# Installation, Commissioning, and Calibration Plan for the 4pi System

Version 1.2

May 17, 2005

The 4pi Group

# Preparing for the 4pi Installation

| | |
|---|---|
| May 15-17 | 4pi workshop and review at LBNL |
| May 31 | LBNL review of 4pi system |
| Early June | disassembly of system & UHV cleaning |
| June | shipment of hardware from LBNL to Japan<br>cables and pole segments will be shipped soon after disassembly |
| June | final cleanliness tests of cable and pole segments on site |
| mid-late June | receiving and pre-assembly of deployment hardware on-site |
| July 1 - | start of 4pi installation? |

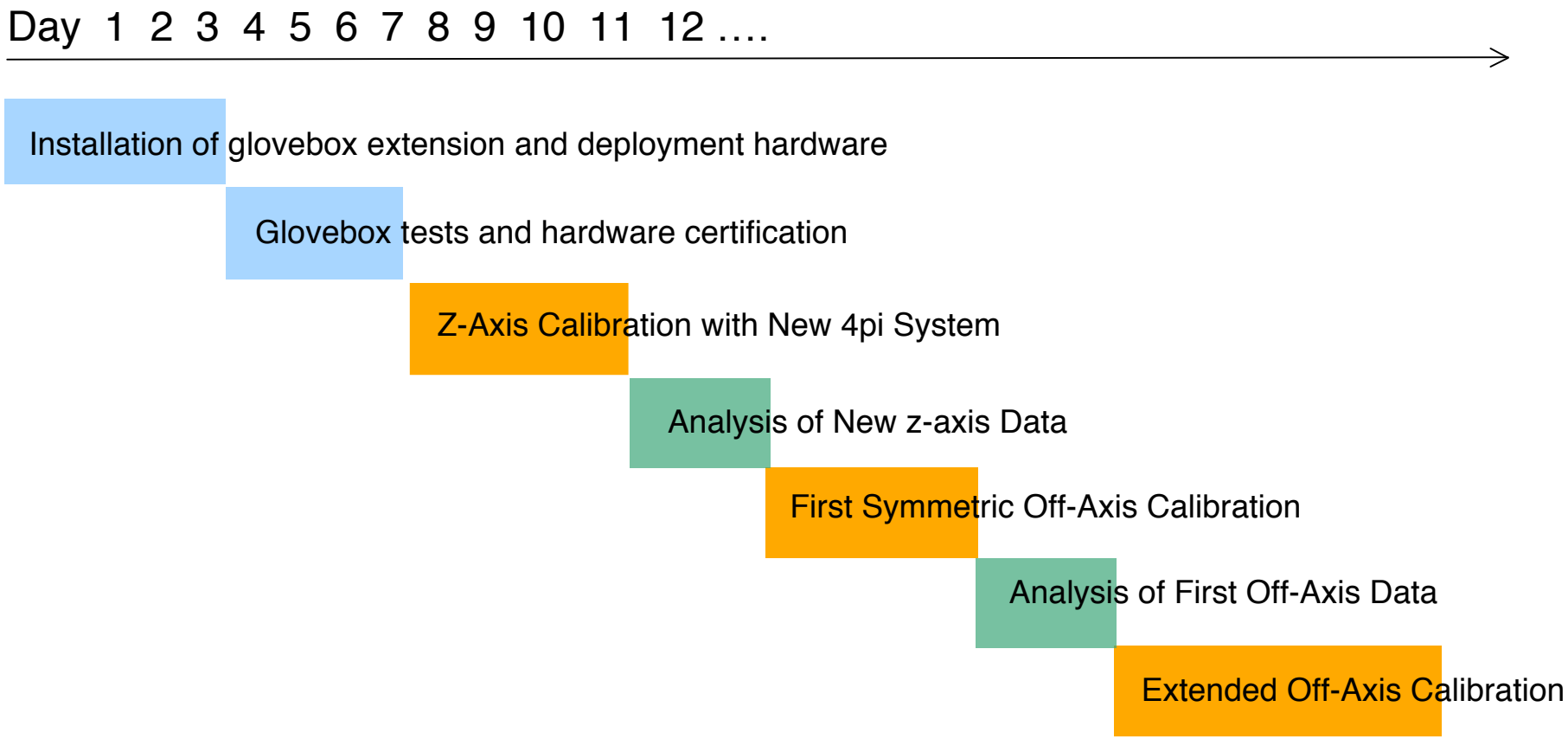
# On-Site Preparations Prior to 4pi Installation

1. Receiving of hardware on site and unpacking.
2. Moving deployment hardware into 4pi clean tent.
3. Perform LS soak or swipe test and background counting of all parts to be immersed in detector. When finished place cables, pivot block, and pole segments and instrumentation units in LS soak with continuous nitrogen purge.
4. Pre-assembly of mechanical deployment system in 4pi clean tent.
5. Installation of controls in electronics rack in HV room.
6. Setting up control computer and UPS.
7. Running cables between control rack and 4pi clean tent.
8. Final testing of 4pi controls, motors, and cabling before installation.
9. Installation of web cams in/near calibration tent.
10. Re-route control cables from 4pi clean tent to calibration deck.
11. Perform z-axis calibrations with old deployment system.

[12. Installation of M5 viewport camera]

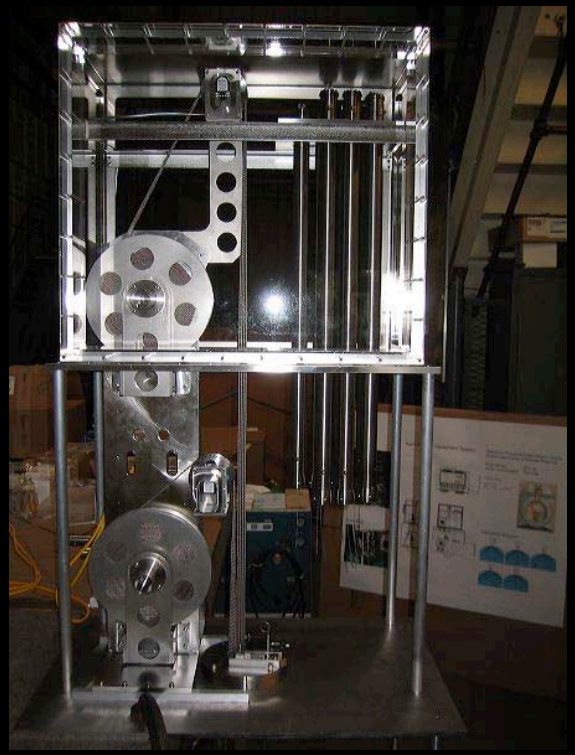
note: independent of other activities. can happen any time before 4pi deployment.

# Installation and Commissioning Plan

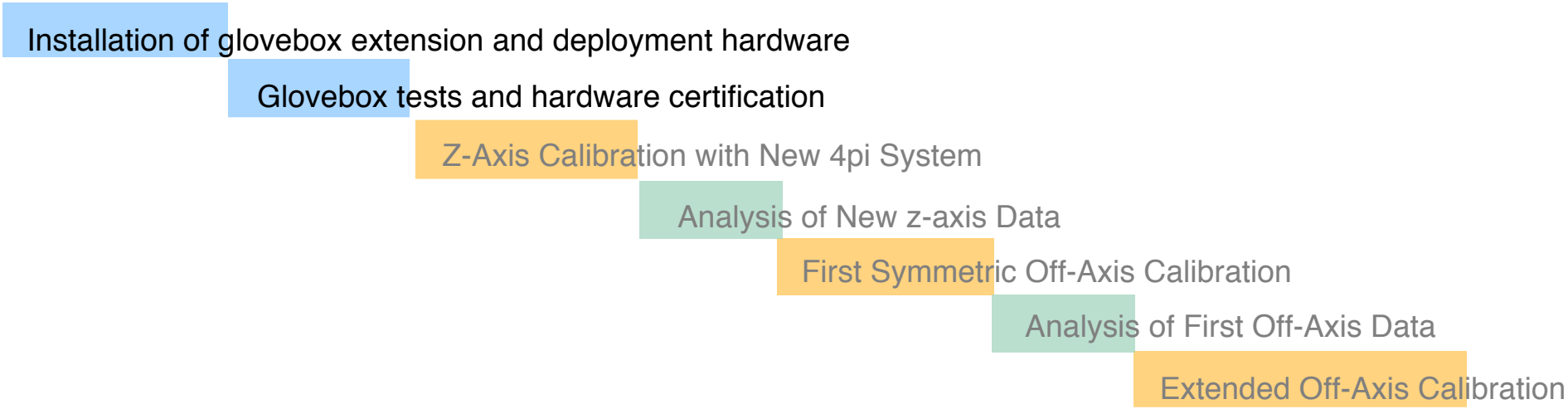



After the installation of the deployment hardware we will have test deployments for the comissioning of the z-axis mode and the off-axis mode of the new deployment systems.

The following slides outline the proposed commissioning activities.

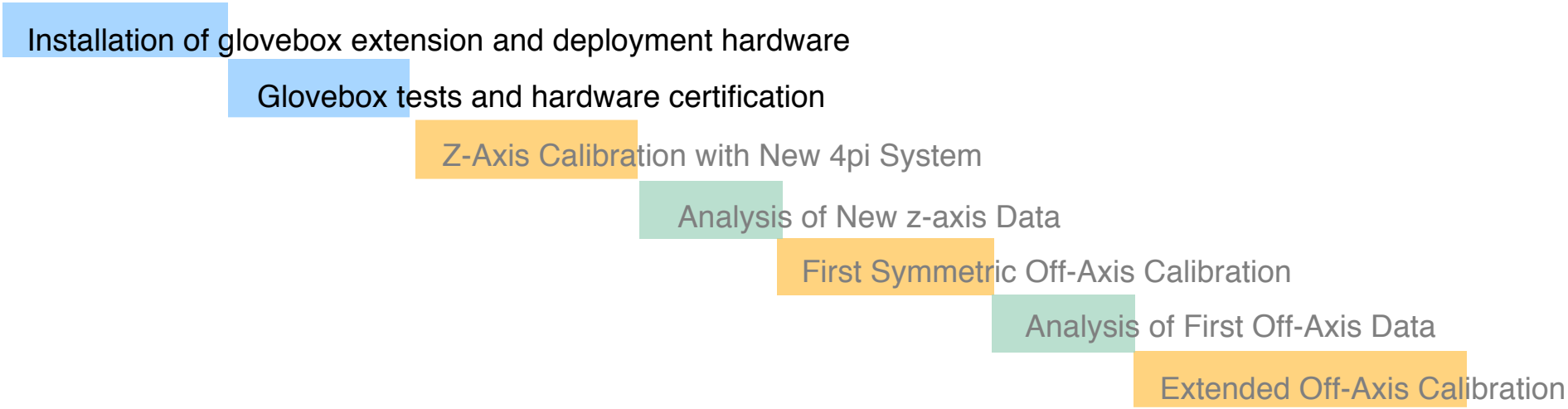


Installation of New
Deployment Hardware




**Day 1/6**
- review pre-assembled hardware in 4pi clean tent
- prepare for exchange of rotary stage
- clean calibration tent
- set up hoist and/or support beams for temporary glovebox support
- measure glovebox leak rate prior to installation of new rotary stage
- measure particle count in calibration tent at beginning and end of day

**Day 2/6**
- lift glovebox
- exchange rotary stage
- start purge
- measure gloveboc leak rate
- measure particle count in calibration tent at beginning and end of day




**Day 3/6**

- Take cables, pivot block, instrumentation units  out of nitrogen purge.
- Install cables on spools in 4pi clean tent.
- Test electrical connections to instrumentation unit
- Enclose spools and cables in plastic bag and fill with nitrogen to minimize exposure to radon.
- measure particle count in calibration tent at beginning and end of day

Installation of glovebox extension and deployment hardware

Glovebox tests and hardware certification

Z-Axis Calibration with New 4pi System

Analysis of New z-axis Data

First Symmetric Off-Axis Calibration

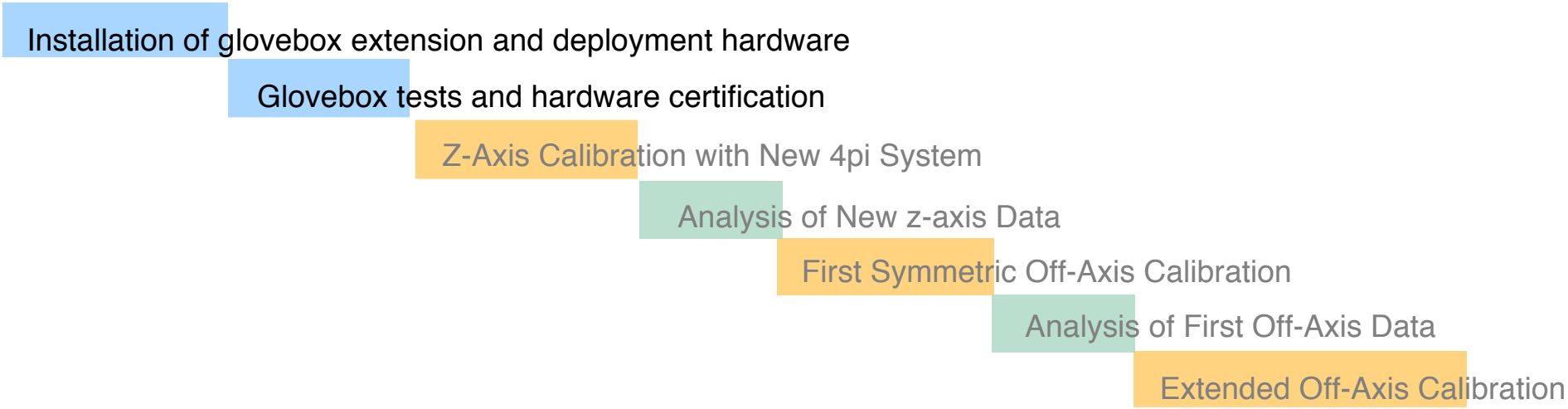
Analysis of First Off-Axis Data

Extended Off-Axis Calibration

**Day 4/6**

- remove top of glovebox (1hr)
- remove z-axis calibration system (1 hr)
- lift deployment system into glovebox (2hr)
- install penthouse without windows (1hr)
- Install axial support (1hr)
- Install new digital pressure gauge on back of glovebox
- Modify nitrogen purge system
- Clean glovebox
- remove plastic covers from spools and cables
- Connect internal cabling
- move pole segments into glovebox
- install penthouse windows (1hr)
- start purge
- measure glovebox leak rate
- measure particle count in calibration tent at beginning and end of day

*Note: This will be a very long day unless we are willing to leave the glovebox open and exposed to the calibration tent overnight.*




**Day 5/6**

- check on pressure in glovebox
- remeasure leak rate of glovebox
- test deployment controls and functionality of spools
- test instrumentation units in glovebox
- measure particle count in calibration tent at beginning and end of day

**Day 6/6**

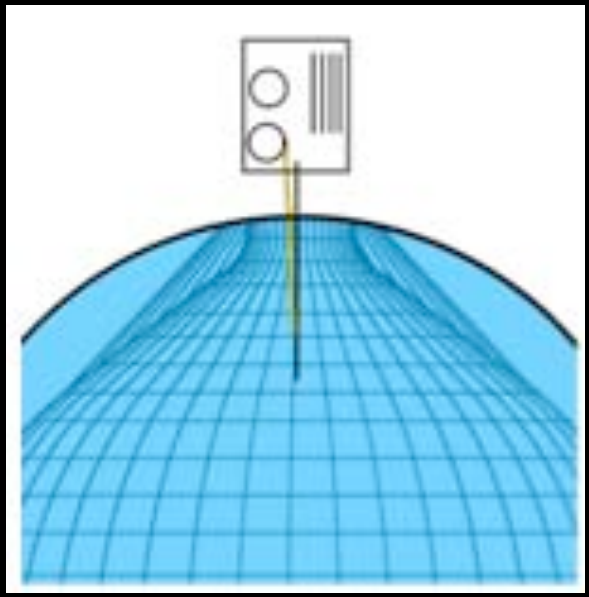
- practice z-axis deployment procedures in glovebox without opening gate valves
- review 4pi deployment procedures in glovebox without opening gate valves
- measure particle count in calibration tent at beginning and end of day

# Issue for Discussion

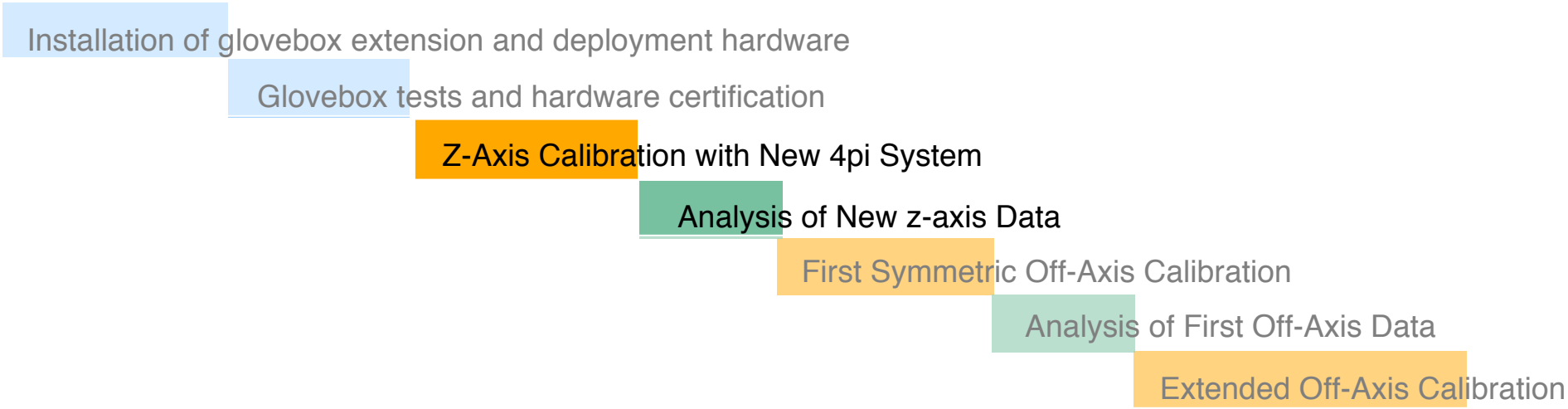
Since the start of KamLAND we have not left the glovebox open and exposed to the air in the calibration tent overnight.

Is the work plan for Day 4 reasonable?
Can we leave the glovebox open overnight?

**Day 4/6**
- remove top of glovebox (1hr)
- remove z-axis calibration system (1 hr)
- lift deployment system into glovebox (2hr)
- install penthouse without windows (1hr)
- Install axial support (1hr)
- Install new digital pressure gauge on back of glovebox
- Modify nitrogen purge system
- Clean glovebox
- remove plastic covers from spools and cables
- Connect internal cabling
- move pole segments into glovebox
- install penthouse windows (1hr)
- start purge
- measure glovebox leak rate
- measure particle count in calibration tent at beginning and end of day



Z-axis Calibration with New Deployment System



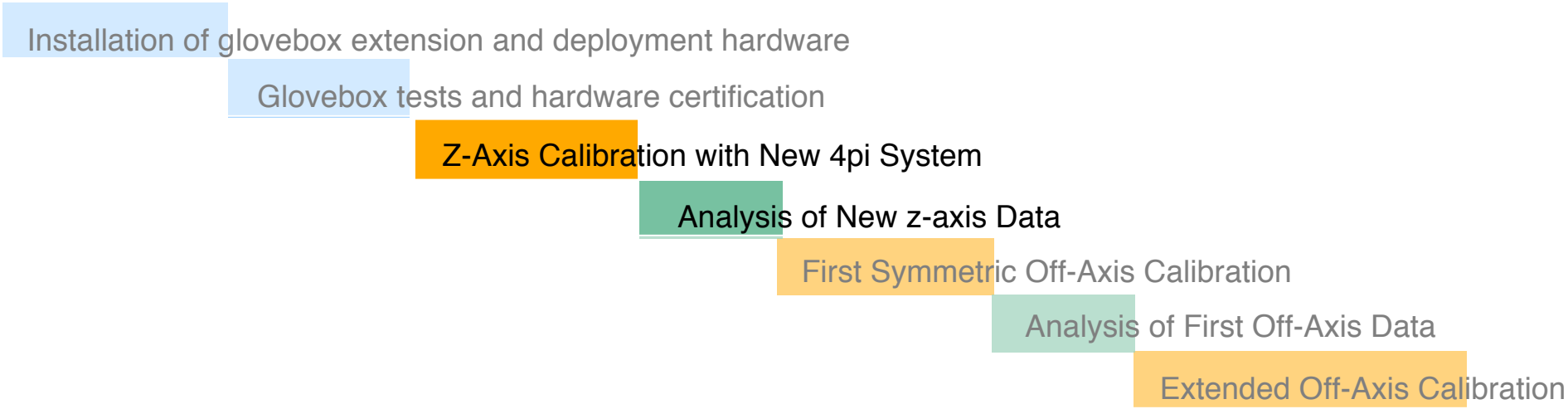

**Day 1/7**

- deploy cable #1 and instrumentation unit #1 with z-axis weight only
- perform in-situ calibration of pressure sensor from +6 <-> -6 m every 50cm.
- deploy cable #2 and instrumentation unit #2 with z-axis weight. Secure pole coupling #2 with hinch to cable to keep it vertical during this test.
- perform in-situ calibration of pressure sensor from +6 <-> -6 m every 50cm.

(24 data points, 3 min per data point, 1-2 min to move system into position
= 2hrs for downscan + 2hrs for upscan = 3-4hrs)

**Day 2/7**

- attach pivot block with instrumentation unit #3 to cable #1
- deploy cable #1 with pivot block and instrumentation unit #3
- perform in-situ calibration of pressure sensor from +6 <-> -6 m every 50cm.
- practice attaching and removing the pivot block from the cable

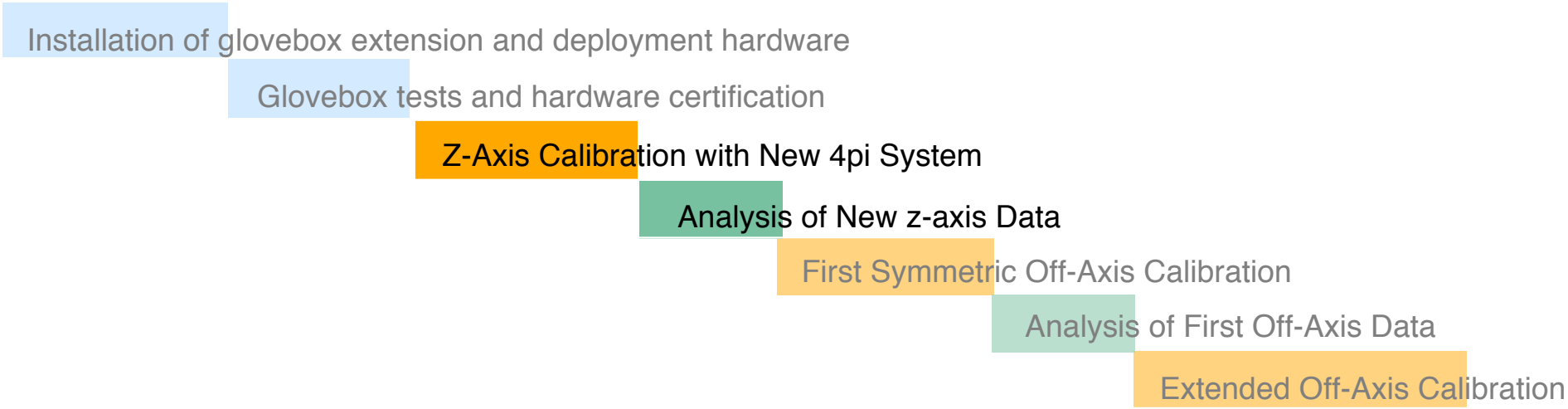



**Day 3/7**
- deploy cable #1 and instrumentation unit #1 with z-axis weight and composite source
- take z-axis calibration data at z=-6,-4,-2,0,2,4,6 m

**Day 4/7**
- deploy vertically 2 pole segments with $^{60}$Co pole sources to compare reconstruction and energy of $^{60}$Co calibration sources (data taken on day 2) with $^{60}$Co pole sources
- perform calibrations at z=-2,0,2 m

**Day 5-6/7**
- analyze new z-axis calibration data
- make plots of “IU depth vs cable”
- load depth calibration into 4pi control software

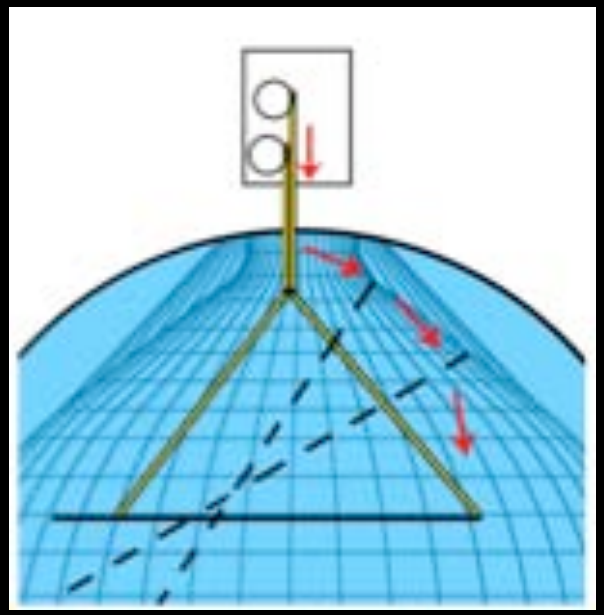
**Day 7/7**
- meeting and phone call. Decision to proceed, or not.




**Day 3/5**
- deploy vertically 2 pole segments with $^{60}$Co pole sources to compare reconstruction and energy of $^{60}$Co calibration sources (data taken on day 2) with $^{60}$Co pole sources
- perform calibrations at z=-2,0,2 m

**Day 4/5**
- analyze new z-axis calibration data
- make plots of “IU depth vs cable”
- load depth calibration into 4pi control software

**Day 5/5**
- meeting and phone call. Decision to proceed, or not.



First Off-Axis Calibration
With Short Pole

Installation of glovebox extension and deployment hardware

Glovebox tests and hardware certification

Z-Axis Calibration with New 4pi System

Analysis of New z-axis Data

First Symmetric Off-Axis Calibration

Analysis of First Off-Axis Data

Extended Off-Axis Calibration

**Day 1-2/6**

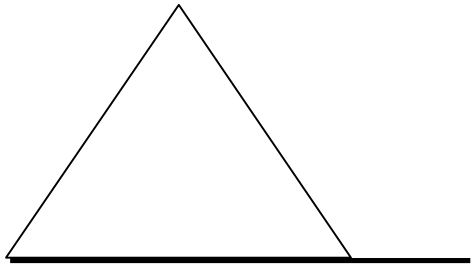
- deploy 4 unweighted pole segments with $^{60}$Co pole sources and composite calibration source in same geometry as longer calibration pole

- monitor first off-axis deployment with CCD cameras

- perform calibrations at $\theta$=0, 45,90,135 deg

- retract calibration pole

- change $\phi$ position with rotary stage
- repeat calibrations at two or more different $\phi$ positions
$\phi$ =0,180 (90, 270)



3+1 segments

Installation of glovebox extension and deployment hardware

Glovebox tests and hardware certification

Z-Axis Calibration with New 4pi System

Analysis of New z-axis Data

First Symmetric Off-Axis Calibration

Analysis of First Off-Axis Data

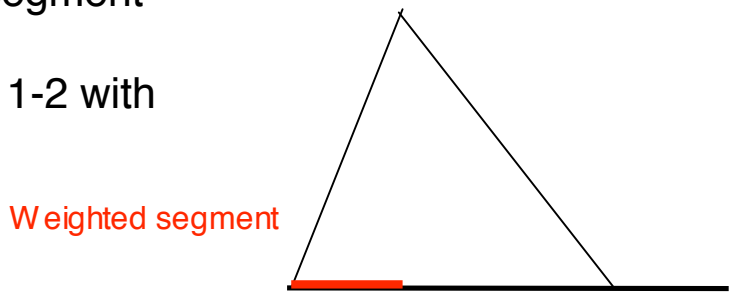
Extended Off-Axis Calibration

**Day 3-4/6**

- replace last pole segment with weighted segment

- deploy 3 unweighted pole segment +1 weighted segment

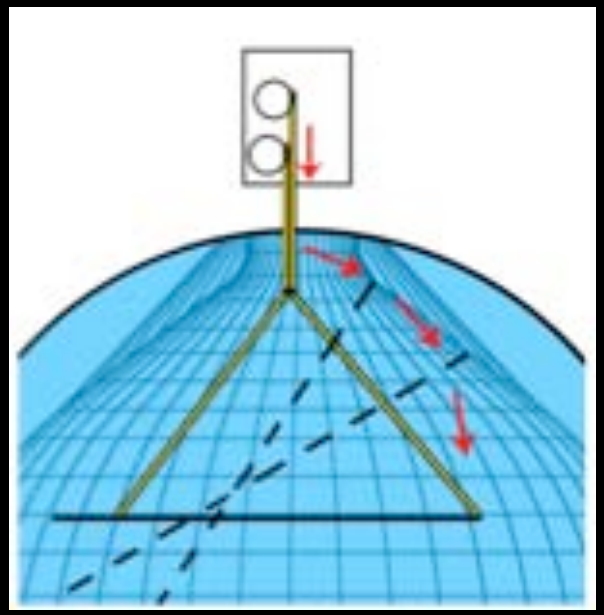
- repeat the same calibration sequence as on days 1-2 with weighted segment




3+1 segments

**Day 5-6/6**

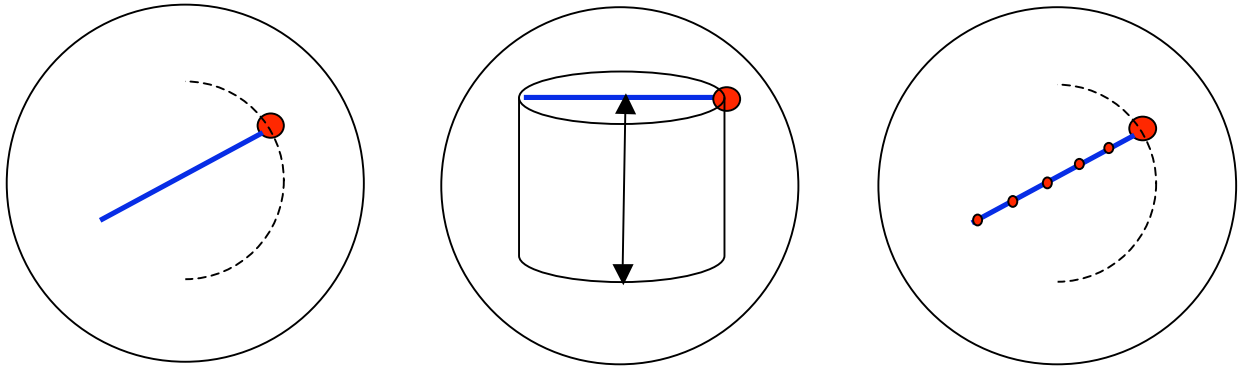
Comparison of online position readout and off-line position reconstruction. How far can we go out in R?



Full Volume Calibration Near
The Fiducial Volume Boundary

# Calibration and Deployment Scenarios

## Several Possible Deployment Procedures

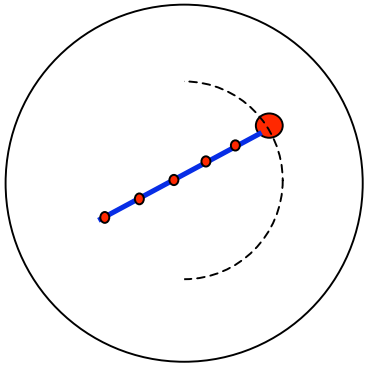


## Recommended Deployment Procedures for First Deployment

- Sweep out semicircles starting from bottom

- Optimized for ease and safety of operation

- Multiple $^{60}$Co source, primarily for vertex reconstruction



## Calibration in Semicircles

**Duration:**

20min of data taking per point

10min to move pole between points

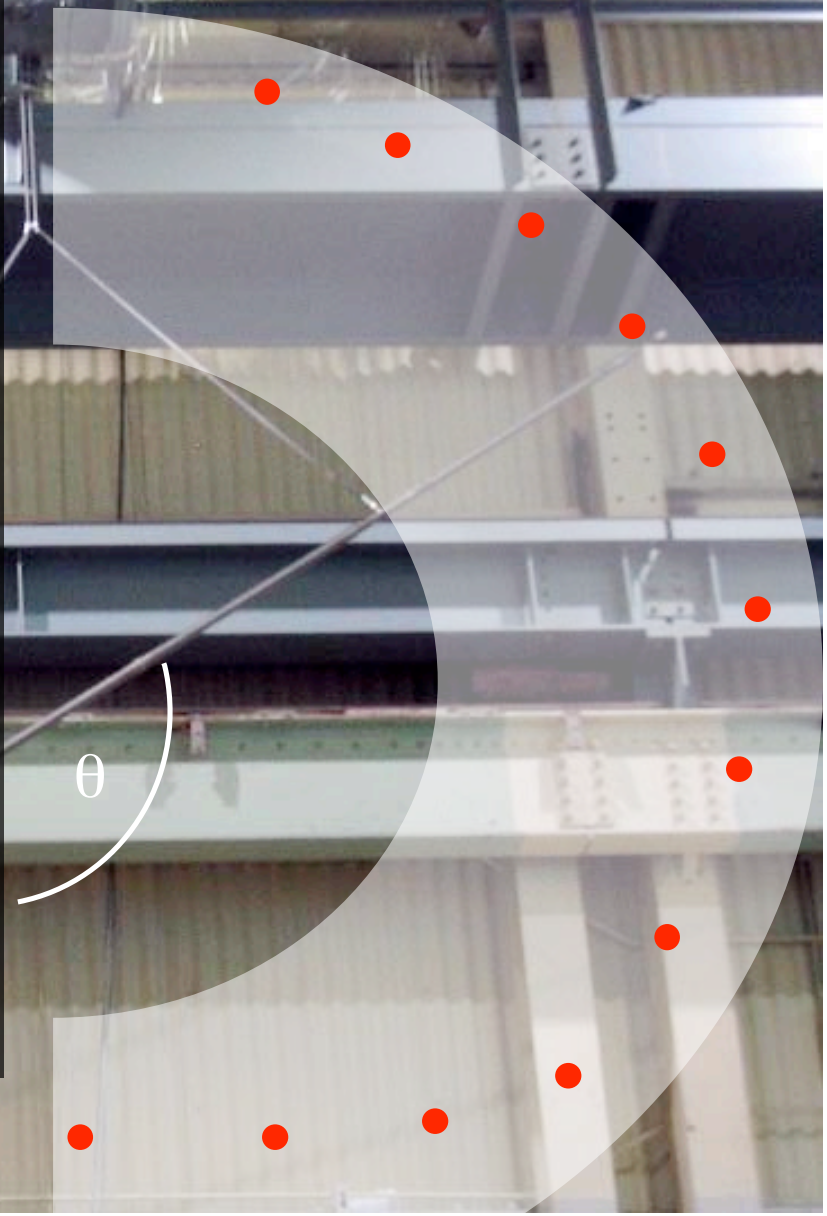
12 points = ~ 6-8hrs of data taking

~1 semicircle at 1 radius per shift

**Procedure:**

Take half the points on the sweep up and half on the way down to check for possible systematic positioning effects.

*Note: Unlikely that we can do more than one radius per shift.*

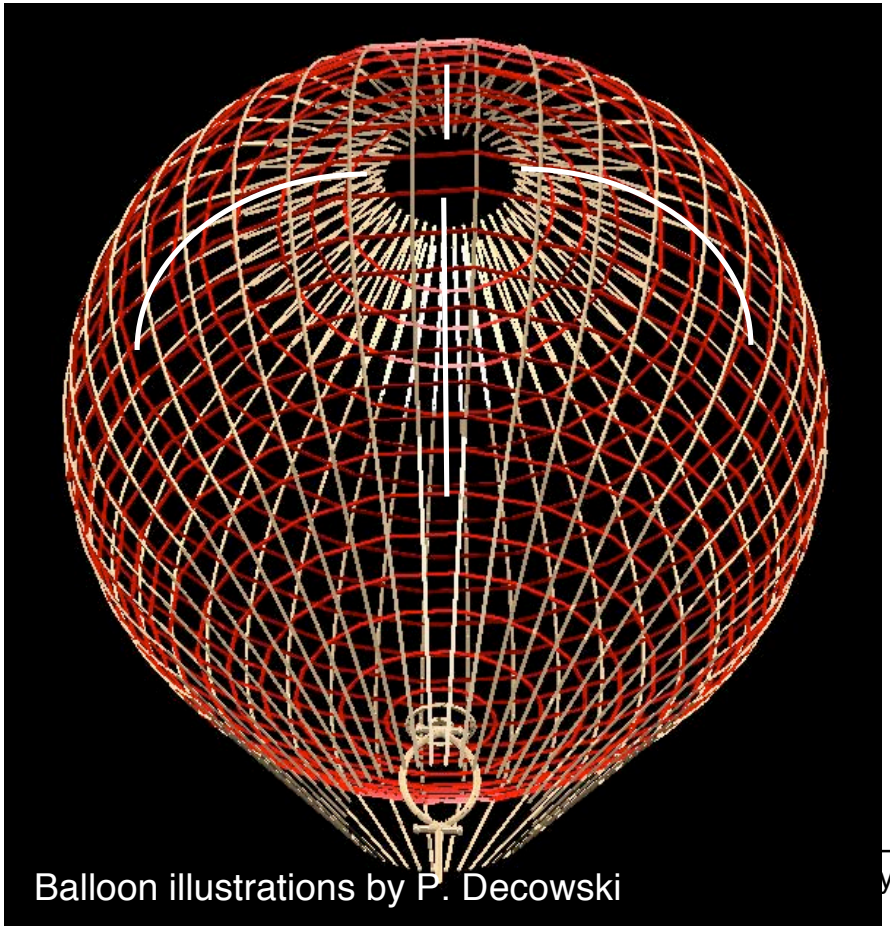


# Proposed Off-Axis Calibration Program

*Note: Already have some calibration data at smaller radii from previous commissioning activity*

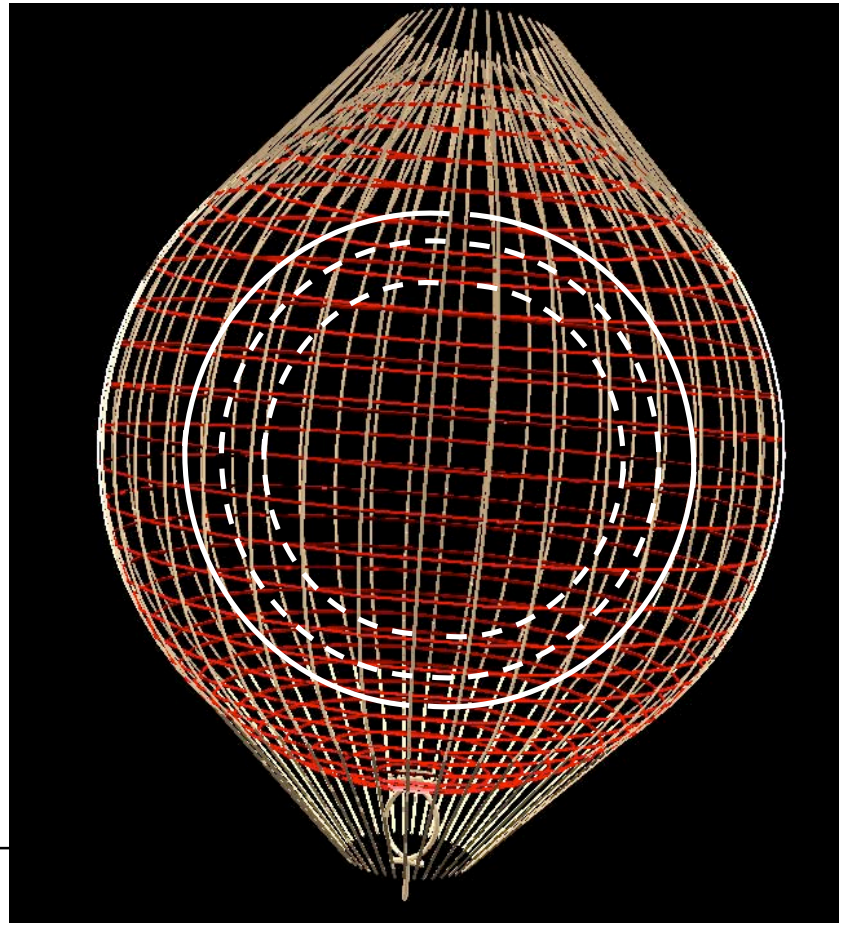
$\phi$ positions

$\phi$=0, 120, 240




Radial positions

R=4.5, 5, 5.5m



# Summary of Off-Axis Data at the End of this Campaign

For $\phi$=0, 180 we will have

R=~2.2 m (4 segments)
$\theta$=0, 20, 40, 135

R=~3.2 m (4 segments including weight)
$\theta$=0, 20, 40, 135

For $\phi$=0, 120, 240 we will have

R=~4.5 m (6 segments including weight)
$\theta$=0, 30, 60, 90, 120, 150 *or more as time on shift permits*

R=~5.0 m (7 segments including weight)
$\theta$=0, 30, 60, 90, 120, 150 *or more as time on shift permits*

R=~5.5 m (8 segments including weight)
$\theta$=0, 30, 60, 90, 120, 150 *or more as time on shift permits*

*→Total about 70 source positions.*

*As we sweep in $\theta$ one can only reduce calibration points by reducing positions in R and $\phi$.*

# Questions and Issues for Discussion

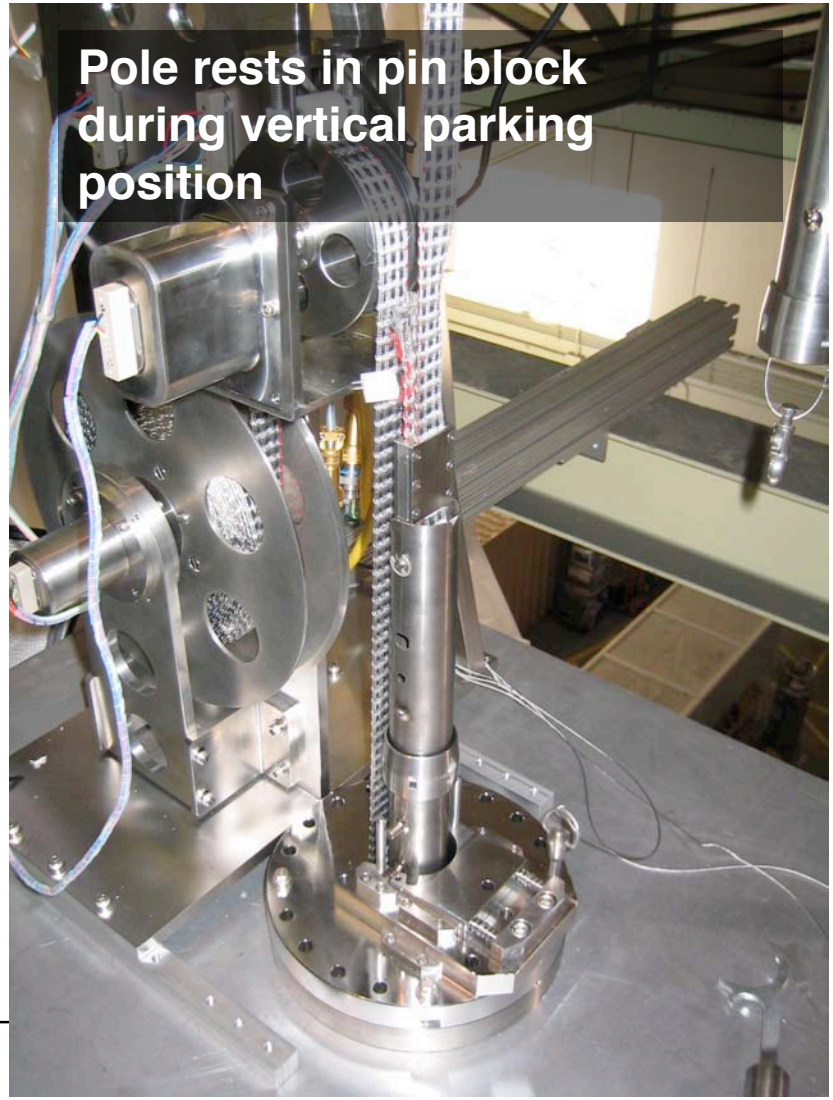
- How many 4pi calibration shifts per day?
- Do we retract and disassemble the pole at the end of each day?
- How do we train the 4pi calibration experts?

Guiding Principles

→ maximize safety
→ minimize loss of detector livetime
→ optimize calibration programs

# ‘Parking’ the Calibration Pole Overnight

Do we want to park the pole overnight or need to disassemble and remove it at the end of each shift?



# ‘Parking’ the Calibration Pole Overnight

We will need several days to perform calibrations of entire detector.

Do we want to park the pole overnight or need to disassemble it at the end of each shift?

**Advantages of leaving the pole hanging vertical in the pin block overnight**

-save ~2-3hrs of time for assembly and disassembly every day

-reduces the number of operations in the glovebox

-reduces the handling of 4pi cables in the glovebox

-reduces the possibility of errors in removing pole the end of the shift

**Disadvantages of leaving the pole hanging vertical overnight**

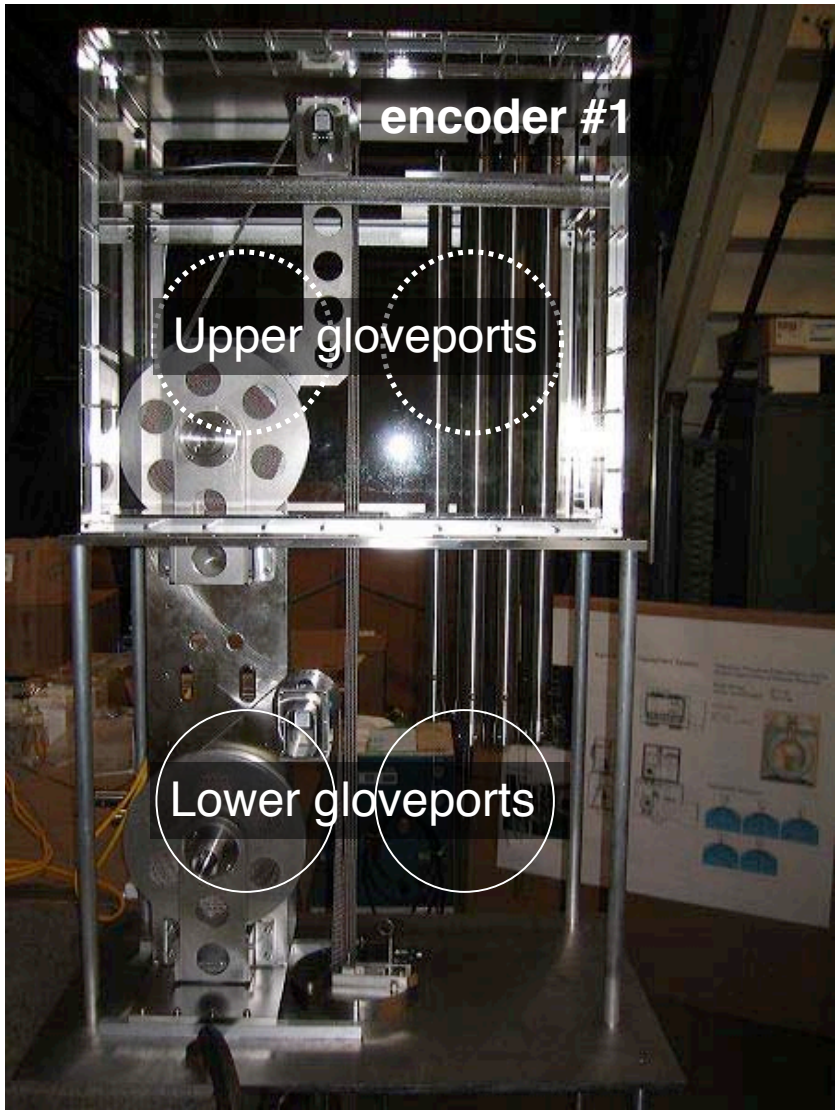
- loss of detector livetime overnight

a. tiny for reactor data

b. unfortunate if supernova occured

- gate valves open overnight

# Manpower During 4pi Deployment



# Manpower for 4pi Deployment

A minimum 4 pi team:

- lower glovebox operator
- upper glovebox operator
- control + check list person

Team should include:

- on-site calibration expert
- software/instrumentation expert
- 4pi hardware expert

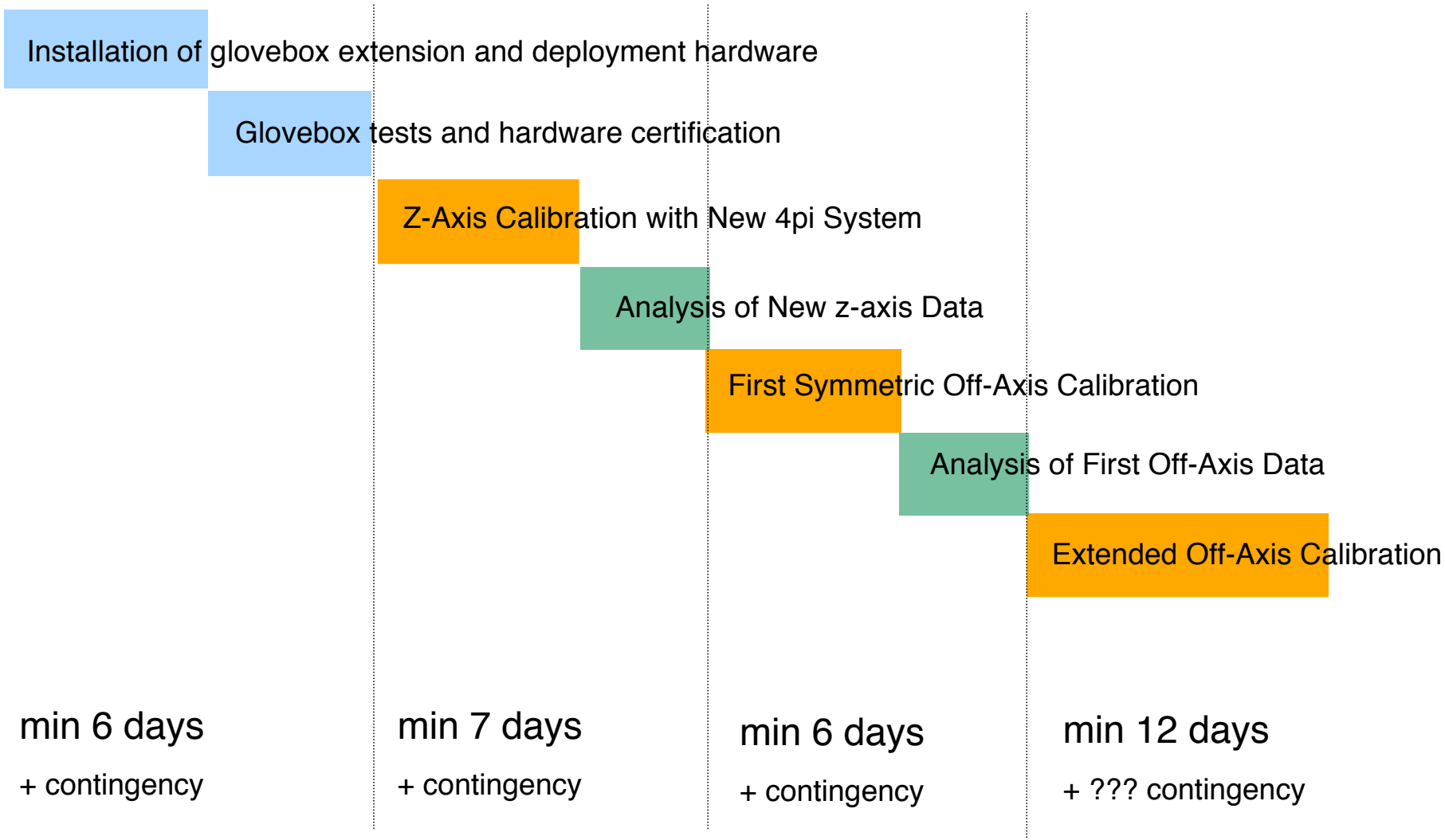
Would like to

- maximize detector safety
- minimize detector downtime
- have sufficient experts on team

My proposal:

2 teams, each team works 8-9 hrs per day
teams overlap by 1hr (16 hrs of work per day)
one team specialized in deployment
other team specialized in retraction

# Summary of Commissioning Schedule



# Suggestions, Comments, and Discussions

- think about handling and purging of cable to minimize radon exposure of detector (Kishimoto)

- analyze data and evaluate potential backgrounds after first z-axis deployment with new system before proceeding (Brian)

- what about off-axis deployments near balloon with short pole? Raising or lowering the pole? (Fred)

- check that laser spool can fit in new system.

- More tests with pole segments in various configurations in z-axis mode.

- can we reverse nitrogen flow (from rotary stage to glovebox) during deployment to minimize radon contamination.

General consensus:

- leave pole in “park” position overnight
- 2 teams for 4pi calibration activities
- do not work 24hrs to leave time to rest and for analysis