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HIGH CURRENT BETATRON STABILITY AND INJECTION STUDIES

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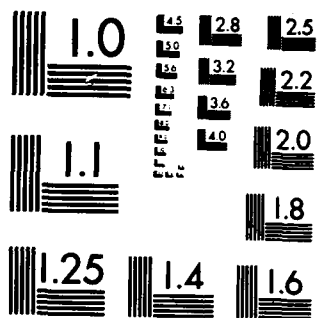
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HIGH CURRENT BETATRON STABILITY AND INJECTION STUDIES

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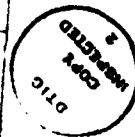
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T. P. HUGHES, B. B. GODFREY, M. M. CAMPBELL
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**MRC CONTRIBUTING IN SEVERAL AREAS OF HIGH CURRENT
CYCLIC INDUCTION ACCELERATOR RESEARCH:**

(1) → LINEAR THEORY OF NEGATIVE MASS AND RESISTIVE
WALL INSTABILITIES IN MODIFIED BETATRON,

(2) → LINEAR THEORY OF BEAM BREAKUP INSTABILITY IN
RECIRCULATING INDUCTION ACCELERATOR,

(3) → SINGLE-TURN INJECTION SIMULATION FOR MODIFIED
BETATRON,

(4) → MULTI-TURN INJECTION SIMULATION FOR CONVENTIONAL
BETATRON, and

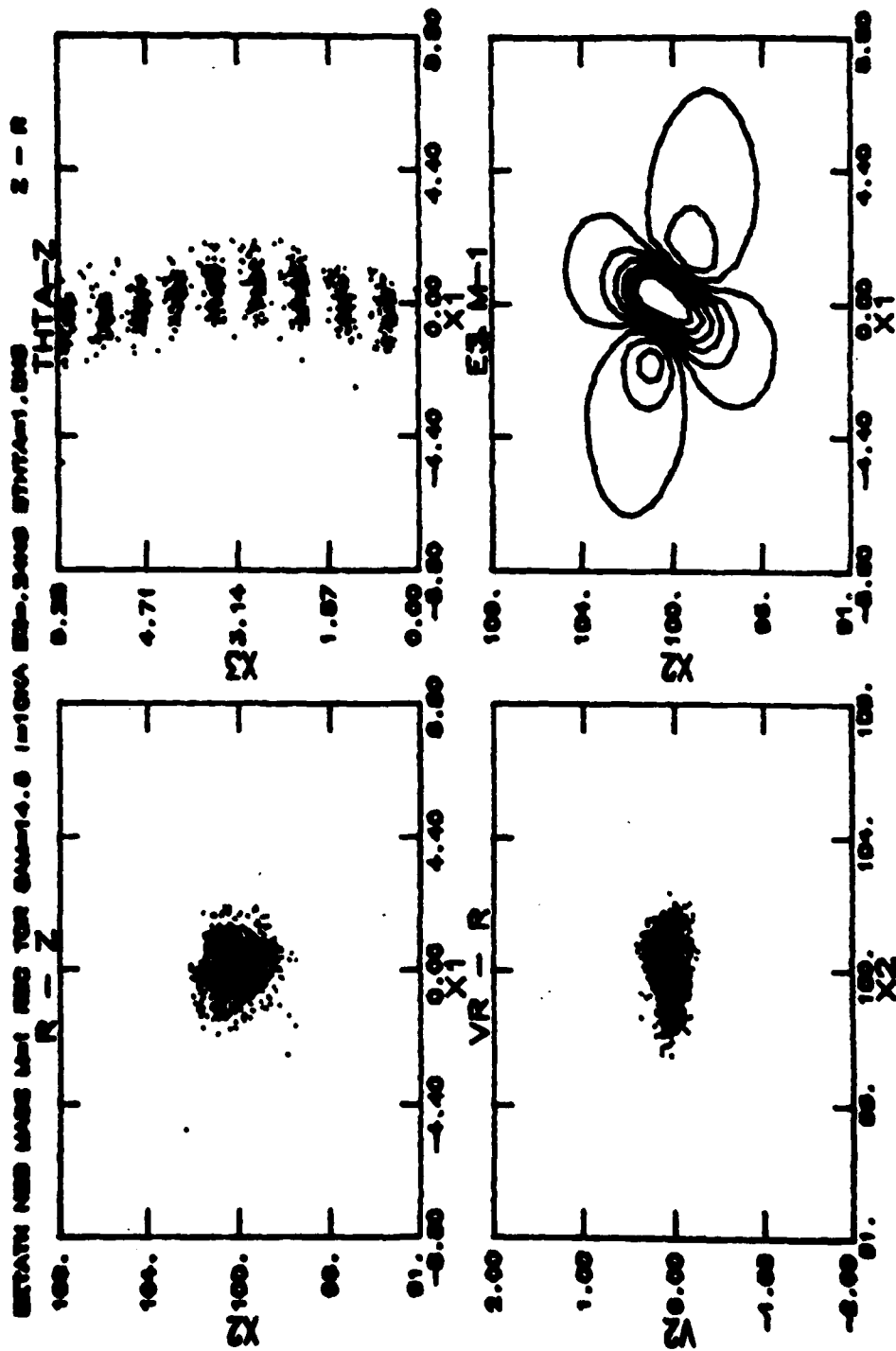
(5) → NEGATIVE MASS INSTABILITY SATURATION SIMULATION.

**PRESENTATION REVIEWS NEGATIVE MASS SATURATION, NEGATIVE
MASS LINEAR THEORY, MULTI-TURN INJECTION.**

**PRELIMINARY SIMULATIONS OF NEGATIVE MASS INSTABILITY
SHOW BEAM DISRUPTION IN SOME CASES, NOT IN OTHERS**

- **SIMULATIONS PERFORMED WITH WELL TESTED 3-D PIC
CODE "IVORY"**
- **CALCULATIONS DONE IN TOROIDAL DRIFTTUBE WITH
RECTANGULAR MINOR CROSSECTION**
- **BEAM INITIALIZED FROM FINN-MANHEIMER EQUILIBRIUM
CODE WHEN APPROPRIATE**
- **SATURATION BY PARTICLE TRAPPING (SEVERE LOSSES)
FOR LAMINAR BEAM BELOW PARAMAGNETIC TRANSITION**
- **APPARENT SATURATION BY BEAM HEATING (SMALL LOSSES)
FOR WARM BEAM ABOVE PARAMAGNETIC TRANSITION**

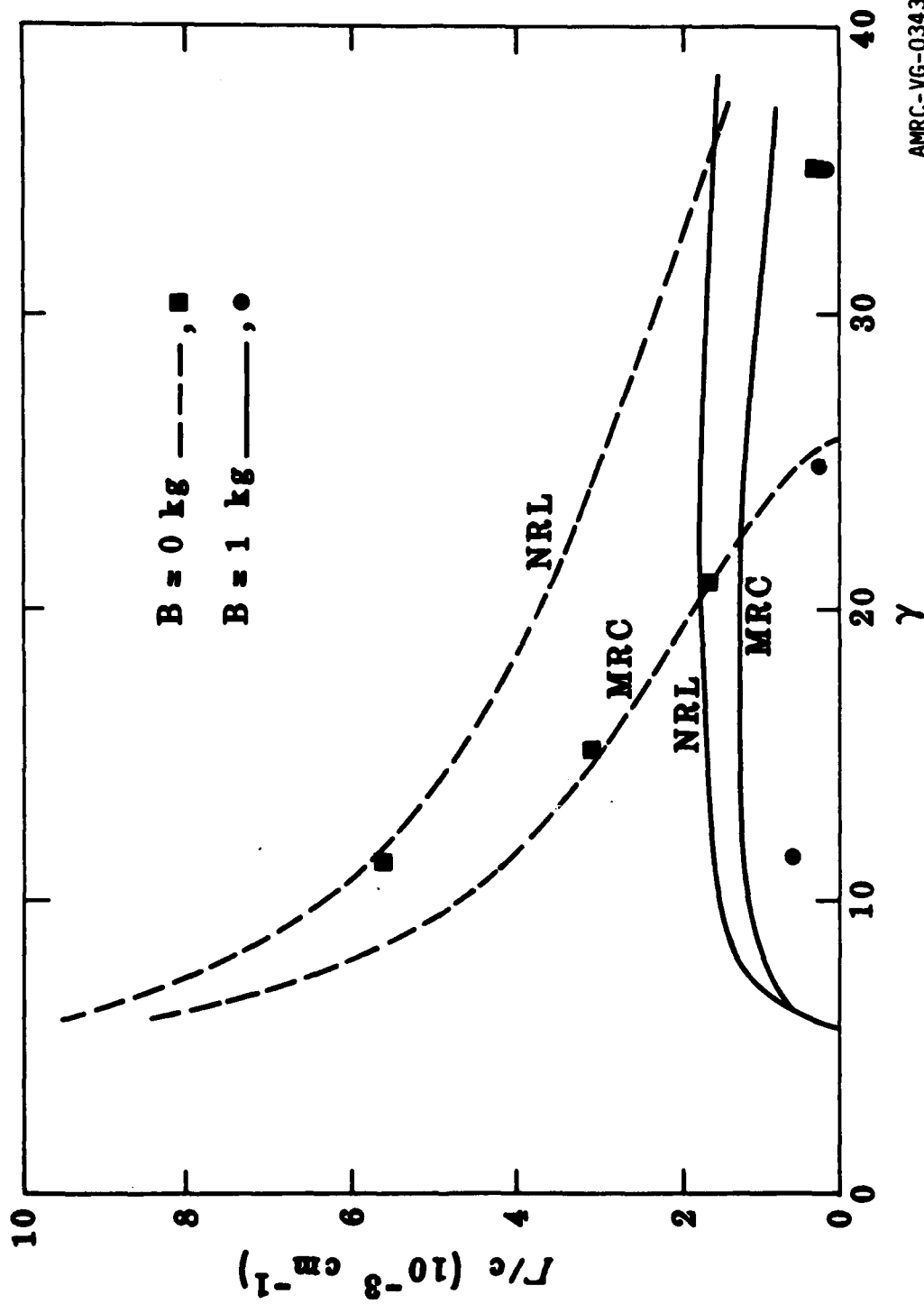
TYPICAL MOVIE FRAME DEPICTING LINEAR STAGE OF NEGATIVE MASS INSTABILITY IN 10kA, 7 MeV BEAM



MORE WORK NEEDED ON NEGATIVE MASS INSTABILITY LINEAR GROWTH RATES TO AID SIMULATIONS, EXPERIMENTS.

- **EXISTING MODELS TREAT BEAM AS STRING OF RIGID DISKS IN TOROIDAL GEOMETRY**
- **ELECTROMAGNETIC FIELDS OF INSTABILITY COMPUTED IN CYLINDRICAL GEOMETRY**
- **NRL, MRC GROWTH RATES TYPICALLY DIFFER BY ABOUT 50%**
- **RIGID DISK SIMULATIONS WITH IVORY SHOW SLOWER GROWTH THAN EITHER MODEL**
- **ANALITICAL MODELS PROBABLY ERR IN IGNORING TOROIDAL FIELD CORRECTIONS**

SIMULATIONS, ANALYTICAL MODELS GIVE DIFFERENT NEGATIVE MASS INSTABILITY GROWTH RATES



MULTI-TURN INJECTION SIMULATION SHOWS GOOD TRAPPING OF 5kA, 40 MeV BEAM.

- TOROIDAL MAGNETIC FIELD NOT NEEDED FOR EQUILIBRIUM OF HIGH ENERGY BEAM
- CURRENT SUPPLIED BY HYPOTHETICAL 125 A, 40 MeV RF LINAC DURING 40 REVOLUTIONS
- BEAMLETS TRAPPED BY ADIABATIC DEPRESSION OF ELECTROSTATIC POTENTIAL, FORM ANNULAR BEAM
- NEGATIVE MASS, DIOCOTRON INSTABILITIES NOT YET INVESTIGATED

MULTI-TURN INJECTION STUDY DONE IN COLLABORATION WITH WESTERN RESEARCH CORPORATION.

**RESEARCH PLANS PUT HEAVY EMPHASIS ON NEGATIVE
MASS INSTABILITY.**

- **IMPROVED LINEAR STABILITY ANALYSIS**
- **IVORY SIMULATIONS OF INSTABILITY SATURATION
FOR WARM BEAMS AT VARIOUS ENERGIES**
- **BEAM BEHAVIOR DURING PARAMAGNETIC TRANSITION**
- **COMPUTATIONAL ASSISTANCE FOR NRL, U.C. IRVINE
BETATRON EXPERIMENTS**
- **COUPLING BETWEEN NEGATIVE MASS, KLYSTRON
MODES**
- **STABILITY OF MULTI-TURN INJECTION**

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AND W. MANHEIMER FOR COPY OF BETATRON BEAM
EQUILIBRIUM CODE

•IVORY DEVELOPED WITH SUPPORT FROM LOS ALAMOS
NATIONAL LABORATORY

RECIRCULATING ACCELERATOR PUBLICATIONS

"RESISTIVE WALL INSTABILITIES IN THE MODIFIED BETATRON", B. B. GODFREY AND T. P. HUGHES, AMRC-R-332 (1982).

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