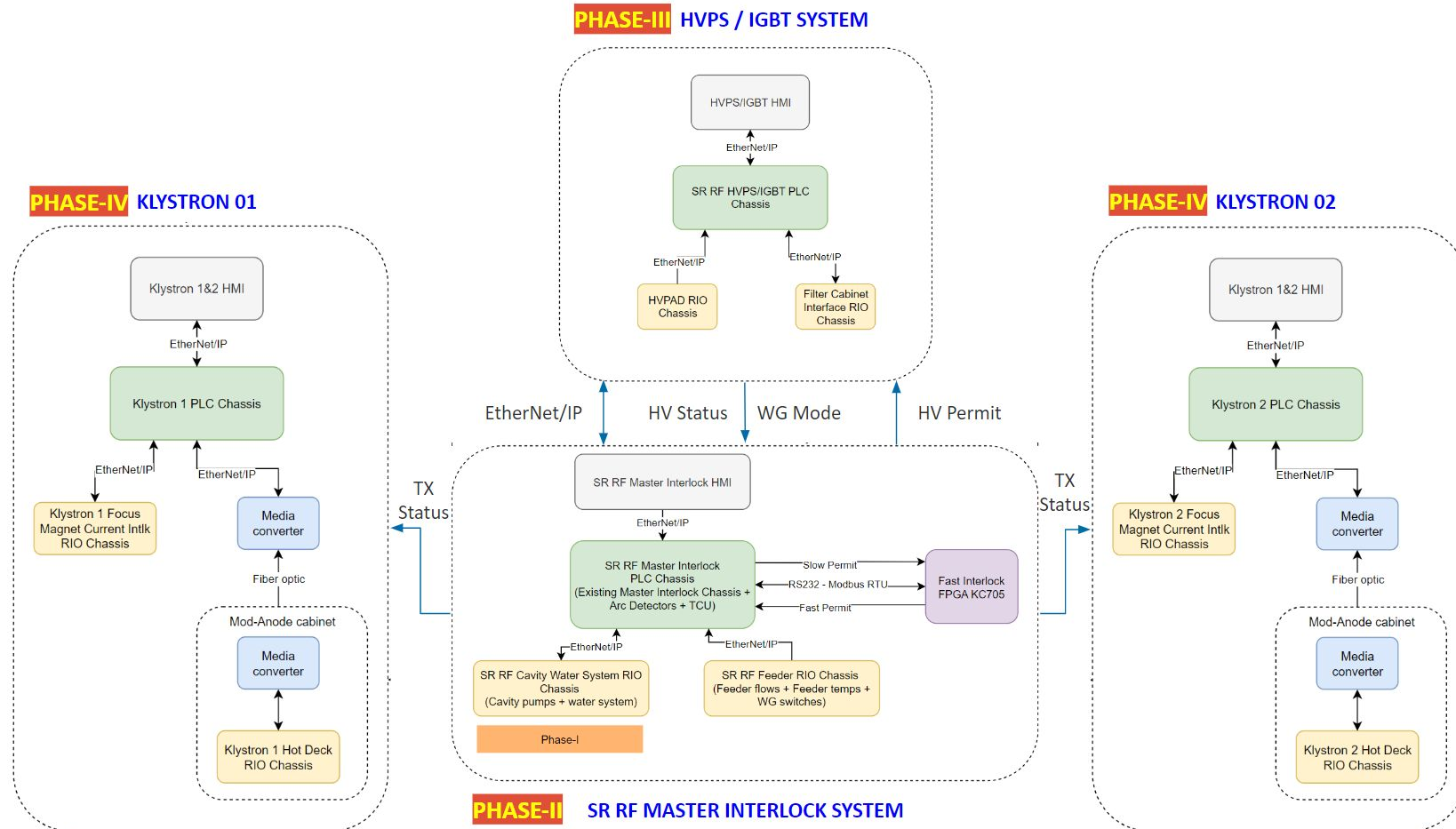
- Horner controllers & HMI are end-of-life
- Not enough spares available



# Upgrade Plan

## Four Phases

- Phase-I: Cavity Water Subsystem ✓
  - (Summer 2024)
  - Testing and Cold Commissioning
- Phase-II: Master Interlock Subsystem
  - (Winter 2025)
- Phase-III: HVPS Subsystem
  - (Summer 2025)
- Phase-IV: Klystron 1&2 Subsystem
  - (Winter 2026)



# Leveraging ALS-U AR RF System Experience

- PLC chassis design
- PLC programming
- HMI development
- EPICS database
- Phoebus OPIs

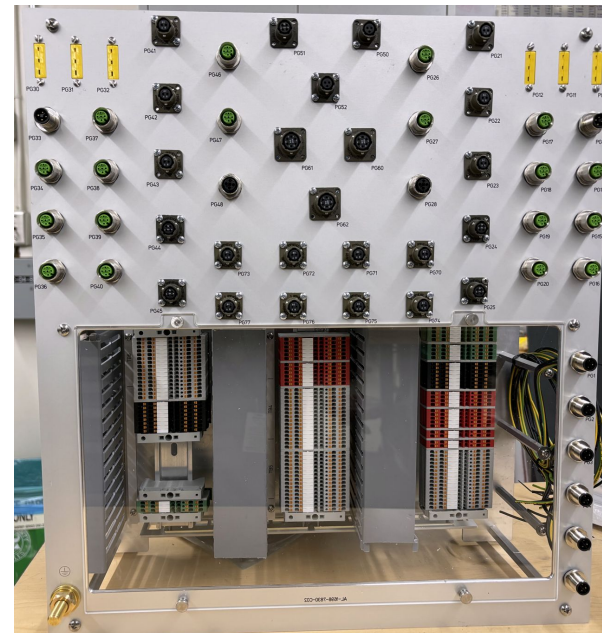
<b>AR RF PLC subsystems</b>	<b>SR RF PLC Upgrade subsystems</b>
HPA 1	Klystron 1
HPA 2	Klystron 2
Master Interlock	Master Interlock
N/A	HVPS

# PLC Chassis Design

- Follow ALS-U standards
- Evolution from ALS-U Slow MPS, AR RF PLC Chassis
- Hardware
  - Allen Bradley 5380 series
    - CPU: 5069-L320ER
    - I/O Modules: 5069-IF8, 5069-OF8, 5069-IY4, 5069-IB16, 5069-OB16
  - PanelView 5510 HMI



Front View



Rear View



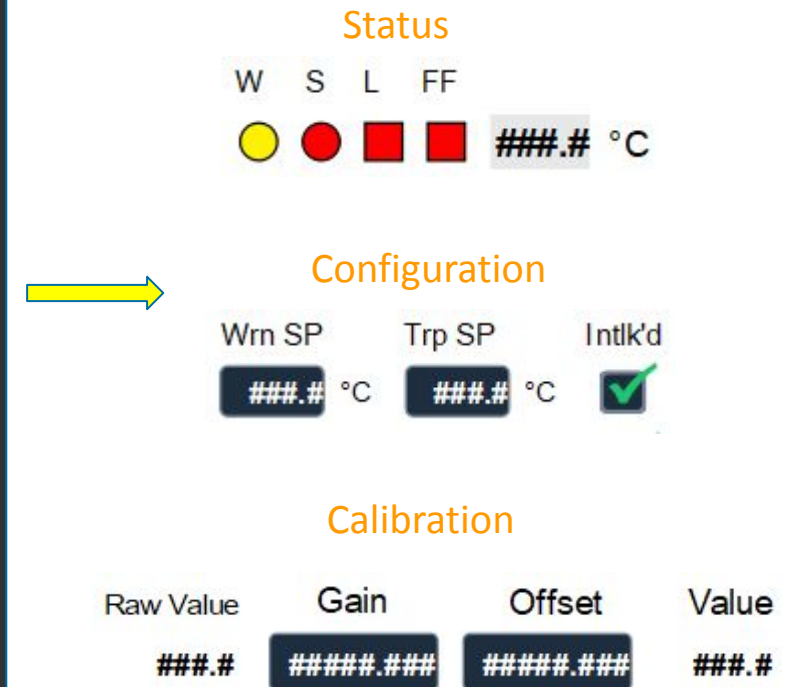
# PLC program/HMI

- User-Defined Types (UDT)
  - Base UDTs
    - Analog signal with high/low thresholds
    - Boolean signal with latch
  - High Level UDTs
    - System specific
    - Utilize Base UDTs
- HMI Add-On Graphics
  - As per base UDTs
- PLC code version control: GitLab + Studio 5000 Logix Compare Tool
- HMI version control: GitLab

## UDT\_aiHi (Temperature)

Raw Value  
Gain  
Offset  
Scaled Value  
Warning Setpoint  
Warning Status bit  
Trip Setpoint  
Trip Status bit  
Trip Latch bit  
Bypass bit

## HMI templates



# EPICS database

UDT\_aiHi  
(Temperature)

- Raw Value
- Gain
- Offset
- Scaled Value
- Warning Setpoint
- Warning Status bit
- Trip Setpoint
- Trip Status bit
- Trip Latch bit
- Bypass bit



ai\_hi\_udt.template

```
record(ai, "$(P)$R$(SIGNAL)") {
  field(DESC, "$(SIGNAL) Value")
  field(DTYP, "EtherIP")
  field(INP, "@$(PLC) $(Tag).Val")
  field(EGU, "$(EGU=°C)")
  field(PREC, "$(PREC)")
  field(SCAN, "$(SCAN)")
  info(archive, "Fast")
}

record(bi, "$(P)$R$(SIGNAL)HiWrnSts") {
  field(DESC, "$(SIGNAL) High Warning Status Bit")
  field(DTYP, "EtherIP")
  field(INP, "@$(PLC) $(Tag).HiWrnSts")
  field(SCAN, "$(SCAN)")
  field(ZNAM, "$(ZNAMHiWrnSts=Warning)")
  field(ONAM, "$(ONAMHiWrnSts=OK)")
  field(ZSV, "$(ZSVHiWrnSts=MINOR)")
  field(OSV, "$(OSVHiWrnSts=NO_ALARM)")
  info(archive, "Slow")
}

record(bi, "$(P)$R$(SIGNAL)HiTrpSts") {
  field(DESC, "$(SIGNAL) High Trip Status Bit")
  field(DTYP, "EtherIP")
  field(INP, "@$(PLC) $(Tag).HiTrpSts")
  field(SCAN, "$(SCAN)")
  field(ZNAM, "Trip")
  field(ONAM, "No Trip")
  field(ZNAM, "$(ZNAMHiTrpSts=Fault)")
  field(ONAM, "$(ONAMHiTrpSts=OK)")
  field(ZSV, "$(ZSVHiTrpSts=MAJOR)")
  field(OSV, "$(OSVHiTrpSts=NO_ALARM)")
  info(archive, "Slow")
}
```



Phoebus  
templates

Status

W S L FF

<SRRF:Cav

Configuration

Wrn SP Trip SP Intlk'd

<SRRF:Cav <SRRF:Cav

Calibration

Raw Value	Gain	Offset	Value
<SRRF:Cav	<SRRF:Cav	<SRRF:Cav	<SRRF:Cav

# EPICS database

## cavity.substitutions

### UDT\_Cavity

Temp → UDT_aiHi
WindowTemp → UDT_aiHi
LCWR_Flow → UDT_aiLo
TunerFlow → UDT_aiLo
XX
yy
zz

```
file ai_hi_udt.template {
```

```

pattern { R,          SIGNAL,          Tag,          EGU}

      { Cav$(N);,      Temp,          Cav$(N).Temp}
      { Cav$(N);,      Pressure,       Cav$(N).Pressure, psi}
      { Cav$(N);,      WindowTemp,    Cav$(N).WindowTemp}
      { Cav$(N)-HOM;:, LCWR_Temp,     Cav$(N)_HOM.LCWR_Temp}
      { Cav$(N)-HOM;:, FlangeTemp,    Cav$(N)_HOM.FlangeTemp}
}

```

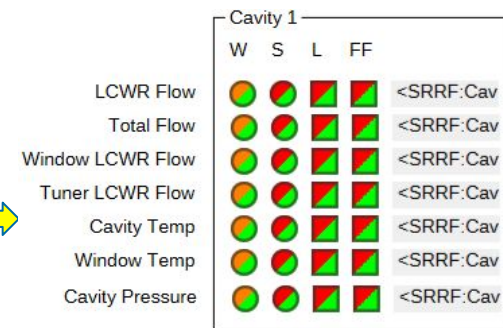
```
file ai_lo_udt.template {
```

```

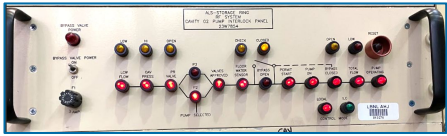
pattern { R,          SIGNAL,          Tag}

      { Cav$(N);,      LCWR_Flow,     Cav$(N).LCWR_Flow}
      { Cav$(N);,      TotalFlow,      Cav$(N).TotalFlow}
      { Cav$(N);,      WindowFlow,    Cav$(N).WindowFlow}
      { Cav$(N);,      TunerFlow,     Cav$(N).TunerFlow}
      { Cav$(N)-HOM;:, LCWR_Flow,     Cav$(N)_HOM.LCWR_Flow}
}

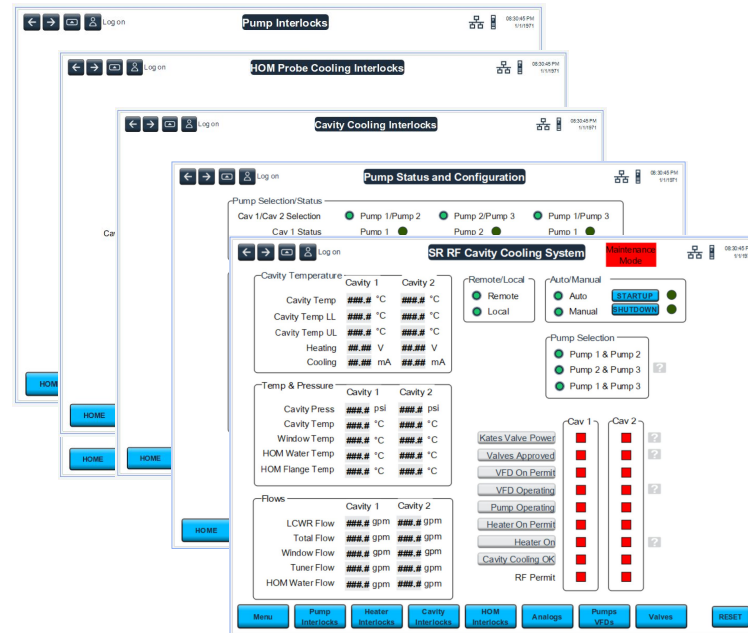
```



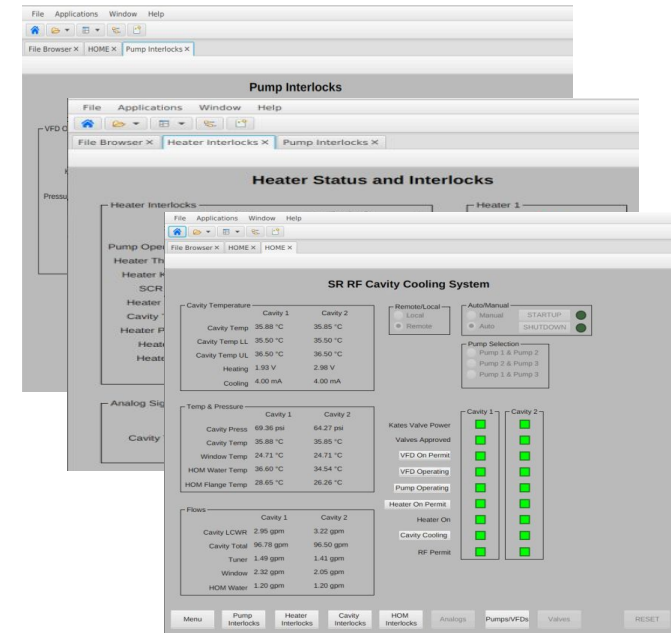
# HMI/Phoebus - Same layouts for operators



Local HMI



Phoebus





**Thank you!**

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