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Abstract

MIMAS is a low energy (187.5 keV/A) boosterstorage ring (12 MeV/A) dedicated to polarized and heavy ions. First beam tests began in spring 1987 and full on-line operation with the main ring SATURNE was reached in fall. All the elements of the most modern synchrotrons are used and successfully operated. But the main particularities of MIMAS are :

- synchrotron phase space stacking by betatron deceleration,

- adiabatic capture and acceleration by large frequency swing RF cavities (0.15 to 2.5 MHz).

- fast dynamic transfer by kickers between MIMAS and SATURNE.

With MIMAS, intensities delivered by SATURNE are increased by a factor 10 in heavy ions up to Argon and between 5 and 10 for polarized particles (p, d).

General description (ref 1, 2, 5, 8, 9, 12)

MIMAS is a 8 periods machine, each one including one focusing quadrupole, one 45 ° bending magnet, and one defocusing quadrupole. The 8 straight sections include : 2 RF cavities, electrostatic injection inflector, betatron, septum magnet, low intensities pick-up electrodes, v measurement.

. The main characteristics of MIMAS follow :

physical radius : 5.85 m 2.27 wave numbers : β x maximum : 6 m Bz maximum : 5.5 m $\Delta v / v$ natural chromaticity : ξ = = - 0.78 δ₂ = - 1.07 horizontal useful aperture : + 13 cm

vertical useful aperture : + 8 cm

. Technical characteristics :

dipoles	: window-frame, rectangular 0.84 m length		
	radius of curvature : l.l m angular deviation : 45°		
	gap : 18 cm		
	B' : 5 T/sec		
quadrupoles	: length : 0.4 m gradient : 0.041 T/m to 1.847 T/m aperture : 26 cm		
	maximum current : 1100 A (foc.) 600 A (def.)		
RF cavities	number : 2 voltage 2 kV by cavity		
	frequency 0.15 MHz to 2.5 MHz		

harmonic 1

Closed orbit and chromaticity correction

In order to control the closed orbit and compensate for the chromaticity at injection, MIMAS is equipped with dipolar and sextupolar correctors made of printed circuits and located between the poles and the vacuum chamber in each quadrupole.

Chromaticity correction is necessary to limit tune spread ($\Delta v \mathbf{x}_{\pm} \pm 0.071$ $\Delta v z = \pm 0.097$) during injection ($\Delta p/p = \pm 2$ %) and after trapping ($\Delta p/p = \pm 4$ %). It is applied from B = Binj up to B = 2 Binj.



Cycle of MIMAS

For polarized particles, one source pulse (l ms) is injected and decelerated in MIMAS. Stored beam is then adiabatically captured and accelerated when a field ramping of 5 T/s is reached.

For heavy ions, several pulses (up to 8) can be injected and stored with a repetition rate of about 100 Hz.

Finally, extraction occurs at flat-top (B = 0.9 T) while SATURNE field is ramped B = 4.2 T/s.



Injection (ref 3, 4, 11) adiabatic capture and acceleration (ref 5)

The beams are injected with constant B ; the beams are pulled to internal radius by betatron deceleration (deceleration voltage up to 500 V), made by flux variation in 8 iron cores by a very particular pulsed current power supply (ref 8)



Example : (polarized deuteron injection), the beam stacking is visible by the means of an intensitytransformer, betatron voltage remain after injection pulse to center the beam on the optical axis.



The efficiency of adiabatic capture is measured below :



Fast ejection and beam transfer to SATURNE (ref 6, 7, 8)

During the transfer B is constant in MIMAS but is rising in SATURNE; RF of SATURNE is locked by RF clock of MIMAS in order to obtain a good trapping of the bunch coming from MIMAS by the "RF bucket of SATURNE".

The line between MIMAS and SATURNE realizes the transverse adaptation ;chromatic elements are included because energies are more compacted in MIMAS than in SATURNE.

The efficiency of the transfer is close to 100 %.

The next picture shows beam transfer with the fastest beam (47 MeV polarized proton).

The same efficiency has been measured for other particles (polarized deuterons, heavy ions).



Vacuum system (ref 10)

The low pressure requirement is very critical to avoid charge exchange at low energy (187.5 keV/A) during injection and adiabatic capture. The following figure shows computation of the influence of pressure for 4 pulses injected with 24 msec between pulses. A pressure of 5.10^{-11} Torr is needed.



For this reason all parts of MIMAS and beam lines were cleaned, degreased, washed with alcaline solution, rinsed and dried and heated at 1000° C under vacuum.

All the machine can be baked "in situ" à 300 ° C with computer control of pressure and heat of all parts of MIMAS and beam lines.

Pumping system of MIMAS includes 13 titanium getter pumps (total pumping speed 13000 l/sec) and 4 triode ionic pumps (total pumping speed : 1600 l/sec).

The figure below shows the pressure repartition around MIMAS.



Results of beam test operation

particle	number of	charge/cycle	in SATURNE
d 1		2.10 ¹¹	
₽↑		1.5.10 ¹¹	
c_{12}^{6+} (4 pulses i	injected)	4.10 ⁹ ch	arges
Ne_{20}^{10+} (4 pulses i	injected)	10 ⁹ charg	es
Ar_{40}^{16+} (3 pulses i	injected)	10 ⁹ charg	es

Conclusion

MIMAS satisfies completely it's specifications ; the improvement of intensities are in SATURNE :

5 for d

10 for pi

10 for heavy ions (C, N, Ne, O)

and now SATURNE reaches to a new kind of particles; today Argon and soon Krypton and Xenon.

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