A compact, tunable plasma beam dump

and

Energy Recovery

Feasibility study 2019 report

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Beam terminating method and beam terminating device

Abstract

Problem to be solved: To terminate a high-energy particle beam by efficiently decelerating it without generating radiation. Solution: Plasma of an encapsulated gas is generated with the incident high-energy particle beam 3 by encapsulating the gas in a waveguide 1 of a linear decelerator; the generated plasma is resonated and vibrated in the waveguide, and the plasma vibration energy is supplied to a load device 9 by taking it out to the outside by electrodes 5a-7a as electrical energy. COPYRIGHT: (C)2009, JPO&INPIT

Images (3)
Discharge capillary
Discharge struck - plasma builds up to its highest density
Density decays to lower values - over several μs
Stationary conditions - few tens of ps e-beam traversing

Discharge vs. e-beam – relative timing – density choice
NEED ionization laser (lower pressure)

Plasma Density Diagnostics
Stark-shift of emission line – was not available

Bunch compressor stability – 100fs

PMQ Triplet: (T-PMQ)
2 x T-PMQ – 1st ahead of the plasma IP & 2nd after exit ahead of spectrometer
1 adjustable focus T-PMQ – ahead of the IP
fixed focus T-PMQ – after plasma exit
needed to increase beam density
Beam energy filtering:

\[ \Delta E = 415 \text{ keV} \]

\[ \sim 290 \text{ px} = ??? \text{ keV} \]

\[ \sim 350 \text{ px} = ??? \text{ keV} \]
BNL-ATF beam dump experiment - preliminary raw data analysis - 20190509

Plasma Dump OFF vs. ON ???
PlasmaDump OFF vs. ON ???
BNL-ATF beam dump experiment - preliminary raw data analysis - 20190510

No plasma:

spec_20190510.1302_NO_plasma.asc

Gaussian fit: \( \mu = 717.1 \text{ keV} \) (1024.5 pixels)
\( \sigma = 32.2 \text{ keV} \) (46.0 pixels)

spec_20190510.1241_NO_plasma.asc

Gaussian fit: \( \mu = 451.7 \text{ keV} \) (645.2 pixels)
\( \sigma = 20.1 \text{ keV} \) (28.7 pixels)

spec_20190510.1120_NO_plasma_delay.0094000.nanosec.asc

Gaussian fit: \( \mu = 574.7 \text{ keV} \) (821.0 pixels)
\( \sigma = 46.9 \text{ keV} \) (67.0 pixels)

spec_20190510.1303_NO_Chirp_NO_plasma.asc

Gaussian fit: \( \mu = 693.6 \text{ keV} \) (990.8 pixels)
\( \sigma = 26.0 \text{ keV} \) (37.3 pixels)
BNL-ATF beam dump experiment - preliminary raw data analysis - 20190510

Some images (external PDF has all images):
Parameters:
Average energy and energy dispersion vs. delay (pressure = 100 Torr):
BNL-ATF beam dump experiment - preliminary raw data analysis - 20190510

Average energy and energy dispersion vs. pressure (delay = 99.8 ns):

- $\mu = 574.7$ eV (89.9 pixels)
- $\sigma = 46.9$ eV (87.0 pixels)

- $\mu = 388.4$ eV (555.1 pixels)
- $\sigma = 144.6$ eV (206.5 pixels)

- $\mu = 253.5$ eV (323.1 pixels)
- $\sigma = 41.7$ keV (59.6 pixels)

- $\mu = 472.9$ eV (674.3 pixels)
- $\sigma = 22.2$ keV (131.7 pixels)

- $\mu = 175.3$ eV (250.4 pixels)
- $\sigma = 60.5$ keV (86.3 pixels)
BNL-ATF beam dump experiment - preliminary raw data analysis - 20190510

Average energy and energy dispersion vs. pressure (delay = 99.8 ns):

![Graphs showing energy vs. pressure](image.png)
Shorter bunch (BC on?) – Energy / energy dispersion vs pressure (99.85 ns):
Shorter bunch (BC on?):

![Graph showing data analysis results]
Shorter bunch (BC on?) – Energy / energy disp. vs pressure (delay = 99.85 ns):
Shorter bunch (BC on?) – Files from “BC_ON_3PM” folder:

No plasma

\[ \mu = 442.0 \text{ keV (631.4 pixels)} \quad \sigma_x = 82.7 \text{ keV (118.2 pixels)} \]

80 Torr, 99.00 ns

\[ \mu = 479.3 \text{ keV (684.7 pixels)} \quad \sigma_x = 81.9 \text{ keV (119.8 pixels)} \]

100 Torr, 99.85 ns

\[ \mu = 311.9 \text{ keV (445.6 pixels)} \quad \sigma_x = 144.3 \text{ keV (206.2 pixels)} \]

100 Torr, 100.00 ns

\[ \mu = 453.5 \text{ keV (647.8 pixels)} \quad \sigma_x = 129.5 \text{ keV (184.2 pixels)} \]