Visitors from Japan to MIT FBML Magnet Technology Division – A Personal Recollection –

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Before I go into the main topic of this article on the visitors from Japan to the Magnet Technology Division (MTD) at the MIT Francis Bitter Magnet Laboratory with whom I have worked, I would like to take up two paragraphs reminiscing about my first trip out of Japan that led me to MIT and a few things I learned and experienced at the beginning of my life at MIT.

In the evening of March 31, 1956, just ~one week after out of 同志社 High School in Kyoto, I left Japan for Honolulu from 羽田国際空港 on a JAL Douglas DC-6, at that time one of the most widely flown commercial 4-propeller airplanes. The plane stopped at Wake Island for refueling. There all passengers were taken by bus to a fancy hotel, ~15-min ride away, with a beautiful Pacific Ocean view. In the hotel dining room we were served breakfast that included a half grapefruit, which I ate for the first time and at once liked, much juicer and sweeter than 夏みかん. Following a leisurely breakfast, we were back in the plane. When the captain announced that we had just crossed the International Date Line, everyone applauded. We landed in Honolulu in the evening of the 31st. In Honolulu, I experienced a 2½ -month American teenage life in a high school, staying in its boys' dormitory. In September I started my college life in a small (~800 students) liberal arts Westminster College, Salt Lake City, chiefly to learn "American" English and taste a bit of playful sides of an American college life, like on the fall weekends watching MLB games on TV (then all from East coast and Midwest), cheering our football team, and in the evenings playing bridge, a new card game for me, in our dorm rooms. In June 1957, I drove my car alone all the way from Salt Lake City to Cambridge, MA, worked in a boys' summer camp in a

small New Hampshire town, and in September enrolled in MIT as freshman.

During the fall semester in 1957, I saw only one black person, an instructor, in MIT—a couple of kitchen staff in Westminister. There were a handful of Asian students, mostly Chinese Americans and Indians, and a few Japanese. Still, MIT had foreign students that comprised 15% of its ~4,500 undergrads. According to the Dean of Foreign Students (now defunct), 15% was the largest % among all American universities. Female students represented only 3% (vs. ~50% in Westminister) of the student body. I was assigned to a room with one roommate in a 4-room, 6-man (5 Americans) suit in a large (300+) men's dormitory on Memorial Drive along Charles River. At the first evening bull session held in each unit of the dorm for the freshmen, where in my unit each of us ~10 freshmen introduced himself to the fellow freshmen and upperclassmen, it became clear to me that I was now in an elitist school. An upperclassman sternly warned us, "If you guys want to survive in this place called 'Tech is hell,' no TV or bridge games, not even on weekends:" a life shockingly in stark contrast to the one I enjoyed in Westminister. Thus, it was easy to understand why the outside world would regard every MIT student a nerd. At the same bull session another upperclassman told us a joke on the difference between MIT and Harvard students. In a supermarket on Memorial Drive located about midway between our dorm and Harvard, a student was in an express lane that had a large sign over it: "8 Items or less." The cashier, staring at his shopping cart, sarcastically asked, "Are you an MIT student who cannot read or a Harvard student who cannot count?"

My passport record shows since 1956 till this year I returned to Japan a total of 115 times: 0 in the first 6 years; 3 times, 1962–1967. Therefore, over a period of the past ~50 years, I've returned to Japan at an average of

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~twice a year. It means that I've encountered many superconductivity counterparts in Japan during the past ~50 years. In this article, however, I focus on the visitors from Japan *limited only to MTD*, who stayed a period of ≥ 2 weeks, though most stayed one year, a few longer. **Table 1** lists these visitors to MTD from Japan.

The first MTD visitor from Japan, hosted by then my boss and MTD head Bruce Montgomery, was 太刀川恭治先生 from then 金材研, 12/67–4/68. Thus, he tops the list in Table 1. He used our high-field Bitter magnets to measure critical currents of his V_3Ga tape samples, which later became the vital conductor for his superconducting magnet, at 17.6 T, a record at that time. My technician Charlie Park (1933–1996) and I assisted 太刀川先生. Later, he visited the Magnet lab a few more times. After the ASC1974 in Chicago, he stayed in our house in Weston. In the 1980s I visited his home in 世田谷 a couple of times and once was a houseguest.

From now on, I'm dropping appellation (敬称略), but occasionally use さん.

Although Bruce was his host, John E.C. WILLIAMS (6/65–9/67) from Culham lab, UK, was the first visiting scientist to MTD not from Japan with whom I worked closely. Indeed when Bruce took a one-year leave just as I was beginning to work on my PhD thesis, supervised by Paul Gray, an associate professor of then Department of Electrical Engineering, John was my day-to-day advisor on my thesis work. In 1974 Bruce invited John back to MTD for good to lead a program on NMR/MRI magnets. In 1981 John became MTD head when he succeeded Bruce who had officially left FBNML to work full time at the Plasma Fusion Center, spun-off from FBNML. Until his retirement in 1996, John had been one of my closest collaborators as well as an advisor to many MTD visitors.

Martin WILSON (9/76–9/77) from Rutherford lab who spent his sabbatical year with us was my second non-Japanese collaborator. Shortly after his arrival, Bruce said to me of Martin, "he's a crackerjack." Indeed he was: great in both analysis and experiment. When he wasn't calculating with his handheld HP calculator, he was in the lab preparing for and running experiments with me. At that time, our focus was magnet stability. In spring 1977 when we had dinner at our house, Martin urged me to attend the first Stability Workshop to be held at LANL in July that year that his friend Stefan Wipf was organizing. Somehow at first I didn't want to go—perhaps, subconsciously, I was hesitant because I knew that LANL had developed the A bombs that were later dropped over Hiroshima and Nagasaki. The workshop turned out to be great, not least of all, because there I met

Photo (6/81) After Yumi Iwasa's ballet recital. From front-left, counter-clockwise 岩佐宗和 (7/11/73–), 岩佐優美 (4/7/70–), 塚本健太 (6/12/80–), 塚本全恵 (1949–2012), 塚本修巳 (#4), 筆者.

塚本修巳, I think the only other Japanese at the workshop. Our meeting there might have made him to consider our lab as the place to spend his sabbatical year, which he began in 4/80 and extended by 5 months till 8/81. As indicated in Table 1, he spent summers in our lab 5 more times (1982–1986).

Luckily for Osami and his family a nice house right next to our house was available for rent. Starting in 1972, *before* the 1st oil shock in the US, my colleague and best friend in the Magnet lab Mat Leupold of hybrid magnet fame—today nearing 91, still active and alert—and I began carpooling. On Tuesdays and Thursdays Mat drove ~5 miles to my house and gave me a ride, and on Mondays, Wednesdays, and Fridays, he left his car in our garage and I drove. So Osami commuted to MIT with us every day during his first stay. Years later, remembering our ride with Osami, Mat thought Osami was, in the best sense of the words, a ball of fire.

In his work at FBNML, he dispelled a notion, first advocated by 野村晴彦, #2 visitor from Japan (7/78–7/79), that acoustic emission (AE) signals originating from superconducting magnets were due to flux motion. Osami performed many seminal experiments that led to the conclusion that disturbances afflicting adiabatic magnets with premature quenches were all mechanical in origin. Years later, Osami told me that his stay in our lab

as one of the most enjoyable times in his life, because for one thing, liquid helium was abundantly available like hot water and that he could freely express his opinion in our group without fear of retribution.

Very interested in AE work that 野村晴彦 was performing in the late 1970s at ETL, I inquired him, at that time by mail and phone, about his work and invited him to spend a year with us. To help me with my research work, Bruce let me hire a young engineer, Mike Sinclair. Mike and I waited for his arrival, already convinced that his theory of flux motion generating AE signals. One unforgettable story about “Harry” was that when his family moved into an apartment in Lexington, the very first thing he did was to change all the light bulbs in the apartment from 100 W to ≤ 60 W. He couldn’t understand why Americans would use so many 100 W light bulbs in the home. Harry also had an excellent ear, and thus although he had not formally studied Russian, he communicated in Russian well with Emanuel Bobrov (1936–2008), a recent arrival to MTD from Moscow; his good ear also made his English flowed naturally from his mouth.

By the mid 1980s, based primarily on our work with Osami, the Japanese visitors, 我妻 洸, 前田秀明, 玉田紀治, 石郷岡 猛 (1944–2009), 八坂保弘, and others in our lab further reinforced our belief that mechanical disturbances were a real culprit of magnet quenches. We also became convinced that AE monitoring would be a powerful diagnostic tool for these magnets.

In 1981 as we completed a 30-T hybrid magnet, a result of our major project that began in the late 1960s, we hosted 能登宏七. At that time his lab, 東北大金属材料研, had a plan to build a hybrid magnet to upgrade its high-field magnet facilities, then all based on Bitter magnets.

Also beginning in the late 1970s, we began a new area of research that we coined “cryotribology”—tribology (study of friction and wear) at cryogenic temperatures—again to understand frictional heating that apparently was taking place in these quench-prone adiabatic NbTi magnets. We applied AE technique to cryotribology too. Also, we studied cracking energies (“cryomechanics”). For this study, we had, in addition to those listed above, 藤田博之, 高木 亨, 船木和夫, 進藤裕英, 小原健司, 市原 直, 淵野修一郎.

市原さん from 三菱電気 had kind of a scoop. When I tipped him off that Bruce was looking for a reliable company to manufacture copper square plates with a hole in the middle (square annuli) for the latest ALCATOR c-mod, he responded quickly and effectively, managing to secure this very interesting job to his company. ALto

Photo (1/29/88) In the author’s office in Plasma Fusion Center (now Plasma Science & Fusion Center). 石山敦士 (#16), 筆者.

(high), CAMPus (field), TORus (toroid) was the MIT’s answer to a high-field Tokamak and the success of earlier prototypes built in FBNML led to a new plasma physics laboratory, the Plasma Fusion Center (PFC), later renamed Plasma Science and Fusion Center, of which, effective on July 1, 2013, FBML became a part. For a period of ~10 years from the early 1980s to the early 1990s, most visitors from Japan, my students, and I had offices in PFC.

At about the same time, we began our research on protection, in which 石山敦士 participated. One of my students, Chad Joshi, was doing his PhD thesis on protection, which included normal zone propagation (NZP). Although his specialty was numerical stimulation, 石山敦士 told me he had to do experimental work in a place like MIT; he did pretty well in designing, building, and running his own experiment on protection and NZP. Along the way, he also advised Chad.

In 1987 we began a collaborative project with 東芝医療用品 to develop actively-shielded gradient coils for their MRI magnets. 河本宏美 and 坂倉良知 worked chiefly with our engineer Bill Punchard. At about the same time we began a collaborative project with 神戸製鋼 to build a 750-MHz NMR magnet, an ambitious vehicle with which for us to advance high-field

superconducting NMR magnet technology and at the same time train 神鋼 engineers. 広瀬量一 and 吉川正敏 stayed with us during most of the project. For this project I had a Chinese student, “Ping” ZHAO (趙宗平) from 東京電気大学, work in this 750-MHz NMR magnet project. Earlier in 1989, 東京電気大 asked me to invite Ping as a visiting scientist to MTD and allow him to complete his PhD thesis under my supervision on a topic of my choice. Today, MIT no longer tolerates this kind of a casual arrangement in which a student from another university can come to MIT as a visiting scientist, let alone, such a student to use MIT facilities, free of charge, to work on a non-MIT thesis based on an MIT project.

In 1990, 木吉司 (1954–2013) and 浅野稔久 stayed in our lab as their lab, NIMS, was building a 40-T class hybrid magnet. 田原恭幸, helping us our on-going 35-T hybrid magnet project, also worked on stability and protection of LTS magnet, advising my thesis student, Joe Brown.

In the early 1980s, we started working on magnetic refrigeration, collaborating with my former undergrad teacher, Joseph L. Smith (1929–2013), who then headed the Cryogenic Engineering Lab; Joe, noted for his work on a superconducting generator, also had several visitors to his lab from Japan. In addition to stability and AE, 玉田紀治 worked on this. In the late 1980s we welcomed two NIMS visitors, 佐藤充典 (1937–2006) and 沼澤健則, who helped our magnetic refrigeration project. Once, 佐藤さん gave me a beautiful, yellow-green $\phi 45$ mm, 43-mm high rod of dysprosium-aluminum garnet, grown in his lab. It’s now on my wife’s desk as a paperweight, surely much more classy and precious than a Baccarat. While at MIT, 沼澤さん married an amateur herpetologist from Japan in a wedding ceremony held in the MIT chapel. When we invited the couple to our house in Weston, his wife immediately went out to our backyard for a survey of the wild life there. Upon finding a few healthy salamanders, she declared, happily to us, that their presence was a proof that our backyard was ecologically pristine. She also found many snakes, big and small, and all sorts of frogs and toads, some of these critters she had never seen in Japan.

Our successful work in the 1980s resulted in adiabatic LTS magnets that operated stably, *but not always*. Magnet stability thus remained a critical issue in the 1990s. For this effort, we had 新政憲, 竹内一浩, 新井和昭 (1960–2010), 二ノ宮晃; some also worked on AE technique.

In 1992 森田郁朗 of 徳島大学 came to our lab. He wanted to observe at close range research activities in superconducting magnet technology. At that time our

activities included a 35-T hybrid magnet, magnetic refrigeration, a 750-MHz NMR magnet, liquid H_2 production for in-field critical current measurements at 20 K of 住友電工 Bi2223 short samples and small coils.

After the HTS era had begun, our activities shifted towards HTS magnet technology. In 1995 澤孝一郎先生 invited me to spend a half year in 1996 at 慶應義塾大学. For my stay there I designed a new HTS experiment, “active maglev,” that could easily be performed at 慶應. The active maglev study was continued at MIT by 津田理 and 野口聰. We also studied beneficial effects of solid nitrogen on HTS, first with 向井栄一 and later with 磯上尚志 and 菅原明. Another HTS activity began in the early 1990s was a compact, persistent-mode NMR magnet assembled from YBCO annuli. This was initiated with the arrival of 富田優 from RTRI, who supplied us a few of his YBCO annuli. Seok Beom KIM (金錫範) studied characteristics of trapped flux in these annuli.

Starting 2000 we began focusing on NMR and MRI magnets incorporating HTS coils, which in turn confronted us with technical challenges, such as spatial field homogeneity, and inspired us to explore other coil options. These included a serious issue of error fields by screening-current field (SCF), which was initially tackled by 安藤竜弥 and 谷貝剛. Field shimming of a magic-angle-spinning NMR magnet was a topic of 野口聰. The non-insulation (NI) winding technique gave a nice opportunity for Xudong WANG (王旭東) and 野口聰 to study circuit modeling of NI coils. The partial-no-insulation coil, a variant of NI coil, seemed viable to NbTi MRI magnets and we formed a collaborative project with JASTEC to investigate this technique to their MRI magnets. The Patriots Nation (in fall and winter; the Red Sox Nation in spring–fall) that covers all 6 New England states was a perfect location for 寺尾泰昭 from

Photo (12/17/14) At a farewell party for 寺尾泰昭 held in the MTD conference room. From front-center-left, clockwise Juan Bascuñán, Seungyong Hahn, Jiayin Ling, Frank Li, Thibault Lécresse, Julio Colque, 寺尾泰昭 (#44), Jungbin Song, 宮城大輔 (#45), John Voccio, 筆者.

JASTEC, a former football (アメフト) player in his college team. This past February, alas after his return to Kobe, the Pats celebrated their 4th Super Bowl championship with a victory parade in the streets of Boston, pounded by the epic snowstorms of this century.

A promising way to minimize SCF-induced error fields, the so-called “shaking-field” technique, advanced by 船木和夫 as early as in the 1980s for LTS magnets, was initiated and studied for HTS coils by his former student and collaborator 柁川一弘. This was further investigated for HTS NI coils by 宮城大輔, who ends the list in Table 1.

Unquestionably these 45 visitors to MTD from Japan have had a huge beneficial impact on our achievements at FBML. I’m deeply grateful for their decision to choose MTD as their destination and perform their great research work while at MTD. Besides these 45 visitors from Japan, MTD has had, since the late 1960s, quite a few (35, through 7/15) visitors, including postdocs, from 10 countries, who not only have contributed to our activities but also collaborated with these 45 visitors from Japan. Below is a summary of these 35 visitors, listed in the alphabetical order of their “common” country names, starting with Austria and ending with the US. Listed for each visitor are name, original affiliation, and start/end dates.

If there are factual errors and omissions in this article, please excuse me.

Austria – Felix SHAUER (Ganz, Austria: 8/81–7/82).

Brazil – Carlos SHIGUE (CEMAR-FAENQUIL: 6/92–9/92).

China – Yinshum WANG (CAS, Beijing: 1/00–6/00); Jiarong FANG (CAS, Beijing: 6/03–8/04); Mingzhi GUAN (CAS, Lanzhou: 3/15–2/16); Timing QU (Tsingua U: 3/15–2/16).

France – Frederic TRILLAUD (CEA, Saclay: 10/05–11/07); Jean-Michel REY (CEA, Saclay: 7/07–9/07); Stephane BERMOND (CEA, Saclay: 10/09–3/10); Thibault LÈCREVISSE (CEA, Saclay: 1/12–3/12; 10/13–3/15).

Italy – Lucio ROSSI (Milano U: 11/85; 3/91).

Korea – Haigun LEE (Illinois U: 6/95–5/96; Korea U: 6/12–10/12); Sangkwon JEONG (KAIST: 9/00–8/01); Ho-min KIM (Yonsei U: 3/02–2/04); Seungyong HAHN (Seoul National U: 10/03–9/05); Guesoo CHA (Sooncheonhyang U: 8/04–7/05); Woo-Seok KIM (Seoul National U: 11/05–12/07); Hangil YEOM (KIMM: 4/06–7/06); Minchul AHN (Yonsei U: 3/07–2/09; Kunsan U: 7/14–6/15); Sangjin LEE (Uiduk U: 7/08–6/09); Dongkeun PARK (Yonsei U: 9/09–2/12); Kwangmin KIM (Changwon U: 8/10–1/11); Youngjae KIM (Yonsei

Photo (3/01/15) The family of 宮城大輔 at the author’s home in Weston. From front-left, clockwise 宮城奏輔 (10/27/08–), 岩佐仁子, 宮城大輔 (#45), 宮城明日香 (1/31/04–), 宮城亮輔 (3/10/06), 宮城有紀子, 筆者.

U: 3/11–10/14); Kwang-Lok KIM (Korea U: 10/12–2/13); Dong Gyu YANG (Korea U: 10/12–2/13); Jungbin SONG (Korea U: 10/12–11/14).

Haigun Lee, our first Korean visitor to MTD, who then became our staff till his move to Korea U in 2006, paved the way for more Korean visitors. Seungyong Hahn, who also became our staff till his move to FSU/NHMFL this March, took over Haigun’s role, promoting MTD as a great research venue for superconducting magnet technology to the young Korean visitors. I’m grateful to my Korean visitors for their tireless dedication and indispensable contributions to our projects. After they left our lab, most, if not all, of them have told me that their time in our lab was like living in paradise.

Mexico – [Frederic TRILLAUD] (Universidad Nacional Autonoma de Mexico: 6/13–9/13)—Trillaud listed above in *France*.

Soviet Union – Vladimir ZENKEVITCH (Joint Institute of High Temperature of USSR, Moscow: 1969, 3 mos.); Valentin SHAKTARIN (All Union Scientific R&D Electro-Machinery Institute, Leningrad: 1973, 6 mos.); Igor MAKSIMOV (Gorky: 6/86–5/87).

Vladimir Zenkevitch (1936–2003) and Valentin, hosted by Bruce in the midst of the cold war, weren’t assigned anything specific. I simply got to know them well, inviting them to our house. Valentin loved American culture, particularly songs of Bob Dylan and the Doors, and poems of Robert Frost and Edgar Alan Poe. Most of the time they spent in our Xerox room, xeroxing every document available. My colleague, Si Foner (1925–2007), gave each a title, Dr. Xeroxology. In his application to the American organization that

sponsored his 1-year study in the US, Igor Maksimov (1952–2005) chose, as his #1 American host, me and as his #2, John Bardeen. Igor pretty much figured that by putting me ahead of the great Bardeen, I would be so flattered not to deny his wish to come to our lab.

UK – John E.C. WILLIAMS (Culham lab: 6/65–9/67); Martin WILSON (Rutherford lab: 9/76–9/77); Min ZANG (U Bath: 7/15–9/15).

US – Earle BURKHARDT (Illinois U: 6/94–8/94); Frank LI (Youngstown U: 7/14–2/15).

Acknowledgement: In preparation of this article, I discovered most pre-digital age records were either lost or misplaced. Also because most of this article was prepared while I was away from my MIT office, I had to rely on some former visitors. In addition to a few individuals whom I contacted directly, the following former visitors helped me a great deal and am very much grateful to them: 我妻 洸, 石山敦士, 沼澤健則, 二ノ宮 晃, and 宮城大輔. Last but not least, I also thank Vitaly Vysotsky for his help in reconstructing my memories of the Russians.

Table 1 MTD Visitors from Japan (1967–2015)

#	Name (Affiliation)	Start–End	Main Research Areas
1	Kyoji TACHIKAWA (NIMS) 太刀川恭治 金属材料研究所	12/67–4/68	V ₃ Sn I _c measurement
2	Harehiko NOMURA (ETL) 野村晴彦 電子技術総合研究所	7/78–7/79; August (1985)	Acoustic emission (AE)
3	Koh AGATSUMA (ETL) 我妻 洸 電子技術総合研究所	11/79–11/80	Stability; mechanical disturbances; AE
4	Osami TSUKAMOTO (Yokohama Nat'l U) 塚本修巳 横浜国立大学	4/80–8/81 Jul–Aug (1982–86)	Stability; mechanical disturbances; AE
5	Hideaki MAEDA (Toshiba) 前田秀明 東芝	4/80–9/81	Mechanical disturbances; AE
6	Koshichi NOTO (Tohoku U) 能登宏七 東北大学	8/81–10/81	Hybrid magnet
7	Noriharu TAMADA (ETL) 玉田紀治 電子技術総合研究所	8/81–7/82	Stability; AE; magnetic refrigeration
8	Takeshi ISHIGOHKA (Seikei U) 石郷岡 猛 成蹊大学	8/82–7/83	Stability; AE; magnet monitoring
9	Yasuhiro YASAKA (Hitachi) 八坂保弘 日立	9/82–7/83	Stability; epoxy cracking; AE
10	Hiroyuki FUJITA (Tokyo U) 藤田博之 東大物性研	7/83–6/84; 7/85–8/85	Mechanical energies; cryomechanics; AE
11	Toru TAKAGI (Tokyo U) 高木 亨 東京大学	7/83–6/84	Mechanical energies; cryomechanics; AE
12	Kazuo FUNAKI (Kyushu U) 船木和夫 九州大学	7/84 (20 days)	Stability; AE
13	Yasuhide SHINDO (Tohoku U) 進藤裕英 東北大学	10/85–3/86	Cryomechanics
14	Takeshi OHARA (ETL) 小原健司 電子技術総合研究所	11/85–11/86	Cryotribology
15	Tadashi ICHIHARA (Mitsubishi Electric) 市原 直 三菱電気	8/86–8/87	Stability
16	Atsushi ISHIYAMA (Waseda U) 石山敦士 早稲田大学	8/86–2/88; 7/90–8/90	Stability; Normal zone propagation (NZP)
17	Mitsunori SATO (NRIM) 佐藤充典 金属材料技術研究所	4/87–9/87	Magnetic refrigeration
18	Hiromi KAWAMOTO (Toshiba Medical) 河本宏美 東芝医療用品	1/88–3/90	MRI gradient coils
19	Shuichiro FUCHINO (ETL) 淵野修一郎 電子技術総合研究所	3/88–2/89	Cryomechanics

20	Takenori NUMAZAWA (NRIM) 沼澤健則 金属材料技術研究所	3/89–4/89; 4/90–3/91; 4/91–5/91	Magnetic refrigeration
21	Zong-Ping ZHAO (Tokyo Denki U) 趙 宗平 東京電気大学	4/89–6/92	LTS magnet protection; NZP
22	Ryoichi HIROSE (Kobe Steel) 広瀬量一 神戸製鋼	1/90–4/92	NMR magnet
23	Tsukasa KIYOSHI (NIMS) 木吉 司 金属材料研究所	3/90–6/90	Hybrid magnet
24	Toshihisa ASANO (NIMS) 浅野稔久 金属材料研究所	3/90–4/90	Hybrid magnet
25	Masatoshi YOSHIKAWA (Kobe Steel) 吉川正敏 神戸製鋼	4/90–3/91	NMR magnet
26	Yasuyuki TAHARA (Mitsubishi Electric) 田原恭幸 三菱電気	4/90–3/91	Stability; Hybrid magnet
27	Yoshitomo SAKAKURA (Toshiba Medical) 坂倉良知 東芝医療用品	12/90–3/93	MRI gradient coils
28	Masanori ARATA (Toshiba) 新 政憲 東芝	9/91–2/93	LTS magnet stability
29	Ikuro MORITA (Tokushima U) 森田郁朗 徳島大学	4/92–9/92	Superconducting magnet technology
30	Kazuhiro TAKEUCHI (Hitachi) 竹内一浩 日立	3/94–2/95	LTS magnet stability; Dissipation
31	Kazuaki ARAI (ETL) 新井和昭 電子技術総合研究所	4/95–3/96	Acoustic emission
32	Eiichi MUKAI (Kumamoto Institute of Tech) 向井栄一 熊本工業大学	7/95 (19 days)	HTS technology; solid nitrogen (SN ₂)
33	Akira NINOMIYA (Seikei U) 二ノ宮 晃 成蹊大学	7/95–8/95 (20 days)	Stability; Acoustic emission
34	Makoto TSUDA (Waseda U) 津田 理 早稲田大学	4/96–3/99	Active maglev
35	So NOGUCHI (Waseda U) 野口 聡 早稲田大学	6/98 (26 days)	Active maglev
36	Hisashi ISOGAMI (Hitachi) 磯上尚志 日立	3/00–2/01	SN ₂ & HTS response
37	Akira SUGIWARA (Niigata U) 菅原 明 新潟大学	3/00–3/01	SN ₂ & HTS response
38	Masaru TOMITA (RTRI) 富田 優 鉄道総合研究所	4/04–3/07	Annulus NMR magnet of YBCO annuli
39	Ryuya ANDO (Hitachi) 安藤竜弥 日立	4/07–10/07	Screening current field (SCF)
40	Tsuyoshi YAGAI (Tohoku U) 谷貝 剛 東北大学	10/07–3/08	SCF
41	Seok Beom KIM (Okayama U) 金 錫範 岡山大学	4/08–3/09	Annulus magnet
[35]	[So NOGUCHI] (Hokkaido U) [野口 聡] 北海道大学	2/12–12/12	Field shimming; Non-insulation (NI) winding technique
42	Xudong WANG (Waseda U) 王 旭東 早稲田大学	3/12–4/12	NI technique
43	Kazuhiro KAJIKAWA (Kyushu U) 柁川一弘 九州大学	4/13–3/14	Cryogenics; “shaking-field” technique
44	Yasuaki TERAU (JASTEC) 寺尾泰昭 JASTEC	6/13–12/14	Partial no-insulation winding technique
45	Daisuke MIYAGI (Tohoku U) 宮城大輔 東北大学	4/14–3/15	Shaking-field technique GdBCO NI coils