Damping Ring Session Summary

S. Guiducci

TILC09

Tsukuba 21 April 2009

DR session on Crucial R&D items

Saturday 18 April 9:00 - 12:30

	kickers	Convener S. Guiducci		
9:00	Fabio Marcellini (Webex)	Strip line kicker design		
9:30	Craig Burkhart (Webex)	Fast Kicker Pulser Development at SLAC		
10:00	Takashi Naito	Fast kicker test at ATF		
10:30	coffee break			
	LET	Convener Junji Urakawa		
11:00	David Rubin	Low Emittance Tuning at CesrTA		
11:30	Shigeru Kuroda	Low Emittance Tuning at ATF		
12:00	Manfred Wendt	BPM DR Upgrade plan		

Sunday 19 April9:00 - 12:30

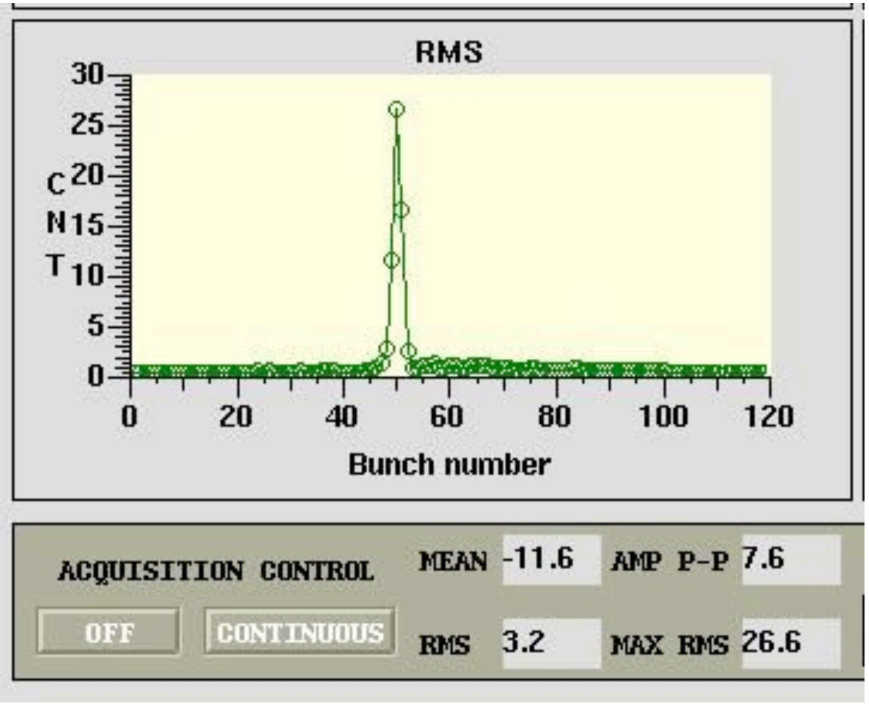
	e-cloud and fast ion	Convener Mark Palmer		
9:00	Theo Demma (Webex)	e-cloud studies at LNF		
9:30	Stefano De Santis (WebEx)	electron cloud studies		
10:00	Gerald Dugan	e-cloud measurements and simulations at CesrTA		
10:30	coffee break			
11:00	Yusuke Suetsugu	e-cloud R&D at KEKB		
11:30	Nobuhiro Terunuma	Fast ion study		
12:00	All	Discussion and Plans for "Minimum Machine"		

Fast kickers at DAFNE

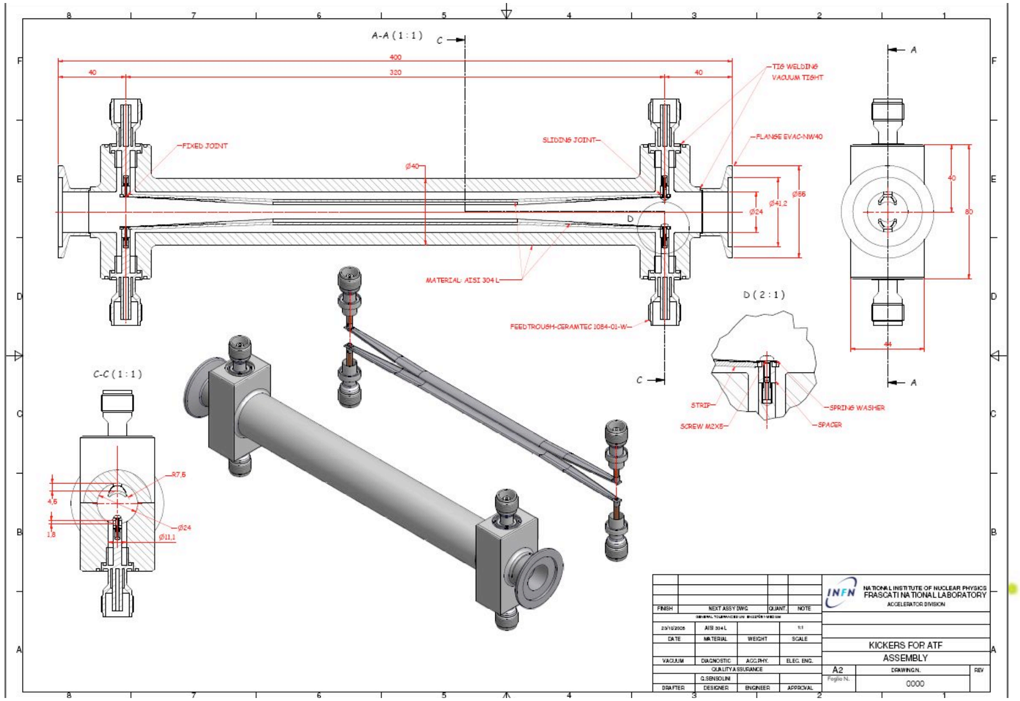
• 24kV FIDs have been tested in the electron ring kickers ("hybrid" configuration)

• They worked well for ~ one month, then one FID failed followed by the other one after one more week of test in the lab

• Interactions with the firm are in progress to improve reliability



rms bunch oscillations with fast kick
120 bunches, bunch distance 2.7 ns



• Short kicker for tests at ATF

• Fabrication in progress

• Ready by the end of April

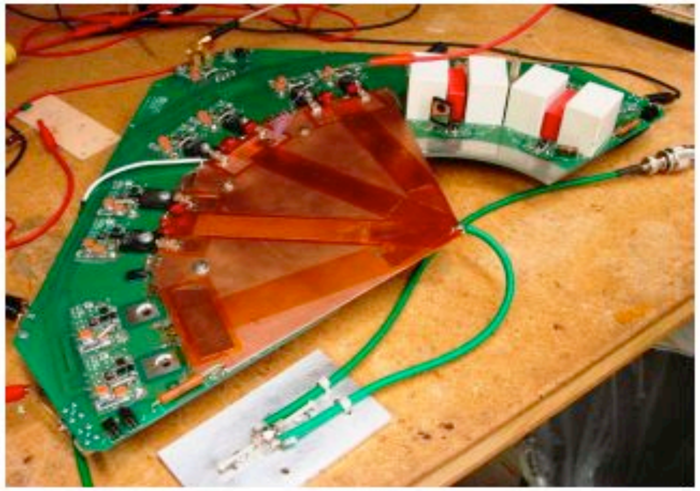
F. Marcellini

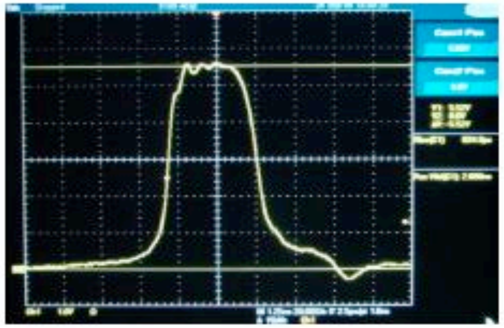
Fast Injection/Extraction Kickers: SLAC

DSRD 2-ns Prototype Tests

4 ns kicker modulator for ATF DR ready by end of 2009 to deliver at KEK in 2010

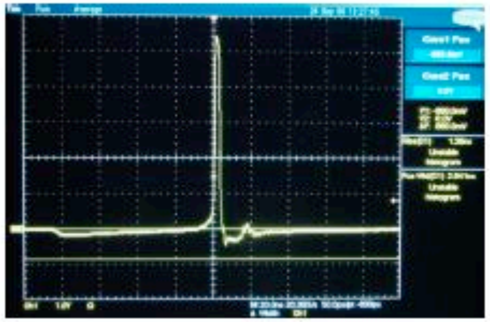
Amplitude	kV	4.4
Impedance of Feeder	Ohm	50
Rise Time	nsec	<1
Pulse Width	nsec	2.9





Waveform detail:

1.25 ns/div



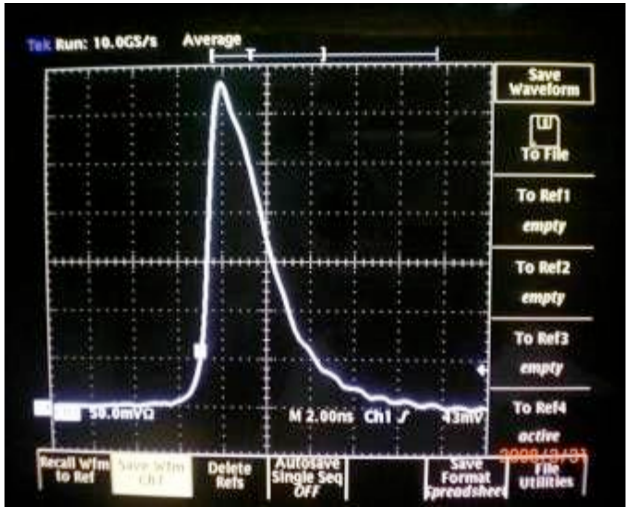
Pre/post pulse:

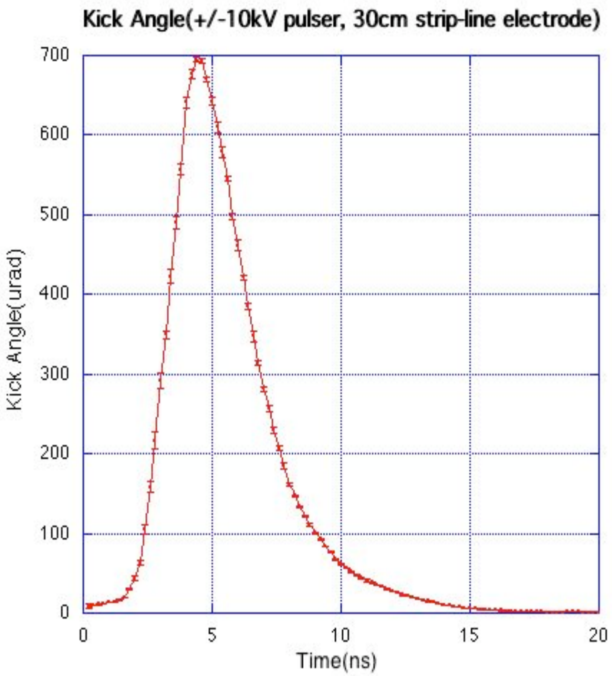
20 ns/div

It's crucial that FID is not the only provider!

Fast Kicker R&D at ATF

Pulser: FID FPG 10-6000KN





Maximum output voltage	10 kV
Rise time, 10 – 90%	< 1 ns
Rise time, 5 – 95%	< 1.2 ns
Pulse duration at 90% peak amplitude	0.2 – 0.3 ns
Pulse duration at 50% peak amplitude	1.5 – 2.0 ns
Output pulse amplitude stability	< 0.7%
Maximum pulse repetition frequency	6.5 MHz
Number of pulses per burst	110 (max)
Burst repetition frequency	5 Hz

Satisfies requirements for 3 ns bunch distance in DR

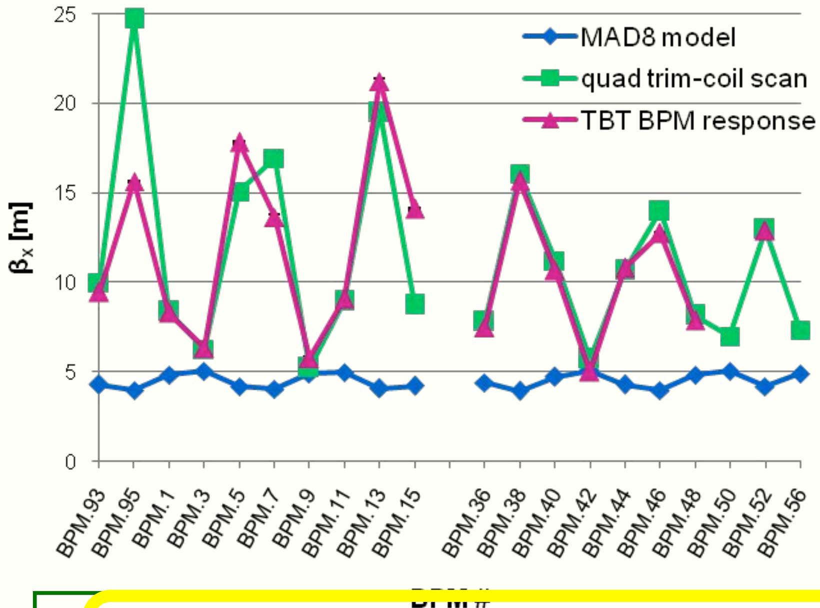
Beam extraction test:January 2009, this failed due to broken pulsers by high level radiation near extraction area.
After repair the pulsers will be installed behind concrete shield block, beam extraction test will be done again in this year (May).

T. Naito

LET - ATF

- 2 pm is a TDP R&D plan deliverable for ATF
- 4 pm has been achieved in 2004
- LET was based on Orbit Response Matrix analysis correcting iteratively orbit dispersion and coupling
- In 2007, after the same tuning procedure, 20-30 pm were measured?
  - **During 2008 DR magnets were realigned**
  - **A BPM upgrade program is in progress**
- This week:
  - **ε_y ~ 10 pm measured by X-SR**
  - **ε_y ~ 5 pm measured by Laser Wire**
- The resolution of the measurement systems needs further check/improvement but progress is in the good direction

ATF BPM System Upgrade

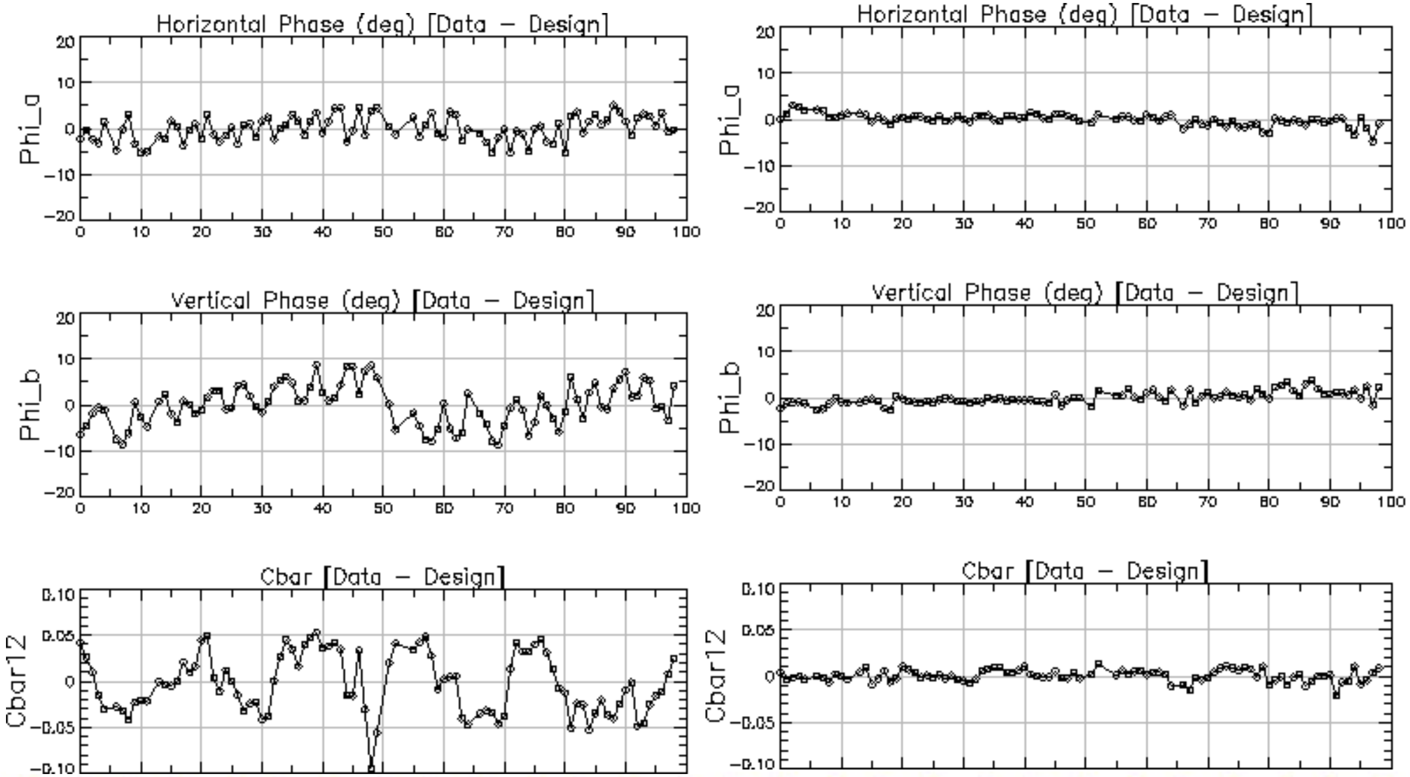


- **TBT kicked beam response studies uncovered discrepancies between theoretical and measured ATF DR optics.**

- **A DR BPM read-out system with high resolution in TBT (few µm), and narrowband mode (<200 nm) has been developed.**
- **An automatic calibration system for gain drift correction was tested. It operates in presence of the beam signal!**
- **A revised analog/calibration electronics has been prototyped to resolve problems and limitations of the first series (20-of-96).**
  - **To be tested right now!**

CesrTA - LET

- Motivated by studies of electron cloud in ultra-low emittance regime
- β-phase and coupling measured using turn by turn bpm information
- Phase measurement insensitive to BPM offset, gain, and calibration errors



β-phase and coupling before and after correction

LET Status

- Survey and alignment
  Quadrupole offsets and rolls, and bend rolls within tolerances
- Quadrupole focusing errors corrected
- Coupling corrected < 1%
- Vertical dispersion ~ 2cm (the goal is 1cm)
- Measured vertical emittance (lifetime and XBSM) ~ 35pm
  (→ corresponds to η_v(RMS)~ 1.8cm)

→ Residual vertical dispersion dominates vertical emittance

- Our ability to correct vertical dispersion limited by BPM resolution
- Implementation of digital BPM electronics (May-June 09 run) will provide required resolution/reproducibility
  [Candidate source of dispersion is sextupole misalignment
  (Developing a plan for measuring and correcting offset errors)]

- Analysis software and infrastructure is flexible, well tested, and mature

CesrTA e-cloud

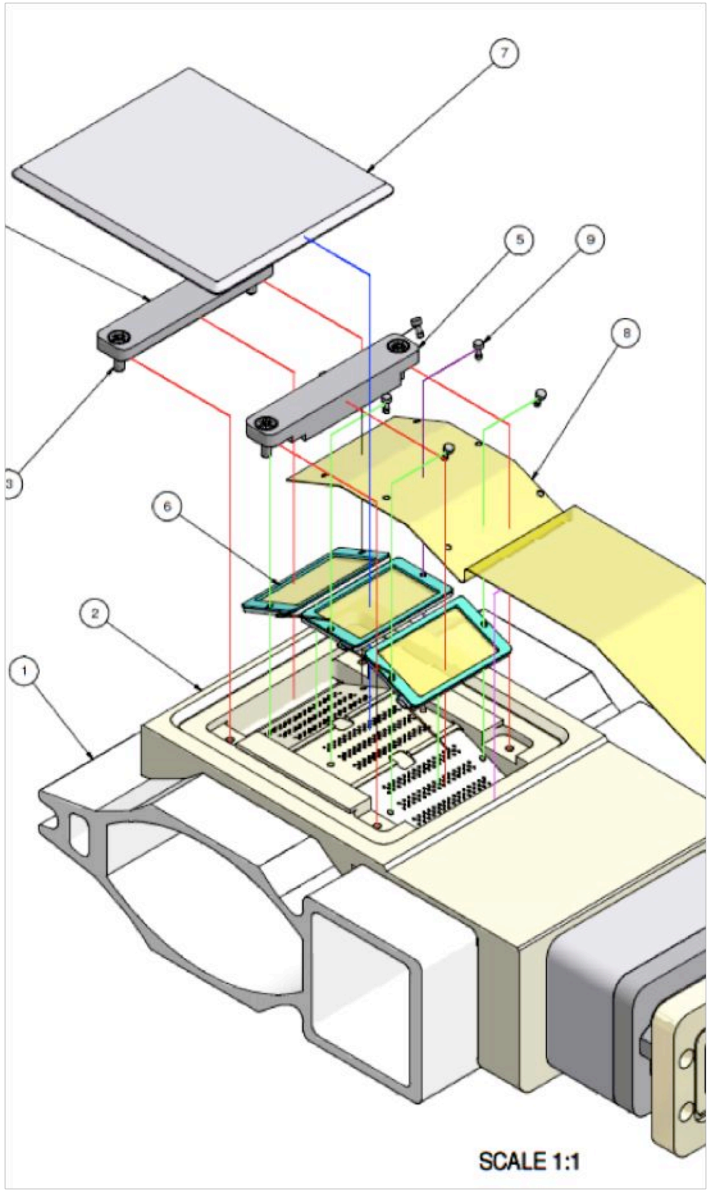
- A large experimental program including
- Mitigation techniques
  - **effects of vacuum chamber coatings (TiN, alpha carbon)**
  - **clearing electrodes**
  - **grooved chambers**
- Tests of these techniques in dipoles and wigglers
- Monitoring with retarding field analyzers
- Measurements of coherent tune shifts produced by the ring-averaged cloud density near the beam
- X-ray beam size monitor for bunch by bunch measurement
- TE Wave Measurements

CesrTA e-cloud

- A large simulation program
- Using three simulation codes which model the formation and decay of the electron cloud: ECLOUD (CERN), POSINST (LBNL), CLOUDLAND (SLAC)
- benchmarking the codes against one another to understand the differences in the physics models and numerical methods
- Comparisons of the simulations with tune shifts measurements, RFA data, and TE wave measurements will allow to validate the physics in the simulation codes and determine the parameters of the codes' physics models
- These validated codes, together with the results of the mitigation techniques measured by the RFA's, will be used to extrapolate the performance of the mitigation techniques to the ILC damping ring conditions.

Experimental overview (2): Retarding field analyzers

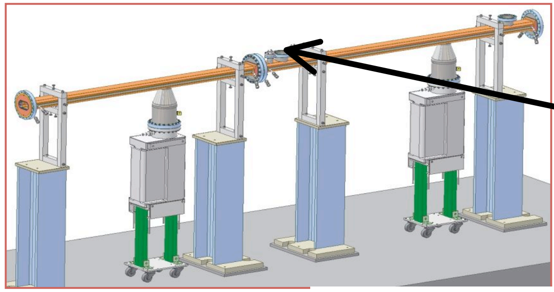
- These devices measure the energy spectrum of the time-average cloud current density which impacts the chamber wall. Most devices are segmented, so that some position information is also available.
- These devices can be placed in drifts, dipoles, quadrupoles, and wigglers.
- RFA's placed in chambers to which mitigation techniques have been applied will be used to measure the effectiveness of these techniques.

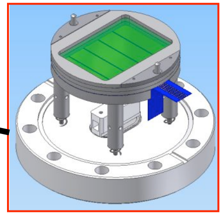


G. Dugan

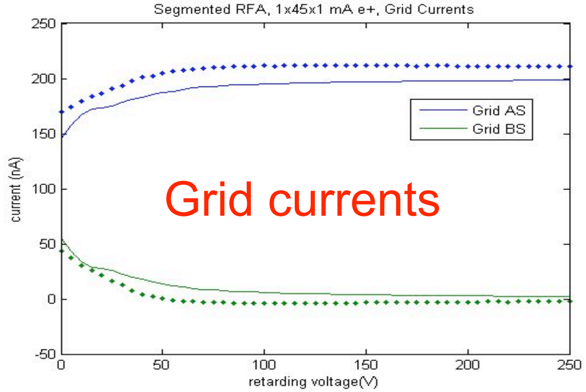
Segmented RFA in drift region

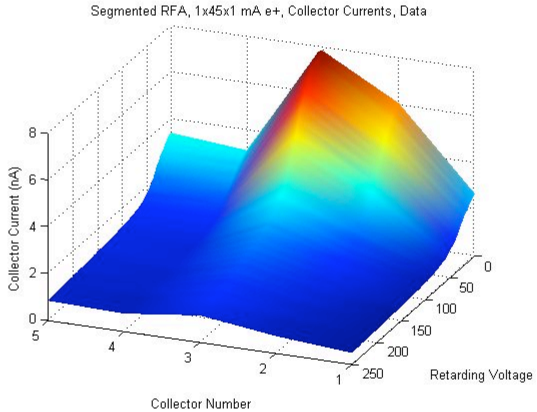
- 2 grids, 5 collectors (probe azimuthal distribution of cloud)
- Simulation accurately predicts grid currents
  - Note that the retarding grid current goes negative in the data: Consequence of SEY?
- Collector currents match qualitatively
  - Plots show collector current vs collector number (collector 1 is opposite source point) and retarding voltage



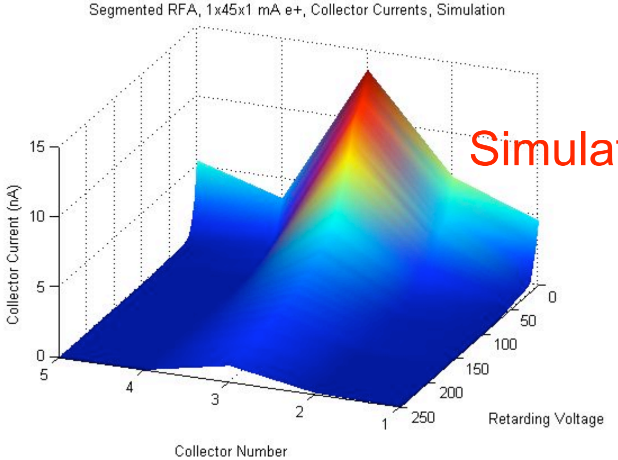


Dots: data
Solid: simulation





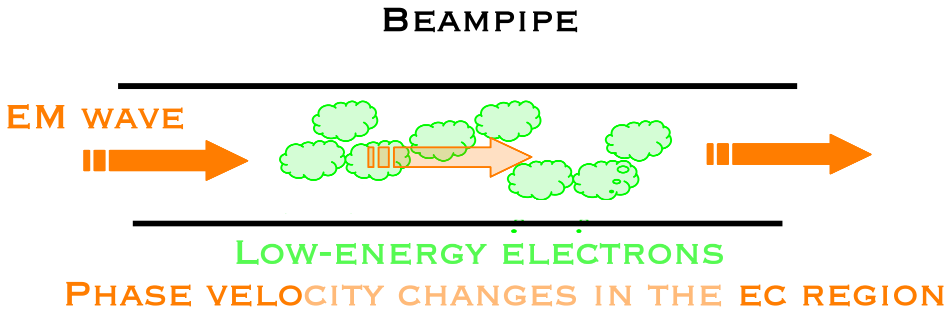
Data



Simulation

G. Dugan

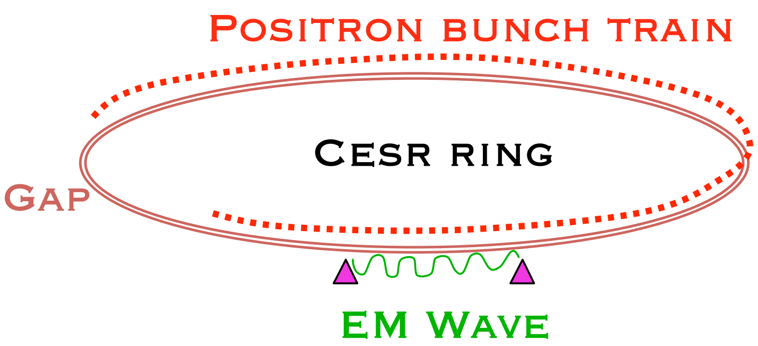
Induced phase modulation in the propagation of EM waves through the beampipe

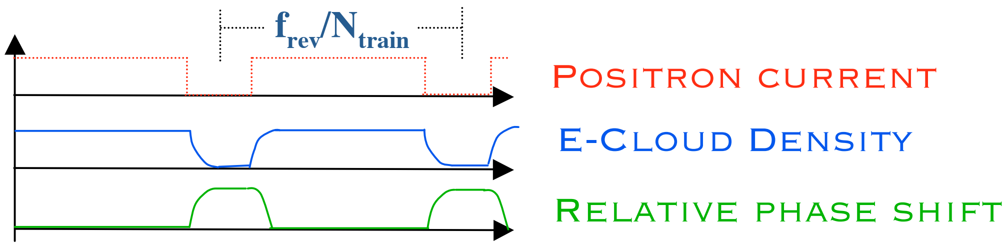


$$k^2 = \frac{\omega^2 - \omega_c^2 - \omega_p^2}{c^2}$$

plasma frequency

$2c(\pi\rho_e r_e)^{1/2}$





Gaps in the fill pattern set the fundamental modulation frequency (1st sideband). Higher order components depend on the transient ecloud time evolution during the gap passage.

S. De Santis

New 3D Wiggler Results Show Electrons Move to Center and Trap at z where B_y=0

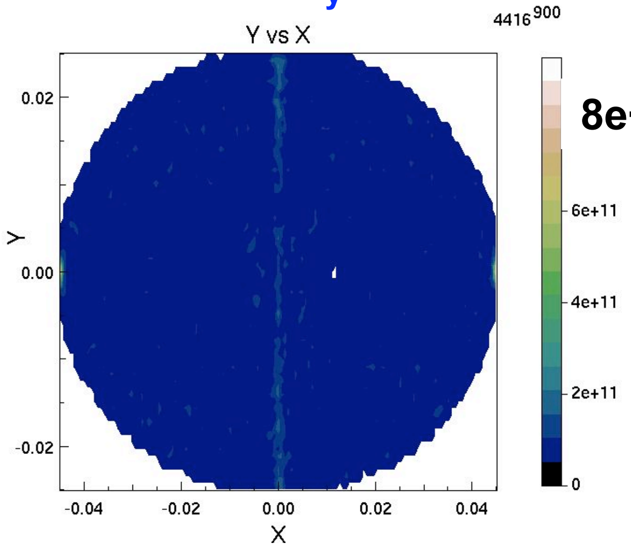
WARP-POSINST

Density scale TBD

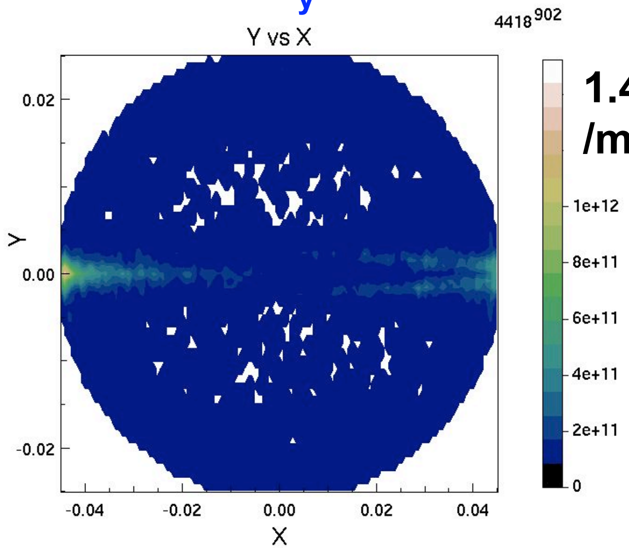
At Peak B_y (1.9 T)

At B_y=0

After 40th Bunch of 45-bunch train



8e+11/m^3



1.4e+12 /m^3

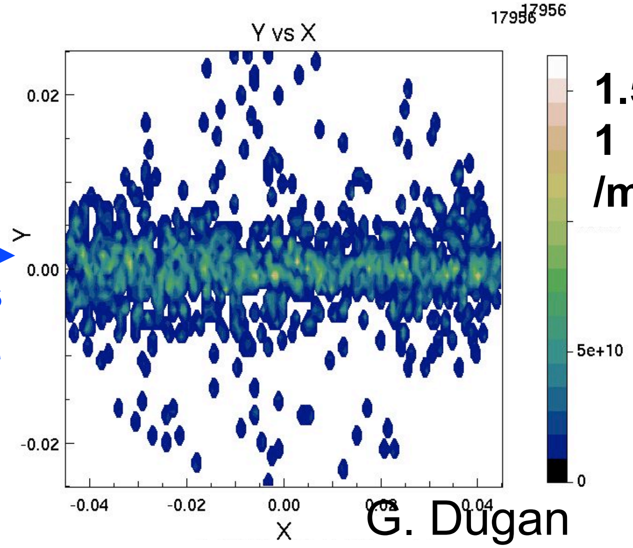
"Stripe" forms where SEY is high.

B gradient & curvature cause drift in x

2 μs after bunch train

No electrons left at peak B_y

~30% of electrons still present



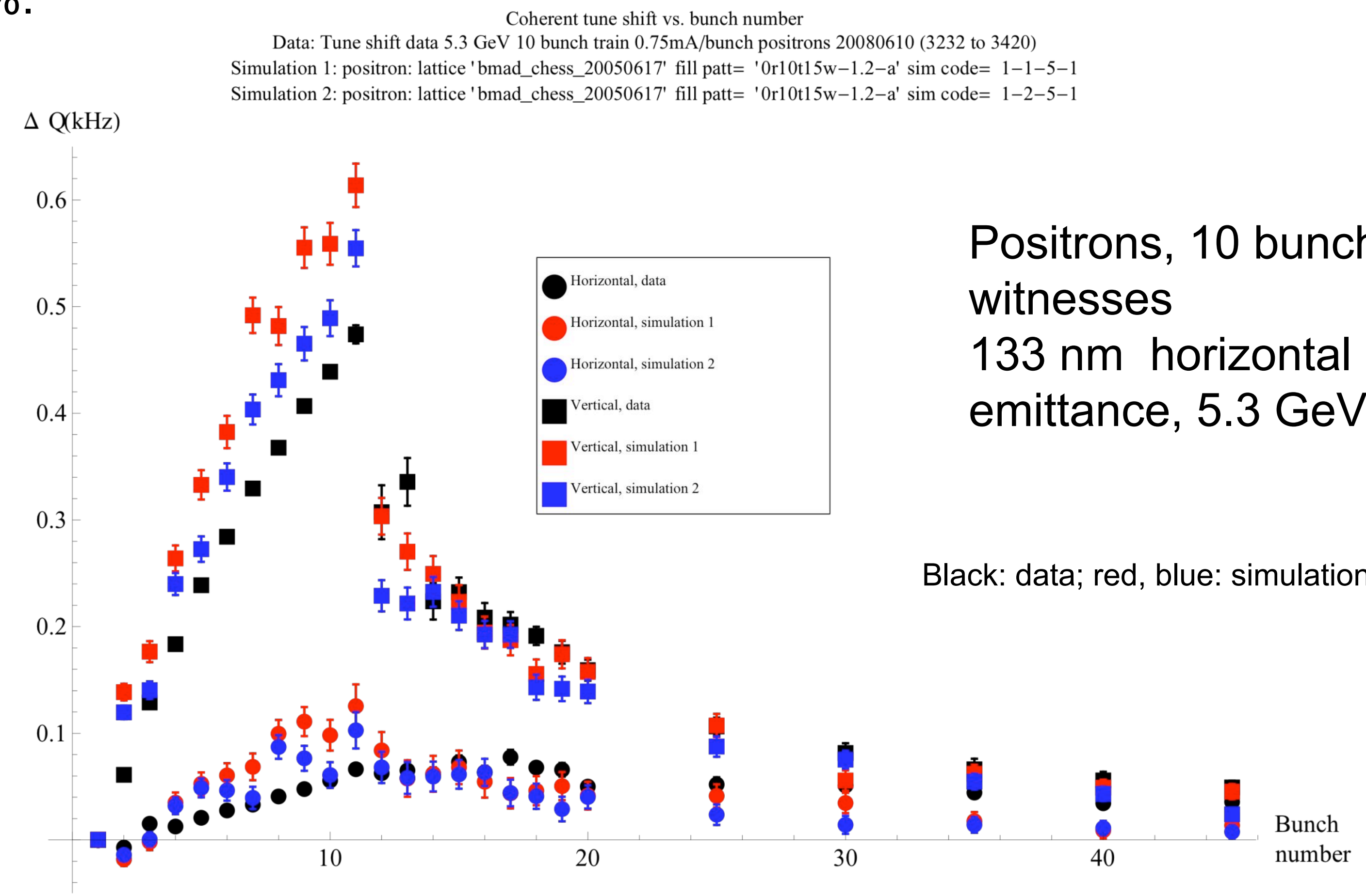
1.5e+11 /m^3

G. Dugan

photon reflectivity = 20%

Coherent tune shifts (5)

Witness bunch data taken in June, 2008, at 5.3 GeV. Red points: Same cloud model parameters as in slide 17; blue points: quantum efficiency reduced by 20%.



Positrons, 10 bunch train + witnesses
133 nm horizontal emittance, 5.3 GeV

Black: data; red, blue: simulations

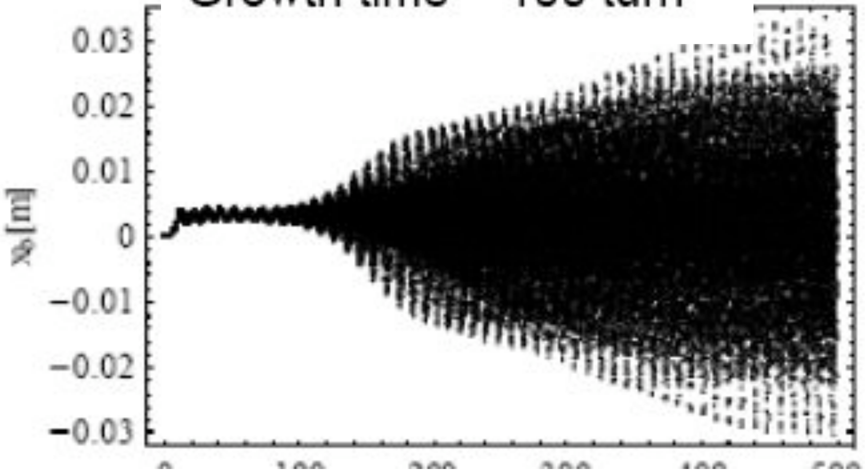
POSINST

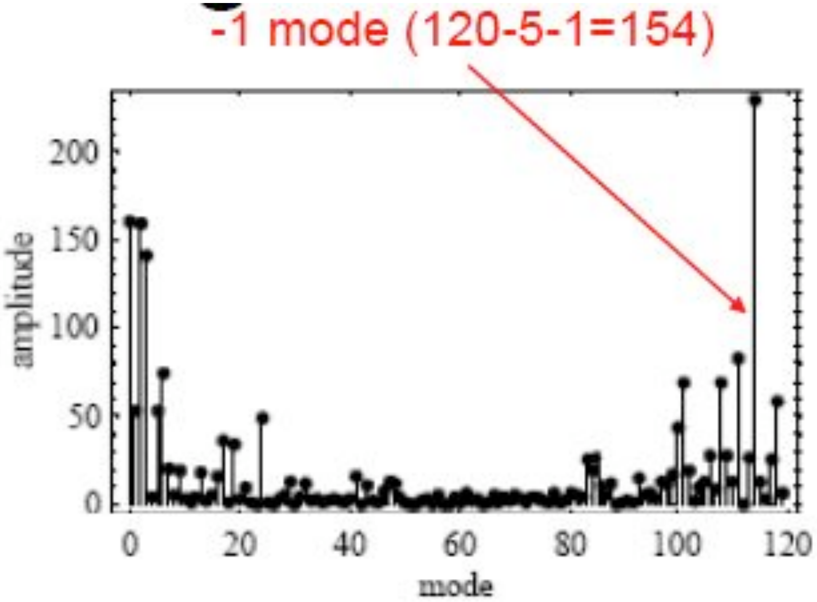
E-cloud at DAFNE

120 equispaced bunches

Beam current 1.2 A

Growth time ~ 100 turn





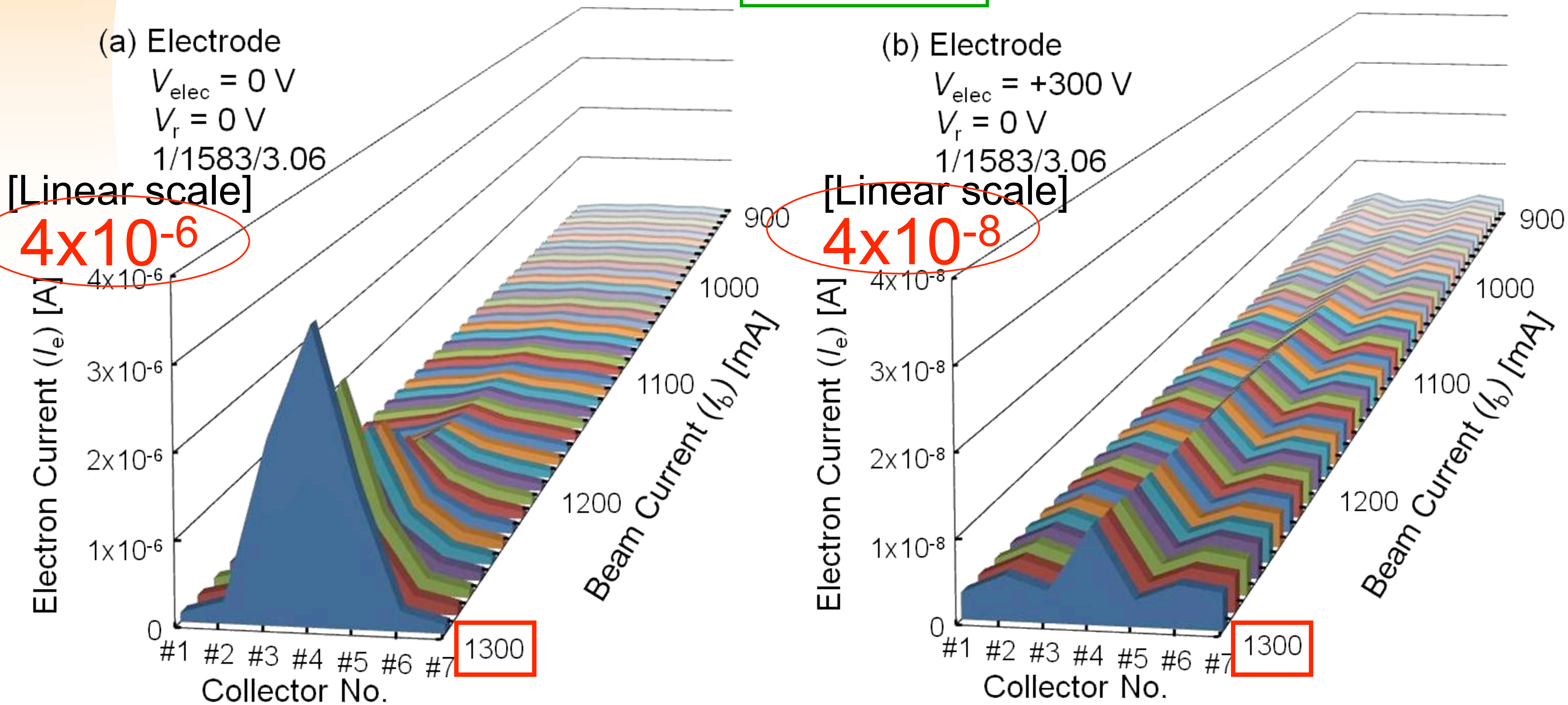
- Coupled-bunch instability has been simulated using PEI-M for the DAFNE parameters
- Preliminary results are in qualitative agreement with grow-damp measurments

Clearing electrode in KEKB wiggler

- **Spatial growths of EC for clearing electrode**
  - EC for V_{elec} = + 300 V was much smaller than the case for V_{elec} = 0V.

Preliminary result (2009)

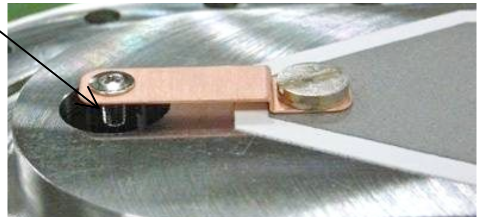
1585 bunches (B_s ~ 6 ns)

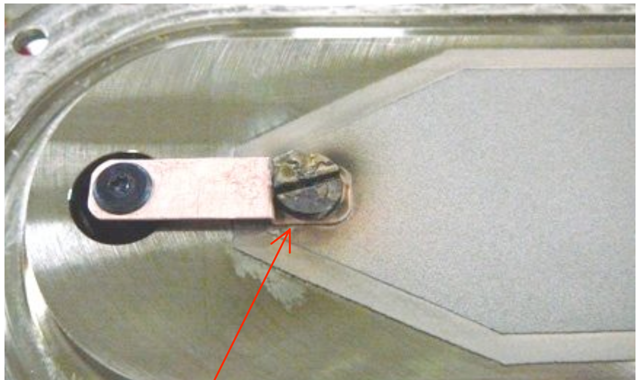


Clearing electrode in KEKB wiggler

- **A key issue: development of a reliable connection to feed through**
  - We had a trouble in the previous version.
  - A revised electrode is under test now (2009).

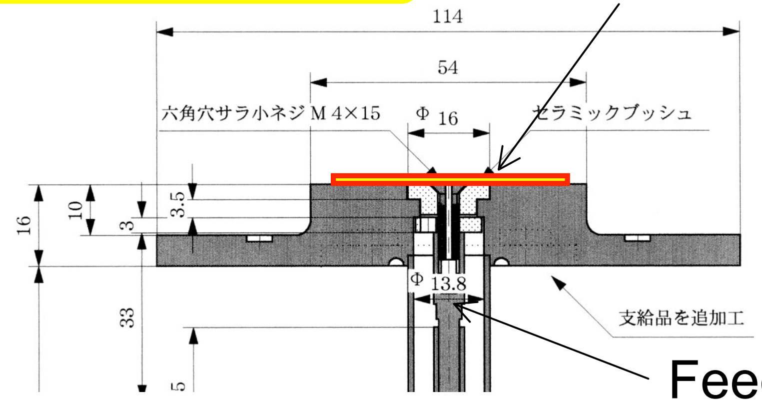
Feed through



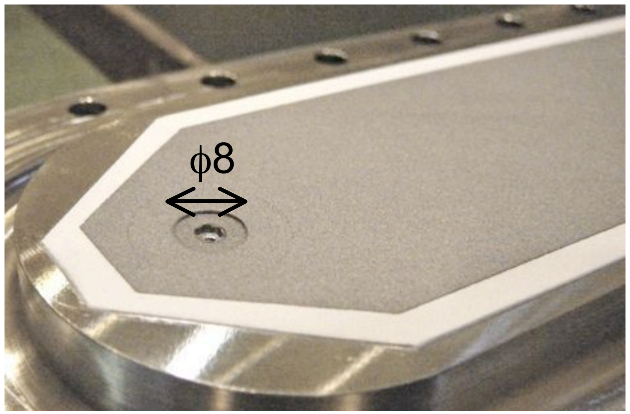


Discharging !

Electrode



Feed through



Conclusion

Progress in crucial R&D is very significative.