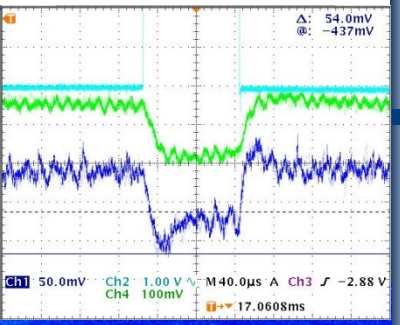
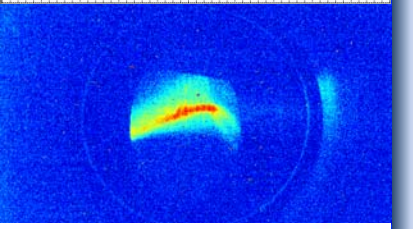
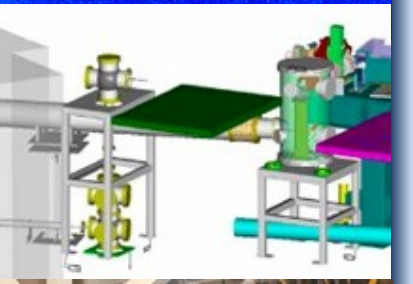
The Cockcroft Institute
of Accelerator Science and Technology







Science & Technology Facilities Council
Daresbury Laboratory

UNIVERSITY OF LIVERPOOL

ALICE Commissioning Results Update

David Holder

The Cockcroft Institute
and the University of Liverpool Department of Physics.

25th February 2009

Outline

- Update on progress since October 2008:
  - Energy recovery;
  - Coherent terahertz radiation.
- Current status:
  - Ceramic processing;
  - FE from wafer.
- Future plans.

Reminder (the other ALICE….)

ERLP (Energy Recovery Linac Prototype)

- conceived as a prototype of an energy recovery-based 4th generation light source…

now called…

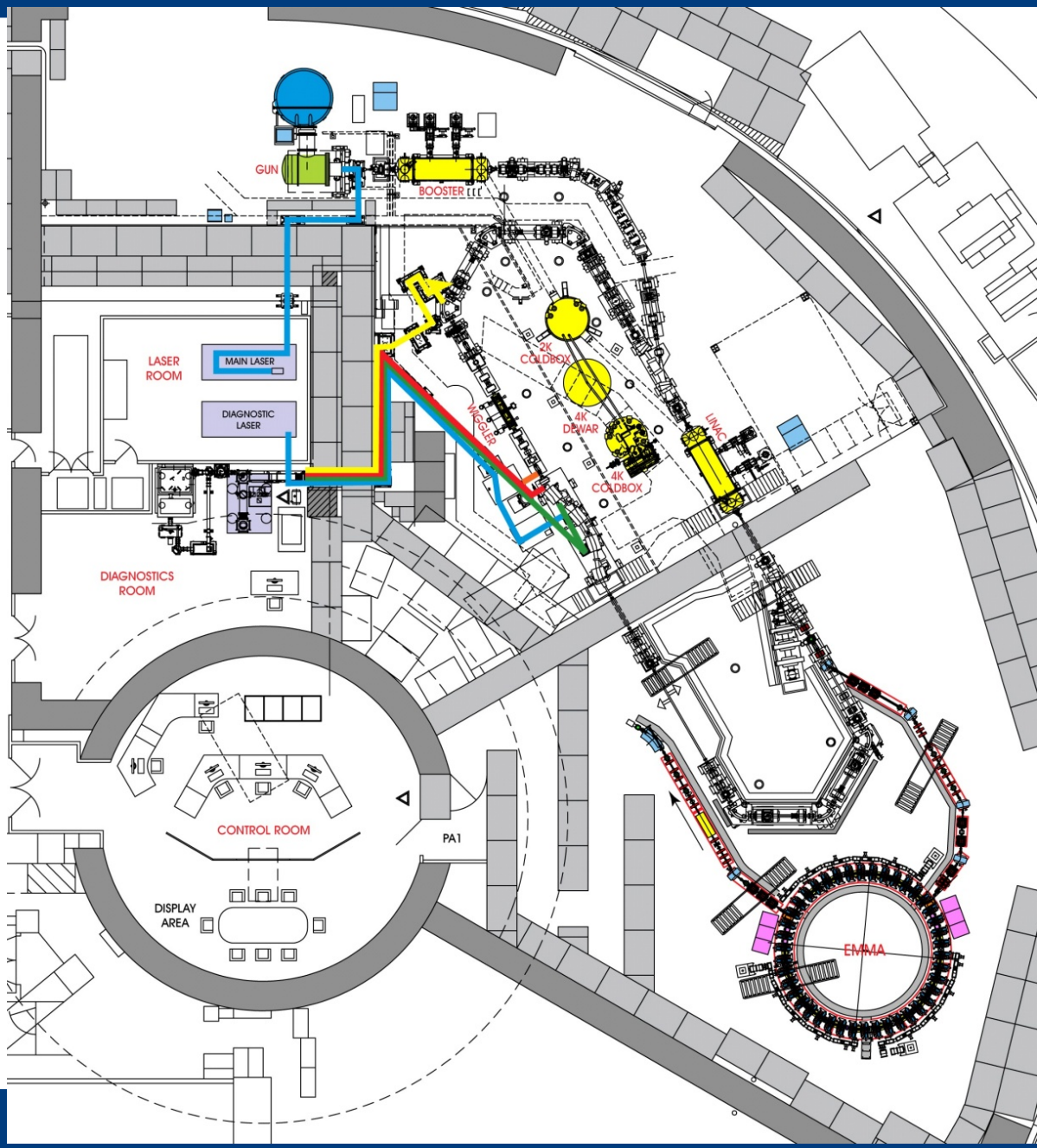
ALICE (Accelerators and Lasers In Combined Experiments)

- An R&D facility dedicated to accelerator science and technology development;
- Offering a unique combination of accelerator, laser and free-electron laser sources;
- Enables studies of photon beam combination techniques;
- Provides a suite of photon sources for scientific exploitation.

ALICE (& EMMA layout)

- **Nominal Gun Energy** **350 keV**
- **Injector Energy** **8.35 MeV**
- **Beam Energy** **35 MeV**
- **RF Frequency** **1.3 GHz**
- **Bunch Rep Rate** **81.25 MHz**
- **Nom Bunch Charge** **80 pC**
- **Average Current** **6.5 mA**

(over the 100 μs bunch train)

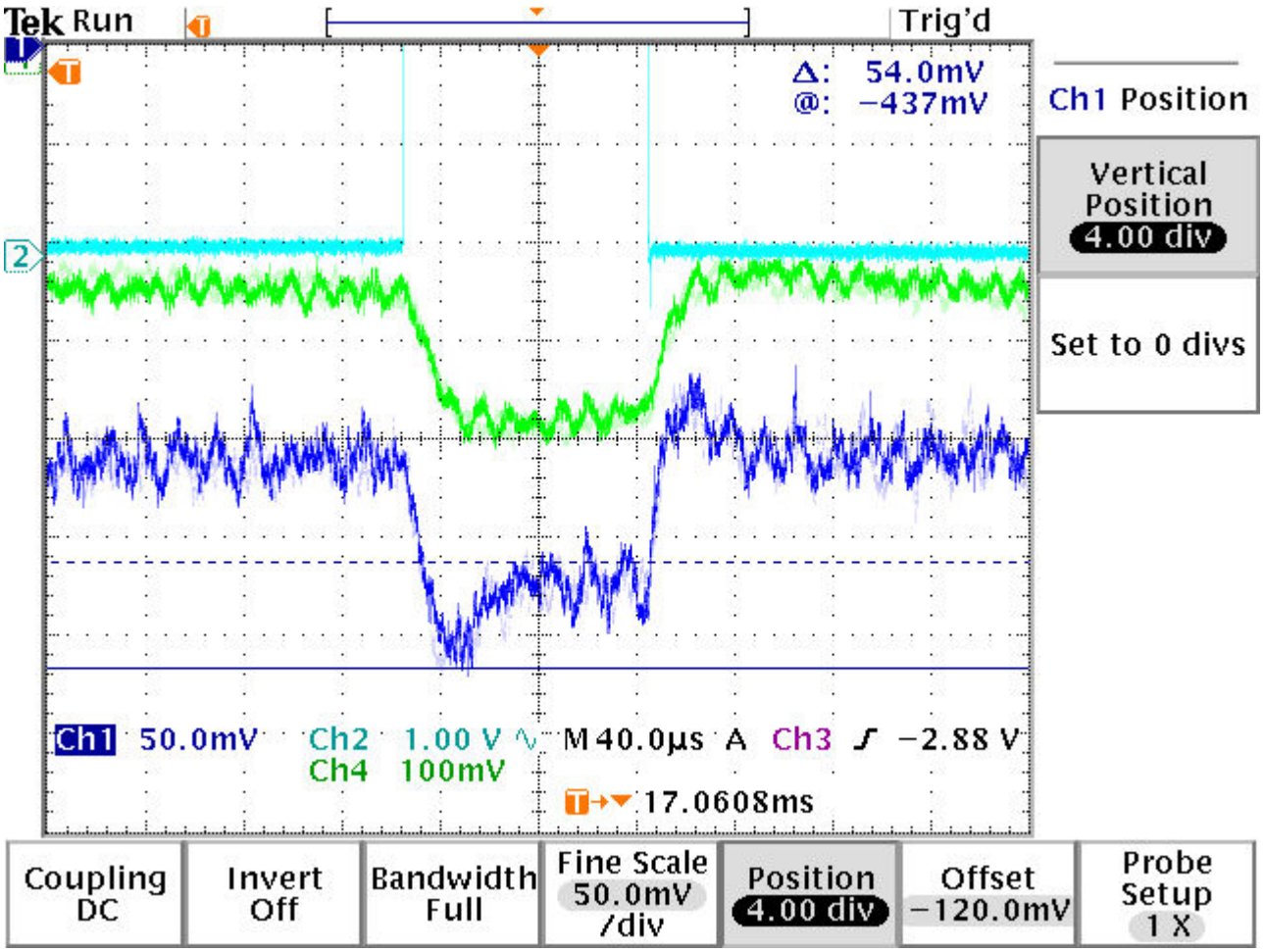


Energy recovery demonstrated

- 20th December 2008:
  - Gun voltage 230 kV (c.f. 350 kV nominal – limited by Stanford ceramic);
  - Injector energy 4.8 MeV (correct ratio to full energy must be maintained);
  - Full energy 20.8 MeV (limited by SCRF cavity performance);
  - 100 μs train length;
  - 5 pC bunch charge

Energy recovery demonstrated

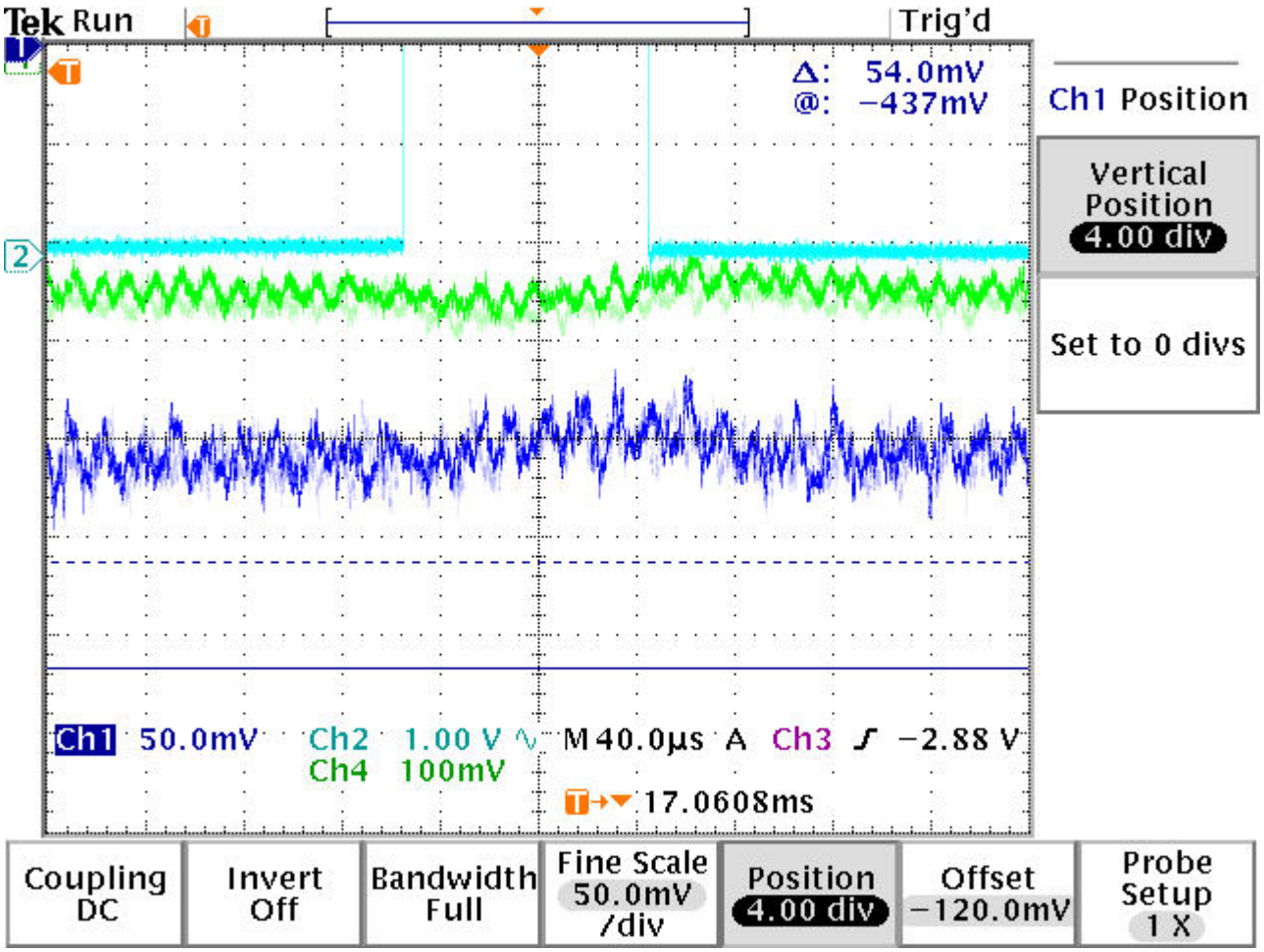
Linac cavity 1 and 2 gradient demand:



Pop-in dump in straight 4 inter-cepting the beam before re-entering the linac

Energy recovery demonstrated

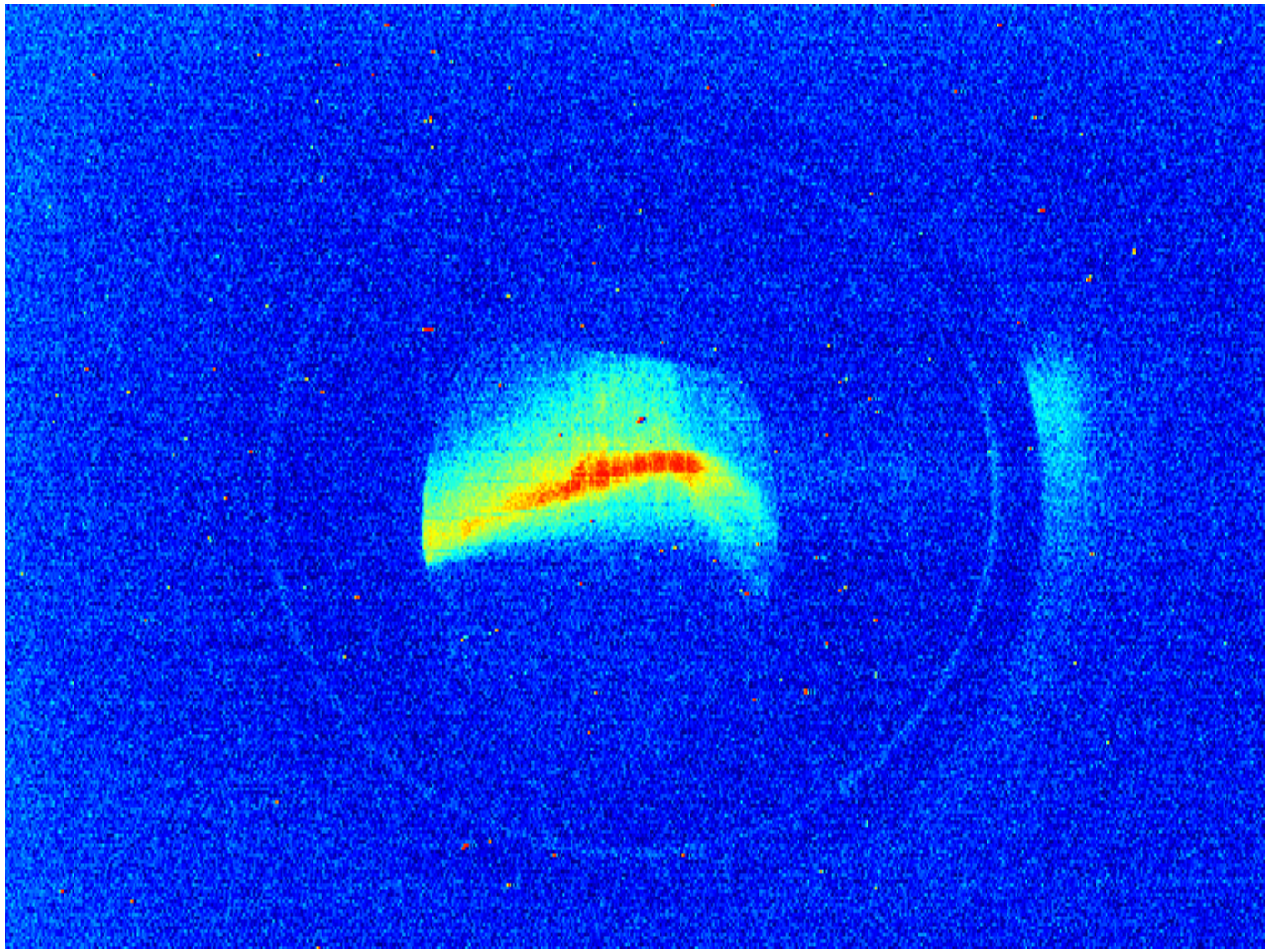
Linac cavity 1 and 2 gradient demand:



Pop-in dump in straight 4 removed -beam re-enters linac

- energy recovery

Image of energy-recovered beam at dump



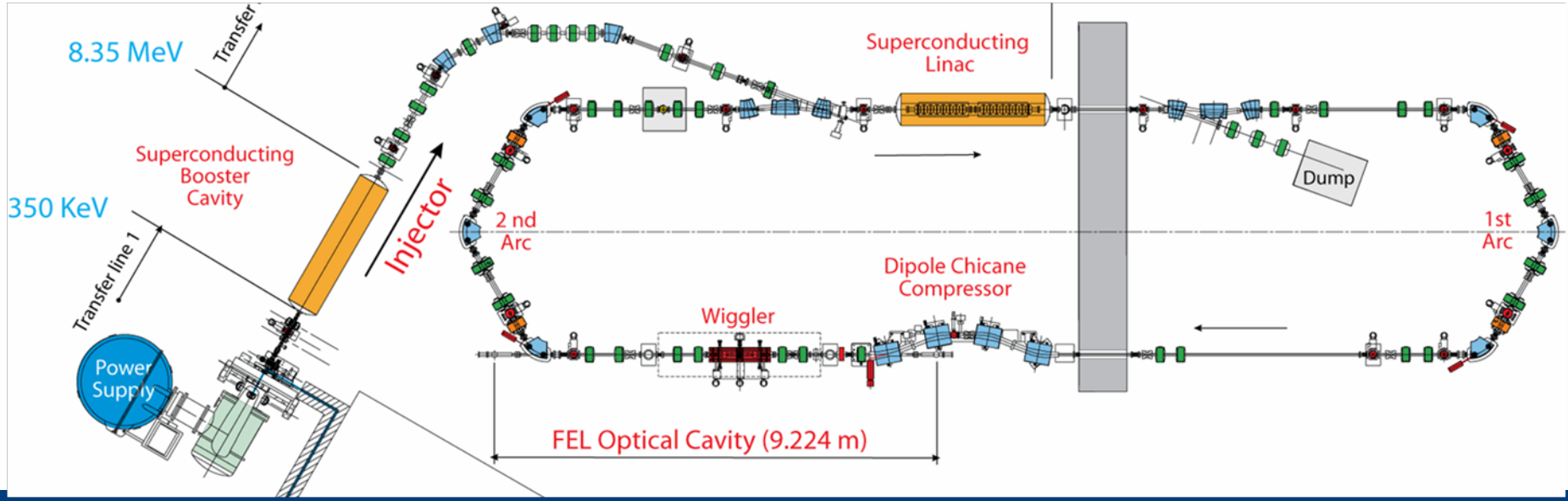
Energy recovery now routine

Energy recovery is now the normal mode of operation, to minimise uncontrolled beam losses.

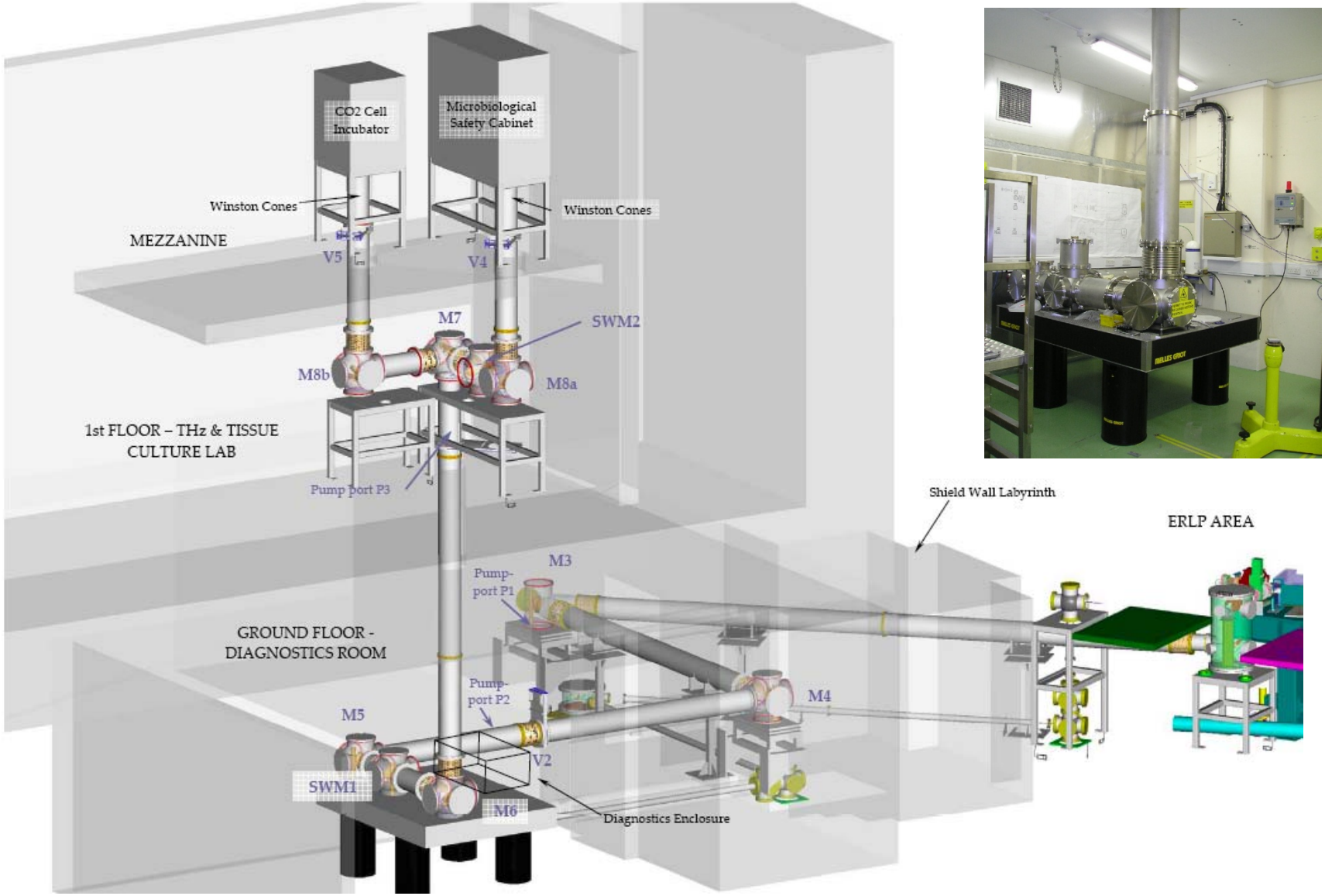
- Gun voltage 200-230 kV/ 4.8 MeV/ 20.8 MeV;
- Next step – longitudinal bunch compression – to produce short bunches and terahertz radiation.

Longitudinal Bunch Compression

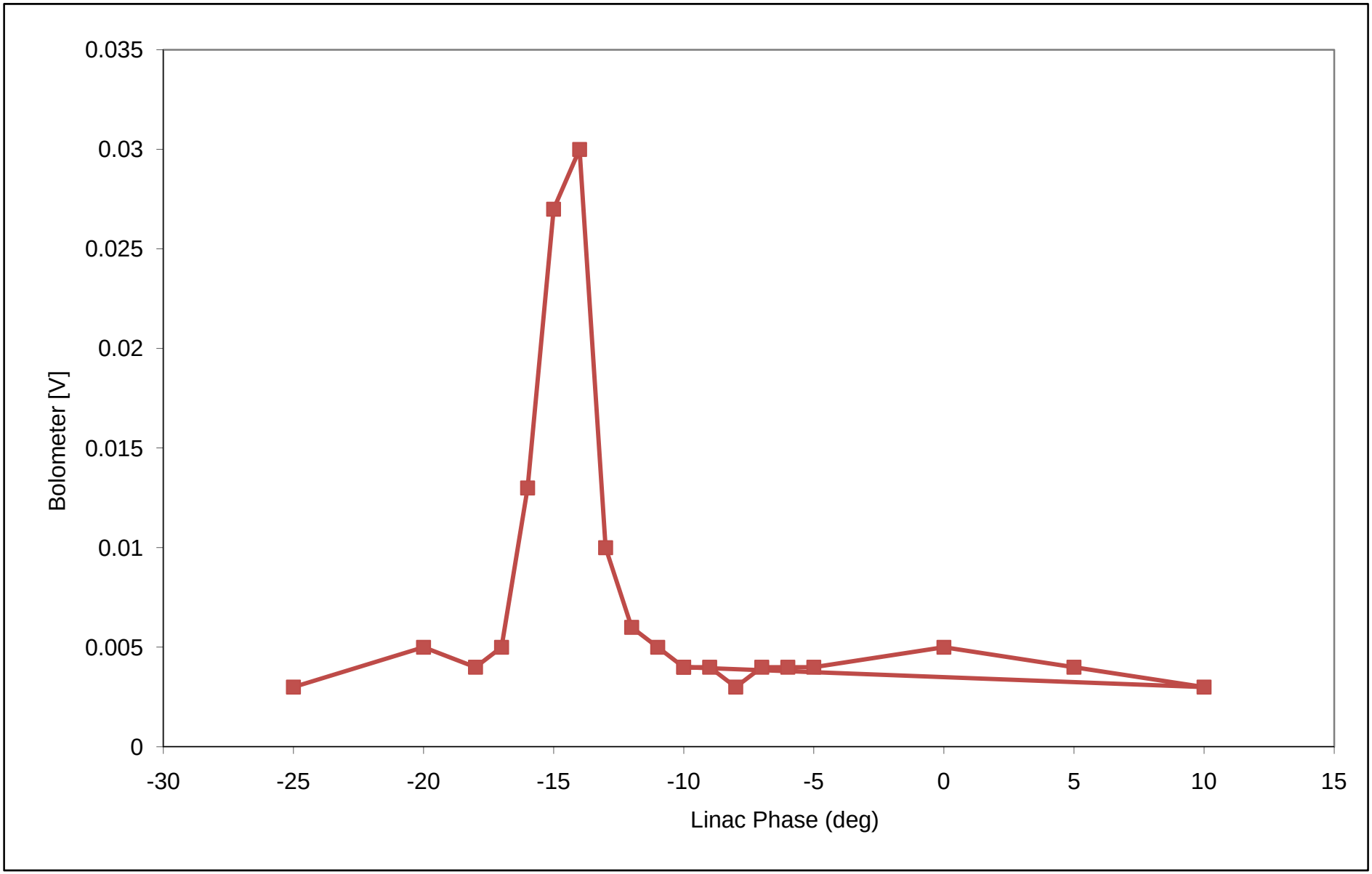
- Both linac cavities operated at about 10 degrees off-crest (energy chirp);
- Outward arc (arc 1) set for $R_{56} = 0$;
- Bunch compression chicane $R_{56} \cong 25$ cm;
- Return arc (arc 2) set for $R_{56} \cong -25$ cm.



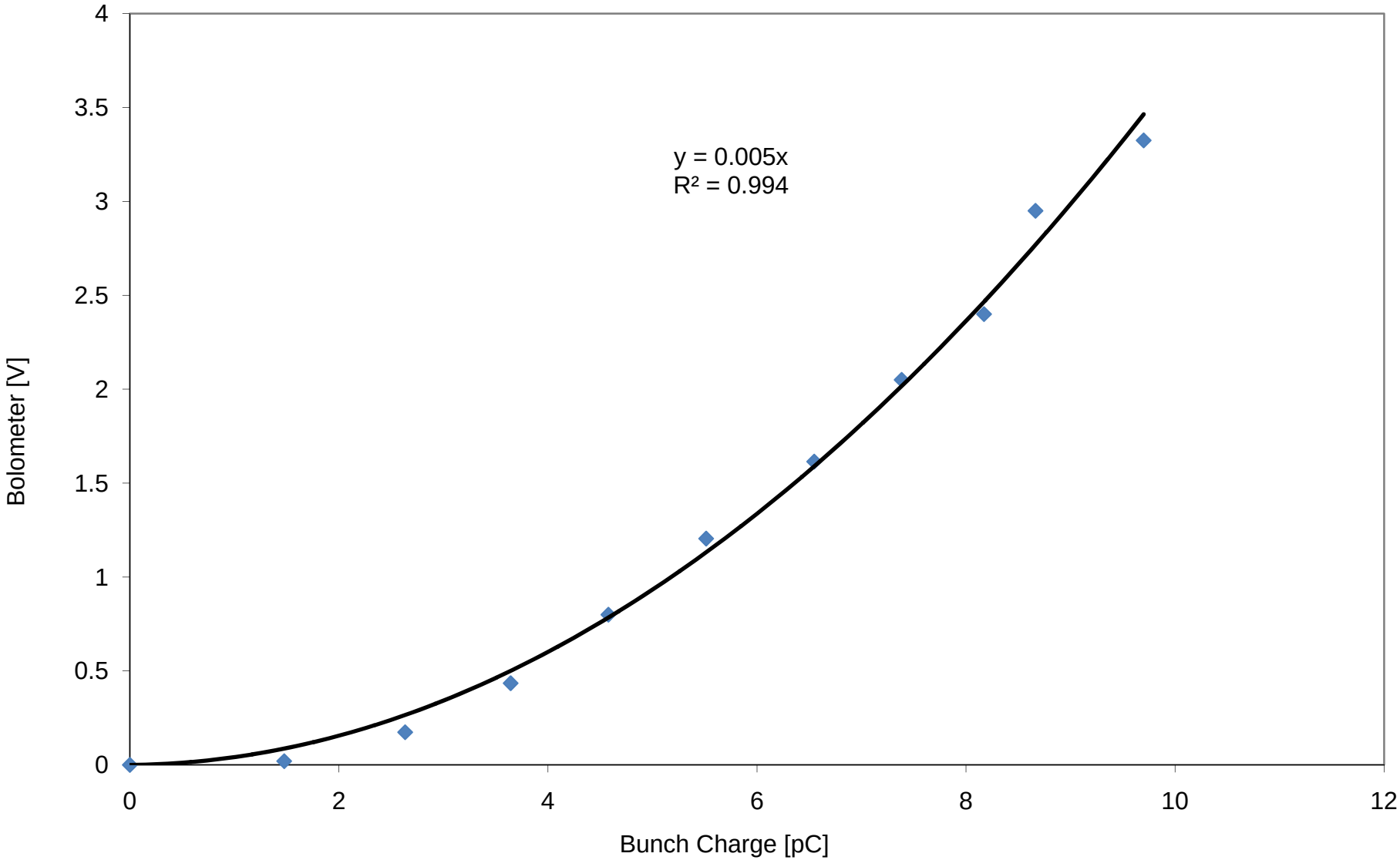
Terahertz beamline



Bolometer Signal vs Linac Phase

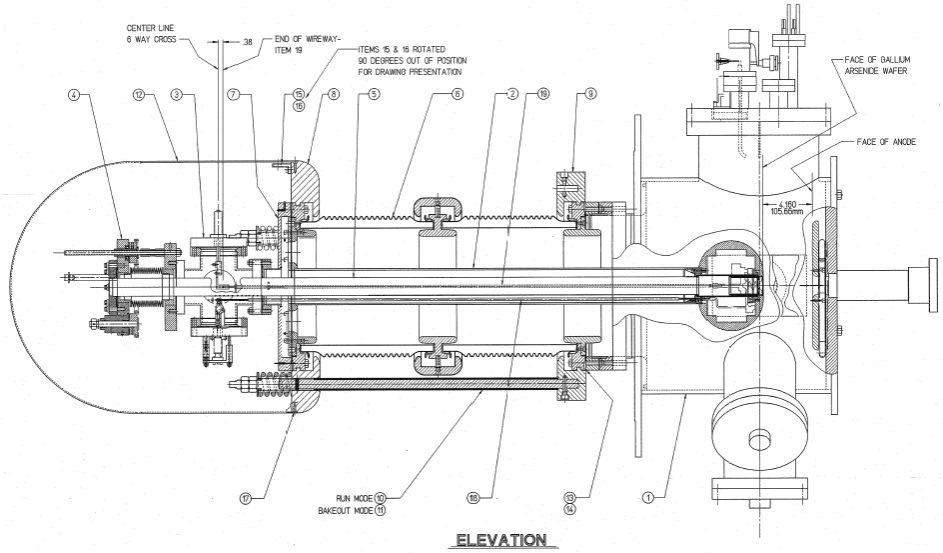


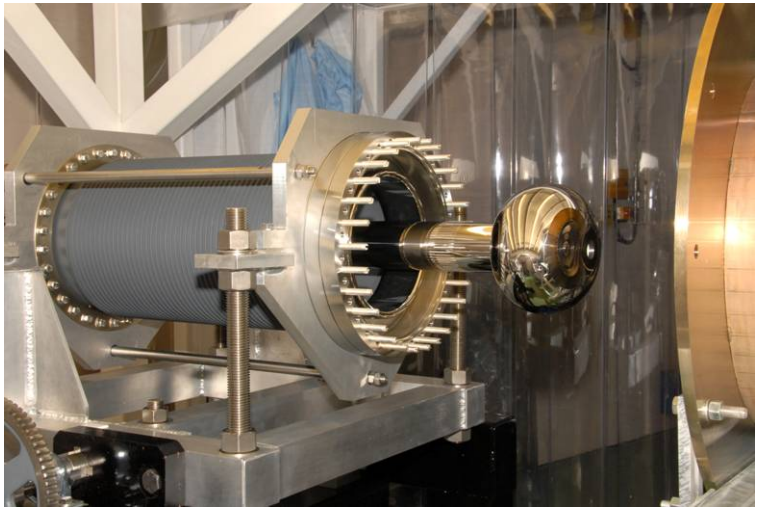
Bolometer Signal vs Bunch Charge



Current status

- HV processing issues:
  - Large HV psu current being drawn, even at 230 kV;
  - Operation briefly restricted to 200kV;
  - HV conditioning with krypton to remove field emitters from ceramic or cathode ball.
- Still a field emitter in the centre of the cathode wafer.





Current status

- Still a field emitter in the centre of the cathode wafer:
  - Do not want to risk further cathode damage by trying to process it away;
  - Do not want to risk cathode change with full gun bake cycle (previously problematical).
- Can however operate at 230 kV with the following provisos:
  - Use off-centre laser spot;
  - Separates the photo-emitted beam from FE beam (but both still accelerated by the booster);
  - Different solenoid focussing settings for photo-emitted beam and FE lead to further separation;
- Emittance at 230 kV/80 pC ~ 23 µm;
- Shutdown (5-6 week) underway for installation of CBS/EMMA components.

Thanks…