



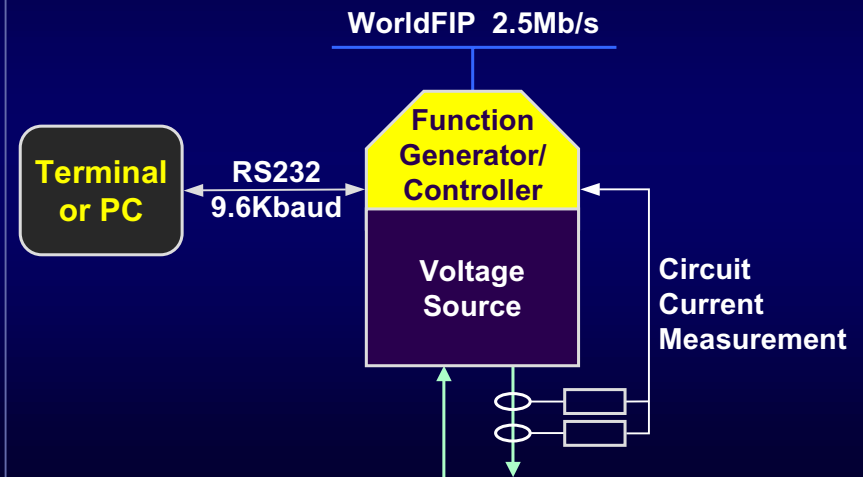
Power Converter Controls for String 2 Phase 1



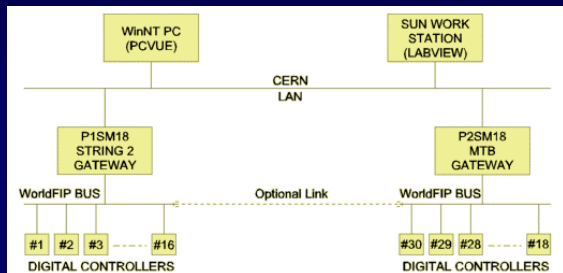
- u Overview
 - u Function Generator Controller (FGC)
 - What worked
 - What were the problems
 - u Gateway
 - What worked
 - What were the problems
 - u PCvue Supervision Application
 - What worked
 - What were the problems
 - u Conclusion
- Dipole current ramp results



Overview of a Power Converter



SM18 Power Converter Fieldbuses and Gateways



- u Two Power Converter fieldbuses: String 2 & MTB
 - u One gateway per network
 - u PCvue on WinNT PC for String2 supervision
 - u Labview on Sun workstation for MTB supervision



Function Generator Controller What worked?



- Control of power converter state machine
 - Fault_off, Off, Starting, Standby, Idle, ...
- Interaction with Interlocks
 - Inputs: Power Permit, Slow Power Abort, Fast Power Abort.
 - Output: Circuit Fault
- Time and data distribution over WorldFIP fieldbus
- Control of current
 - No tracking errors, overshoot/undershoot
 - Even at very low current in 1-Quadrant converter!



Function Generator Controller

What were the problems?



System lock ups and other strange behavior

Fortunately rare: < 10 occasions during 2001 for 20 systems in String and MTB (up time record = 4 months)

DC offset due to floating point errors

2 ppm at 11 kA

Fixed in November 2001

Commissioning new circuits is a slow process

No automatic circuit identification

All current loop parameters (7) set individually



Gateway

What worked?



Command-response via TCP

Status publication via UDP

At 0.1 Hz to Cryo PLC

At 4 Hz to PCvue

At 1 Hz to mccsmon (HPux monitoring app)

At up to 100 Hz to mccslog (HPux logging app)

HPux diagnostic applications

mccsrun – control interface

mccsmon – monitoring interface

mccsrtm – remote terminal interface

mccslog – logging application



Gateway

What worked?



Synchronous control of power converters (for tracking tests)

Password protection

Command logging



Gateway

What were the problems?



Prototype Gateway written by part-time consultant

Very basic functionality – fragile and immature

Taken over by fellow (Stephen Page) in October and tidied up and reinforced.

Slow WorldFIP interface driver couldn't handle 16 FGCs – caused several gateway crashes

More efficient driver provided by Pedro

Connections not cleaned up if clients died

Inactivity timeout added by Stephen Page



PCvue Supervision What worked?



Independent control and supervision of main circuits.

Control of power converter state (Off, Standby, Idle)

Current ramps using PELP functions

Power converter status subscription

4 Hz updates received directly from Gateway

Currents displayed on scrolling trend window.



PCvue Supervision What were the problems?



PCvue scripting language inadequate for the task

No arrays

Very limited choice of data types (bit operations almost impossible)

Hard to maintain compared to a conventional program

PELP parameters muddled

Programming errors corrected by Vivek

Floating point current values rounded to 4 significant figures

10A steps above 10kA – no wonder the current read 11850.00A at flat top when the DG was watching!

Bug in DLL used in PCvue fixed by BARC team



PCvue Supervision What were the problems?



Connection to Gateway lost after changing windows a few times

Traced to PCvue script bug:

```
Function Disconnect()
```

```
{  
  connected_flag = FALSE
```

```
  if ( connected_flag == TRUE ) DisconnectGateway()  
}
```

If Gateway rebooted, PCvue interface had to be restarted to reconnect

Takes ten minutes and sometimes fails on first attempt

Reconnect button added



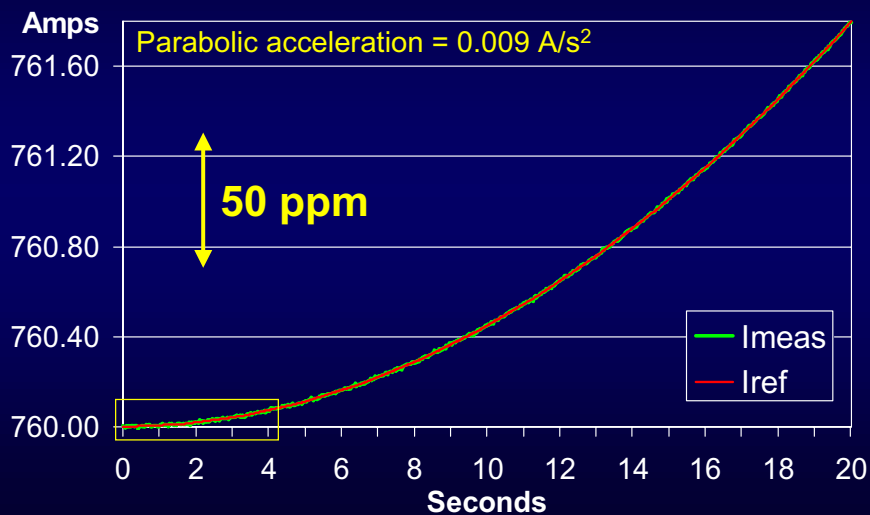
Conclusions



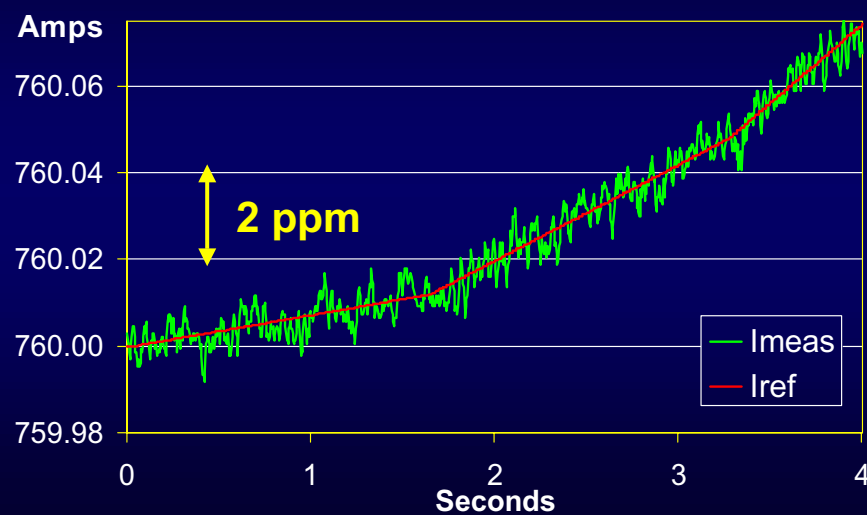
- ✓ High Precision digital regulation of current
- ✓ WorldFIP fieldbus – very reliable
- ✓ Local and remote terminal facilities
- ✗ Fragile prototype gateway
- ✗ PCvue for power converter supervision



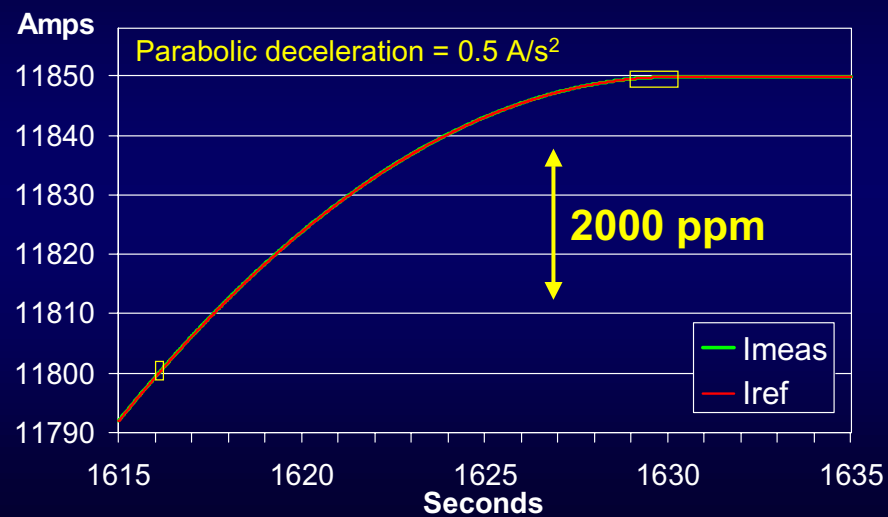
LHC dipole circuit ramp (0-20s)



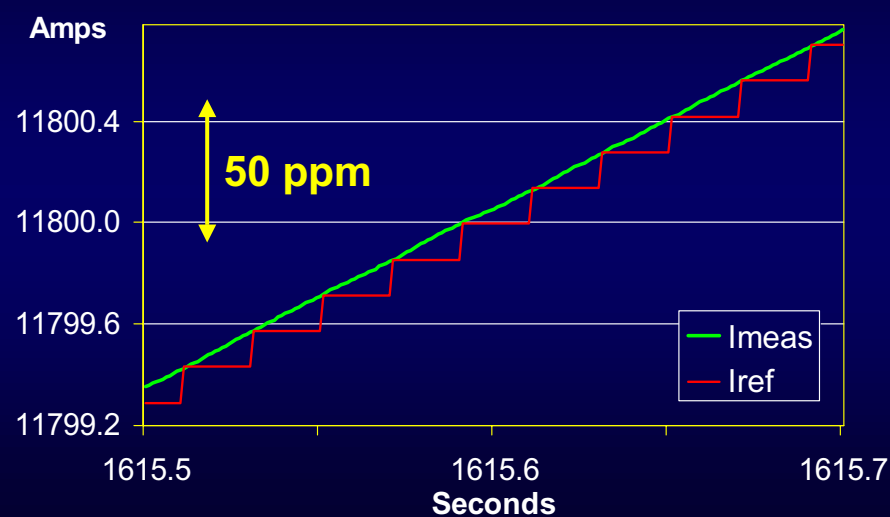
LHC dipole circuit ramp (0-4s)



LHC dipole circuit ramp (last 15s)

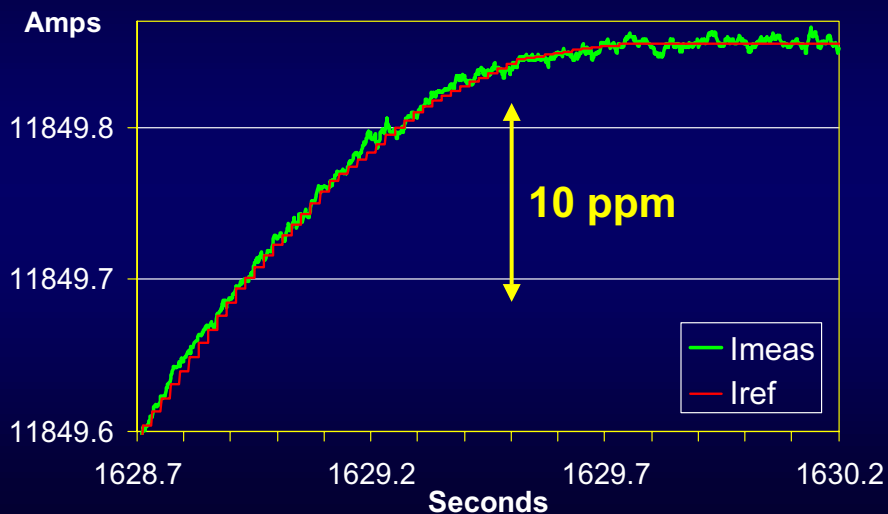


LHC dipole circuit ramp (200ms)

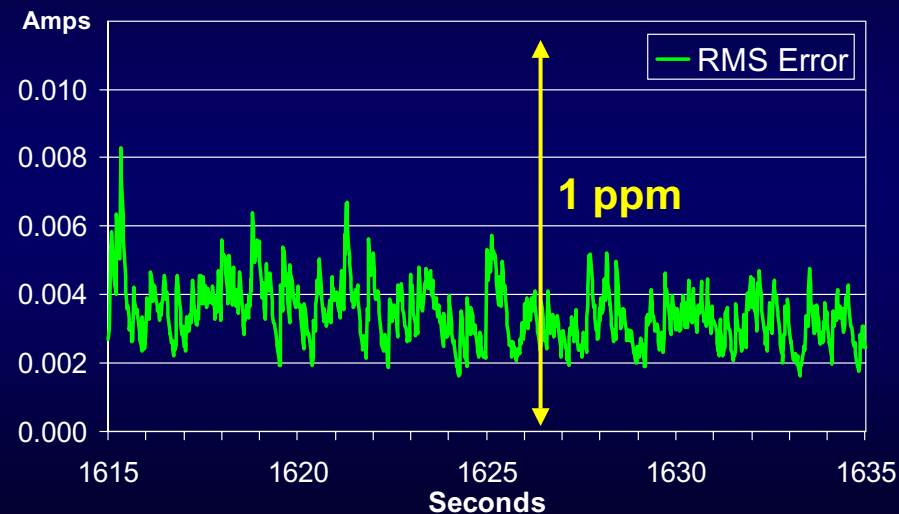




LHC dipole circuit ramp (last 1s)



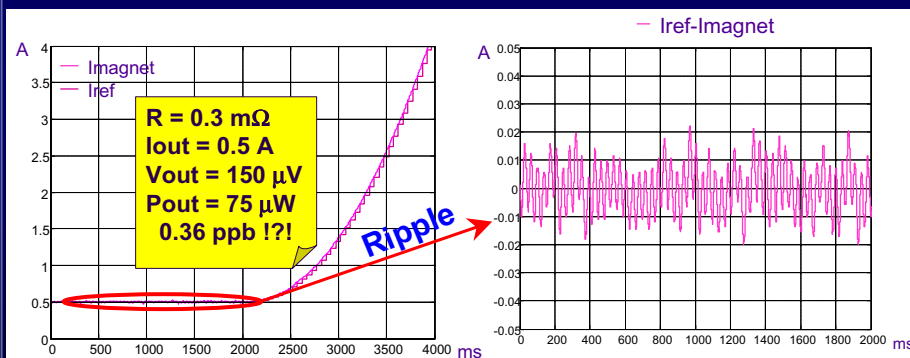
Control Algorithm RMS Error (last 15s)



Low Current Test with 1-Quadrant Converter



13kA 16V converter with 4 out of 5 sub-converters enabled (208 kW)



Thanks to...



- u John Pett and CERN SL/PO/CC hardware team for building the FGCs
- u Hughes Thiesen, Freddy Bordry & Patrick Sabouret for the RST current control algorithm
- u John Brazier (Brazier Consultants Ltd) and Stephen Page for the prototype Gateway software
- u SL/CO/FE for Gateway support (especially Alastair Bland)
- u BARC team for suffering the PCvue environment.