GWADW2018 Report

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Overview

- More talks on 3G
  3G detectors are slowly getting real (S. Ballmer)
- 3G > 2G+ >> O3
- Coordinated R&D for 3G
- Good progress in Newtonian noise, coating, 2um squeezing, radiation pressure studies
- No parallel sessions
  - good that I can attend every talks
  - parallel sessions allow discussion among smaller number of people
- No panel discussion, no workshop lunch, not many questions, few posters
  - not very workshop-like

Ando Lab Related Talks

- Izumi, Enomoto: KAGRA status
  hard working, good progress, comment on FPMI
- Somiya: KAGRA+
  no question!!
- Michimura: Sensitivity optimization
  comment on weighting for SRC detuning
- Miyoki: Underground
  comment on water NN and seismometer
- Shimoda: TOBA
  question on vibration from cryo
- Komori: Radiation pressure
  question on finesse asymmetry and beam position

KAGRA and KAGRA+

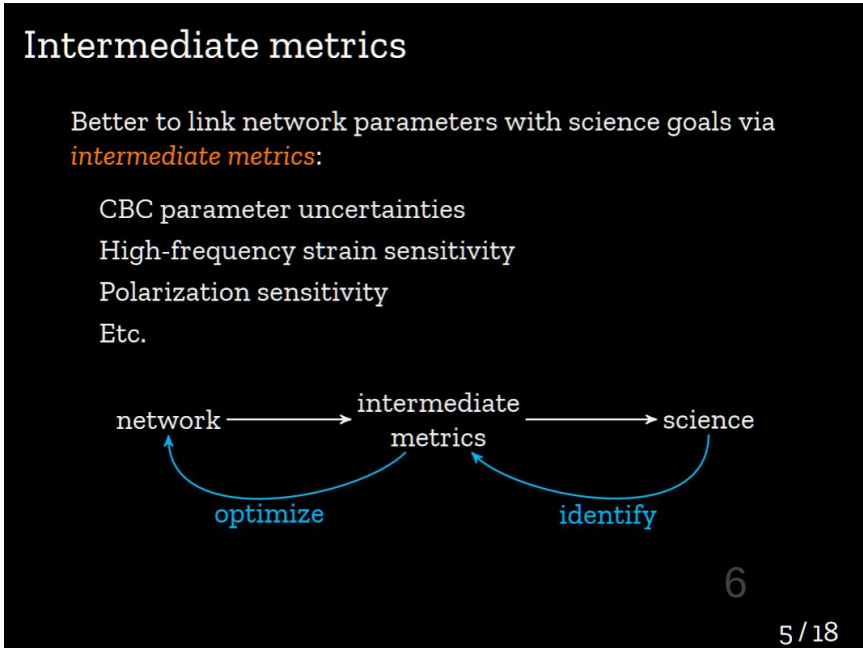
- Very low visibility
  We should be experts on cryogenics, underground, water Newtonian noise, detuned RSE etc. but we are not…
- Only two management level professors attended
  Are we really joining O3???
- Not official KAGRA+
  Lacking details compared with A+ and AdV+
  Sounds very uncertain

Selected Talks

- Evan Hall LIGO-G1800954
  Metrics for evaluating 3G network performance
- Rana Adhikari LIGO-G1800988
  TIANGO (deci Hertz space IFO)
- Jeff Kissel LIGO-G1800953
  Absolute Calibration of a Galactic GW Detector Network
- Gabriele Vajente LIGO-G1800874
  Machine Learning and Controls in GW Detectors
- Fulvio Ricci LIGO-G1801019
  3G Infrastracture
- Gabriele Rosi LIGO-G1801039
  Magia Advanced: atom interferometry for gravity tests and GW detection

Figure of Merit for 3G (Evan)

- What is the figure of merit to optimize 3G network?
- Top 1%? Median? Rare events?
- Did calculation of some metrics using fixed 3G detector locations and sensitivity
  - CBC SNR
  - CBC distance uncertainty
  - CBC localization
  - number of highly eccentric systems, highly precessing systems

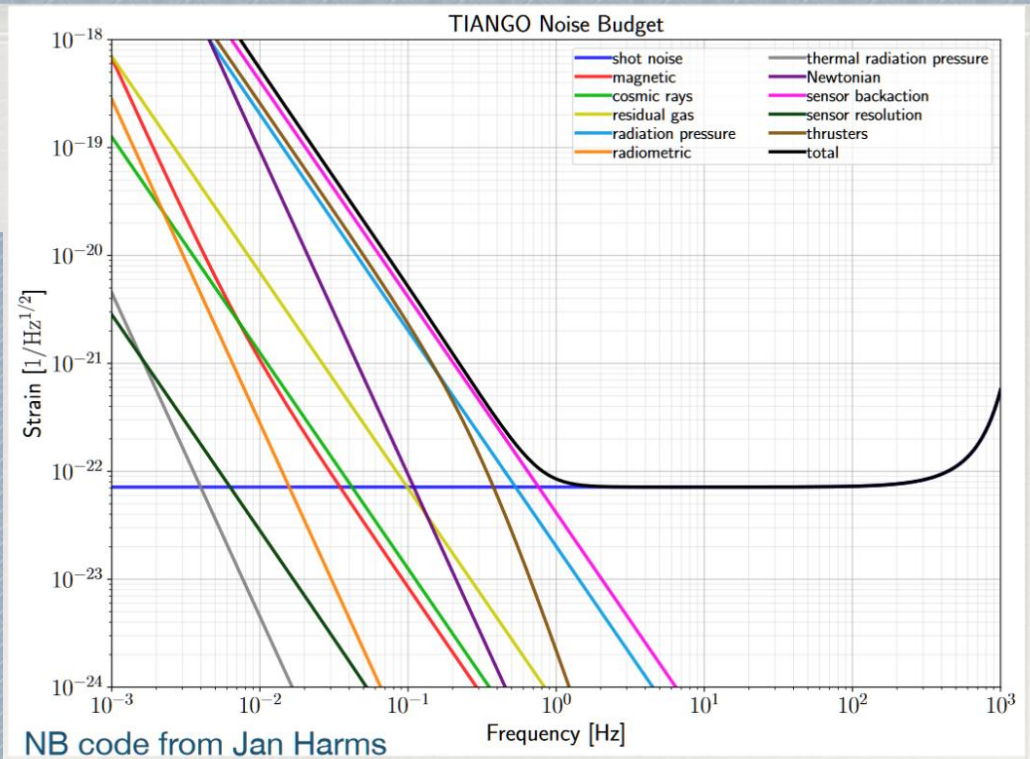


TIANGO (Rana)

- DECIGO band
- x100 worse sensitivity but simple Michelson

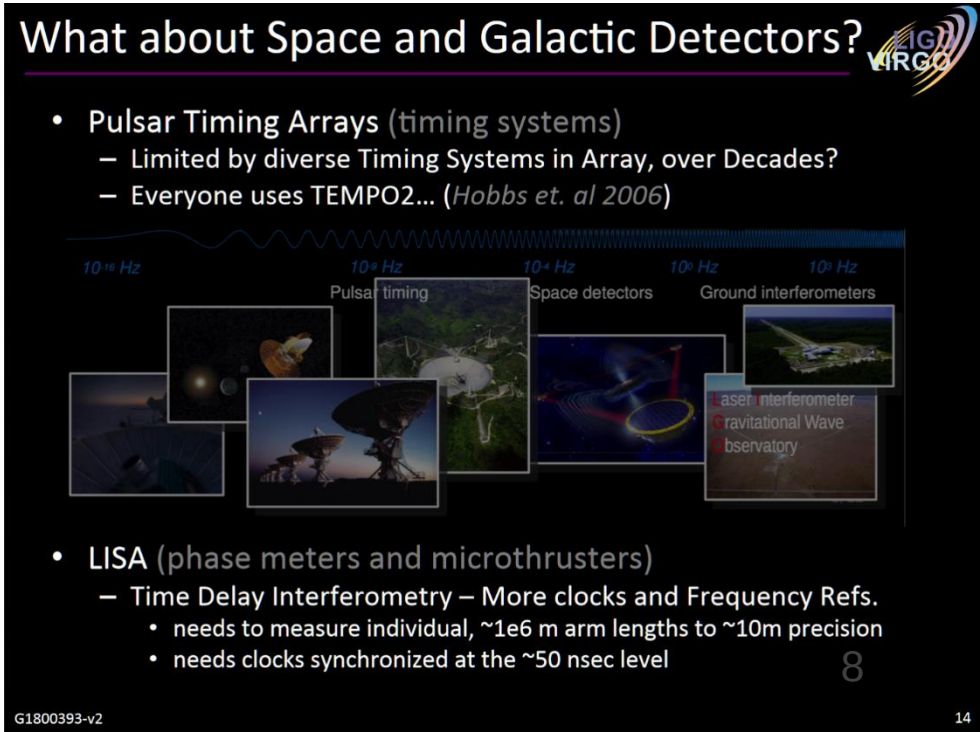
Try something else...

- Simple Michelson: **P_{laser} = 20 W, \lambda** = 532 nm
- L = 100 km, m = 10 kg, d_{mirror} = 0.35 m
- no transponders(?) in remote satellites
- Technical RIN -> RP noise cancellation
- Squeezing ! (clipping loss < 3%)



Absolute Calibration (Jeff)

- Less calibration uncertainty necessary for 3G
  e.g. ~0.1 % for SNR of ~1000
- Newtonian Gravitational Calibrators?
- Need to begin checking calibration between other detectors (PTA, space-based, …)

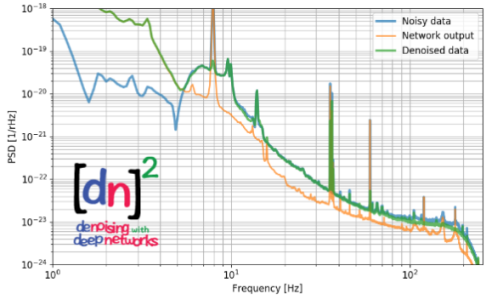


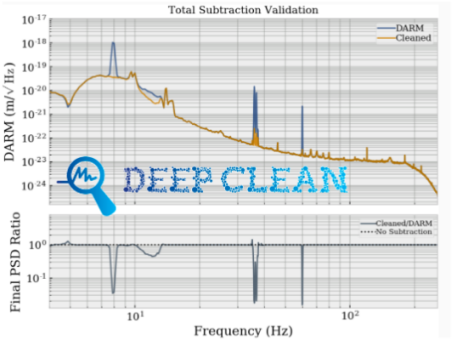
ML for Controls (Gabriele)

- ML applied for
  - image processing for beam centering
  - non-linear noise subtraction
  - error signal reconstruction (40m PRMI)
    not yet applied for real locking

LIGO

Real Data – LHO during O2



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H1:GDS-CALIB_STRAIN
H1:PSL-DIAG_BULLSEYE_PIT_OUT_DQ
H1:PSL-DIAG_BULLSEYE_YAW_OUT_DQ
H1:PSL-DIAG_BULLSEYE_WID_OUT_DQ
H1:IMC-WFS_A_DC_PIT_OUT_DQ
H1:IMC-WFS_B_DC_PIT_OUT_DQ
H1:IMC-WFS_A_DC_YAW_OUT_DQ
H1:IMC-WFS_B_DC_YAW_OUT_DQ
H1:ASC-DHARD_P_OUT_DQ
H1:ASC-DHARD_Y_OUT_DQ
H1:ASC-CHARD_P_OUT_DQ
H1:ASC-CHARD_Y_OUT_DQ
H1:LSC-CAL_LINE_SUM_DQ
H1:LSC-SRCL_IN1_DQ
H1:LSC-MICH_IN1_DQ
H1:LSC-PRCL_IN1_DQ
H1:PEM-EY_MAINSMON_EBAY_1_DQ
H1:PEM-EY_MAINSMON_EBAY_2_DQ
H1:PEM-EY_MAINSMON_EBAY_3_DQ
H1:CAL-CS_LINE_SUM_DQ
H1:CAL-PCALY_TX_PD_OUT_DQ
H1:CAL-PCALY_EXC_SUM_DQ
H1:SUS-ETMY_L3_CAL_LINE_OUT_DQ
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- The network is able to discover the beam jitter coupling and subtract
- Some improvement at low frequency too
- We did not expect much non-linearity or non-stationarity in LHO/O2

3G Infrastracture (Fulvio)

- Realistic and detailed study of ET infrastracture
- Newtonian noise and residual gas noise as a facility limit

COST - SUMMARY TABLE

	ET book p.313	Triangle "realistic"	L
TUNNELS	280	727	367
CAVERNS	110	97	60
ACCESSES	61	164	117
TOTAL	**451**	**988**	**544**

cost in Meuros, no contingency

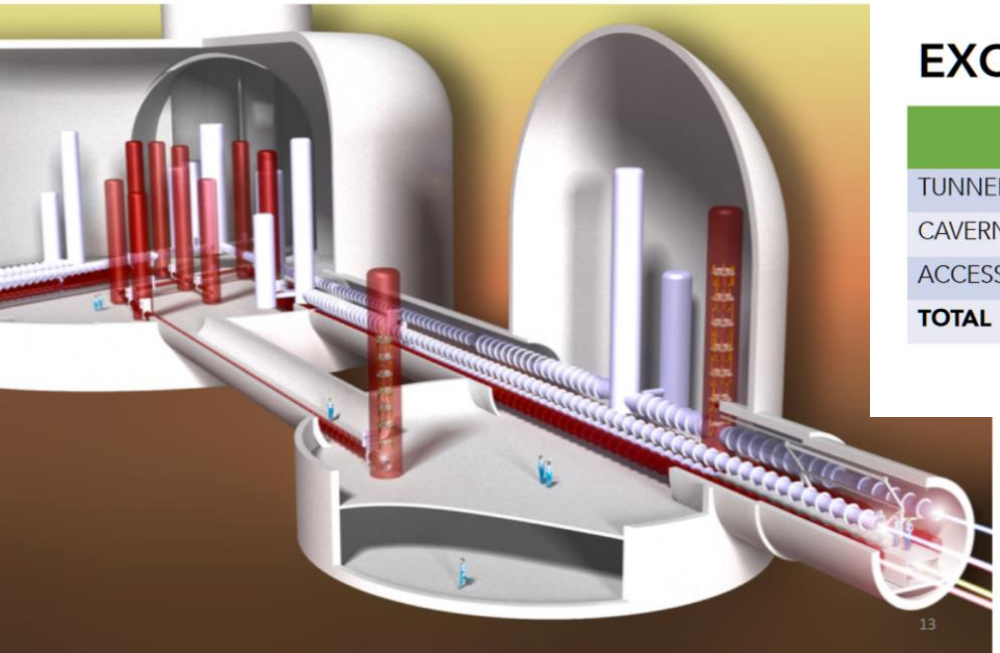
EXCAVATED VOLUME

	ET book p.313 (no excavation factor)	Triangle "realistic" (excavation factor 1.3)	L (excavation factor 1.3)
TUNNELS	1.081	4.458	1.482
CAVERNS	0.426	0.831	0.654
ACCESSES	0.236	1.786	1.057
TOTAL	**1.742**	**7.075**	**3.193**

volume in Mm^3

42

CAVERN DIMENSIONS



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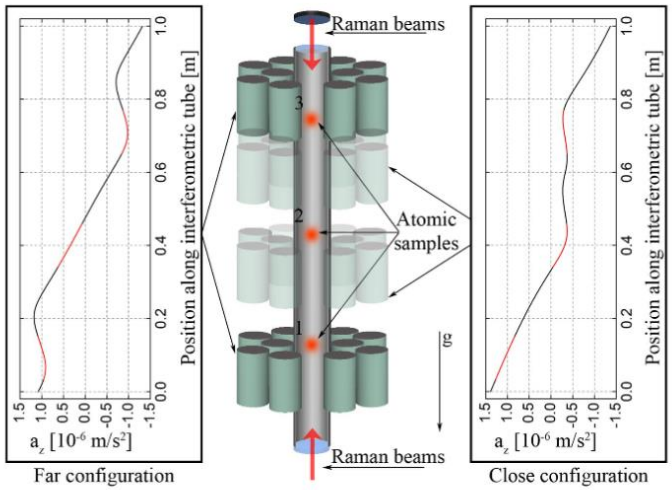
MAGIA (G. Rosi)

- Atom interferometry for big G measurement
  G. Rosi+ Nature 510, 518 (2014) (1.5e-4 level)
  see, also, my seminar slides on 20150430
- Aims 1e-5 accuracy

Cancelling gravity gradients

We simultaneously interrogate three clouds with the Raman interferometer for two source masses configurations. During the π pulse the frequency of the Raman lasers is changed by Δv*.

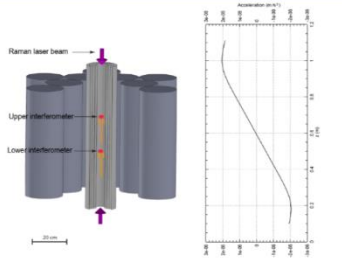


For the three gravity gradiometers (1-2, 2-3, 1-3) we measure the linear dependence Φ(Δv) vs Δv (Φ gradiometric phase)

Gravity gradient is traslated into a frequency!

*D'amico et al. "Canceling the Gravity Gradient Phase Shift in Atom Interferometry" Phys. Rev. Lett. 119, 253201 (2017)

Towards a improved AI determination of G

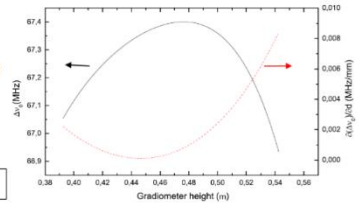


Experimental strategy:

- Measuring the vertical gravity gradient generated by a proper shaped source mass by cancelling it
- G retrieved by measuring the gravity gradient difference with and without source mass

✓ Compensation point almost independent from vertical positions and velocities of the atoms
✓ Sensitivity with respect to the radial coordinate greatly attenuated (no need ultracold atomic samples

Target relative accuracy on G: 10^{-5}*



*G. Rosi "A proposed G determination at 10^{-5} using a cold atomic fountain" Metrologia 55, 50 (2018)

Metrologia 55, 50 (2018)

…and more talks

- Harald Lueck LIGO-G1800984
  sapphire upto 233 kg, 520 mm dia.
  absorption improving (20 ppm/cm in smaller samples)
- Hang Yu LIGO-T1800077
  arm cavity ASC by compensating Sidles-Sigg instability using H-infinity and mu-syntheses (simulation)
- Gabriele Vajente LIGO-G1800920
  good summary on coating thermal noise
  has summary table on coating parameters for 2G+ and 3G
- Stefan Hild LIGO-T1800221
  Benchmark Parameter Set for Configuration Comparisons of Future Gravitational Wave Detectors

Upcoming GWADW

- 2019: Elba!
- 2020: Japan!
  - Toyama: 12
  - Okinawa: 18
  - Hokkaido: 18