CHEF Mapper® Pulsed Field Electrophoresis System

Now you can accurately separate everything from Yeast Artificial Chromosomes (YACs) to M13 inserts with a single instrument. The CHEF Mapper system, based on CHEF (Clamped Homogeneous Electric Fields)[1] pulsed field electrophoresis technology, also offers the flexibility of PACE (Programmable Autonomously Controlled Electrodes)[2] technology. With its versatile PACE architecture, you can completely control electrical field vectors with respect to switch time, voltage, and angle. Consequently, you achieve higher resolution, greater speed of separation, and greater accuracy than could be obtained with previous pulsed field systems. Furthermore, the CHEF Mapper system provides fast results. Built-in protocols optimize pulsed field separations, eliminating months of trial and error.

Auto-Algorithm mode
39.2 hour run time, 120° included angle
47 to 74 seconds switch time ramp
6 V/cm (200 V), 0.5x TBE at 14 °C
1.0% Pulsed Field Certified Agarose

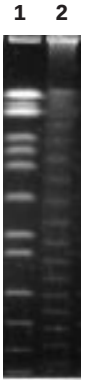

Fig. 1. Auto-algorithm based separation of 400–800 kb size range. Lane 1. Saccharomyces cerevisiae *chromosomes. Lane 2. lambda ladder.*

Pulsed Field Expertise on a Computer Chip

The CHEF Mapper XA system's unique built-in algorithm automatically selects the optimum conditions for your separation. Based on 5 expert years of protocols, the algorithm, embedded on an EPROM chip, interrelates 11 key variables: DNA fragment size, buffer type and concentration, agarose type and concentration, buffer temperature, initial and final switch time (ramp), pulse angle, voltage gradient, and run time. See Figure 1. Protocols may be refined by using the extended, PC based, Interactive Program Disc. The PC version allows you to record a hard copy of your protocols.

Multi-Angle Switching for Maximum Speed

The CHEF Mapper system lets you choose any pulse angle from 0° to 360°. Electrophoretic separation time can be reduced, without loss of resolution, by electronically changing the pulse angle. *Schizosaccharomyces pombe* chromosomes (3.5–5.7 mb) migrate 50% faster using a 100° included angle than they do using a 120° angle.[3] See Figure 2.

Two-state mode
30 min switch time
2 V/cm (67 V), 14 °C, 1x TAE
48 hour time
0.8% Chromosomal Grade Agarose

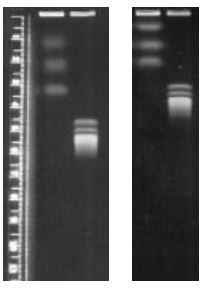

Fig. 2. Increased mobility of S. pombe *chromosomes. A. 106° angle. B. 120° angle.*

BIO-RAD

Speed and Resolution for Screening Small DNAs

With the CHEF Mapper system, you can separate small DNA fragments (<50 kb) with outstanding resolution using 180° angle FIGE with asymmetric forward to reverse voltages and switch times as fast as 50 msec. This method has been shown to be superior to all other PFGE techniques in this range,[4] and is the method of choice for sizing restriction digests of cosmid and phage vectors, RFLP mapping, and DNA fingerprinting. See Figure 3.

When speed is more critical than resolution, the CHEF Mapper system allows you to separate small DNA fragments in less than an hour using narrow pulse angles (106°) and high voltage gradients (up to 9 V/cm).

FIGE mode
180° angle
1x TAE, 14 °C
9 V//cm forward
6 V/cm reverse
Switch time 200–800 msec ramp
Forward time = reverse time
Run time = 18 hr
Lane 1: Bio-Rad's l-Hind lll standard (6.6, 9.4, 23.1 kb)
Lane 2: Bio-Rad's 8–48 kb size standard (8.3, 8.6, 10.0, 12.2, 15.0, 17.1, 19.4, 22.6, 24.8, 29.9, 33.5, 38.4, 48.5 kb)

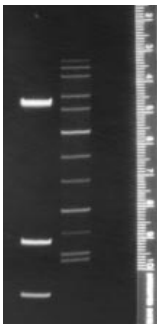

Fig. 3. High resolution of 8–48 kb size standard with asymmetric voltage FIGE.

A. Two-state mode
24 hour run time, 120° included angle
60 to 120 second switch time ramp
6 V/cm (200 V), 0.5x TBE
at 14 °C 1.0% Pulsed Field Certified Agarose

B. Multi state mode
60 hour run time
State (vector)
1. 90 second switch time, -60° angle
2. 45 second switch time, 180° angle
3. 90 second switch time, 60° angle
4. 90 second switch time, -60° angle
5. 90 second switch time, 60° angle
6. 45 second switch time, 180° angle
7. 90 second switch time, -60° angle
8. 90 second switch time, 60° angle

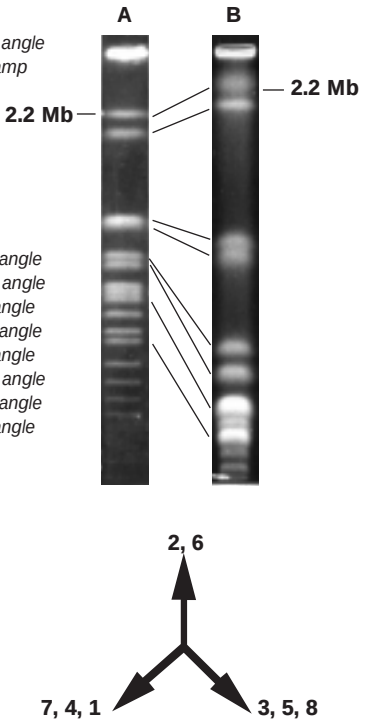

Fig. 4. High resolution separation with multiple states (vectors). S. cerevisiae *chromosomes separated under A. two-state conditions. B. multi state conditions. Notice separation of the co-migrating chromosomes with multi state conditions.*

Multi State Switching for Highest Resolution

The multi state mode of the CHEF Mapper system enhances resolution in selected fragment size ranges by allowing you to combine up to 15 different electrical field vectors during a single pulse cycle. Additional vectors have been shown to increase resolution in selected size ranges. Each vector can be assigned its own pulse angle, voltage, and switch time. Up to eight different blocks or regimens may be combined to separate any size of DNA. See Figure 4.

Greater Accuracy in Mapping

Accurate sizing of fragments requires an expanded linear range of separation. Switch time ramps increase the mobility of fragments in a sample as a function of molecular weight by gradually changing the switch time during the course of a run. Non-linear ramps (*e.g.*, concave or convex shapes) have been shown to provide very linear separations from 50 kb–700 kb. Therefore, fragment sizes will be measured more precisely, and the maps you construct will be more accurate. See Figure 5.

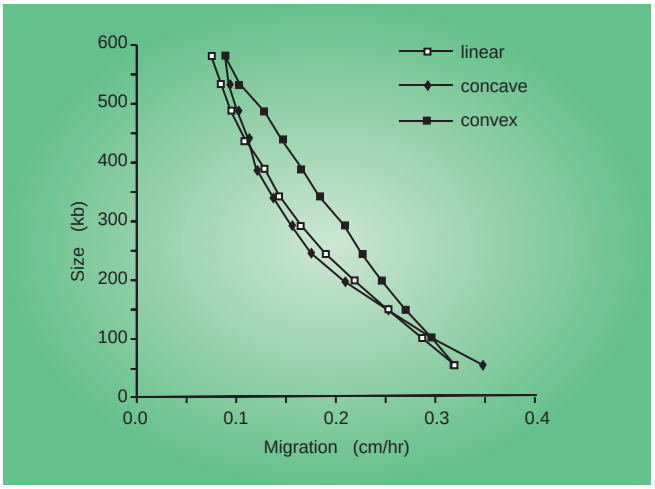

Fig. 5. Mobility effects of non-linear switch time ramps. Molecular size vs migration for linear, concave, and convex ramps. The convex ramp results in the widest linear range.

Secondary Pulses for Increased Separation

The application of additional vectors (secondary pulses[5]) of defined voltage, duration, angle, and frequency to the primary vector can enhance the separation of large DNA molecules. These secondary pulses may act by releasing DNA molecules caught in the gel matrix. See Figure 6.

Multi state mode
20 hour run time, 120° included angle
60 to 120 seconds switch time ramp
6 V/cm (200 V), 0.5x TBE at 14 °C
1.0% Molecular Biology Certified Agarose

Secondary pulses
6 V/cm (200 V), 0° angle
3 second switch time
4 pulses/minute

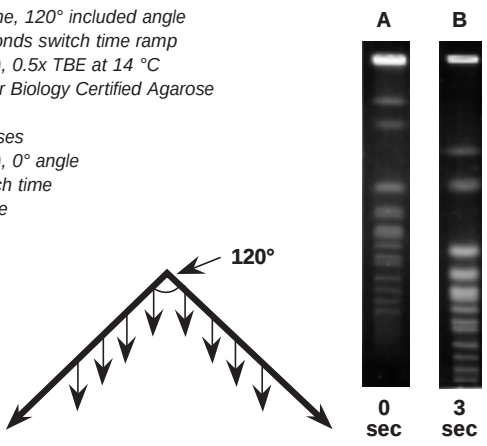

Fig. 6. Increased separation with secondary pulsed field electrophoresis (SPFE). S. cerevisiae *chromosomes separated under A. two-state conditions. B. two-state conditions with secondary pulses.*

In conventional PFGE systems, variations in temperature and ionic strength due to buffer breakdown can cause fluctuations in voltage, leading to variations in pulse angle which result in loss of reproducibility and resolution. The CHEF Mapper system prevents that problem by using a patented technology called Dynamic Regulation[6] (DR). With DR, the voltage across each electrode pair is monitored and regulated at the proper level. That way, no matter what the buffer conductivity, temperature, or gel size, the electric field remains homogeneous throughout the run. DR strictly maintains the electronically generated pulse angle so you get straight, reproducible lanes and better resolution.

Temperature regulation is a key to high resolution separations. The CHEF Mapper XA system includes the Cooling Module. This direct buffer chiller precisely maintains temperatures from 5 °C to ambient. The Cooling Module is compact and lightweight (42 cm long x 23 cm wide x 24 cm high, 14 kg). Maximum cooling capacity is 75 W of input power at a set temperature of 14 °C. Buffer is circulated through the system using the Variable Speed Pump. The flow rate is easily adjusted by a dial on the pump.

The CHEF Mapper System is Easy to Use

The CHEF Mapper system is easy to operate, even for beginners. Its two-line fluorescent display prompts you for all information to set up a run. Any program generated may be edited on the CHEF Mapper system, and then stored in its long-term memory (up to 99 programs). The instruction manual also includes parameters for numerous common separations.

The CHEF Mapper system has its own built-in power supply, switcher, and electronics for maintaining the electric fields. The parameters are battery backed up in memory so that a run will automatically restart.

Versatile Electrophoresis Cell

The electrophoresis cell has these convenient features

- 11 x 44 x 50 cm, horizontal format, molded construction
- 24 individually replaceable 0.02" diameter platinum electrodes
- Accommodates 14 cm (w) x 13 cm (l), 21 x 14 cm, and 14 x 21 cm gel formats
- Temperature probe in the base of the gel box, with digital readout on the Cooling Module panel
- Safety interlocked lid

Service and Support

In addition to the CHEF Mapper system, Bio-Rad has a range of agaroses, pulsed field size standards, and plug preparation reagents. All of Bio-Rad's PFGE products are backed by years of electrophoresis experience and expertise to help you through all phases of sample preparation, separation, and detection, as well as system troubleshooting. We also provide periodic procedural and algorithm updates, technical support, and a strong service organization to give you immediate solutions to any problems.

References

1 *Chu, G., Vollrath, D. and Davis, R.,* Science, ***234,*** *1582 (1986).*
2 *Clark, S., Lai, E., Birren, B. and Hood, L.,* Science, ***241,*** *1203 (1988).*
3 *Lai, E., Birren, B., Clark, S., Simon, M. and Hood, L.,* BioTechniques, ***7,*** *34 (1989).*
4 *Birren, B., Lai, E., Hood, L. and Simon, M.,* Anal. Biochem., ***234,*** *1582 (1989).*
5 *Zhang, T. Y., Smith, C. L. and Cantor, C. R.,* Nucleic Acid Res., ***19,*** *1291 (1991).*
6 *US Patent 4,878,008 issued to Bio-Rad Laboratories.*

Ordering Information

Catalog #	Description
SYSTEMS	
170-3670	CHEF Mapper XA Chiller System, 120 V, includes CHEF Mapper XA power module, embedded auto algorithm for protocol optimization, interactive algorithm program disc, electrophoresis cell, Cooling Module, Variable Speed Pump, Temperature Probe, 12 feet Tygon tubing, 14 cm wide x 13 cm long casting stand, 15 Well Comb and Comb Holder, Screened Cap, Disposable Plug Molds, leveling bubble, cables, *S. cerevisiae* standards, 0.5 A FB fuses, 2, Pulsed Field Certified Agarose, 5 g, Chromosomal Grade Agarose, 5 g, instruction manual
170-3671	CHEF Mapper XA Chiller System, 100 V
170-3672	CHEF Mapper XA Chiller System, 220 V
170-3673	CHEF Mapper XA Chiller System, 240 V
ACCESSORIES	
170-3654	Cooling Module, 120 V
170-3688	Cooling Module, 100 V
170-3655	Cooling Module, 220/240 V
170-3644	Variable Speed Pump, 120 V
170-3648	Electrodes, thick gauge (0.02"), 6
170-3711	Screened Caps, 5
170-3713	50 Well Disposable Plug Molds, 5
170-3622	10 Well Reusable Plug Molds
170-3689	Standard Casting Stand, includes 14 x 13 cm frame and platform
170-3699	Combination Comb Holder
170-3704	Wide/Long Combination Casting Stand, includes 21 x 14 cm frame and platform
170-4326	10 Well Comb, 14 cm wide, 1.5 mm thick
170-4325	10 Well Comb, 14 cm wide, 0.75 mm thick
170-4324	15 Well Comb, 14 cm wide, 1.5 mm thick
170-4323	15 Well Comb, 14 cm wide, 0.75 mm thick
170-4322	20 Well Comb, 14 cm wide, 1.5 mm thick
170-4344	30 Well Comb, 14 cm wide, 1.5 mm thick

Catalog #	Description
ACCESSORIES (CONT.)	
170-3627	15 Well Comb, 21 cm wide, 1.5 mm thick
170-3628	30 Well Comb, 21 cm wide, 1.5 mm thick
170-3645	45 Well Comb, 21 cm wide, 1.5 mm thick
170-3623	Preparative Comb, 14 cm wide, 1.5 mm thick, with 2 outer wells for size standards
170-4046	Leveling Table, 20 cm x 30 cm
170-3643	Gel Scoop
170-3625	Gel Stops, 4
165-5031	GS Gene Linker UV Chamber, 120 V
165-5032	GS Gene Linker UV Chamber, 220 V
165-5033	GS Gene Linker UV Chamber, 240 V
165-5034	GS Gene Linker UV Chamber, 100 V
162-0196	Zeta-Probe GT Membrane, 30 cm x 3.3 m roll
162-0197	Zeta-Probe GT Membrane, 20 cm x 3.3 m roll
AGAROSES SIZE STANDARDS AND PLUG PREPARATION	
162-0017	Low Melt Preparative Grade Agarose, 25 g
162-0019	Low Melt Preparative Grade Agarose, 100 g
162-0133	Molecular Biology Certified Agarose, 100 g
162-0134	Molecular Biology Certified Agarose, 500 g
162-0135	Chromosomal Grade Agarose, 25 g
162-0136	Chromosomal Grade Agarose, 100 g
162-0137	Pulsed Field Certified Agarose, 100 g
162-0138	Pulsed Field Certified Agarose, 500 g
170-3605	DNA Size Standard, *S. cerevisiae*, 25–40 lanes
170-3633	DNA Size Standard, *S. pombe*, 25–40 lanes
170-3635	DNA Size Standard, lambda ladder, 25–40 lanes
170-3624	DNA Size Standard, 5 kb ladder, 20–30 lanes
170-3667	DNA Size Standard, *H. wingei*, 5 blocks
170-3707	DNA Size Standard, 8–48 kb
170-3591	CHEF Mammalian Genomic DNA Plug Kit
170-3592	CHEF Bacterial Genomic DNA Plug Kit
170-3593	CHEF Yeast Genomic DNA Plug Kit

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Bulletin 1906 US/EG Rev B *98-534 1297 Sig 100798*