SLAC - End Station A
ILC testrun – April '06

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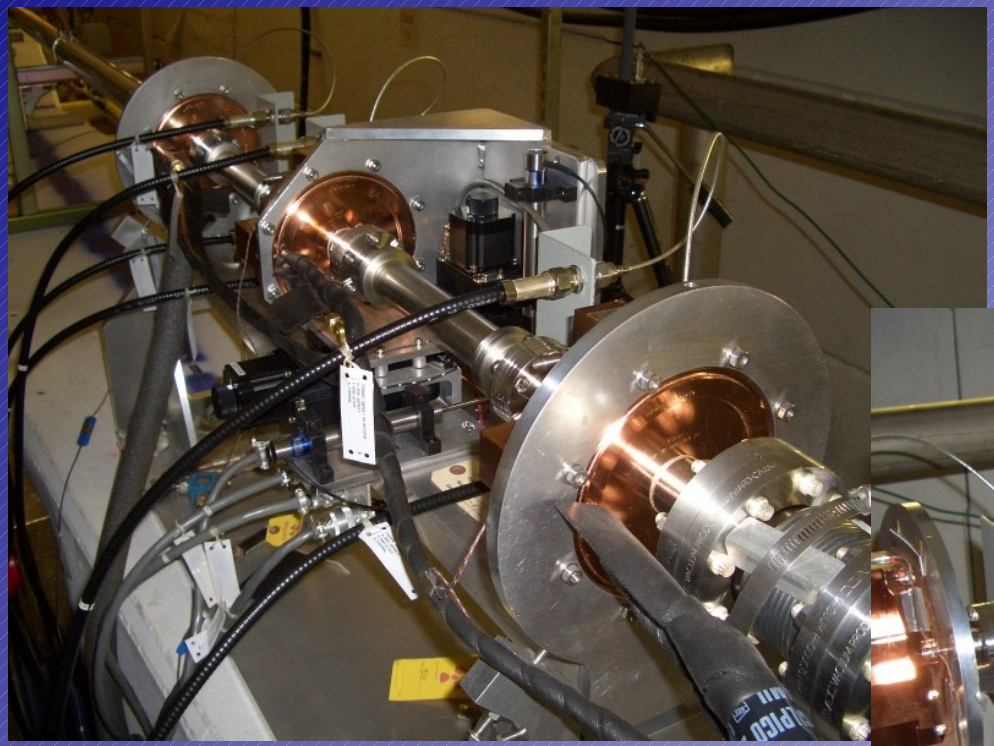
Overview, status, results and future plans

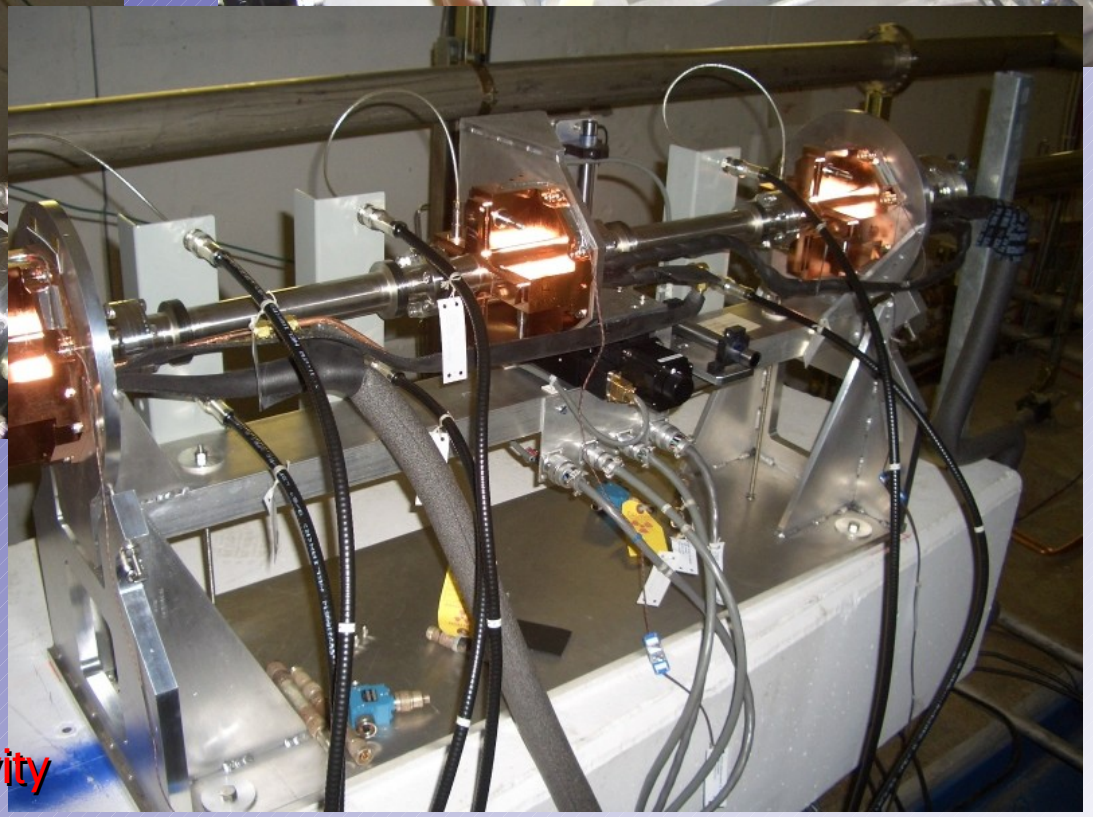
End Station A

- Technical drawing of the End Station setup
  - In the alcove (BPMs 41, 42) (ESA_zlocations1.pdf)
  - Further downstream: SPEAR girders with BPMs 3,4,5 (new triplet) and BPMs 9,10,11 (ESA_zlocations2.pdf)
- Last run :
  - T474 : energy spectrometer
  - T480 : wakefield box
  - Bunch length studies

BPMs used :

Old SLAC BPMs, x and y separate



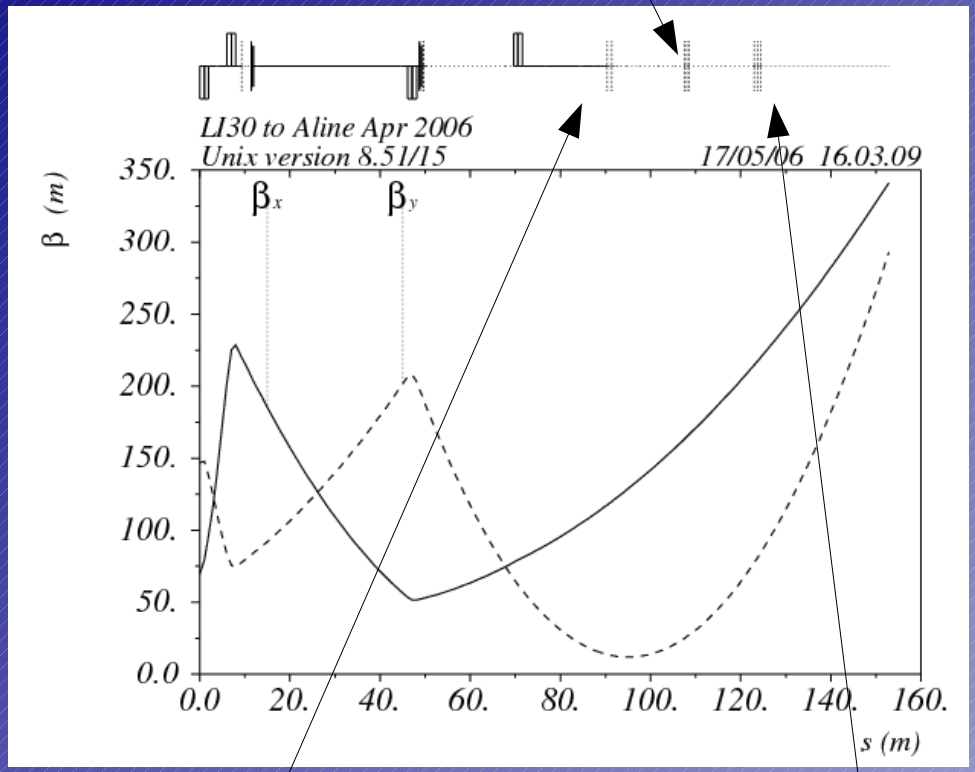


New model, no Q, x and y in same cavity

A-Line setup, optics configurations

C455

BPM3, 4, 5

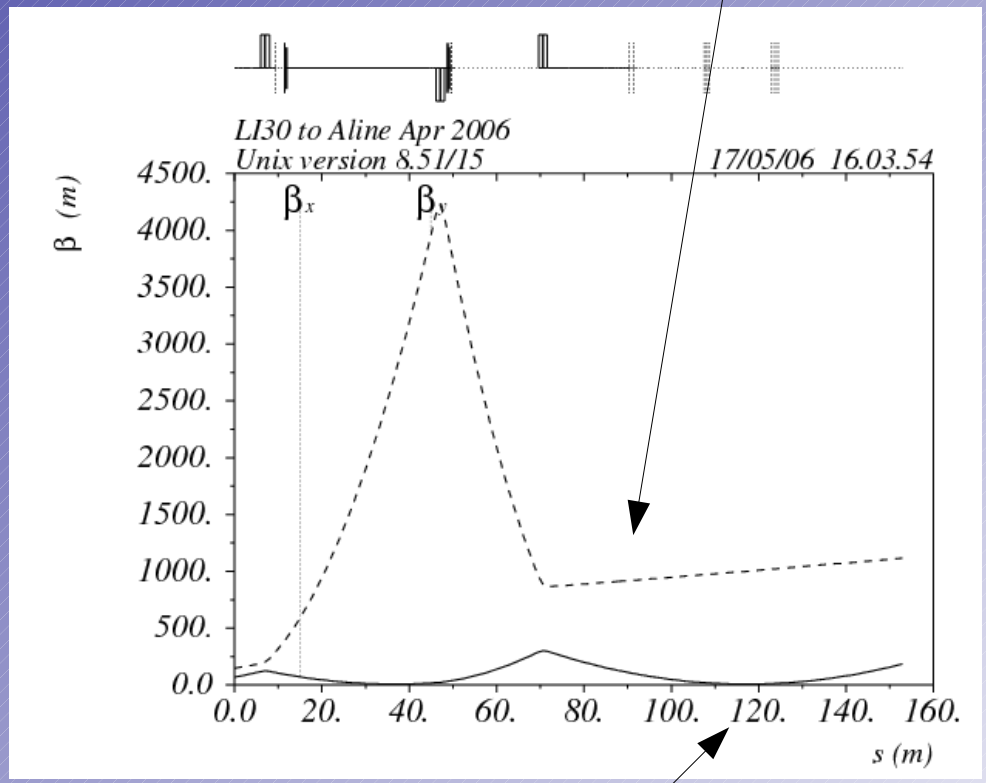


BPM41, 42

BPM9, 10, 11

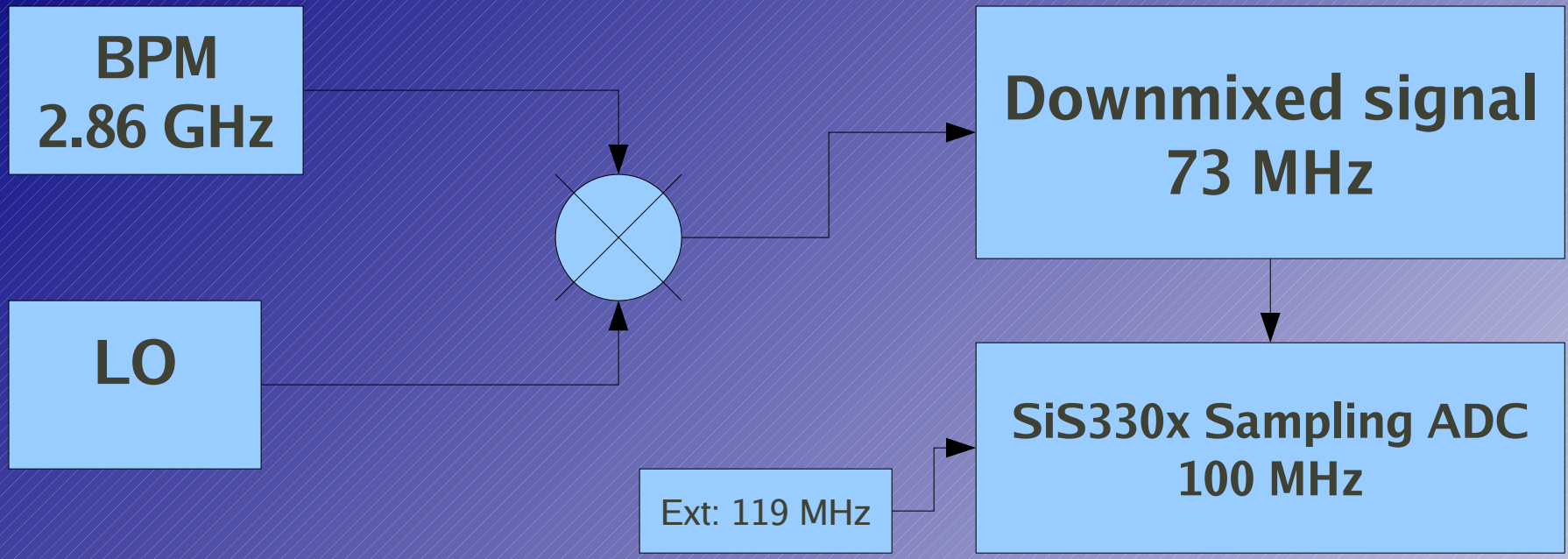
C458

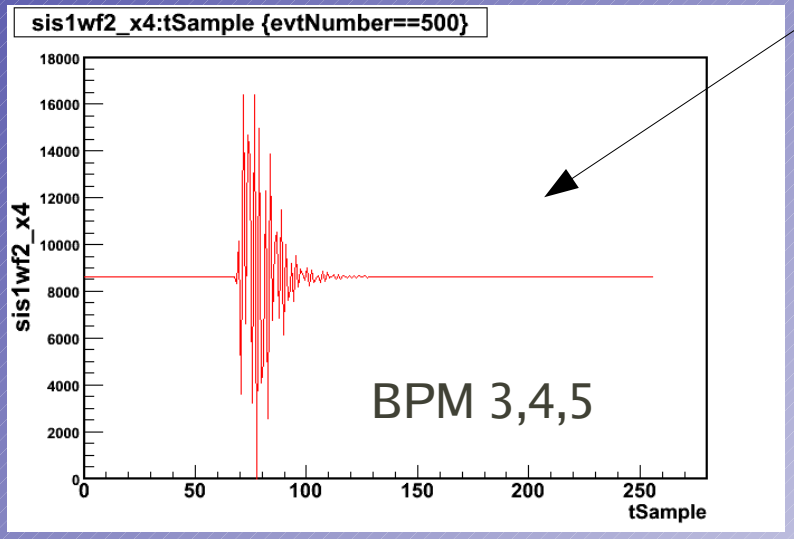
Blow up beam in y

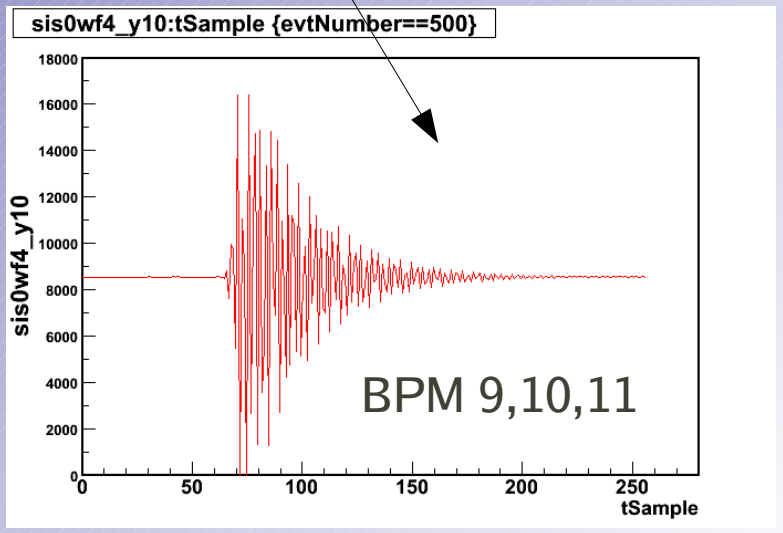


Configuration with a 'waist' in center of future chicane

BPM Data Acquisition, Readout



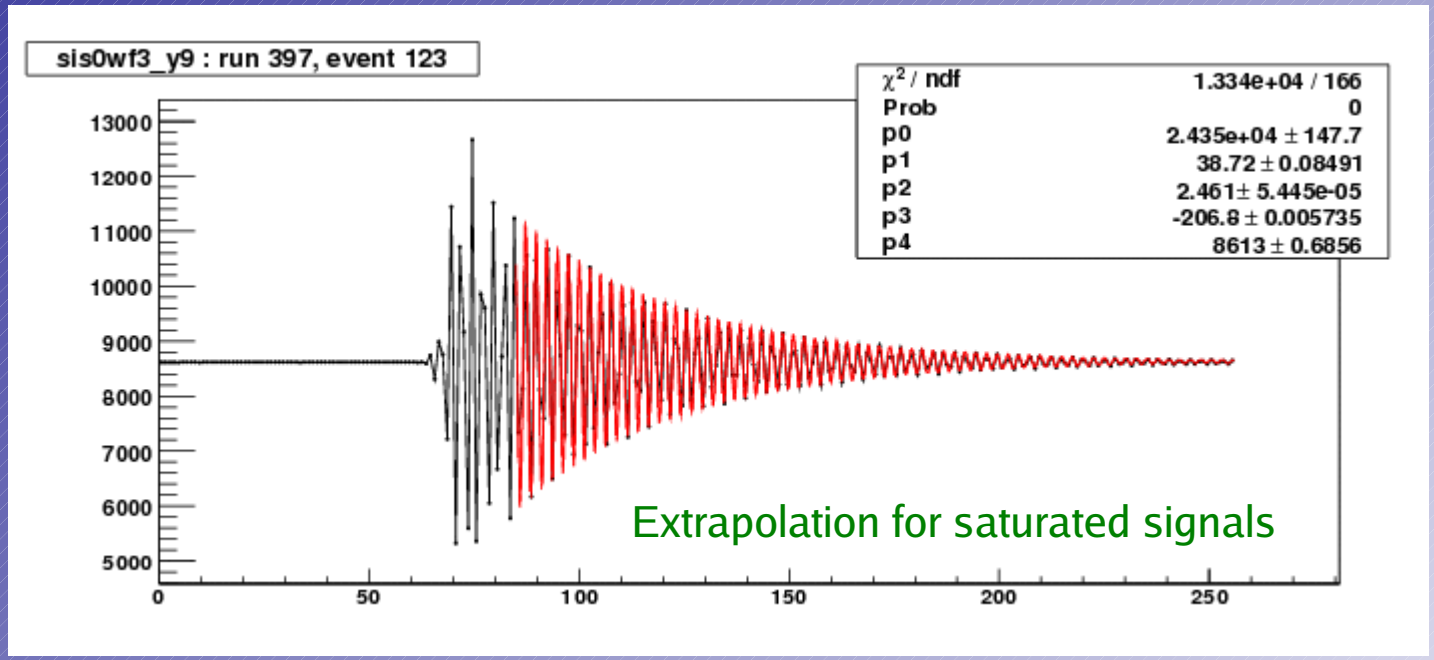




Amplitude and Phase determination

One way.. fitting the waveforms !

$$p_0 e^{\frac{-t}{p_1}} \sin(p_2 t + p_3) + p_4$$



However extremely sensitive :

- initial frequency of waveform
- starting point for fit

→ Often fails :-(

Practical method : Digital DownConversion (DDC)

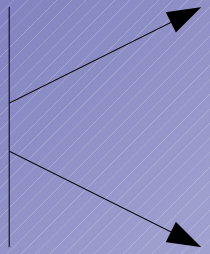
Amplitude and Phase determination

The other way... DDC

Conversion to baseband by software multiplication with sin wave in timedomain,

Subject to number of input parameters :

- filter bandwidth
- decay constant of exponential (Q factor)
- resonance frequency
- starting time of signal (t0)



Determine by hand

Using minimization

Handling of saturated pulses : needs some work !!

Amplitude and Phase : normalization by Q cavity (monopole signal)

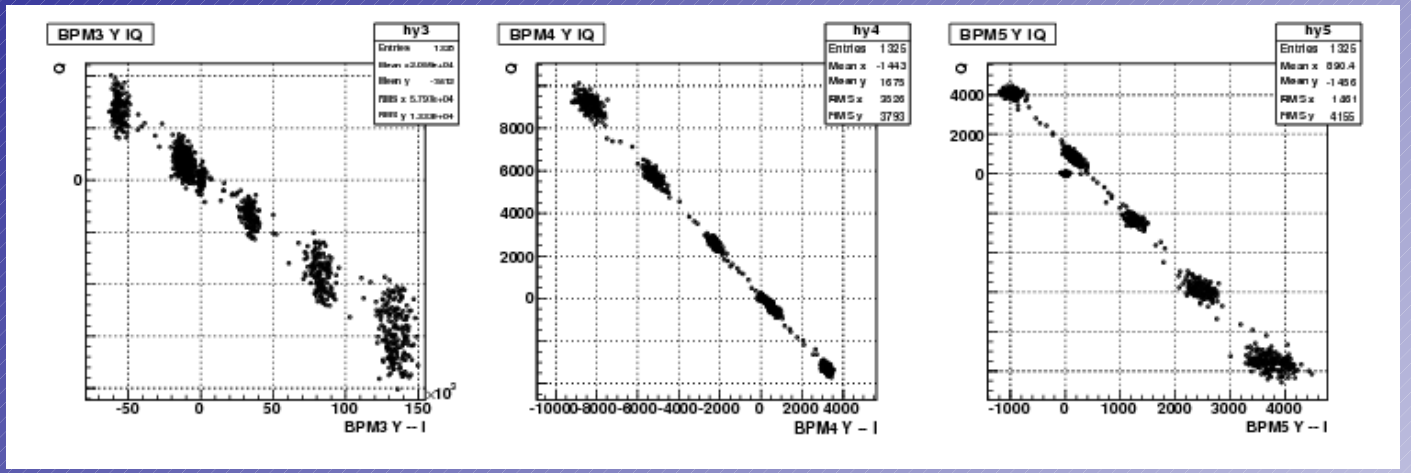
Default calibration : corrector scans

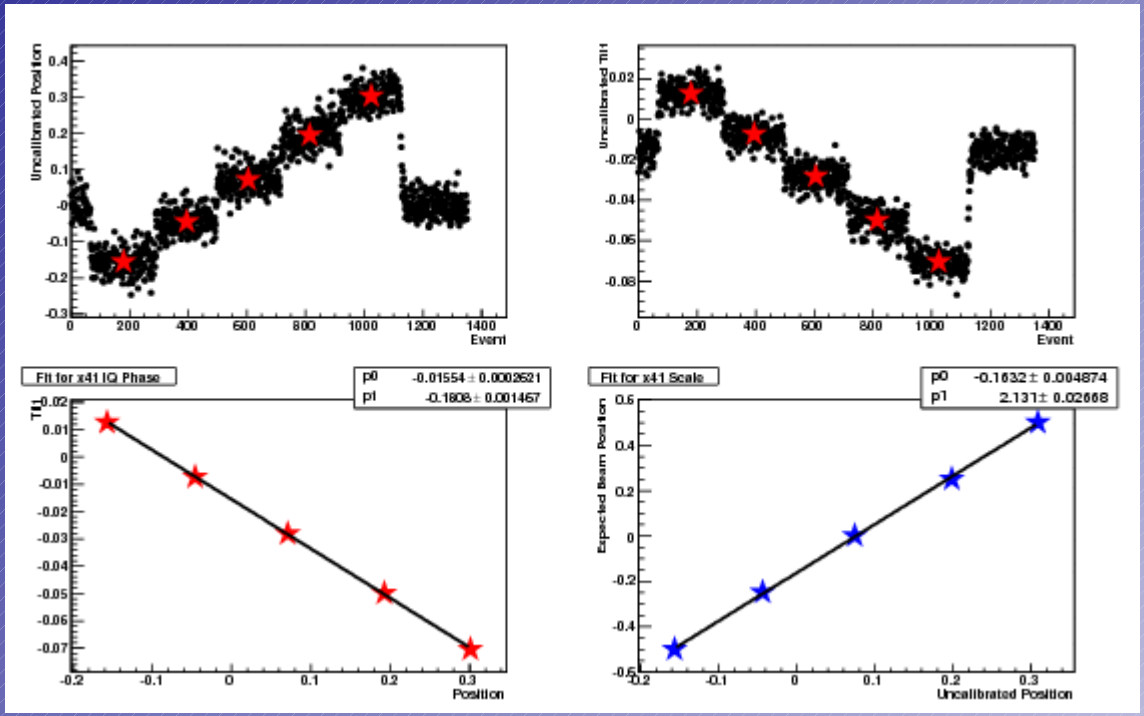
IQ plots :

Amplitude & Phase

↓

Position & Tilt





Corrector scans to calibrate the measured positions in BPMs

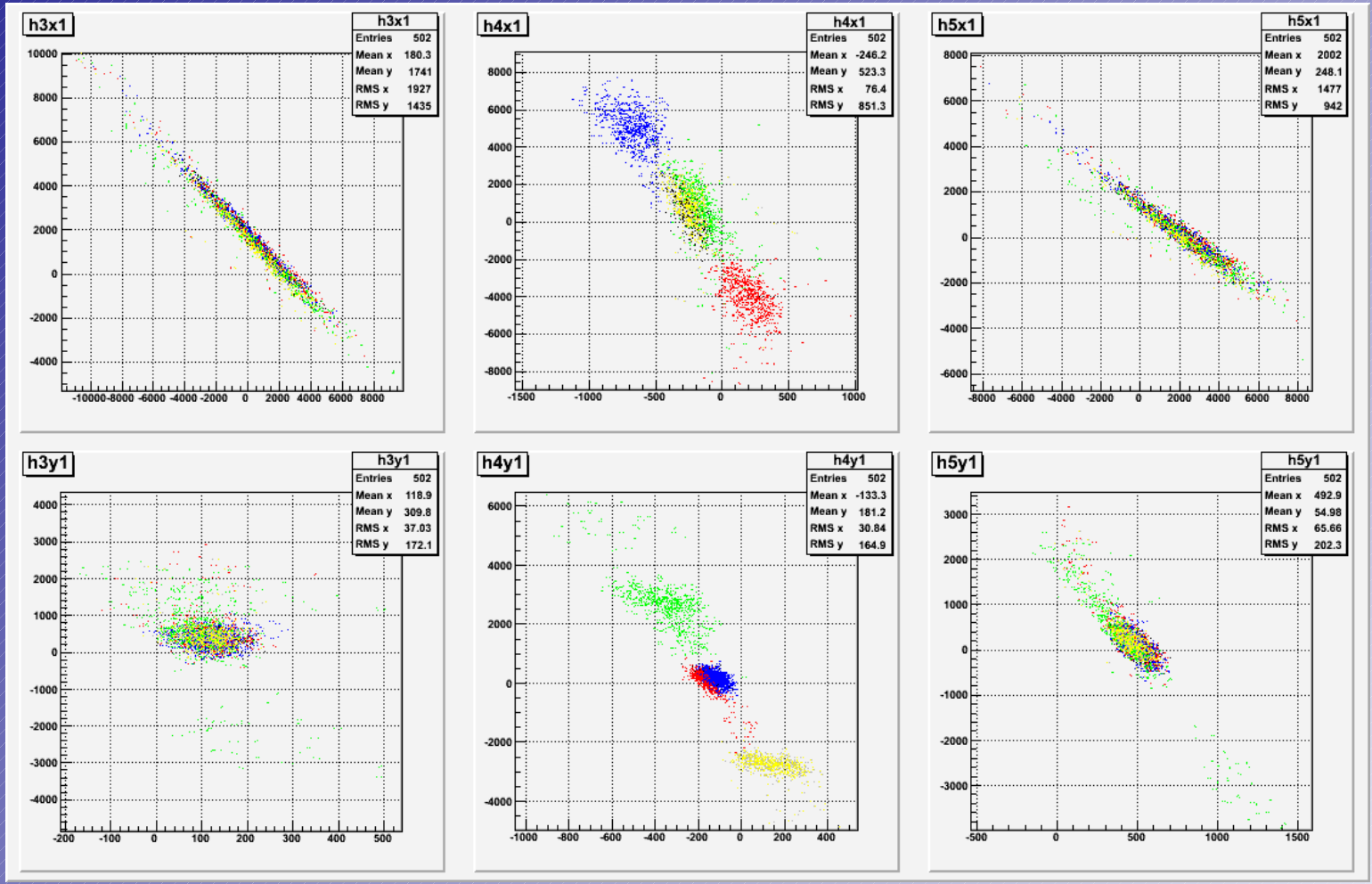
use 2 correctors in both x and y

BPM4 mover calibration

In ILC would be very 'unpopular' to use corrector scan for BPM calibration...

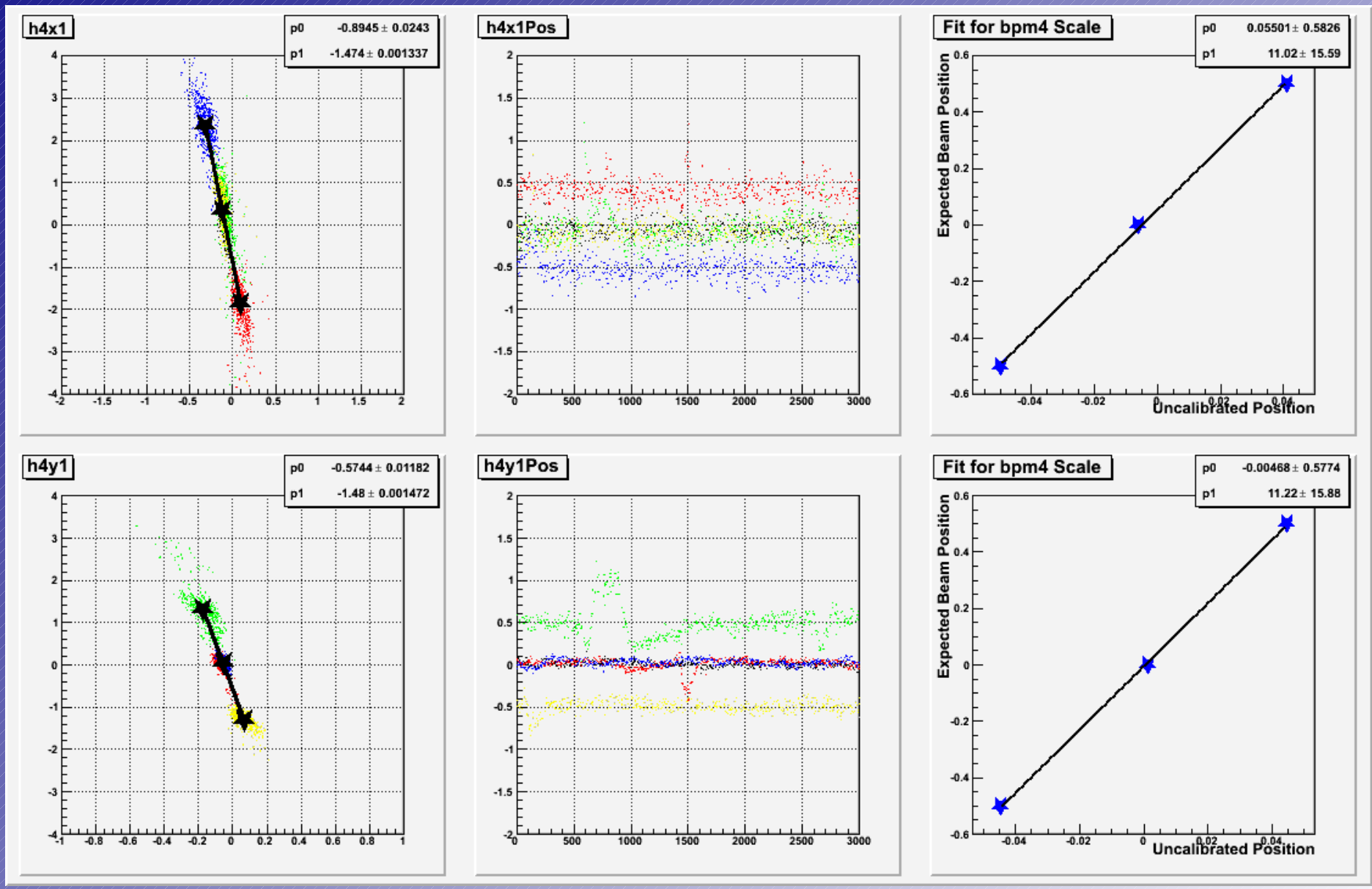
Use BPM4 mover (high precision!) to calibrate BPM4 : both x and y !

- Crosscheck existing calibrations
- Could be very valuable tool for energy BPMs (all on moving platform...)

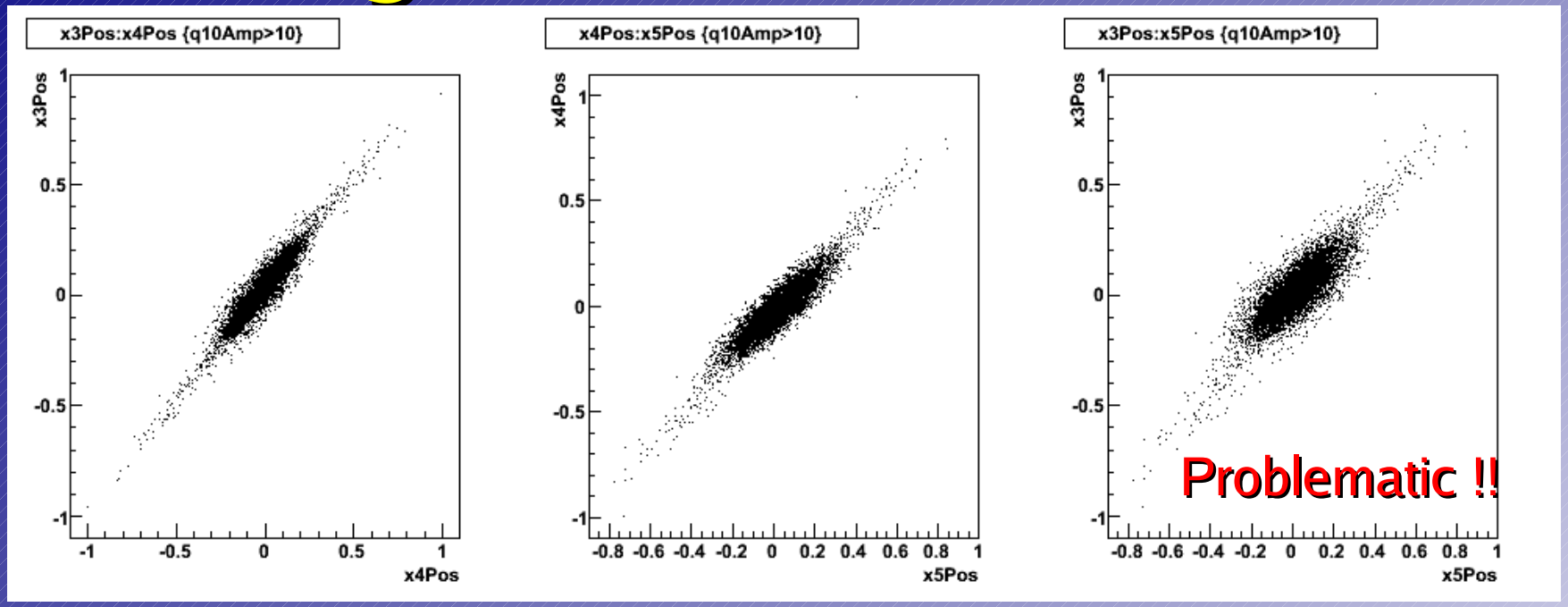


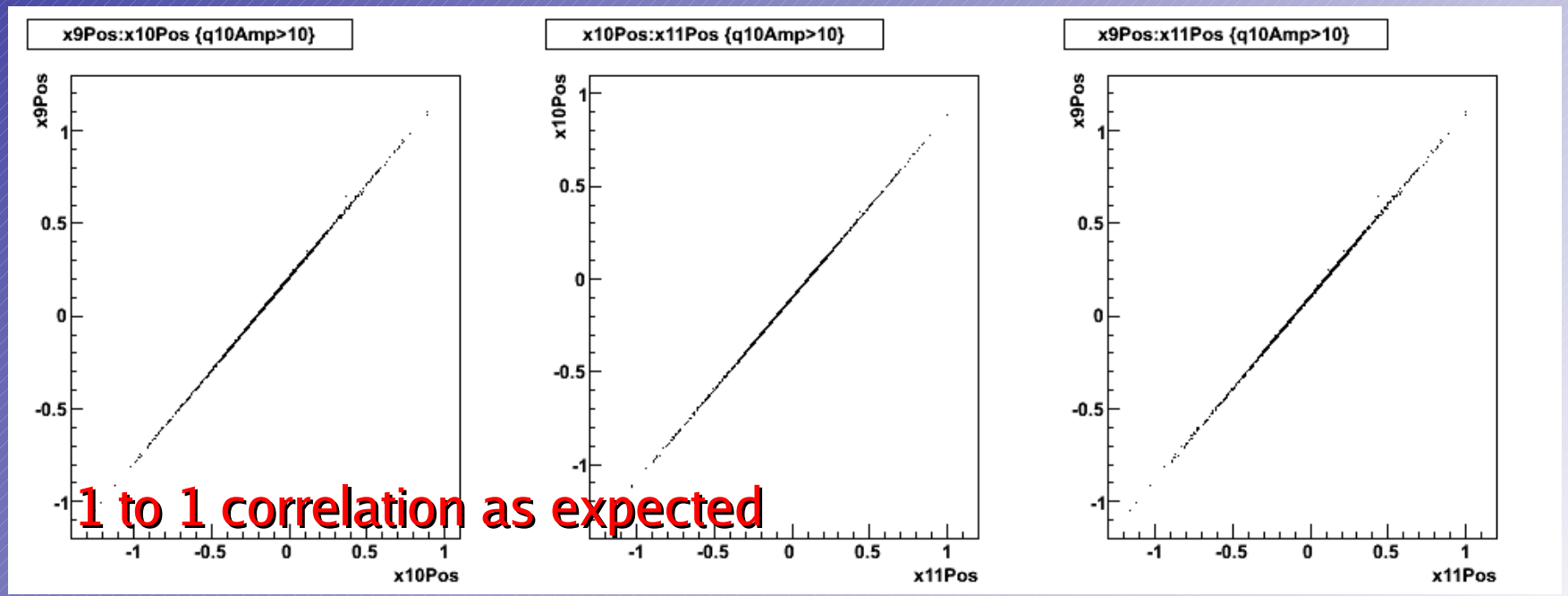
BPM4 mover calibration

Results e.g. for runs 319-320-321-323-324 :



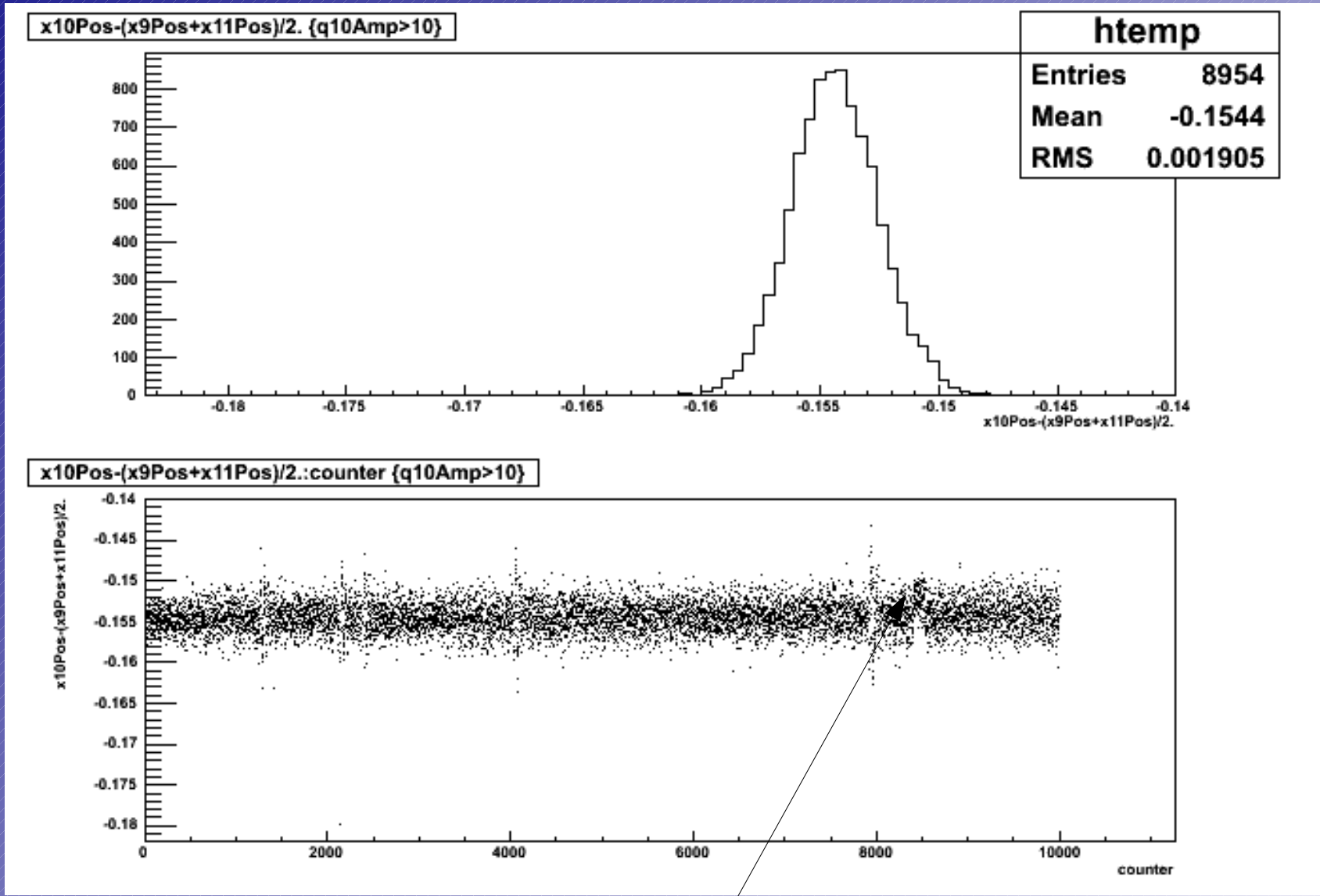
Determining BPM resolution





Rough BPM resolution : eg. x10Pos

Get rid of beam jitter : correlate positions in different BPMs

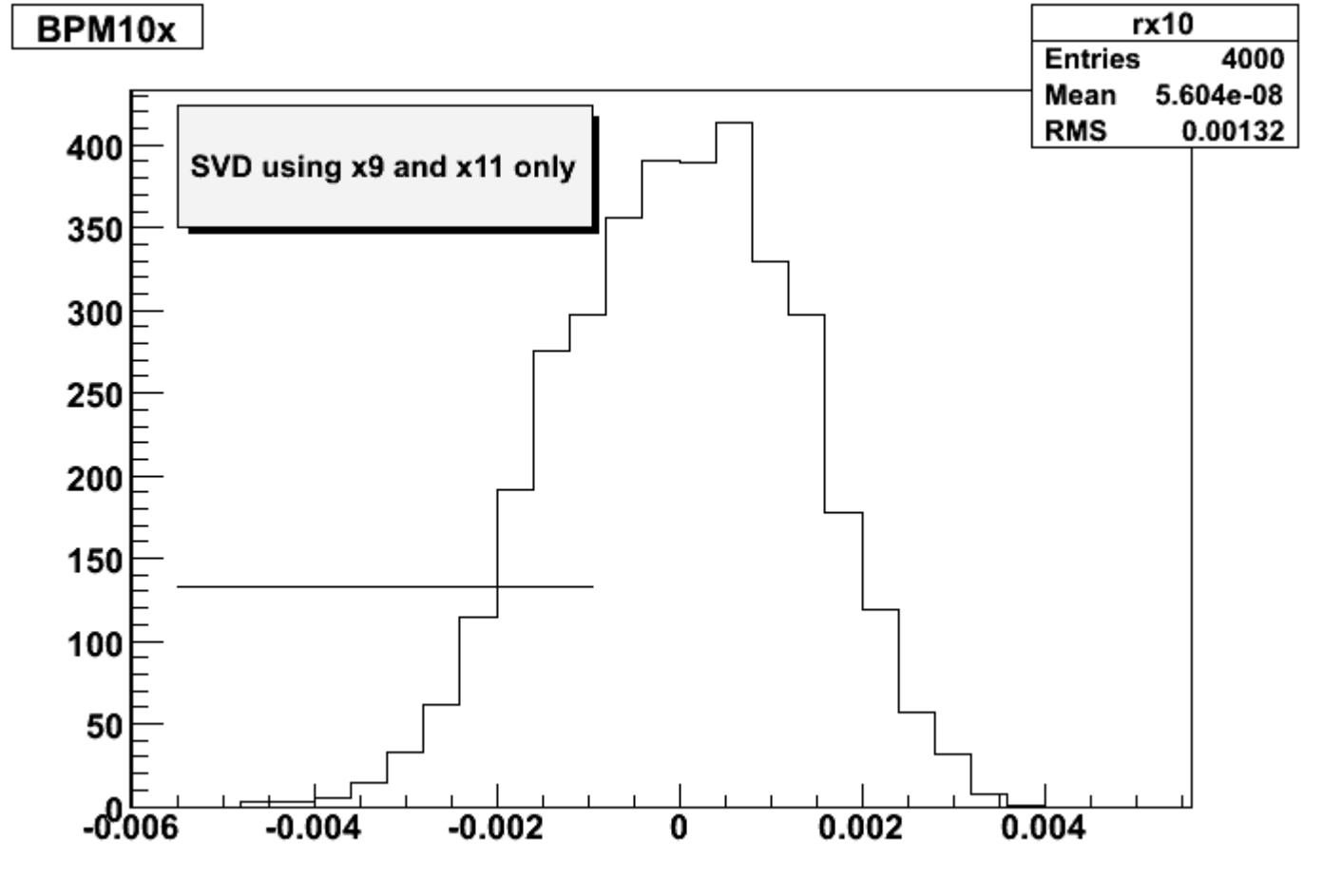


Task is now e.g. to understand features like :

Singular Value Decomposition

$$A \,.\, x = b$$

x : vector with correlation coefficients
b : measured position in BPM10x

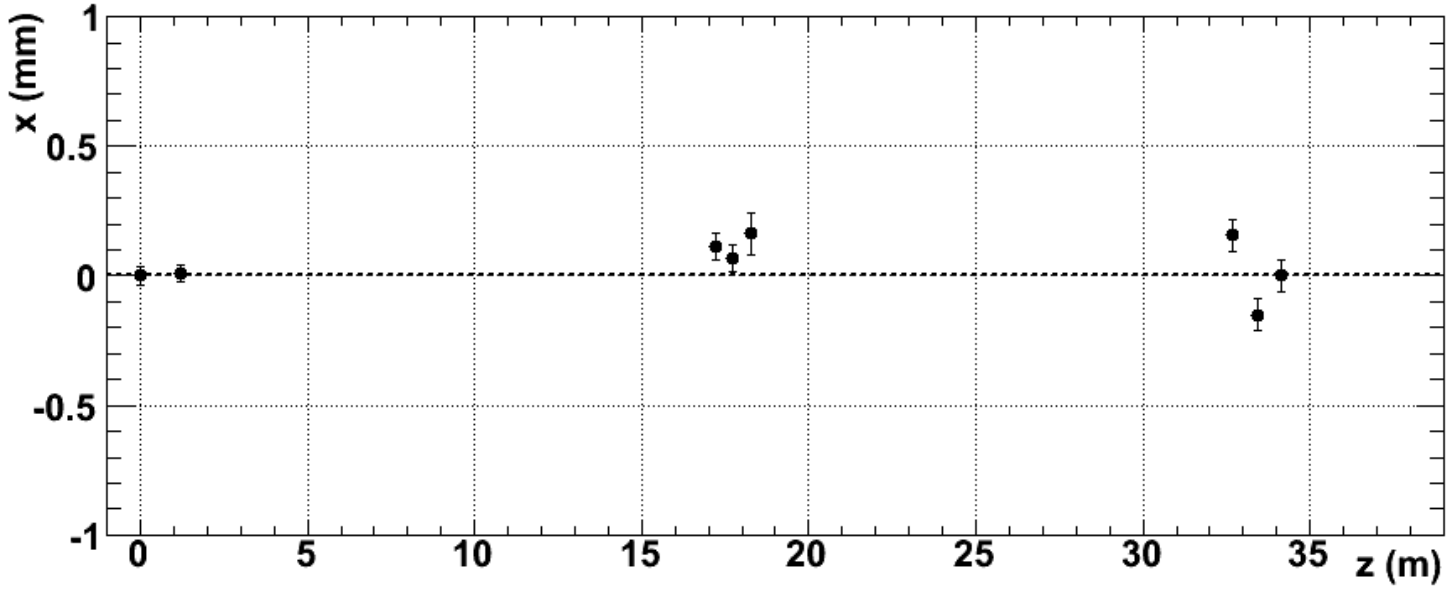


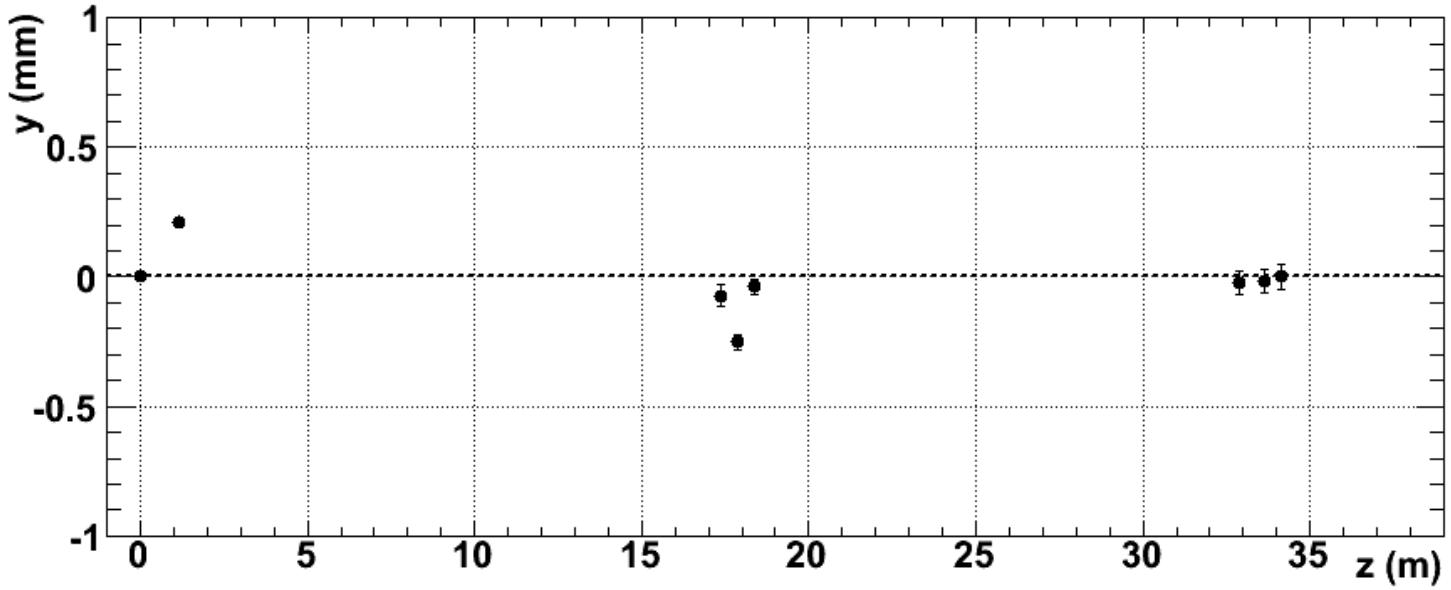
Matrix A :

ev 1	1	x9	x11
ev 2	.	.	.
...	.	.	.

Same data run (712), using BPMs 9x and 11x

Alignment plots : used BPMs 41 & 11





Fairly possible to stear beam down on all BPMs even though they are not on movers

Least square fitting with systematics

- Trying to determine the orbit : need some discussion (T474 meeting)
  - drawing straight line between BPMs 41 and 11 ?
  - define orbit by BPMs 31,32 and 41,42 ?
  - Fitting globally, a line ?, a parabola (earth's magnetic field)?
- Trying to implement an alternative for SVD:
  - http://www.phys.ufl.edu/~avery/fitting.html

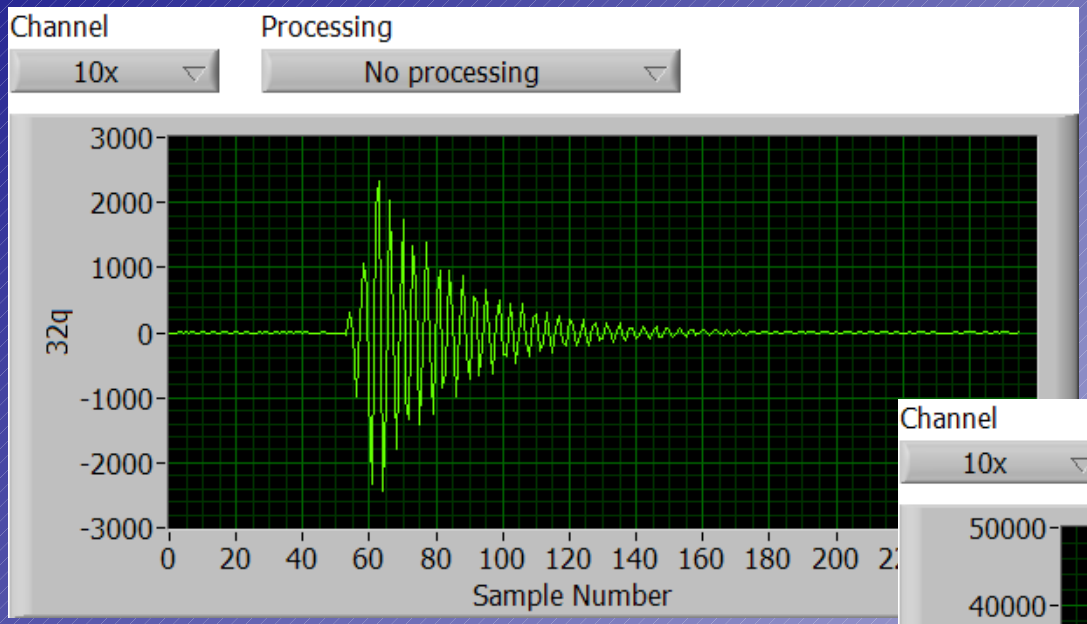
$$\chi^2 = (\vec{y} - A\vec{\eta})^T V^{-1} (\vec{y} - A\vec{\eta})$$

$$\chi^2 = \sum_l (\vec{y}_l - A_l\vec{\eta}_l - B_l\vec{v})^T V_l^{-1} (\vec{y}_l - A_l\vec{\eta}_l - B_l\vec{v})$$

Systematic effects (offsets) you try to get out by collecting multiple fits

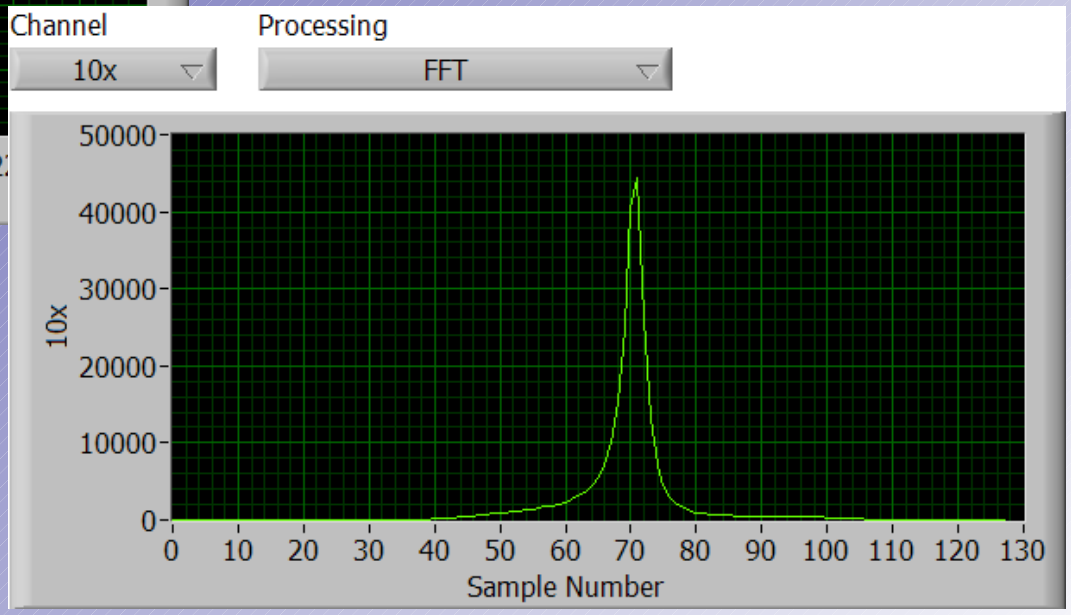
Online position display in LabVIEW

- Apply and tune DDC algorithm in LabVIEW, and hope it's fast enough ;-)
- Integrate calibration information
- Ship as subvi to DAQ computer for July test run



Raw waveform

Online integration of the calibration

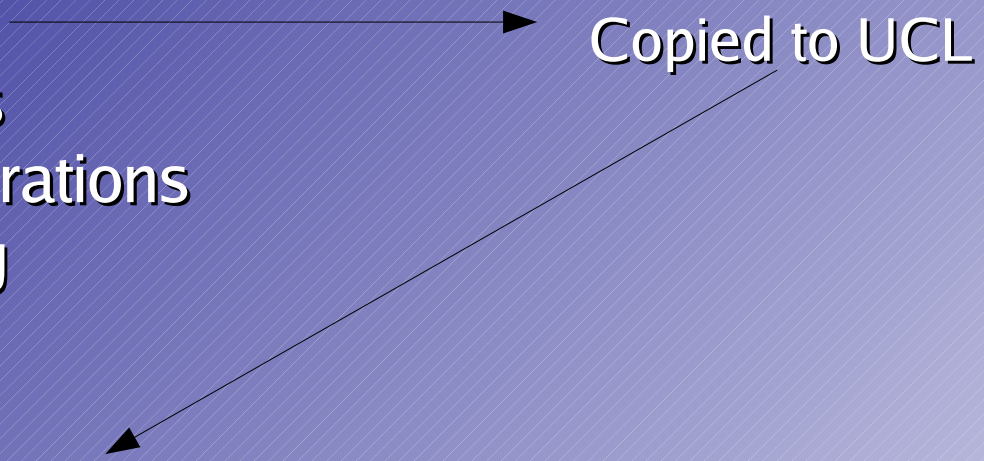


FFT

Data processing

Large amount of runs taken :

- stability runs, calibration runs
- different beam optics configurations
- external and internal clocking



NEED :

Determine optimised parameters (filtBW, gamma, freq,...)
for DDC algorithm on BPMs 3,4,5

Go over all calibrations manually and redo
(check stability, think of automation)

Reprocess runs

Next few weeks

- Agree upon default data quality, selection criteria, orbit definition (meeting) :
  - encoded in libRooEsa
- Start systematic studies : run conditions in runlist : resolution stability versus :
  - Temperature (ambient, thermocouple,...)
  - Beam energy
  - Bunch charge and shape
  - Internal vs. external clocking
  - Effect of beam optics configuration
- Check calibration stability, seek out factors that influence calibration...

Endgoal for data analysis should be a report describing in detail the collective studies done during this testrun and come up with a plan for the July running !!

Long term stability runs : 8-hrs shift : calib – stability – calib - stability...

Actively study effect of temperature ...

FONT plans to install a mess up the beam --> study effect on BPM resolution...

Discussion, phoneconf. preparation

- What needs to be done in for the next years of testrunning
  - Refurbishement of magnets (at SLAC)
  - Setup for measurements for magnets : readout, control (power supply)
    - Think of how accurately magnets need to be measured ?
    - Do we need to monitor continuously ? + which probes/method ? + how accurate ?
    - What is available (SLAC, Dubna ?) (possible to transport ?)
  - Magnet installation
  - Magnet specifications from old SLAC magnet --> Dubna simulation
    - What is sergei's code doing, using TOSCA simulation of magnets ? Calculation of effect of imperfections on beam optics ??
    - What kind of effects can TOSCA simulate ? + how accurate ?
- How do we split the tasks, who is doing what ?
- What equipment is needed, what is available ??
  - Should come up with a list !!! + assign people to that list
  - If stuff needs to bought, where does the money come from ?