SNS Accelerator Ion Source RF System

SNS RF Systems

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Outline

- **Introduction**
- **Brief Accelerator Tour**
- **Overview of Ion Source RF work**
  - **Details in separate presentations**
- **Solid State Ionizing Amplifier Details**
- **Topics for Discussion**

SNS RF Group

- **Tom Hardek** — **Group Leader**
  - **Linda Siecinski** — **Administrative Assistant**
  - **Pamela Kite** — **Technician (Work Control etc.)**
- **RF Structures**
  - **Yoon Kang** — **Lead Engineer**
  - **Alexandre Vassioutchenko** — **Engineer**
  - **Robert Peglow** — **Technician**
- **Linac RF**
  - **Michael McCarthy** — **Lead Engineer**
  - **Mark Cardinal** — **Technician**
  - **Dale Heidenreich** — **Technician**
  - **Curtis Phibbs** — **Technician**
- **Ring/MEBT/Ion Source**
  - **Mark Middendorf** — **Lead Engineer – Ring/MEBT**
  - **Chip Piller** — **Lead Engineer – Ion Source + LLRF Engineer**
  - **Michael Clemmer** — **Technician**
- **Low Level RF**
  - **Mark Crofford** — **Lead Engineer**
  - **Sung-Woo Lee** — **Engineer LLRF + RF Structures**
  - **Jeff Ball** — **Technician**
  - **Taylor Davidson** — **Technician**
  - **Stacy Jones** — **Technician**

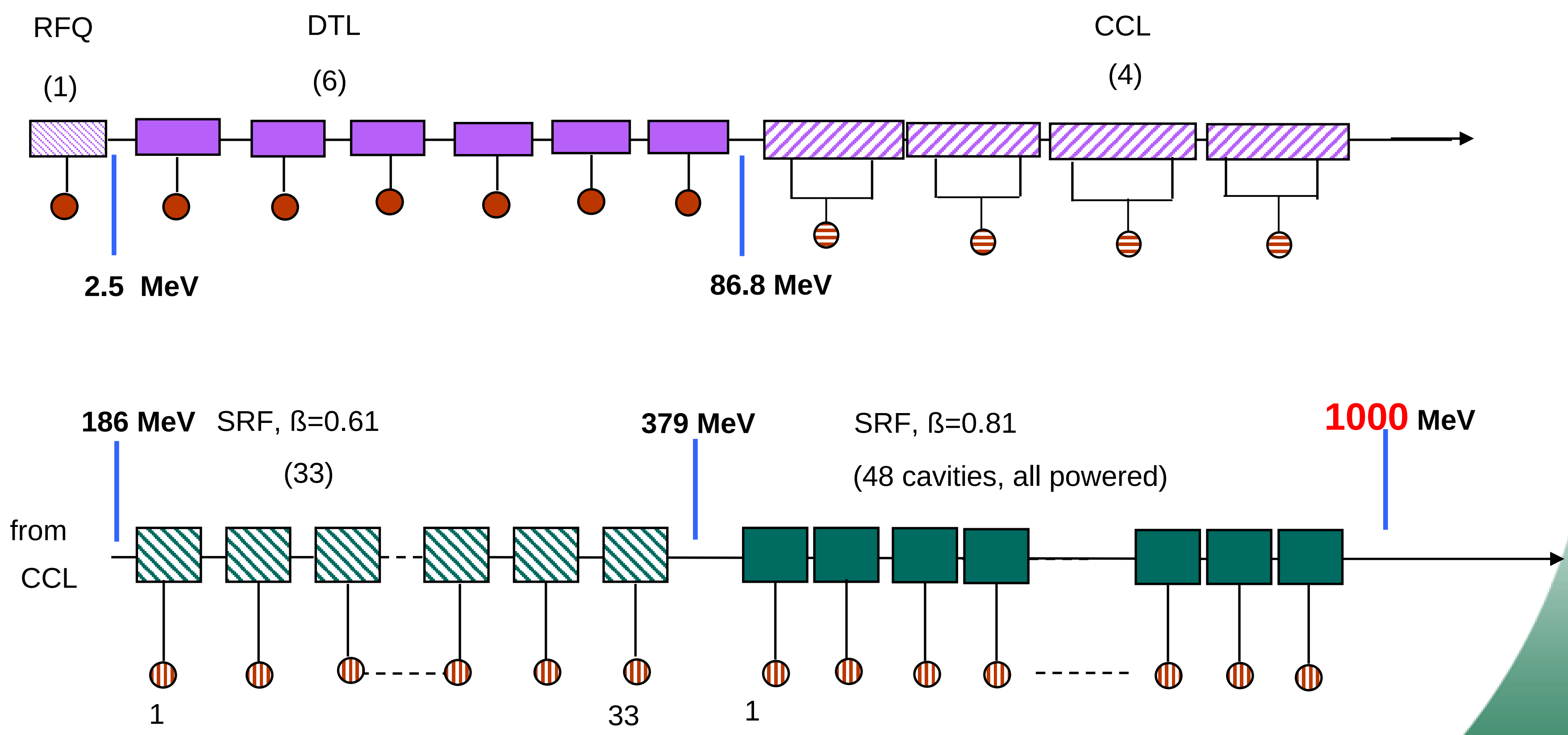
  - **Ray Fuja** — **Consultant**

Accelerator RF Systems

A Brief Photo Tour of the various RF systems

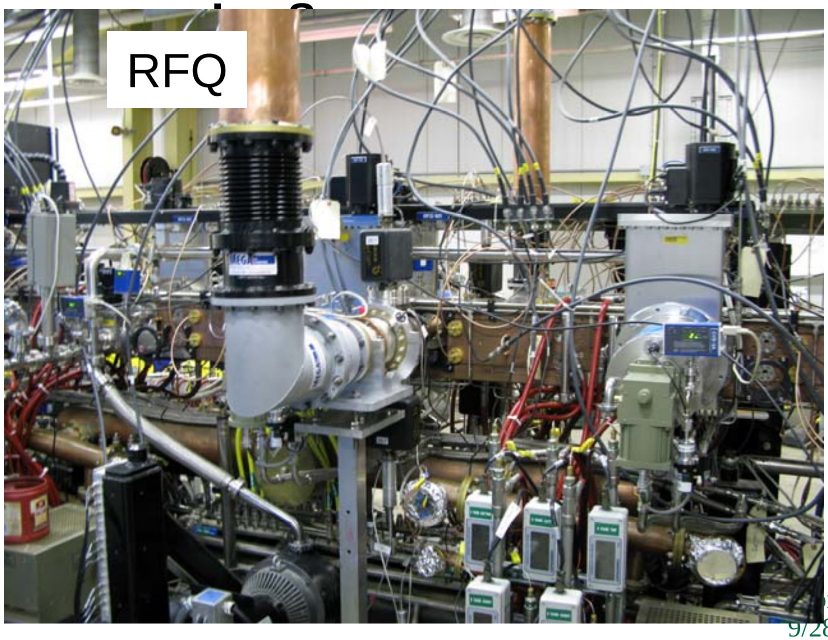
Layout of Linac RF Modules

402.5 MHz, 2.5 MW klystron	3 Transmitter	3 Modulators
805 MHz, 5 MW klystron	4 Transmitter	4 Modulators
805 MHz, 0.55 MW klystron	14 Transmitter	7 Modulators



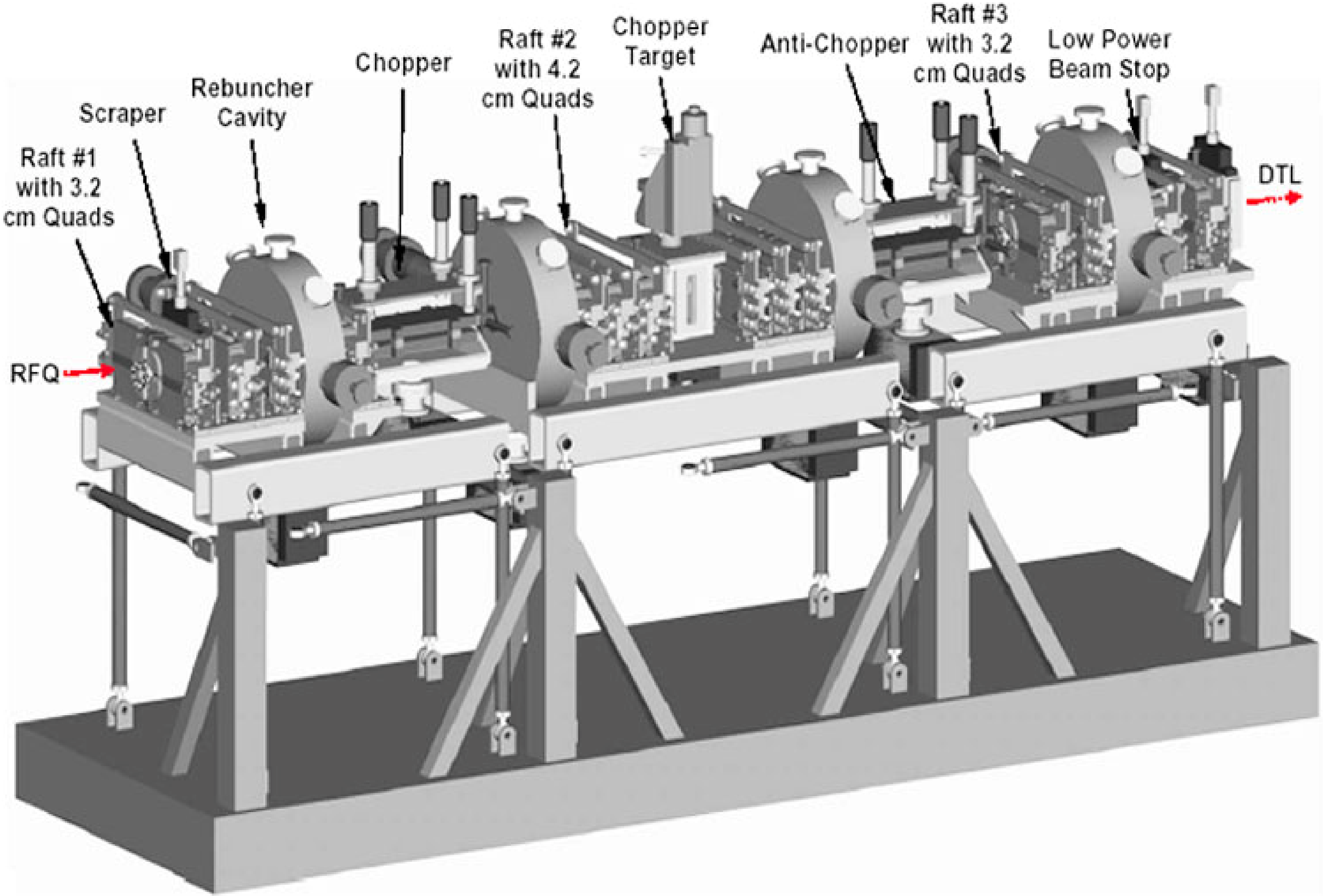
Ion Source & RFQ

- **Currently using an Internal Antenna**
- **Have used an External Antenna**
- **Pulsed 2 MHz at 50+ kW**
- **13 MHz CW applied to the same antenna**



- **Recently modified to use only 2 Drive Couplers**
- **Accelerates antiprotons to 2.5 MeV**

Medium Energy Beam Transport - MEBT



Klystron Gallery Normal Conducting RF

- **RFQ**
  - **1st klystron powers the RFQ structure.**
  - **800 kW, 402.5 MHz**
  - **E2V klystrons**
  - **The klystron can provide 2.5 MW so this klystron has excess power.**
- **DTL**
  - **6 Klystrons power the DTL**
  - **2.5 MW, 402.5 MHz**
  - **E2V klystrons**
  - **Circulator Loads use a Water – Glycol mix.**

Klystron Gallery Normal Conducting RF

- **CCL**
  - **4 Klystrons power the CCL cavities**
  - **5 MW, 805 MHz Thales Klystrons**
  - **Output window is gas insulated with SF6.**
  - **Circulator is gas insulated with SF6**
  - **Circulator load is conventional water load.**

Drift Tube Linac and Coupled Cavity Linac
Los Alamos National Lab

The 402.5 MHz DTL is composed of six sections.

The 805 MHz CCL is composed of four sections.

Klystron Gallery Superconducting Cavity RF

- **SCL RF**
  - **81 Klystrons each powering a separate cavity**
  - **550 kW @ 75 kV**
  - **805 MHz**
  - **CPI and Thales**

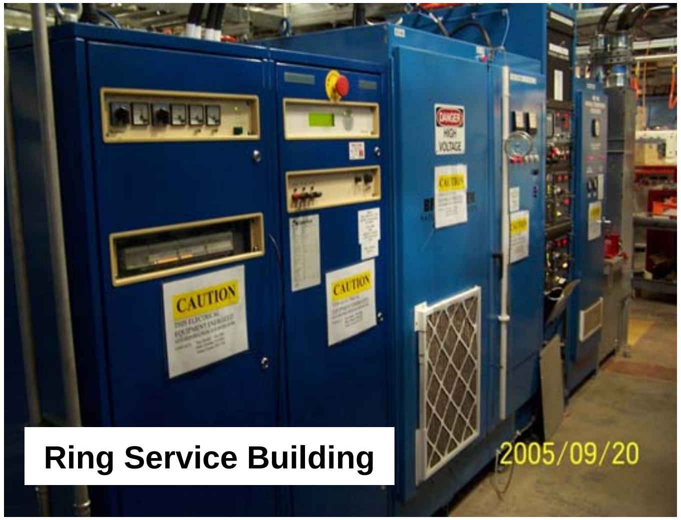
Superconducting Linac
Jefferson Lab

- **First and highest energy superconducting proton linac in the world**
- **23 cryomodules**
  - **11 medium-beta**
  - **12 high-beta**
- **33 medium-beta cavities**
- **48 high-beta cavities**
- **One klystron per cavity**

Accumulator Ring RF

- **Ring RF**
  - **4 Bunching Cavity/Amplifier stations**
    - **Ferrite loaded (Phillips 4M2)**
    - **Cavity Bias provides dynamic tuning**
    - **Beam pipe and outer housing used for bias.**
  - **2 bunching gaps per cavity**
  - **3 Buncher Cavities operate at the revolution frequency 1.05 MHz**
    - **Maintain a gap to allow the extraction kickers adequate time to reach full field.**
  - **1 Cavity operates at the 2nd harmonic 2.1 MHz**
    - **Reduce the peak beam current to minimize the possibility of exciting instabilities.**
  - **All cavities and amplifiers are the same.**
    - **Resonating capacity reduced for the 2nd harmonic cavity allowing use of the same structure.**

Ring Tunnel



Ring Service Building

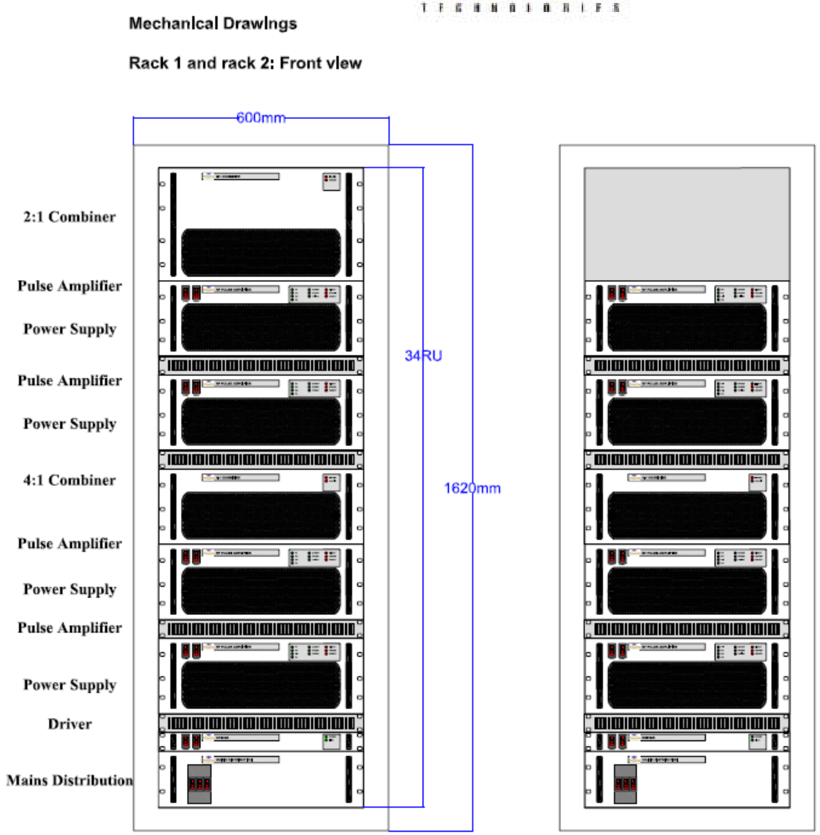
Present RF Systems Team Direction

- **Without the Ion Source all the hardware I just showed you is useless.**
  - **RF Group has always offered some support**
  - **We have made a commitment to fully support Ion Source**
- **Present RF Systems Group Ion Source Involvement**
  - **Ionizing RF Amplifier and component reliability issues (Chip Piller)**
  - **Replacement Amplifiers**
  - **Desire to operate the RF amplifiers at ground potential**
  - **Developing High Voltage isolation transformer (Mike McCarthy)**
  - **Assisting with antenna design (Sung Woo Lee)**
  - **Assisting with matching network design**

QEI Amplifier

- **QEI provides the entire system**
  - **Pulsed RF Source**
  - **Driver Amplifier**
  - **Power Amplifier**
- **We have 3 of these QEI amplifiers**
- **Worked fine during development and initial operation of SNS**
- **We will continue to use them**
- **Have caused much downtime**
- **Chip Piller will offer a discussion**

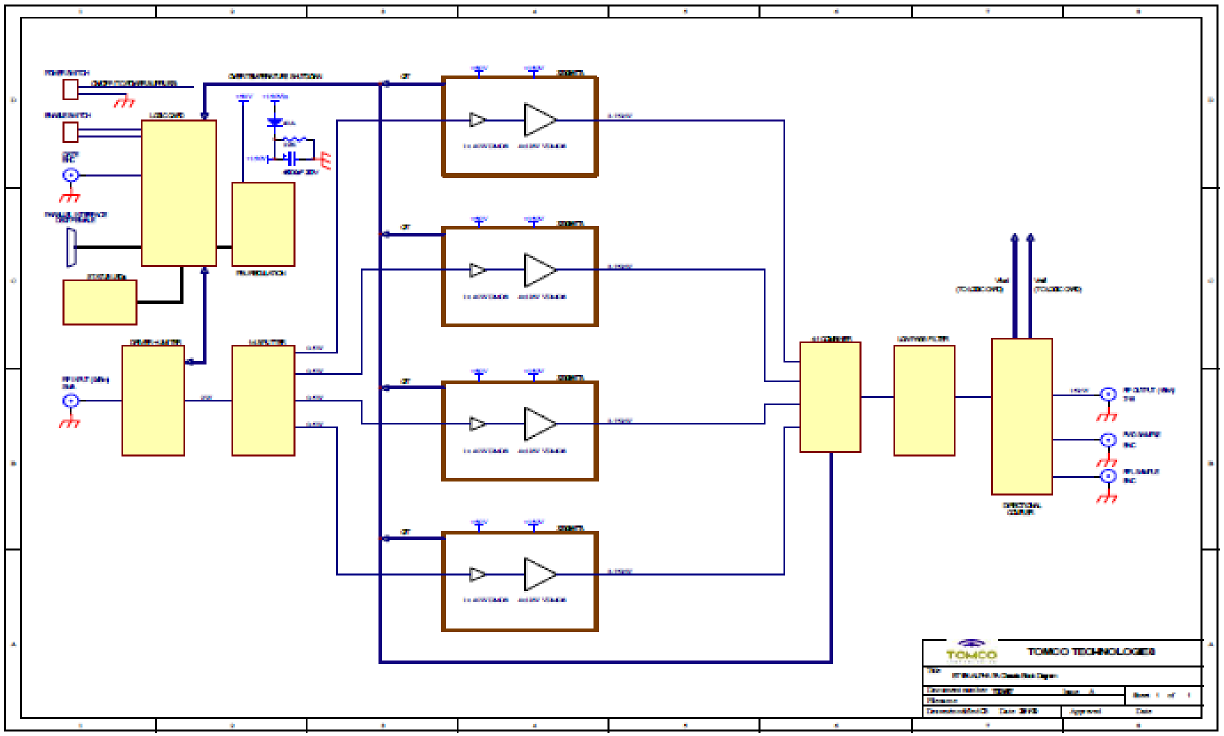
Tomco Solid State Amplifier



- **Two independent racks providing 60 kW each**
- **A 60 kW rack will fit inside the Big Blue Box**
- **We prefer to operate the amplifier at ground potential**
- **We are developing a High Voltage Isolation transformer**
- **We have 2 on order**

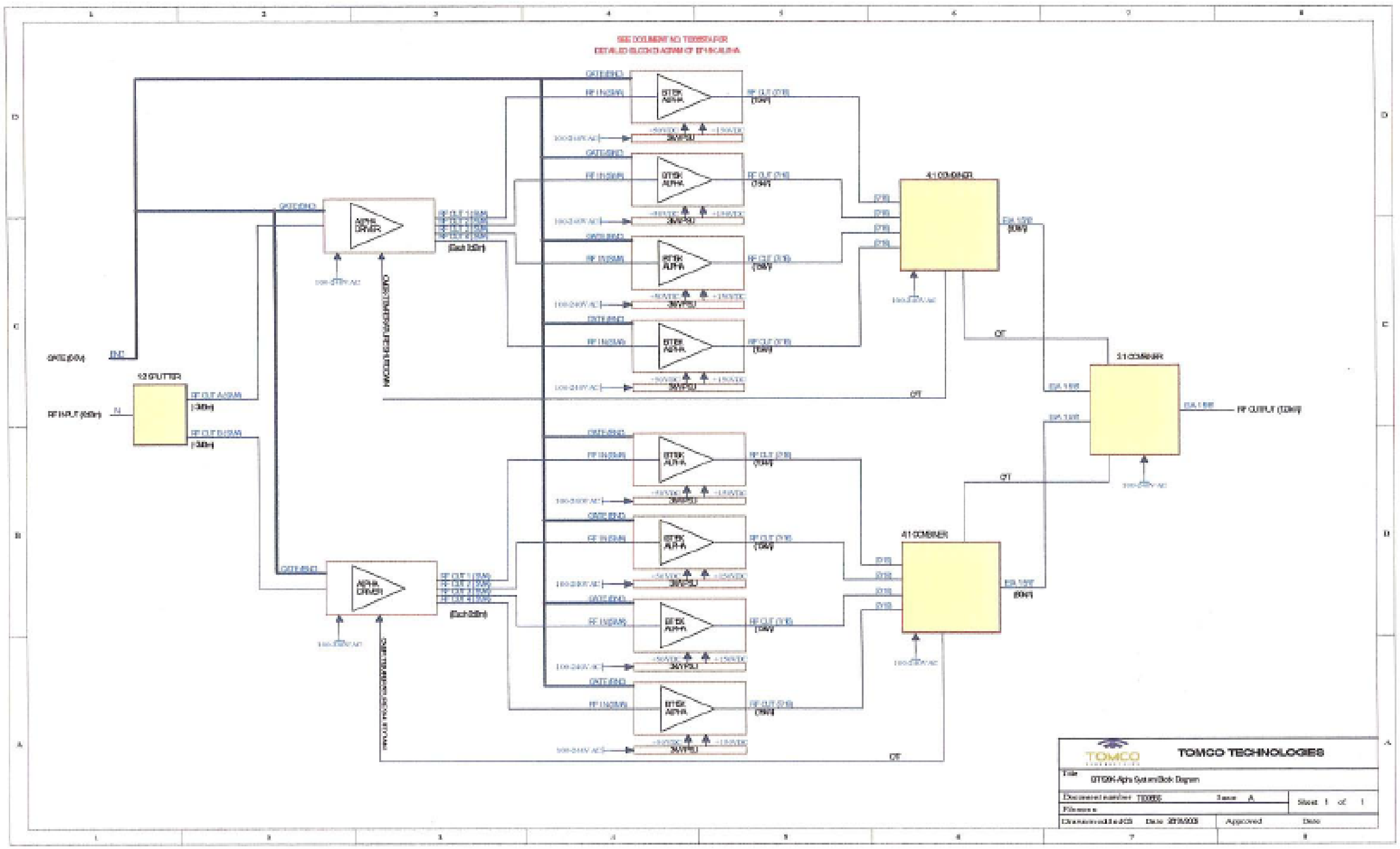
Block Diagram of Tomco 60 kW Rack

BT15K Amplifier Block Diagram T003557



Block Diagram of 15 kW module

BT120K System Block Diagram (T003556A)



Topics for Discussion

I conclude with a list of Topics for Discussion

- **What RF Frequency to use**
- **Antenna Issues**
- **How do we protect the solid state amplifier**
  - **Vacuum tube amplifier is forgiving**
  - **Have had failures possibly related to the floating 65 kV deck**
  - **We have a 13 MHz solid state amplifier that works well at 65 kV**
  - **We chose to tune the primary of our isolation transformer**
    - **This may give us added immunity to transients**
- **The Ionizing RF System is more than an amplifier.**
  - **How do we generate a pulsed RF signal for the amplifier input**
  - **We would like to operate with a feedback LLRF system to regulate the amplitude**
- **Should we work on operating the 13 MHz System at Ground Potential**