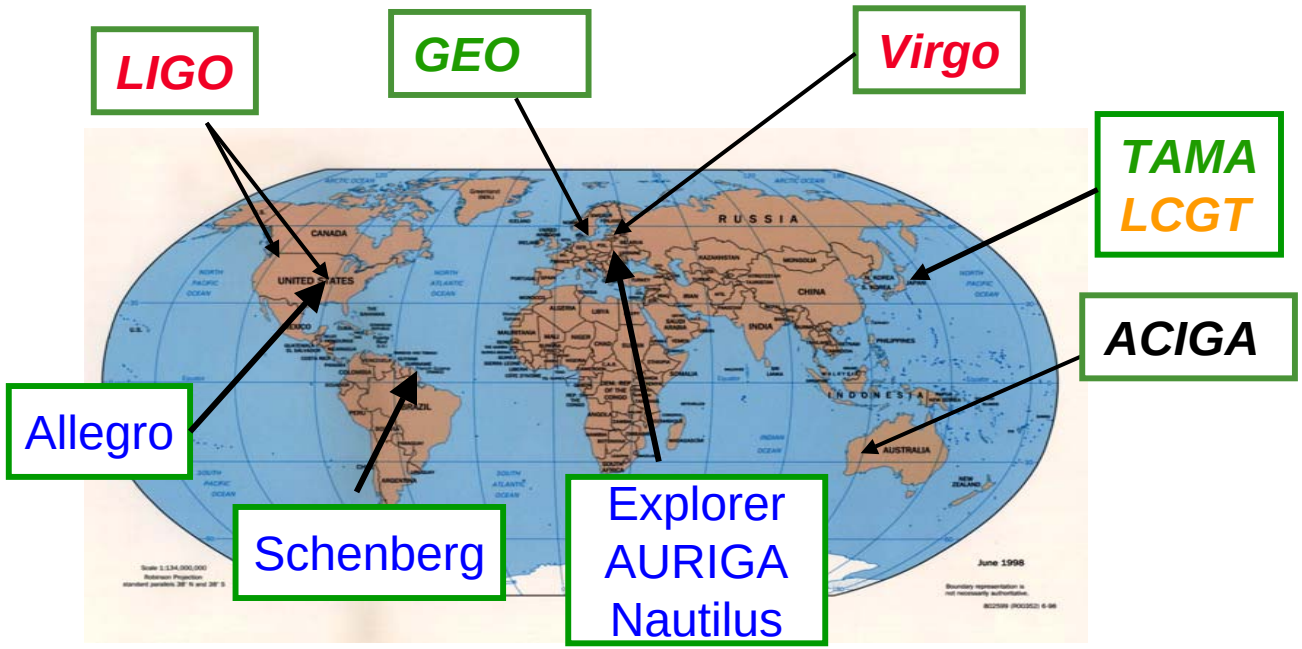
Détecteurs et prototypes



Full size, commissioning

LIGO : 2x4km
1x2km
Virgo : 3km
LCGT : 3km
(project)

Smaller size,commissioning

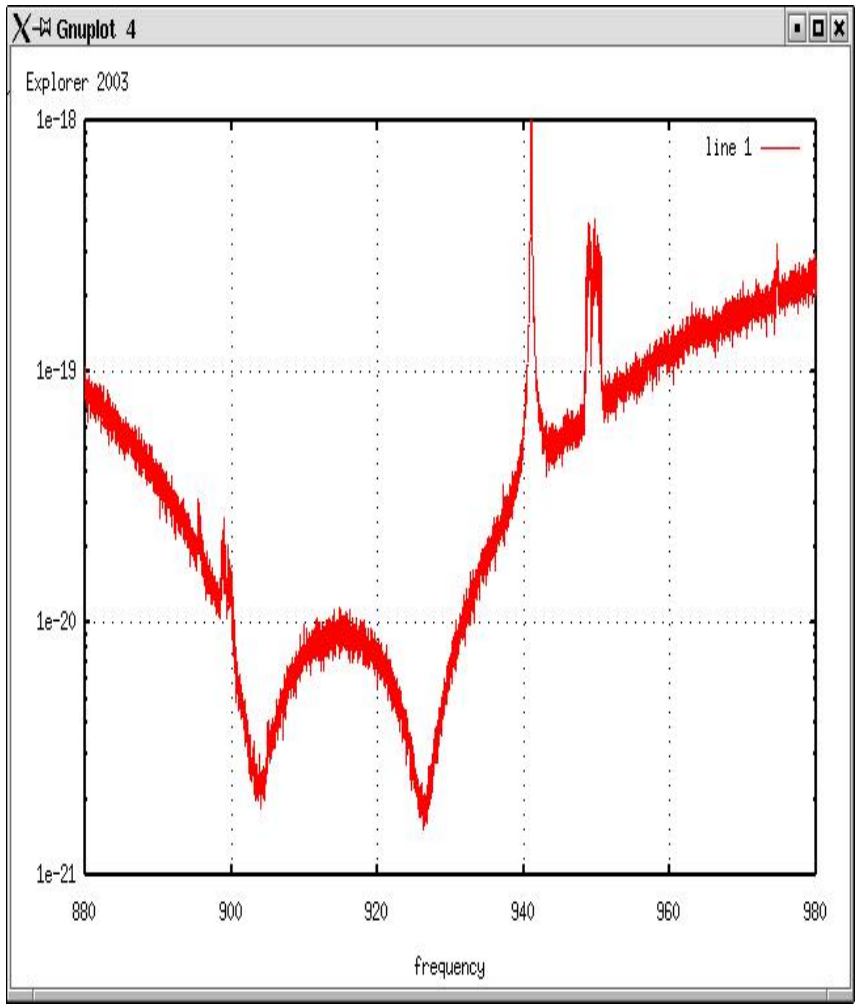
GEO: 600m
TAMA: 300m
ACIGA: 80m
(in construction)

Resonant bars and spheres

Barres résonantes

- AURIGA, Legnaro
- EXPLORER, CERN
- NAUTILUS, Frascati
- ALLEGRO, Baton Rouge

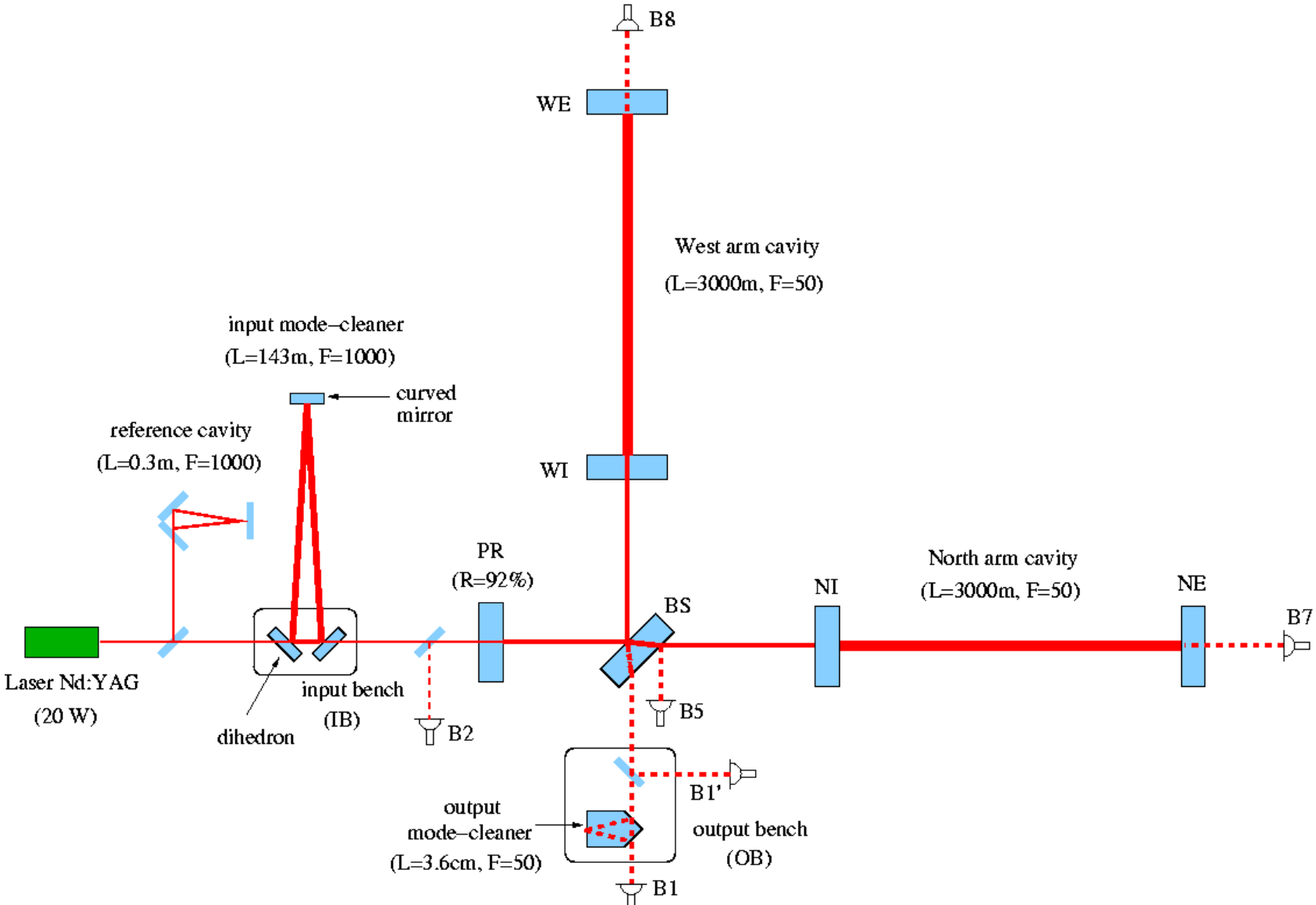
- Fiabilité, faible coût
- Sensibilité et bande passante insuffisantes
- Futurs développements:
  Géométrie sphérique
  – (Leiden, Brésil)



A brief history of interferometers

- 1973 Noise studies and initial design: Rainer Weiss (M.I.T)
- 1975 Prototypes in Glasgow and Garching
- 1980's Recycling interferometers: Ron Drever (Glasgow and Caltech)
- 1982 First activities in France and Italy (optics, seismic isolation) (Orsay-Palaiseau and Pisa)
- 1986 (?) Ph.Tourrenc: création du proto-GREX
- 1986-1989 Proposals for kilometric projects (USA, RFA, Italy)
- 1990-1994 Construction starts in USA and Italy
- 2000-2005 Commissioning
- Dec.2003-Feb.2004 LIGO-GEO 1st « science run »
- 2005+ High sensitivity searches, first detections ?
- 2008+ LCGT, Virgo first major upgrades, Advanced LIGO ?
- Later: more advanced detectors (Europe, Australia)?

Interféromètre à recyclage

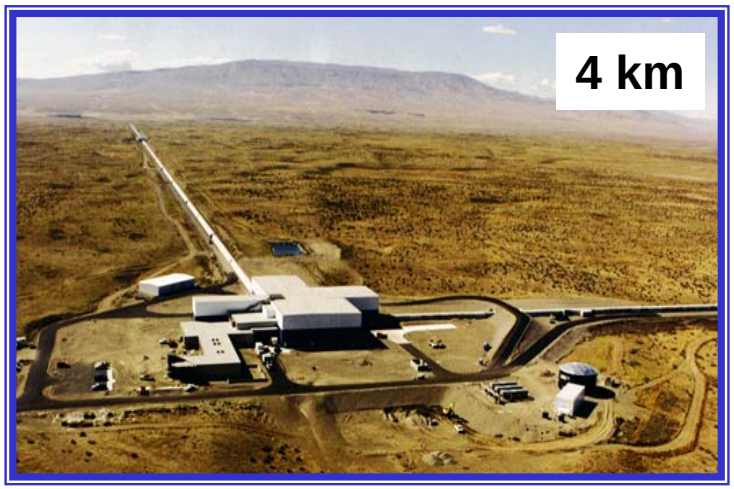


Key technologies shortlist

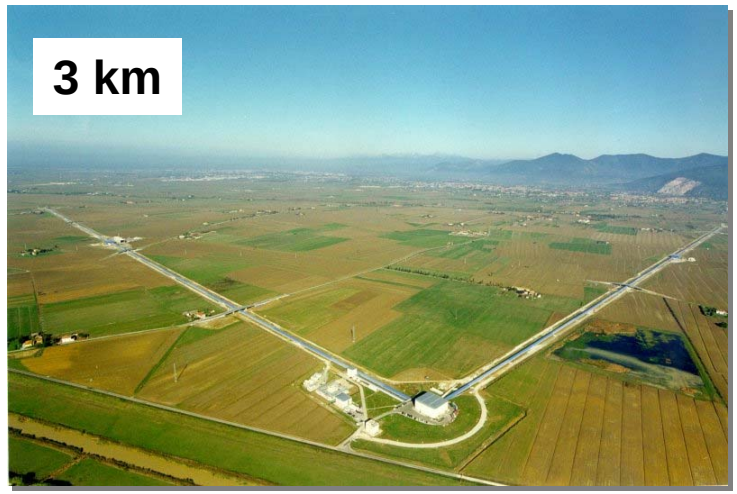
- Ultra high vacuum at low cost: lower outgassing rate, welding, …
- Seismic isolation: need 10^{12} at ten Hz (all DoF)
- Laser: very low noise (F&P), MTBF, high power, beam stability
- Optics: ultra low losses (substrates and coatings)
- Optical materials: high Q for low thermal noise
- Monolithic suspensions (silica wires)
- Real time control system: > 100 servo loops, many DoF, very low noise from mHz to MHz
- Data processing: high rate (6MB/s), fast processing (Tflop)

Full size detectors

LIGO, Hanford, Wa



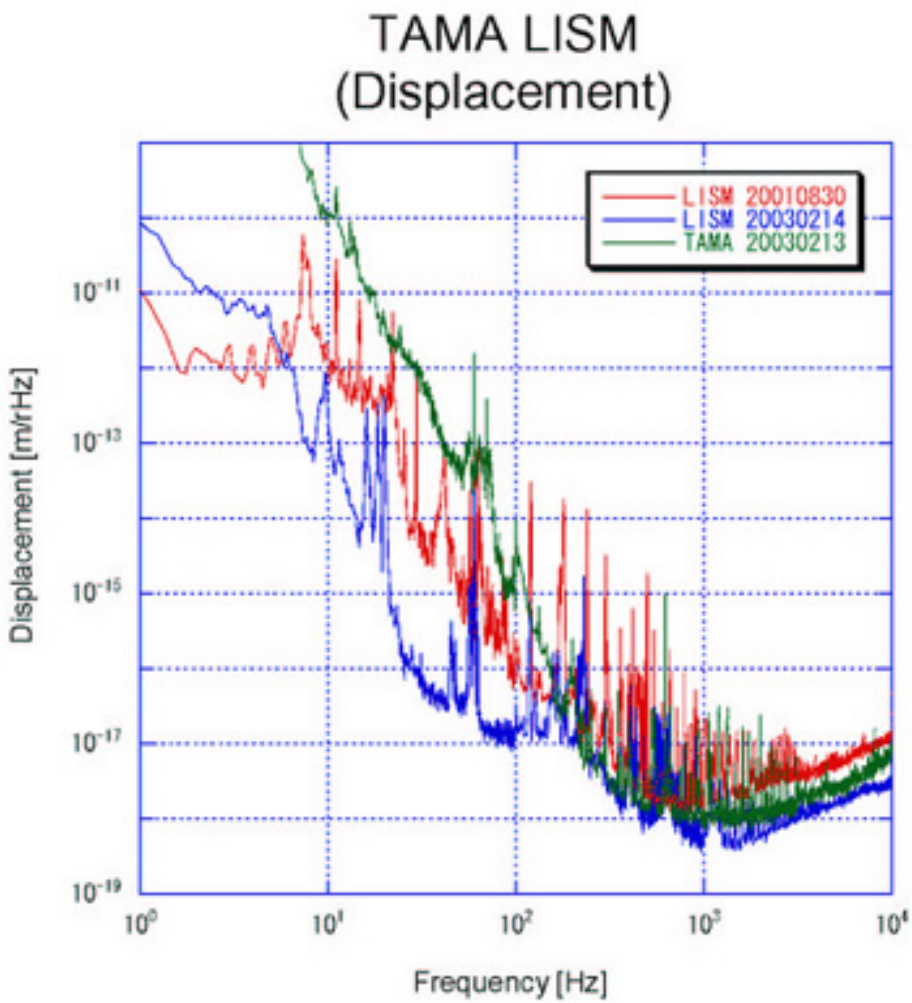
Virgo, Cascina, Toscana



LIGO, Livingston, La

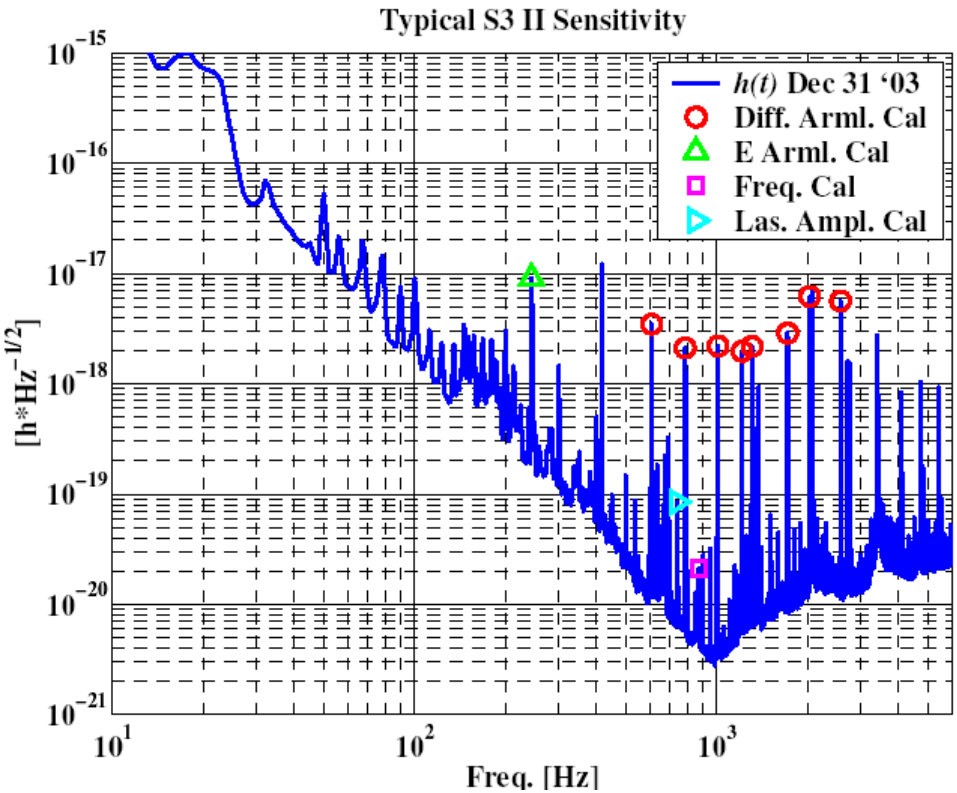
TAMA

- TAMA (1998 → …)
  - 300m recycled interferometer
  - Tokyo suburbs →high environmental noise
  - First “detector” to reach nominal sensitivity
  - Genesis of a Japanese GW community
  - Followed by cryogenic studi
    - First cryogenic mirror
    - 100m cryo prototype in construction
    - LCGT project (Kamioka)

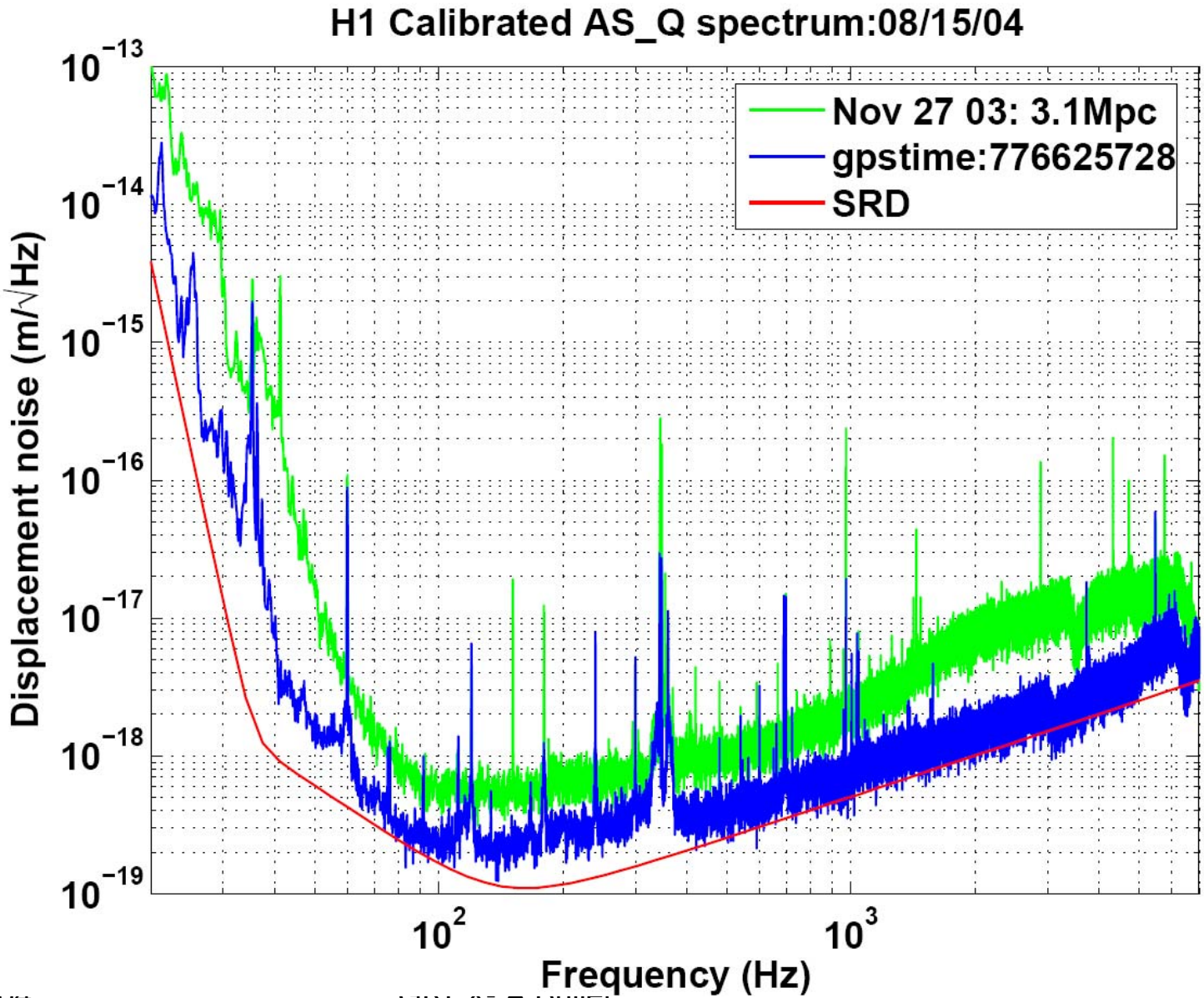


GEO 600

- 600m advanced prototype
  near Hannover
- German-British collaboration
- Advanced design:
  - Dual recycling
  - High Q suspensions
  - Thermal mirror reshaping
- Duty cycle > 98%
- Advanced data analysis
- Participation to LSC & advanced LIGO

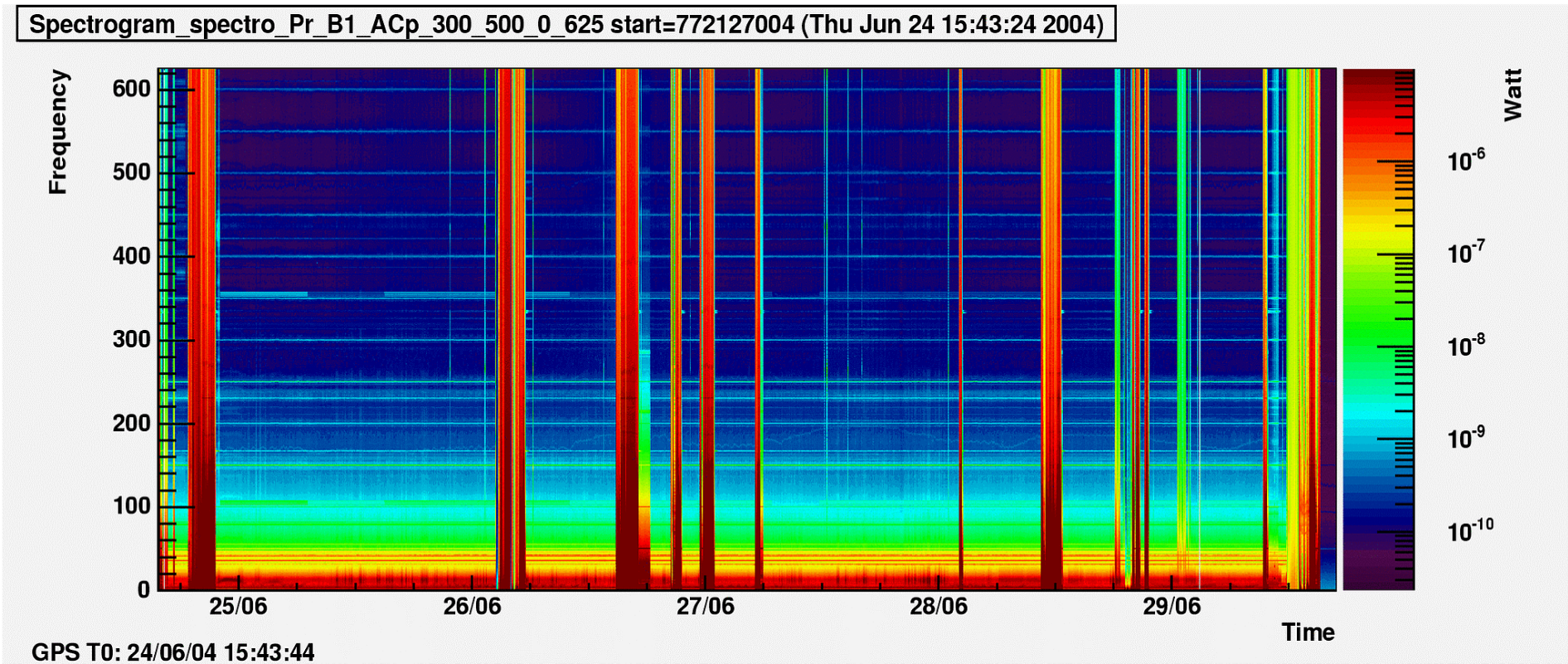


LIGO sensitivity

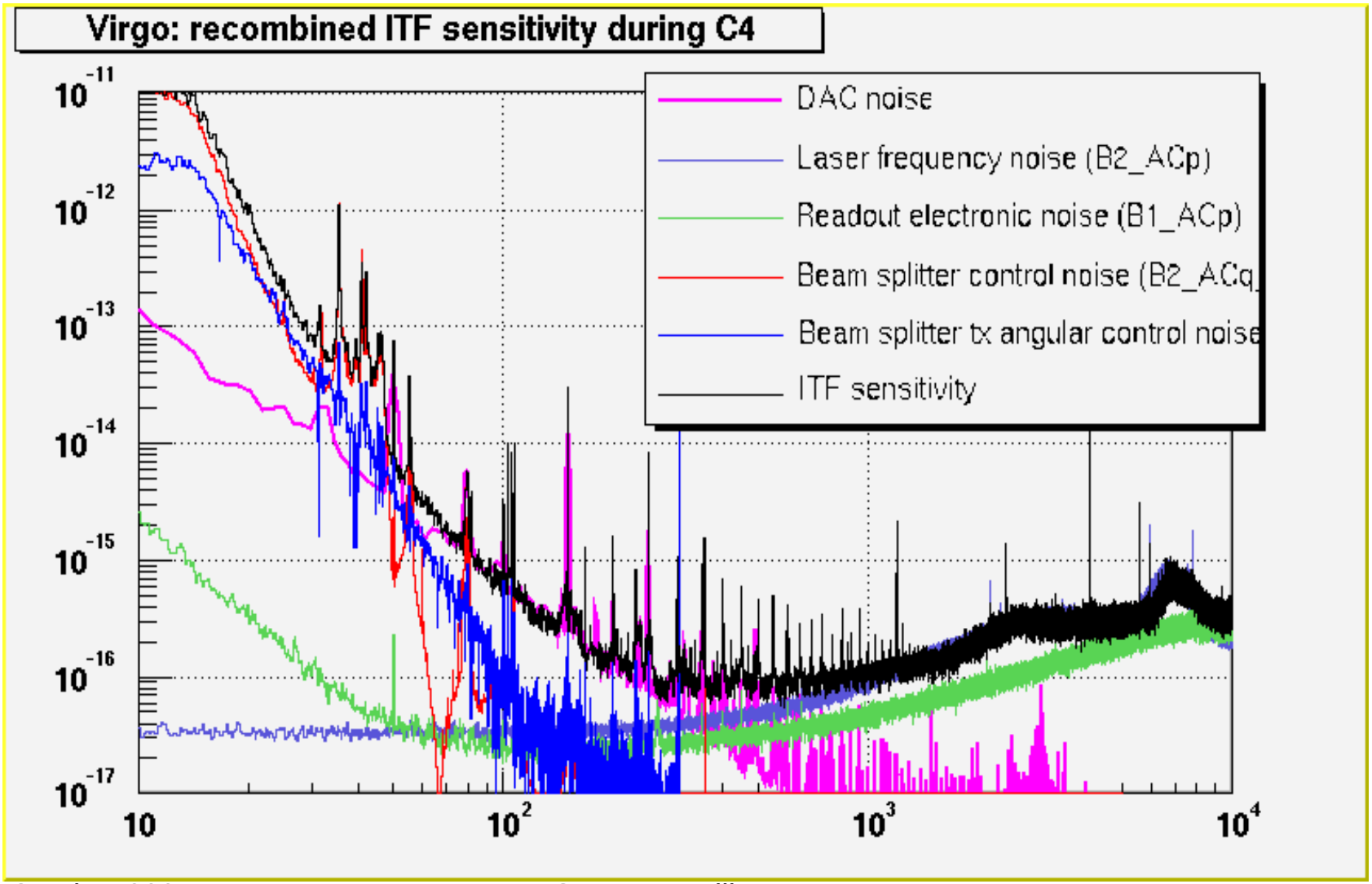


Virgo duty cycle

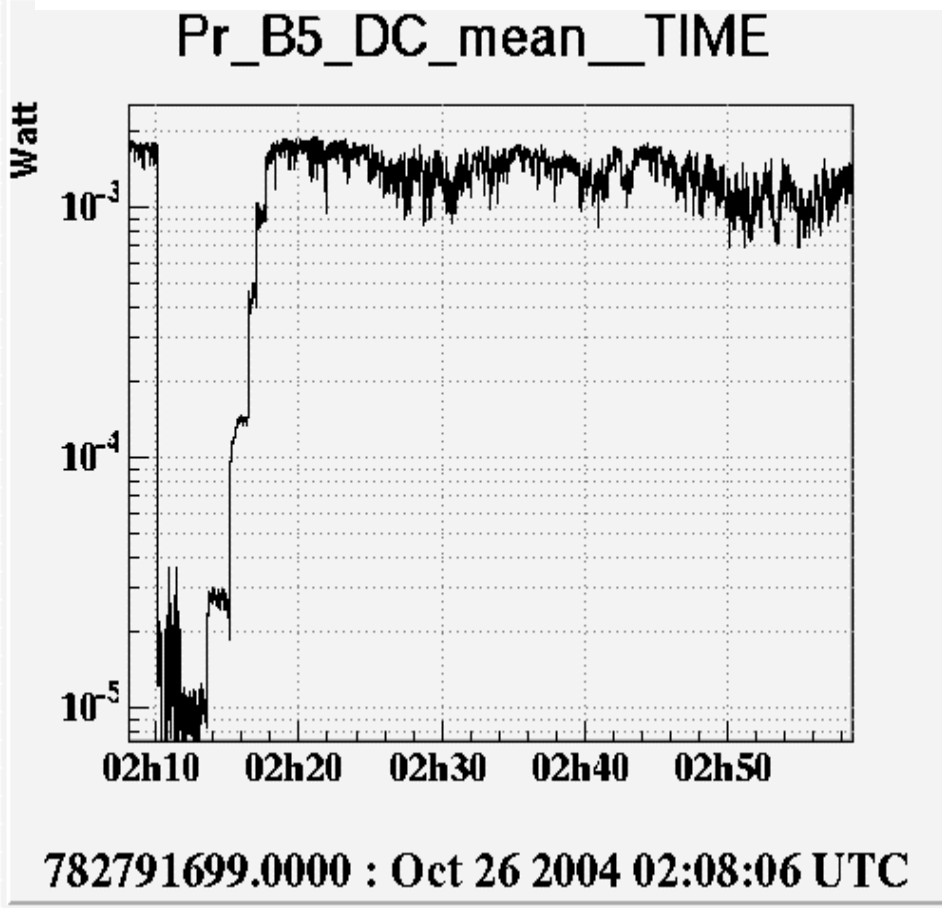
- Configuration: recombined ITF with ‘nearly’ complete control system
- Duration: 5 days, 24-29 June 2004
- Test periods at the beginning and at the end of the run
- 9 losses of lock during quiet periods (all understood, one de to an earthquake in Alaska)
- Longest locked period: ~ 28 h, relatively stable noise level



Michelson recombiné (sans recyclage)



26/10/04 Virgo recycle !!!



1er essai: lock de 40’

Conditions

- pas d’alignement automatique
- coefficient de recyclage: 24
- puissance laser atténuée: 0.7 W

Evolution prévisible

- 2005: premières acquisitions à faible bruit
- 2006-2007: fonctionnement semi-continu, améliorations mineures
- 2008: Virgo: bruit thermique et quantique

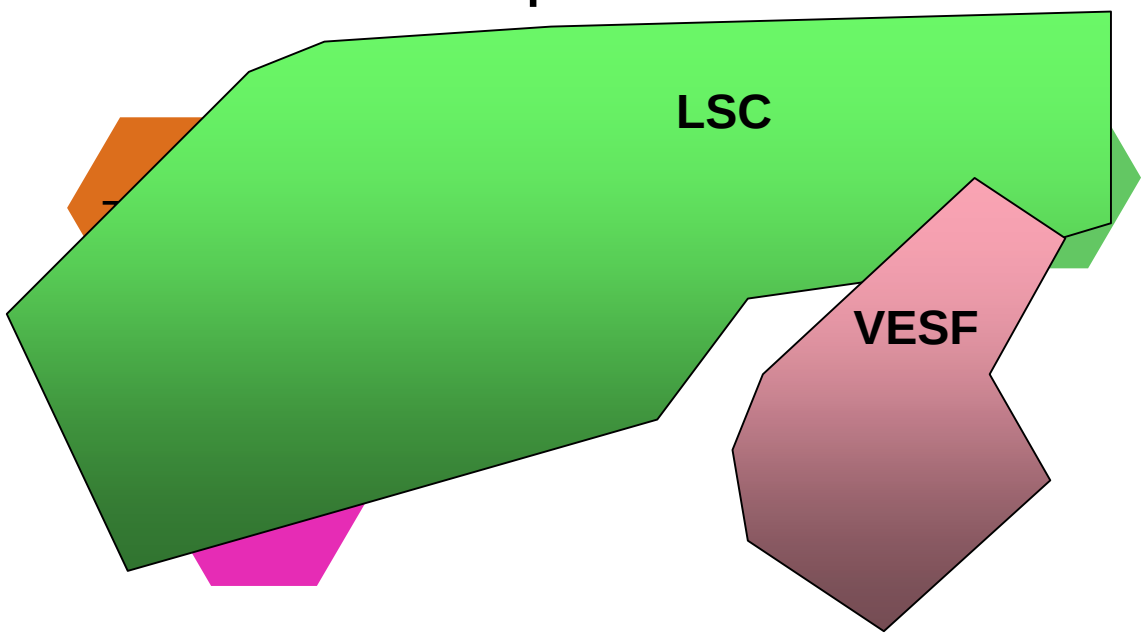
  LIGO: → advanced LIGO

  Virgo-LIGO: analyse cohérente ?

➢ 2008 ???

Compétition et collaboration

- Barres et interféromètres
- LIGO vs Virgo
  - Expérience et analyse de données
  - Communautés scientifiques



Conclusions

Optimistes: - construction réussie, budgets OK
- bruits stationnaires : sans surprises
- opération stable

Questions:

- bruits non stationnaires à découvrir
- analyse “in time” à réaliser
- [S/B = f(S)] →probabilité de détection ???
- coût et financement des “advanced detectors” ?
- R&D adaptée ?
  (resources budgétaires et humaines en Europe)
- Transition compétition / collaboration ?