The beauty of hindsight: a discussion of mis-steps in Virgo

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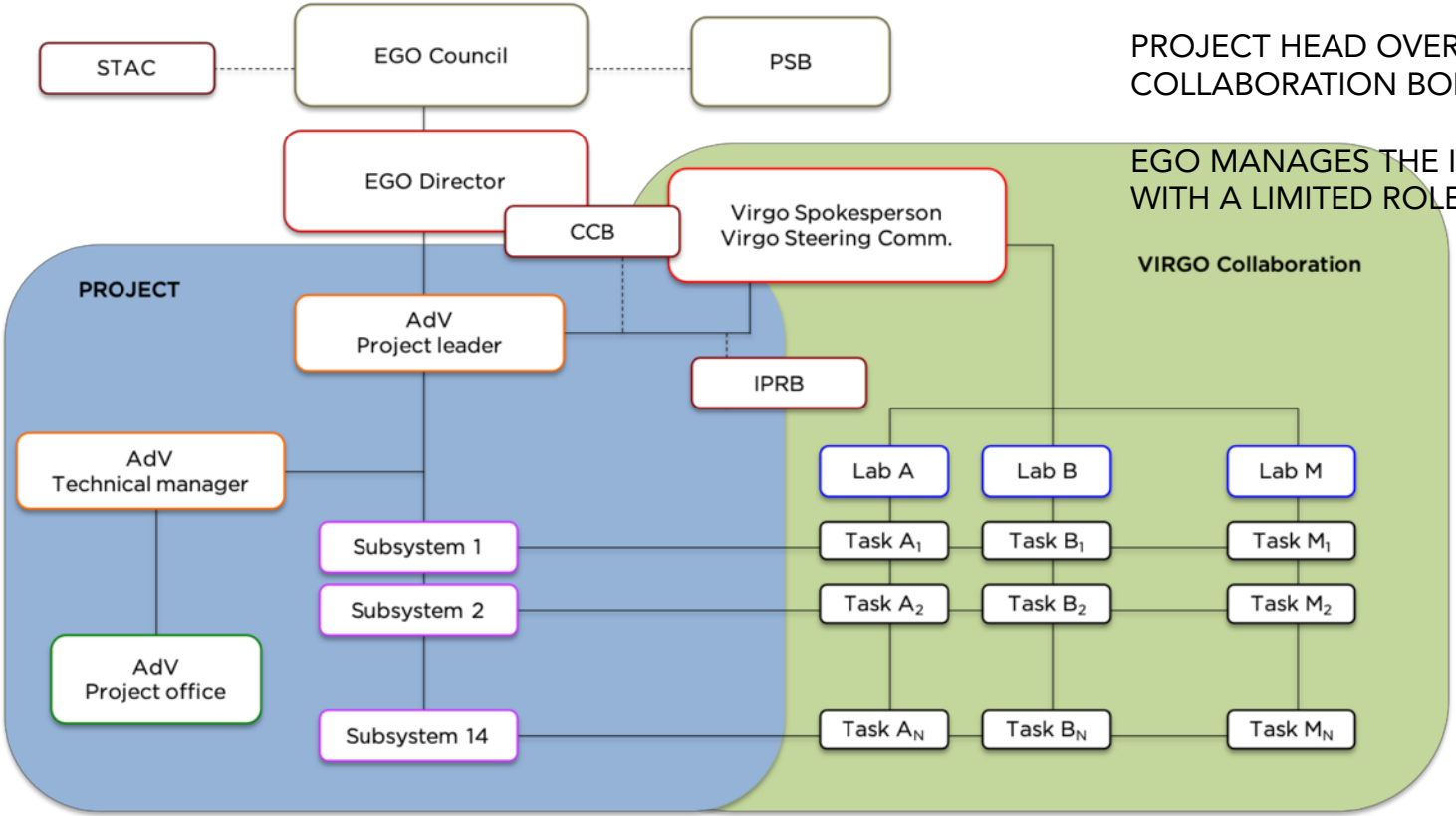
DISCLAIMER

- Very stimulating talk but...,
  - Complicated, extended and delicate matter
  - A variety of points of view exist
- I will give MY point of view
- I will focus on the Advanced Virgo experience, but cannot avoid to discuss some historical/context aspects
  - Choices which may appear as "errors" are sometimes unavoidable in a given context

AdV – MANAGEMENT ISSUES

A "mild" project structure



PROJECT HEAD OVER A COLLABORATION BODY

EGO MANAGES THE INFRASTRUCTURE WITH A LIMITED ROLE IN CONSTRUCTION

- Limited control on the work of the labs
  - AdV MoU signed but implementation not monitored on regular basis
  - Labs director (with a crucial role in managing the human resources) did not interact directly with the project
- Lack of central quality control
- Lack of a system engineer
- Resistance to the production of adequate technical documentation
- Resistance to standardization ("Engineers need to develop something challenging to be involved in the project")

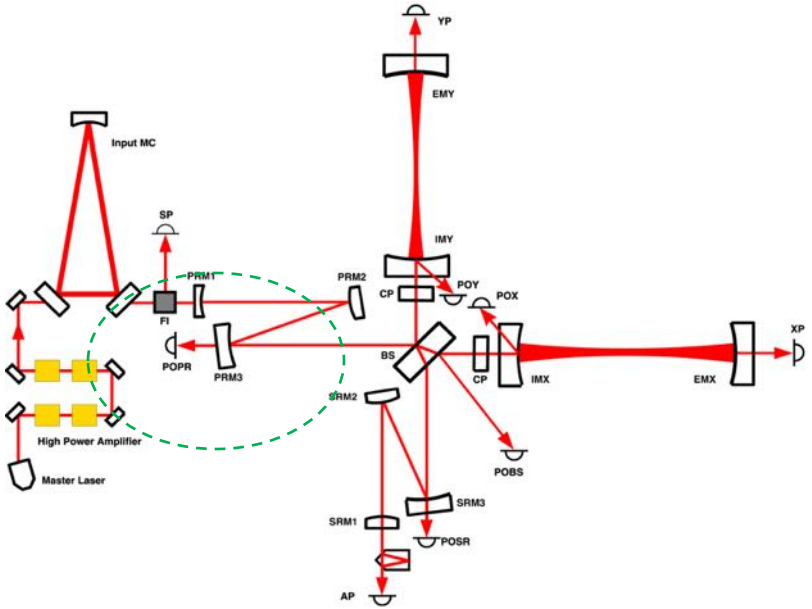
BUDGET

- 21.8 MEuros, **budget for investments only** (+ NIKHEF in kind contribution)
  - Very difficult to face urgent/unpredicted manpower needs
- R&D basically halted for the duration of the project
  - Forces people to focus on the detector realization but never a wise decision: risks of jeopardizing the future

AdV – TECHNICAL ISSUES

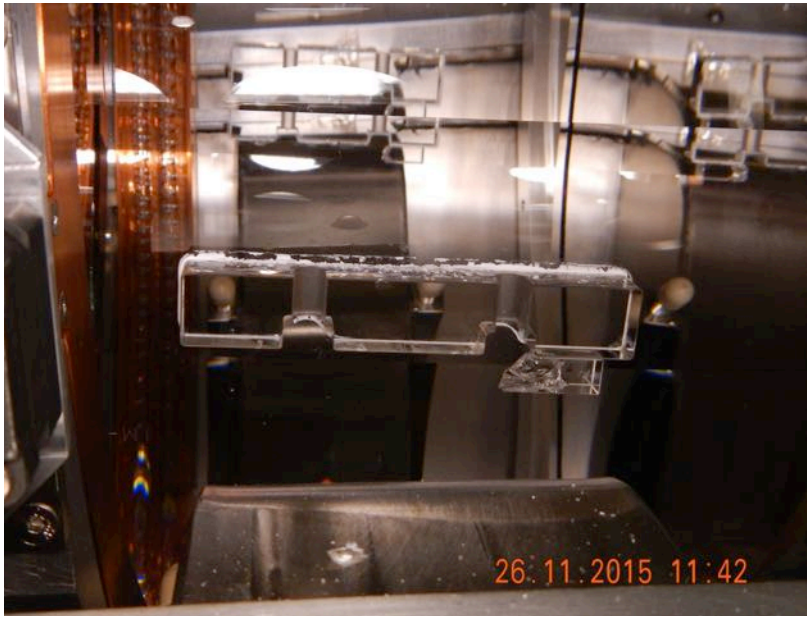
STABLE REC. CAVITIES

- It was impossible to realize stable recycling cavities (baseline!)
  - Difficult to suspend >1 mirror from a SA
  - **No room** for more towers
  - **No budget** for new tubes
- Design modified in a rush after the approval of the project
  - Issue with multipayloads identified late, due to the concurrent effort on Virgo+
  - A time of strong tensions in Virgo
- Problem: not enough focus/resources on the AdV design effort in due time



MONOLITHIC SUSPENSIONS ISSUE

- ~1 yr needed to understand the cause of monolithic suspension failures
- Dust produced by scroll pumps injected in vacuum at high speed during tower venting
- The lack of a thorough contamination control strategy has been a big mistake



- Single points of failure often threaten the project
- Lessons to be learned:
  - Quality control
  - Documentation
  - Openness: work as a team, address problems openly, ask for help
  - Do not take too many responsibilities

SIMULATION

- Simulation is crucial for success, difficult to develop properly, even more difficult to document and maintain
- Too many tools (each one wants his/her own), never enough
- Not a work to be done upon an emergency call: requires preparation, coordination, long-term vision

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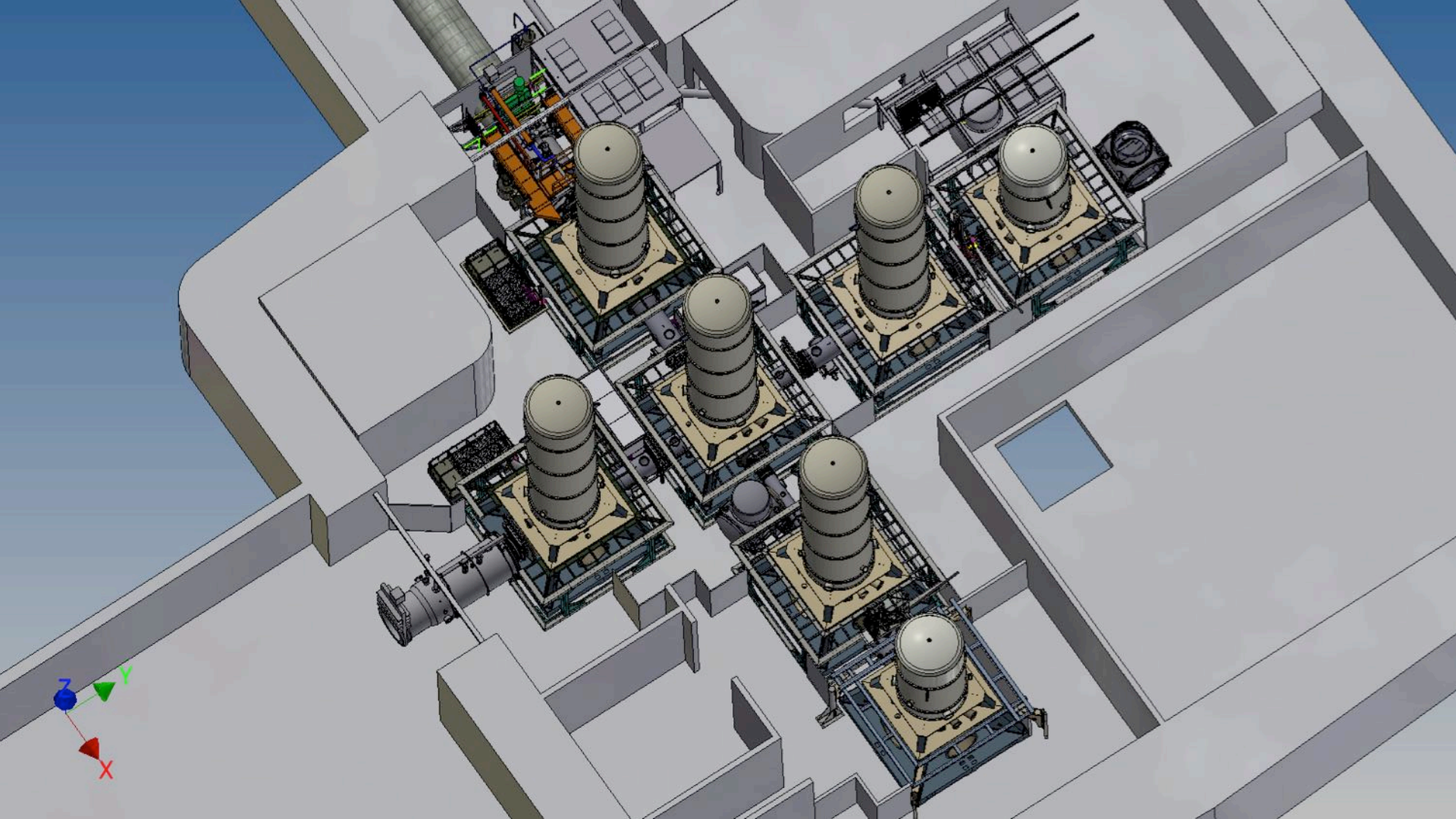
SPACE

- Virgo main hall is too small/too crowded
  - Makes implementation of upgrades challenging or impossible
- When designing a new detector also add some "room contingency" for upgrades you are not able to imagine now


Z
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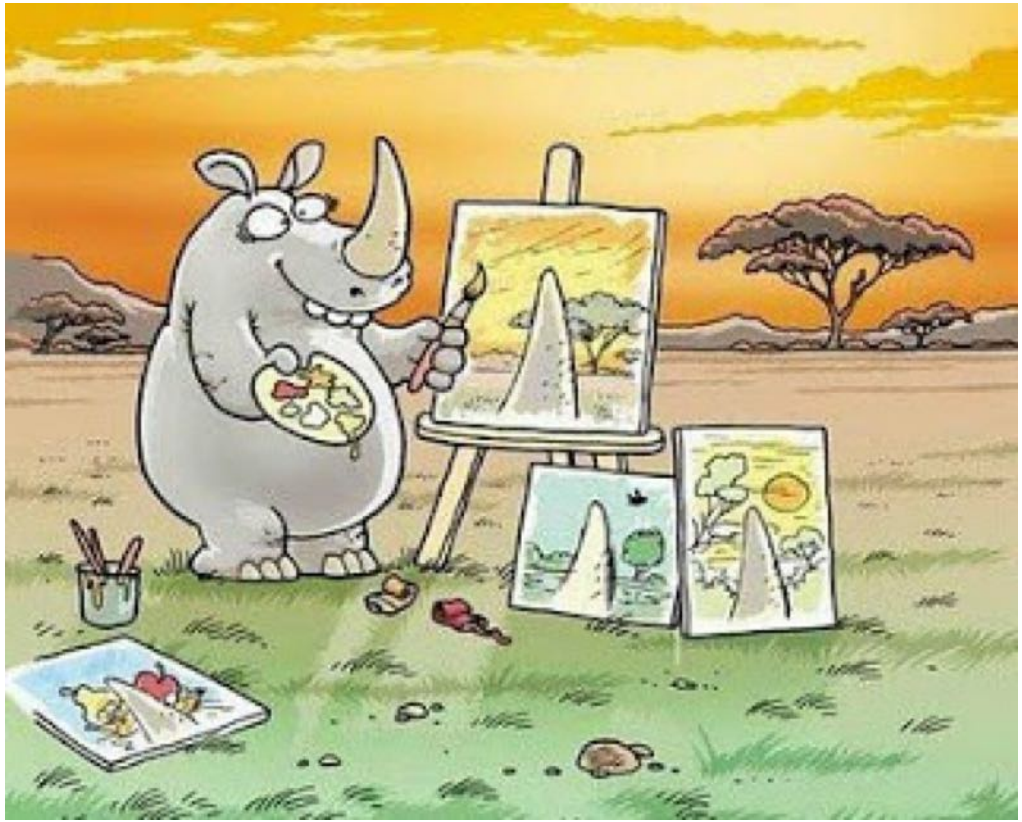
SOCIOLOGY ISSUES

- Focus on the tasks/expertise of one's own group, losing the global picture
- Difficult to welcome new groups (nobody wants to give away any responsibilities, even when understaffed) and exploit their skills and resources
- Commissioners have a symbiotic relationship with the detector: tendency to become a closed "Delta Force" team
  - Always difficult to welcome newcomers and invest time in training them
  - Eventually, not enough people to cover shifts 24/7. Machine often underused

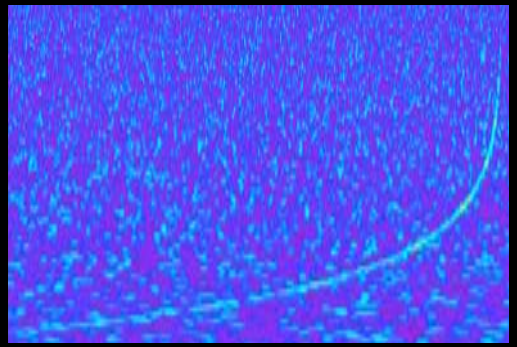
GW DETECTORS REQUIRE A LOT OF SPECIALIZED SKILLS.
A MAJOR CHALLENGE IS TO MAINTAIN THE GLOBAL VISION



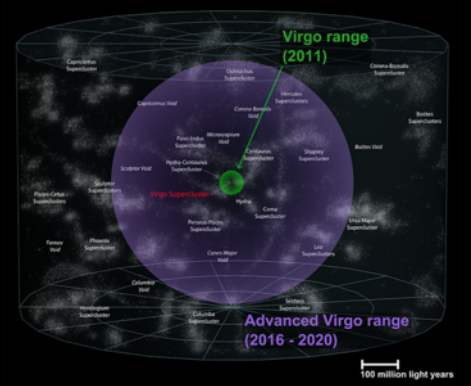
TOP LEVEL ISSUES
historical context

1989: LIGO/Virgo proposal submitted

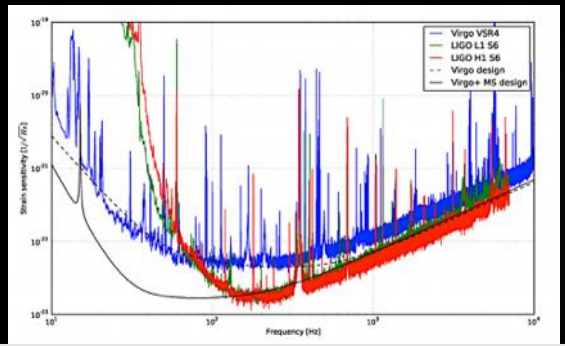
Funding: LIGO 1992, Virgo 1994



1st signal: LIGO 2015, Virgo 2017



2G Funding: LIGO 4/2008, Virgo 12/2009



1G design sensitivity: LIGO 2009, Virgo 2011

THE EARLY TIMES

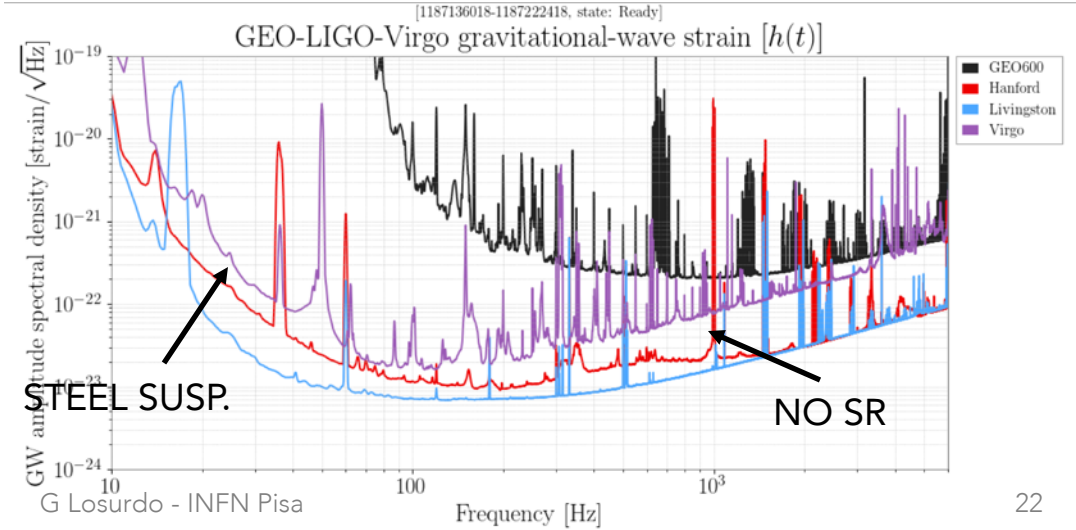
- Skepticism in the funding agencies (far from HEP core business)
  - Virgo funding agencies are the same which funded LEP/LHC
- No data for decades, limited access to R&D funds, positions → weak attractive power
- Too small (born by the effort of just two countries)
  - Virgo has missed the strength and expertise of UK and D
  - Nikhef joining was a big step forward. Now 8 countries in the Collaboration, easier to plan the future

THE CRUCIAL STEPS TOWARDS 2G

- 2003: Virgo inauguration (and first light), aLIGO 1st project review
  - 2005: first efforts towards AdV (White Paper)
- Virgo had too stand a 3-fold effort:
  - Virgo commissioning
  - Virgo+ construction
  - Advanced Virgo design
- This was too much for the Virgo Collaboration as it was in the 2000s
  - Hindsight: doing Virgo+ has delayed AdV
  - On the other hand: Virgo+ was useful as prototype for some AdV technologies

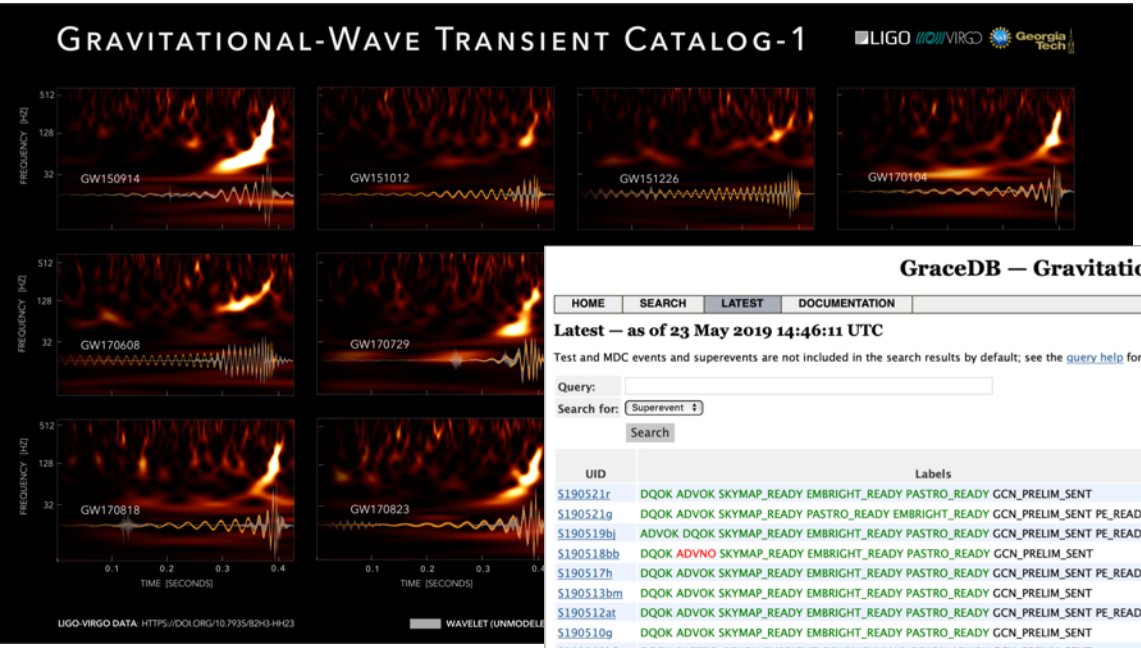
- AdV was funded 2 yrs later than aLIGO. We needed to join the data taking asap (commitment with the funding agencies)
- This triggered some non-optimal technical choices
  - 2-phases project: start without SR to save commissioning time
  - Start with steel wire suspensions upon the multiple failures of monolithic suspension

WAS IT AN "ERROR"?
NOT AT ALL!
THESE CHOICES ALLOWED TO JOIN O2




The BEAUTY of hindsight?

YES, IF THE DETECTOR IS EVENTUALLY DOING SCIENCE!



GraceDB — Gravitational Wave Candidate Event Database

HOME | SEARCH | LATEST | DOCUMENTATION | LOGIN

Latest — as of 23 May 2019 14:46:11 UTC

Test and MDC events and superevents are not included in the search results by default; see the query help for information on how to search for events and superevents in those categories.

Query:

Search for: Superevent

Search

UID	Labels	t_start	t_0	t_end	FAR (Hz)	Created (UTC)
S190521r	DQOK ADVOK SKYMAP_READY EMBRIGHT_READY PASTRO_READY GCN_PRELIM_SENT	1242459856.453418	1242459857.460739	1242459858.642090	3.168e-10	2019-05-21 07:44:22 UTC
S190521g	DQOK ADVOK SKYMAP_READY PASTRO_READY EMBRIGHT_READY GCN_PRELIM_SENT PE_READY	1242442966.447266	1242442967.606934	1242442968.888184	3.801e-09	2019-05-21 03:02:49 UTC
S190519bj	ADVOK DQOK SKYMAP_READY EMBRIGHT_READY PASTRO_READY GCN_PRELIM_SENT PE_READY	1242315361.378873	1242315362.655762	1242315363.676270	5.702e-09	2019-05-19 15:36:04 UTC
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S190512at	DQOK ADVOK SKYMAP_READY EMBRIGHT_READY PASTRO_READY GCN_PRELIM_SENT PE_READY	1241719651.411441	1241719652.416286	1241719653.518066	1.901e-09	2019-05-12 18:07:42 UTC
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LIGO VIRGO LSC