

# **Solar Orbiter**

## **Instrument contingency recovery and re-entry into timeline**

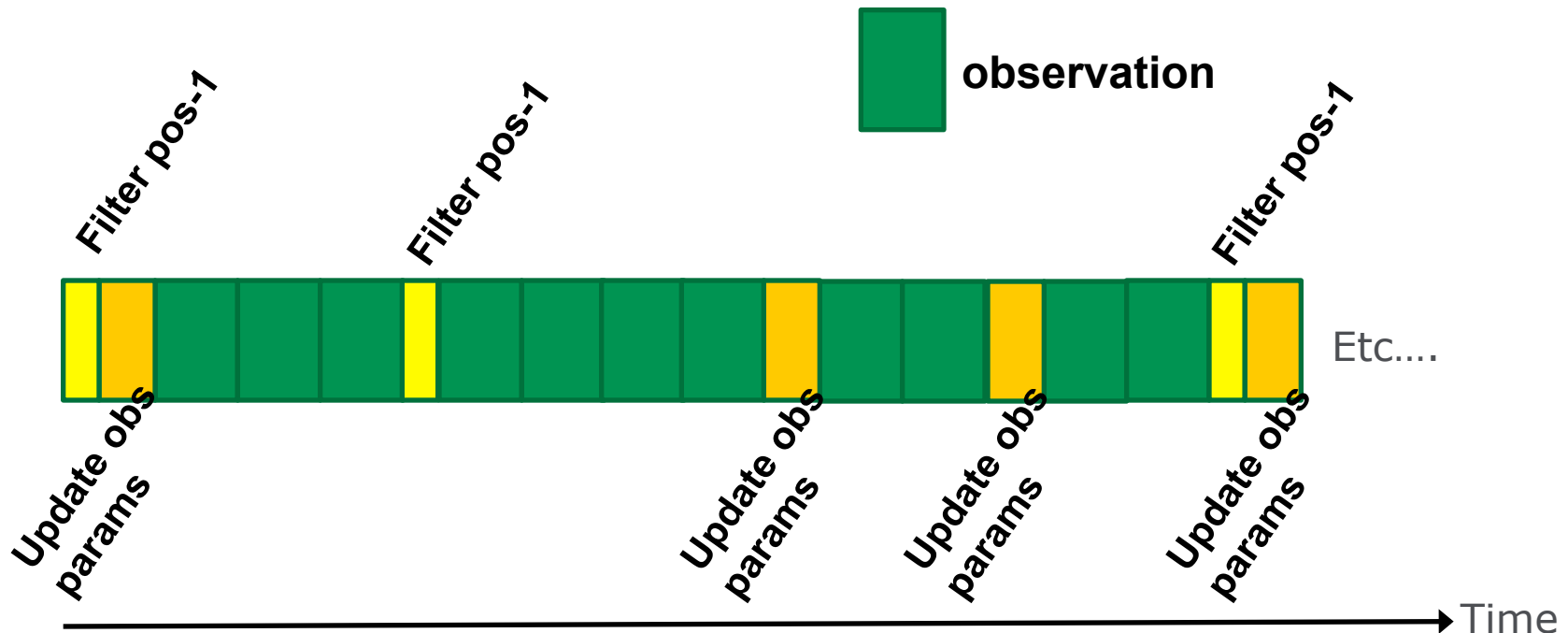
**Chris Watson**  
**ESAC/SOC**  
*Nov 2013, SOWG*

## ■ Background

- Mission planning is always done in advance
- Spacecraft platform is shared by 10 instruments
- In almost all NMP+EMP situations, if a single instrument has a problem, the approach will be to continue the planned profile with the remaining active instruments. Meanwhile contingency recovery on the problem instrument will attempt to bring it back into the plan.

## ■ plus

- Re-entry into a running timeline is not always trivial
- There can be dependencies on previous timeline commanding, e.g.
  - Filter / door / slit / feed-select positions
  - Mode
  - Observation parameters
  - Look Up Tables
  - etc



## ■ Timelines often contain assumptions about previous commanding.

- What happens if some of the above <filter> or <obs-parameter> commanding goes missing during contingency?
- We can talk about a section of timeline being “self contained” if it doesn’t make any assumption about preceding commanding

# Graphical representation of contingency with ground recovery...



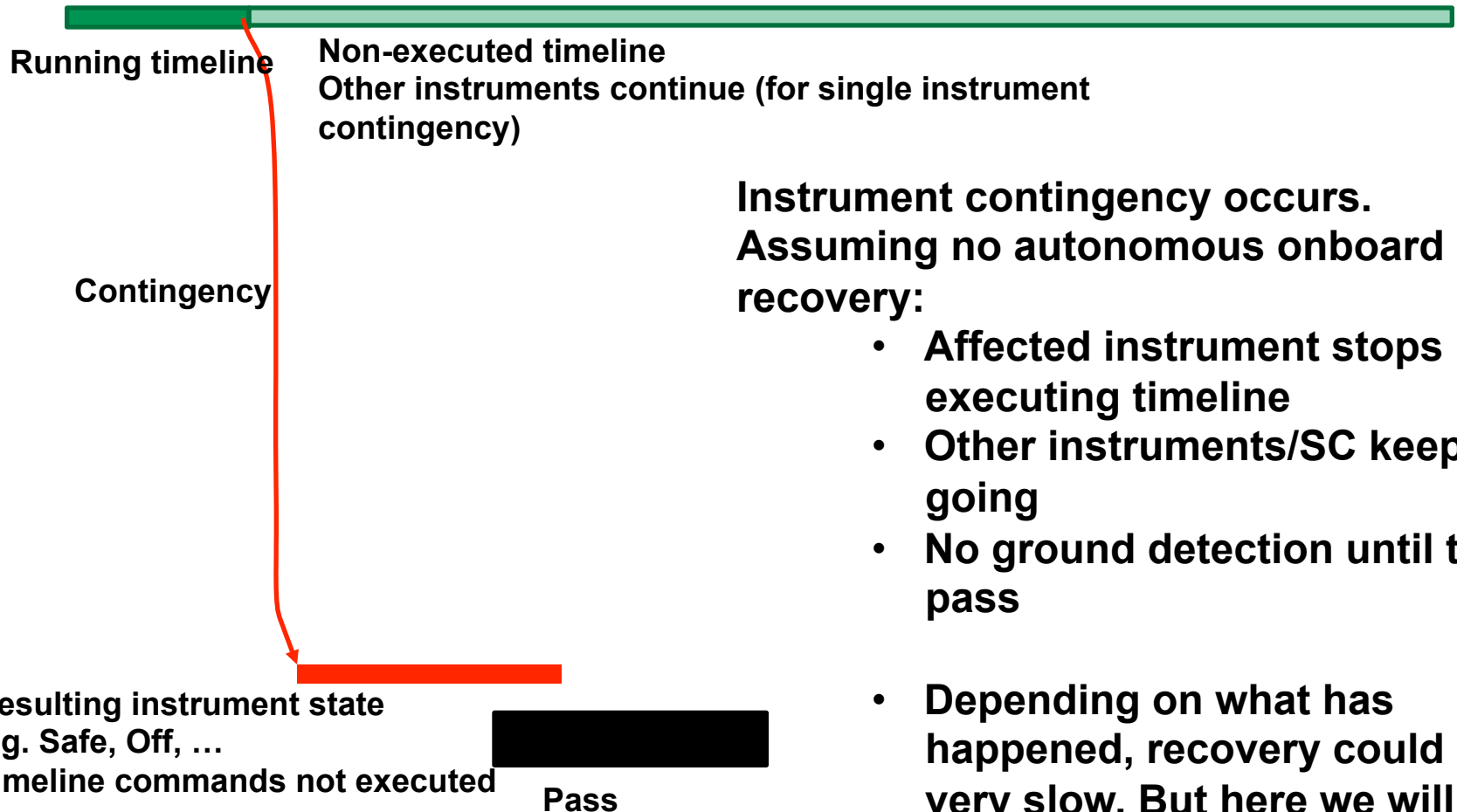
Running instrument timeline



**Preplanned instrument timeline is consistent with other instruments and with spacecraft constraints (not shown).  
I.e. this instrument timeline does not exist in isolation**

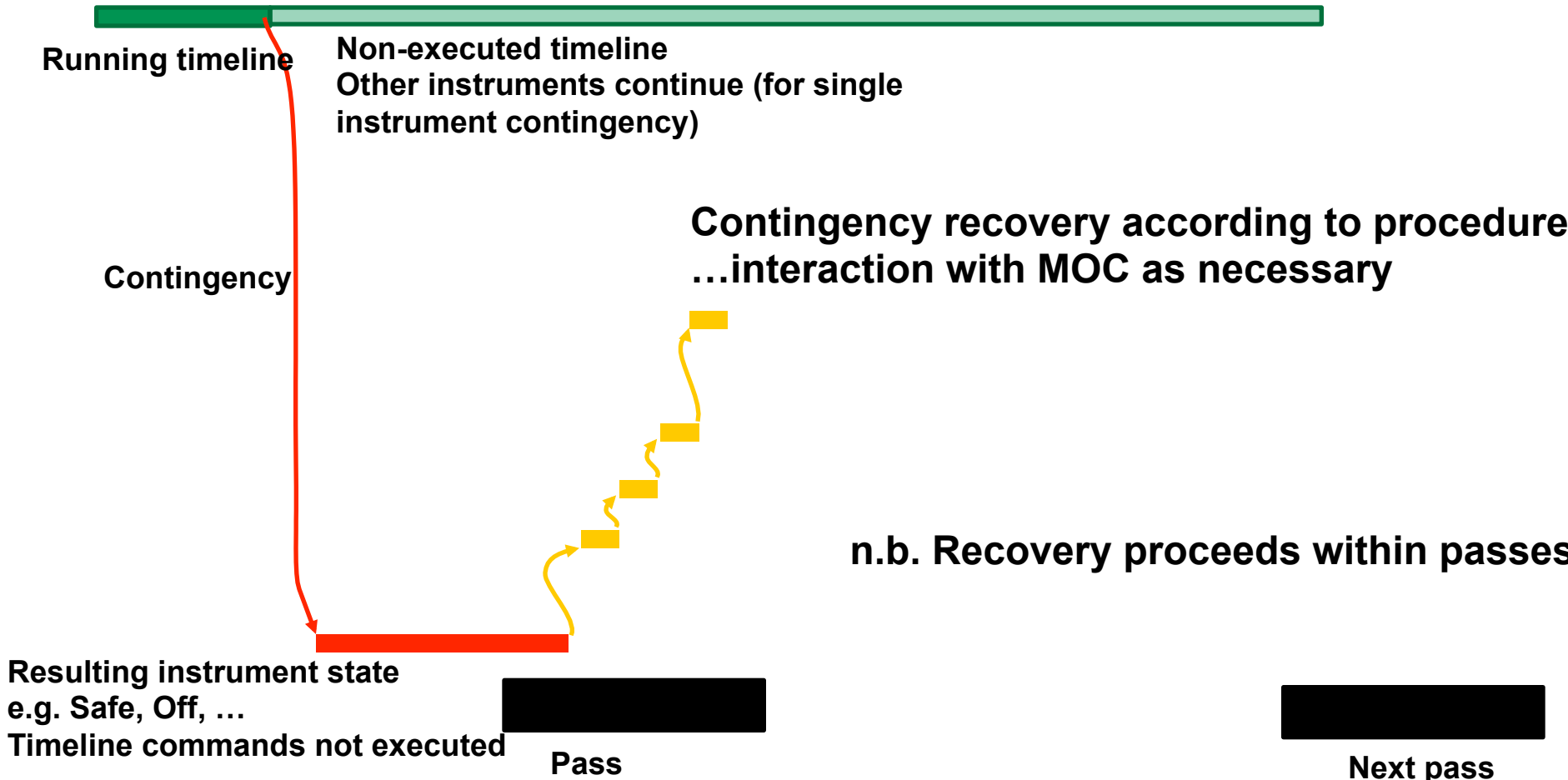


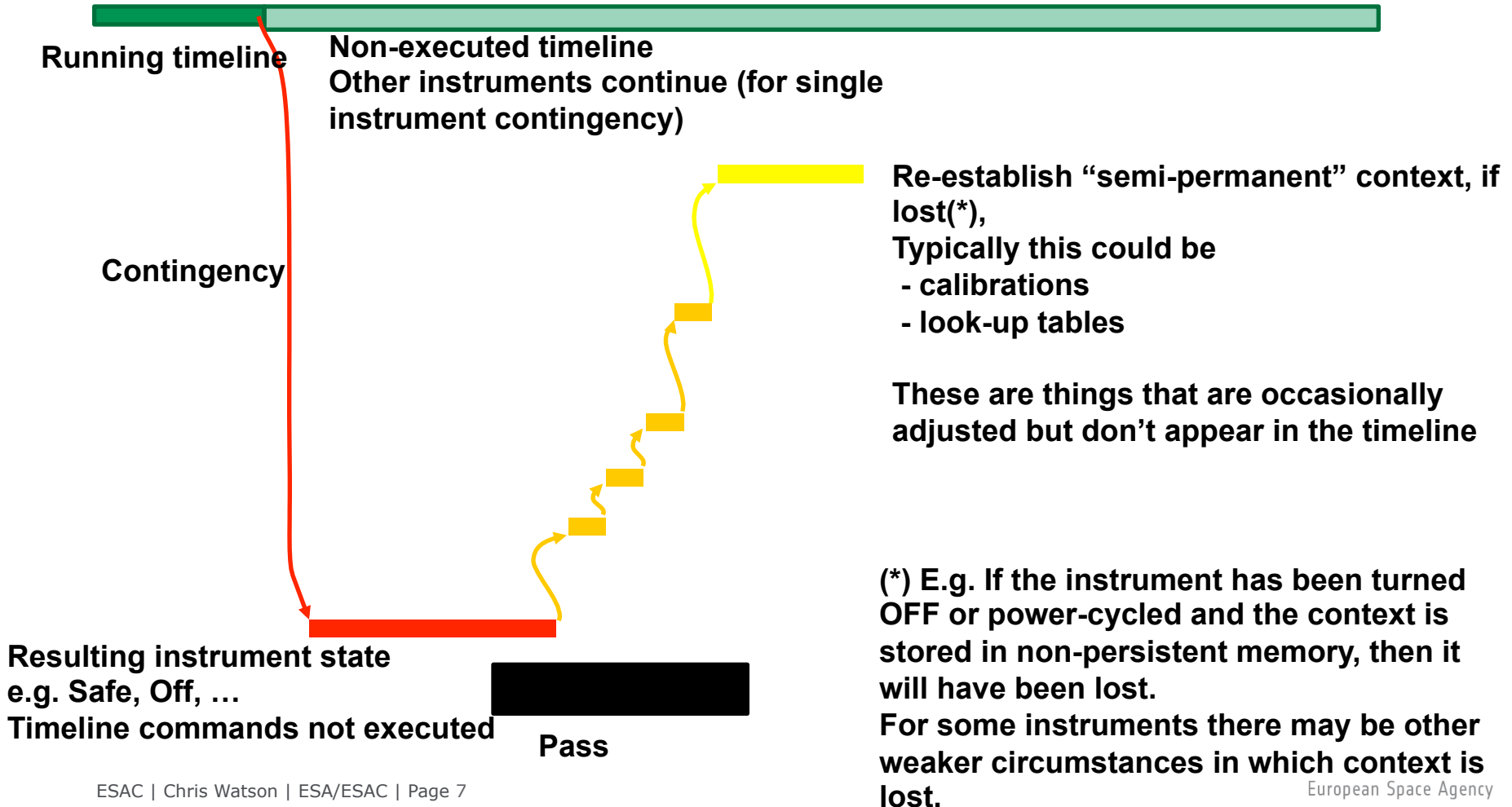
**Pass**

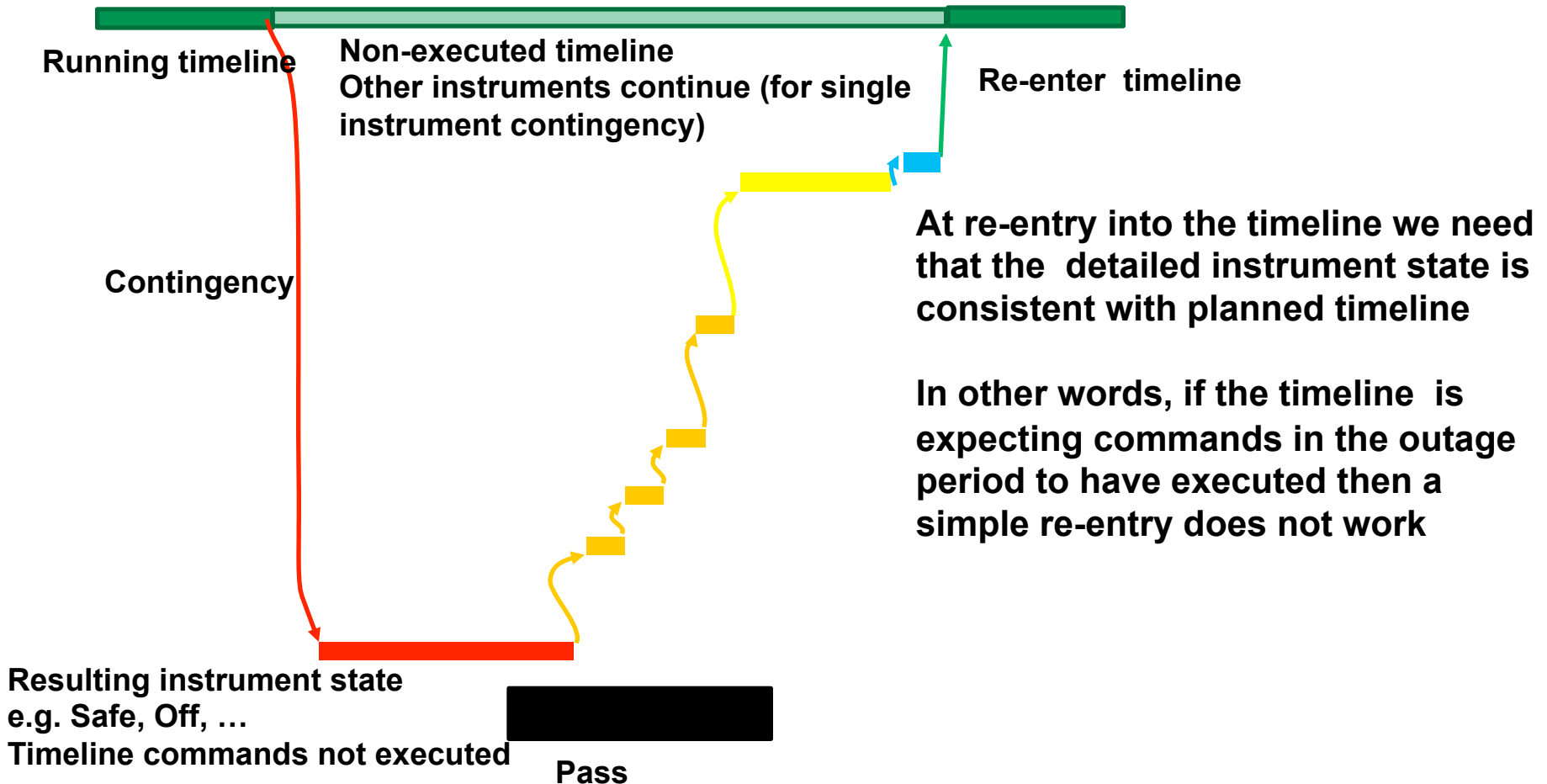


**Instrument contingency occurs.  
Assuming no autonomous onboard recovery:**

- Affected instrument stops executing timeline
- Other instruments/SC keep going
- No ground detection until the pass
- Depending on what has happened, recovery could be very slow. But here we will assume a well understood contingency where recovery









## Three aspects to the recovery back to science

### ■ Contingency recovery procedures

- Pre-defined procedures for ascending through the instrument modes back to science-ready state

### ■ Context re-establishment

- Re-establishing “semi-permanent” context. These are things that can’t have explicit values in the recovery procedure, but equally aren’t part of the normal timeline commanding either. Typically calibrations or look-up tables.
- In the end the context re-establishment is probably a step within the instrument CRPs, but the CRP can’t be the vehicle for the context data itself (unless this changes exceedingly rarely, and you reissue the procedure each time).

### ■ Timeline re-entry

- Restart the execution of the instrument timeline at a point where the instrument state is consistent with what the timeline is assuming.

**On a very simple instrument there might be no need for context re-establishment or control of timeline re-entry.**

- **In the aftermath of a contingency recovery, manually trying to determine how and where to “jump back in” to the existing plan, and manually commanding into a consistent starting state is not recommended**
- **Much better to have a strategy for how this shall be done**
- **Possibilities:**
  - Make every <observation> self-contained in terms of commanding. I.e. the observation makes no commanding assumption about previous timeline commands having been executed. Time of each <observation> start needs to be obvious to the operators.  
Simple but has the disadvantage: may lead to too-high command load in the timeline, too many unnecessary (re-enforcing) commands
  - Otherwise have some **re-entry** points, e.g. once a day, at which the instrument timeline makes no assumption about previous state.  
The location of these re-entry points has to be clear such that operators can find them easily.

## ■ Contingency recovery procedures

- The CRPs are prepared by the instrument teams.
- The instrument recovery back to “science” should ideally be single flow (no branching) to a unique end-state.  
(Although the starting point can differ depending on how serious the initial contingency was – whether the instrument was sent to off, or merely to stand-by)
- What single “science ready” state are you aiming for as the end-point of the execution of these pre-defined contingency procedures.

## ■ Context re-establishment

- How do you want to manage context re-establishment (if needed)
- Options:
  - Onboard service,
  - Context commanding stored at MOC. Instrument team responsibility to have always sent the most recent context state to MOC