2005 International Linear Collider Physics and Detector Workshop
and Second ILC Accelerator Workshop
Snowmass, Colorado, August 14-27, 2005

ILC WG4
Beam Delivery

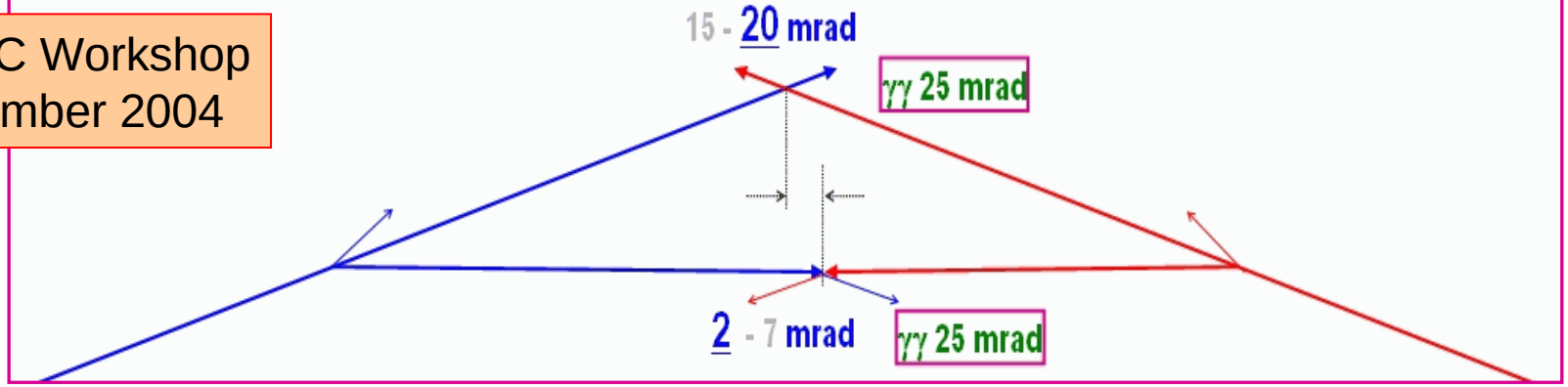
Conveners: Grahame Blair, Tomo Sanuki, Andrei Seryi

Some points of discussion
- Upgradeability to “Multi TeV option”
- Two detectors one IR or two detectors push pull on single IR ⇔ civil engineering
- Technology of FF quadrupoles
- Backgrounds for different crossing angles different beam parameter sets
- Technologies for head on collisions
- Detector backgrounds for different ILC parameter sets
- How to integrate diagnostics
- Beam dump design

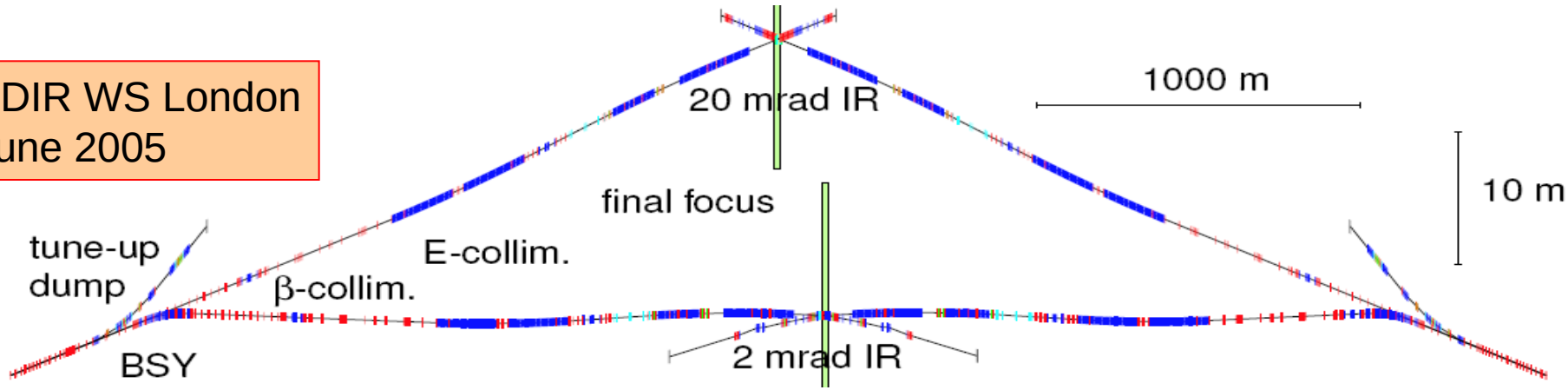
Recommendations from the WG4

Tentative, not frozen configuration, working hypotheses, "strawman"

1st ILC Workshop
November 2004



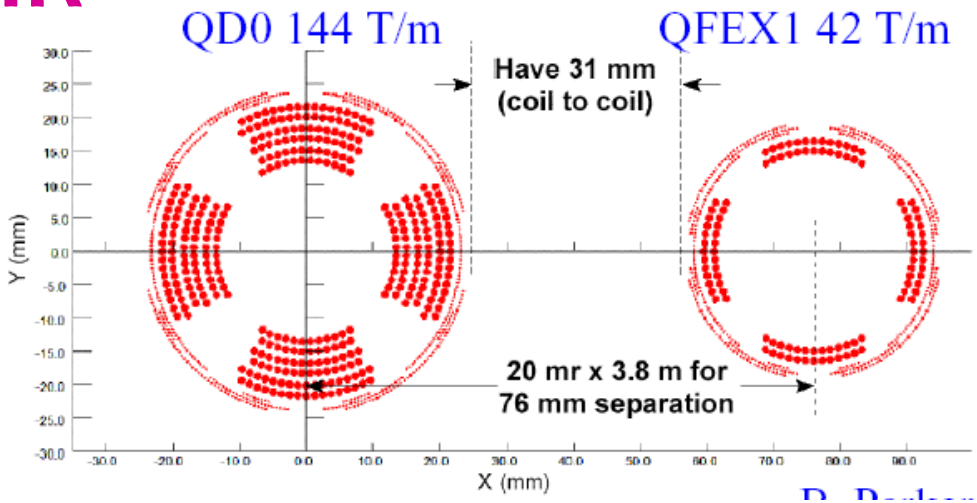
BDIR WS London
June 2005

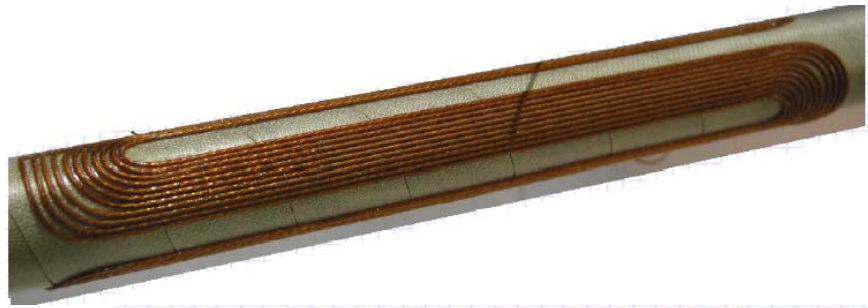


Strawman tentative configuration turns into real design:

Full optics for all beamlines; Mature 20mrad optics and magnets design; Several iteration of optics for 2mrad IR; Upstream and downstream diagnostics for both IRs

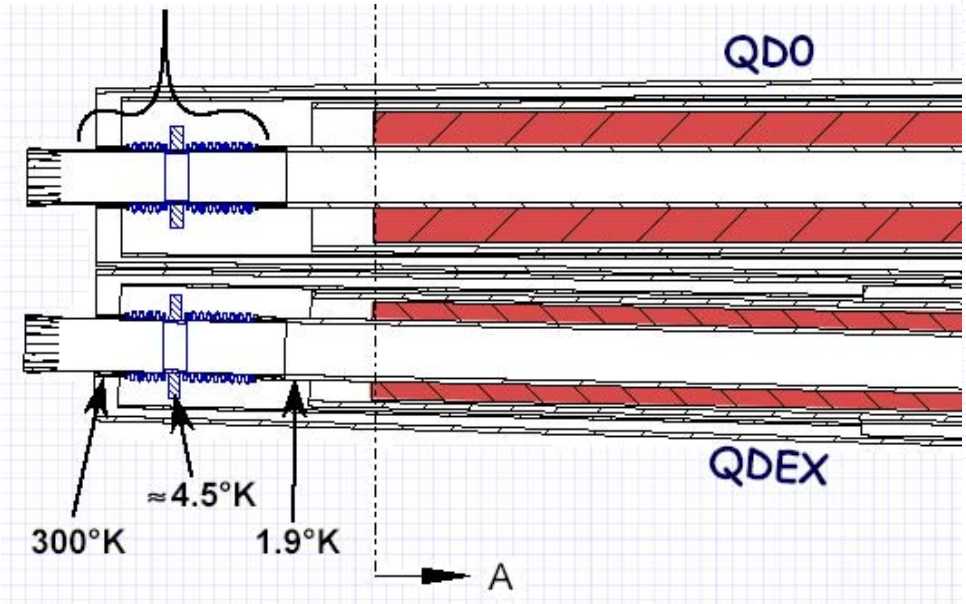
Compact S C Final Doublet for 20mrad IR

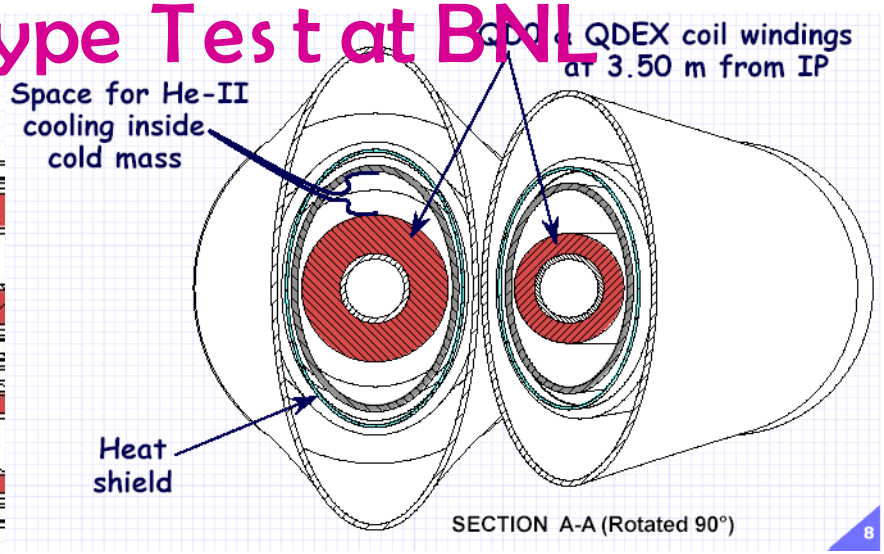




- Achievement in BNL direct wind technology allow to make even tighter bend radius => quad is more compact => allow to start the extraction quad at the same distance from IP as QD0

Compact QD0 Mechanical & Cryo-engineering and Prototype Test at BNL





380mm QD0 Test Prototype

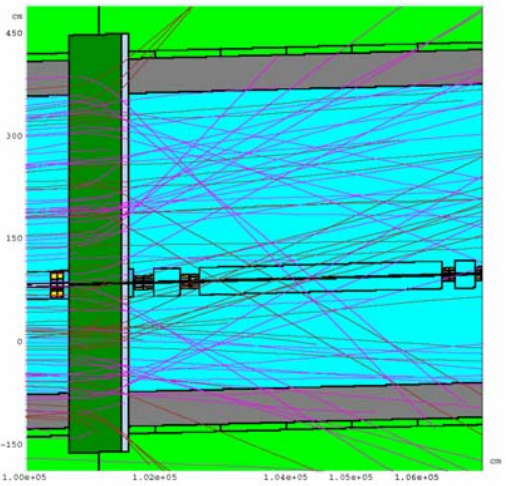
QT Quench Test Results

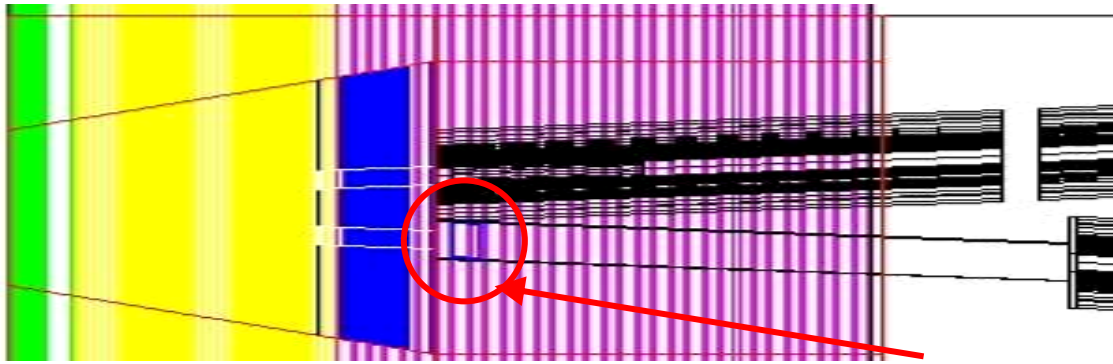
Background Solenoid (T)	Temp (°K)	Gradient (T/m)
3	4.30	158
4	4.22	139
5	4.22	134
6	3.00	137

Exceeded design goal !

goal: 140T/m with 3T background field while cooled with pressurized He-II at 1.9K

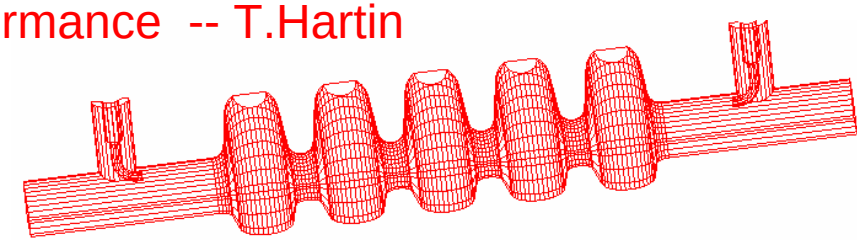
Detailed design & studies of performance



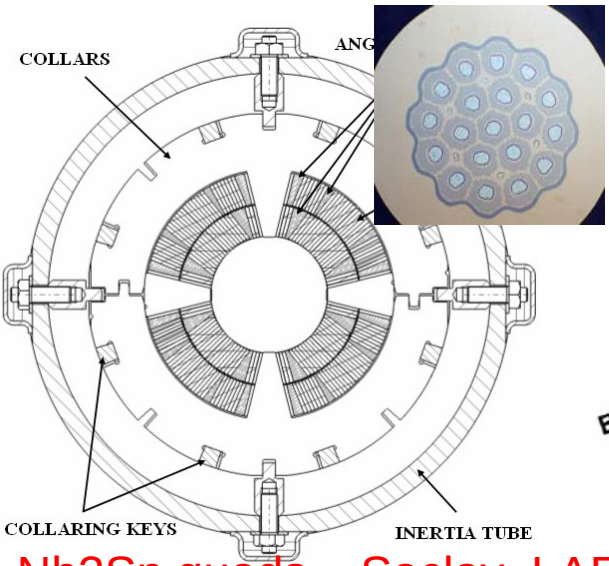


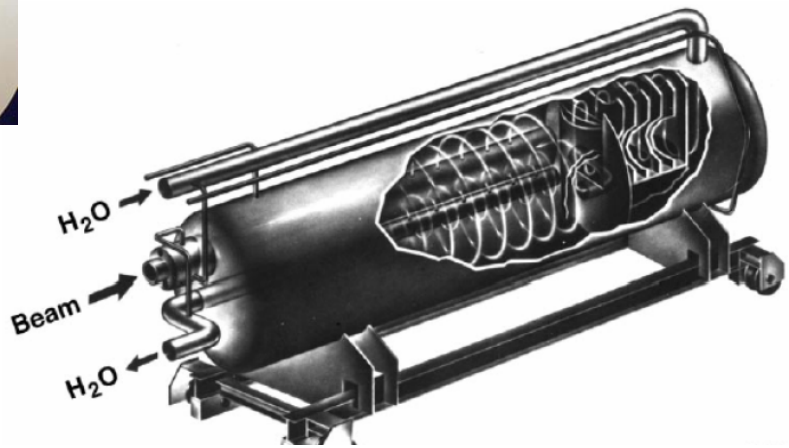
Evaluation of effects of pairs on feedback
BPM performance -- T.Hartin

Collimation, machine background –
UK, FNAL, SLAC, …

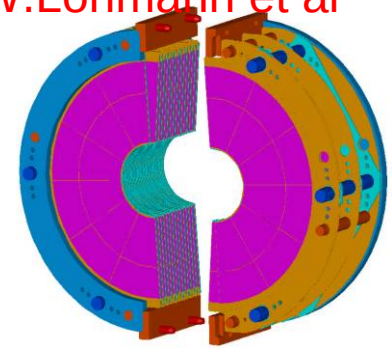


Crab cavity design consideration – UK, FNAL, …





Frwd.reg. design –
W.Lohmann et al



Nb3Sn quads – Saclay, LARP Beam dump design – D.Walz et al

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ILC GG2
Instrumentation and Controls

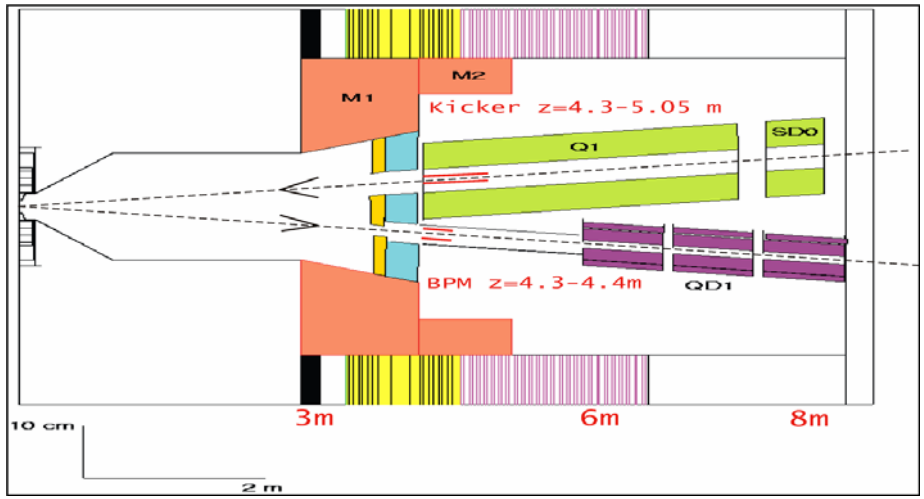
Conveners: Marc Ross, Junji Urakawa, Hans Braun

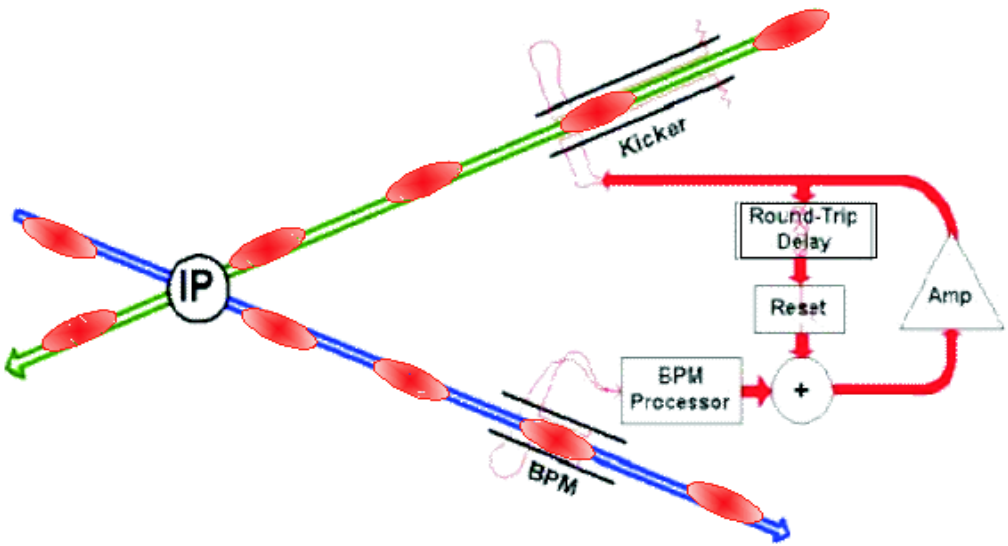
Some points of discussion

- Inventory of beam diagnostic needs
- Required BPM resolution
  $\Rightarrow$ point of interest: $\sigma/3$ requirement in most cases more stringent than requirements for emittance growth
- High resolution BPM's
- Specific requirements for BPM's in cryo modules
- HOM detection as diagnostic for cavity alignment
- Laser wire systems
- Intra train feedback
- Machine protection based on pilot bunch
- Measurement of long. Phase space and longitudinal/transverse correlations (Banana effect)
- Minimising MTBF (=Mean Time Before Failure) in control system components
- Needs to define standards for platforms and protocolls

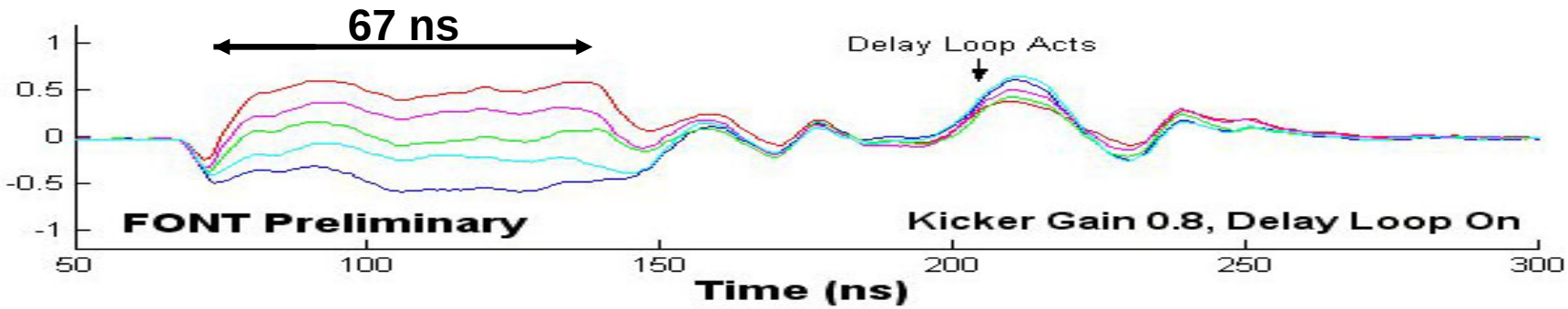
Critical Feedback/Feedforward Components

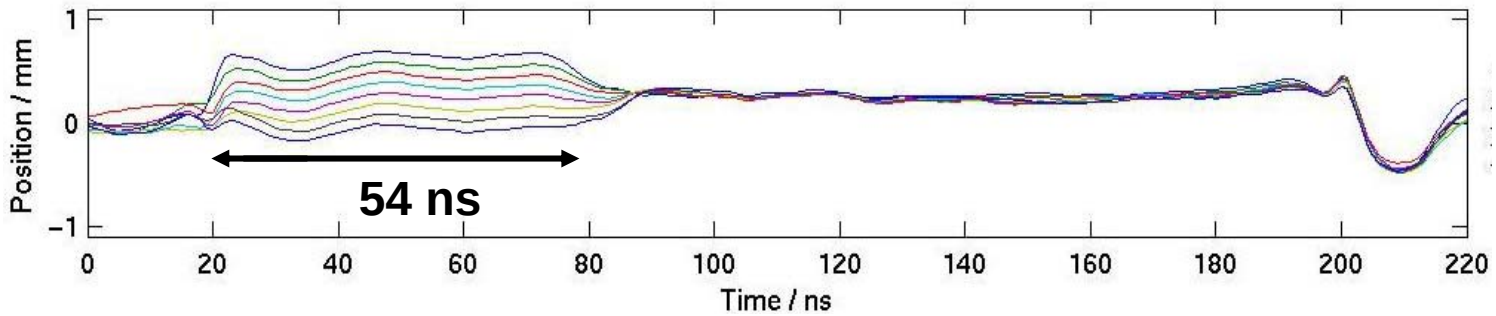
- **BPMs**
- **BPM signal processor**
- **Feedback processor**
- **Amplifie**
- **Kicker**
- **Intra-tra**
- **FB at II**

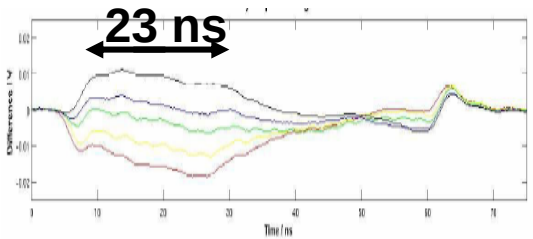




FONT1,2,3: Summary







Even fast enough for CLIC intra-train FB!

FONT4: Digital FB Processor Module (Dabiri Khah)

JTAG connector
JTAG circuit
RAM
Flash/ EEPROM
DAC
DAC
AOUT2
AOUT1
Serial connector
UART circuit
FPGA
ADC
ADC
ADC
ADC
Differential To single
Differential To single
Differential To single
Differential To single
AIN4
AIN3
AIN2
AIN1
USB connector
USB circuit
Clock circuit
5v
3.3v
2.5v
? v
Clk IN

Latency goal 100ns

43 is the Question
Re-entrant or Cavity BPMs?

Steve Smith for Global Group 2: Instrumentation & Controls

Linac & BDS BPM Requirements

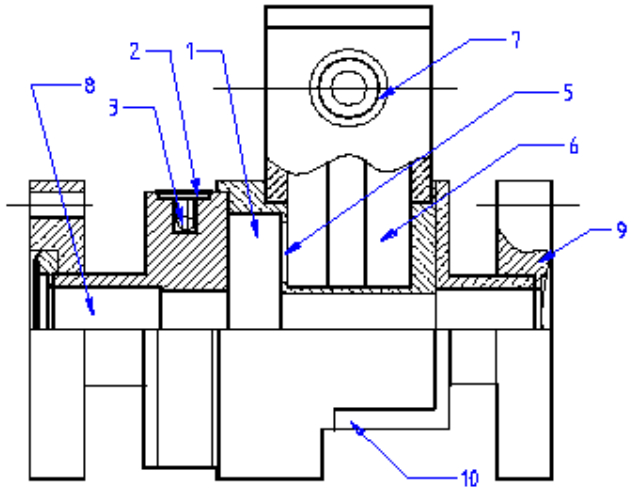
Parameter	Requirement	Comments
Quantity	800	linac
	500	BDS
Resolution	0.5 micron	linac
	σ/10 ~100 nm	BDS
Stability	<10 microns	long term
	< 1 micron	Spectrometer
Temporal resolution	bunch-by-bunch	many places, assume all

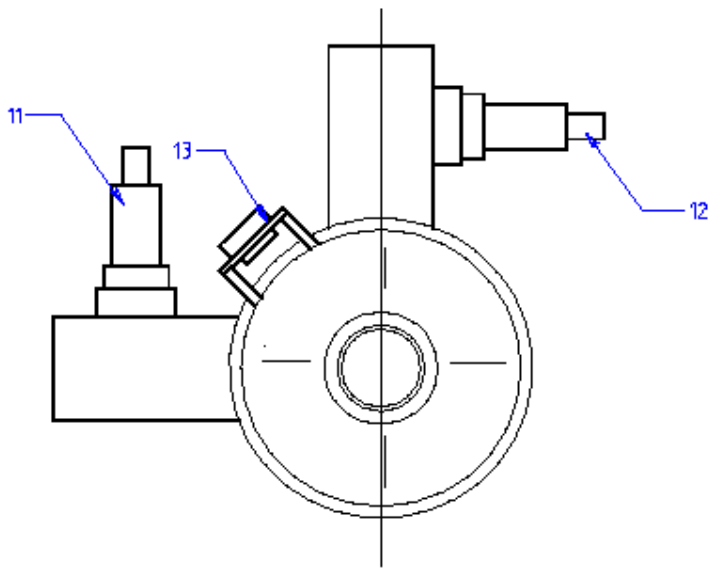
C-Band Cavities

BINP Cavities (Vogel, *et al.*)

~ 2cm aperture

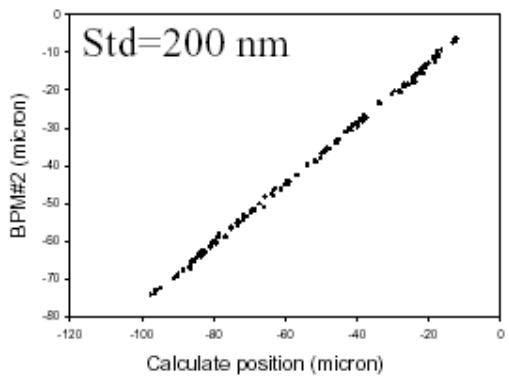
Dipole-mode selective couplers





Cross-sectional view of BINP cavity BPM 6426 MHz, (5p. in KEK ATF + 1p.). 2000.

1.- Cavity sensor .
2- Heater.
3 – Temperature sensor.
5 – Coupling slot.
6 – Output waveguide.
7 – Output feedthrough.
8 – Beam pipe.
9 – Vacuum flange.
10 – Support plate.
11 – Y position output.
12 - X position output.
13 – Heater control connector.

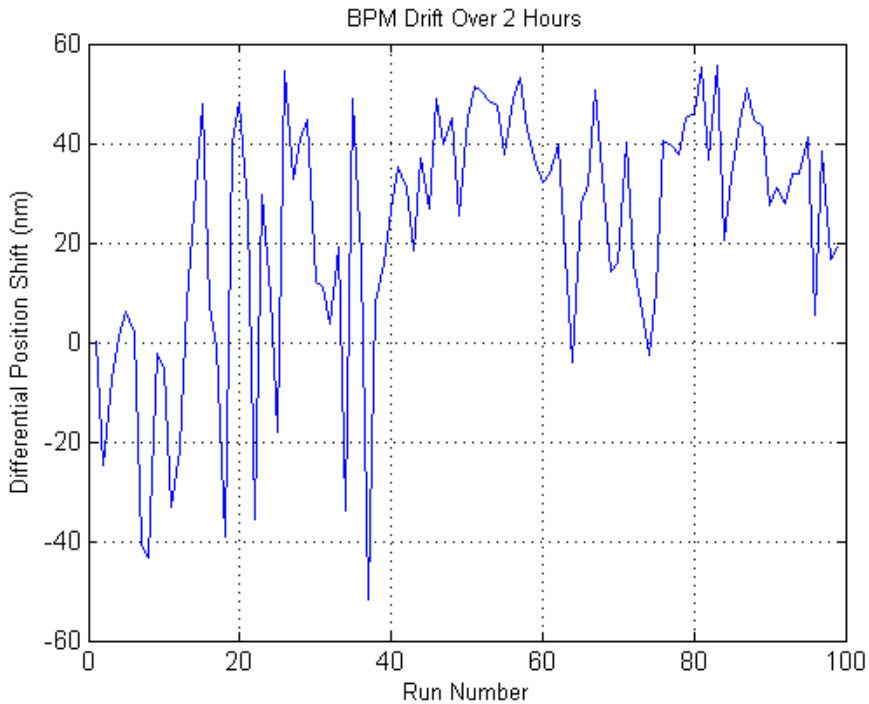


Measurements with BINP / SLAC cavity BPM in ATF

- Move one BPM at a time with movers
- Extract BPM phase, scale, offset as well as beam motion by linear regression of BPM reading against mover + all other BPM readings.

r.m.s. resolution 24 nm

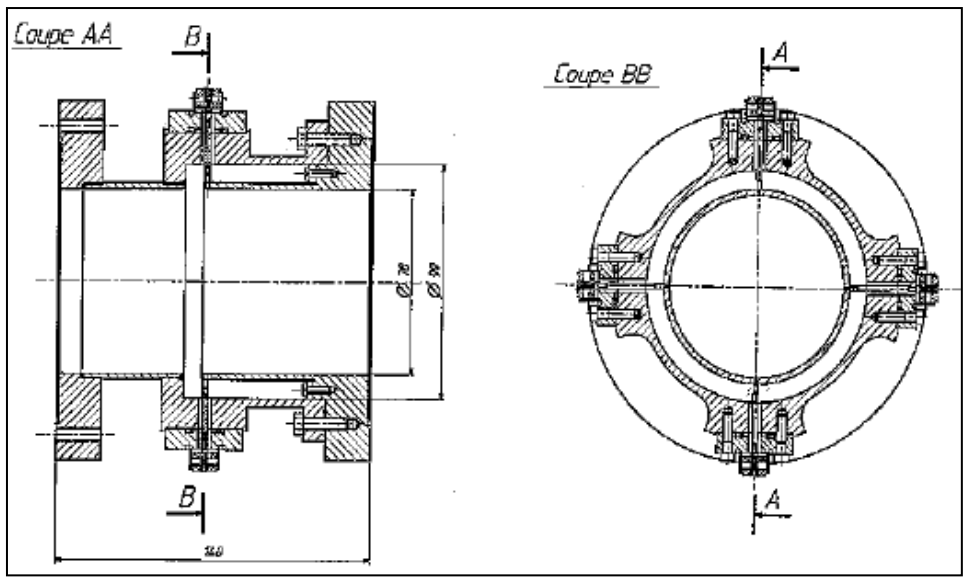
Stability Check



Re-entrant RF BPM

- Broad band cavity $Q_L = 50$, $\Delta\tau \sim 10$ ns
  $\Rightarrow$ single bunch and bunch to bunch BPM
- Resolution proportional to beam pipe diameter:
  it can be ~1 µm (cf. C. Simon presentation).
- Bunch Charge and Dark Current measurements are possible via TM010 mode at the Σ output
- Mechanics:
  - \+ Robust in the cold
  - \+ Symmetrical
  - \+ Easy machining
  - – Cleaning issues

TTF-ACC1 prototype



Difference between re-entrant cavity and common-mode-free cavity BPMs

- Common-mode-free BPMs are designed for no monopole-mode signal out of beam pipe.
  - Monopole present only due to imperfections
  - Calculated sensitivity of CM to fab tols
    - 10 micron should be achievable
- Re-entrant BPMs have substantial monopole-mode signal out of beampipe by design.
  - Reject monopole mode by frequency separation (in cavity)
    - Residual monopole signal ~2mm
  - Spatial structure Δ/Σ (hybrid in electronics)
    - Can achieve further 50 dB rejection
    - By phase and amplitude balancing
  - Yields estimated 75 micron monopole mode offset (my estimate)
- Stability: Cable/connector changes of 0.03 dB cause apparent offset shift of ~10 (entire budget) microns in reentrant BPM

Cryo Compatibility

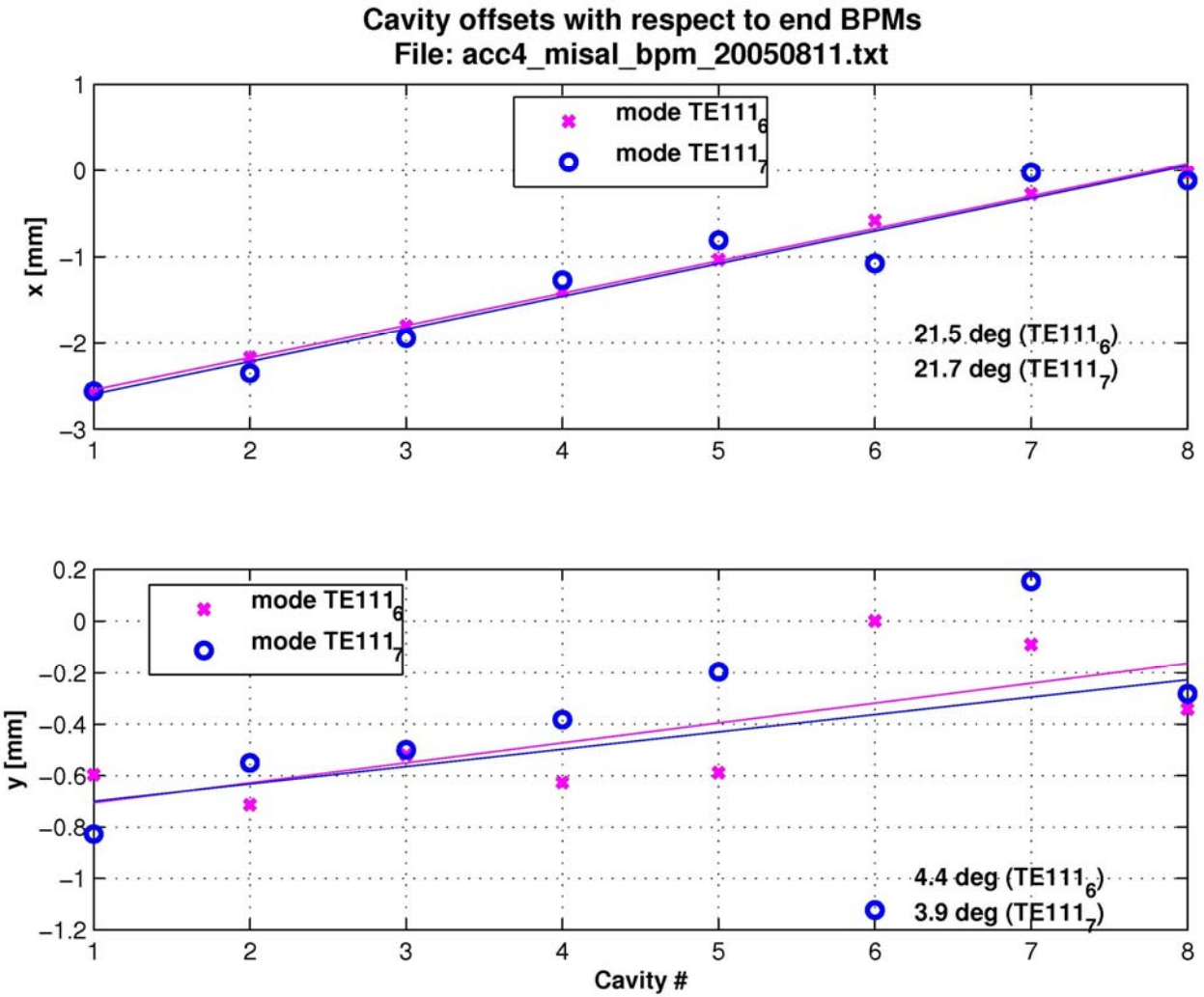
- Issues
  - Cryo people are cautious about what can go in the module
  - Cleanliness critical for cryomodules
    - Cleanability of device
  - Motion on cooldown

- Re-entrant BPMs proven in cryo system

- Any other BPMs require cryo R&D

Accelerating RF Cavity HOM

PRELIMINARY RESULTS (problems of reproducibilty of HOM center reconstruction w.r.t. steering ranges !!)



Many exciting experiences and communications …

… but sometimes I felt a bit exhausted