The Advanced Virgo Project Office a Report from the Field

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on behalf of the Virgo Collaboration

2017 SKA Engineering Meeting

Rotterdam, 15/06/2017

Outline

- Detecting GWs with Interferometers
- Advanced Virgo (AdV)
- The AdV Project Office
- The AdV Project Management
- A Procurement Case: the CB Scaffolding
- A Project “Crisis” Case: Monolithic Suspension Failure
- Conclusions

Detecting GWs with Interferometers

Effect of GWs:

Squeeze and stretch the space in perpendicular directions: strain
$h = \Delta L / L$

We'll need:

A set of free test masses, far apart,

A means to measure their relative motion, and

Isolation of the masses from other causes of motion.

Here's the challenge:

Even for the most tremendous events in Universe, **h~10^-21**

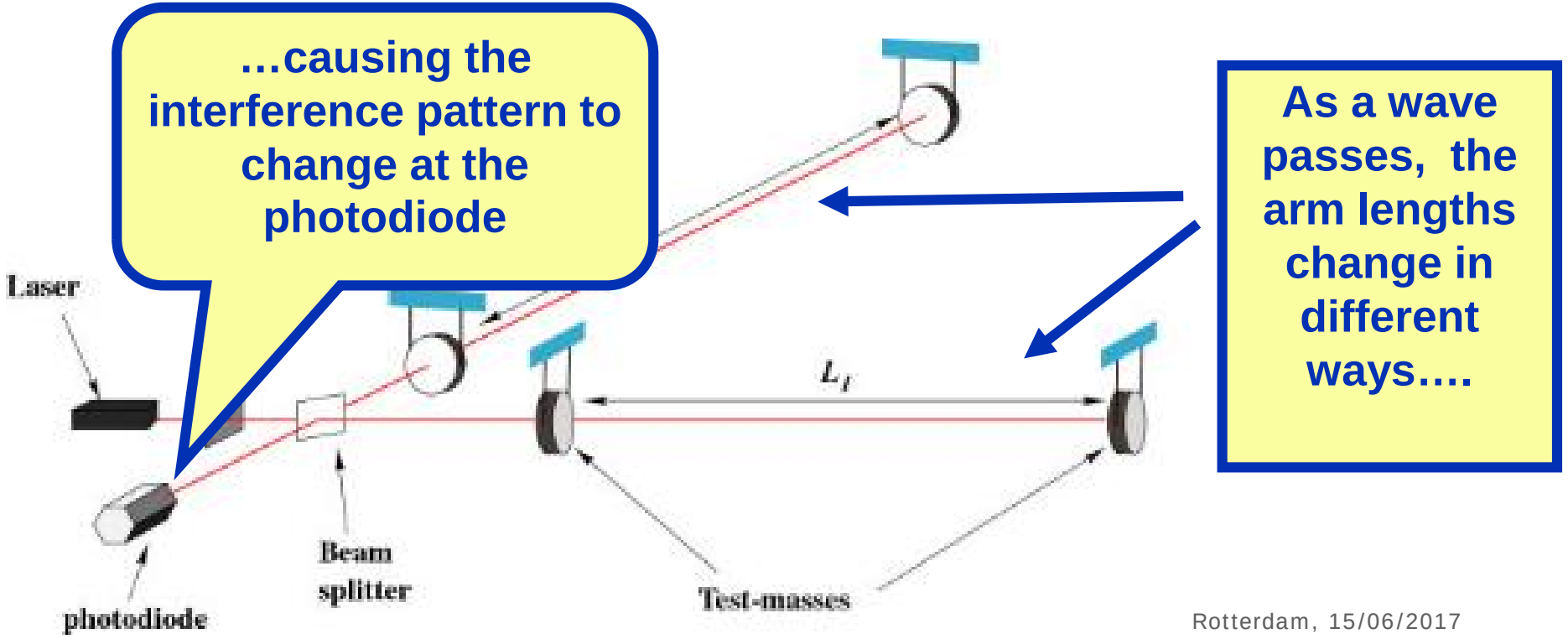
If test masses are separated by 3 km, that means a **length change less than 10^{-18}m**!

Detecting GWs with Interferometers

Laser used to measure relative lengths of two orthogonal arms

Arms are few km

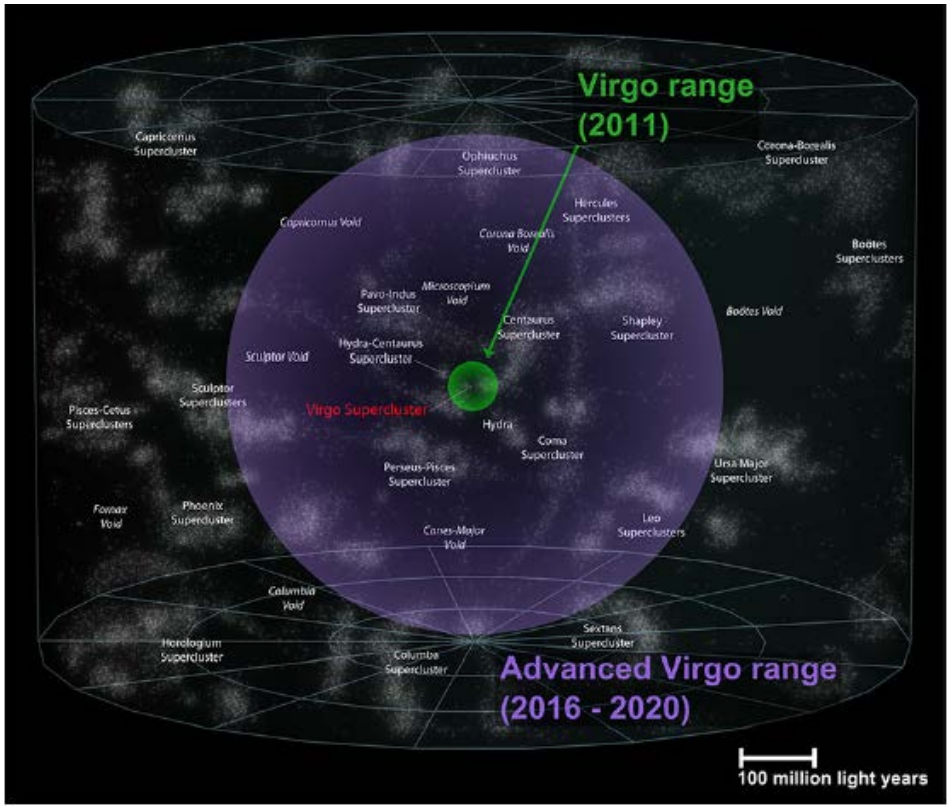
Measure difference in length to one part in 10^{21} or 10^{-18} meters



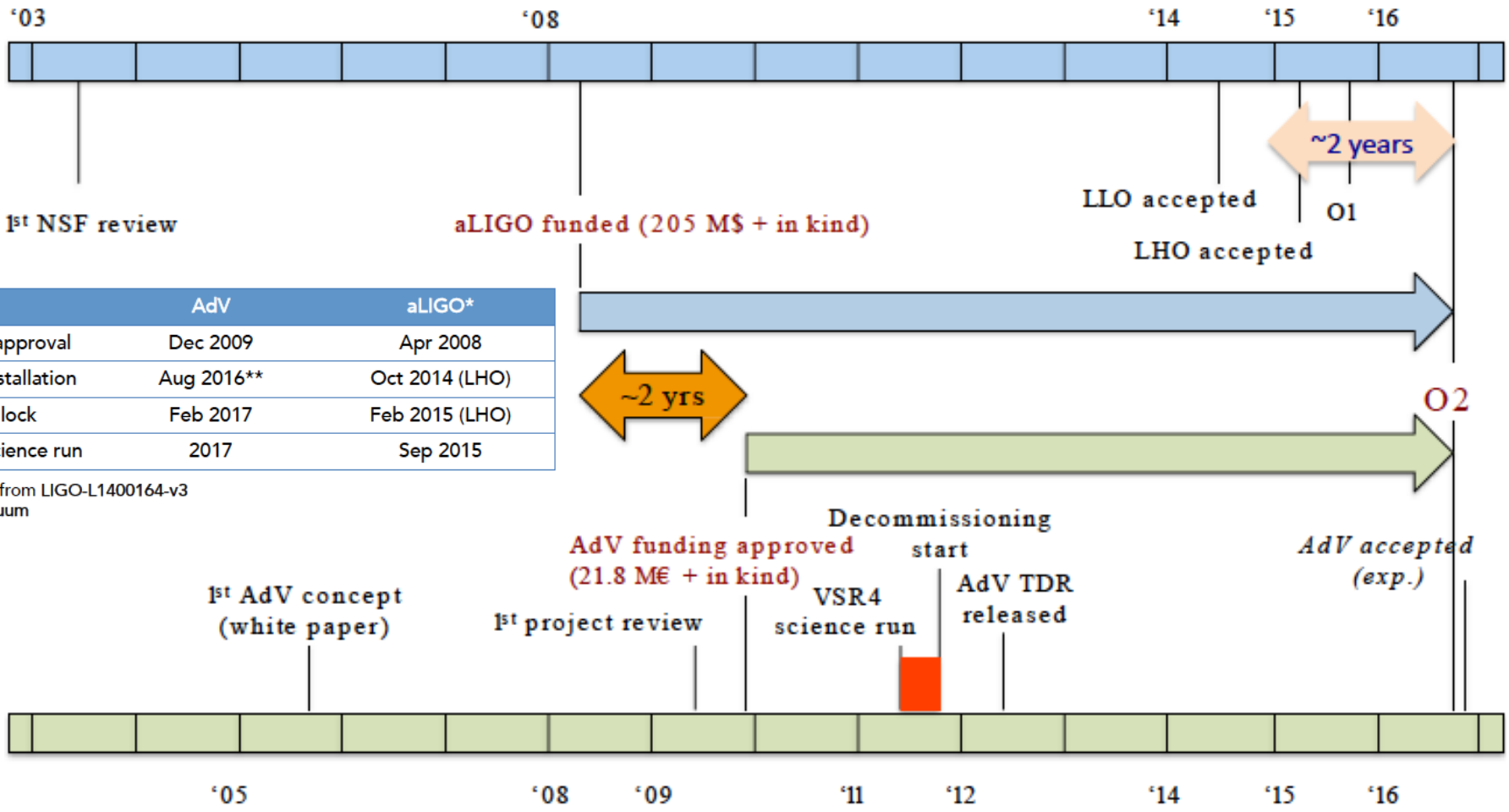
1st Generation and Advanced Detectors

LIGO and Virgo achieved the nominal sensitivity set more than a decade ago with good duty cycle during science runs but no detections were made

- A next generation of machines, was designed and constructed
  - 10 x sensitivity improvement over 1st generation
  - 1000 x increase of observation volume
  - 1 day of AdV data >> 1 yrs of Virgo data



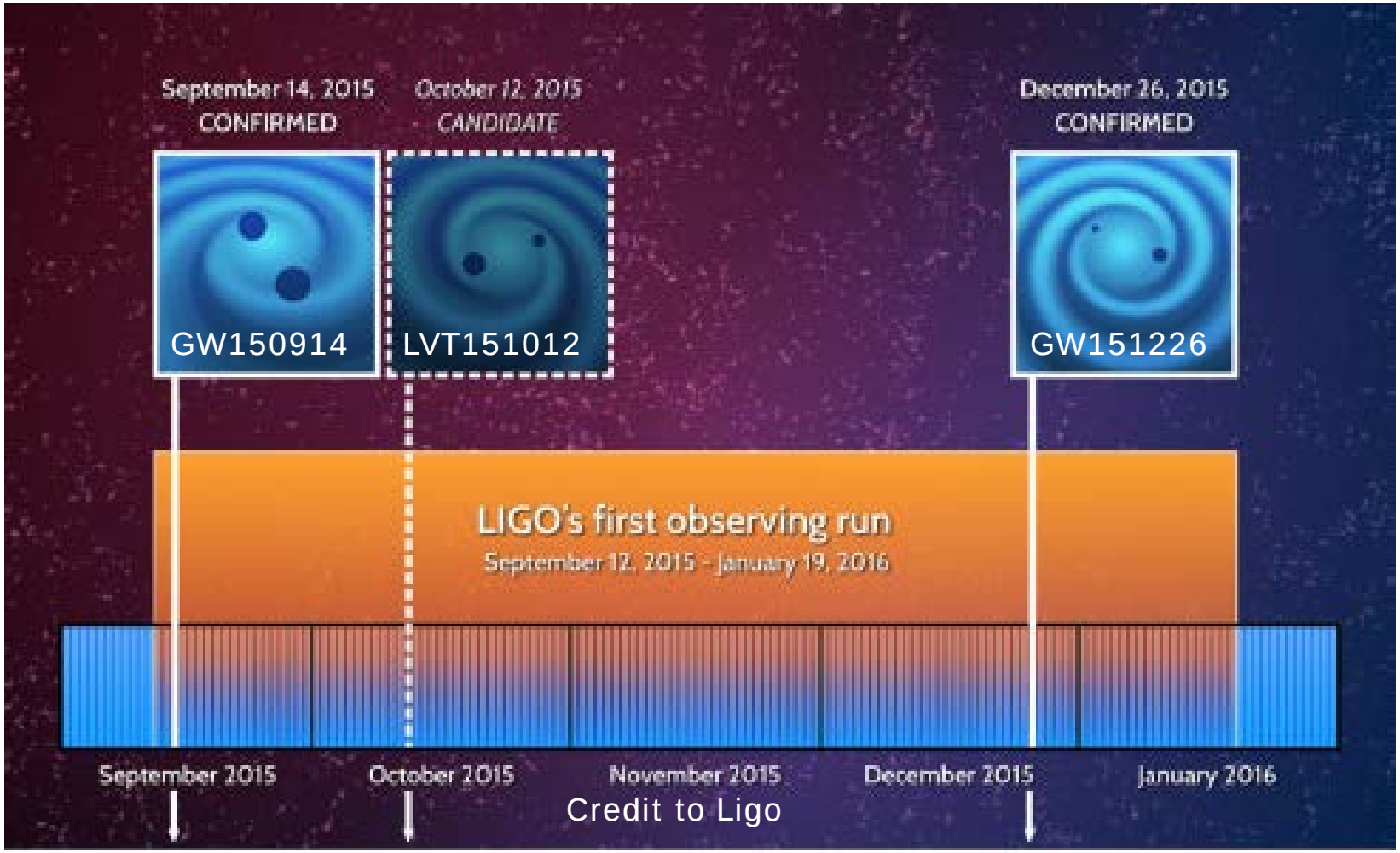
A Bit of History



	AdV	aLIGO*
Date of approval	Dec 2009	Apr 2008
End of installation	Aug 2016**	Oct 2014 (LHO)
First lock	Feb 2017	Feb 2015 (LHO)
Start of science run	2017	Sep 2015

*LIGO data from LIGO-L1400164-v3
**ITF in vacuum

The GW astronomy era has begun (and is awaiting for us...)



SNR=23.7
FAR < 6 10^{-7} yr^{-1}
Significance > 5.3 σ

SNR=9.7
FAR =0.37 yr^{-1}
Significance = 1.7 σ

SNR=13.0
FAR < 6 10^{-7} yr^{-1}
Significance > 5.3 σ

Image credit: LIGO

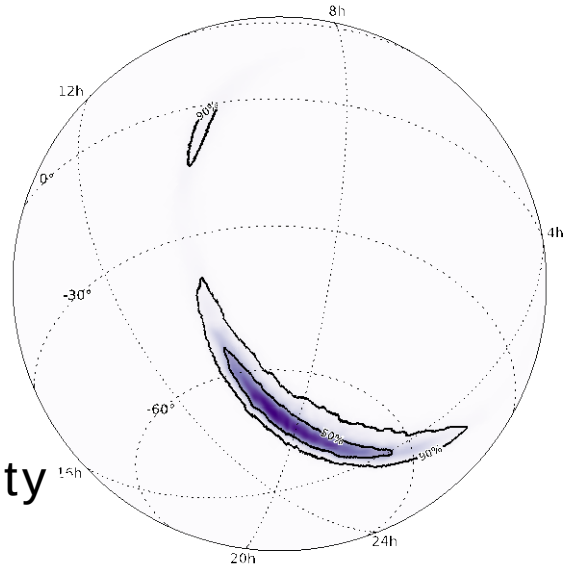
Sky location

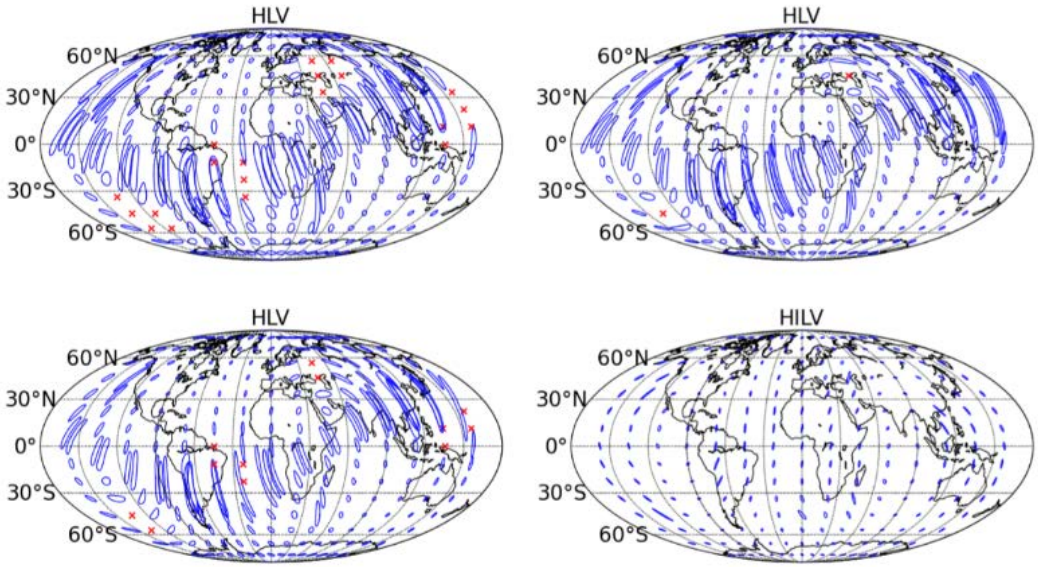
GW laser interferometers are not pointing telescopes

Sky location can be reconstructed through the time of arrival of GW radiation at the different detector sites, as well as the relative amplitude and phase of the GWs in different detectors

In the design LIGO-Virgo network, GW150914 could have been localized to less than 20 deg^2

GW150914 sky location is with large uncertainty





LVC - Living Rev. Relativity, 19, (2016),1

Advanced Virgo

- Advanced Virgo (AdV): upgrade of the Virgo interferometric detector
- Participated by scientists from France and Italy (former founders of Virgo), The Netherlands, Poland and Hungary
- Funding approved in Dec 2009 (21.8 ME + Nikhef in kind contribution)
- End of installation: July 2016
- Part of the international network (MoU with LSC)
- Short-term goal: join O2b in ~March 2017

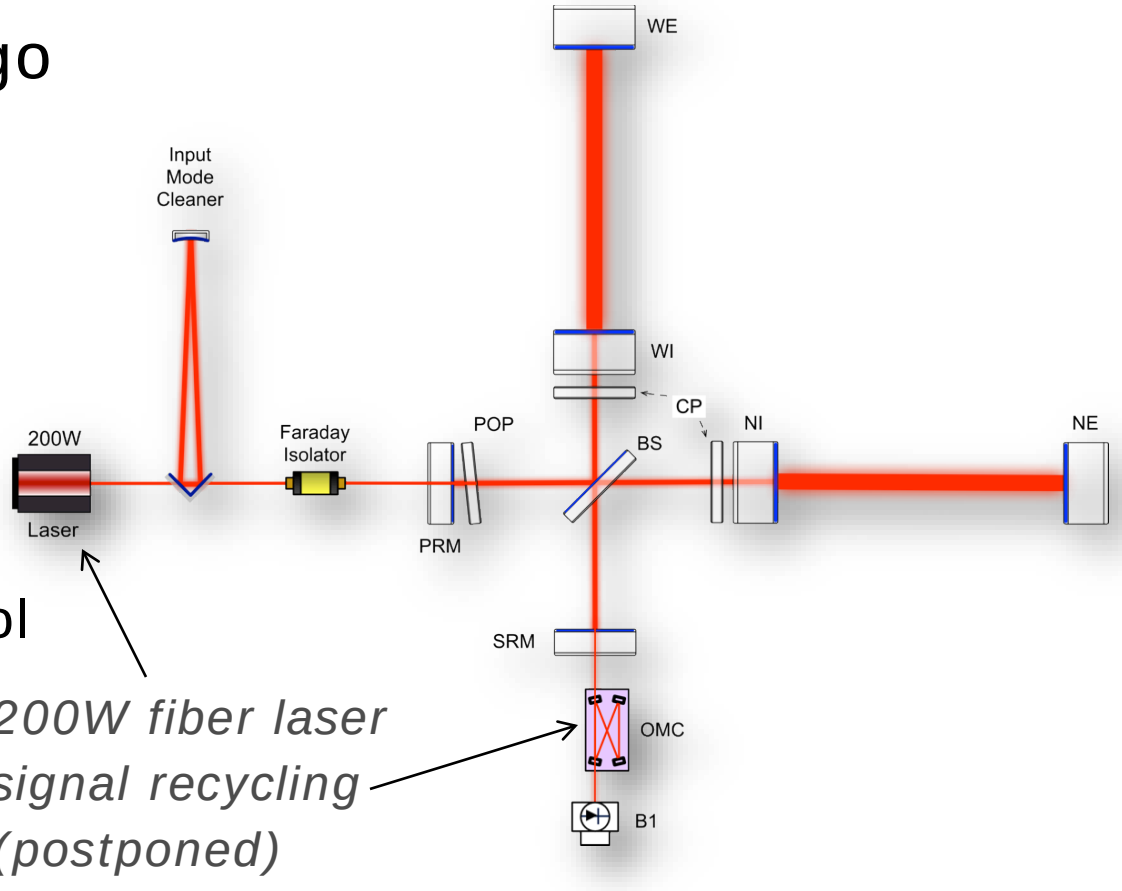
6 European countries
20 labs, ~250 authors

APC Paris
ARTEMIS Nice
EGO Cascina
INFN Firenze-Urbino
INFN Genova
INFN Napoli
INFN Perugia
INFN Pisa
INFN Roma La Sapienza
INFN Roma Tor Vergata
INFN Trento-Padova
LAL Orsay – ESPCI Paris
LAPP Annecy
LKB Paris
LMA Lyon
NIKHEF Amsterdam
POLGRAW(Poland)
RADBOUD Uni. Nijmegen
RMKI Budapest
Univ. of Valencia

AdV Detector Design

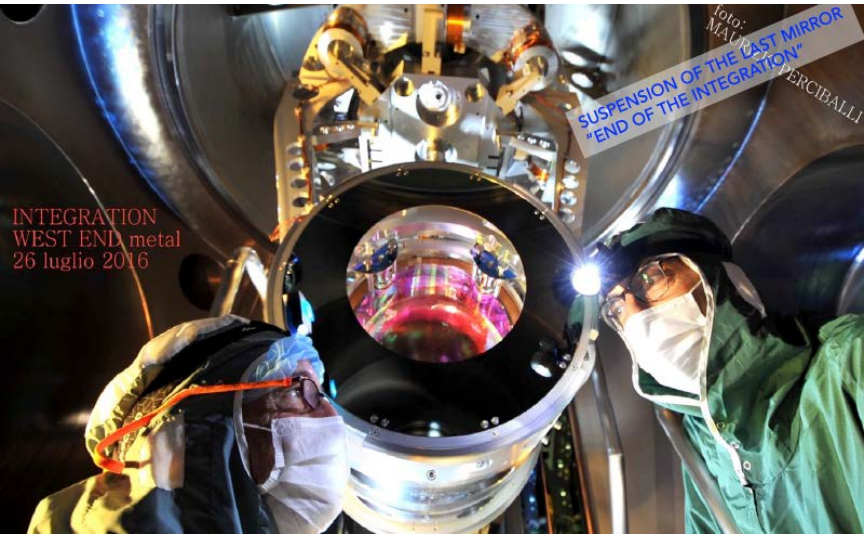
MAIN CHANGES wrt Virgo

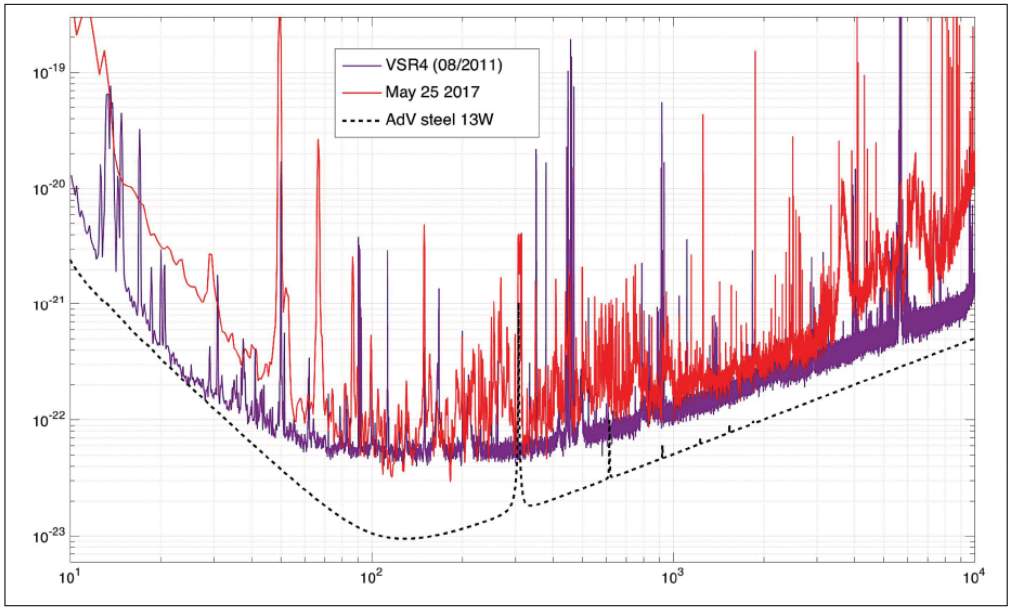
- larger beam
- heavier mirrors
- higher quality optics
- thermal control of aberrations
- thorough stray light control
- better vacuum



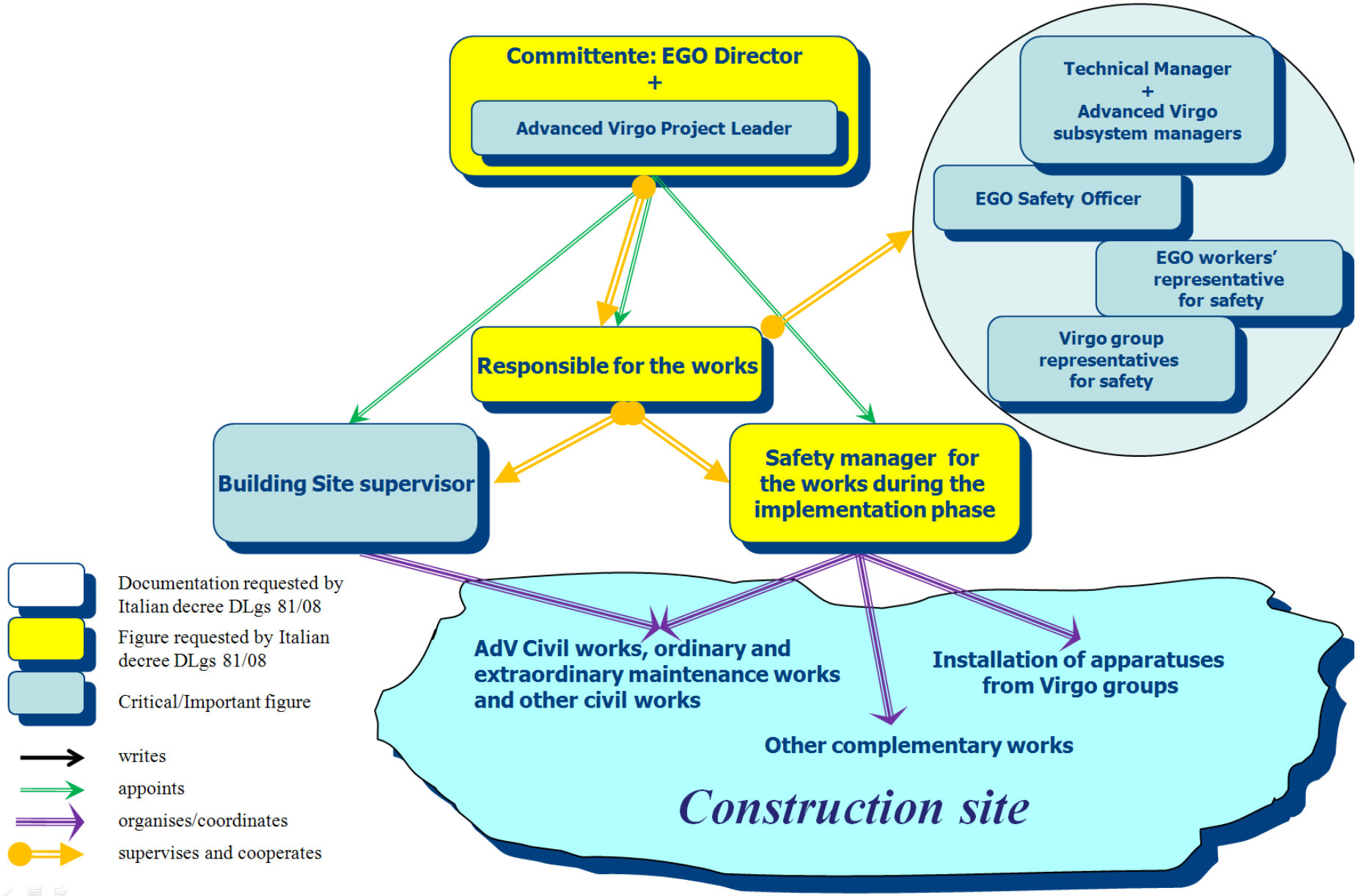
AdV Commissioning Progress

- Last mirror (WE) suspended in July 2016
- November 2016, full ITF available for commissioning
- First lock at half fringe (December 30th)
- February 2017, ITF locked at dark fringe for 15 minutes
- June 2017, ITF operational and automated, noise hunting fully ongoing. Performed the first 3 days engineering run

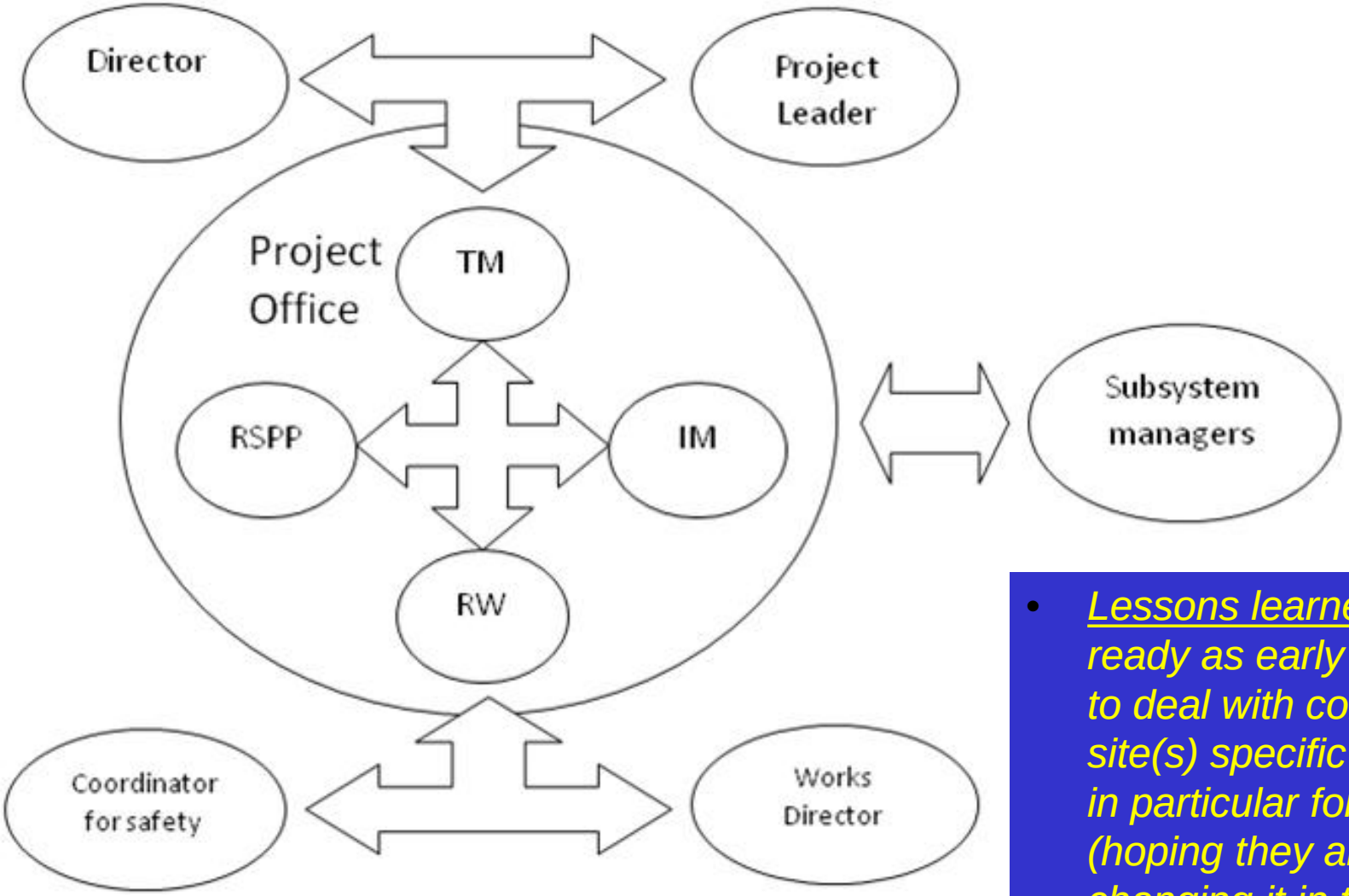




AdV Project Office: Safety Legislation "driven"

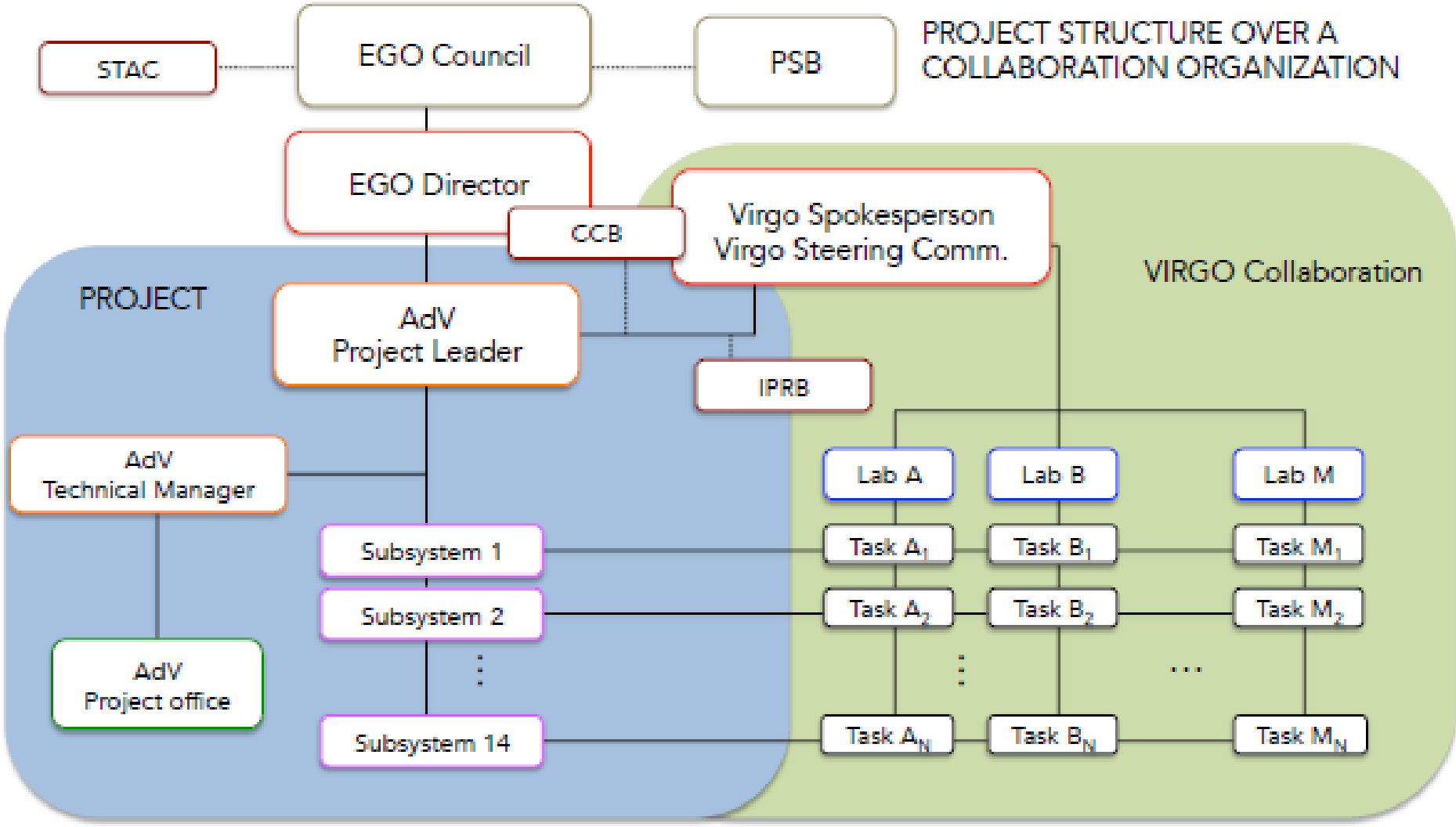


AdV Project Office: Structure



- *<u>Lessons learned</u>: Get ready as early as possible to deal with construction site(s) specific legislation, in particular for safety (hoping they are not changing it in the meantime…..)*

AdV Management Chart



AdV Project Management

On-site works coordination

- Advanced Virgo Works Requests Tracking (WRT) System: use this link for submitting a work request.
- Minutes of the weekly on-site works coordination meetings.
- Short/mid term on-site works planning (MPP/PDF).

Long-term planning and project resources

- The long-term AdVirgo planning is in the TDS, in format MPP and PDF (planning data 16/10/2012, version -p).
  - See the "annex files" section for the 2nd WBS level planning; See "other releases" for previous versions.
  - Milestones: SS milestone files, chart
  - Critical path (16/10/12)
  - Technical explanations on the planning
- Budget
  - Reference budget (17/10/12)
  - Report of the May 2012 cost review committee.
  - AdV financial procedures
- Manpower
  - Profiles of needed manpower for AdV, each SS and each laboratory (16/10/2012)
  - Table of available manpower as reported by laboratories (16/07/2012)

Work Breakdown Structure

- Advanced Virgo WBS, derived from the AdV planning (17/10/12, -p)
- Equivalence table for different versions of the WBS codes
- Subsystem WBS files. Make sure to always use the last version before changing the WBS of your SS.

Project progress

- Archive of Advanced Virgo Site News
- Monthly reports of the AdV subsystems
- Monthly report template

Interface control

- List of SS interfaces: external dependencies and inter-SS links in global planning (17/10/2012)
- Interface control matrix with links to all existing ICD documents
- Template for interface control documents

Risk management

- Risk management plan
- Risk register: list of project risks with evaluation of probability and impact, and mitigation actions

Configuration control

- AdV change requests

Standardization

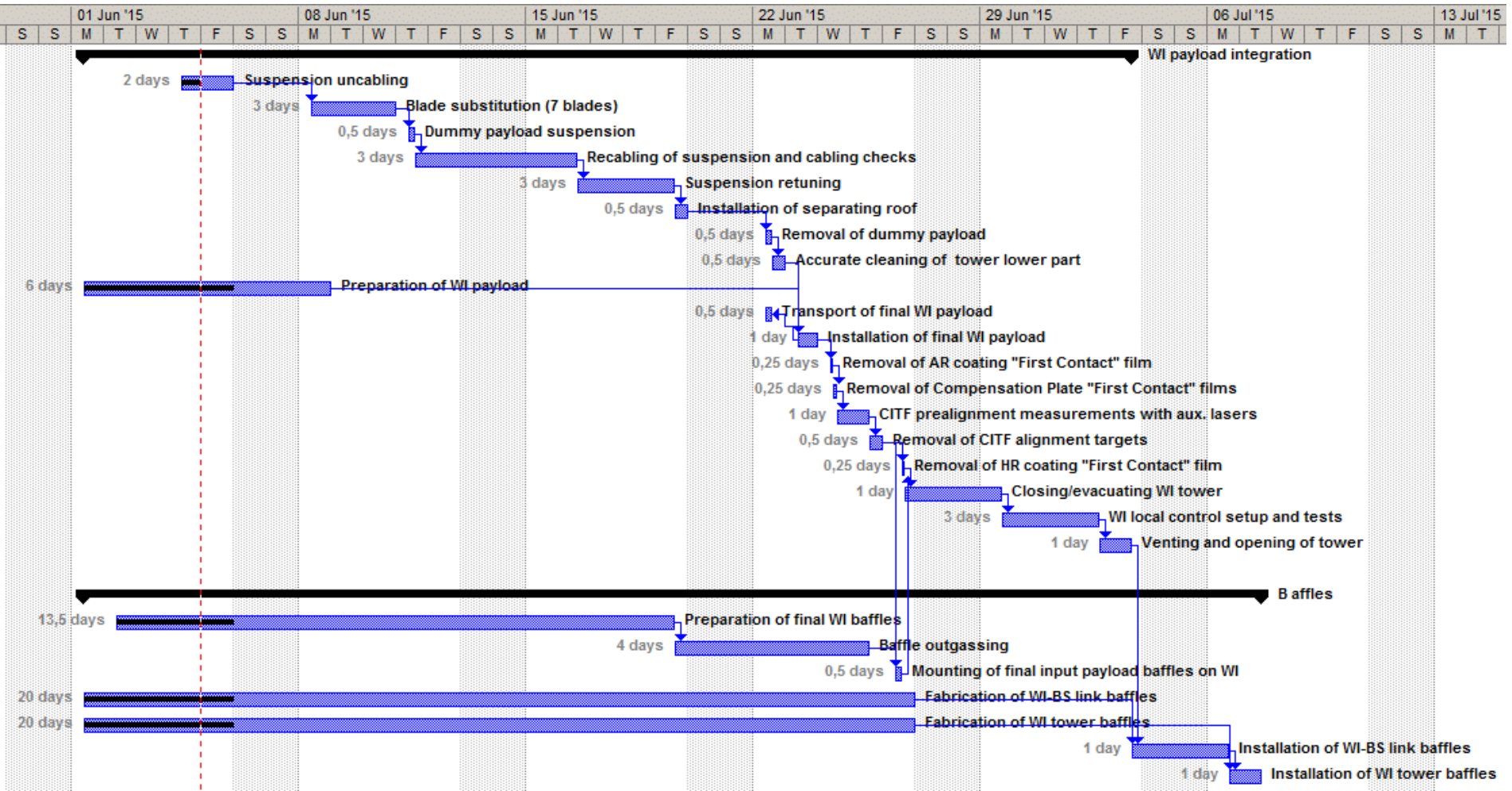
The following documents, not yet officially discussed, are proposed as guidelines for electronics development and integration.

- Guidelines for an electronics systems engineering approach
- Guidelines and Requirements for Electronics
  - Part I: Installation
  - Part II: Systems.
- Integration of electronics in Virgo: list of minimum requirements
- Integration of electronics in Virgo: check list form

www.virgo.infn.it/advirgo/protected/project_management.html

On Site Works coordination

For the most complex activities integrated detailed planning were drafted during the weekly coordination meetings, circulated and refined considering the feedback of all involved parties



Work Breakdown Structure

WBS principles

Ideally 3 levels

1. Subsystem
2. Task
3. Subtask

4th level possible if needed for work attribution to laboratories.

Everything that needs budget or manpower must be in the WBS.

Include all tasks: design, prototyping, commissioning

MIR.06.03-d	Modification scatterometer [LMA]
MIR.06.04-d	New bench for high accuracy flatness measurement- Design/Manufacturing/Test [LMA]
PAY	
PAY.01-d	Subsystem Management [Roma1]
PAY.02-d	Recoil Mass for NE and WE Monolithic Payloads
PAY.02.01-d	Recoil Mass design [Roma1]
PAY.02.02-d	Recoil Mass prototyping [Roma1]
PAY.02.03-d	Recoil Mass production [Roma1]
PAY.02.04-d	Recoil Mass integration in NE and WE Payloads [Roma1]
PAY.03-d	Recoil Mass for NI and WI Monolithic Payloads
PAY.03.01-d	Recoil Mass design [Roma1]
PAY.03.02-d	Recoil Mass prototyping [Roma1]
PAY.03.03-d	Recoil Mass production [Roma1]
PAY.03.04-d	Recoil Mass integration in NI and WI Payloads [Roma1]
PAY.04-d	Marionette for Monolithic Payloads
PAY.04.01-d	Marionette design [Roma1]
PAY.04.02-d	Marionette production [Roma1]
PAY.04.03-d	Marionette integration [Roma1]
PAY.05-d	Marionette Recoil Mass for Monolithic Payloads

Interface Management

AdVirgo interface control matrix

The links in the matrix entries lead to the last version of the interface control document between the two subsystems.

	DAQ	DET	IME	INJ	ISC	MIR	OSD	PAY	PSL	SAT	TCS	VAC
DAQ		v0.1	v0.1					v0.1				v0.1
DET			v0.1	v0.2	v0.1		v0.1	v0.1				
IME				X								v0.1
INJ					v0.1	X		v0.1	**v1.2**	v0.1		X
ISC							v0.1	v0.1	X	v0.1		
MIR							v0.1	v0.1			v0.1	
OSD								v0.1			v0.1	
PAY										v0.1	v0.1	v0.1
PSL												
SAT												v0.1
TCS												v0.1
VAC												

X = to be written

ICD documents version 0.1: interfaces inserted in ICD template based on the subsystem WBS information.

Interface Management

VAC << SLC: baffles inside the central interferometer links installed

< SLC < Installation < Central interferometer link baffles installation (31/10/13)

VAC << SLC: small cryotrap baffles installed

< SLC < Installation < Small cryotrap baffles installation (07/02/14)

SS external dependencies

Connections in global planning

SS depends on task from other SS

TCS

TCS external dependencies:

Linked to:

TCS << AdV: Start of second upgrade phase

< MAN < AdV: Start of spending for second upgrade phase (01/07/14)

TCS << DAQ: DAQ-Boxes with all mezzanines (ADC, DAC, detection) ready for installation

< DAQ < DAQ: DAQ-Boxes with all mezzanines (ADC, DAC, detection) ready for installation (02/05/14)

TCS << DET: Start of detection area pre-commissioning

< DET < DET: Start of detection area pre-commissioning (18/11/14)

TCS << INJ: SS precommissioning finished

< INJ < General opto-mechanical layout, common parts construction, Installation and pre-commissioning < Pre-Commissioning (Low power) (03/03/15)

TCS << INJ: SS precommissioning start

< INJ < INJ:SS precommissioning start (30/09/14)

TCS << MIR: CP produced

< MIR < Coatings < 2 CP coatings (09/05/14)

TCS << OSD: Opt. design finalized

< MAN < AdV: Optical design frozen (31/10/11)

TCS << PAY: Detection Beam Line complete

< PAY < PAY:WI payload suspended and controlled (06/02/15)

TCS << PAY: Input payloads integrated into towers

< PAY < PAY:WI payload suspended and controlled (03/12/14)

TCS << PAY: NE integrated into tower

< PAY < PAY:NE payload suspended and controlled (24/07/15)

TCS << PAY: PR integrated into tower

< PAY < PAY:PR payload suspended and controlled (09/01/15)

TCS << PAY: WE integrated into tower

< PAY < PAY:WE payload suspended and controlled (12/06/15)

TCS << VAC: Central towers displaced

< VAC < VAC:Central Towers displaced (03/04/13)

TCS << VAC: enlarged links design finalized

< VAC < Enlarged Links < Design finalization (with SLC) (14/02/13)

TCS << VAC: enlarged links installed

< VAC < Enlarged Links < Installation (06/03/14)

TCS << VAC: NE displacement finished

< VAC < VAC:NE displacement finished (19/06/13)

Other SS depends on task from this SS

Other subsystems' external dependencies from TCS:

Linked to:

PAY << TCS:Ring Heater Prototype Ready

< TCS < Ring Heater < Full-scale RH prototype assembly and (05/04/13)

VAC

VAC external dependencies:

Linked to:

VAC << AdV: Start of second upgrade phase

< MAN < AdV: Start of spending for second upgrade phase (01/07/14)

VAC << EGO: Scaffolding installation finish

< EGO < Scaffolding < EGO: CB scaffolding installed (30/08/13)

Risk Management

Advanced Virgo Risk Register

Level	Probability
5	Extremely Likely – 90% probability of occurrence over the project life
4	Highly Likely – 70% probability of occurrence over the project life
3	Moderately Likely – 50% probability of occurrence over the project life
2	Unlikely – 30 % probability of occurrence over the project life
1	Highly Unlikely – 10% probability of occurrence over the project life

Level	Cost Consequence	Schedule Consequence	Performance Consequence
5	> 300 kE	> 4 months	Unacceptable
4	50 ... 300 kE	2 - 4 months	Doesn't meet important goals
3	25 ... 50 kE	1 - 2 months	Doesn't meet goals in some areas
2	5 ... 25 kE	<1 month	Doesn't meet high goals
1	< 5 kE	Negligible	Negligible

			Initial Risk Evaluation								
Risk manager	Risk Event	Affected WBS code	Prob-ability	Consequence			Risk Score	Priority follow-up list	Action Date (check)	Proposed Mitigation Actions	Comments
				Cost	Sched-ule	Perform					
A.Paoli	If specifications for Detailed Design are not sufficient in view of the final AdV sensitivity, the project shall be revised.	IME.03-h, IME.05-h	1	4	3	2	Low		Dec 10	Alternative strategy: assuming high safety margins (i.e. damping platforms, increasing the distance of the machines, etc.)	
A.Paoli	Decision on electronics displacement and design can delay infrastructure support works or change costs.	IME.06-h	2	3	1	3	Med		Dec 10		
A.Paoli	Realization of clean room for the DET lab: feasibility under study for space issues. Such works will increase the cost.	IME.07-h	5	3	1	5	High		Jun 10	Verification of the feasibility to take the decision.	

Configuration Control

2014

2014/004 Increase of the End Mirror transmission

2014/003 Clean air filtering for central building ventilation system

2014/002 Continuous LN2 supply for small cryotraps

2014/001 Lower clamps design modification for test-mass payloads

2013

2013/001 Auxiliary lasers

2012

2012/001 Foundations for the PAY test facility

2011

2011/001 Upgrade of machines for fiber pulling

AdV CRQ 2014/002

Continuous LN2 supply for small cryotraps

Abstract

The two smalltraps cryostats are presently under construction; their delivery is foreseen at the end November 2014. In the original design of AdV they have been conceived as operating in batch mode refilling the 200 liters reservoir twice per week, such as for the cryotrap which was functioning during +. Here we propose to install a dedicated LN2 supply line per each smalltrap, in order to operate th smalltraps in continuous mode, feeding a continuous flux of cryogen. Main advantage is to improve th duty cycle of AdV, limiting the downtime for maintenance breaks, and to improve the operationa functioning of the two smalltraps.

Change request documents

VIR-0509A-14	AdV change request - Continuous LN2 supply for smalltraps
VIR-0517A-14	IPRB Report on the change request "Continuous LN2 Supply for smalltrap"

Other documents

VIR-0504A-14	Presentation at weekly meeting 06/11/2014

Review Process (IPRB)

Past reviews

- **Acceptance reviews**
  - Injection/detection clean rooms: see the July 2014 report: VIR-0384A-14, October report: VIR-0457A-14 and the final November rep
- **Installation reviews**
  - **Questions asked to the subsystem manager for an installation review:**

1. Most recent version of the planning, are the interfaces checked?
2. Status of various components: which are the missing ones?
3. Hardware data base: status of the registration of the components and their documentation?
4. What are the sensors monitoring the active devices?
5. What is the list of channels produced by the subsystem?
6. What are the acceptance criteria you propose for a possible acceptance review?

  - INJ: January 2014. Final report: VIR-0011A-14.
  - PSL: Febrary 2014. Final report: VIR-0057A-14.
- **Change request reviews (see also the AdV CRQ web page)**
  - CRE-2014/004: Increasing the end test mass transmission (VIR-0535A-14). Nov 2014 review, report: VIR-0596A-14.
  - CRE-2014/003: Clean air filtering for central building ventilation system(VIR-0512A-14). Nov 2014 review, report: VIR-0519A-14.
  - CRE-2014/002: Continuous LN2 supply for small traps (VIR-0509A-14). Nov. 2014 review, report: VIR-0521A-14.
  - CRE-2014/001: Lower clamps design modification for test-mass payloads (VIR-0463A-14). July-Oct. 2014 review , report: VIR-0469A
  - CRE-2013/001: Auxiliary laser wavelength change: (VIR-0352B-13). April 2014 review, report: VIR-0204A-14.
  - CRE-2012/001: Infrastructure modification for the PAY test facility. Oct. 2012 review, report: VIR-0394A-12.
  - CRE-2011/001: Upgrade of the fiber machines. Sep-Nov 2011 review, report VIR-0698A-11.
  - CRE-2010/001: CRE- PSL baseline change (fiber solution). December 2010 review, report VIR-0710A-10.
    - April 2015 follow up review: report VIR-0208A-15.
- **Technical readiness reviews**
  - First cryolink; May 2011. Final report: VIR-0323A-11.
  - 100W laser: Nov-Dec 2011. Final report: VIR-0730A-11

Tools: Quality Control Tracking System

Advanced Virgo Quality Control Tracking System (QCT)

Main | My View | Sheets List | New Sheet | My Account | Help | Logout | Check Sheet | Jump

Example: BS03 mirror

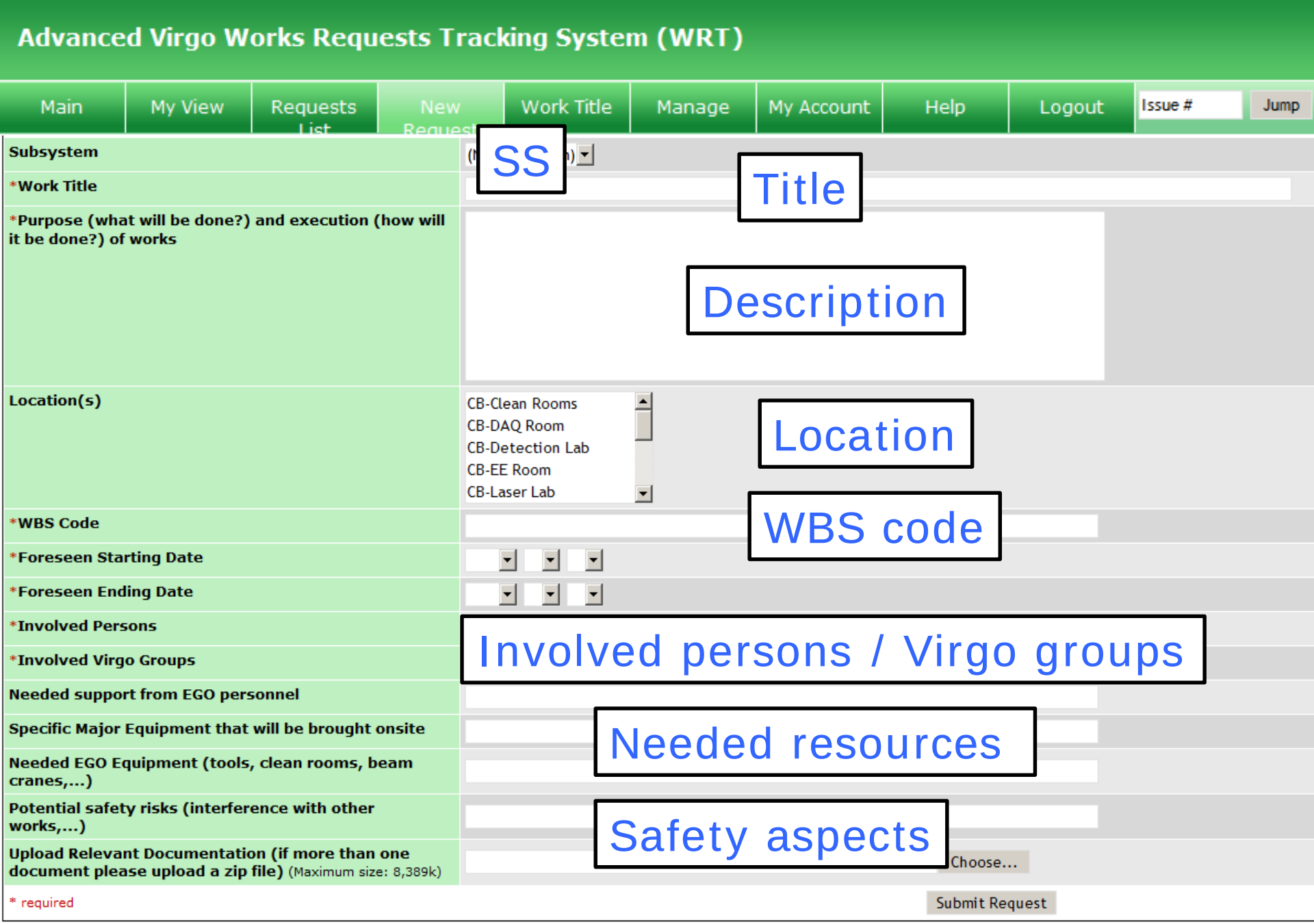
Recently Visited: 0000057, 0000059, 0000074, 0000084

View Check Sheets Details [Jump to Notes] [<<] [>>] [Check Sheet History] [Print]

ID	Project	Subsystem		Date Submitted	Last Update
0000060	Advanced Virgo	[] MIR		2013-10-25 12:17	2015-10-12 20:58

Reporter	richard
Subsystem Manager	
Status	non-compliant ← Not all documentation available yet
Component	0000060: Beam Splitter Mirror 03
Required Documentation	Substrates: Data sheet (Heraeus): VIR-0614A-11: https://tds.ego-gw.it/ql/?c=8671 [^] Absorption measurements (LMA): VIR-0567A-11: https://tds.ego-gw.it/ql/?c=8624 [^] Acceptance reports: VIR-0605A-11: https://tds.ego-gw.it/ql/?c=8662 [^] VIR-0606A-11: https://tds.ego-gw.it/ql/?c=8663 [^] Polishing: Specifications (LMA): VIR-0316A-12: https://tds.ego-gw.it/ql/?c=9137 [^] Measurements (Zygo): VIR-0378A-14: https://tds.ego-gw.it/ql/?c=10428 [^] Measurements (LMA): Mirror characterisation (LMA): ← Spare - not coated yet
Quality Priority Level (QPL) - Cost	4 (50 ... 300 kE)
Quality Priority Level (QPL) - Delay	5 (> 4 months)
Quality Priority Level (QPL) - Performance	5 (Unacceptable)
Attached Files	

Available documentation


Advanced Virgo Works Requests Tracking System (WRT)
Main
My View
Requests List
New Request
Work Title
Manage
My Account
Help
Logout
Issue #
Jump
Subsystem
SS
*Work Title
Title
*Purpose (what will be done?) and execution (how will it be done?) of works
Description
Location(s)
CB-Clean Rooms
CB-DAQ Room
CB-Detection Lab
CB-EE Room
CB-Laser Lab
Location
*WBS Code
WBS code
*Foreseen Starting Date
*Foreseen Ending Date
*Involved Persons
*Involved Virgo Groups
Involved persons / Virgo groups
Needed support from EGO personnel
Specific Major Equipment that will be brought onsite
Needed EGO Equipment (tools, clean rooms, beam cranes,...)
Needed resources
Potential safety risks (interference with other works,...)
Safety aspects
Upload Relevant Documentation (if more than one document please upload a zip file) (Maximum size: 8,389k)
Choose...
* required
Submit Request

Tools: Hardware Inventory

HW inventory for keeping track of installed components

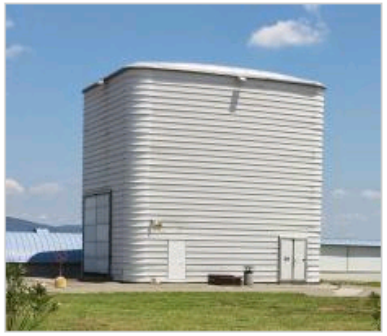
- Electronics, viewports, optics, ...
- Location based

Location

Map

Mode Cleaner Building (MCB)

This is a Building



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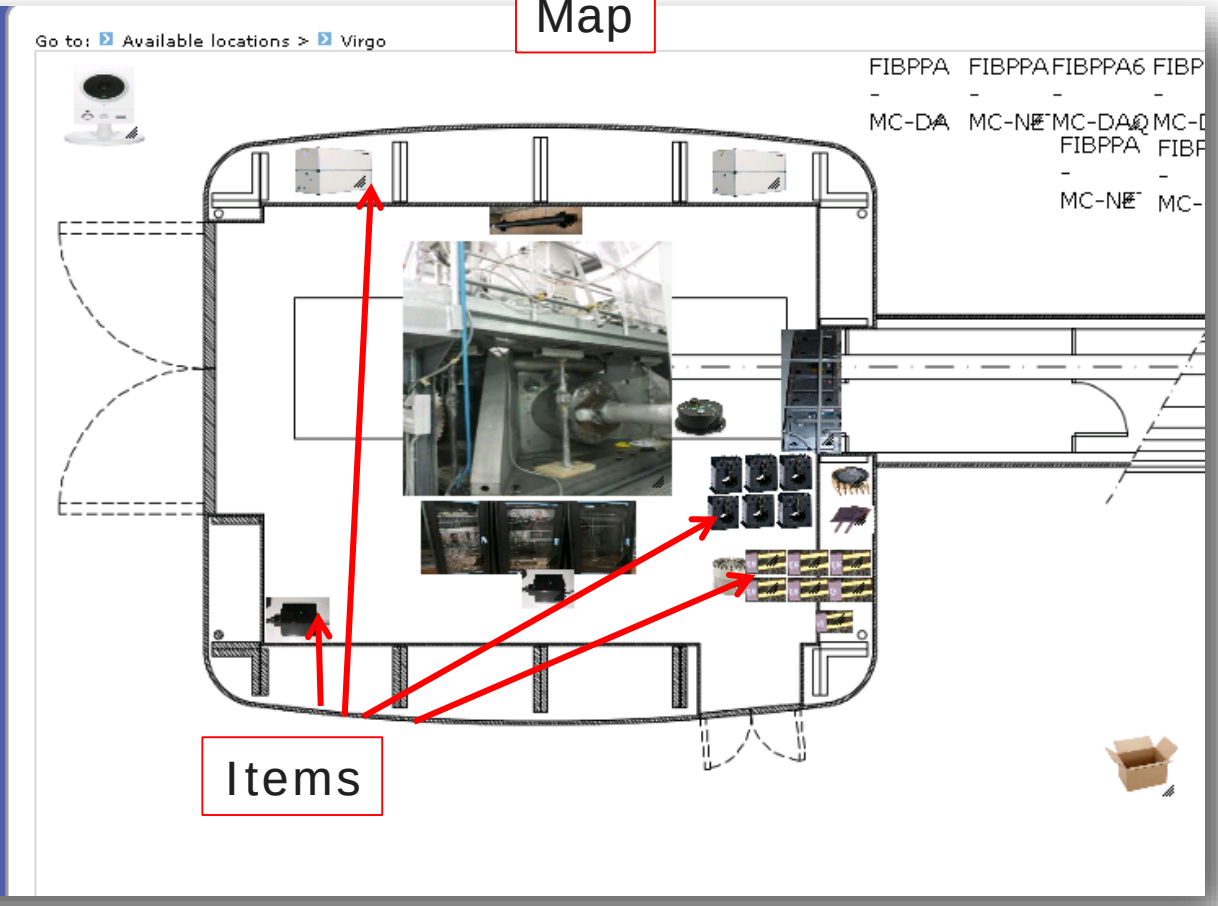
Date	Details	User
21/11/14, 15:42	Part edited	hemming
19/11/14, 16:29	Topology saved: left 540, top: 371, height: 30, width: 33	hemming
19/11/14, 15:46	Topology saved: left 540, top: 371, height: 30, width: 33	hemming
19/11/14, 14:06	Topology saved: left 540, top: 371, height: 30, width: 33	hemming
11/02/14, 17:24	File 00017_Preboot_v001.tar deleted.	pacaud



Tools: Hardware Inventory

Tracking of individual items

Items can be modified, moved, ...: tracked in item's history log

Connections between electronics parts are managed in the HW database

Item

History worklog

Connections

rtpc12

This is a Real-time PC

With the serial no: 6I003213TF

Dual Core
Detection NE

Documentation:

intelpro1000pxe.txt

History:

Date	Details	User
20/11/14, 13:08	Topology saved: left 182, top: 174, height: 75, width: 196	rolland
20/11/14, 13:07	Moved from: 20.	rolland
20/11/14, 11:04	2 PCI (1) Real-time PC - rtpc12 disconnected from 6 PCI (5) Real-time PC - rtpc-test2	hemming
20/11/14, 11:04	2 PCI (1) Real-time PC - rtpc12 connected to 6 PCI (5) Real-time PC - rtpc-test2	hemming

Go to: Available locations > Virgo > Central Building (CEB) > Level 3 (CEB-L3) > DAQ Room (CEB-L3-09) > Rack_42U - 16

1 RJ45 (eth0)
2 PCI (1)
3 PCI (2)
4 PCI (3)
5 PCI (4)
6 PCI (5) TOLM PCI - 15
7 IEEE-I394
8 RJ45 (eth1)

Connecting information

Currently connecting: ieee-i394 7 IEEE-I394 R-t PC - rtpc12

Outputs available for connection:

- ieee-i394 7 IEEE-I394 R-t PC - rtpc02
- ieee-i394 7 IEEE-I394 R-t PC - rtpc03
- ieee-i394 7 IEEE-I394 R-t PC - rtpc04-mem issue
- ieee-i394 7 IEEE-I394 R-t PC - rtpc-roma
- ieee-i394 7 IEEE-I394 R-t PC - rtpc01
- ieee-i394 7 IEEE-I394 R-t PC - rtpc06
- ieee-i394 7 IEEE-I394 R-t PC - rtpc11
- ieee-i394 7 IEEE-I394 R-t PC - rtpc08

Stop connecting

Tools: Hardware Inventory

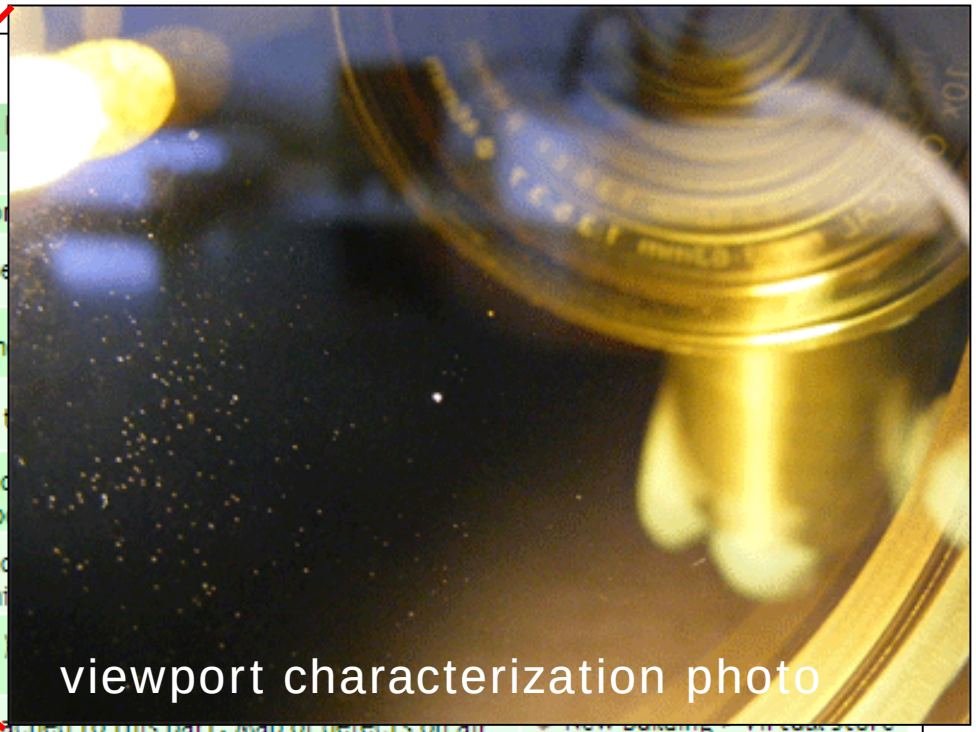
Keeps track of part history

Contains also documentation (link to documentation system)

Data sheets, photos, measurement results, …

Worklog of a viewport

Date	User		
16:24 24/09/08	maillet	Part attached to Wall-MC-W (97).	
15:55 23/09/08	maillet	Part moved to: Wall-MC-W > Larso	
11:59 17/09/08	maillet	On the polariscope, the viewport se	
11:55 17/09/08	maillet	File points (1).jpg (v001) attach	
11:55 17/09/08	maillet	File points.jpg (v001) attached	
11:55 17/09/08	maillet	File Y01b.jpg (v001) attached to polariscope (45 degree rotation clo	
11:54 17/09/08	maillet	File Y01a.jpg (v001) attached to (engraved ID on the right, in the mi	
11:54 17/09/08	maillet	File Y01-vacuum-side.png (v001 vacuum side	
11:54 17/09/08	maillet	File Y01-air-side.png (v001) attached to this part. Map of defects on air side	>
11:53 17/09/08	maillet	Dusty surfaces but no particular defect on air side. May have a bubble on vacuum side	New Building > Virtual store >
11:52 17/09/08	maillet	Part added to database.	New Building > Virtual store >



viewport characterization photo

Tools: Documentation System (TDS)

Virgo TDS v2r4 https://tds.ego-gw.it/ql/?i=VIR

Virgo ET PPPS GraWIToN ? Logged in as heitmann > LOG-OUT

Code List | Add Code | View Series | Full Search | Help | Upgrades | Feedback

Displaying Codes **1-20** of **9940** 1 2 3 4 5 6 7 8 9 10 End ?

Code ?	?	Title ?	Date ?	Author(s) ?
VIR-0446A-15		Virgo Interferometer Channels DB (VIC) Update for Detchar	23/10/15	G. Hemming, L. Rolland, B. Swinkels, D. Verkindt
VIR-0445A-15	STAC	Commissioning planning for the STAC	23/10/15	B. Swinkels
VIR-0444A-15	LSC	Memorandum of Understanding between the Fermi GBM, the LSC, and VIRGO	22/10/15	Jordan Camp, Nelson Christensen, Peter Shawhan
VIR-0443A-15		TCS CO2 viewports investigation	22/10/15	TCS team
VIR-0442A-15	LSC STAC KAGRA	Planning for Central Interferometer commissioning preparation	21/10/15	mann, F. Carbognani
VIR-0441A-15		CMake evaluation as CMT replacement at 03 Feb 2014 VDASC meeting		ognani
VIR-0440A-15	LSC KAGRA	AdV weekly meeting minutes	19/10/15	H. Heitmann
VIR-0439A-15	VSC	V... ...ber 14th, 20...	19/10/15	Fulvio Ricci
VIR-0438A-15		Sun... ...mpensation Plate CP01 issue	19/10/15	L. Pinard
VIR-0437A-15	PUB	CWB ...llow Management System - Architectural Design Document	19/10/15	Lisa Zangrando
VIR-0436A-15		VDASC report to the STAC	19/10/15	Michele Punturo
VIR-0435A-15		Gabriela Gonzales, Albert Lazzarini, Dave Reitze, Fulvio Ricci	16/10/15	From Step 1 to STEP 2 ofthe the DET. Proc.
VIR-0434A-15	AdV	PL report @CCB (Oct 7)	15/10/15	G Losurdo
VIR-0433A-15	VSC	Com...	14/10/15	B. Swinkels
VIR-0432A-15	VSC	VEB...	14/10/15	Gianluca Gemme for the VEB
VIR-0431A-15	VSC	DA update	14/10/15	Chris Van Den Broeck
VIR-0430A-15	VSC	Communications to the VSC 14-10-2015	14/10/15	Fulvio Ricci
VIR-0429A-15	VSC	Draft Commissioning documents for the STAC	14/10/15	B. Swinkels
VIR-0428A-15	VSC	AdV report @VSC	14/10/15	G Losurdo
VIR-0427A-15	VSC	VDASC report to VSC	14/10/15	Michele Punturo

> 10.000 codes

Release control

Quick Search for a Code ?

Title
Author(s)
Code
Date from (dd-mm-yyyy)
Date to (dd-mm-yyyy)
> CLEAR > SEARCH

Currently Highlighted Series ?

User details ?

Forename heitmann
Surname
Email

? You have access to files attached to Codes with the following Access Privileges:

PUB Public
Virgo
LSC LSC
STAC STAC
VSC VSC
COU Council
AdV AdV-MAN
ELiTES ELiTES
KAGRA KAGRA
PPPS PPPS
ETRND ETRND
GWIN GraWIToN
VESF VESF EB

? You are a TDS Administrator

? Your Default TDS Instance is: Virgo

Tools: Excel + MPP + VBA scripting

Global AdV mpp planning was the reference for project data

- Global AdV WBS
  - Cost
    - Cost distribution over labs, subsystems,…
    - Cost profile
    - Cost statistics during project evolution
  - Manpower estimate
  - Assignment of tasks to labs
  - Budget structure

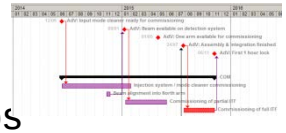
- *Lessons learned: some of those tools have be less used than others. While introducing tools plan for long term sustainability*

- Heavy use of VBA scripting for automating work with planning

SS WBS

SS.xls from SSM

Excel macros + mpp



SS.mpp

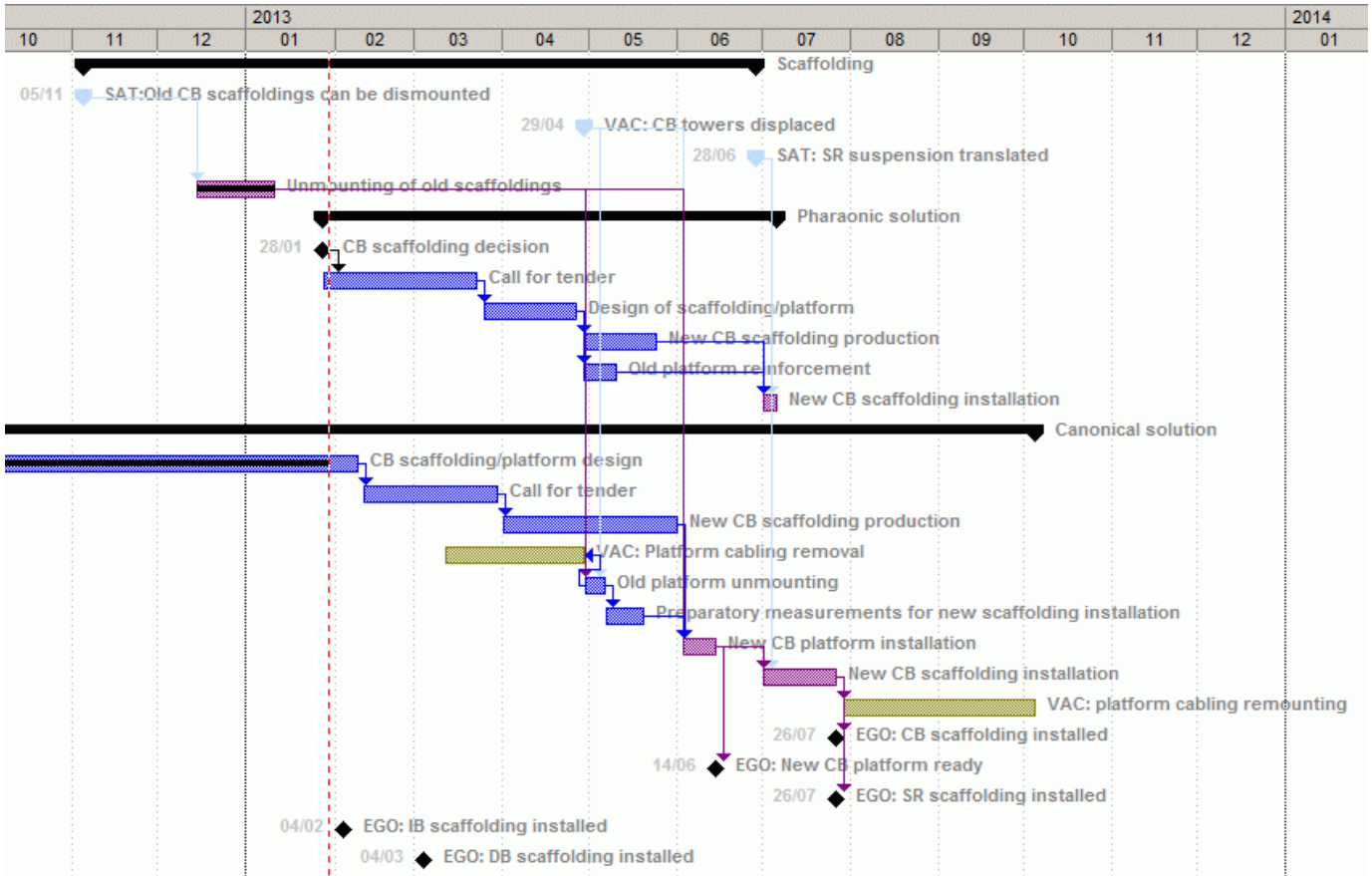
Mpp macro

AdV.mpp

mpp macros for: plausibility checks, critical path, etc.

Procurement Case: CB Scaffolding

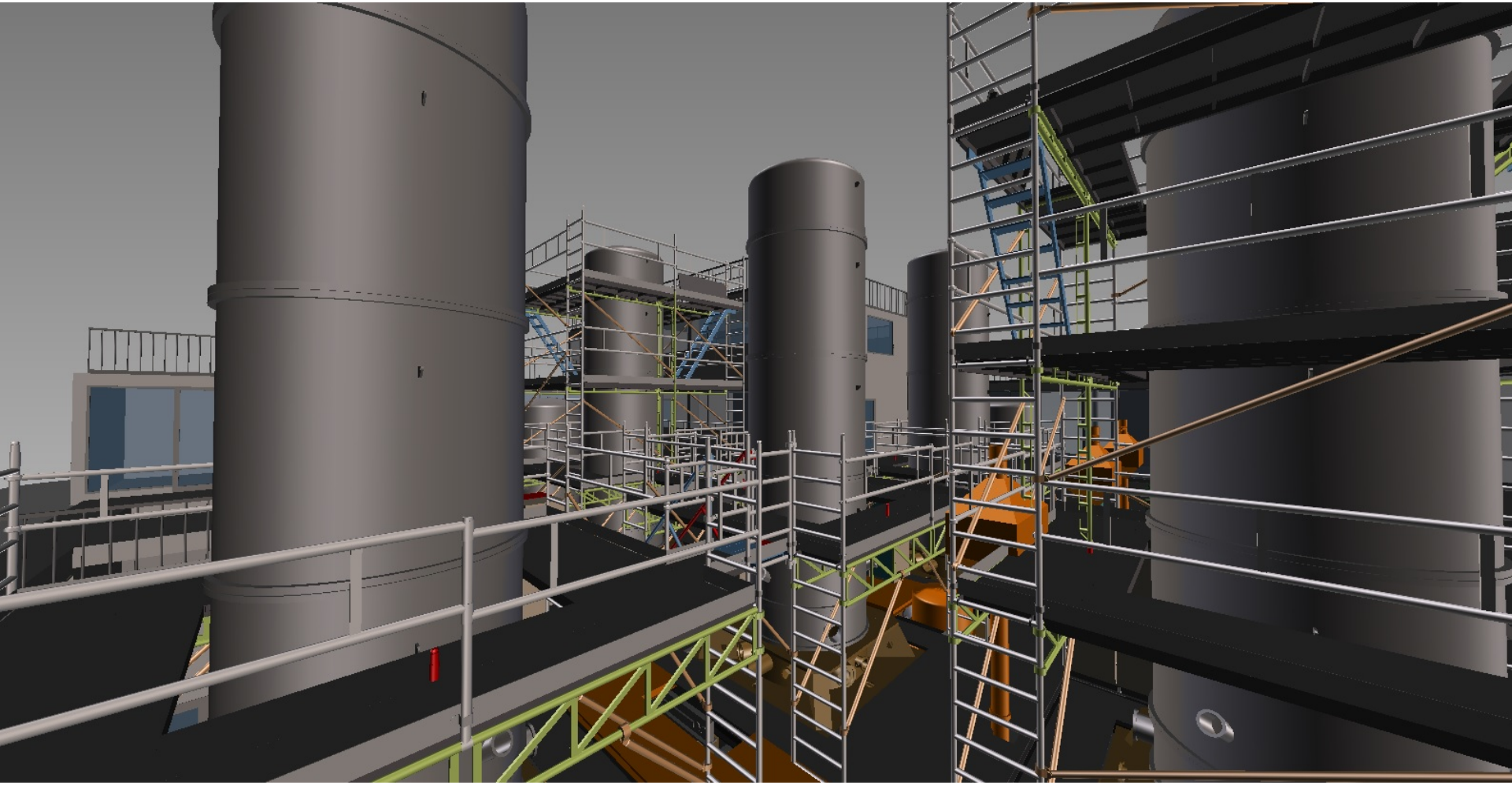
- The Problem: a canonical (full permanent) scaffolding solution would have implied:
  - A complete rebuilt of the platform impacting the AdV planning
  - The creation of very strong infrastructural constraints for what concern foreseen or not yet foreseen CB equipment installation (Minitowers, Cryotraps, etc.) or others needs (towers displacement, etc.)



Procurement Case: CB Scaffolding

Draft executive design

- Integrated into overall CB 3D Design and early feedback provided to contractor



Procurement Case: CB Scaffolding

- Good example of M-CAD Model based Engineering with very tight collaboration with contractor including several visit to contractor production plant.

- *Lessons learned: take your time to wisely select contractors even under tight planning constraints. The time you may waste with not appropriate choices will be much larger*

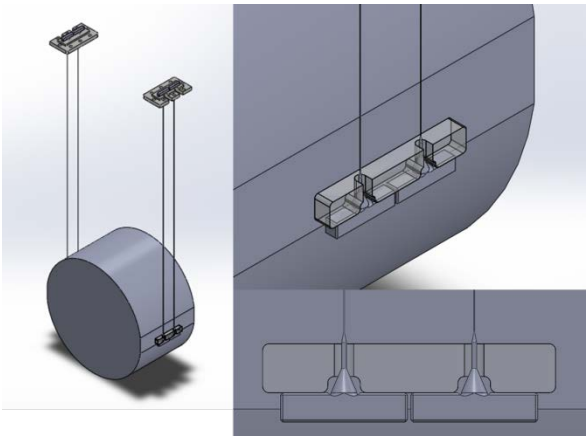
- *Lessons learned: the effort spent in building an integrated CAD design is well worth. Plan for the use of 3D laser scanners or photogrammetry for creating the models of your buildings/laboratories/plants in which the 3D CAD of the new components can be integrated.*
- *Making those models interactive with Virtual Reality (VR) headset technology would be best.*
- *We spent a non negligible time in correcting problems of mechanical incompatibilities that would have been immediately evident using VR walk troughs*

A Project "Crisis" Case: Monolithic Suspension Failure

From late 2015 to late 2016 we experienced several monolithic suspension failures

Temporary solution: steel wires

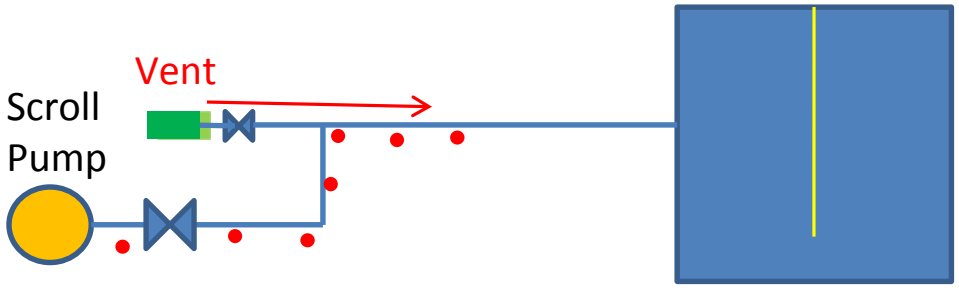
After long investigations all the events were found correlated with vacuum operations: fast dust particles, produced during pumping/venting cycles, hit the fibers and produce the initial fracture



Several improvements to reduce high-speed dust effect will be implemented:

- Protection structures for the fibers
- Different paths for chamber venting
- New multistage root pumps substituting scroll pumps

A Project "Crisis" Case: Monolithic Suspension Failure



- *<u>Lessons learned</u>: Problem investigation could greatly speed up once we had been able to reproduce the failure events on a separate test chamber which was late in its setup at the site. Never let your testing facilities lacking behind on the project schedule.*

Conclusions

- The scientific community is eagerly awaiting AdV entering Science operations and join the international detectors network.
- Despite starting late and with less resources we have an operating detector and joining Ligo for the last part of the O2 Science Run is becoming a realistic goal
- We (The Virgo Collaboration and EGO) have been learning a lot during first and second generation detectors construction and we are ready for the third generation

THANKS FOR YOUR ATTENTION!

For more information and for staying up to date on the VIRGO project:

https://www.virgo-gw.eu/