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# Track3P - Particle Tracking

Advanced Computations

*SLAC National Accelerator Laboratory*

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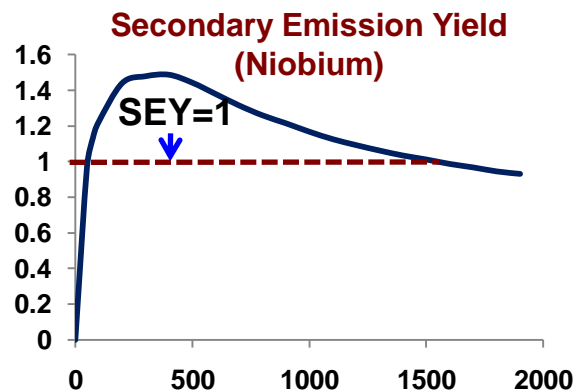
# Multipacting

## ○ Multipacting (MP)

- Secondary emitted electrons are in resonance with the RF fields
- When their impact energy falls within the **SEY (secondary emission yield curve) > 1**, resonant electrons impacting on the material surface generates more electrons leading to an exponential multiplication.
- A large number of electrons build up an electron avalanche - **MP**

## ○ MP can lead to

- Low achievable field gradient
- Significant power loss
- Distortion or loss of RF signal
- Thermal breakdown in SC structures
- Heating of cavity wall and damage of RF components



- MP effects can be mitigated by modifying the geometry, changing surface conditions to reduce SEY and/or applying DC biasing.

# Track3P - Multipacting Simulation

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## ○ Multipacting Simulation

- Perform parameter scan - field level, location, phase, impact energy, multipacting order
- Record all impact particle information - field level, emit location, emit phase, impact location, impact phase, impact energy, impact number etc
- Analyze resonant conditions - field level, location, order, phase, impact energy
- Calculate MP map using impact energy and SEY data
- Plot particle trajectory at a given field level

# Track3P - Benchmark with Measurements

Multipacting obeys power scaling laws (E. Somersalo. et al )



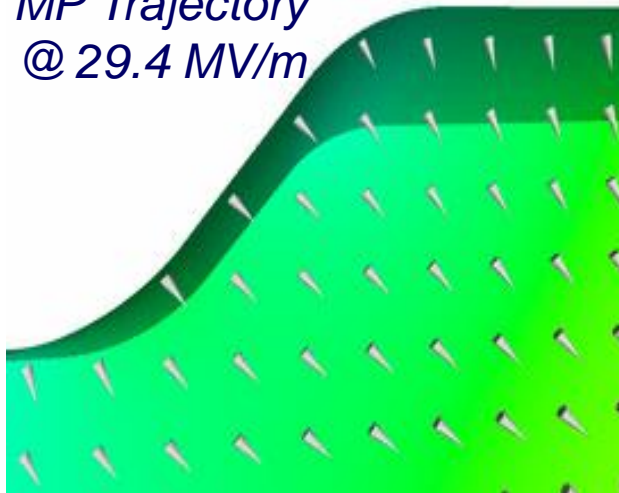
Standing wave:  $P_{one-point} \sim (fd)^4 Z$

Traveling wave:  $P_{TW} = 4P_{SW}$

**ICHIRIO cavity** experienced multipacting with hard barrier at gradient predicted by **Track3P** simulation

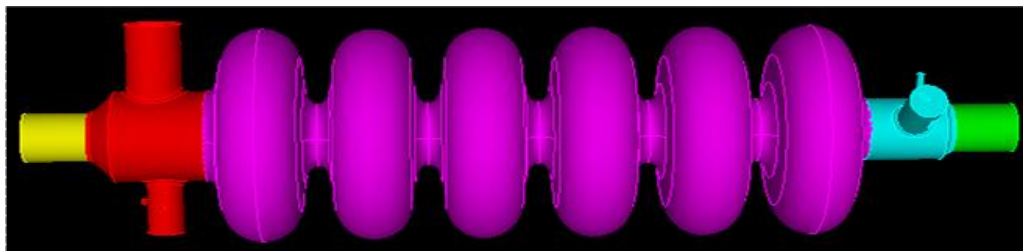


MP Trajectory  
@ 29.4 MV/m



ICHIRO #0	Track3P MP simulation	
X-ray Barriers (MV/m)	Gradient (MV/m)	Impact Energy (eV)
11-29.3 12-18	12	300-400 (6 <sup>th</sup> order)
13, 14, 14-18, 13-27	14	200-500 (5 <sup>th</sup> order)
(17, 18)	17	300-500 (3 <sup>rd</sup> order)
20.8	21.2	300-900 (3 <sup>rd</sup> order)
28.7, 29.0, 29.3, 29.4	29.4	600-1000 (3 <sup>rd</sup> order)

# Track3P - Multipacting in SNS Cavity/HOM Coupler

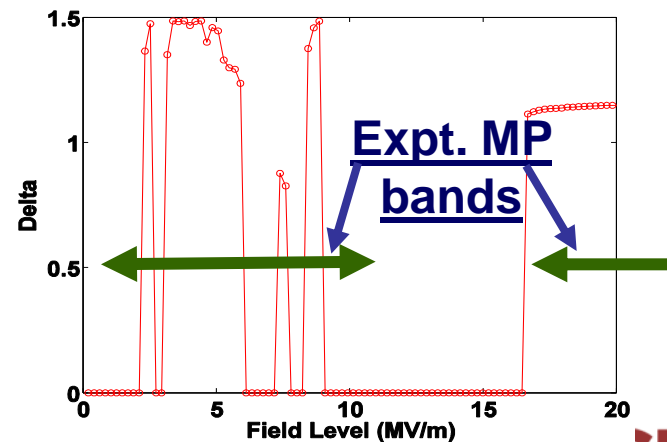
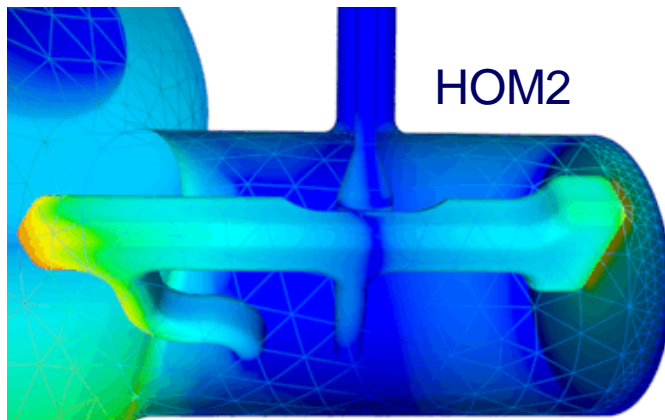
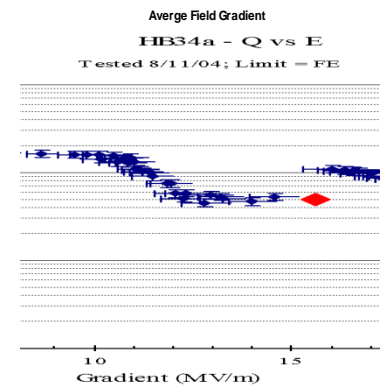
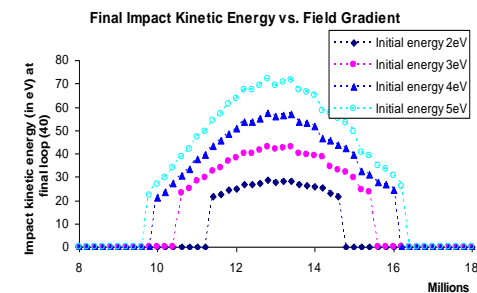


## SNS Cavity

- Both Experiment and Simulation show same MP band: 11 MV/m ~ 15MV/m

## SNS Coupler

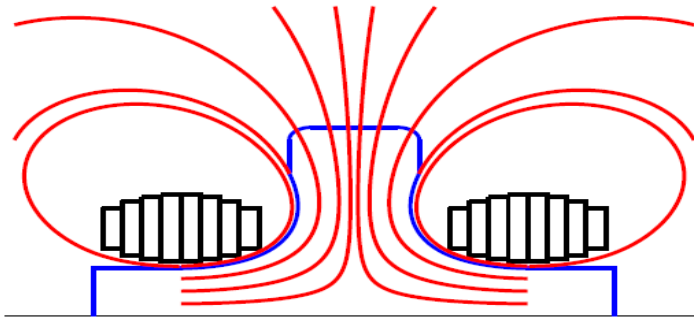
- SNS SCRF cavity experienced rf heating at HOM coupler
- 3D simulations showed MP barriers close to measurements



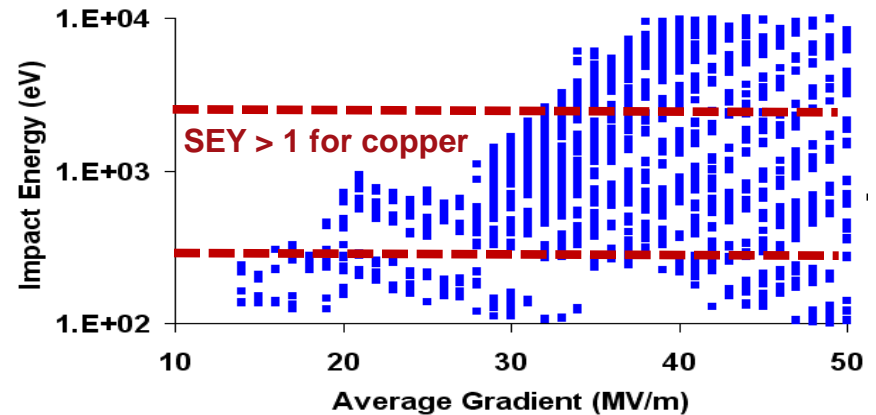
# Track3P - Multipacting in 805MHz Muon Cavity

- Use designed external magnetic map to eliminate multipacting
- Multipacting activities are not observed in the cell, but in the beam pipe region

Magnetic insulation: design cavity surface to follow external magnetic field lines



Impact energy vs. average field gradient for particles with resonant trajectories



- Field level: 28 MV/m
- Impact energy: 535 eV
- Location: beam pipe
- MP type: one point second order

