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# Hardware Operations

Jesse Wirth/UC  
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# User Requirements (Level 1)

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- **Operable and maintainable with minimal support staff**
- **Straightforward processes for calibration, maintenance, servicing and flight operations**
- **Minimal training required for support personnel**
- **Design shall allow system to be continuously maintained in flight-ready state at SSMOC between flight series**
- **Documentation convenient to access, easy to read and understand**
- **Easy to operate and maintain on extended deployments**



# Design Approach

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- **Project Implementation Plan captures requirements, design principles, performance models (implicit knowledge of instrument builders is transformed into explicit form accessible by SSMOC personnel)**
- **First draft for operational manuals and time and resources model developed through use-case scenarios during critical design phase**
- **Refined through continued data gathering and frequent formal revisions and reviews during development phase**



# Performance Models



- **Use-case scenarios**
  - **Assembly/disassembly of cryostat**
  - **Assembly of system**
  - **Inspection**
  - **Cool down / warm-up procedures**
  - **Cycling of ADR**
  - **Power-up / power-down procedures of system**
  - **Warm tests to be performed**
  - **Cold tests to be performed**
  - **Calibration procedures**
    - **Optical alignment**
    - **Photometric calibration**
    - **Spectral calibration**
  - **Installation / removal onto simulator / telescope**
  - **Transport to telescope**



# Performance Models continued

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- **Time and Resources Model**
  - **Flight operation**
  - **Stand-by operation**
  - **Stand-down operation**
  - **Warm-up procedures**
  - **Cool-down procedures**
  - **Calibration procedures**



# Design Requirements (Level 2)

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- **Any operation (except installation/de-installation of system on Telescope Assembly or Telescope Assembly Alignment Simulator) shall be manageable by one person**
- **Support personnel requirements:**
  - 1.0 FTE Scientist
  - 0.5 FTE Technician
- **Time and Resources Model**
  - spreadsheet
  - supporting explanations
- **Min. cryogen hold time in “operational” (flight) mode**
  - LHe4: 24 hrs
  - ADR: 15 hrs
- **ADR cycling time < 2 hrs**
- **Stand-by mode**
  - LHe4 hold time >72 hrs
  - Must be able to leave instrument unattended for 72 hours



# Deliverables

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- **Time and resources model**
- **Operators manual**
- **Maintenance manual**
- **Shop (Service) manual**
- **Trouble shooting guide**
- **Test results**
- **Project Implementation Plan**



# Test/Verification Plan

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- **Time and Resources requirements observed and recorded during development testing**
- **Time and Resource model, ease of training, ease of use, effectiveness of manuals will be verified by training SSMOC personnel**



# Risk Analysis and Mitigation Plan

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- **Risk**

- SSMOC personnel not able to operate instrument as effectively as instrument builders
- Not enough HAWC resources to compile, format and produce manuals

- **Mitigation**

- Bring SSMOC people in to do tests before delivery, continue refinement of procedures during commissioning phase
- Can SSMOC provide common resources which can be tapped by all facility instrument groups?



# Development Plan



- **Time and resource model**
  - **Baseline model (Version 1) developed from estimates based on use-case studies during critical design phase**
  - **Model tested and refined during construction/integration/testing by HAWC personnel resulting in “Version 2 model”**
  - **Version 2 model tested and refined during training of SSMOC personnel resulting in final (Version 3) model delivered with instrument**
  
- **Manuals**
  - **Use case analysis identifies level 2 requirements for normal operations**
  - **Draft outline (ready by CDR)**
  - **Capture data during development and test phase**
  - **Produce drafts of manuals**
  - **Review of drafts by Science Support IPT and selected outside reviewers**
  - **Produce revised version of manuals based on reviewer comments**
  - **Test and refine manuals during training of SSMOC scientists**
  - **Produce final version incorporating suggestions of SSMOC scientists**



# Development Plan contd.

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- **Manuals will be provided in:**
  - PDF format
  - Original format of programs used to create the materials (e.g Word, Photoshop, Pro-E etc.)



# Interface Control Documents

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- **Manuals will constitute ICDs**



# Stakeholders



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- **Engineering IPT**
  - **SSMOC**