ORBIT Simulations of ISIS in the presence of the MICE Target

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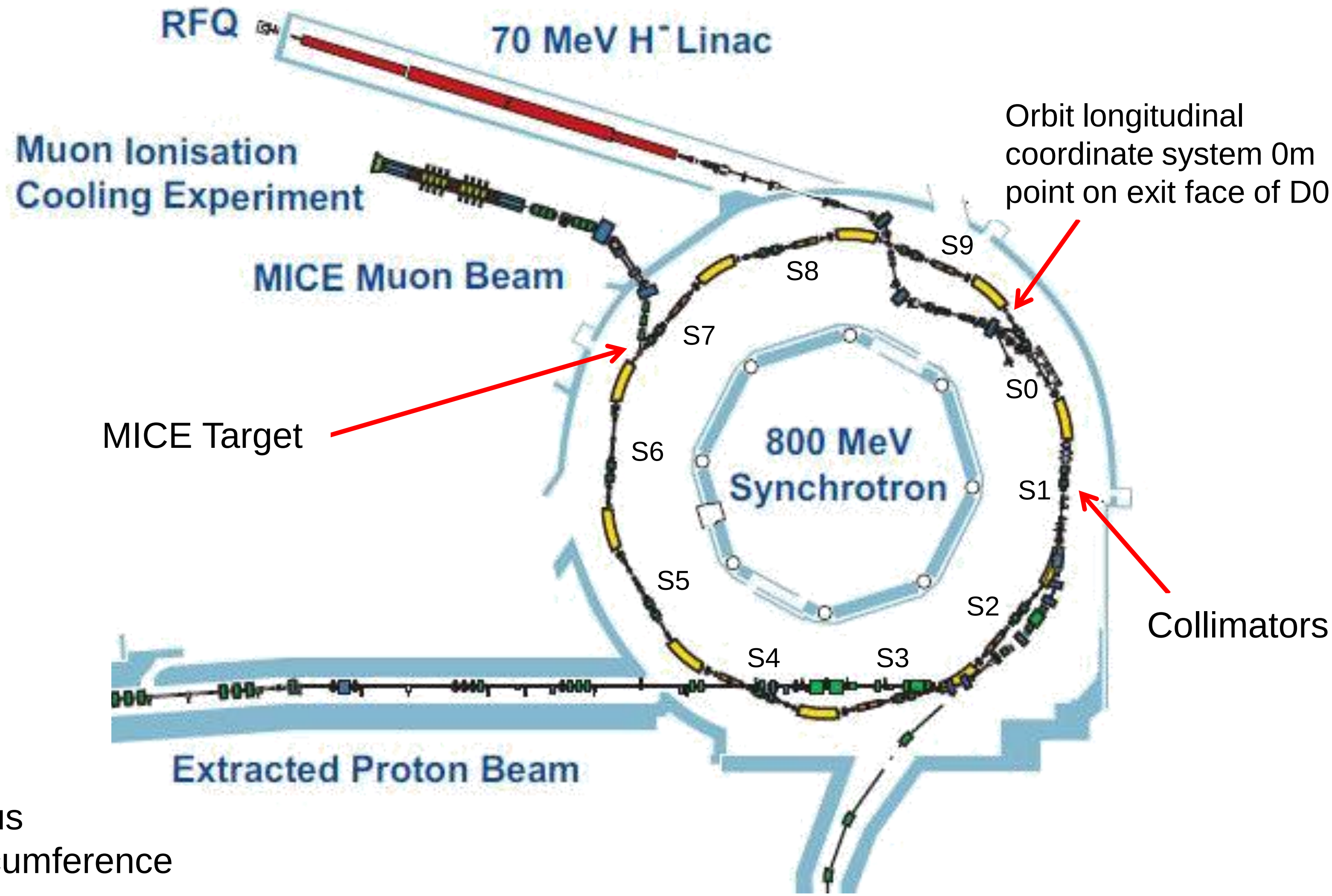
Motivation

- Already taken ISIS to higher losses than ever seen before...
- ... and we may need to go higher still
- Important to understand where the losses we induce are deposited around the Ring e.g. which areas are likely to be activated, where to build collimators
- Are there any changes we can make to maximise MICE particle rate whilst minimising beam loss?

ORBIT

- Objective Ring Beam Injection and Tracking
- Developed at SNS in the 90's
- Particle tracking for rings
- Compiled C++ modules run by the SuperCode driver shell
- Space charge
- Tool of choice for ISIS

ISIS

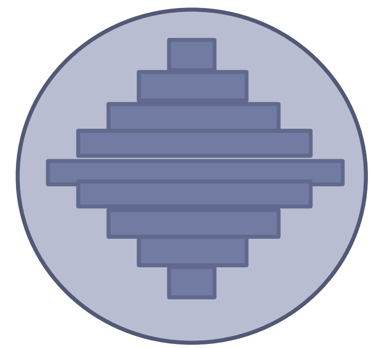


26m radius
163m circumference

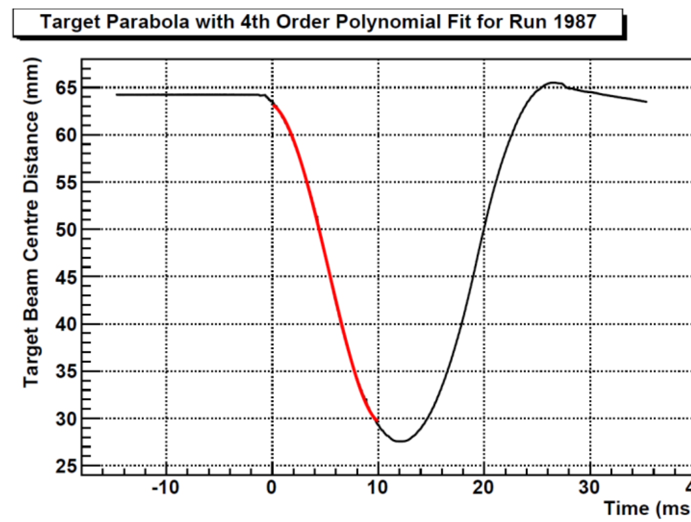
Simulation Description

- MICE target modelled using 10 rectangular collimator elements
- Iron used instead of Titanium
- No Space Charge – too CPU intensive
- ~ 34,000 macro particles
- Performed in two parts:
  - Injection, 0 – 5000 turns, 0 – 5ms, fast ORBIT (minutes)
  - Continuation, 5000 – 12000 turns, 5 – 10ms, slow ORBIT (day or two)
- Target now **Dynamic**

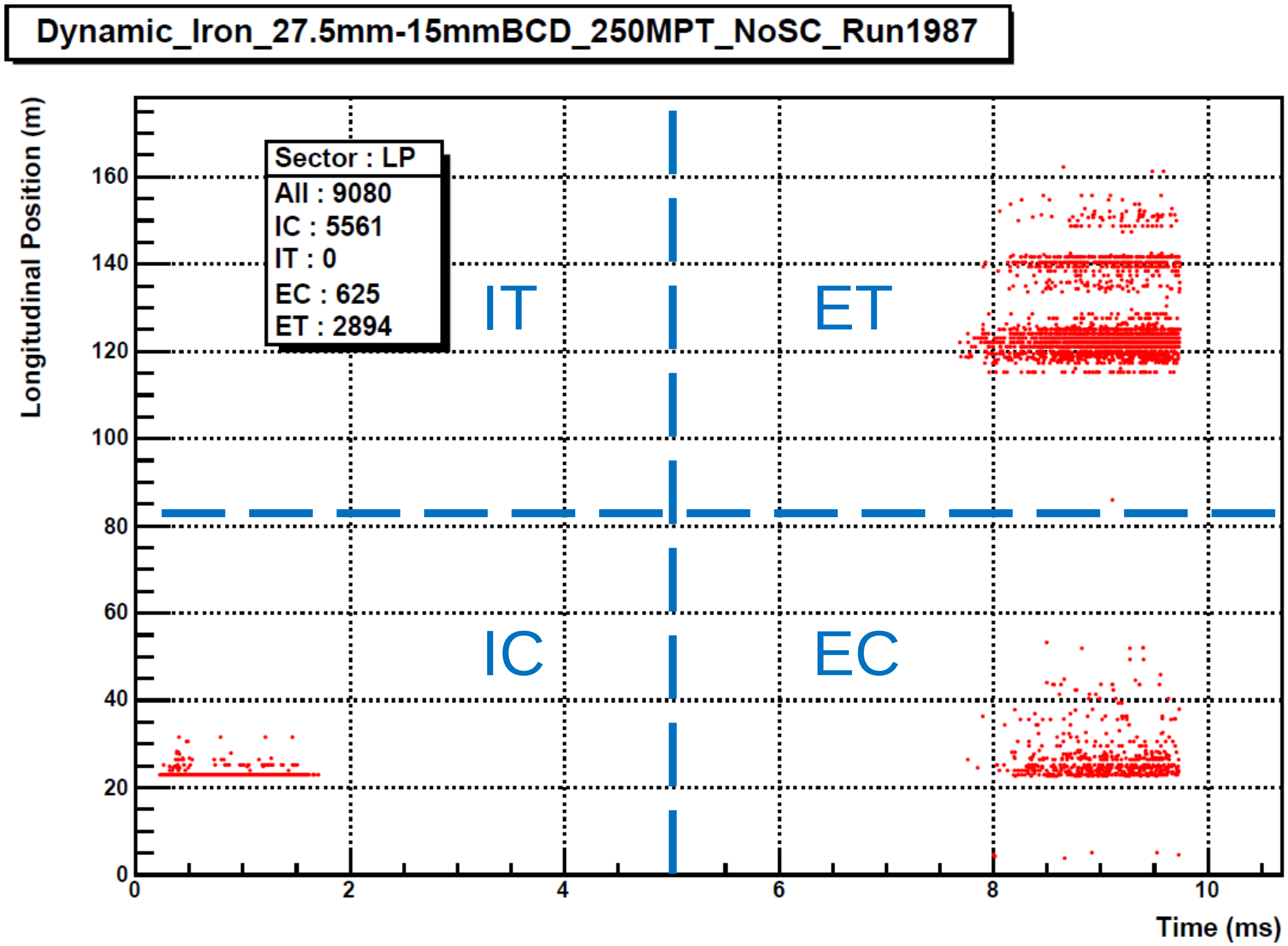
Modelling the target:



Modelling the dip (fit shown in red):

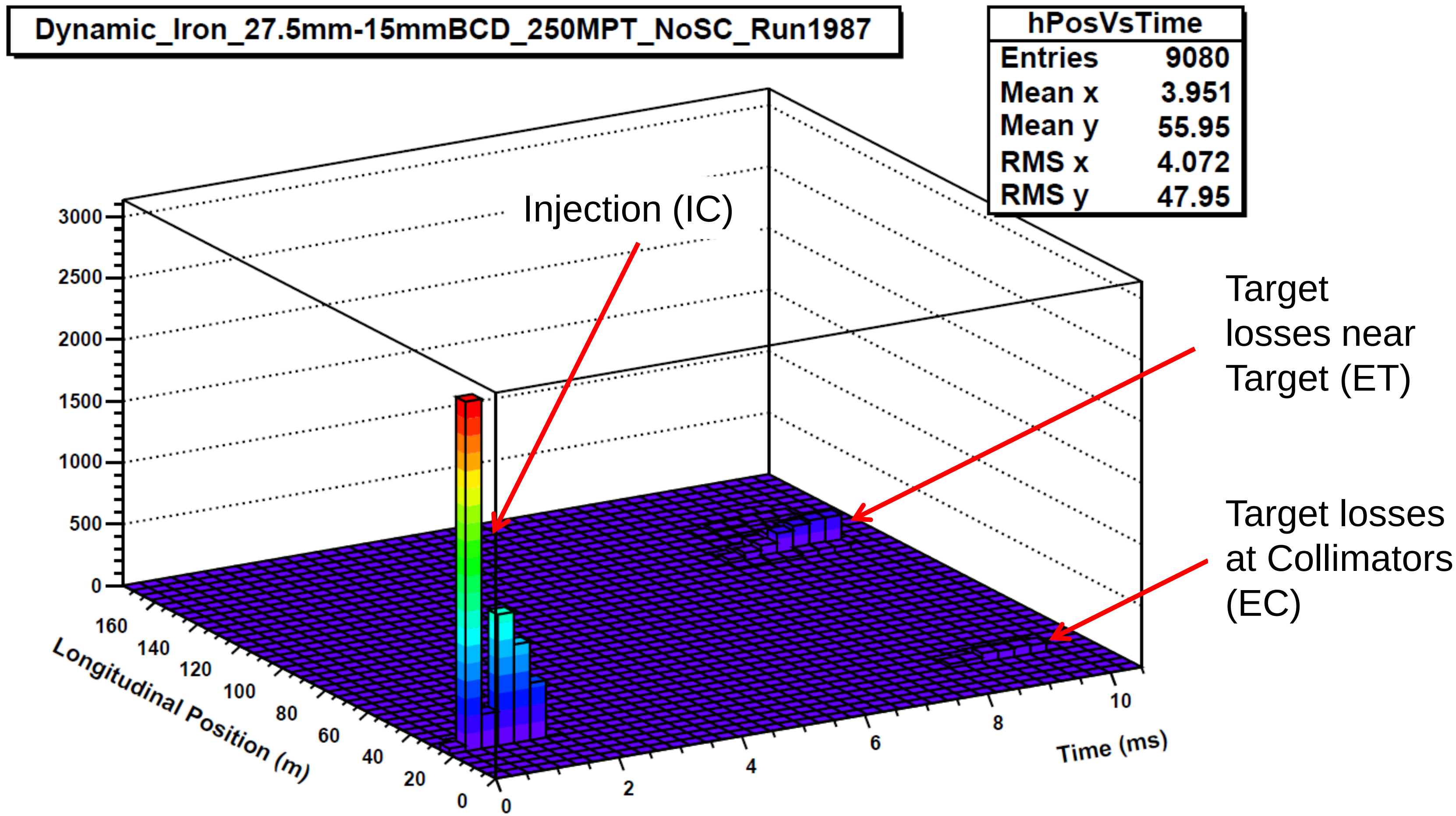


Beam Loss Distribution (Graph)



I = Injection
E = Extraction
C = Collimators
T = MICE Target

Beam Loss Distribution (TH2D)



Depth Study

Run	Nominal BL (mV.ms)	BCD (mm)	All	EC	ET	EC / ET
1985	2750	26.5	10732	862	4309	5.00
1987	2130	27.5	9080	625	2894	4.63
1988	1400	28.7	7623	365	1697	4.65
1989	1060	29.95	6573	158	854	5.41
1991	590	31.9	5694	29	104	3.59

- Short Delay = 13.1ms
- BCD offset = -15mm
- Material = Iron
- IC losses = 5561 particles

Little to no variation with target depth of where losses are deposited

Delay Study

Run	Nominal BL (mV.ms)	Short delay (ms)	All	EC	ET	EC / ET
2888	1400	13.5	16144	1771	8812	4.98
2890	600	14.3	11266	936	4769	5.10
2893	1500	12.7	20181	2386	12234	5.13

- BCD = 30.5mm
- BCD offset = - 20mm
- Material = Iron
- IC losses = 5561 particles

Little to no variation with short delay of where losses are deposited

Materials Study

Run	Nominal BL (mV.ms)	Material	All	EC	ET	EC / ET
1987	2130	Carbon	8881	2053	1267	0.62
1987	2130	Iron	9080	625	2894	4.63
1987	2130	Tungsten	9105	156	3388	21.72

- BCD = 30.5mm
- BCD offset = -15mm
- Short Delay = 13.1ms
- Material = Iron
- IC losses = 5561 particles

- Heavier Z materials dump preferentially at the MICE target not the Collimators
- Check particle rate in MICE for each material with G4BeamLine

Conclusions

- MICE target losses appear in the vicinity of the target and at the collimators (with some overspill)
- Depth and delay observed to have little effect as to where the losses are deposited

  NB: know from experience that losses do begin to propagate around the ring for highest BCDs
- Higher atomic number materials cause a large shift of losses to the target vicinity, with only a slight increase in overall losses
- To do: simulate effect of Z on MICE particle rate, errors, understand loss mechanism (multiple coulomb scattering, dE/dx, ...)