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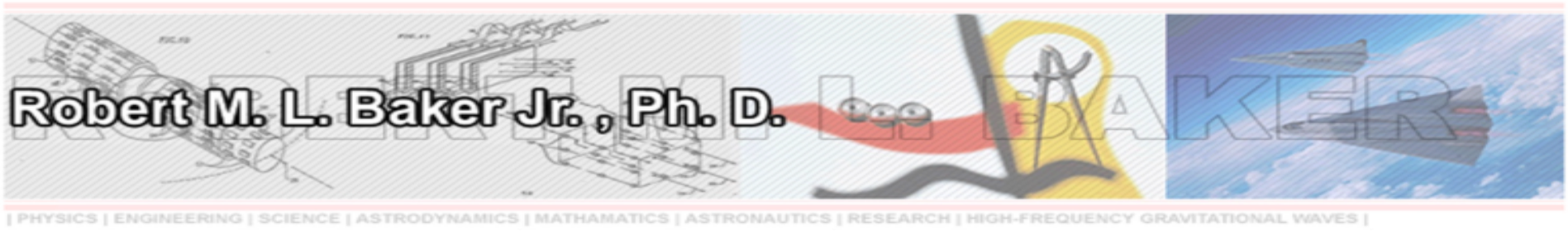
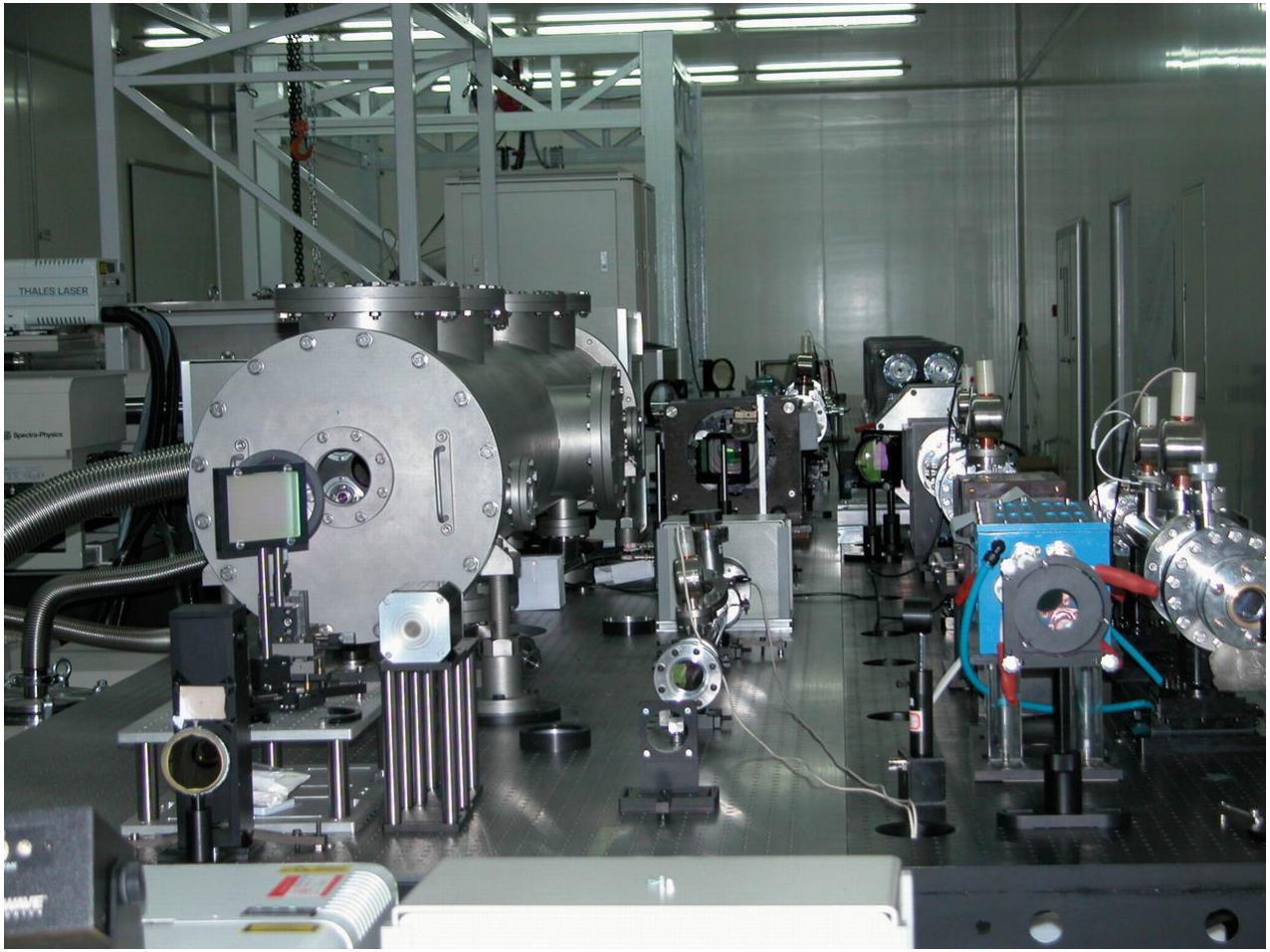
Chinese High-Frequency Gravitational Wave Research Program

Robert M L Baker, Jr.



Typical Equipment Layout, Notional Picture of possible Stainless Steel and Titanium Vacuum/ Cryogenic Containment Vessel and Faraday Cage for Laser research on left, which could be utilized for the Li-Baker HFGW Detector,
Shanghai Institute of Optics and Fine Mechanics (SIOM)



Schematic of Li-Baker HFGW Detector

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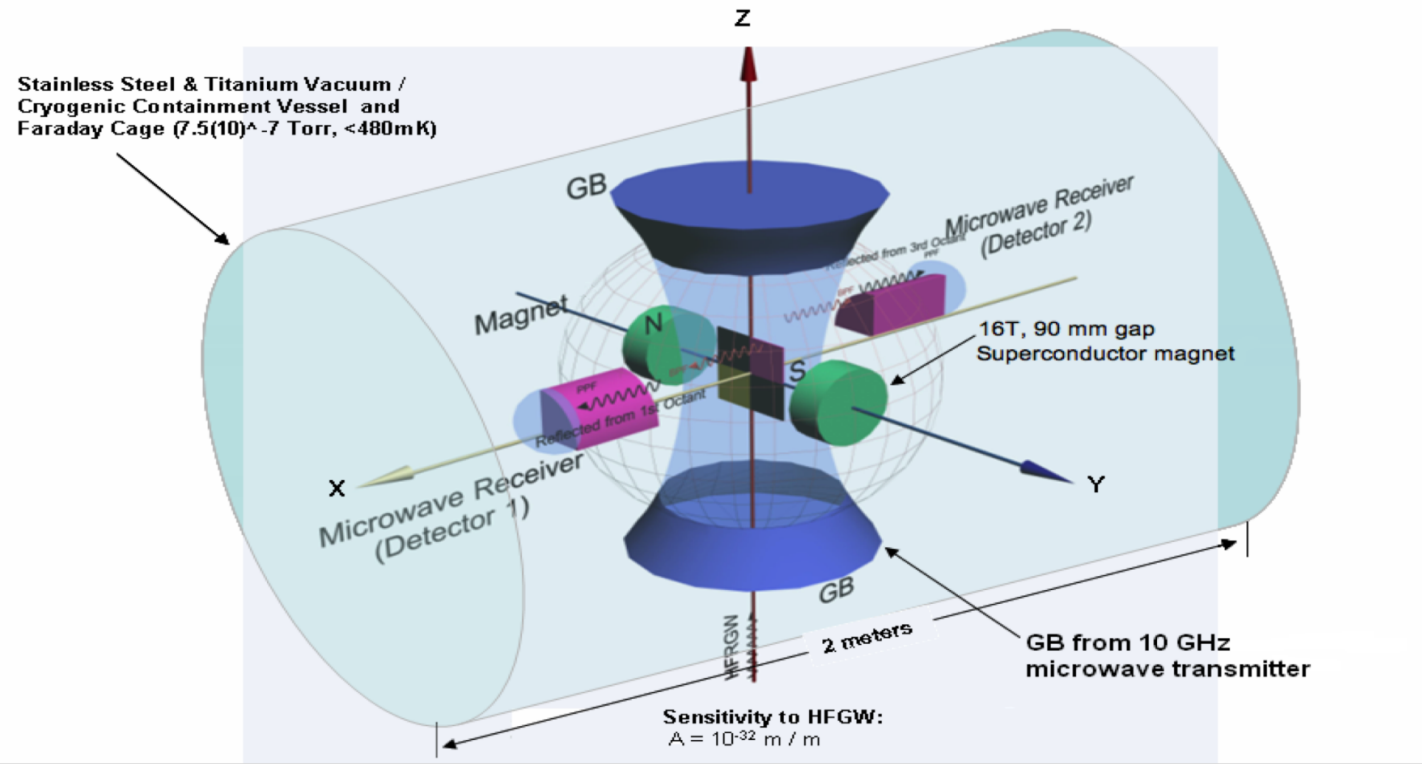

GravWave® Estimate of Peoples Republic of China HFGW Research Program

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- 联合汉语和GRAVWAVE® 重心波浪提出的项目
- (Joint Chinese & USA GRAVWAVE® High-Frequency Gravitational Wave Project)
-
- 高频引力波
- ***(High-Frequency* Gravitational Waves)**
- **Start: 2012**

- 高频遗迹引力波探测器的研制
- ***(Development of a High-Frequency Relic Gravitational Wave (HFRGW) Detector)***
- 探测器的实验室检验和高频遗迹引力波的测量
- ***(Laboratory Test of the Detector and Measurement of HFRGWs)***
- 高频引力波源和探测器的研制
- ***(Development of a High-Frequency Gravitational Wave (HFGW) Generator and Detector)***
- 高频引力波源和探测器的实验室试验
- ***(Laboratory Test of the HFGW Generator and Detector)***
- 高频引力波技术的实际应用
- ***(Practical Application of HFGW Technology)***

项目时间表
(ESTIMATED PROJECT TIMETABLE)

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- **5年、10年和20年期间的规划**
- **(THE FIVE, TEN AND TWENTY YEARS PROJECTIONS:)**
- ●5年（2017）：
- 1．在GHz频段对振幅为$h=10^{-30}$-10^{-31}的高频遗迹引力波的成功探测，包括探测器的必要的精制和改进，以提高其性能。下一步的计划包括探测灵敏度、频带、结构甚至探测方式上的改进。
- 2．完成高频引力波的实验室产生和探测，给出高频引力波产生和探测的概念上的检验，借助于高频引力波获得相关的科学和技术知识。
- *(*● Five Years (2017):
- 1. Successful construction of high-frequency relic gravitational waves (HFRGWs) ($h=10^{-30}$-10^{-31}) in the GHz band including necessary refinements and modifications of the detector in order to improve performance. Plan for the next step, including further improvement of the sensitivity, frequency band, structure and even detection method.
- 2. Laboratory generation and detection of HFGWs accomplished--a proof-of-concept test for HFGW generation and detection--and gaining familiarity with the science and art associated with HFGWs.)

Estimated Chinese Time Table Continued

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- ● 10年 (2022):
- 对全球通讯和成像进行实验。研制全球无绳通讯系统。开展对全球勘测和勘查系统的实验。并研究通过海洋、建筑物内部的成像技术和医疗全身扫描的成像技术，以及引力波和核科学的交叉课题。
- (● Ten Years (2022):
- Global communications and imaging successfully tested. Wireless global communications system deployed. Global survey and reconnaissance system tested and through-ocean, building-interior and medical full-body-scan imaging as well as GW-nuclear projects under development.)
-
- ● 20年 (2032):
- 研究全球勘测和勘查系统，通过海洋、建筑物内部的成像技术和医疗全身扫描的成像的课题并使之可供使用。进行高频引力波推进实验。对远距离的高频引力波云层聚结系统进行研究。对高频引力波的质量穿击束和放射性废料游离核能的检测展开试验。
- (● Twenty years (2032):
- Global survey and reconnaissance system and through-ocean, building-interior, medical full-body-scan imaging projects deployed and operational. Successful test of HFGW-propulsion system. Remote HFGW cloud-coalescence system deployed. HFGW mass-disrupter-beam and radioactive-waste-free nuclear energy systems successfully tested.)

IMAGE APPLICATIONS

成像的应用

Potential for through-earth or through-water "X-rays" to observe subterranean structures and geological formations (such as oil deposits), allow for a transparent ocean, and view 3D building interiors, buried or submerged devices, such as missile systems, mines, explosives, etc.

高频引力波将具有穿过地球和水的能力，如同x射线一样，从而能观察地层结构和地质构造（如石油沉积物等）。海水对引力波是透明的，从而可望以三维立体的形式去观察其内部，如被海水覆盖的东西，诸如导弹系统、水雷、爆炸物等。

Chinese High-Freqency Gravitational Wave Scientists

GRAVWAVE ® LLC.

Chinese HFGW Li-Baker Detector Team

KEY MEMBERS:

[1] Participant/Invitee 2003 HFGW Workshop I, The MITRE Corporation.

[2] Briefed Dr. Baker during 2005 Lecture Tour.

[3] Participant/Invitee 2007 HFGW Workshop II Austin, Texas.

[4] Briefed Dr. Baker during 2008 Lecture Tour.

[5] Author of Peer-Reviewed HFGW Technical Paper(s)

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Chinese Faculty and Students involved in HFGW Research, Chongqing University, China April 12, 2008

ESTIMATED WORK STATEMENT FOR Li-Baker HFGW DETECTOR

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Component	*Design $*	*Design Months**	*Plans & Specs $*	*Plans & Specs Months**
1.1 Containment Vessel	CC:9.000:GT:3.000	5	CC:6.000:GT:1.000	2
1.2 Test Apparatus	CC:12.000:GT6.000	6	CC:3.000:GT:1.000	2
1.3 Transmitter	CC:15.000:GT:5.000	7	CC:9.000:GT:3.000	4
1.4 Fractal Membranes	CC:15.000:GT:10.000	8	CC:12.000:GT:6.000	4
1.5 Receiver(s)	CC:18.000:GT:9.000	9	CC:12.000:GT:3.000	3
1.6 Refrigeration	CC:24.000:GT:6000	8	CC:15.000:GT:3.000	3
1.7 Magnet	CC:30.000:GT10.000	8	CC:18.000:GT:3.000	4
Total $	CC:123.000:GT:49.000		CC:75.000:GT:20.000	

* Many tasks can be done in parallel.

ESTIMATED WORK STATEMENT Continued

Component	*Design $*	*Design Months**	*Plans & Specs $*	*Plans & Specs Months**
2.1 Piezoelectric Resonators	CC:9,000;GT:12,000	4	CC:6,000;GT:6,000	2
2.2 Survey Plan	CC:12,000;GT:4,000	6	CC:9,000;GT:3,000	3
2.3 Power Supplies	CC:12,000;GT:6,000	7	CC:12,000;GT6,000	4
2.4 Phased-Array Feeds	CC:15,000GT:10,000	8	CC:12,000; GT:9,000	4
2.5 Cluster/Array Construction Plan	CC:18,000GT:36,000CC:	8	CC:12,000; GT:24,000	4
2.6 Magnetron Phase Locking	CC:24,000;GT:48,000	9	CC:15,000; GT:15,000	3
2.7 Superconductor Optics	CC:30,000;GT:50,000	8	CC:18,000; GT:20,000	4
2.8 System Engineering	OC:20,000;GT:30,000	6	CC:10,000; GT:20,000	3
Total $	CC:131,000; GT:196,000		CC:88,000; GT:103,000	

* Many tasks can be done in parallel.

Conclusions

- The Chinese currently have the most vigorous and well-planned research program on HFGWs throughout the world.
- They have designed two Li-Baker HFGW detectors based upon the Li-effect that are expected to have the unprecedented sensitivity to HFGW amplitudes on the order of 10^{-32} m/m.
- The Chinese, especially, recognize the potential practical commercial and military applications of HFGWs. The US scientific community, although very active in Low-Frequency Gravitational Wave (LFGW) research (e.g., LIGO), has not chosen to become involved in HFGW research to date.
- It is concluded that the US should sponsor study groups to analyse appropriate programs of basic and applied HFGW research.