List of Symbols

\( a_i \) Used as variables

\( \hat{a}_i \) Used to represent action

\( a_{11}, a_{12}, ..., a_{ij} \) Used for Matrix elements

\( A \) Set of actions = \( \{\hat{a}_1, \hat{a}_2, ..., \hat{a}_n\} \)

\( \hat{A} \) Area in vector space

\( b_i \) Used as variables / voltage of BPI electrodes

\( B \) Belief set

\( B(s) \) Local Magnetic field

\( \mathring{B}_{i,stor} \) Stored value of \( i^{th} \) BPM

\( \mathring{B}_{i,mes} \) Measured value of \( i^{th} \) BPM

\( \mathring{B}_{i,MO} \) Value at \( i^{th} \) BPM in most probable offspring

\( c \) Used to represent condition

\( C \) Condition set = \( \{c_1, c_2, ..., c_n\} \)

\( \mathring{C}_{MIC} \) Control Input set = \( \{i_{ca}, rf_{fre}\} \)

\( \hat{C} \) Used to represent corrector magnet

\( d_1, d_2 \) Used to represent search distance

\( D \) Desire set

\( D_{xx} \) Drift space, where \( xx \) represents the drift space number

\( \hat{D} \) Limiting distance

\( e \) Beam emittance / error / charge of electron

\( e_x \) Emittance in horizontal plane
$e_y$  
Emittance in vertical plane

$e_{noise}$  
Noise in system

$\dot{e}$  
Used for representing Emission

$\dot{e}$  
Error component

$E$  
Emission signal vector

$\dot{E}$  
Total error

$f$  
Used for function

$f_{MIC}^g$  
State mapping function with Microtron tuned as per $\vartheta$

$f_{MIC}$  
State mapping function with Microtron tuned as per last applied settings

$f_{TL1}^g$  
State mapping function with TL-1 tuned as per $\vartheta$

$f_{TL1}$  
State mapping function with TL-1 tuned as per last applied settings

$\ddot{f}$  
Used to represent FCT signal

$\ddot{F}$  
Used to represent FCT vector

$\ddot{F}_E$  
FCT signal contribution due to Emission

$g$  
Used to represent reflected power signal

$G$  
Used to represent reflected power vector

$h$  
Function representing possible history of actions

$H_{Bump}$  
Used to represent bump height

$i_{ca}$  
Cathode current of Microtron

$i_{tl1}$  
TL-1 current(normalised)
\( I \) Intention set

\( I_{BR} \) Booster current

\( I_{MIC} \) Beam current at Microtron output

\( I_{TL1} \) Beam current at TL-1 output

\( I_{ca} \) Cathode current of Microtron

\( I_{inj,mes} \) Measured value of injection

\( I_{inj,sim} \) Simulated value of injection

\( I_{lim} \) Injection current limit

\( I_{ca}^{ASP} \) Acceleration start point cathode current, Amperes

\( \tilde{I} \) Predicted injection current vector = \([I_{mj}(1), I_{mj}(2), ..., I_{mj}(n)]\)

\( J, J_1, J_2 \) Used for representing the optimisation function

\( k_i \) Used as variables

\( K \) Focussing strength

\( K(s) \) Local focussing strength

\( l \) Used for representing length of magnets and drift space

\( ln(x) \) Used for representing the natural logarithm of x

\( L_{BH} \) Bump height Limit

\( m_i \) Used as variables

\( \tilde{M} \) Magnet settings vector = \([I_1, I_2, ..., I_n]\)

\( N \) The set of Natural Numbers

\( p \) Used for momentum, also used for position vector

\( \tilde{p}_{value} \) Used to represent performance value
$P$ Percept function

$P$ Used for set of position vectors

$P$ Used for set of position vectors

$\tilde{P}$ Used for set of $P$

$\tilde{P}_{TL1}$ TL-1 operating point (operation state vector)

$\tilde{P}_{MIC}$ Microtron operating point (operation state vector)

$\tilde{P}$ Predicted start position vector

\[ \tilde{P} = [\tilde{X}_{start}(1), \tilde{X}_{start}(2), ..., \tilde{X}_{start}(n)] \]

$q$ Used for charge

$\tilde{Q}$ Predicted position at BPM vector

\[ \tilde{Q} = [\tilde{X}_{BPM(i)}(1), \tilde{X}_{BPM(i)}(2), ..., \tilde{X}_{BPM(i)}(n)] \]

$r$ Used to represent rule

$\tilde{r}_{cav-fre}$ Cavity resonant frequency

$\tilde{r}_{fre}$ RF frequency

$R$ Behavioural rule set $= \{r_1, r_2, ..., r_n\}$

$\tilde{R}_{fre}$ Set of RF frequency

$s$ Used to represent state

$S$ Set of States $= \{s_1, s_2, ..., s_n\}$

$S_{MIC}$ Set of Microtron states

$S_{TL1}$ Set of TL-1 states

$T_s$ Sampling time

$V$ Volts
$w_i$ Used to represent weights

$x$ Coordinate in x direction, otherwise as defined

$x'$ Beam angle in x direction

$\hat{x}$ optimised horizontal beam position

$x_d$ desired horizontal beam position

$\tilde{X}$ Beam parameter vector $= (x, y, x', y')$

$X_E$ Horizontal beam position movement due to Emission

$X_{\delta f}$ Horizontal beam position movement due to RF frequency deviation

$\tilde{X}_{\text{start}}$ Beam parameter vector at TL-1 start

$\tilde{X}_{\text{end}}$ Beam parameter vector at TL-1 end

$\tilde{X}_{a,b}$ Beam parameter vector at the location $a$ obtained by the method $b$

$y$ Coordinate in y direction, otherwise as defined

$y'$ Beam angle in y direction

$\hat{y}$ optimised vertical beam position

$y_d$ desired vertical beam position

$Y_E$ Vertical beam position movement due to Emission

$Y_{\delta f}$ Vertical beam position movement due to RF frequency deviation

$\alpha$ Twiss parameter That gives the correlation established by optics between $\beta$ and $\gamma$, $\beta \gamma = 1 + \alpha^2$
\[ \alpha_x \quad \alpha \text{ in horizontal plane} \]
\[ \alpha_y \quad \alpha \text{ in vertical plane} \]
\[ \beta \quad \text{Twiss parameter (for beam size)} \]
\[ \beta_x \quad \beta \text{ in horizontal plane} \]
\[ \beta_y \quad \beta \text{ in vertical plane} \]
\[ \delta \quad \text{Dispersion} \]
\[ \delta_x \quad \text{Dispersion in horizontal plane} \]
\[ \delta_y \quad \text{Dispersion in vertical plane} \]
\[ \delta f = (RF_{fre} - CAV_{fre}) \quad \text{frequency deviation} \]
\[ \gamma \quad \text{Twiss parameter (for beam divergence)} \]
\[ \gamma_x \quad \gamma \text{ in horizontal plane} \]
\[ \gamma_y \quad \gamma \text{ in vertical plane} \]
\[ \rho_s \quad \text{Local radius of curvature} \]
\[ \sigma \quad \text{Beam size} \]
\[ \psi_{a,b} \quad \text{Phase advance from the location } 'a' \text{ to the location } 'b' \]
\[ \theta \quad \text{Used to represent kick angles} \]
\[ \pm \Delta \theta \quad \text{Used to represent angle deviation in beam lines} \]
\[ \pm \Delta P \quad \text{Used to represent position deviation in beam lines} \]
\[ \Delta p \quad \text{Used for momentum deviation} \]
\[ \Delta_{\text{start}} \quad \text{Iteration start limit} \]
\[ \Delta_{\text{stop}} \quad \text{Iteration stop limit} \]
\[ \Delta_{\text{const}} \quad \text{Used for representing some constant value} \]
\( \epsilon \)  Used for representing beam emittance

\( \vdash \)  Used for logical inference (rule deduction) for example

\( x \vdash y \) means, \( y \) is derivable from \( x \)

\( \not\vdash \)  Used for logical negative inference (\( \equiv \neg \vdash \)), for example

\( x \not\vdash y \) means, \( y \) is not derivable from \( x \)

\( \varnothing \)  used for set operation

\( \neg \)  Logical NOT operator

\( \land \)  Logical AND operator

\( \lor \)  Logical OR operator

\( \forall \)  Universal quantification (for all), for example

\( \forall x : P(x) \) means, \( P(x) \) is true for all \( x \)

\( \mu \)  Used to represent Microtron state

\( \hat{\mu} \)  Used to represent optimised Microtron state

\( \lambda \)  Used to represent TL-1 state

\( \hat{\lambda} \)  Used to represent optimised TL-1 state

\( \varrho \)  Predicted beam position vector

\( \xi \)  Set of predicted beam positions

\( \vartheta \)  Optimised coalition state

\( \varsigma \)  Set of optimised coalition states