



# Diagnostics of low-charge electron bunches at REGAE

**Shima Bayesteh** Hamburg University

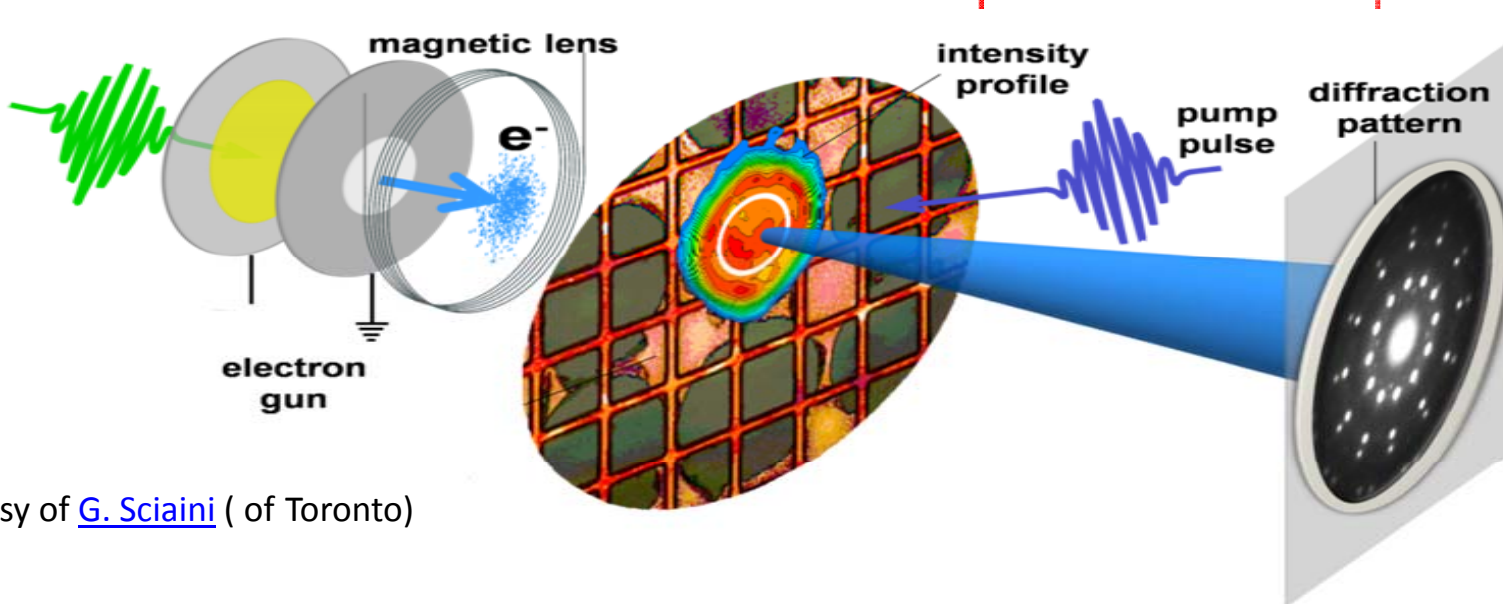
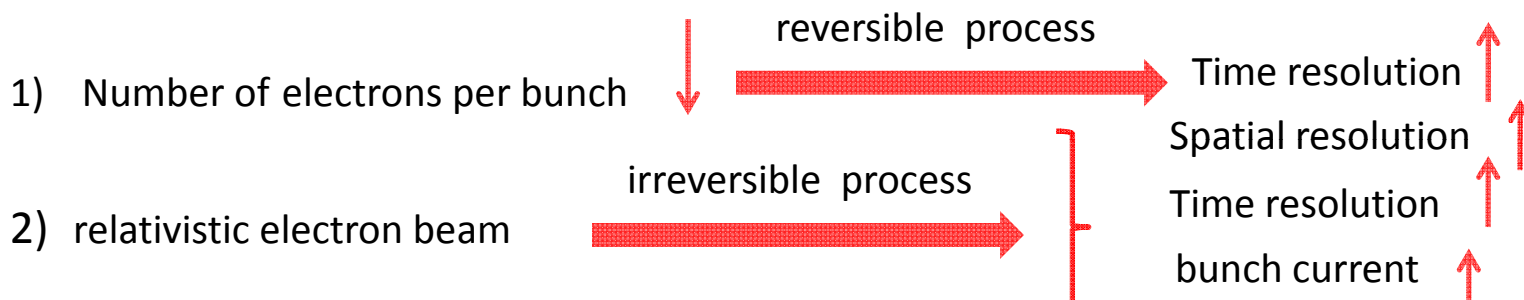
for REGAE team

DPG, Karlsruhe, March 2011

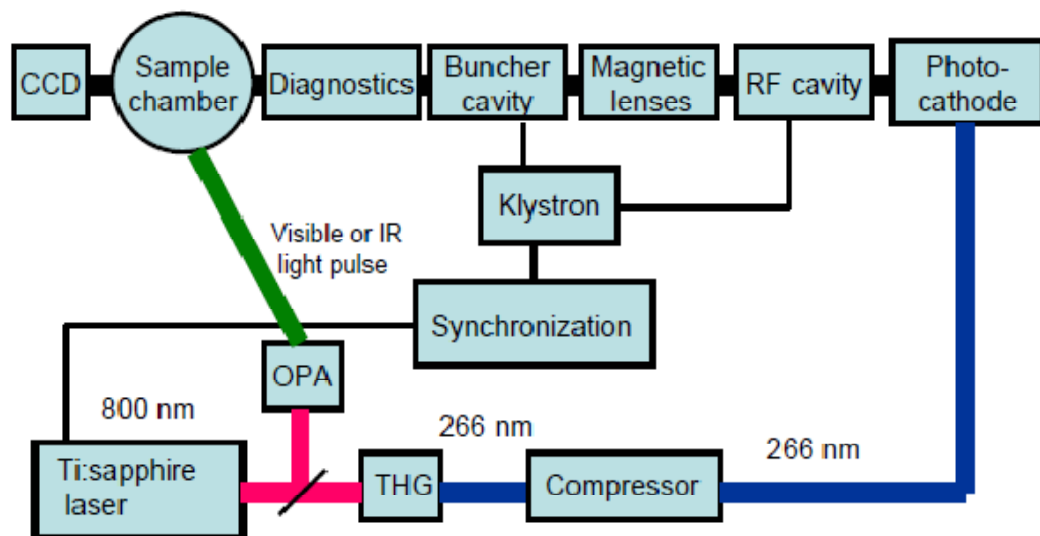
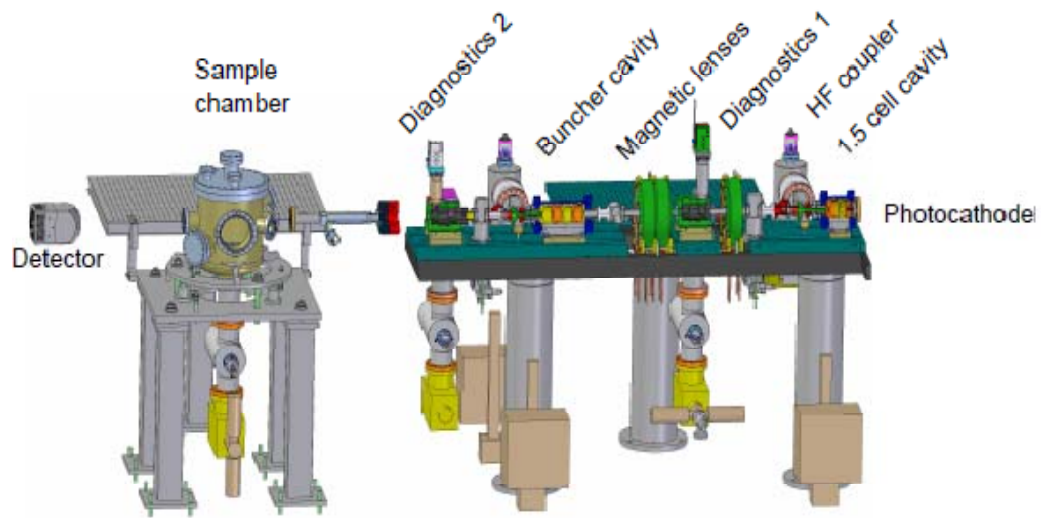
## REGAE (Relativistic Electron Gun for Atomic Exploration)

Femtosecond Electron Diffraction (FED): Fundamental information on ultra fast atomic processes or making a molecular movie,

How to solve Space-charge problem?



Courtesy of [G. Sciaini](#) ( of Toronto)



# Beam requirements

## single shot capability

Electron beam energy	2-5 MeV
Bunch charge	100fC ~ $10^6$ electrons
Bunch length	30 fs (9 $\mu$ m)
Coherence length	30nm
Transverse emittance	$6 \times 10^{-3}$ mrad mm
rep. rate	50 Hz



Scintillator screens are used for diagnostics of transvers profile.



For charged particles : high density materials to increase energy loss by collision.

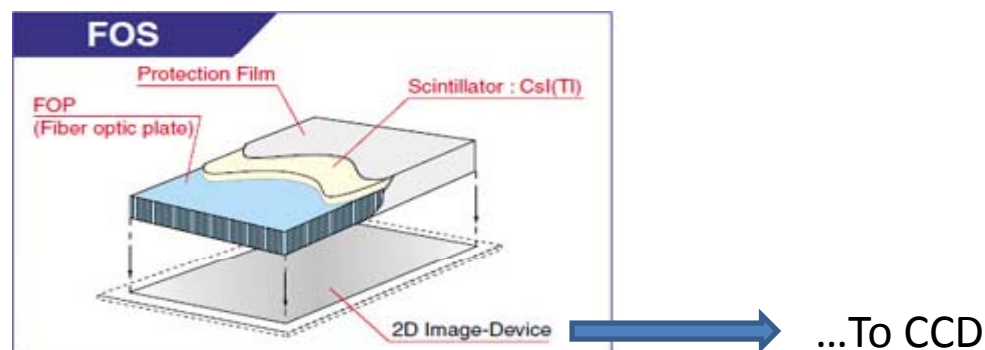
	LYSO *	CsI(Tl)
Density (g/cm <sup>3</sup> )	7.4	4.51
Effective Atomic Number	66	54
Decay Constant (ns)	40-44	1000
Peak Emission (nm)	428	560
Light Yield /MeV	27000	51800
Index of Refraction	1.82	1.79

\* Cerium-doped Lutetium Yttrium Orthosilicate



- Type of scintillators and their thicknesses can be studied.
- a general purpose Monte-Carlo program simulating light propagation in isotropic or anisotropic media. <http://gentitfx.fr/litrani/>
- The program takes into account the variation of the physical parameters as a function of the wavelength.
  - scintillation properties
  - Absorption length
  - Stopping power
  - Refractive index

Fiber Optic Plate (FOP) is used to transfer an image without using a lens. They consist of a large number of optical fibers bundled together.



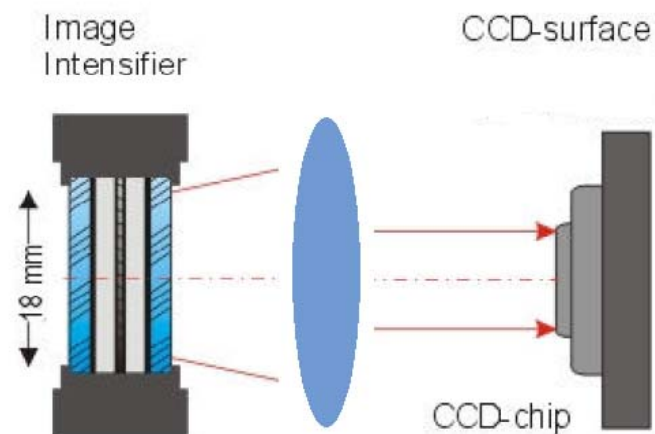
- ✓ CsI(Tl) & Gd<sub>2</sub>O<sub>2</sub>S (terbium-doped gadolinium oxysulfide) offered by Hamamatsu.
- ✓ Proxitronic also offers the same product coated with other crystals.



➤ I+CCD

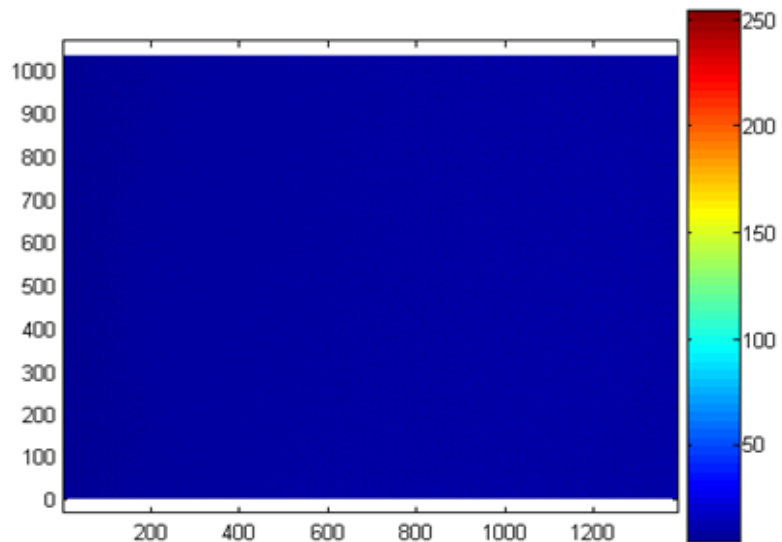


➤ EMCCD

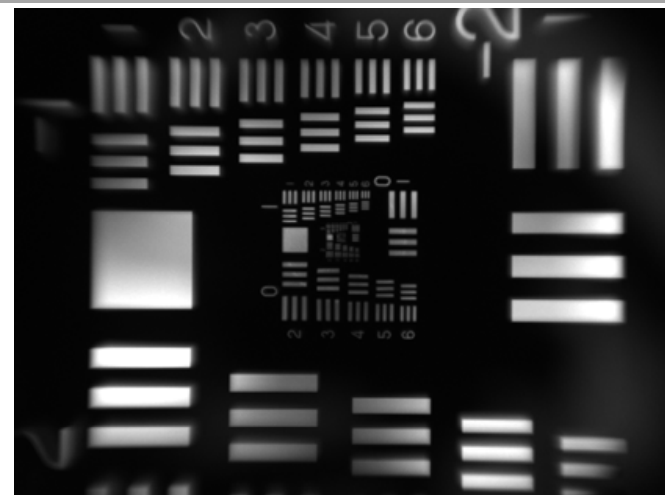


	ICCD(GENII)	ICCD (GENIII)	EMCCD
Gating	Can reach to 2ns		3μs
QE	>15%	>70%	>70%
Coupling to CCD	☹	☹	☺
Price	☺	☹	☹

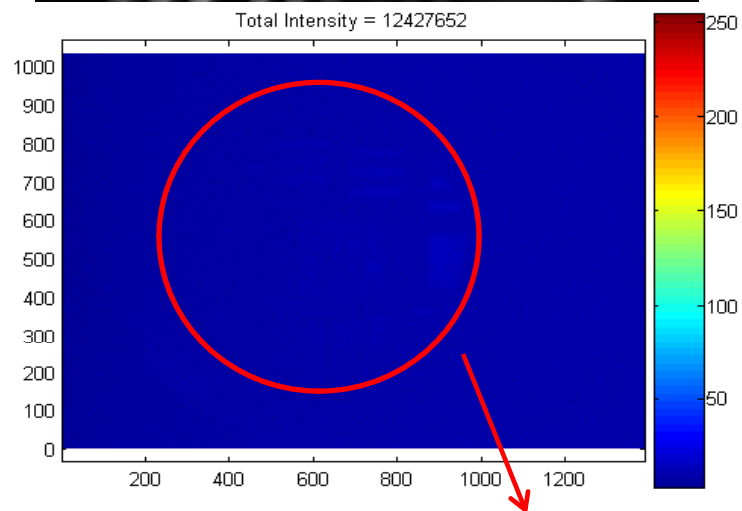




Background

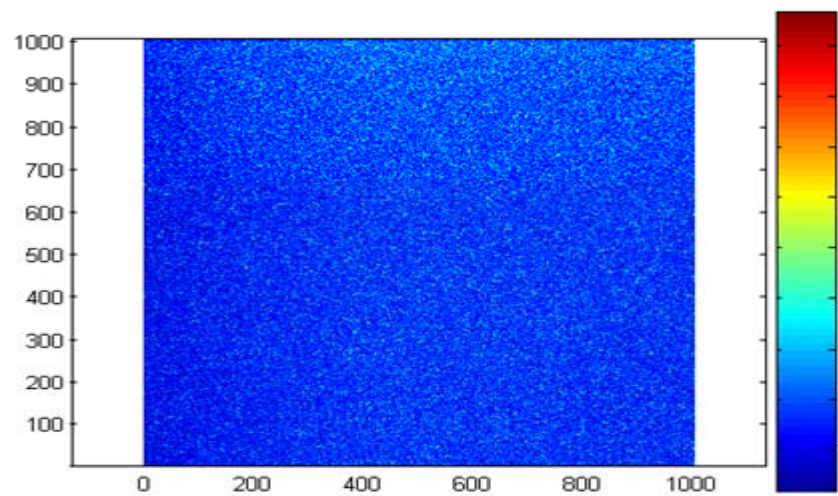


Total Intensity = 12427652

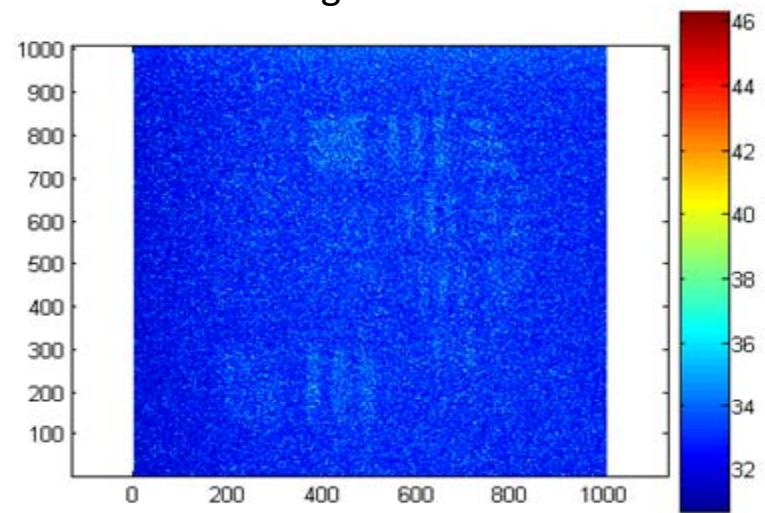


Region of interest  $(24 \pm 2)$  photons per pixel

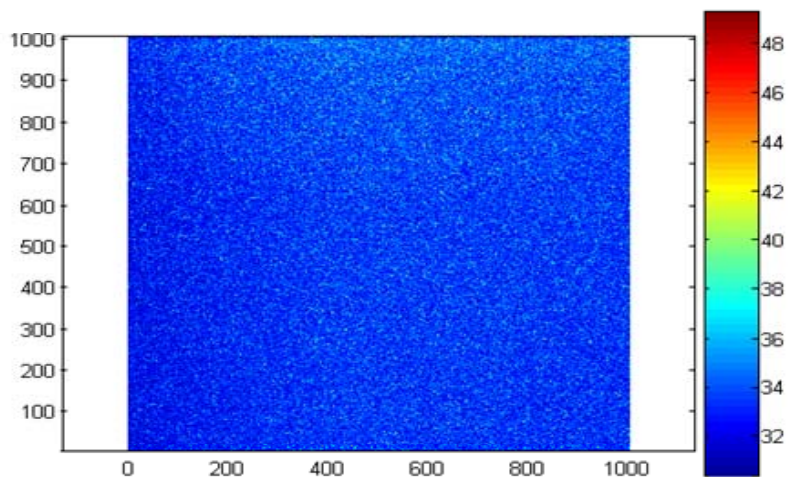
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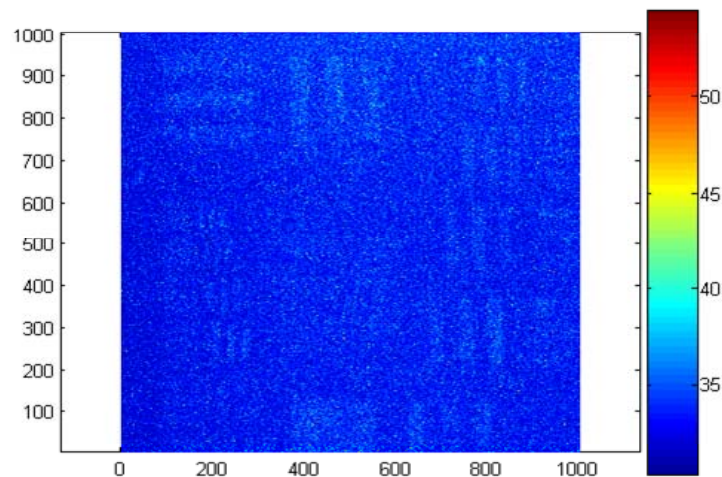
Signal



Background



Signal



EMCCD has the potential to detect few photons per pixel and is appropriate for low-charge diagnostics but other detectors should be tested.

- The first version of diagnostics stations are ready for commissioning at April 2011.
- New image intensifiers and different scintillators efficiency should be investigated for the next version of diagnostics.
- We hope to have the first beam in REGAE by summer 2011.

# Acknowledgments



**K. Floettmann<sup>1</sup>, H. Delsim-Hashemi<sup>1</sup>, R. J. D. Miller<sup>2,3</sup>, M. Huening<sup>1</sup>, S.Lederer<sup>1</sup>, J. Hircht<sup>2</sup>, D.A. Mazurenko<sup>2</sup>, D. Zhang<sup>2</sup>, G. Moriena<sup>3</sup>**

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Thanks for your attention!

