NEWS

H2020-MSCA-RISE-2016 – Grant Agreement N° 734303

Gravitational Wave Physics

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WP-2 Co-Leaders

WP2 Outline (partners)

Gravitational Wave Physics

Two main themes

1) Joint GW Science
2) 3G Detector Roadmap

Collaborating Partners

leading → INFN
UNIPI
CNRS
UNIPG
UNIRO
UNINA
hosting → CALIFORNIA INSTITUTE OF TECHNOLOGY CORP

LIGO CALTECH has been invited to propose a co-chair to join as co-chair WP2 board

WP2 Outline (schematic)

Two main themes

1) Joint GW Science
2) 3G Detector Roadmap

1 and 2 are detailed in the project as "Objectives",

they are pursued through "Work Tasks"

in some cases leading intellectual "Milestones"

and certified by the project "deliverables"

WP2 Outline (objectives)

- O2.1: Establish a network for searches of electromagnetic counterparts to Gravitational Waves.
- O2.2: Reduce the localization latency for gravitational wave events with electromagnetic counterparts.
- O2.3: Develop a collaboration network for third generation detectors.
- O2.4: Collaborate with LIGO on digital preservation of gravitational wave data.

WP2 Science and data (MS2 tasks)

- T2.1 (1-48): Optimization of localization strategy (INFN,UNINA, UNIPI, UNIRO)

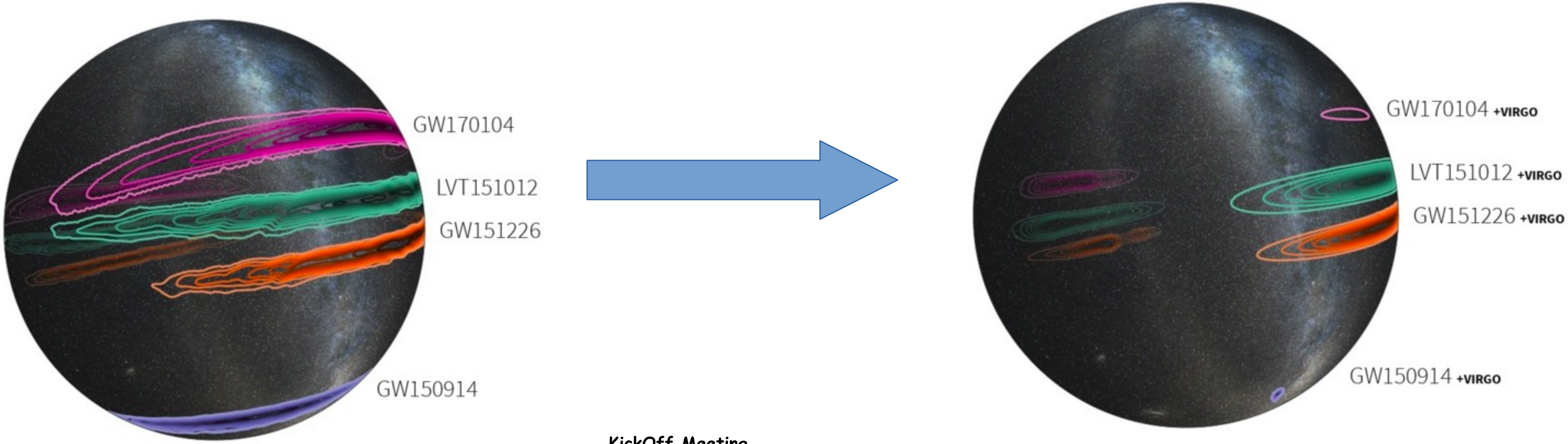
MS2 (deliverable m24)

The multi-messenger approach requires to know with a very low latency the localization of a GW event, if an electromagnetic follow up is required.

- T2.4: Preparation of a Virgo digital preservation structure (CNRS,INFN).

WP2 Science and data (MS2 tasks)

- T2.1 (1-48): Optimization of localization strategy (INFN,UNINA, UNIPI, UNIRO)
- Localization is a key ingredient to find electromagnetic counterparts and open the era of multimessenger astronomy
- Virgo will soon contribute to improve the localization (adding a 3rd detector to the triangulating network)



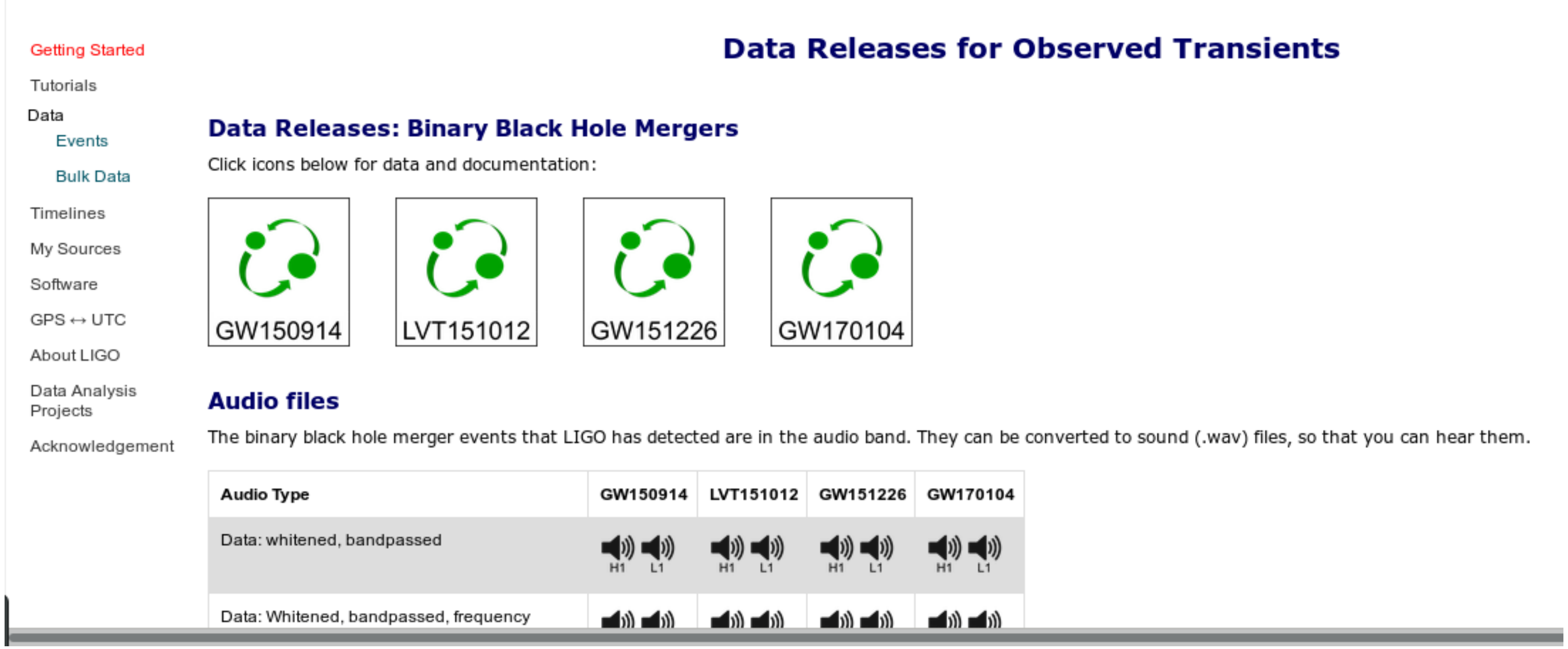
WP2 Science and data (MS2 tasks)

- T2.1 (1-48): Optimization of localization strategy (INFN,UNINA, UNIPI, UNIRO)
- Having more detector will help for a smaller localization area
- However, fast search algorithms are required
  - Detection now can be fast (<~ mins)
  - Building a skymap for localization still requires time (hours—~ 1 day
- Develop and test new approaches (e.g. PCA, machine learning, GPU-based code)

WP2 Science and data (MS2 tasks)

- T2.4 (1-48): Preparation of a Virgo digital preservation structure (CNRS,INFN).

- LIGO has started the LIGO Open Science Data Center (LOSC)
- losc.ligo.org



WP2 Science and data (MS2 tasks)

- T2.4: Preparation of a Virgo digital preservation structure (CNRS,INFN).

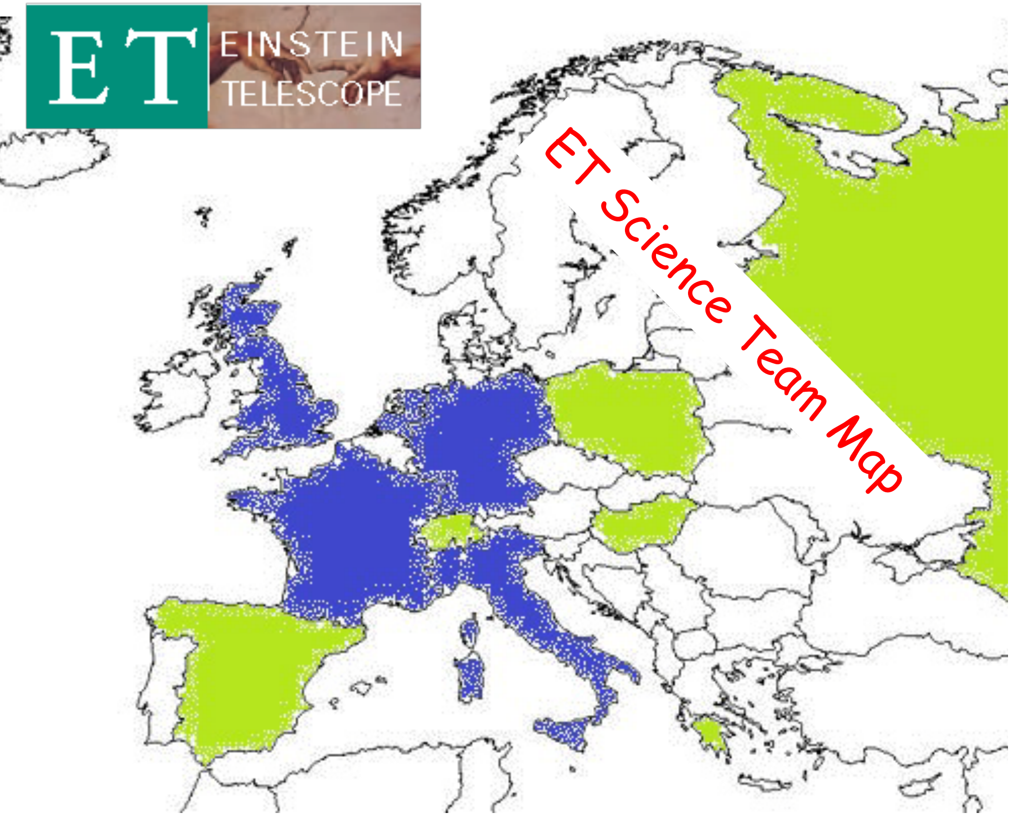
- Main data products
- Event data relative to transient events
- Scripts, tools, tutorials to analize them
- Virgo is expected to join the effort with its data
  - Contribute to build a Virgo Open Science Certer or, in alternative, develop with LIGO a joint project of GW data center

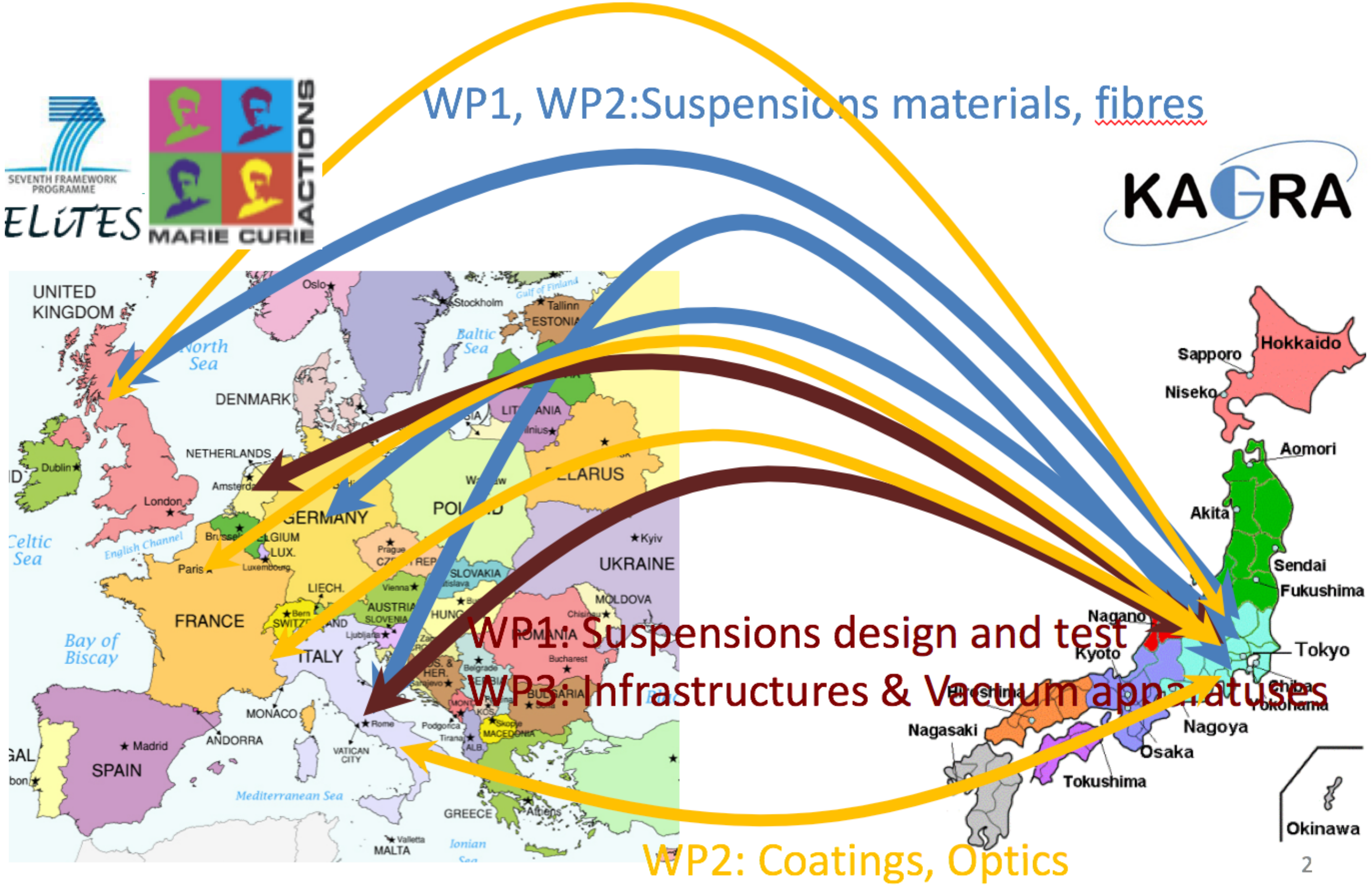
WP2 Science and 3G (MS1 tasks)

- **T2.2** (1-48): **Evolution of 2nd generation detectors (2G) towards 3 G**: HW design and options.

- Virgo community started earlier, producing a preliminary ET conceptual design in 2011 delivered in the ET FP7 grant 211743.
- The exchange activity was significantly depleted during design-construction-integration-commissioning phases of AdV
- FP7 supported this engagement, exploiting the excellent opportunity of KAGRA, development as a bridge towards 3G, with ELiTES 295153 and with GRAWIToN, that brought fresh ESR as PhD into the field of 3G research.

The role of WP2 VS WP3: a glance to the past





WP2 Science and 3G (a glance backwards, the example of cryogenics)

Searching the word "cryogenic" in the archives organized around the two main room-temperature Experiments LIGO and Virgo **over two years** during 2G settling

ET EINSTEIN TELESCOPE

https://tds.ego-gw.it/ql/?i-ET

TDS code	Title	Authors	Date
ET-0009A-15	Silicon and Sapphire for test masses of cryogenic detectors	D. Heinert	27/09/15
ET-0007A-15	WP1, Cryogenics and suspensions, 36 month deliverables: 1.1,1.3	E. Majorana	23/03/15
ET-0004B-15	Study of a cryogenic suspension system for the gravitational wave telescope KAGRA	D. Chen	23/03/15
ET-0060A-14	Recent results of hydroxide catalysis bonding for cryogenic suspensions - 6th ET Symposium	R. Douglas et al.	27/11/14
ET-0024A-14	Recent progress of KAGRA cryogenic system - 6th ET Symposium	K. Yamamoto	24/11/14
ET-0035A-14	Low Thermal Noise Suspensions for Future Detectors - 6th ET Symposium	G. Hammond et al.	24/11/14
ET-0032A-13	Modelling and Testing of Crystalline Cryogenic Suspensions	A. Cumming	23/10/13
ET-0028B-13	Cryogenic payload for KAGRA	K. Yamamoto	27/10/13
ET-0027A-13	The Latest Status of the KAGRA Cryogenics	N. Kimura	22/10/13
ET-0030A-12	Cryogenic Silicon Suspensions	G. Hammond	19/12/12
ET-0027B-12	Current status of cryogenic system of KAGRA	K. Yamamoto	27/10/13

- **11 reports** in 2 years.
- **Experimental reports are mainly referred to the ELiTES activity.**
- **The activity is not so properly represented. Many are missing and disseminated elsewhere**

➔ **AdV opeation works preveal.**
➔ **ELiTES has to sustain the effort towards cryogenics and 3° generation detectors**

WP2 Science and 3G (a glance backwards, the example of cryogenics)

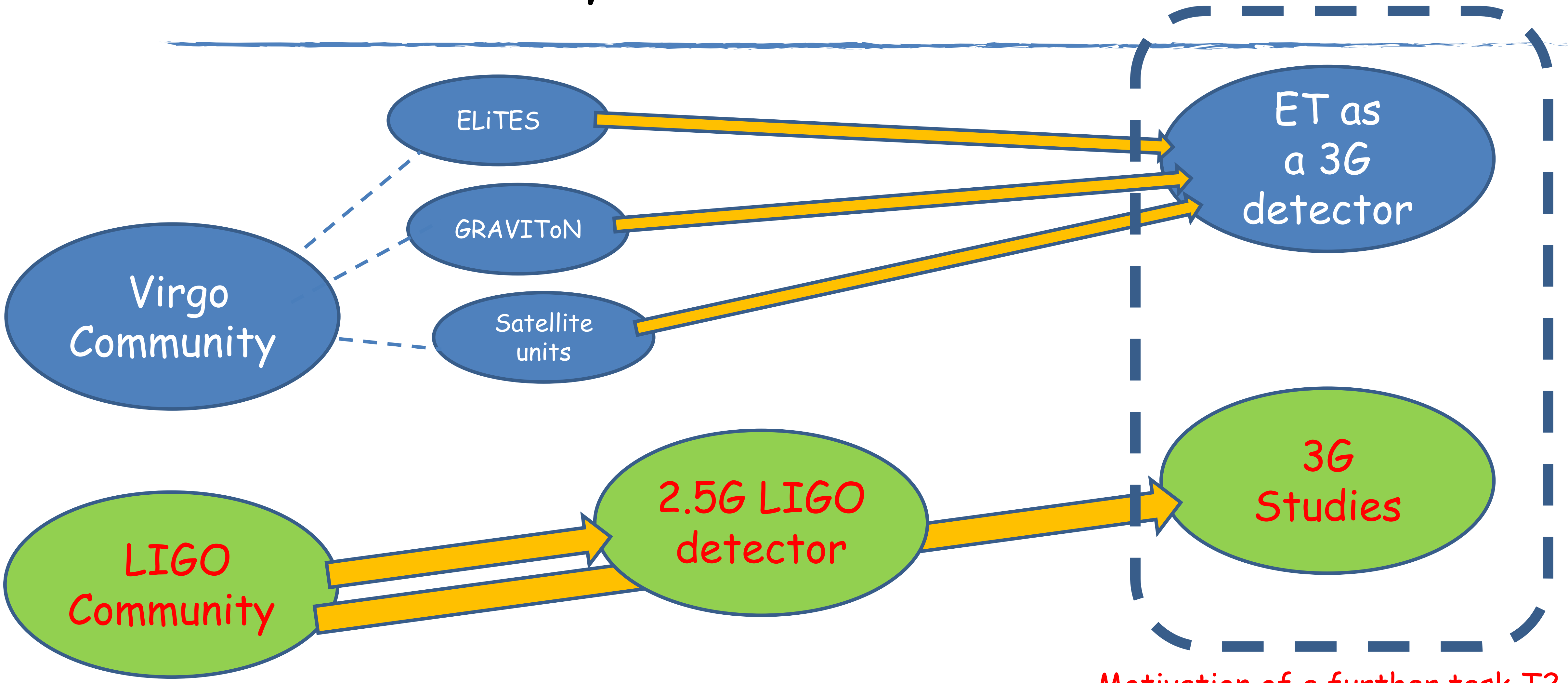
https://dcc.ligo.org/dcc

LIGO-Number	Title	Author(s)	Topic(s)	Last Updated
T1400668-v1	Mechanical Quality Factor of Cryogenic Silicon (SURF Final Report)	Marie Lu et al.	Suspensions	04 Nov 2015
P1400229-v4	Investigation of mechanical properties of cryogenically treated music wire	Alastair Heptonstall et al.	Basic R&D Suspensions	08 Oct 2015
G1501070-v2	Mechanical loss reduction for nm-layered composites by thermal annealing and introduction to a closed loop cryogenic Q-measurement system	Shiuh Chao et al.	Meeting	01 Sep 2015
G1501050-v3	Multi-Nested Pendula System: Mechanics and Cryogenics for LIGO Voyager	Odylio Aguiar et al.	Basic R&D Seismic Isolation	31 Aug 2015
G1200532-v1	Cryogenic Silicon Reference Cavities	Frank Seifert	Basic R&D	17 Aug 2015
G1500246-v2	Low Vibration Cryogenics for LIGO Voyager	Brett Shapiro	Basic R&D	23 Jul 2015
G1500681-v1	Optical absorption for cryogenic substrates	Jerome Degallaix et al.	Basic R&D	19 May 2015
G1500651-v1	Towards a direct measurement of Voyager-style suspension thermal noise with cryogenic ribbon cavities	William Korth	Basic R&D Suspensions	18 May 2015
G1500172-v3	Multi-Nested Pendula System: Mechanics and Cryogenics Update	Odylio Aguiar et al.	Seismic Isolation	17 Mar 2015
[illegible]	The effect of crystal orientation on the cryogenic strength of hydroxide catalysis bonded sapphire	Karen Haughian et al.	Basic R&D	19 Nov 2014
[illegible]	Mechanical Quality Factor of Cryogenic Silicon	Marie Lu et al.	Conceptual Design Detector Characterization Sensing and Control	19 Sep 2014
[illegible]	A Cryogenic Silicon LIGO upgrade	Nicolas Smith et al.	Conceptual Design Vacuum System Engineering Upgrades Suspensions	01 Sep 2014
P1300172-v1	Quality Factor of Crystalline Silicon at Cryogenic Temperatures (SURF Report)	Edward Taylor	Suspensions	31 Aug 2014
G1400926-v1	Cryogenic Test Mass Work at Stanford	Brett Shapiro	Basic R&D	26 Aug 2014
G1400973-v1	Cryogenic LIGO Upgrade	Nicolas Smith	Detector	24 Aug 2014
G1400963-v1	Participation in the Multi-Nested Pendula Project: A New Cryogenic Module of Vibration Isolation for Future LIGO Detectors.	Allan Silva	Basic R&D Seismic Isolation	23 Aug 2014
G1400940-v2	Cryogenic systems for Future LIGO Detectors	Brett Shapiro	Basic R&D	22 Aug 2014
P1400107-v1	Mechanical loss of a multilayer Ta2O5 / SiO2 coating on a sapphire disk at cryogenic temperatures toward the KAGRA gravitational wave detector	Ian Martin et al.	Basic R&D	17 Jun 2014
G1400561-v1	Cryogenic silicon ribbon cavities for thermal noise investigation	William Korth et al.	Basic R&D	21 May 2014
G1400565-v1	Experiments towards a cryogenic interferometer: From the sublime to the practical	David Tanner	Basic R&D	21 May 2014
G1400475-v1	A Preview of Future Cryogenic Suspensions for aLIGO Upgrades	Brett Shapiro	Basic R&D	28 Apr 2014
G1400385-v3	Cryogenic behavior of LEDs for use in third generation LIGO position sensors and actuators	Ryan Goetz	Sensing and Control Public Talk / Colloquium	08 Apr 2014
G1400024-v2	Investigation of Coating Thermal Noise at Cryogenic Temperatures for Third-Generation Interferometric Gravitational-Wave Detectors	Johannes Eichholz et al.	Basic R&D	08 Apr 2014
G1400250-v3	Progress on Cryogenic Test Masses for aLIGO Upgrades	Brett Shapiro	Basic R&D	23 Mar 2014
G1400245-v7	Cryogenic Test of the Multi-Nested Pendula System	Odylio Aguiar et al.	Seismic Isolation	18 Mar 2014
G980135-x0	A Cryogenic Suspension for LIGO - PAC5 Proposal Presentation, 16-17 November 1998	La State University	Document Migration	18 Mar 2014
G1400281-v1	Development of high power cryogenic Er:YAG lasers for 3rd-generation GWI	Peter Veitch et al.	Basic R&D	17 Mar 2014
G1400195-v1	Bonding experiments for cryogenic detectors	Rebecca Douglas	Core Optics Basic R&D	17 Mar 2014
G1300966-v5	Progress on Cryogenics for aLIGO upgrades	Brett Shapiro	Basic R&D	23 Nov 2013
G1300972-v5	Multi-Nested Pendula: studing a tubular version and preparing a cryogenic test	Odylio Aguiar et al.	Meeting Reports Seismic Isolation	

- **30 reports in 2 years !** Most of of them related to actual experimental activity and modeling
- Most of them targeted as **R&D** and test-mass **Suspensions**

LSC engagement in this context seems stronger ➔ we must pursue what started in with success

WP2 Outline (WP2-MS1 tasks): towards 3G, very different scenarios



Motivation of a further task T2.3

WP2 Outline (WP2 tasks)

- **T2.3** (1-48): **Future networks (including 3G)**

- Due to structural reasons the roadmap towards 3G was initiated through quite different path.
- In LIGO it is significantly based also upon the researchers directly involved in 2G operation
- After GW observation LIGO is promoting a common effort
- Serious issues urge to be discussed collaboratively :
  →feasibility of common design
  →accounting differt frameworks as India, Australia and, remrakably, **Japan**
- **Unifying the Science case seems to be the only viable case**
- **A corollarium of this task is the study of a Science using hybrid case (2G+3G)**

MS1 (deliverable m36)

Roadmap for Third Generation Gravitational Wave Detectors.

WP2 Conclusions

- Under the pressure of recent GW detection and expected nework detection, a primary engagement is foreseen in source localization codes, aimed to multimessenger physics.

➔ NEWS will contribute supporting the exchanges. Starts from the present network and multimessenger framework, it will be the base for future 3G networks.

- Activity aimed to EinsteinTelescope was pursued outside the "AdV horizon", by dedicated research units, mainly in NL and UK (E.g. U. Nikhef, Birmingham, U. Glasgow). Within AdV builders the activity was tiny. The concept of a completely new 3G detector
- On the contrary LIGO activity was strongly supported by the researchers dealing with 2G design and operation.

➔ NEWS has to contribute to the scientific debate, providing relevant studies concerning 3G engagement in Europe and addressing a roadmap which involves also Japan in the process.