Name	Country	Location	Operating	Config.	Major radius (m)	Minor radius (m)	TF (T)	IP (MA)	ECH (MW)	ICH (MW)	NBI (MW)	LH (MW)	Notes and special features
ADITYA	India	Gandhinagar	1989	Circular Limiter	0.75	0.25	1.5	0.25	0.2	0.2	-	-	Gradually upgraded heating systems as a testbed for SST-1. 0.25s pulses.
ALCATOR A (ALto CAmpo TORu	USA	MIT, Cambridge, MA	1969 - 1982	Circular Limiter	0.54	0.10	10	0.3	-	0.1	-	0.1	First of the Alcator series of tokamaks at MIT. (Note that Alcator-B was designed but never built.) Some evidence that it might have had as few as four TF coils leading to an unusually large TF ripple, see Jassby et al, Nuclear Fusion 18 6 (1978) p825.
ALCATOR C (ALto CAmpo TORus)	USA	MIT, Cambridge, MA	1978 – 1987	Circular Limiter	0.64	0.16	12	0.9	-	-	-	4	Used extensively to study plasma confinement under strong ohmic heating, and achieved record confinement in 1983. Also studied high-density plasmas and used frozen fuel pellet injection. Probably the first tokamak to produce the density and confinement necessary for a useful fusion reactor. Was donated or sold to Livermore (LLNL) in 1987 for use as the Microwave Tokamak eXperiment (MTX), now shut down.
ALCATOR C-Mod (ALto CAmpo TORus)	USA	MIT, Cambridge, MA	1993 – 2016	D-shape Divertor (single or double null)	0.67	0.22	8	2	-	6	DNB only	2.5	Not an upgrade of Alcator C but a completely new machine. All-metal walls - molybdenum. Highest operating toroidal field on a divertor tokamak, using liquid nitrogen cooled field coils. Unique baffle divertor configuration. New upper divertor in-vessel cryopump installed 2007 (10,000l/s). Generally ran single null into the one closed divertor, but could run near-balanced double null discharges. During its last day of operation, the Alcator C-Mod tokamak reached a record plasma pressure of roughly 2 atmospheres, breaking its own previous world record of 1.77 atmospheres, which dated from 2005.
Alvand	Iran	Tehran	1981	Circular Limiter	0.46	0.13	0.8	0.03	-	-	-	-	The first Alvand Tokamak was constructed in 1975 with a rectangular cross section inspired by the Sidney Tokamak and it started operating in 1976. In 1980 ALVAND-IIC was constructed with circular cross section. ALVAND-IIC was upgraded to ALVAND-U in 2004. Plasma duration is about 10 ms and typical values of electron and ion temperature are, respectively, Te=200 eV and Ti=350 eV. Alvand and Damavand are names of two mountains which symbolise of greatness and pride in Iranian history. Thanks to Dr A. Sadighzadeh, Director of Plasma Physics and Fusion Research School, for this information.
ASDEX (Axially Symmetric Divertor EXperiment)	Germany	Garching	1980 - 1990	Circular Divertor (double null)	1.54	0.40	2.6	0.5	-	3	4.5	2	H-mode discovered in 1982 and ELMs observed. Stabilisation of sawteeth by modifying the q profile with LH current drive. Initially open geometry divertor, but best H-modes observed with closed divertor configuration. Now HL-2a in China.
ASDEX upgrade	Germany	Garching	1991	D-shape Divertor	1.65	0.5-0.8	3.9	1.4	4	6	20		Walls completely converted from CFC to tungsten. Pellets successfully used for ELM pacing. High field side pellet track available. Large amount of heating power is available (> 25 MW), which makes it possible to achieve heat fluxes (normalized to the plasma surface) in the same range as are projected for a fusion reactor. No boronisation used for wall conditioning after completion of the tungsten first wall. 10 sec pulses.
ATC	USA	Princeton	1972 - 1976		0.88	0.11	2	0.05		0.15			Compression to R=0.38m, a=0.17m, Ip=0.118MA, at Bt=4.7T.
Caltech Tokamak (sometimes known as ENCORE)	USA	Caltech	Late 1970s - early 1990s	Circular (No limiters)	0.45	0.16	0.35	0.02	-	?	-	-	Spheromak injection, edge turbulence studies, and ICRF coupling experiments. The machine was routinely operated without any localised limiters. Taylor Discharge cleaning routinely used.
CASTOR	Czech Rep.	Prague	1985 - 2007	Circular Limiter	0.40	0.09	1.5	0.025	-	-	-	0.02	Circular section with molybdenum limiters. Hydrogen only. Pulses up to 50 ms, reach Te max of 200eV. This machine was the former Russian TM1-VCh (sometimes known as TM-1MH) with a considerably refurbished vacuum vessel. TM-1MH was an upgrade of TM-1 from 1960 (see Braams, Stott page 132), so Castor is from the first generation of tokamaks with a metal vacuum vessel. CASTOR has now been moved to the Czech Technical University where it will be reinstalled, as a tokamak called GOLEM. (Thanks to Jan Mlynar for this update.)
CCT (Continuous Current Tokamak)	USA	Los Angeles (UCLA)	Late 80s to mid 90s	Circular Limter	1.50	0.40	>0.2	0.05				y	Pre-ionization of a tokamak discharge using an emissive LaB6 cathode compared to initiation of discharges with a 15 kHz breakdown oscillator. Full toroidal and poloidal liner which acted as a limiter.
CLEO (Closed Line Electron Orbit)	UK	Culham	1972 - 1987	Limiter tokamak and stellarator	0.90	0.13	2	0.12	0.2	-	0.04		Originally designed to be run as either a stellarator (with l=3 windings) or a tokamak, but after the success of T3 it was built as an iron cored tokamak. First NBI experiments on a tokamak. Early demonstration of vertical plasma position control in 1973-4. (See TO-1 for comparison.)
COMPASS-D	UK	Culham	1989 - 2001	D-shape Divertor	0.56	0.21	2.1	0.32	1.5	-	DNB only	0.2	Originally circular section but converted to D shaped. Saddle coils used to simulate error fields for the first time. 1.1 sec pulses. Sent to Prague to replace CASTOR in 2007.

Note! All figures are approximate and optimal (not necessarily current or simultaneously achievable).

COMPASS	Czech Republic	Prague	2008	D-shape Divertor	0.56	0.21	2.1	0.32			0.6	1	Received from Culham, UK in October 2007 to replace CASTOR. First plasma achieved on 8th December 2008. It is expected to continue in the existing areas of Czech expertise (achieved on the CASTOR tokamak) ie. plasma edge research and (hopefully) Lower Hybrid. COMPASS is bigger and, unlike CASTOR, has an ITER-like plasma configuration (scale approx 1:10). From 2010 it should be neutral beam heated (in UKAEA it was mainly heated by ECRH).
CSTN-I (Current Sustaining Torus of university of Nagoya)	Japan	Nagoya Univ.	1981 - 1982	Circular Limiter	0.30	0.04	0.2	?	-	-	-	0.035 (289 MHz)	Proof of principle demonstration of current generation due to travelling lower hybrid wave with helical antennae.
CSTN-II (Current Sustaining Torus of university of Nagoya)	Japan	Nagoya Univ.	1982 - 1986	Circular Limiter / Ergodic divertor (m/n=10/1)	0.40	0.09	0.875	0.003	-	-	-	0.025	Stable tokamak discharge with a high repetition rate (approx 10Hz at 2kA). Current drive by travelling lower hybrid wave with helical antennae and its propagation in tokamak configuration. Impurity transport, anomalous diffusion, plasma induced arc and Alfven wave propagation are also studied.
CSTN-III (Current Sustaining Torus of university of Nagoya)	Japan	Nagoya Univ.	1987 - 1995	Circular Limiter / Ergodic divertor (m/n = 6/1, 18/3)	0.40	0.10	0.875	0.001	-	-	-	-	60Hz AC operation achieved, using compact pulse width modulation (PWM) with invertor power supply. Basic characteristic of ergodic magnetic limiter, sheath physics and computed tomography diagnostics were studied.
CSTN-AC (Current Sustaining Torus of university of Nagoya)	Japan	Nagoya Univ.	1996 - 1998	Circular Limiter	0.40	0.10	0.12	0.001	-	-	-	-	60Hz bipolar AC operation at 0.5kA with 2ms flat top. Operation period limited by the temperature rise of the vessel walls, not by dissipation in the iron core. This device has also been used to deposit pure TiN films on substrates.
CSTN-IV (Current Sustaining Tokamak of univerity of Nagoya)	Japan	Nagoya Univ.	1998	Ergodic divertor	0.40	0.10	0.15	0.001	-	-	-	-	An upgrade of CSTN-AC with increased iron core capability. Studying AC operation and effects of rotating helical magnetic perturbations (RHMP) and fuel recycling. Penetration of RHMP into tokamak plasma and fluctuation measurements are carried out.
CT6-B	China	Beijing	1995 - 2002	Circular Limiter	0.45	0.13	0.75	0.04	y	-	-	-	AC operation and novel start-up using ECRH. 8 sinusoidal cycles at 4kA.
Damavand	Iran	Tehran	1993	Divertor (double null?)	0.36	0.07	1.2	0.035	-	-	-	-	Damavand is a small tokamak with elongated plasma cross section, having the parameters b=10 cm and a=7 cm. Plasma duration is about 21 ms and typical values of electron and ion temperatures are, respectively, Te=300 eV and Ti=150 eV. Damavand is equipped with a magnetron microwave source in order to pre-ionize the neutral gas before the main discharge. It has an active feedback control system for R and Z. It was obtained from Russia in 1994, formerly called TVD which was built by the Kurchatov Institute with an elongation of 4. It began operating at the Atomic Energy Organization of Iran after some modifications, including reducing the plasma elongation. In 2011 another modification is being made to improve the feedback system by installing new IGBT invertors in power supplies, digitizing the control system, simulation and some experimental work to change the analogue control system to an advanced control mechanism like adaptive control neural network and upgrading diagnostic systems. Alvand and Damavand are names of two mountains which symbolise of greatness and pride in Iranian history. Thanks to Dr A. Sadighzadeh, Director of Plasma Physics and Fusion Research School, for this information.
DANTE	Denmark	Roskilde	1977 - 1986	Circular Limiter	0.50	0.11	0.625	0.015	0.02	-	-	-	Electron Bernstein wave heating of the plasma. It was also a testing ground for the Risø pellet injectors, which were later installed on other machines around Europe.
DITE (Divertor Injection Tokamak Experiment)	UK	Culham	1974 - 1989	Circular Limiter / Bundle divertor	1.17	0.26	2.8	0.28			2.4		Designed to study injection techniques and plasma clean-up by use of a divertor. The DITE tokamak was unique in that it included a bundle divertor, which diverted the toroidal field at one toroidal and poloidal location. However, use of the bundle divertor was not the main focus of operation of the machine. The Hugill Diagram was developed on the basis of the work done on this machine.
Doublet II	USA	San Diego.	1972 - 1974	D-shape doublet Limiter	0.60	0.10	0.95	0.21					Copper field shaper.
Doublet IIA	USA	San Diego.	1976 - 1977	D-shape doublet Limiter	0.66	0.15	0.95	0.21					Copper field shaper removed, and demonstrated stable control using coils and power supplies.

Doublet III	USA	San Diego.	1978-84	D-shape doublet Limiter	1.45	0.45	2.6	2.2	1.2	-	8	-	Largest tokamak in the world at the time it was built. Demonstrated the importance of elongated, high current plasmas in reaching high beta (4.5%) and high confinement times. First large-scale international collaboration for tokamak research established between DOE and JAERI. Developed the expanded boundary divertor by using the lower D-section as a divertor for the upper D-section. The machine was converted to a large D-shaped tokamak with a poloidal divertor, DIII-D.
D III-D	USA	San Diego.	1986	D-shape Divertor (double null)	1.66	0.67	2.2	3	6	5	20	-	DIII-D is the largest tokamak currently operating in the United States, and holds the conventional-tokamak record for beta, the ratio of plasma pressure to magnetic field pressure (beta=12.5%). Features include carbon walls, cryopumped single-null and double-null divertor, and 18 independently controllable shaping coils to produce plasma cross-sections ranging from circular to highly triangular D-shapes. An additional, unique set of asymmetric magnet coils is used to suppress plasma instabilities. Auxiliary heating systems include mixed co- and counter-injected neutral beams, electron cyclotron heating, and ion cyclotron (fast wave) heating, allowing great flexibility in the application of heating, current drive, and rotation drive. A sophisticated digital control system provides precise control of the plasma shape, pressure, rotation, and current density profile. DIII-D research is aimed at establishing the scientific basis for future fusion power-producing tokamaks such as ITER, and developing "advanced" operational regimes with high beta and self-sustained plasma current for ITER and tokamaks beyond ITER. Thanks to Ted Strait for this information.
EAST (Experimental Advanced Superconducting Tokamak) (HT-7U)	China	Hefei	2006	D-shape Divertor (single or double) and limiter	1.75	0.43	5 SC	0.5	0.5	3	-	4	Not an upgrade of HT-7, but running in parallel on the site of the former HT-6M, in the same building as HT-7. First fully superconducting machine with non-circular section. 1000s pulses planned. Claim to have built it for only $37 million, and taken only 5 years. First plasma September 2006. Reported the first operation controlled from a remote site in February 2007, in conjunction with General Atomics in the USA. (See DIII-D.) 10 to 12 MW of additional heating planned by 2010. In early 2016 EAST achieved 100 sec operation in L-mode with high core electron temperature. (A milestone (for the government) was to exceed 50 million degrees.) Later in 2016 the machine achieved another milestone: 61 sec in fully-non-inductive H-mode, with a tungsten ITER-like divertor. (This significant achievement was surpassed by KSTAR later in 2016, but this is surely not the end of the race.)
EGYPTOR	Egypt	Cairo	1982	Rectangular Limiter	0.30	0.10	1.2	0.1	-	-	-	-	Studies plasma-wall interactions and material testing.
Erasmus	Belgium	Bruxelles	1976 - 1983	Circular Limiter	0.50	0.25	0.38	0.05	-	0.5	-	-	First university tokamak in Europe, designed by Robert Taylor, built in Cambridge, Mass, USA. Tested at MIT, shipped to Belgium. It had fiberglass epoxy PF magnets and copper strip TF magnets wound direct on the vacuum vessel. Air cored. It had a particularly low aspect ratio (for the time) and was useful to test the stability of this configuration in preparation for construction of JET. Instrumental in the development of ICRH as a key heating system for a tokamak, leading to a 4 MW ICRH on TEXTOR, and thus to a higher power system on JET. Thanks to Jef Ongena and by Stephen Fairfax for this information.
ET (Electric Tokamak) also known as TSX	USA	UCLA	2000	Limiter	5.00	1.00	0.25 (1.0)	0.045	-	2	<1	-	Claims to be the "largest tokamak" and indeed has the largest major radius and plasma volume, although not the largest torus volume (190m3 compared with 200m3 for JET). But note low plasma current. 3 sec pulses. Low energy beams (5keV). Unusual rectangular section torus. Mainly used for for beta-limit studies. Operations suspended about 2005.
FT (Frascati Tokamak)	Italy	Frascati	1975 - 1989	Circular Limiter	0.83	0.20	10	0.8	-	1	-	1	High TF machine, operating in ohmic regime until 1982, when RF and LH were added. Plasma temperatures up to 1 keV achieved. Not to be confused with FT1 and FT2 at Ioffe.
FTU (Frascati Tokamak Upgrade)	Italy	Frascati	1990	Circular Limiter (Mo)	0.93	0.30	8	1.6	1.3	0.5 IB	DNB only?	2.5	Upgrade of FT. All-metal walls - molybdenum. First machine to be capable of studying synergy between ECRH and LH. 1.5 sec pulses.
FT-1	USSR	IOFFE	1972 - 2002	Circular Limiter	0.63	0.20	1.2	0.045	0.25			0.1	Originally the T-5 machine in the Kurchatov Institute, Moscow.
FT-2	USSR	IOFFE	1979	Circular Limiter	0.55	0.08	2.2	0.04				0.2	Low plasma current leads to unusually low poloidal field compared with the TF, so ion poloidal Larmor radii are comparable in size to the minor radius. Also studies LH current drive phenomena.
FY-1	China	Leshan (near Chengdu)	1981 - 1988	Non-Circular Limiter	0.48	0.10	1	0.18					Non-circular plasma with a=10cm and b=25cm.
GOLEM	Czech Republic	Prague	2009?	Circular Limiter	0.40	0.09	1.5	0.025	-	-	-	0.02	This is probably now the oldest tokamak in the world and it has now been brought back into operation hosting the innovative (http://tokamakglobal.com/) "Global Tokamak Experiment". Circular section machine from the first generation of tokamaks with a metal vacuum vessel. This machine was originally the Russian TM1-VCh (sometimes known as TM-1MH) with a considerably refurbished vacuum vessel. TM-1MH was an upgrade of TM-1 from 1960. It was transferred to Prague to run as CASTOR from 1985 to 2007, and now to the Czech Technical University.
HBT-EP(High Beta Tokamak)	USA	Columbia Univ	1993	Circular Limiter	0.92	0.15	0.3	0.03	-	5	-	-	Specilises in study of resistive wall modes. Has an adjustable segmented conducting wall close to the plasma. Feedback control of external MHD activity achieved using an array of 20 pairs of radial control coils and 20 polidal sensor coils.
HL-1	China	Leshan (near Chengdu)	1984 - 1992	Circular Limiter (Mo)	1.02	0.20	3	0.225	0.25	-	-	0.25	Designed and constructed by SWIP in 1984. Iron transformer, inner (stainless steel bellows) and outer vacuum (5cm thick copper shell) vessels . L-H transition induced by a biased electrode and improved ohmic confinement was achieved. 1.6 second pulses.

Note! All figures are approximate and optimal (not necessarily current or simultaneously achievable).

HL-1M	China	Leshan (near Chengdu)	1994 - 2001	Circular Limiter	1.02	0.26	3	0.32	0.5	1	1	1	Modified from HL-1 by removing the conductive shell and replacing the vacuum chamber to increase the plasma minor radius and improve the accessibility. Supersonic molecular beam injection (SMBI) used for fuelling. Boronisation, siliconisation and lithiumisation used for wall conditioning. First machine to demonstrate the electron fishbone instability excited by RF heating alone. Note HL is Huan-Liuqi = "Toroidal Current Device" in Chinese.
HL-2A	China	Chengdu	2002	Circular Divertor	1.64	0.40	2.8	0.48	5	0	3	2	Plasma vessel and field coils from the former ASDEX, becoming the first divertor tokamak in China. Note HL is Huan-Liuqi = Toroidal Current Device. Mission to study advanced tokamak operation, including confinement, MHD instabilities, wall conditioning, heating and current drive. Single or double null operation possible. Siliconisation found to be very beneficial. 5 second pulses. Initially closed divertor but planning to change to an open divertor with Ip = 1.2MA. 14 titanium getter pumps in the divertor, with main torus pumping achieved by turbo pumps and cryopumps. Supersonic molecular beam injection (SMBI) and pellets for plasma core fuelling. First observation of 3D feature geodesic acoustic mode (GAM) zonal flows. Figures in brackets are planned upgrades to heating systems. See IAEA article http://www-pub.iaea.org/mtcd/meetings/PDFplus/fusion-20-preprints/OV_5-1Ra.pdf
HL-2M	China	Chengdu		D-shape Divertor	1.78	0.65	2.2	2.5	2	-	2	-	Upgrade of HL-2A to give higher plasma current operation in double null configuration. Exact specifications and schedule still seem a little unclear.
HT-II	Japan	Ibaraki-ken	1989 - 2001	Circular Limiter	0.44	0.11	2	0.05	-	-	-	0.016	In Hitachi Labs at Ibaraki-ken. Studied LH current drive with incoherent waves and effects of ferritic steel liners.
HT-6B	China	Hefei	1983 - 1992	Circular Limiter	0.45	0.12	0.75	0.04	0.1	-	-	0.1	Seeking further information about this machine's work in China. Now installed as IR-T1 in Iran.
HT-6M	China	Hefei	1985 - 2000	Circular Limiter	0.65	0.20	1.5	0.15	-	y	-	y	Now replaced by the new superconducting machine, EAST (HT-7U).
HT-7	China	Hefei	1993 – 2013	Circular Limiter	1.22	0.35	3 SC	0.4	-	2	-	2	Large TF ripple addressed by installing ferritic steel liners, operating 2003. 2MW ohmic heating. 4 minute pulses. (Uses the coils from the Russian T-7) (Note that HT-7U =EAST but this was not an upgrade of HT-7). AC operation achieved, LH assisted, with 10 cycles at 125 kA, terminated by saturation of the iron core.
HYBTOK-I (Hybrid Tokamak)	Japan	Nagoya Univ.	1970 - 1987	Circular Limiter	0.30	0.10	0.65	0.025	-	-	-	0.006	Octopole configuration. Constructed to test the concept of stable operation without a conductive shell. LH power introduced by T shaped wire antenna (as there was not enough space for any other type of launcher).
HYBTOK-II (Hybrid Tokamak)	Japan	Nagoya Univ.	1997	Ergodic Divertor (m/n = 6/2)	0.40	0.11	1.5	0.015	-	-	-	-	Effects of rotating helical magnetic perturbations with an ergodic divertor on impurity transport and penetration of RHMP into tokamak plasma are studied along with the research on limiter biasing on the plasma confinement using laser blow-off Li beam probing.
IGNITOR	Russia (Italy)	TRINITI	TBA	D-shape Divertor	1.32	?	13	11	-	20	-	-	Proposed collaboration between Frascati, MIT and TRINITI to build a medium sized high field/high current machine to study burning plasmas in the existing facility at Troitsk, just south of Moscow. Press release.
IR-T1	Iran	Tehran	1994	Limiter	0.45	0.13	1.2	0.06	-	-	-	-	An air-cored, ohmically heated tokamak, originally built in 1984 at the Institute of Plasma Physics, China and operated as HT-6B. Working since 1994 at Plasma Physics Research Center (PPRC) - Islamic Azad University, Tehran, Iran. Main IR-T1 research activities: MHD behavior activities; Edge Plasma Physics (Limiter Electrode Biasing, Fluctuation measurements); Plasma Wall Interaction; Plasma position control; X-Ray Tomography; Developing Heating System; Resonant Helical Magnetic Field Perturbation; Diagnostic development and improvement (SXR & UV-V Spectroscopy, ECE, Interferometer, advanced probes: Rake, Langmuir, Magnetic, Mach, Gunderstrup). Thanks to Pejman Khorshid for this information.
ISTTOK	Portugal	Lisbon	1992	Circular Limiter	0.46	0.08	0.6	0.01	-	-	-	-	Obtained from FOM in NL (where it was called TORTUR) but extensively modified. Currently the oldest operating tokamak in EU. Probably the first machine to operate in a multicycle alternating flat-top plasma current regime, and one of a few tokamaks currently capable of producing AC discharges regularly. They have pushed their 35ms pulse duration to 1s by using AC operation.
ISX-A (Impurity Study eXperiment - A)	USA	Oak Ridge	1977-1978	Circular Limiter	0.92	0.26	1.8	0.22	-	-	-	-	
ISX-B (Impurity Study eXperiment - B)	USA	Oak Ridge	1978 to 1984	Non-circular Limiter	0.93	0.27	1.8	0.24	0.2	-	2.5	-	Upgrade of ISX-A. Technically important for beta studies and impurity transport studies. By having about ten times more power available than needed to reach the ideal limit, it demonstrated the existence of a beta limit before theory predicted it. One of the few machines to have studied the beneficial effects of beryllium as a plasma facing material.

ITER	France	Cadarache	2025	D-shape Divertor	6.20	2.00	5.3 SC	15 (17)	20	20 (40)	33 (50)	0 (40)	Max heating power will be 110MW at any time during the high performance phase of operation. Planned fusion power 500MW. Subsequently up to 3000s pulses planned (although at lower power).
JET(Joint European Torus)(origin	EU	Culham	1983 - 1992	D-shape Limiter	3.00	1.25-2.1	3.45	7	-	18	21	7	Largest volume tokamak, with a torus volume of about 200 m^3. Held various records, including the longest duration 2MA plasma (60s). Iron cored. Beryllium coated first wall from 1989. TF limited to 3.45T at that time.
JET (Joint European Torus) (divertor config.)	EU	Culham	1992	D-shape Divertor	2.96	0.96	4	6	-	12	24	7	Plasma volume of about 90 m^3 since installation of pumped divertor with in-vessel cryopump (130,000 l/s) in 1993. Minor radius 0.96 in horizontal direction but 2.1 in vertical direction. Beryllium evaporation used (uniquely?) for vessel conditioning. Currently the world's only tritium compatible machine. Record fusion power 16.1 MW. Positive ion NBI power injection reached 24 MW in 2006 and further upgrades planned. The only machine that is capable of adjusting the amount of TF ripple by varying the current through alternate TF coils (of which there are 32). Now regularly running ITER shaped plasmas with injected power over 20 MW, often over 30MW. Upgrade to ICRH progressing 2007, with new antenna to provide at least 8MW extra. New high-frequency (50 Hz) pellet injector and full beryllium first-wall planned. 6 MA plasma current achieved, but rather lower current, perhaps 4.5MA, available in ITER shaped plasmas.
JFT-2 (Jaeri Fusion Torus)	Japan	Tokai	1972 - 1973	Circular Limiter	0.90	0.25	1.8	0.17	0.2	1	2.4	0.6	The first medium size tokamak in Japan. Exceptional confinement times achieved by emphasis on cleanliness and vessel conditioning. Also attempted to remove the effects of plasma wall interactions by rapidly withdrawing the limiters, with inconclusive results due to the high speed of diffusion of the plasma edge. Dynamic limiter speed of 9 m/s.
JFT-2a (Jaeri Fusion Torus) or DIVA	Japan	Tokai	1974 - 1982	Circular Divertor	0.60		1	0.02	-	0.2	-	-	The first tokamak with a poloidal divertor, called DIVA. First demonstration of impurity control by divertor in tokamaks.
JFT-2M (Jaeri Fusion Torus)	Japan	Tokai	1983 - 2004	D-shape Divertor (open 1983-1994, 1999-2004, closed 1995-1998)	1.30	0.35	2.2	0.5	1 (60 GHz)	4.5 (10-30 MHz)	1.6 (40 keV)	0.15 (650-750 MHz)	Remodelled version of JFT-2. Non-circular section with a closed/open divertor and a pumped limiter. Fast wave current drive, 0.8 MW, 200 MHz. 'Compact toroidal injector' for fuelling centre of plasma with gas (300km/s). Solenoid-less start-up demonstrated, using PF coils only. Three kinds of ergodic coils (EML coil, Ladder coil, Saddle coil). Had the world's largest DC flywheel generator (210 MJ, 51.3 MW). Ferritic plates to reduce TF ripple (1999-2000) and ferritic (F82H) liner covering almost the whole inside wall (2002-2004) were installed to study compatibility of ferritic steel blankets with high performance plasmas (AMTEX). Boronization with trimethyl boron. Thanks to N Hosogane for info about all versions of JFT2.
JIPP-TII	Japan	Nagoya Univ.	1976 - 1982	Circular Limiter	0.93	0.23	2.6	0.16	-	-	0.1	0.2	A hybrid tokamak/stellarator with l=2 helical windings which was later modified to a tokamak with local helical windings, JIPP-TIIU. Deliberate dust spreading experiments to determine the effect of dust on the plasma. First use of visible Bremstrahlung as a plasma probe.
JIPP-TIIU	Japan	Nagoya Univ.	1983-1995	Circular Limiter	0.93	0.23	3	0.3	-	1.3	1.5	0.2	Modification of JIPP-T2, becoming a tokamak with local helical windings. Studied non-inductive start-up by LH current drive, assisted by ICRH (and Ion-Bernstein) heating.
JT-60 (outer divertor configuration)	Japan	Naka	1985 - 1987	Outer Divertor / Circular Limiter	3.00	1.00	4.5	D2.1 /L2.7	-	5	20	10	The largest tokamak to be designed and buit in divertor configuration. Circular cross-sectional plasma with an outer divertor, which was formed by divertor coils installed in the vacuum vessel. All metal walls and divertor plates with TiC coated Mo limiters and plates. Plasma operation with hot wall of 300 degree C baking. Hydrogen operation only.
JT-60 (lower divertor configuration)	Japan	Naka	1987 - 1989	Lower Divertor / Limiter	3.00	0.70	4.5	LD2.2 /L3.2	-	5	20	10	Modified to lower divertor by installing a new divertor coil beneath the vacuum vessel for H-mode study, and carbon wall for high-current limiter operation up to 3.2 MA for achieving objective QDT. Hydrogen operation only. This tokamak was replaced by a new machine in the same building, JT-60U.
JT-60 SA	Japan	Naka	2019	D-shape Divertor (double null)	3.16	1.02	2.7 SC	5.5	7	-	24 +ve + 10 -ve	-	SA for 'super-advanced'. Planned upgrade of JT-60U, as part of the broad-approach to fusion combined with the Japanese National Programme. 100 sec flat top pulses. 18 TF coils (like ITER). EC at 110 and 140 GHz. Formerly known as NCT, JT-60 SU or JT-60SC. First plasma estimated to be in 2019 (as of 2015).
JT-60U	Japan	Naka	1991 - 2010	D-shape Divertor	3.40	1.00	4.2	5	4	10	40 +ve and 10 -ve	8 to 12	Plasma volume of 90 m^3. Air cored. Negative ion neutral beams since 1995. Long pulses (65s) at reduced current since 2003. Modified from open divertor to W-shaped divertor with pump in 1997. Holds current world records for fusion triple product, $Q_{equivalent}$ of 1.25 (i.e. equivalent of better than break even performance if D-T plasmas could be run), and ion temperature of 5.2 x 10^8 degrees. 'Steady state' operation reported in 2005 with 28s pulse. TF ripple problems addressed by fitting ferritic steel liners. Planned upgrade to become 'JT-60 SA'. Thanks to N Hosogane for info on all versions of JT-60.
J-TEXT (Joint-TEXT)	China	Huazhong University, Wuhan	2007	D-shape Divertor	1.05	0.26	3	0.4					Formerly TEXT-U, now recommissioned in Wuhan. Ready for first plasma, late 2007. Includes a 100MW motor/flywheel generator set.

Note! All figures are approximate and optimal (not necessarily current or simultaneously achievable).

KAIST	S Korea	Daejeon	1992 - 2002	Circular Limiter	0.53	0.14	0.5	0.12	0.0005	-	-	-	Re-assembly of the PRETEXT tokamak imported from Texas Univ, USA. Hydrogen only plasmas. Basic studies of high-temperature plasma physics, RF and microwave-assisted tokamak startup, and diagnostics development for KSTAR.
KSTAR (Korea Superconducting Tokamak Advanced Research)	S Korea	Daejeon	2008	D-shape Divertor	1.80	0.50	3.5 SC	2	0.5 (4)	2 (6)	(14)	(3)	All superconducting TF and PF coils (30 coils in total, 26 made of Nb3Sn and 4 of NbTi). First plasma in June 2008. Successful plasma start-up using second harmonic ECH pre-ionisation for low voltage discharge. Expect pulses up to 2 MA and over 300 seconds. Figures in brackets are planned enhancements to heating systems. In 2016, KSTAR achieved a high-performance H-mode plasma stable for 70 seconds in 'high poloidal beta scenario', which uses a high-power neutral beam in combination with several other techniques, including the use of a rotating 3D field to alleviate the accumulated heat fluxes on the plasma-facing components.
KT-1 (Kaerit-1)	S Korea	Daejeon	1988 - 1997	Circular Limiter	0.27	0.04	1.5	0.02	-	-	-	-	General research including boronisation and plasma position control.
KT-5C	China	Hefei	1985 - ?	Circular Limiter	0.33	0.13	0.7	0.03	-	-	-	-	Fluctuations and transport in the plasma edge.
LIBTOR (TM-4A)	Libya	Tajour	1982	Circular Limiter	0.53	0.12	4	0.12	-	-	-	-	Formerly the Russian TM4-A. Studies disruptions, runaway, sawteeth, plasma wall interactions and confinement.
LT-3 (Liley Tokamak)	Australia	Canberra	1964 - 1978	Circular Limiter	0.40	0.10	1	0.033					From 1964-69 this was the only tokamak operating outside the Soviet Union. Previously called LT-1 and LT-2 when operated with earlier versions of its capacitor bank based power supply and different magnetic field configurations. Runaway electrons first systematically studied on this machine.
LT-4 (Liley Tokamak)	Australia	Canberra	1978 - 1984	Circular Limiter	0.50	0.10	2.1	0.07					Powered by the 'Homopolar Generator' with 64 single turn TF coils operating in parallel. Plasma controlled by feedback. Studied the onset of disruptions and the first experimental use of infra-red imaging of plasma density fluctuations.
Macrotor	USA	UCLA	70s to 80s	Rail Limiter	1.00	0.47	0.3	0.06					Low power density machine, a predecessor to ET. Designed in part to test scaling laws by comparison with Microtor. Studied magnetic and electrostatic fluctuations. Taylor discharge cleaning used.
Microtor (and Microtor II)	USA	UCLA	1976 - 1983?	Rail Limiter	0.38	0.13	2	0.1		?			Same PF/TF magnet construction as Erasmus. Used to help with development of Taylor Discharge cleaning. First demonstration of the use of a FIR laser to study density fluctuations using a two view interferometer. Ion Bernstein wave heating (including second harmonic).
Mini Torus	China	Leshan (near Chengdu)	1978 - 1982	Circular Limiter	0.20	0.05	1.2	0.015					14 ms pulses
Minimak	Japan	Tokyo	Early 1980s	Circular Limiter	0.23	0.06	1.4	0.06					Small iron cored machine built to study MHD with probes inserted into the plasma. Particularly used to study m=2 resistive tearing modes.
MT-1	Hungary	Budapest	1978 -1992	Circular Limiter	0.40	0.09	1.2	0.03	-	-	-	-	Built to study MHD. 20 TF coils. Upgraded to MT-1M (1992).
MT-1M	Hungary	Budapest	1993 -1998	Circular Limiter	0.40	0.13	1.2	0.04	-	-	-	-	Upgrade of MT-1. 8 msec pulses. Included pellet injection. Hydrogen only. Thanks to Sandor Zoletnik for helping to complete the missing details.
MTX (Microwave Tokamak eXperiment)	USA	LLNL	1989 - 1992	Circular Limiter	0.64	0.16	12	0.9	-	-	-	?	Formerly Alcator C, reinstalled in building 431 at Lawrence Livermore National Labs. Used microwaves generated by a free-electron laser in the Experimental Test Accelerator (ETA II) to heat the plasma.
NOVA-I	Japan	Kyoto	Late 1970s to early 1980s	Circular Limiter	0.18	0.03	0.6	0.002	-	-	-	-	Small tokamak with no conductive shell. 1cm thick Mo sheet as a limiter. Runaway electron studies.
NOVA II	Japan	Kyoto	Mid 1980s to ?	Circular Limiter	0.30	0.06	1	0.01	-	-	-	-	Later became NOVA-UNICAMP in Brazil.
NOVA-UNICAMP	Brazil	Campina	1996	Circular Limiter	0.30	0.06	1	0.01	-	-	-	-	Formerly the NOVA-II tokamak from Kyoto University, Japan, this is a small iron-cored machine with conducting shell stabilisation. Studies plasma-wall interactions.
NOVILLO	Mexico	Mexico City	1983 – 2004	Circular Limiter	0.23	0.06	0.5	0.012	-	-	-	-	Not run as a tokamak after about 2000, but used for studies on film deposition using plasmas. Shutdown in 2004.
(dc) OCTOPOLE	USA	San Diego	1969 - 1980s	Divertor-like structure	1.43	0.40	0.085	0.004				0.033	Large 'supported-inner-ring' torus, operated as an octopolar tokamak some of the time. The four internal rings allowed the machine to resemble a non-circular tokamak with an axi-symmetric divertor. Slow wave LH power introduced using half-wave resonant dipoles, at about eight times the ohmic heating power, but not enough to sustain the discharge in the low temperature highly resistive plasma. Observations of the transition from collisional to neo-classical transport.

ORMAK	USA	Oak Ridge	1971 - 1976	Circular Limiter	0.80	0.23	2.5	0.34	-	-	0.34	-	First injection of pellets, and first machine where neutral beam heating exceeded ohmic heating power. Featured on J Bronowski's renowned BBC TV series, "The Ascent of Man". Had an unusually large number of TF coils, at 56. Eventually used to build the HBTX reversed field pinch at Culham.
OT-1	Japan	Osaka Univ	Early 1970s	Limiter	0.30		1.3	0.25					A tokamak for studying turbulent heating by rising plasma current, with a power crowbar to keep plasma current constant after heating.
PBX (Princeton Beta Experiment)	USA	Princeton	1984 - 1985	Divertor	1.45	0.30	2.4	0.6					Was PDX. Indented plasma (on the inside, unlike the Doublet machines).
PBX-M	USA	Princeton	1987 - 1993	Divertor	1.65	0.30	2	0.6					
PDX	USA	Princeton	1979 - 1983	4 null divertor	1.40	0.45	2.5	0.6					Fishbone instability first observed here in 1983. Bean shaped plasmas. Studies here lead to the heliac configuration in stellarators. Later converted to become "PBX".
PETULA	France	Grenoble	1974 - 1976.	Circular Limiter	0.72	0.14	1.6	0.08				y	Constructed to study compressional transit time magnetic pumping (TTMP) using up to 2% modulation of the TF. Iron core and 2cm thick copper shell. Alumina limiters and 80% of first wall covered with alumina, leading to lower recycling of fuel compared with stainless steel vessel. LH studies. Low temperture hydrogen cryuopump at close to 2.2K.
PETULA-B	France	Grenoble	1976 - 1986.	Circular Limiter	0.72	0.16	2.5	0.23	-	-	-	1	Upgrade of PETULA, removing the copper shell. Used mainly for LH studies, and the concept of a LH grill was introduced to launch the slow wave. Established clear improvement in the MHD stability and supression of the sawtooth instability. Low temperature hydrogen cryuopump at close to 2.2K. Became RTP.
Phaedrus-T	USA	Madison	1989 - 90s	Circular Limiter	0.93	0.25	1	0.1		0.3			First experimental evidence of Alfven Wave Current Drive (AWCD) report in 1994. University of Wisconsin at Madison.
PLT (Princeton Large Torus)	USA	Princeton	1975 – 1986	Circular Limiter	1.32	0.40	4	0.7 (1)	-	5 (inc 1IB)	3	1	Largely a copy of the Russian T-10, but with addition of NBI and LH systems. Demonstrated current drive from breakdown by LH, but that LH only effective in low density plasmas. Variable minor radius by adjusting limiter position. The first machine to achieve a plasma current of 1MA. Metal limiters replaced by carbon limiters (for the first time?) about 1978. PLT test cell now used for NCSX (National Compact Stellarator eXperiment).
Pretest Torus	China	Leshan (near Chengdu)	1977 - 1980	Circular Limiter	0.26	0.05	1.5	0.008					2 ms pulses
PRETEXT (PRE Texas Experimental Tokamak)	USA	Austin, Texas	Late 70s to 1990?	Circular Limiter	0.53	0.15	0.8	0.06					Designed to investigate the initial stages of a tokamak discharge. The ohmic-heating (OH) transformer was unique among operating machines at that time, having an iron core and air return. Early evidence of discrete Alfven Eigenmodes. Later recommissioned in S Korea as KAIST.
Pulsator	Germany	Garching	1973 - 1979	Circular Limiter	0.70	0.11	3	0.125					Corrugated bellows stainless steel liner (a=0.14), stainless steel torus and 2.5cm thick copper shell. Vertical field windings supported on the torus. A pre-programmed current profile was able to achieve precise centring of the plasma within the limiter. Helical windings with m=2 and n=1 were designed for currentless pre-ionisation but never used for this purpose. However, they were used to study resonant helical fields. Pellets dropped into tokamak and discharge struck as they reached plasma centre position (1978).
R-05 (previously known as RT-2)	USSR	Sukhumi	1966-1970	Circular Limiter	0.65	0.10	3	0.1	y	-	-	-	ECRH Heating, feedback control. Quartz torus. Alfven heating of the plasma shown to improve the stability of the plasma core. (Note that R-01 and R-02 were stellarators. R-03 was a design study and R-04 never existed.)
RECTOR	USA	MIT, Cambridge MA	1972-1983	Rectangular Limiter	?	?	?	0.03					Early/first rectangular cross section device with coils built from welding cable like Verator I. Demonstrated improved confinement in elongated plasmas. Taylor Discharge cleaning used.
REPUTE-1 in tokamak config. (REversed field Pinch University of Tokyo Experiment)	Japan	Tokyo	1984 - ?	Limiter	0.82	0.20	0.4	0.1	-	-	-	-	Designed as a reversed field pinch but eventually operated in tokamak configuration with very low q profile. Hydrogen only. 6ms pulses.
RT-4M	USSR	Sukhumi	1971 - 1974	Circular Limiter	0.20	0.04	2	0.025	y	-	-	-	ECRH Heating. Difficult to obtain more details due to the political situation in Abhazia.
RTP (Rijnhuizen Tokamak Project)	Netherlands	Rijnhuizen	1989 - 1998	Circular Limiter	0.72	0.16	2.5	0.16	0.9	-	-	-	Circular limiter tokamak with good electron diagnostics. Obtained from France (the PETULA machine which opera
SINP	India	Kolkata	1987	Circular Limiter	0.30	0.08	2	0.06	-	-	-	-	Built by Toshiba to an Indian design Ultra-low q discharges.

SNUT-79 (Seoul National University Tokamak)	S Korea	Seoul	1982 - 1992	Circular Limiter	0.65	0.15	0.08	0.006	-	-	-	-	Basic study of tokamak plasma discharge using capacitors. Now decommissioned but stored/displayed in the KSTAR building in Daejeon.
SST-1 (Steady-state Superconducting Tokamak)	India	Gandhinagar	2013	Double-null Divertor	1.10	0.20	3 SC	0.220	0.2	1.5 FW + ICR?	0.8	31-Dec	Designed for operation at high bootstrap currents, and advanced configurations. Started in 1994. First plasma achieved June 2013. A good presentation about the construction of the machine can be found here, http://www.vecc.gov.in/writereaddata/upload/colloquia/SST-1_VECC_Jan22_15.pdf
ST (Symmetric Tokamak)	USA	Princeton	1970 – 1974	Circular Limiter	1.09	0.13	5	0.13	?	?	?	?	Originally the 'Model C' stellarator, but converted into a tokamak. Quickly matched the results obtained on Russian tokamaks after breakthroughs in the late 1960s. Experimented with aluminium limiters.
STOR-1M	Canada	Saskatoon	1983 - 1992	Circular Limiter	0.22	0.04	1	0.004	-	-	-	-	Turbulent heating and AC operation. First 'stable' AC operation of a tokamak in 1987. Operated with both air and iron cores.
STOR-1M (revived)	USA	Utah State University	2007	Circular Limiter	0.22	0.05	1	0.004	-	-	-	-	Recently moved from Saskatoon to Utah.
STOR-M	Canada	Saskatoon	1987	Circular Limiter	0.46	0.13	1	0.06					The STOR-M tokamak is a research tokamak designed and built in the Plasma Physics Laboratory of the University of Saskatchewan for studies on plasma heating, anomalous transport, and developing novel tokamak operation modes and advanced diagnostics. Has a unique heating mechanism called 'turbulent heating' and achieves 'ohmic H-mode' operation. Compact Torus Injection fuelling. NBI heating coming soon?
T-1 (known as Moscow torus 5)	USSR	Kurchatov	1957 - 1959	Circular Limiter	0.63	0.13	1	0.04	-	-	-	-	Unbaked metallic liner inside copper torus. Macroscopic stability, q > 1. Impurity radiation found to be the main route for plasma energy losses.
T-2	USSR	Kurchatov	1959 - 1965	Circular Limiter	0.63	0.13	1	0.03	-	-	-	-	400°C bakeable stainless steel liner inside copper torus to improve vacuum/surface conditions. Circular metal diaphragm as a limiter. Effects of stray poloidal fields on plasma equilibria observed.
T-3 (later called T-3a)	USSR	Kurchatov	1960 - 1971	Circular Limiter	1.00	0.12	4	0.06	-	-	-	-	Discrepency between experimental measurements of energy confinement time and the Bohm formula. First proved viability of the tokamak principle, by producing a plasma temperature of 10 million degrees, or 1 keV. (Result was disbelieved in the West until a British team confirmed the results using Thomson scattering.) Refractory metal limiters (similar to most machines at the time). First machine to produce measurable amount of thermonuclear neutrons in 1969.
T-4	USSR	Kurchatov	1971 - 1978	Circular Limiter	0.90	0.16	5	0.22	-	-	-	-	Equilibrium studies with Mirnov coils, special coils to set up a time-varying vertical magnetic field. Introduction of carbon limiters to replace refractory metal limiters (in parallel with TFR).
T-5	USSR	Kurchatov	1961 - 1965	Circular Limiter	0.63	0.15	1.2	0.06	-	-	-	-	Introduction of PF currents for plasma equilibrium control. Moved to IOFFE, St Petersburg, to become FT-1.
T-6	USSR	Kurchatov	1965 - 1975	Circular Limiter	0.70	0.25	1.5	0.27	-	-	-	-	Plasma temperatures less that 0.5keV. Investigated stabilising effect of a copper shell. Gold evaporation used. Ultra low q for the time. Updated to become T11.
T-7	USSR	Kurchatov	1979 - 1985	Circular Limiter	1.20	0.31	3SC	0.3	-	-	-	0.25	First superconducting TF coil machine. Equipped with LH current drive. Eventually parts went to China to become HT-7.
T-8	USSR	Kurchatov	1973 - 1978	Non-circular Limiter	0.28	0.06	1.2	0.035	-	-	-	-	One of the first machines with non-circular cross section, 0.2 m in height and 0.06 (radius) in width.
T-9 (aka Finger Ring)	USSR	Kurchatov	1973 - 1976	Non-circular Limiter	0.36	0.07	1	0.04	-	-	-	-	Extremely elongated cross-section. Stability of plasmas with elongation up to 2 demonstrated. The name "Finger Ring" comes from the shape of the torus which had a shape reminiscent of a ring. Converted to become T12.
T-10	USSR	Kurchatov	1975	Circular Limiter	1.50	0.36	4	0.6	2	-	-	-	Then the biggest tokamak in the world. Initially optimised to achieve high ion temperatures with ohmic heating, but later changed to study ECRH including ECR current drive. 5 gyrotrons at 130 and 140 GHz. Now achieves high electron temperature (10 keV) but only low ion temperature (1.5 keV) so few neutrons and little shielding. Good diagnostics and two pellet injectors. Pulse length typically 0.8 sec. Now studying transport, stability and ECR assisted breakdown.
T-11	USSR	Kurchatov	1975 - 1984	Circular Limiter	0.70	0.25	1	0.17	0.6	-	-	-	Based on T-6. Glow discharge cleaning introduced in 1976. Z eff approached 1. Molybdenum liner. Moved to TRINITI, Troitsk to become T-11M.
T-11M	USSR	TRINITI	1985	Circular Limiter	0.70	0.20	1.5	0.17	-	1	-	-	Based on T-11 from Kurchatov, used for studies of NBI. Extensive studies of low-q behaviour (down to below unity) establishing difficulties of 'barriers' at q=3, 2 and 1. Now mainly studying lithium evaporating limiters.

T-12	USSR	Kurchatov	1972 - 1983	Double-null Divertor	0.36	0.08	1	0.03					Elongated double zero poloidal divertor using many components of T-9. Modified to become T-13.
T-13	USSR	Kurchatov	1983 - 1988	Circular Limiter	0.36	0.08	1.2	0.035	-	-	-	-	Modification of T-12. R compression secenario development for T-14
T-14 (aka TSP, Tokamak Silnoya Pole)	USSR	TRINITI	c. 1989	Adiabatic comp.	1.00	0.32	2	3	-	-	-	-	Small very high field machine (12T at centre, 22T at walls, in large well shielded hall that would have been re-used for another bigger machine. Designed to be tritium compatible (although not all-metal), for plasma current up to 3MA, several 1GJ flywheels and large toroidal winding underneath the torus as inductive storage, 10g capacity tritium plant never used. Never operated above 2% of design capacity, and inactive since early 1990s.
T-15 (limiter config.)	USSR	Kurchatov	1988 - 1995	Circular Limiter	2.40	0.70	3.6 SC	1	2	-	1	-	Iron cored, circular cross section machine for H plasmas with option for trace D. Has the world's largest current niobium tin superconducting toroidal magnet, and this was the first machine to use a forced flow of liquid helium instead of pool boiling liquid. Normal (i.e. non-superconducting) PF coils. Pulses >1.5 seconds long, with design plasma current up to 1.8MA (but so far reached 1MA max). High enough power in form of ECRH and NBI to reach high beta configuration. 'Uniquely capable' of studying interaction between NBI and EC heating. Cryoplant power 5kW at LHe temperature! Operations suspended in 1995 because of the cost but planning to re-start an ITER relevant programme in about 2009, with newly designed divertor.
T-15 (divertor config.)	USSR	Kurchatov	2009 - 2022	Divertor	2.43	0.42	3.5 SC	1	7	-	9	4	Planning to re-start an ITER relevant programme in about 2009, with elongated divertor, up to 20MW of heating and 5 sec pulses, rising eventually to 1000s.
TBR	Brazil	Sao Paulo	1980 – 1998	Circular Limiter	0.30	0.11	0.5	0.085	-	-	-	-	Plasma transport and stability, Mirnov oscillations and electrostatic turbulence and chaotic field line studies. Helical windings used for disruption propagation studies.
TCA (Tokamak Chauffage Alfven)	Switzerland	Lausanne	1980 - 1990?	Circular Limiter	0.61	0.18	1.5	0.17	-	0.4	-	-	Air cored machine with rectangular cross section torus, but circular cross-section plasmas. 180ms pulses. 8 RF antennae, above and below the plasma. Alfvén wave heating studies. Kinetic Alfvén wave was first seen - an important validation of kinetic theory. Later sent to Brazil to become TCABR.
TCABR (Tokamak Chauffage Alfv	Brazil	Sao Paulo	1999	Circular Limiter	0.61	0.18	1.1	0.11					Alfven wave heating studies, up to about 1MW. Previously Tokamak Chauffage Alfven at EPFL, Lausanne, Switzerland.
TCV (Tokamak a Configuration Variable)	Switzerland	Lausanne	1992	Variable config. (elongation)	0.88	0.25-0.7	1.4	1.2	4.5	-	-	-	Very variable configuration. 100% bootstrap current achieved in 2006. World record of fully non-inductive operation with with ECCD, 210 kA in 2000. Highest elongation for a conventional aspect ratio (2.8). The only machine capable of negative triangularity. Fully ECCD sustained eITB's. Thanks to Henri Weisen for this information.
TdeV (Tokamak de Varennes)	Canada	Montreal	1987-1999	Circular Divertor (double)	0.84	0.23	2.1	0.25	y	-	DNB only	y	6s pulses. Total injected power 1.3MW. De-commissioned 1999. On display at the Canada Science and Technology Museum, Ottawa. Iran attempted to buy the machine in 1999, but failed. Links at http://www.flickr.com/photos/cstmweb/3548973411/ and http://www.iran.org/tib/public/6201.htm.
TEXT (Texas EXperimental Tokamak)	USA	Austin	1981 - 1995	Circular Divertor	1.00	0.27	2.8	0.34	0.6	-	DNB only	-	Specialised in turbulence measurements and 'ergodic limiter' studies. Now moved to Wuhan in China and called J-TEXT.
TEE	Germany	Juelich	1972 - 1977	Circular Limiter	0.25	0.10	0.45	0.025	-	-	-	-	High beta compact torus experiment. Heating by fast magnetic compression. Discontinued in 1977 to prepare for construction of TEXTOR.
TEXTOR	Germany	Juelich	1981 (1994) – 2013	Circular Limiter / Dynamic Ergodic Divertor	1.75	0.47	2.8	0.800	1	4	4	-	Dynamic Ergodic Divertor (DED) unique to this machine. Built to study plasma-wall interactions. Typical pulses 6-10 seconds long. Last major upgrade 1994. TS system has the tokamak plasma inside the laser cavity. Boronisation techniques for vessel conditioning pioneered at TEXTOR. Possible to split the torus into two to gain access (but later difficult due to presence of DED). Closed down December 2013.
TF-2	USSR Frunze	Bishkek	1984 - 1998	Circular Limiter	0.23	0.04	1.5	0.015	-	-	-	-	Modification of TV-1 (new vacuum chamber and improved parameters), moved in 1984 from Institute of High Temperature (Moscow). Low ripple toroidal magnetic field. Investigation of turbulence and transport in the plasma edge, plasma-wall interaction. Langmuir probe 3D arrays . Biasing experiments and ergodic magnetic limiter experiments. Thanks to Dr Slava Budaev for information.
TFR 400	France	Fontenay-aux-Roses	1973-78	Circular Limiter	1.00	0.20	6	0.49	-	-	0.7	-	Reached temperatures > 2 keV. Initially damaged by runaway electrons. Ref. Equipe TFR, Nucl. Fusion 16, 473 (1976). Thick copper shell for stability, achieving record plasma currents for the time. Introduction of carbon limiters (in parallel with T-4).
TFR 600	France	Fontenay-aux-Roses	1978 - 1984	Circular Limiter	1.00	0.20	6	0.49	0.6	1.5	-	-	Copper shell removed and plasma position controlled by a feedback system, although this was less effective than expected due to problems with disruptions and impurities.

TFTR (Tokamak Fusion Test Reactor)	USA	Princeton	1982 - 1997	Circular Limiter	2.40	0.80	6	3	-	11.4	39.5	-	Circular cross section limiter tokamak. It had an a full inner graphite armor belt on the center stack, and graphite limiters outboard. Tritium-compatible with D-T experiments carried out from 1993 (about 1000 shots), with a peak fusion power of 10.7 MW which was a world record at the time. Tritium plant had a 1.5g inventory limit, but processed (recycled) 99g of tritium overall. Machine operated at ambient temperature but could be baked to 150 degrees C for conditioning, with limiters baked to 250 degrees. Extensive GDC to condition limiters led to edge recycling reduction, and thus increased central ion temperatures and peaked the density profile for so called 'supershots'. Benefits of enhanced reversed shear pioneered on TFTR. NTMs, bootstrap current (sustainment of plasma current by diffusion of the plasma) and ballooning modes discovered here . Record 510 million degree plasma temperature 1995. Decommissioned 'early' due to cuts in the US Fusion Research Budget.
THOR	Italy	Milan	1978 - 1989	Circular Limiter	0.52	0.16	1.1	0.05	0.2	-	-	-	ECRH studies of supra-thermal plasmas.
TJ-1	Spain	Madrid	1983 - 1994	Circular Limiter	0.30	0.10	1.9	0.07	-	-	-	-	25 msec pulses. Heavy Ion Beam Probe (HIBP) diagnostic used here. In 1994 it began operation as TJ-1U, a torsatron (special kind of stellarator). Transferred to Kiel, Germany in 1999 to become TJ-K. (Note that TJ-2 is a stellarator, not a tokamak, so its specifications do not appear on this site.)
TM-1 (M means "малый", translates to "small" in English)	USSR	Kurchatov	1963 - 1968	Circular Limiter	0.40	0.10	3	0.1	-	-	-	-	Adiabatic compression. Became TM-1-Vch (also known as TM-1-Mh) and then eventually Castor.
TM-1-ВЧ (TM-1VCh in Latin)	USSR	Kurchatov	1970 - 1976	Circular Limiter	0.40	0.08	1.4	0.03	-	1	-	?	ICRH miniority ion heating. Ion-ion hybrid resonance scenarios discovered here. Later sent to Prague to become CASTOR.
TM-2	USSR	Kurchatov	1963 - 1967	Circular Limiter	0.40	0.10	2	0.1	-	-	-	-	May have discovered disruptions, but certainly demonstrated them when modified to become TM-3. First MHD stable regime. Concept developed of the complicated tokamak magnetic structure later called a magnetic island.
TM-3	USSR	Kurchatov	1967 - 1974	Circular Limiter	0.40	0.08	2.5	0.1	?	-	-	-	Modified version of TM-2. The first tokamak to demonstrate the phenomenon of a plasma disruption. ECRH demonstrated in 1976. Eventually modified to become TM-G.
TM-4	USSR	Kurchatov	1969 - 1973	Circular Limiter	0.53	0.09	2	0.1	?	-	-	-	ECRH studies. Bakeable to 1000°C, with stainless steel bellows liner. Sometimes claimed to have become LIBTOR via TM-4A, but other accounts explain that LIBTOR was a copy of TM-4 (but called TM-4A). This original TM-4 actually went to Sukhumi, and was modernised to be installed as TMR.
TM-G	USSR	Kurchatov	1976 - 1980	Circular Limiter	0.40	0.09	2.5	0.11	?	-	-	-	Modified version of TM-3. This was the first machine to operate with a full carbon first wall with Zeff of 1.2 to 1.4. For same discharges at TM-3 (stainless steel liner), Zeff was typically 2 to 4.
TMP	USSR	Kurchatov	1954 - 1957	Circular	0.80	0.13	1.5	0.26	-	-	-	-	The first toroidal machine with a strong toroidal magnetic field, Bt>Bj, built at the Kurchatov Institute in Moscow by Yavlinski and Golovin. In some cases this machine has been known as TMB, incorrectly due to a transcription of the cyrillic character into latin script. Porcelain torus with a stainless steel spring inside. Studied plasma discharge start conditions and plasma column stability, X-rays and runaway electrons.
TMR (written TMP in cyrillic)	USSR (now Abkhazia)	Sukhumi	To 1992	Circular Limiter	0.54	0.12	1	0.06	-	5	-	-	The TMR-device is a modernized version of the TM-4 tokamak, which initially operated at Kurchatov Institute in Moscow. After modernisation and commissioning, TMR was ready for the experiments, but has not operated since 1992. TMR is intended for development of current drive and plasma heating by Alphen waves. The main speciality of TMR is a powerful, developed HF system (16 antennas) for generation of travelling Alphen waves. Thanks to Vitaly Merezhkin for this information.
TNT (Tokyo Non-circular Tokamak)	Japan	Tokyo	1976 - ?	Non-Circular Limiter	0.40	0.10	4.4	0.05					Air cored tokamak with elongation of the plasma up to 1.4. Active plasma shaping and feedback control of vertical position of plasma. Upgraded to TNT-A
TNT-A (Tokyo Non-circular Tokamak)	Japan	Tokyo	Early 1980s	Non-Circular Limiter	0.40	0.10	4.4	0.04					Iron transformer core added to TNT, increasing the discharge time. Elongation of the plasma up to 1.4. Electron heating by IB waves, active plasma shaping and feedback control of vertical position of plasma by eight shaping coils mounted outside the TF coils.
TO-1	USSR	Kurchatov	1972 - 1978	Circular Limiter	0.60	0.13	1.5	0.07					Early (perhaps first) demonstration of feedback control of plasma position using a vertical magnetic field. This was subsequently adopted for the majority of tokamaks. (See CLEO for comparison.)

TO-2	USSR	Kurchatov	1976 - 1994	Circular Divertor	0.60	0.15	1.6	0.05	-	0.2	-	-	Racetrack tokamak with two toroidal divertors. Ion Bernstein heating and current drive.
TODOROKI-I	Japan	Tokyo Inst of Technology	1995 - 2001?	Limiter	0.30	0.06	0.9	0.01	-	-	-	-	A novel tokamak with a new type of toroidal field (TF) coils and a central solenoid (CS) - force balanced coils (FBC) - whose stress is much reduced to a theoretical limit determined by the virial theorem. However, the PF used to control the plasma shape/position and error fields from the FBC complicate the force balance. (Presumably from a concept developed by Jiro Todoroki?)
TODOROKI-II	Japan	Tokyo Inst of Technology	2002 - ?	Limiter	0.30	0.07	1.55	0.04	-	-	-	-	Follow up device to TODOROKI-I, using a modified "virial-limit coil" (VLC).
TOKAPOLE II	USA	Wisconsin	1978 - mid 1980s	Non-circular Poloidal Divertor	0.50	0.10	0.5	0.025	-	2	-	-	True magnetic limiter'. Stable low q discharges produced. Trapping of gun injected plasmas.
TOKOLOSHE	South Africa	Pretoria	1980 - 1990	Limiter	0.52	0.24	0.6	0.14	-	-	-	-	Low aspect ratio machine (with R/a=2.17). Studied fuel recycling. Toroidally rotating saturated 2/1 and 3/1 tearing modes locked by current in an external resonant helical coil, allowing the stabilizing effect of the wall boundary condition to be varied in a controlled manner. In African folklore a tokoloshe is a small mischeivous evil spirit.
Tore Supra	France	Cadarache	1988 – 2011	Circular Toroidal Pumped Limiter	2.25	0.70	4.5 SC	2	<2.4	9	1.7	5	Very long pulses, reaching a record of 6.5 minutes in 2003, with 500kA plasma current. Holds the record for the energy injected/extracted from a pulse at 1.1GJ. Planned upgrade in 2008 to allow 1000s pulses (CIMES project). Already runs fully non-inductive pulses. Most in-vessel components are actively cooled. NbTi TF coils run at a temperature of 1.8K. Since about 2011 the machine has been undergoing a substantial modification to convert it to a D-shaped plasma divertor machine under the name 'WEST' which stands for "W Environment in Steady-state Tokamak", where "W" is the chemical symbol of tungsten. (Note - see the entry for the Chinese machine 'EAST'.)
TORIUT-3	Japan	Tokyo Univ.	?	Circular Limiter	0.25		0.2	?	-	-	-	-	A tokamak for studying plasma heating by high voltage theta pinch
TORIUT-4	Japan	Tokyo Univ.	?	Circular Limiter	0.30	0.12	0.5	0.02	-	-	-	-	Low q discharges achieved by fast plasma current ramp and application of helical field.
TORIUT-5	Japan	Tokyo Univ.	?	Circular Limiter	0.38	0.13	0.5	?	-	-	-	-	Studies comparison of tokamak plasmas with reverse field pinch plasmas.
ToriX	France	Paris	c 1995	Circular Limiter	0.60	0.06	?	?	-	-	-	-	Installed at the French École Polytechnique, and used to train students in various diagnostic methods.
TORTUR (or TORTURE I)	Netherlands	Rijnhuizen	1974 - <1991	Circular Limiter	0.46	0.09	2.9	0.55					Turbulent heating experiment. Later moved to Portugal and became known as ISTTOK.
TORTUS	Australia	Sydney	1981 - 1992	Circular Limiter	0.44	0.10	1.2	0.035		y?			Alfven wave physics studies.
TORUS II	USA	Columbia University, NY	1978 - ?	Non-circular Limiter	0.23	0.13	0.35	0.03	-	-	-	-	High beta tokamak with rectangular cross section torus. A cool Z-pinch plasma created during pre-ionisation could be converted into a hot high beta tokamak plasma. (Note that TORUS I was not a tokamak but a "belt pinch".)
TOSCA (TOroidal Shaping and Compression Assembly)	UK	Culham	1974 - 1987	Flexible Shaping Limiter	0.30	0.10	1	0.025	-	-	-	-	Operated in Culham 'E' buildings which are no longer used for fusion research. 10mS pulses. Pioneered flexible plasma shaping, including divertor configurations, and use of second harmonic (28GHz) ECRH in a tokamak. Some TF compression experiments carried out.
TOTUS	Ukraine	Kiev	1987 - 1991	Circular Limiter	0.25	0.05	3.5	0.05	-	-	-	-	Small high toroidal field machine studying plasma control.
TRIAM (Tokamak of Research Institute for Applied Mechanics)	Japan	Kyushu Univ.	Late 1970s to early 1980s	Limiter	0.25	0.04	4	0.047	-	-	-		A small tokamak with high toroidal field, which confirmed high field tokamak performance. PF coils in the bore of the TF coils. Two ceramic breaks in the vacuum vessel (toroidal direction). Studied turbulent heating. This device was part of the development work for TRIAM-1M.

TRIAM-1M (Tokamak of Research Institute for Applied Mechanics)	Japan	Kyushu Univ.	1986 - 2005	D-shape Limiter, with divertor added later	0.80	0.12 - 0.18	8 SC	0.42	0.2	-	-	0.45	Very long pulses with LH current drive. Until 2015 held the world record for pulse duration (5 hours 16 minutes reported in Nuclear Fusion, vol 45, no 10, 2005) but now overtaken in this record by ST25 HTS. Injected energy (110MJ). Little capability to adjust the shape of the plasma. PF coils mounted inside the bore of the TF coils to minimise heating. Probably first machine to use Nb3Sn superconductor in its 16 D-shaped TF coils, cooled by pool boiling liquid helium. Originally limiter configuration, but molybdenum divertor plate added. Hydrogen only. Air cored. To be replaced by a steady state spherical tokamak called "QUEST".
TTF (Frascati Turbulent Tokamak) aka Torello	Italy	Frascati	1973	Circular Limiter	0.30	0.04	1	0.05					Studies of turbulent plasmas.
TTT (Texas Turbulent Torus)	USA	Austin, Texas	1974 – 1980	Circular Limiter	0.60	0.10	1.2	0.08	-	-	-	-	Arguably not a tokamak but was certainly operated in tokamak-like configurations. Designed to study turbulent heating of plasmas. The torus consisted of an aluminium shell which (unusually) formed the primary transformer winding in the machine. A quartz liner insulated the shell from the plasma. The TF was generated by 16 Bitter coils.
TUMAN-2	USSR	IOFFE	1971 - 1975	Circular Limiter	0.40	0.08	1.2	0.08					Minor radius compression.
TUMAN-2A	USSR	IOFFE	1977 - 1985	Circular Limiter	0.40	0.08	1.5	0.012					Further compression studies.
TUMAN-3	USSR	IOFFE	1980, rebuilt 1990.	Circular Limiter	0.55	0.24	1.2	0.16	-	1	0.5	-	Confinement and compression studies, and studies of ITB formation and evolution during the ramp up of ohmic discharges.
TV-1	USSR	IVTAN, Moscow	Late 70s to 1983	Circular Limiter	0.24	0.04	1.6	0.015	-	-	-	-	Stainless steel walls and Mo limiters. Discharge duration up to 8.5 ms. Studied turbulence-induced transport and edge plasma turbulence, laser diagnostics, plasma convection in the poloidal limiter shadow of a tokamak. Zeff=2-3. Te(0)=200eV. Later transferred from Institute of High Temperatures of Russian Academy of Science (IVTAN)) to Kyrgyzstan in Bishkek and it was renamed to TF-2
ТВД (TVD in Latin)	USSR	Kurchatov	1988 - 1992	Double-null Poloidal Divertor	0.37	0.08 x 0.16	1.5	0.05	-	-	-	-	Modification of T-12. Studied shaping, vertical stability and control of elongated plasmas. Double zero poloidal divertor.
UNITOR	Germany	Dusseldorf	1982 - 1990s	Circular Limiter	0.30	0.10	1.4	0.03	-	-	-	-	First use of beryllium in a tokamak, demonstrating that beryllium limiters reduced the Zeff by a factor of two by reducing metallic and light (e.g. O and C) impurity content of the plasma.
Versator I	USA	MIT, Cambridge MA	1970 - 1978	Circular Limiter	0.54	0.14	0.6	0.012					Built from early discarded version of Alcator A vacuum vessel by winding welding cable around the torus. Disruption studies and plasma radiation emission studies. Taylor discharge cleaning used.
Versator II	USA	MIT, Cambridge MA	1977 - c.1988	Circular Limiter	0.41	0.13	1	0.06	-	-	-	0.15	Development of LH in hydrogen plasmas at 800MHz and 2.45 GHz. Max 75 ms pulses. This was probably the first machine to have been designed to use LH specifically for current drive, and was one of the first to publish results. Titanium sublimation as wall conditioning technique, but no baking. Some divertor designs (bundle and poloidal) were produced in 1984 but they were not installed.
WEGA (now Wendelstein Experiment in Greifswald für Ausbildung. See notes.)	Germany	Greifswald	1975 to 80s	Circular Limiter	0.72	0.19	2.25	0.04			DNB only	0.2	Built in Grenoble in 1975 as a French-German project to study high frequency (Lower Hybrid) heating of plasmas in tokamak and stellarator configuration. Initially operated as a tokamak with 40 field coils in Grenoble, then converted to stellarator configuration about 1977. Refurbished and installed as in Stuttgart (Institute for Plasma Technology?), but not operated successfully due to lack of funding. Since 2000, running in Griefswald as a stellarator, with modified torus and 4 helical coil packets. Mainly for educational work, but now also testing diagnostic systems for the W-7X stellarator. See http://www.ipp.mpg.de/eng/for/bereiche/e3/archive/sn106_Nov2006.pdf. The name WEGA was used for this device since it was in Grenoble, but clearly the acronym had a different meaning at that time.
WEST	France	Cadarache	2016	D-shape Divertor	2.50	0.50	3.7	1	0.6	9	-	7	Between 2011 and 2016 the Tore Supra machine underwent a substantial modification to convert it to a D-shaped plasma, divertor machine under the name 'WEST' which stands for "W Environment in Steady-state Tokamak", where "W" is the chemical symbol of tungsten. First plasma was achieved in December 2016. (Note - see the entry for the Chinese machine 'EAST' - fusion scientists do have a sense of humour!) Pulse lengths up to 1000s are anticipated.
WT-1	Japan	Kyoto Univ.	1977 - 1981	Circular Limiter	0.28	?	0.7	?	y				Use of ECRH to for reduction of loop voltage during breakdown and suppression of production of runaway electrons.

WT-2	Japan	Kyoto Univ.	1981 - 1986	Circular Limiter	0.40	0.09	1.3	0.03	0.1	-	-	0.05	Aluminium shell. Plasma current sustained and ramped up by the EC wave only, without OH power.
WT-3	Japan	Kyoto Univ.	1981 - 1999	Circular Limiter	0.65	0.20	1.75	0.15	0.35	-	-	0.2	Non-inductive current drive including EC Current Drive, Electron Berstein Wave studies and Ion Bernstein Wave studies.

Key to colour code
Currently operating
Under construction
Proposed or planned
Currently not operating
Unknown status
Decommissioned (or not built)

Spherical Tokamaks
are covered in a separate table.
Follow the link at www.tokamak.info.

Key to Abbreviations

DNB: Diagnostic Neutral Beam. ECH: Electron Cyclotron Resonance Heating. FW: Fast Wave. IB: Ion Bernstein Wave. ICH: Ion Cyclotron heating. IP: Max plasma current. LH: Lower Hybrid Current Drive. NBI: Neutral Beam Injection. SC: Superconducting. TF: Toroidal Field. SMBI: Supersonic Molecular Beam Injection. "y" means yes, but that no details have been obtained.
Blank boxes - not known.