Rejuvenating the Booster Space Charge Study

November 21, 2002, Huddle

http://www-bd.fnal.gov/pdriver/booster/

Motivation

- This is one of the recommendations of the DOE Review panel
- Although the Booster looks fine for Run2, its beam intensity (protons per second) is only 1/8 of the MiniBooNE goal

What's new since last meeting

- The Booster Dept has done a number of beam studies on space charge
- The Booster magnet measurement at the E4R is progressing
- The linac space charge code IMPACT is being modified for simulating rings
- The simulation code ORBIT is up and running on the BP Dept parallel computer cluster and has started to give interesting results

Purpose of this meeting

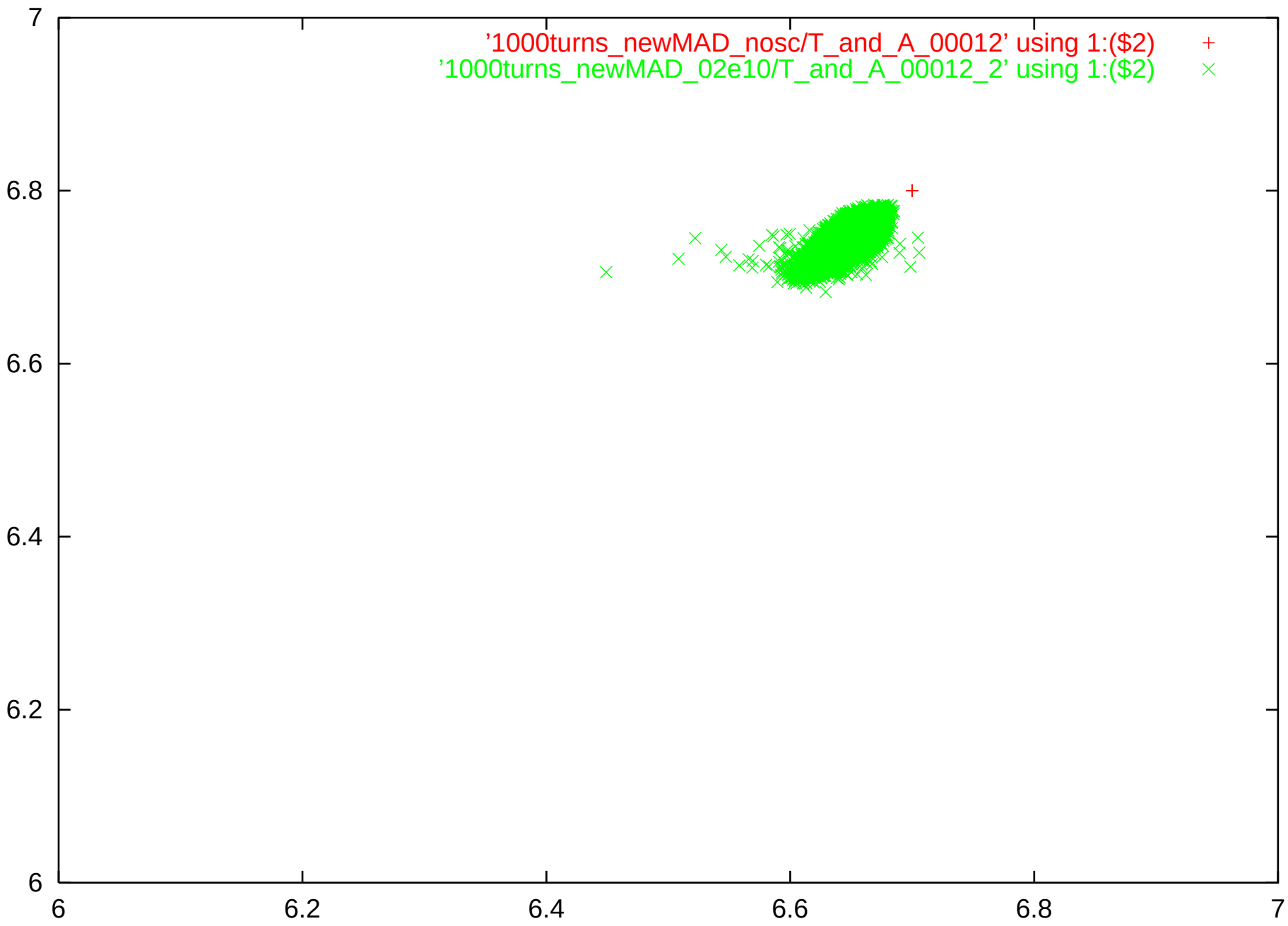
- To discuss a plan
- To coordinate an on-going effort
- To introduce the code ORBIT

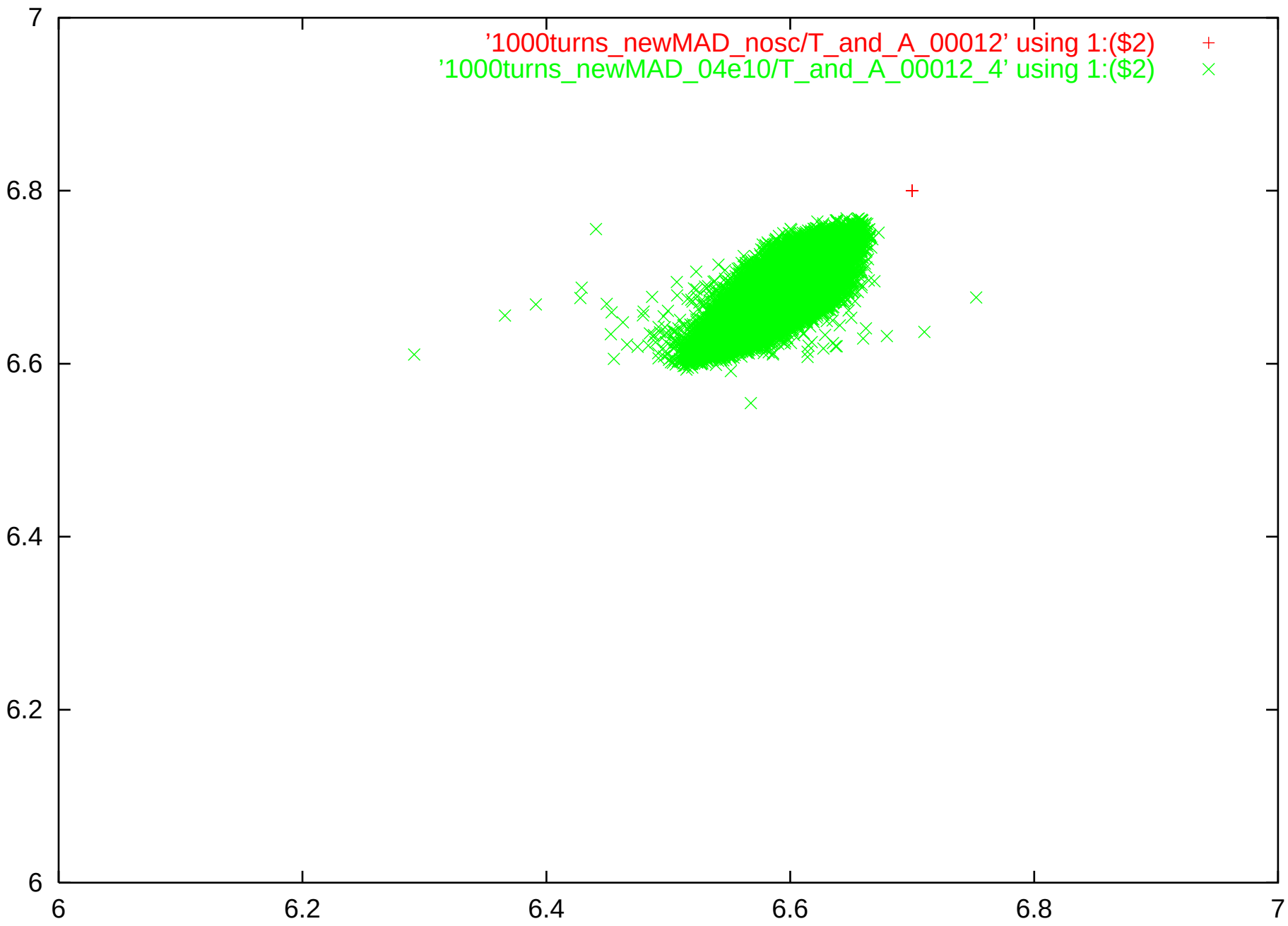
Plan for discussion

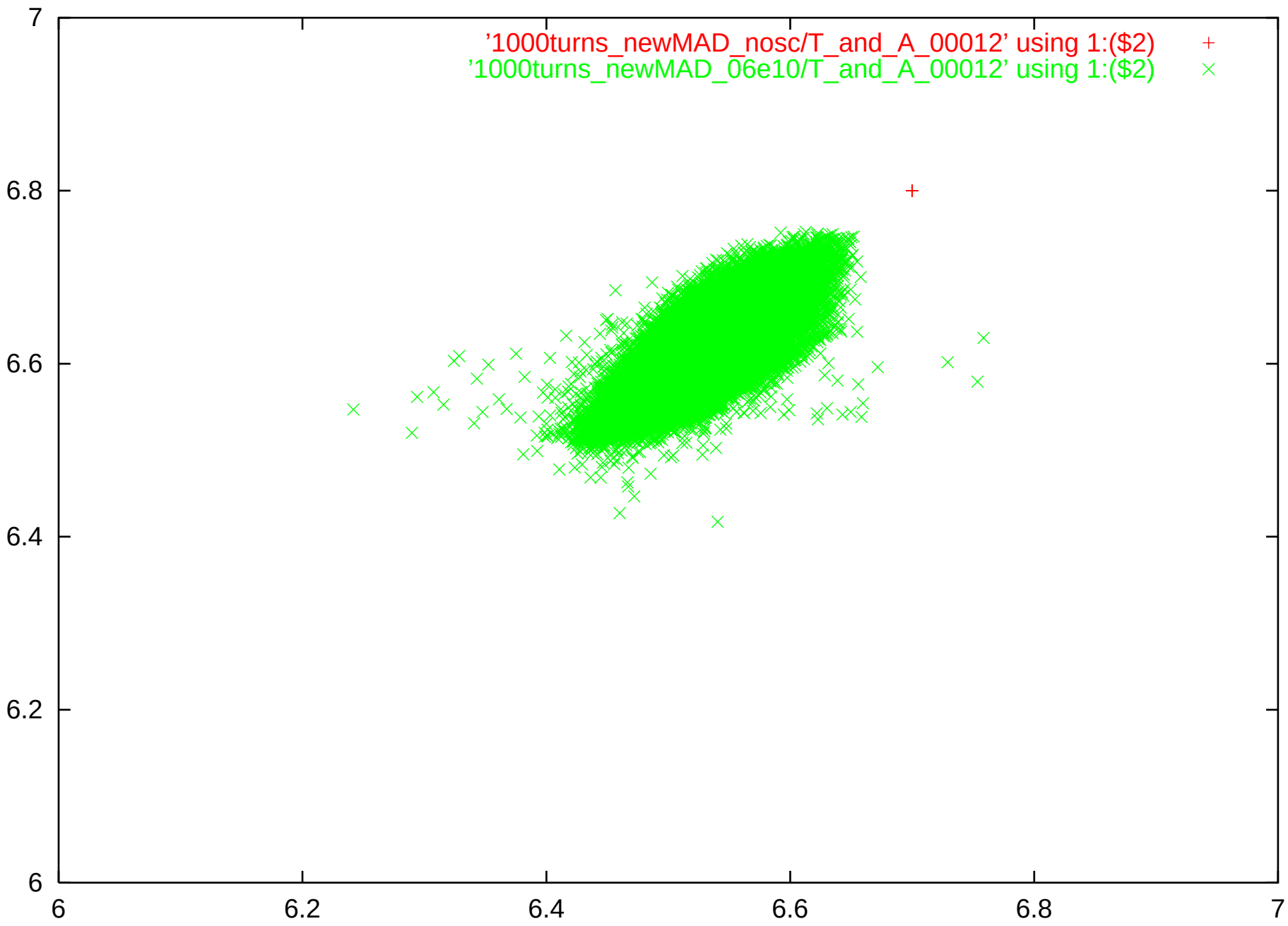
- Simulations
  - To make ORBIT a production code
  - To compare ORBIT with ESME for longitudinal space charge
  - To compare ORBIT with IMPACT
- Booster modeling
  - To continue the improvement of the Booster lattice model, which will include sextupoles, correctors, alignment errors, magnet field errors, orbit bump and impedance
- Booster magnet measurement
  - To continue the flat coil measurement at the E4R, in particular for body and ends sextupole component
- Booster beam studies
  - Will be coordinated by the Booster Dept
  - A key device is the IPM (ion profile monitor), which should be a high priority item
  - Work on other devices, e.g., quadrupole pickup, pingers, etc.
- Inductive inserts study
  - 10 modules are being manufactured and will be installed in the Booster. We are working on the schedule.
- Collaborations
  - SNS/ORNL (Jeff Holmes) on ORBIT
  - Indiana University (S.Y. Lee) and ANL (S. Milton) on space charge study
  - CERN (B. Dehning) and BNL (R. Connolly) on IPM

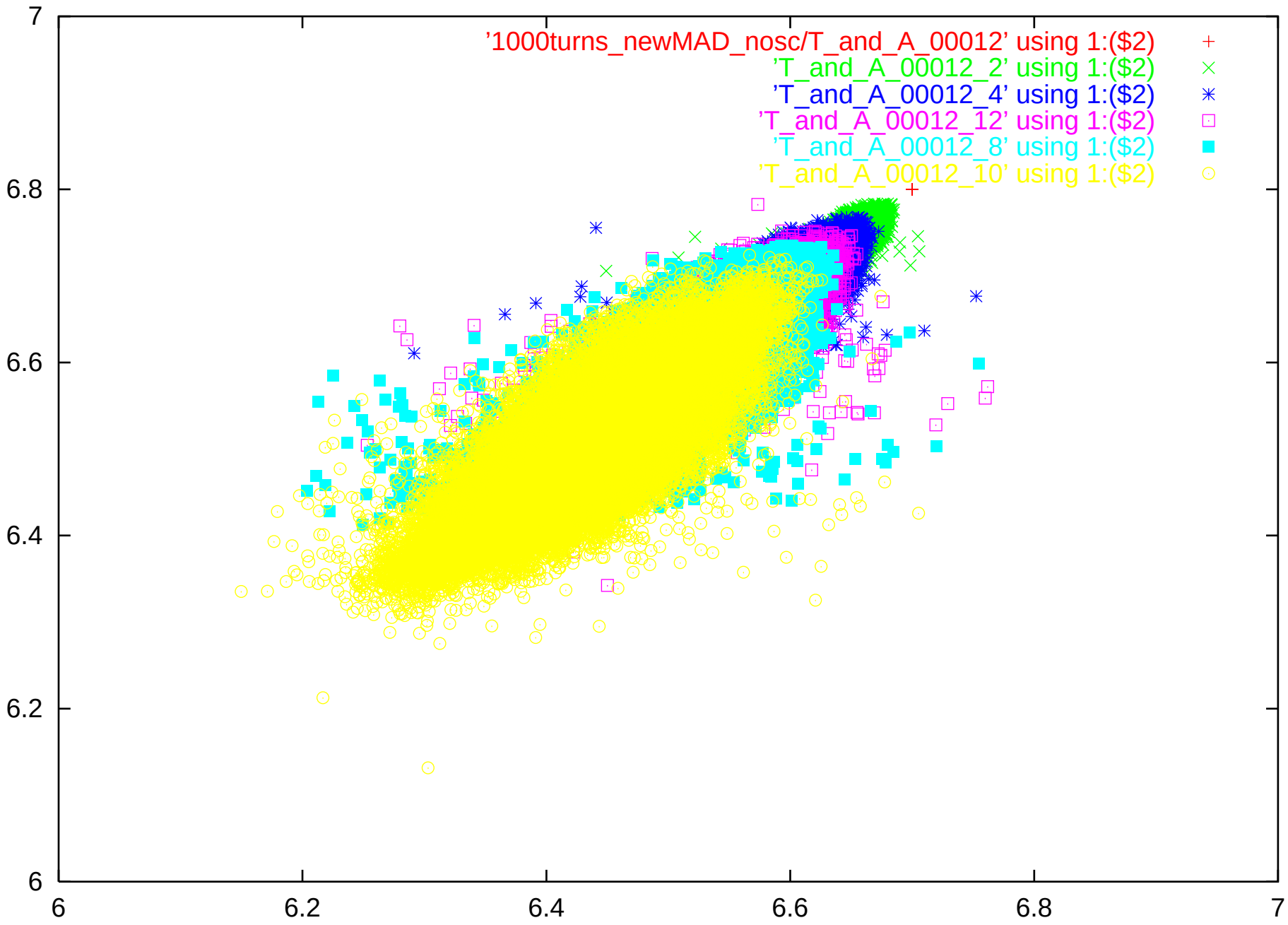
How this study will help improve the Booster performance

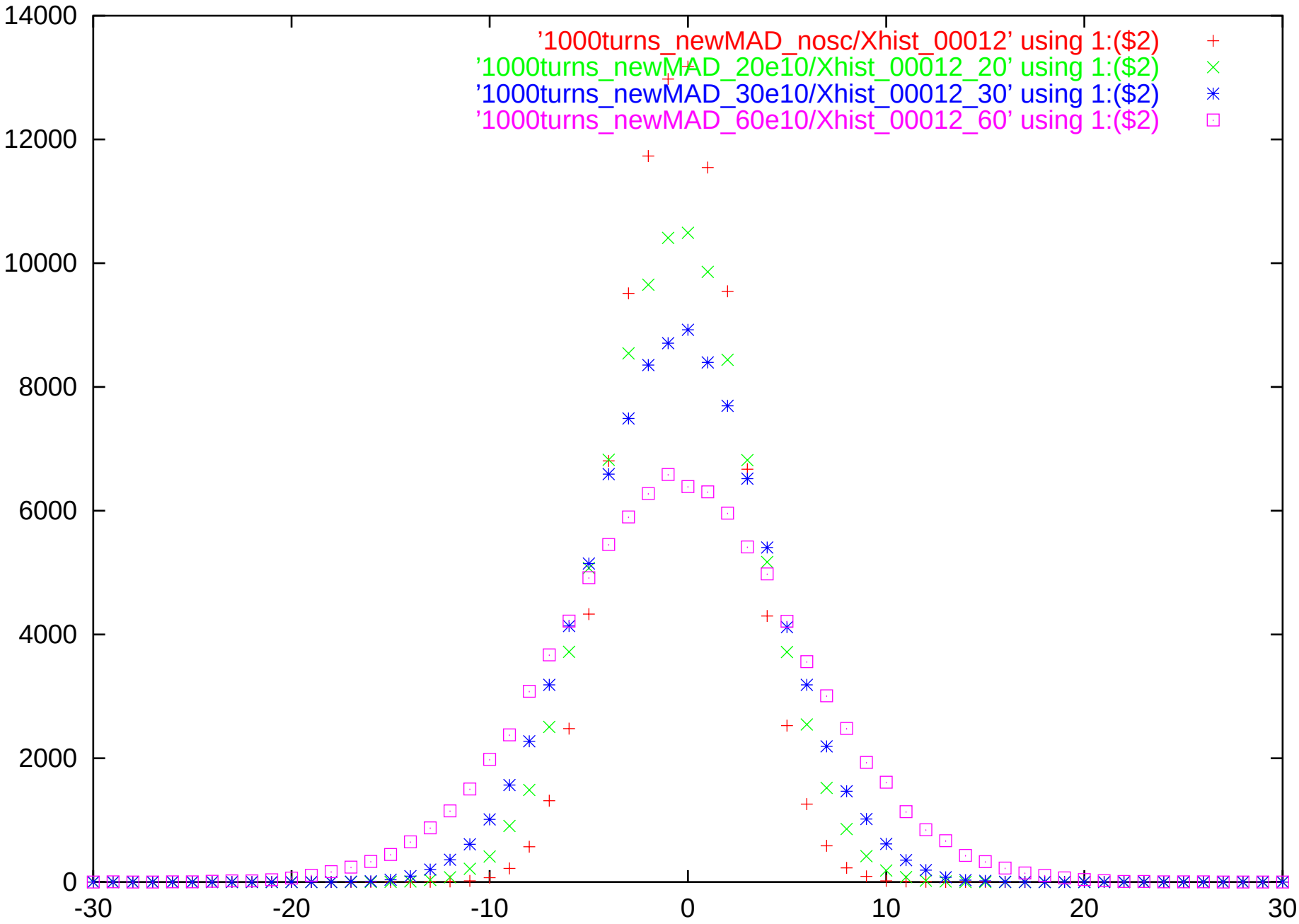
- To build a reliable, up-to-date and useful Booster model
- To understand emittance dilution and beam loss, and the role of the space charge and other associated effects (e.g., electron cloud)
- To evaluate possible changes in machine operation, e.g.,
  - The waveform of the injection bump
  - Tune ramp curve
  - RF voltage curve
  - Tune split, etc.
- To get insight of what happens during transition crossing
- To investigate and experiment
  - Inductive inserts (D. Wildman)
  - Transverse quadrupole mode pickup and damper (A. Jansson)
  - Electron beam compensation (V. Shiltsev)
  - Other proposals

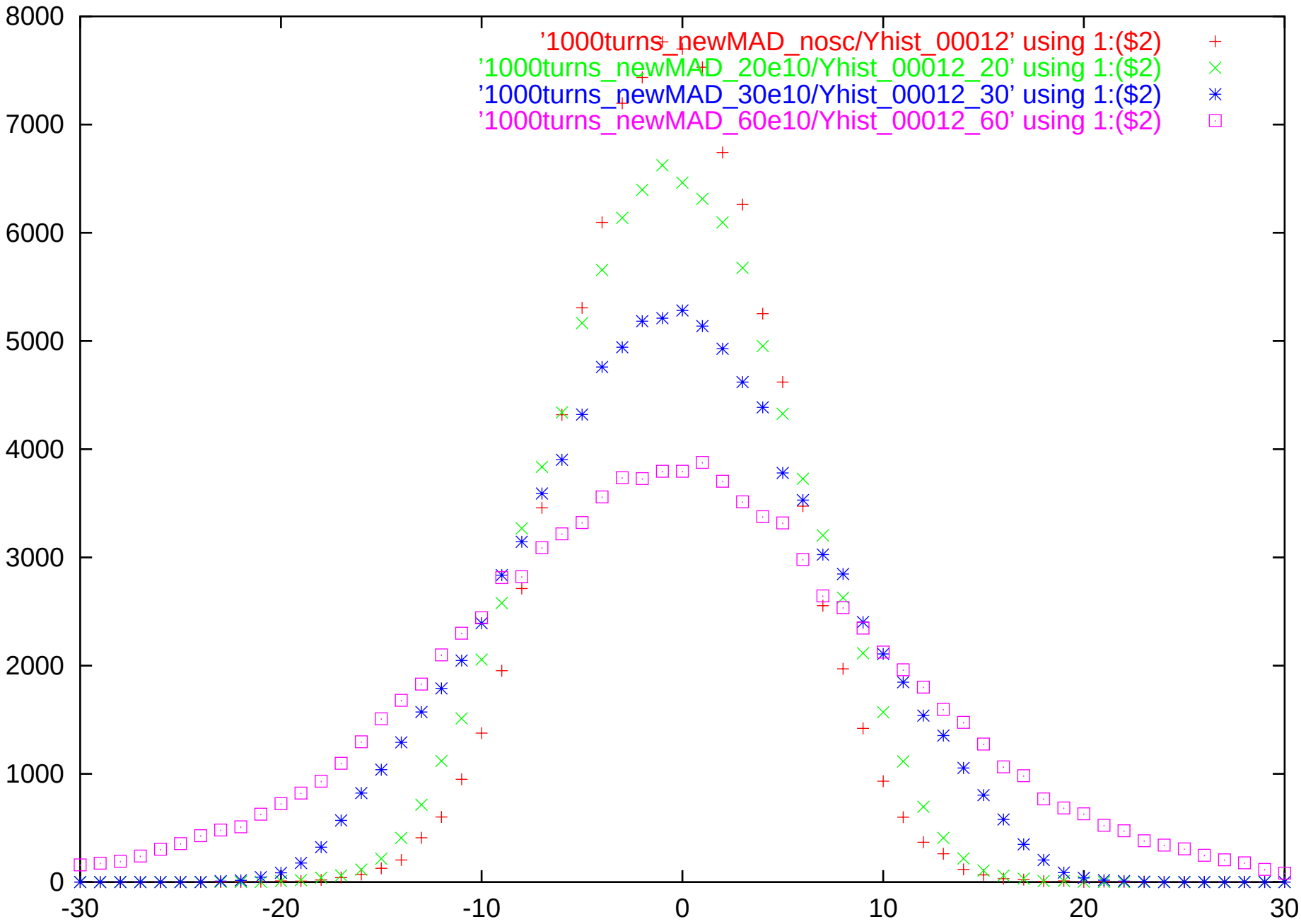

'1000turns_newMAD_nosc/T_and_A_00012' using 1:($2)
'1000turns_newMAD_02e10/T_and_A_00012_2' using 1:($2)
7
6.8
6.6
6.4
6.2
6
6
6.2
6.4
6.6
6.8
7

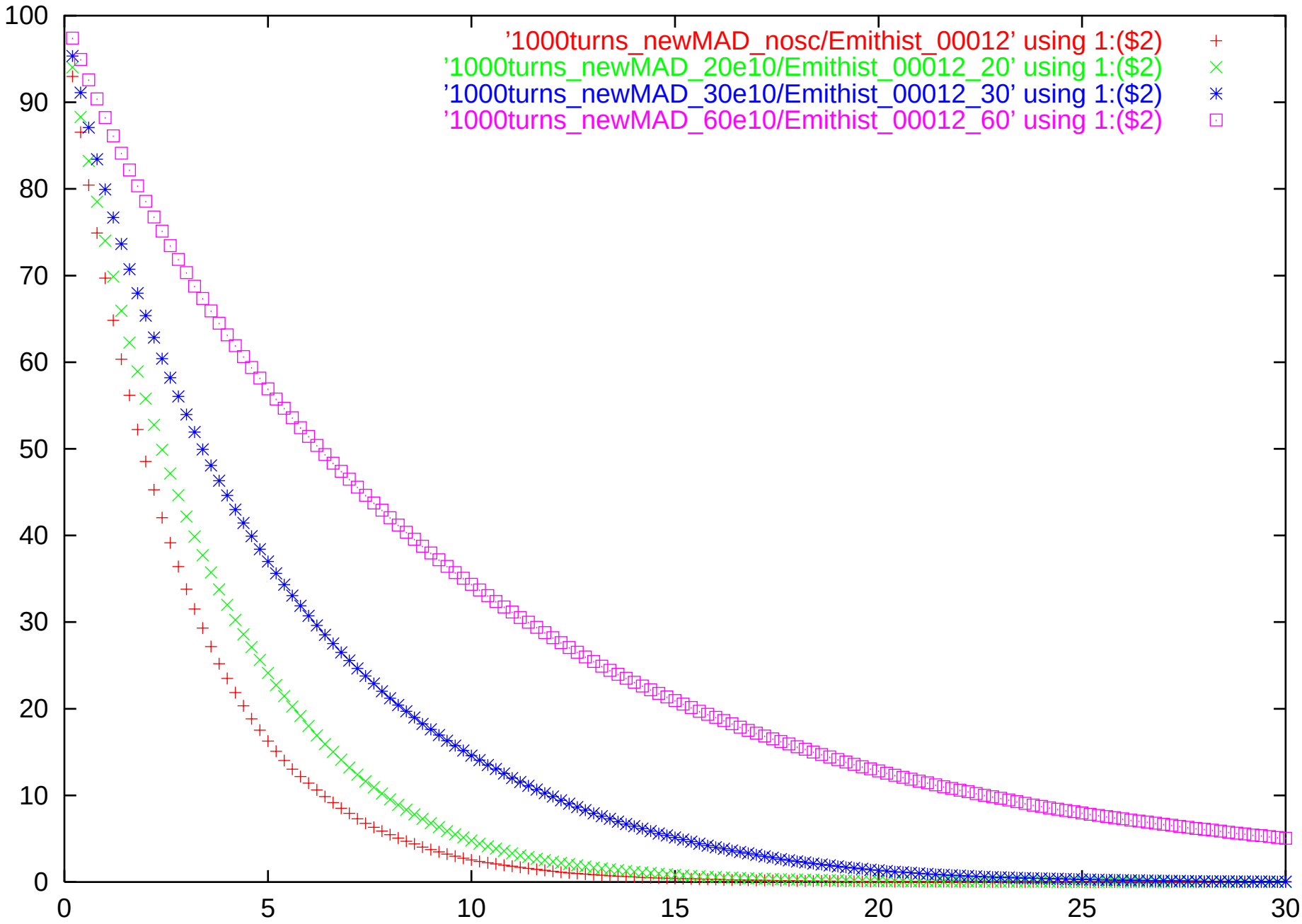

'1000turns_newMAD_nosc/T_and_A_00012' using 1:($2)
'1000turns_newMAD_04e10/T_and_A_00012_4' using 1:($2)
7
6.8
6.6
6.4
6.2
6
6
6.2
6.4
6.6
6.8
7

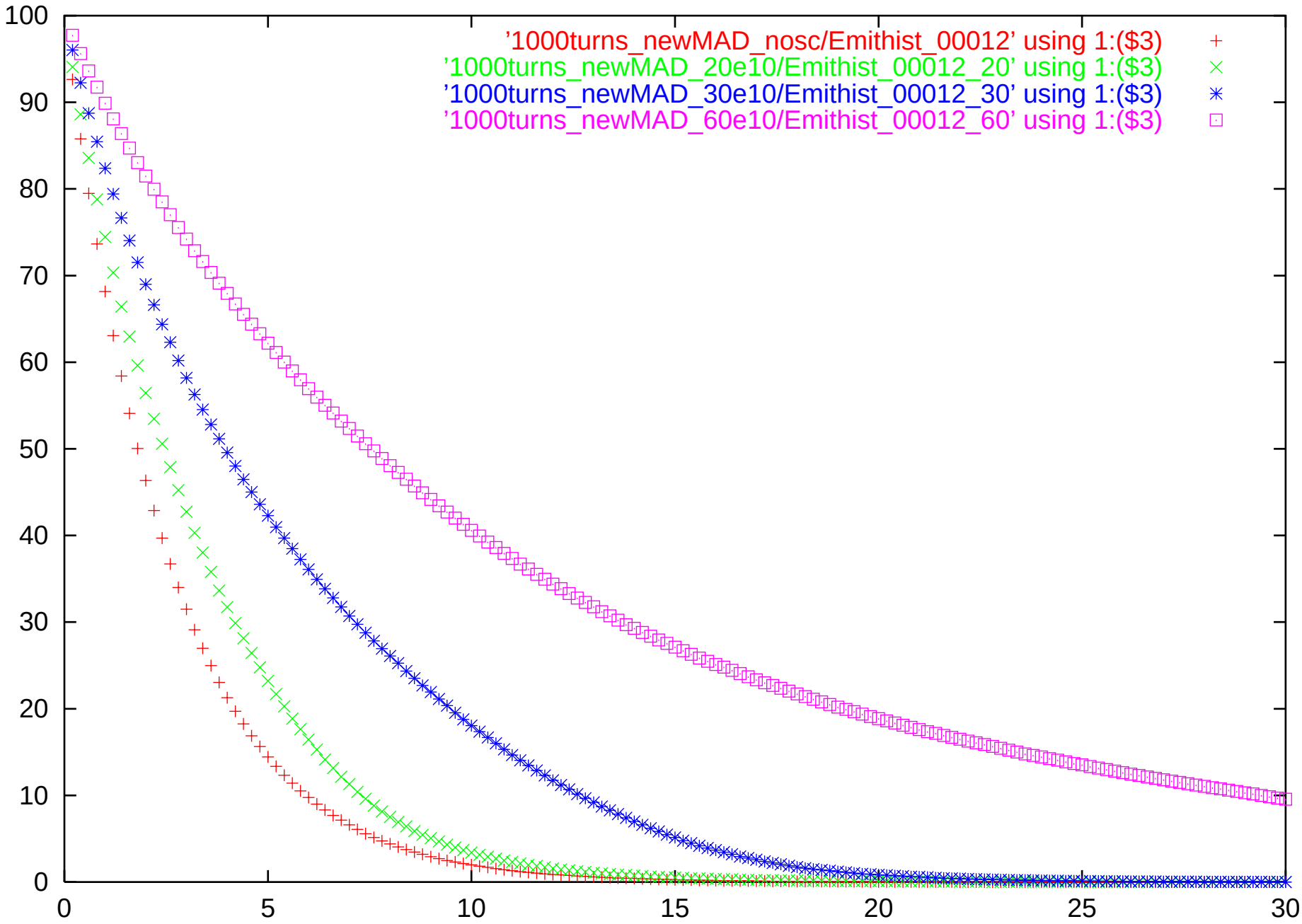

'1000turns_newMAD_nosc/T_and_A_00012' using 1:($2)
'1000turns_newMAD_06e10/T_and_A_00012' using 1:($2)
7
6.8
6.6
6.4
6.2
6
6
6.2
6.4
6.6
6.8
7

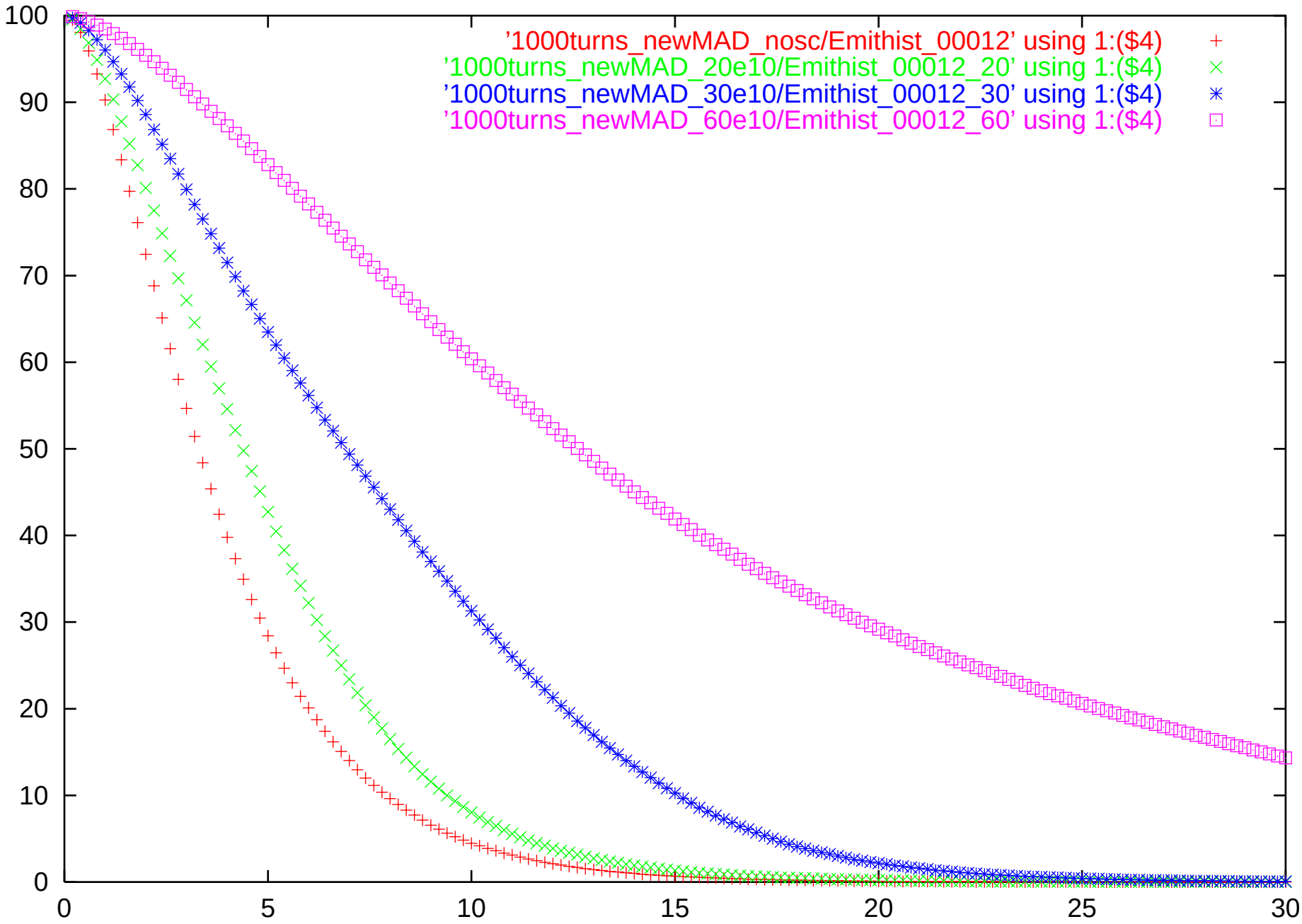

'1000turns_newMAD_nosc/T_and_A_00012' using 1:($2)
'T_and_A_00012_2' using 1:($2)
'T_and_A_00012_4' using 1:($2)
'T_and_A_00012_12' using 1:($2)
'T_and_A_00012_8' using 1:($2)
'T_and_A_00012_10' using 1:($2)
7
6.8
6.6
6.4
6.2
6
6
6.2
6.4
6.6
6.8
7


'1000turns_newMAD_nosc/Xhist_00012' using 1:($2)
'1000turns_newMAD_20e10/Xhist_00012_20' using 1:($2)
'1000turns_newMAD_30e10/Xhist_00012_30' using 1:($2)
'1000turns_newMAD_60e10/Xhist_00012_60' using 1:($2)
14000
12000
10000
8000
6000
4000
2000
0
-30
-20
-10
0
10
20
30


'1000turns_newMAD_nosc/Yhist_00012' using 1:($2)
'1000turns_newMAD_20e10/Yhist_00012_20' using 1:($2)
'1000turns_newMAD_30e10/Yhist_00012_30' using 1:($2)
'1000turns_newMAD_60e10/Yhist_00012_60' using 1:($2)
8000
7000
6000
5000
4000
3000
2000
1000
0
-30
-20
-10
0
10
20
30


'1000turns_newMAD_nosc/Emithist_00012' using 1:($2)
'1000turns_newMAD_20e10/Emithist_00012_20' using 1:($2)
'1000turns_newMAD_30e10/Emithist_00012_30' using 1:($2)
'1000turns_newMAD_60e10/Emithist_00012_60' using 1:($2)
100
90
80
70
60
50
40
30
20
10
0
0
5
10
15
20
25
30


'1000turns_newMAD_nosc/Emithist_00012' using 1:($3)
'1000turns_newMAD_20e10/Emithist_00012_20' using 1:($3)
'1000turns_newMAD_30e10/Emithist_00012_30' using 1:($3)
'1000turns_newMAD_60e10/Emithist_00012_60' using 1:($3)
100
90
80
70
60
50
40
30
20
10
0
0
5
10
15
20
25
30


'1000turns_newMAD_nosc/Emithist_00012' using 1:($4)
'1000turns_newMAD_20e10/Emithist_00012_20' using 1:($4)
'1000turns_newMAD_30e10/Emithist_00012_30' using 1:($4)
'1000turns_newMAD_60e10/Emithist_00012_60' using 1:($4)
100
90
80
70
60
50
40
30
20
10
0
0
5
10
15
20
25
30

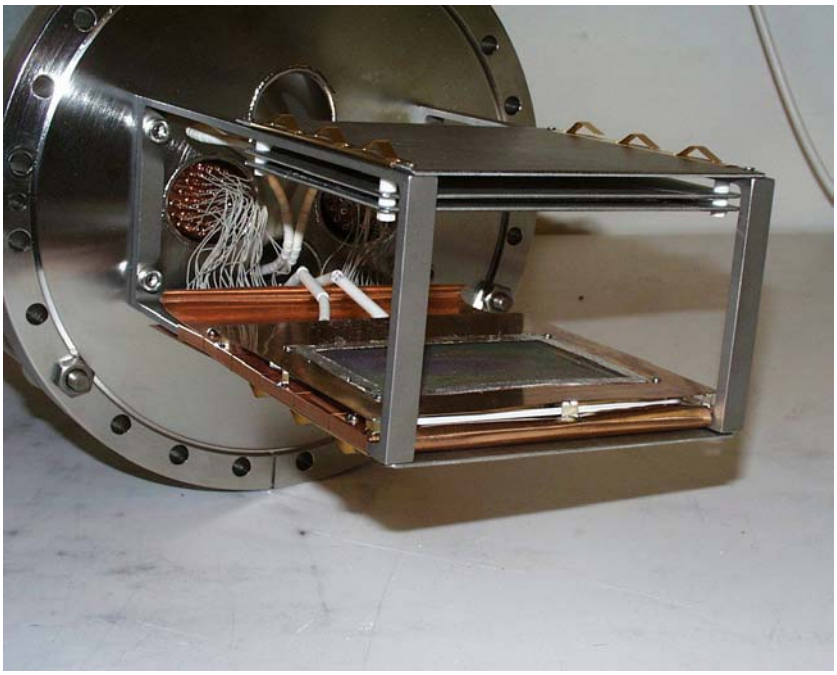


Figure 1. Complete, MCP.
This is the original transducer head which is inserted into a side port of a 4" x 6" rectangular chamber. This design has been susceptible to rf pick up from the beam, readiation spray and background electrons.

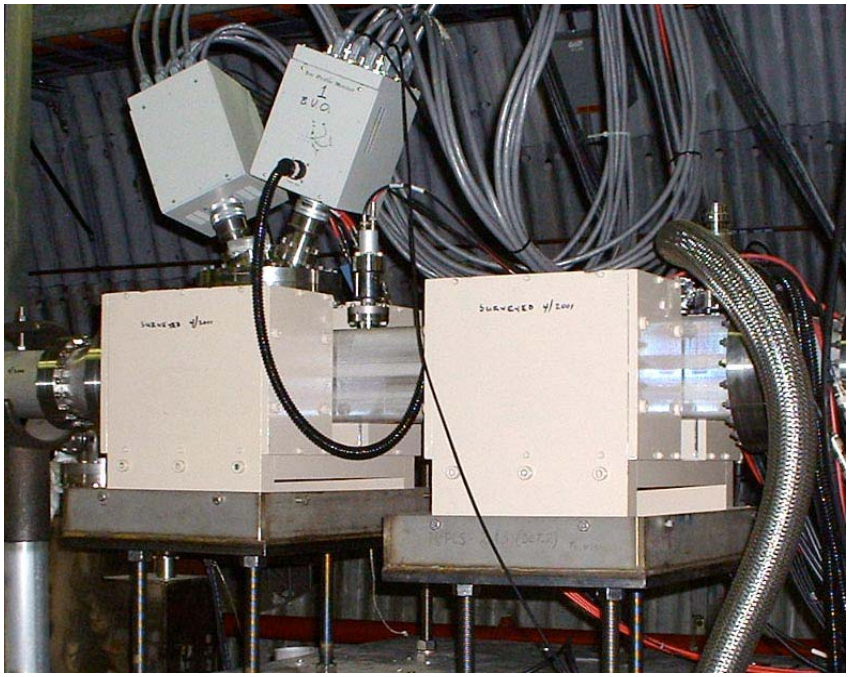


Figure 2. Vertical IPM.
One IPM in the tunnel. The amplifiers are attached directly to the mounting flange.

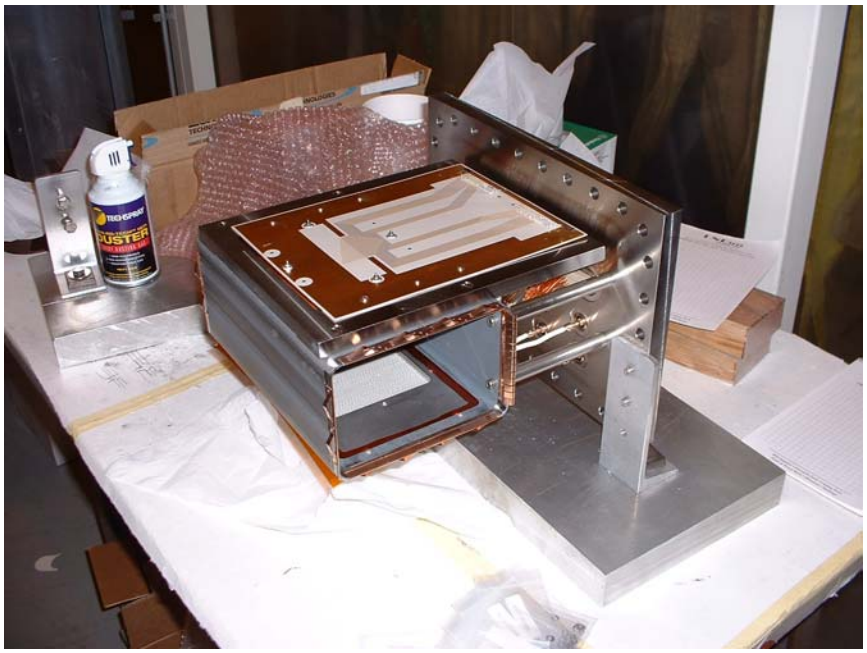


Figure 3. Finished, 1.
The new detector head. The rectangular insert provides an uninterrupted path for image current. The MCP and collector circuit board are outside of the image current path. The sweep electrode is flush with the beam pipe and longer to sweep background electrons from the pipe before they get to the collector.

Figure 4. Detector inserted chamber.
An unfinished transducer head being inserted into the vacuum chamber.