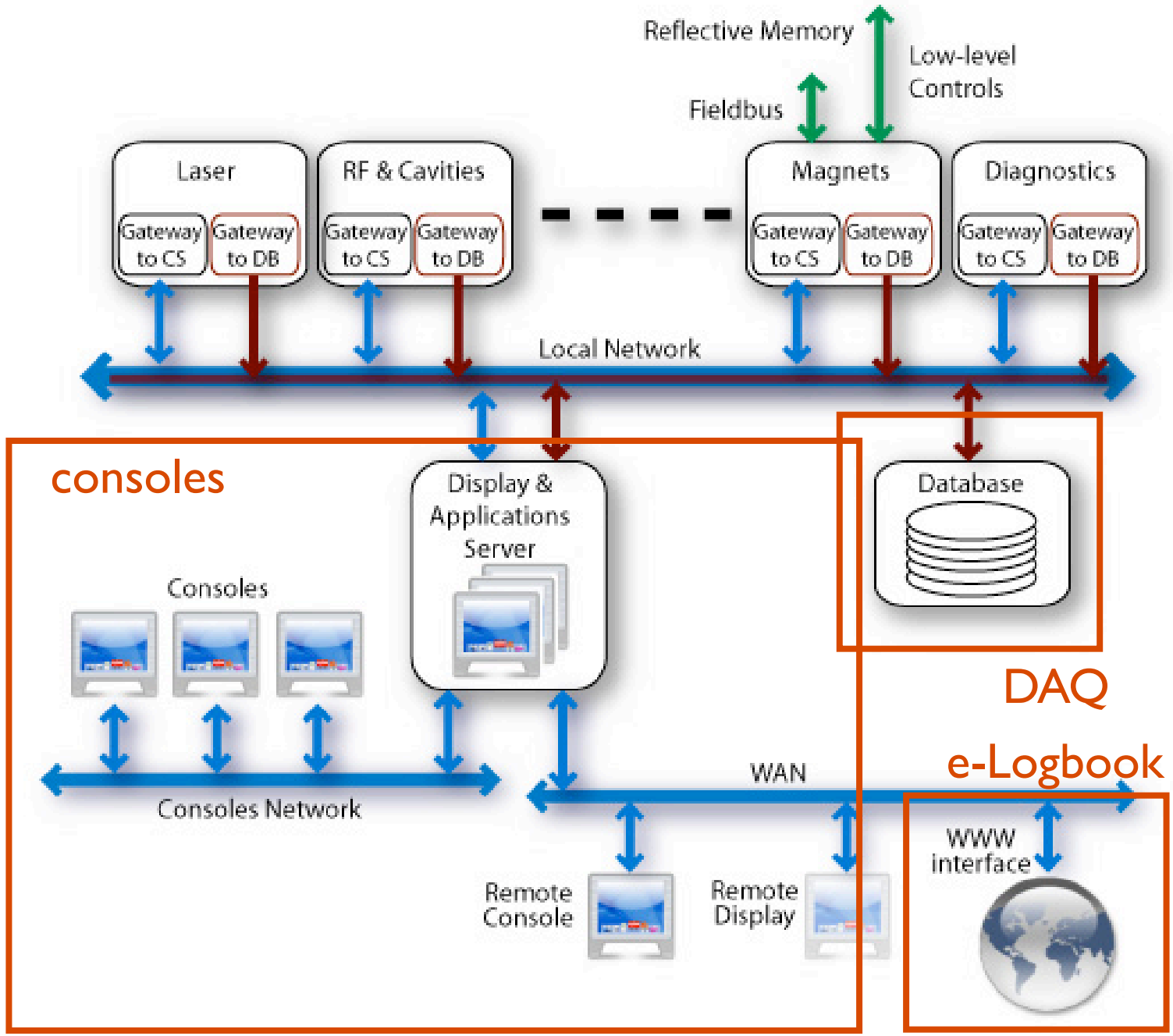
Diagnostics & Controls activities at Roma2

INFN-Roma2
Università Roma2 "Tor Vergata"

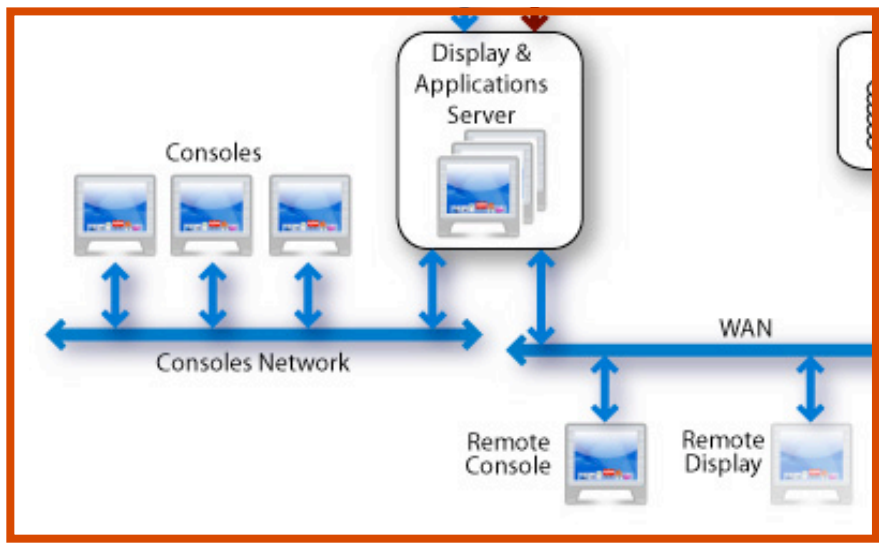
Activities

- diagnostics
  - gun emittance-meter
  - optical diagnostics-OTR (Emitt&Twiss Params, Energy, etc.)
  - bunch length
- controls
  - design of the console system
  - e-Logbook
  - DAQ

Controls

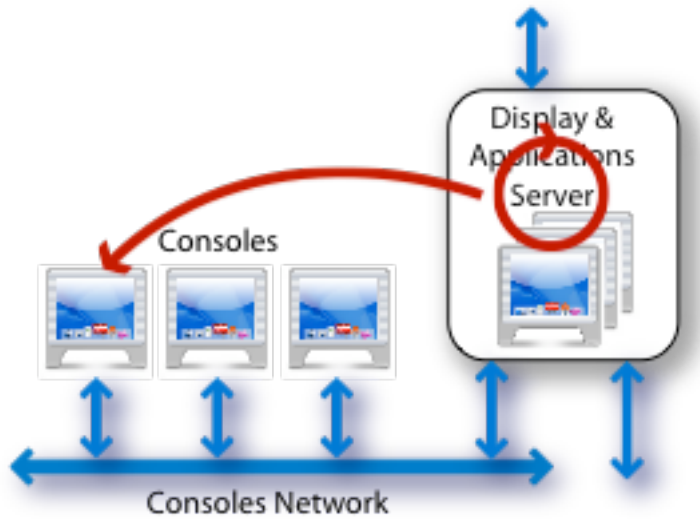

Reflective Memory
Low-level Controls
Fieldbus
Laser
RF & Cavities
Magnets
Diagnostics
Gateway to CS
Gateway to DB
Local Network
consoles
Display & Applications Server
Database
Consoles
DAQ
e-Logbook
WAN
Consoles Network
WWW interface
Remote Console
Remote Display

consoles



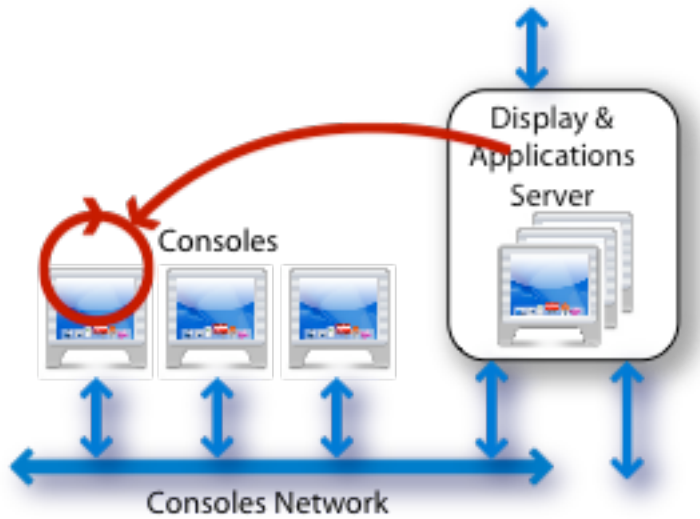
- are intended to be the part of the control system where display programs and high–level applications (measurements, analysis tools, etc.) run
- can be simple displays or “intelligent” components of the control system
- consoles in the control room must be equipollent
- remote operations should also be possible

possible configurations to investigate



- thin-clients (Dafne)
- workstations (TTF)
- hybrid (Linux Terminal Sever)
- other..(distributed resources- ex. openmosix.org)

possible configurations to investigate



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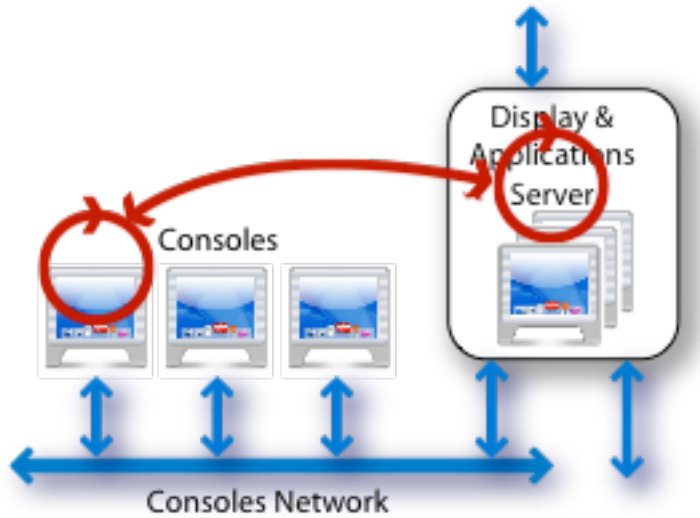

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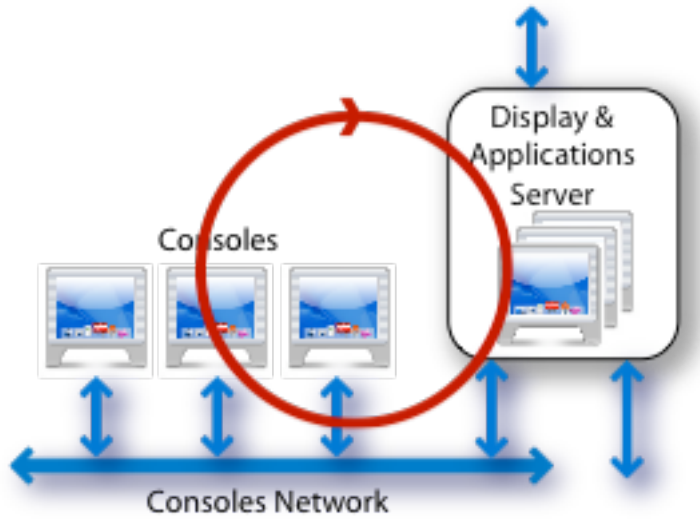

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- workstations (TTF)
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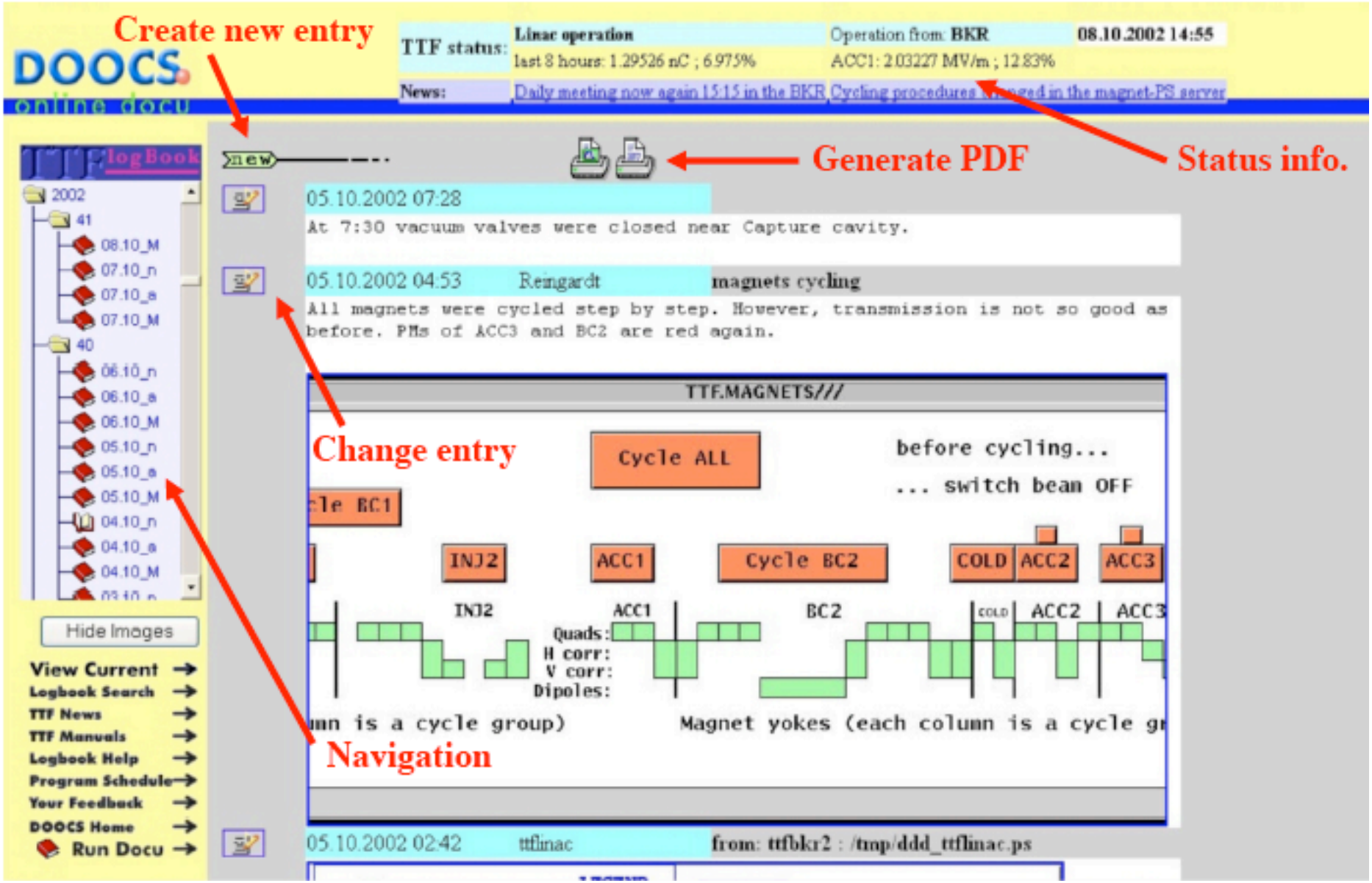
- other..(distributed resources- ex. openmosix.org)

e-Logbook

- the electronic implementation of the operations logbook provides very useful features:
  - easy to use (interface is a web browser) and platform independent
  - easy to consult (also from remote!) and to back-up
  - possibility to easily add graphs and snapshots from operator consoles
  - essential for remote operations



TTF e-Logbook (R. Kammering, O. Hensler, A. Petrosyan, K. Rehlich)

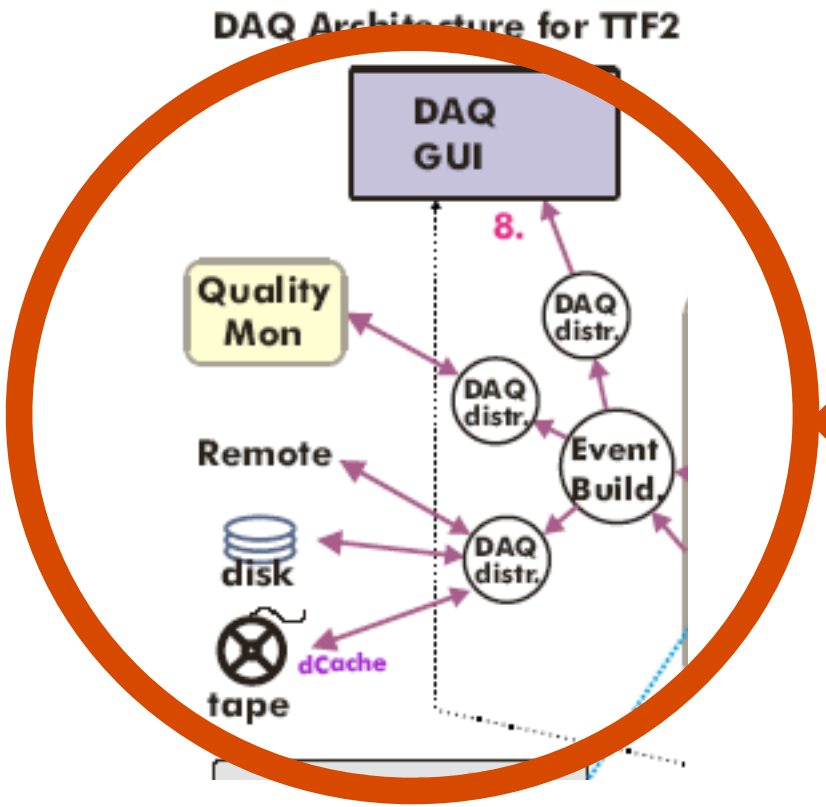
e-Logbook

- possible solutions:
  - use the TTF e-Logbook (but we have limited experience with the software tools used for its development)
  - new development based on different software tools (if it will be worth the time needed) gives the possibility to better integrate it in the control system

Data AcQuisition system

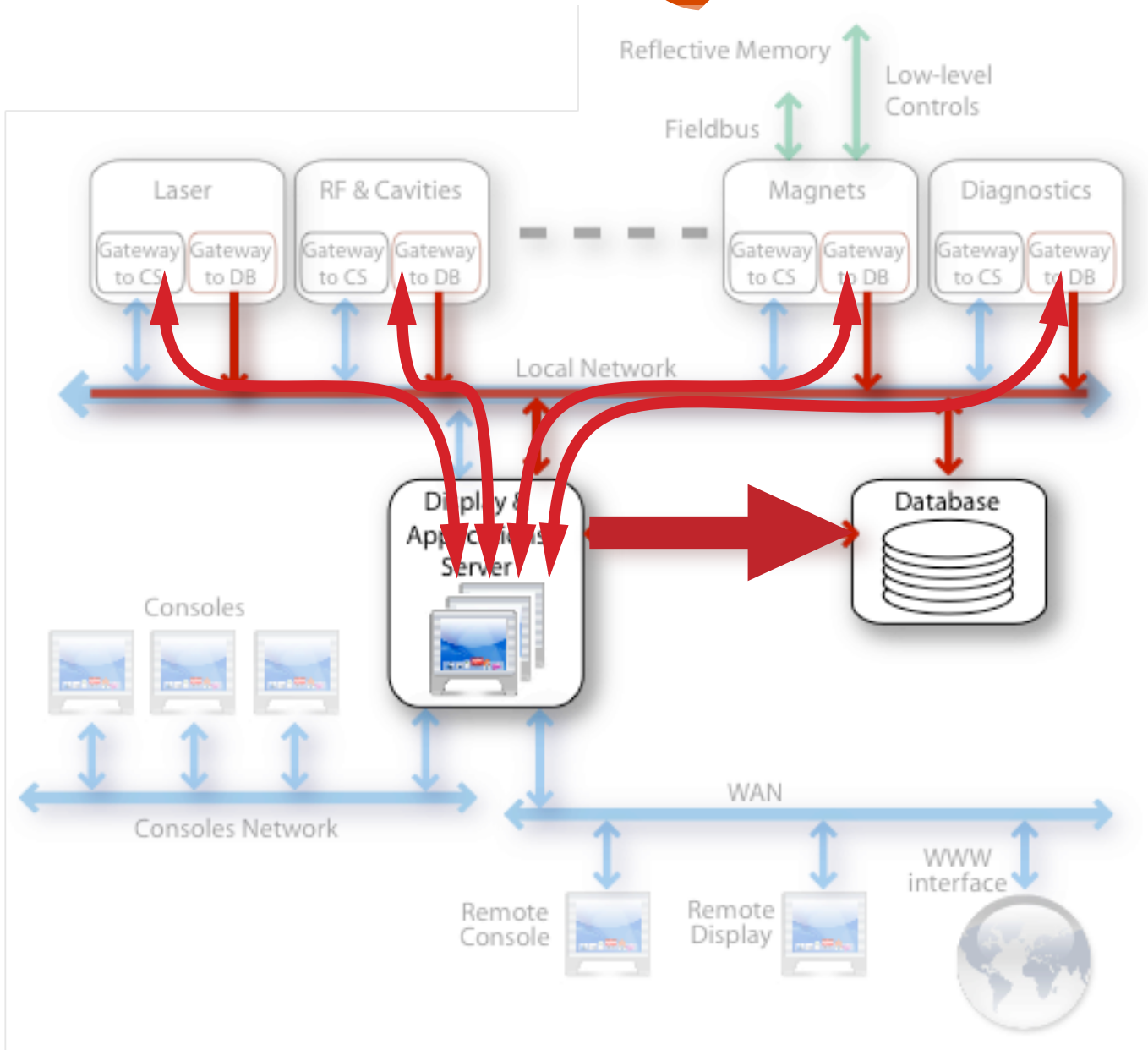
- will automatically capture and store relevant information from the accelerator system
- will "take pictures" of settings and status values of accelerator equipments and diagnostics in order to later recover and reproduce the status of the system for off-line analysis
- time scale can be bunch repetition rate; in analogy with HEP Experiments acquisition system it can be considered as an "event"

DAQ



display and application server

DAQ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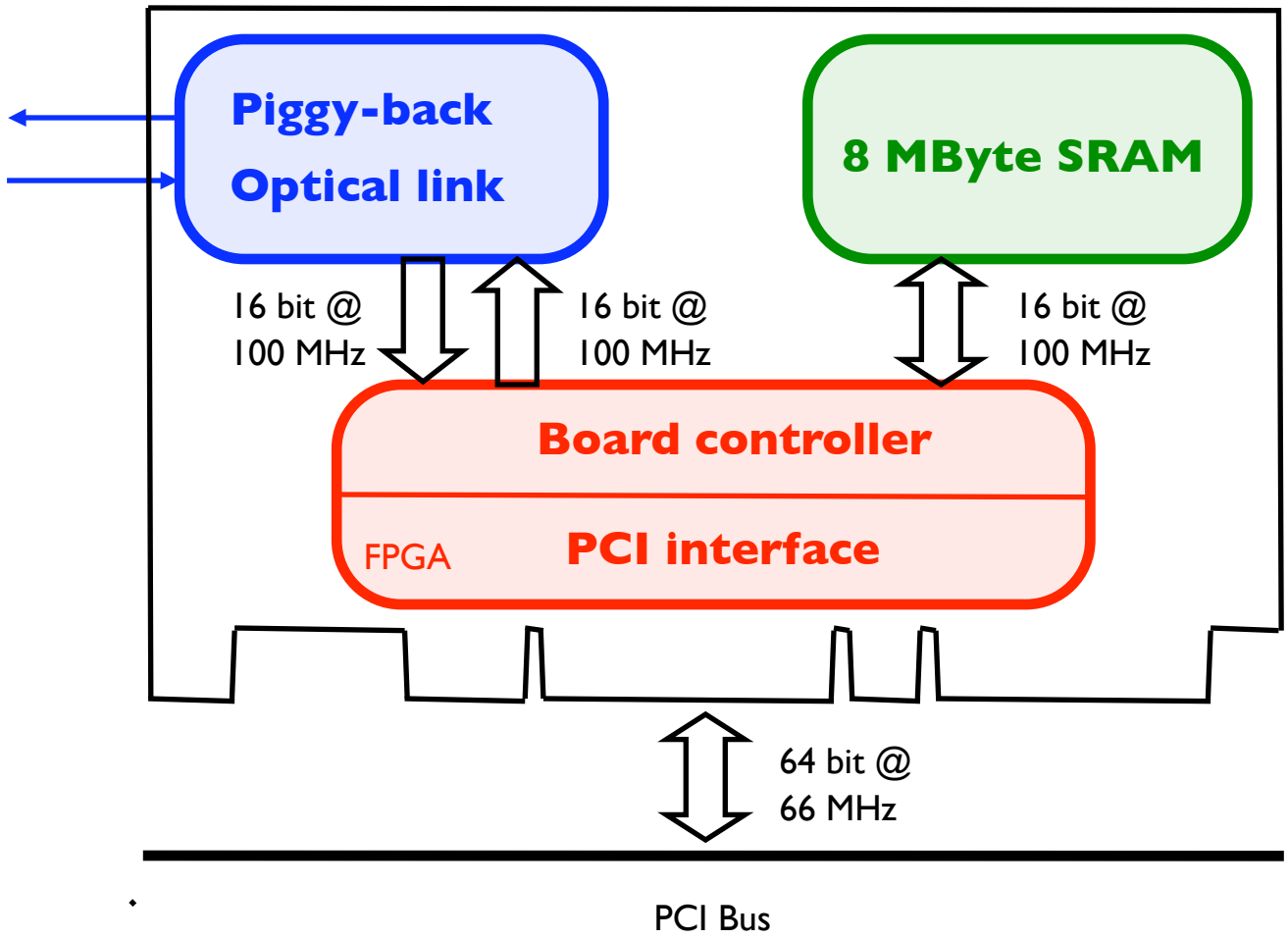
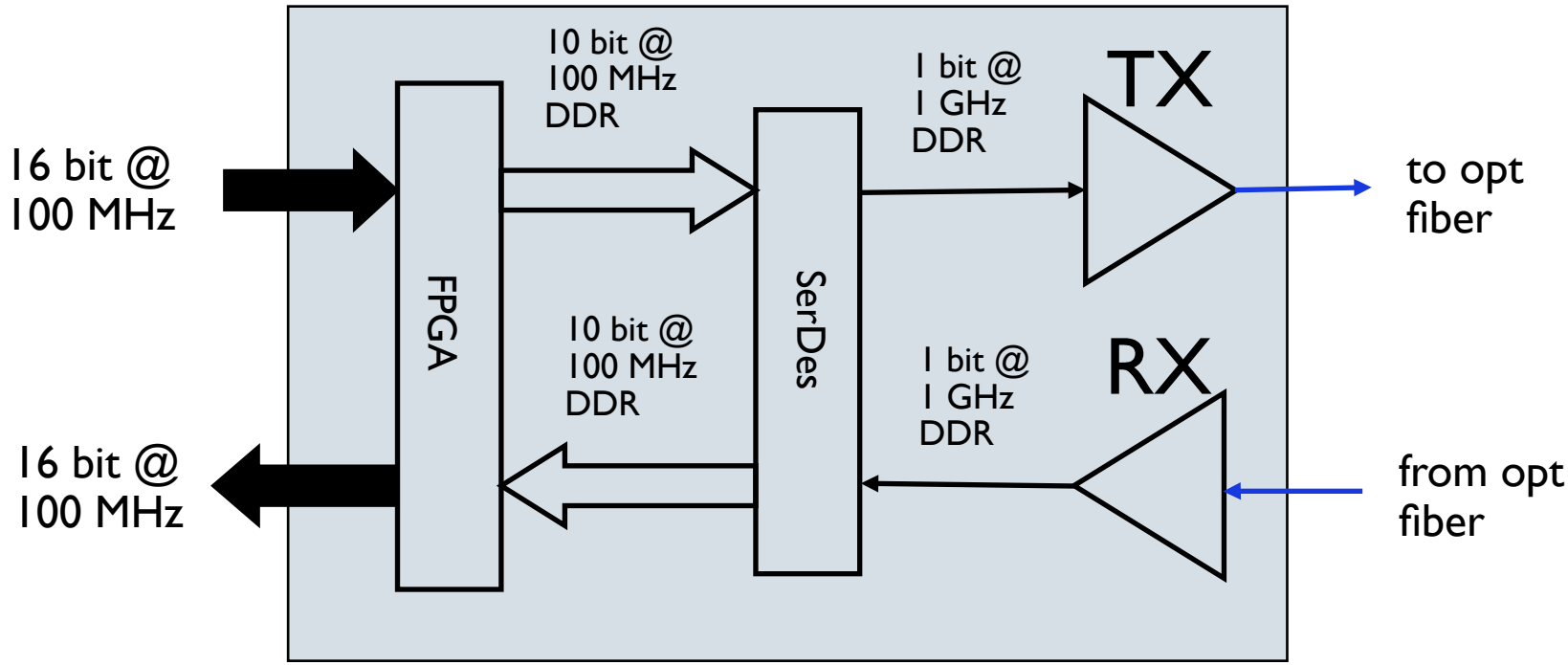
Reflecting memory board

- PCI master-target interface 64 bit x 66 MHz
- 8 MByte on-board memory
- 2 or 1 Gbps bidirectional optical link for board to board communication (0.5 to 300 m)
- Reflecting memory
- Data from optical link sent to the on-board memory without using the PCI bus
- Changes of the on-board memory notified to the host PC via the PCI bus
- Only modified memory blocks are written to PCI
- Of course also direct PCI to/from optical link and PCI to/from on-board memory data transfers are possible

Reflecting memory board



Piggy-back optical link



- Piggy-back: can be plugged on different host boards
- FPGA for 8b/10b encoding and single data rate to double data rate conversion
- Agilent HDMP-2630B/HDMP-2631B serializer-deserializer
- Agilent HFBR-5720AL/5720ALP optical transceiver

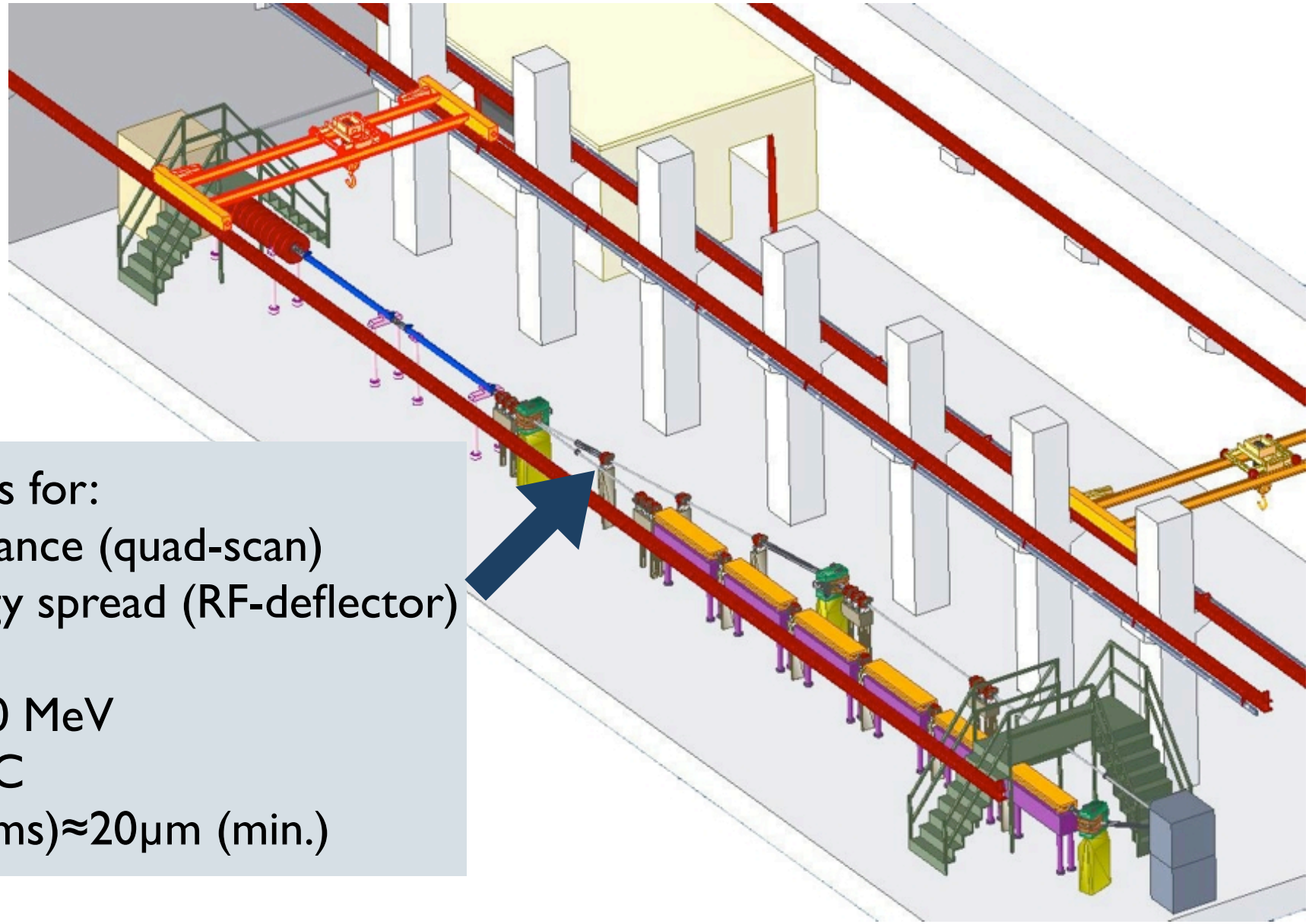
Costs

- Altera Acex 1K 100: 100 Euro
- Optical transceiver Agilent HFBR-5921L: 89 Euro
- SerDes circuits Agilent HDMP-2630B: 21 Euro
- Altera MAX or Actel: ??
- 8 MByte Cypress SRAM: ??
- PCB manufacturing: ??

Open issues

- Radiation hardness
- Simulations to check for maximum FPGA working frequency and PCB traces propagation delay

Optical Diagnostics

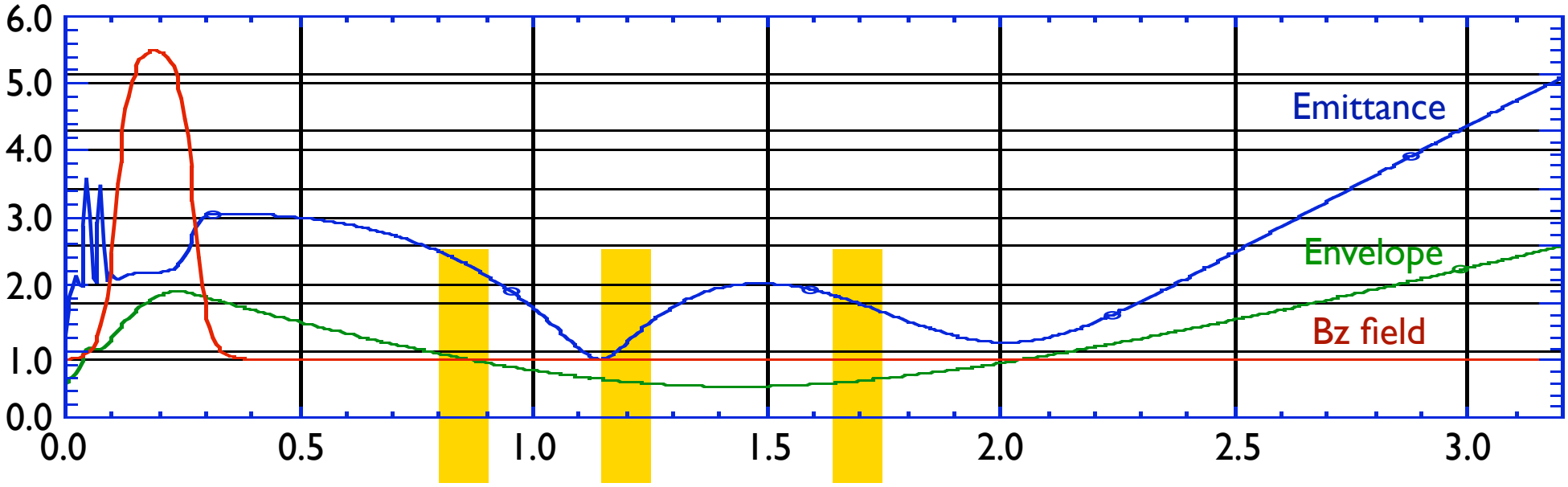


Stations for:
- emittance (quad-scan)
- energy spread (RF-deflector)

En≈150 MeV
Q= 1nC
σ xy(rms)≈20μm (min.)

gun emittance-meter

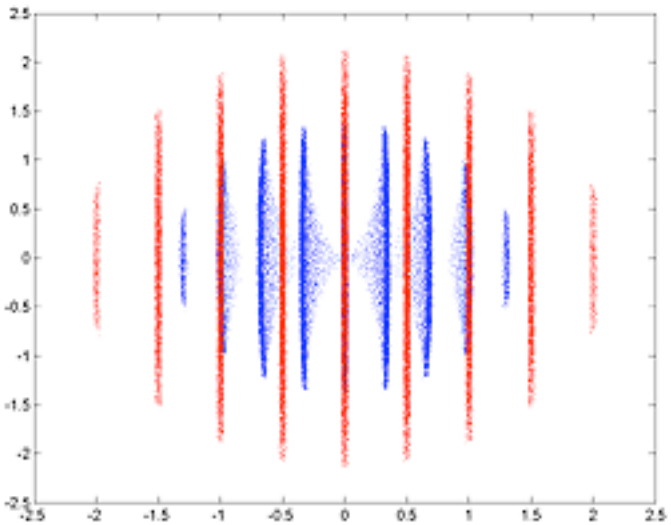
- simulations
  - provided better understanding of the measurement: converging or diverging beam will result in different measurement conditions
  - the read-out system will be able to provide the needed resolution, but the analysis procedures should be optimized according to the different situations
- updates from LNF-Vacuum Group (A.Clozza, V.Lollo)
  - mechanical drawing of the movable measurements system is in progress
  - the multi-slit pepper-pot has been designed and is now under fabrication

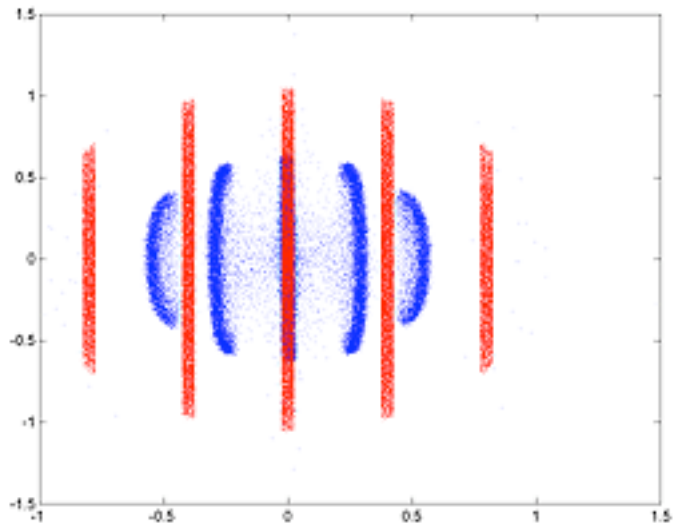


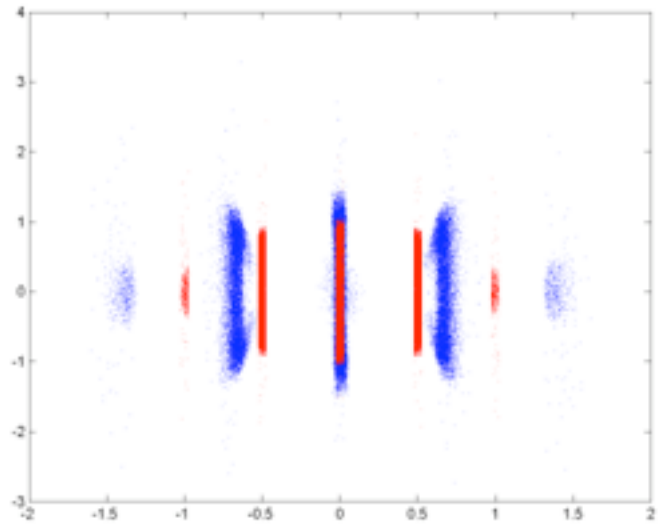
Z= 85 cm

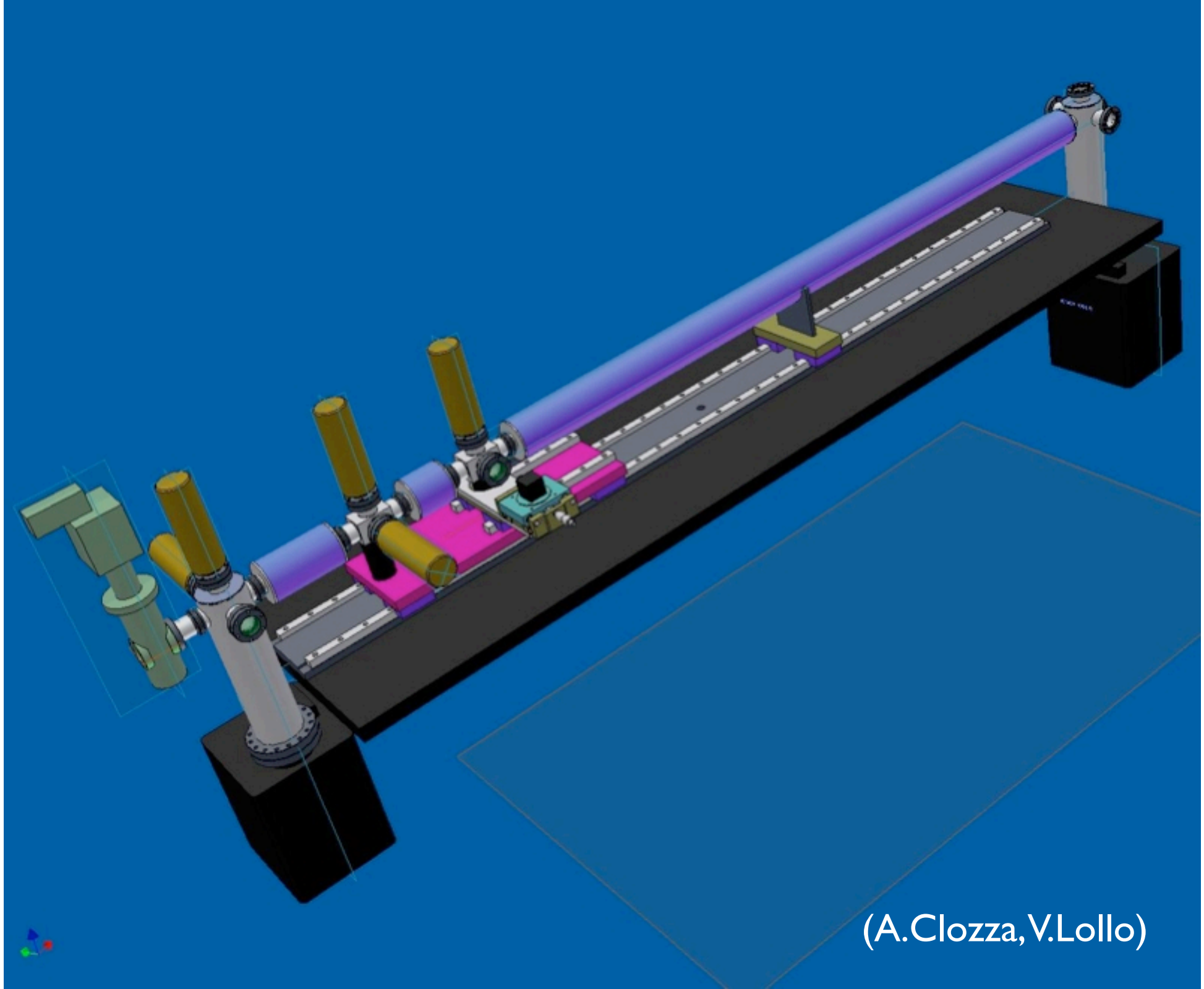
Z= 120 cm

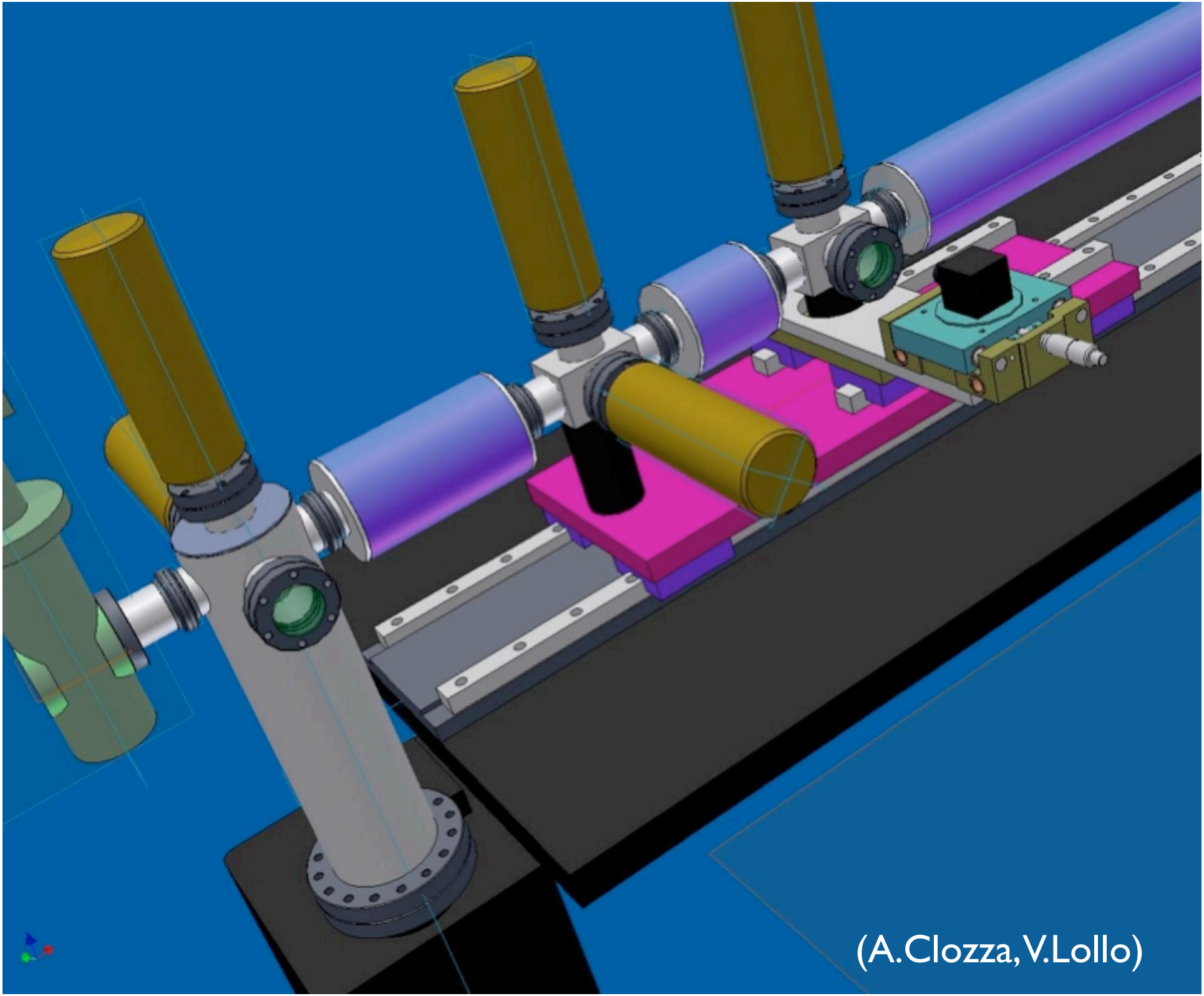
Z= 170 cm








(A.Clozza, V.Lollo)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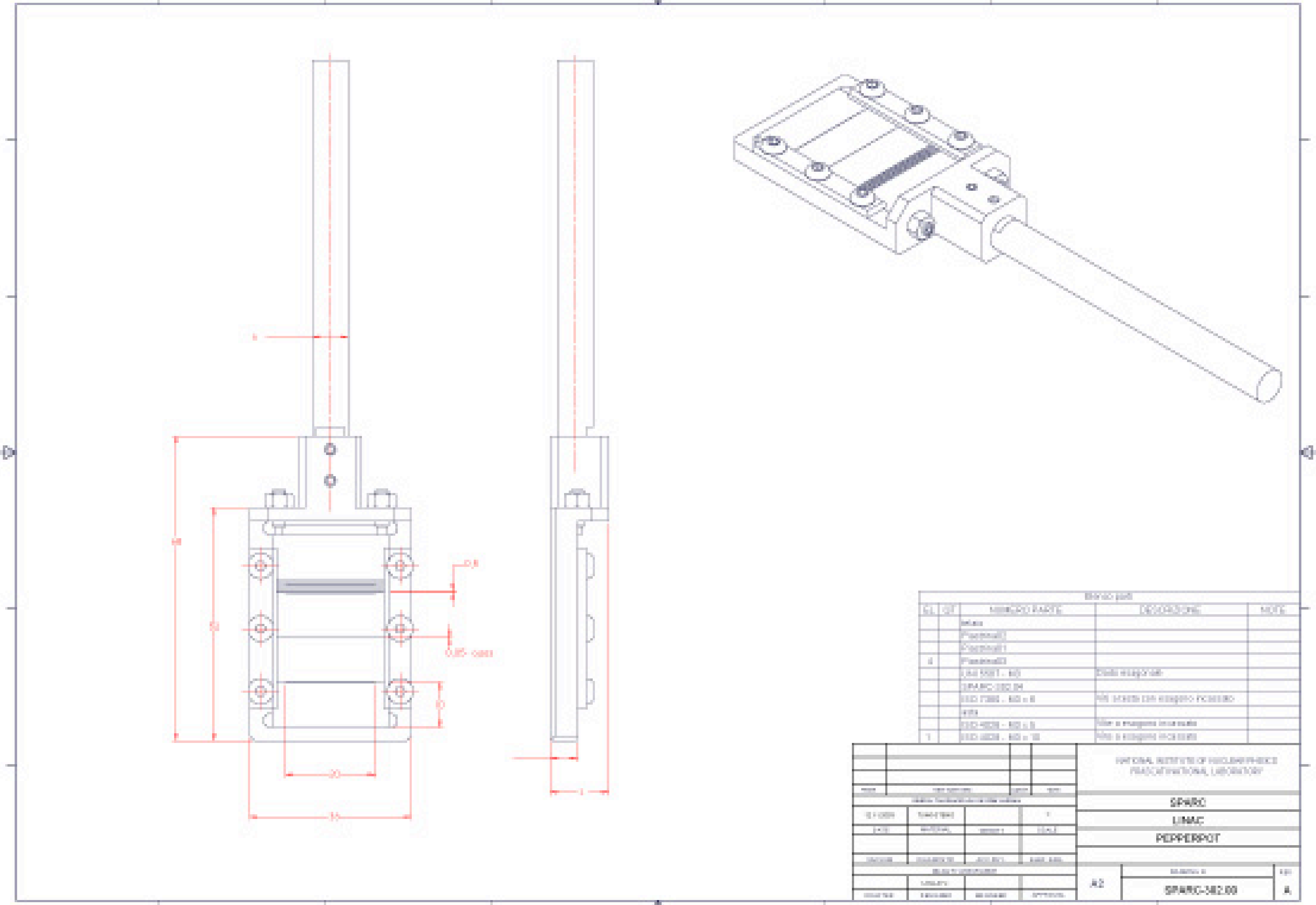
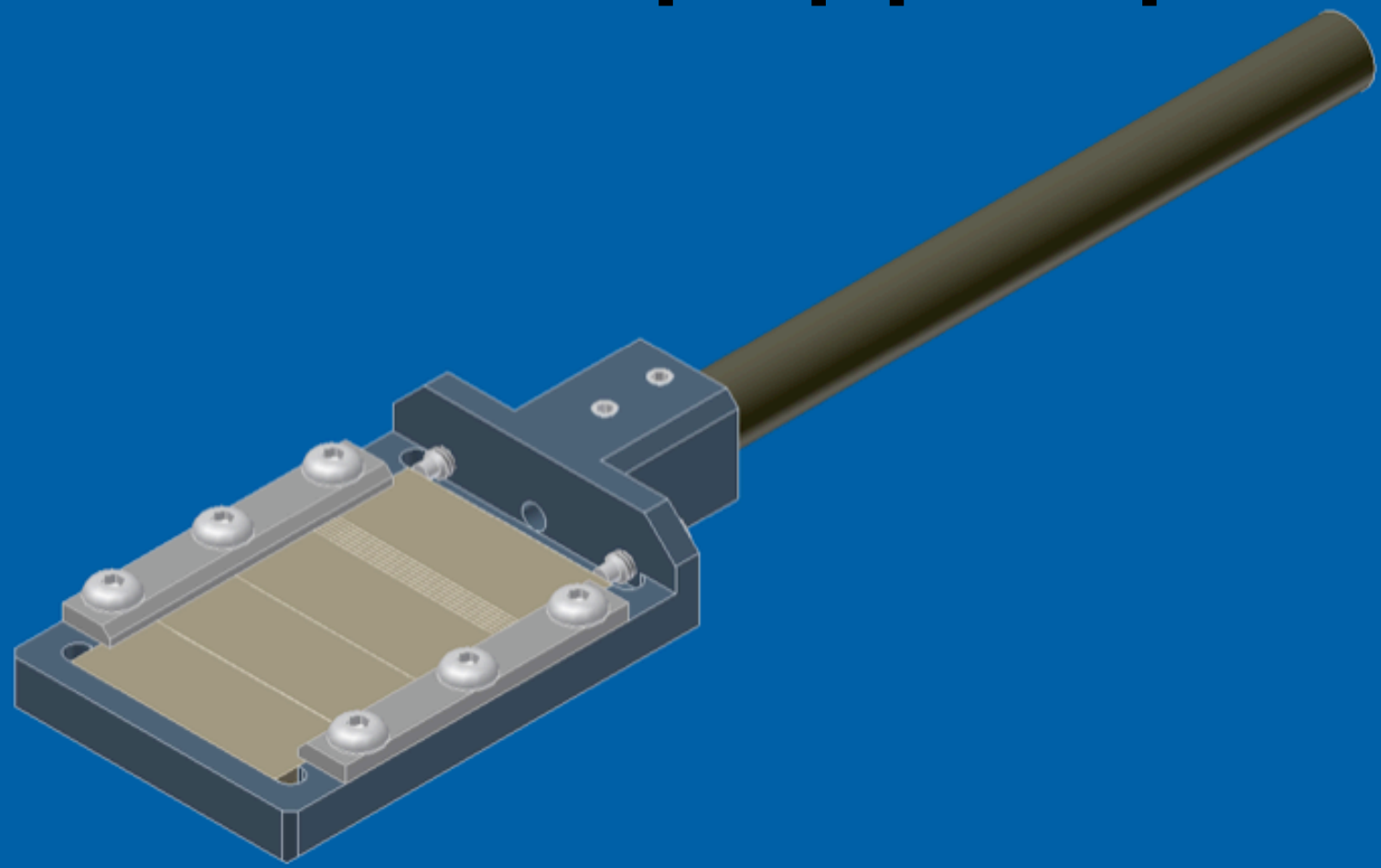
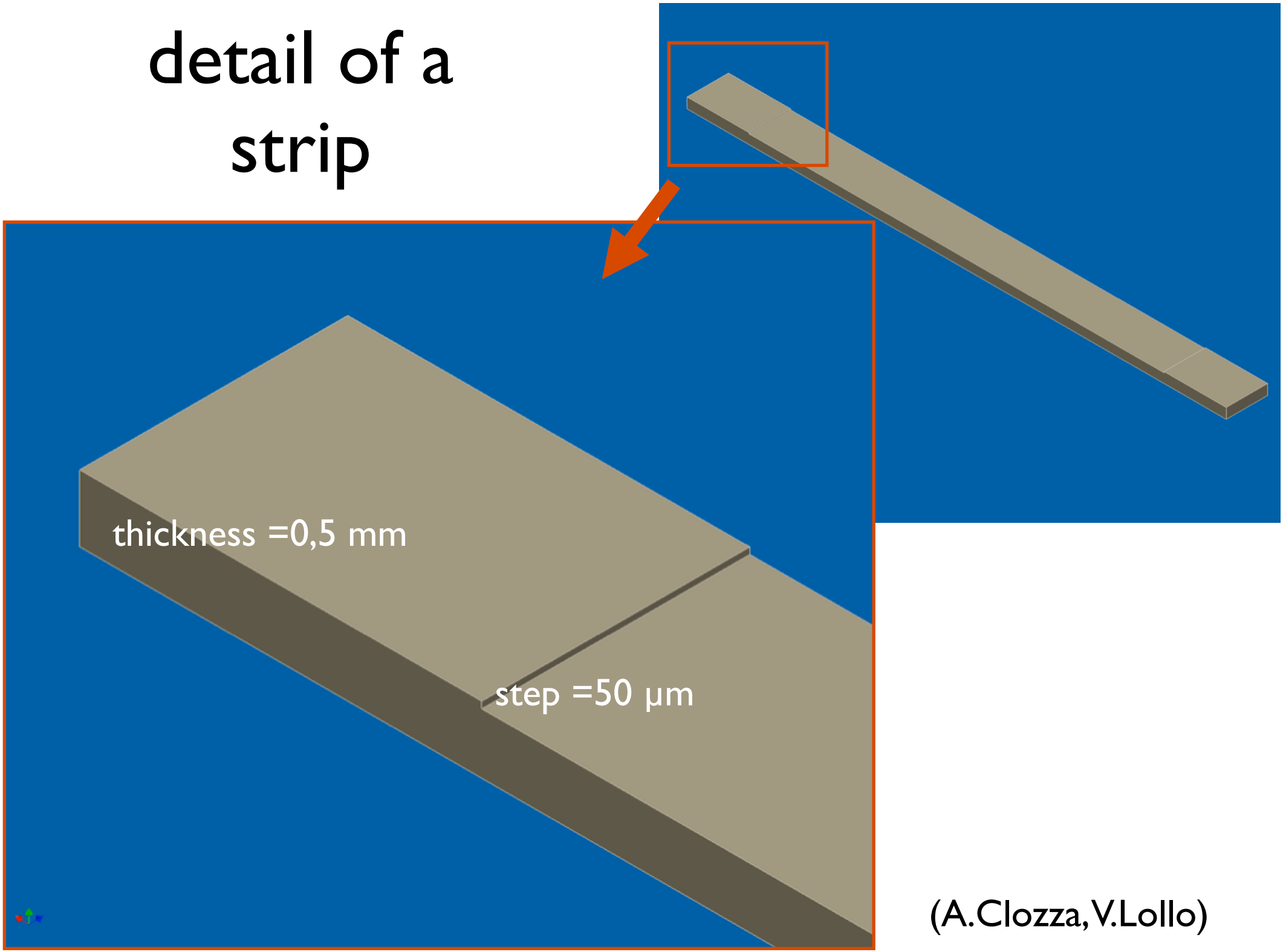

NATIONAL INSTITUTE OF NUCLEAR PHYSICS
FRASCATI NATIONAL LABORATORY
SPARC
LINAC
PEPPERPOT
A2
A

Multi-slit pepper-pot



(A.Clozza, V.Lollo)

detail of a strip



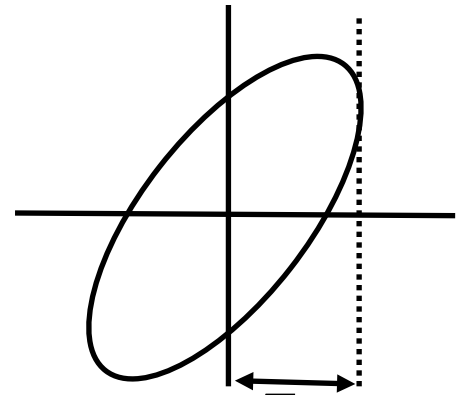
(A.Clozza, V.Lollo)

Quadrupole Scan

- Quadrupole scan is well known technique (we have "daily" experience in TTF)
- Small transverse beam size (min. $\sigma_{rms} \approx 20$ μm) and single-bunch macropulse determines the choice of the optical system
- OTR can guarantee this resolution but has lower photons emission compared with fluorescent materials
- Important requirement addressed by optical system:
  - Magnification (in the order of 1:1)
  - Low aberration
  - Good light collection

Emittance measurement in the Linac

$$\sigma = \begin{pmatrix} \sigma_{11} & \sigma_{12} \\ \sigma_{12} & \sigma_{22} \end{pmatrix} = \varepsilon \begin{pmatrix} \beta & -\alpha \\ -\alpha & \gamma \end{pmatrix}$$

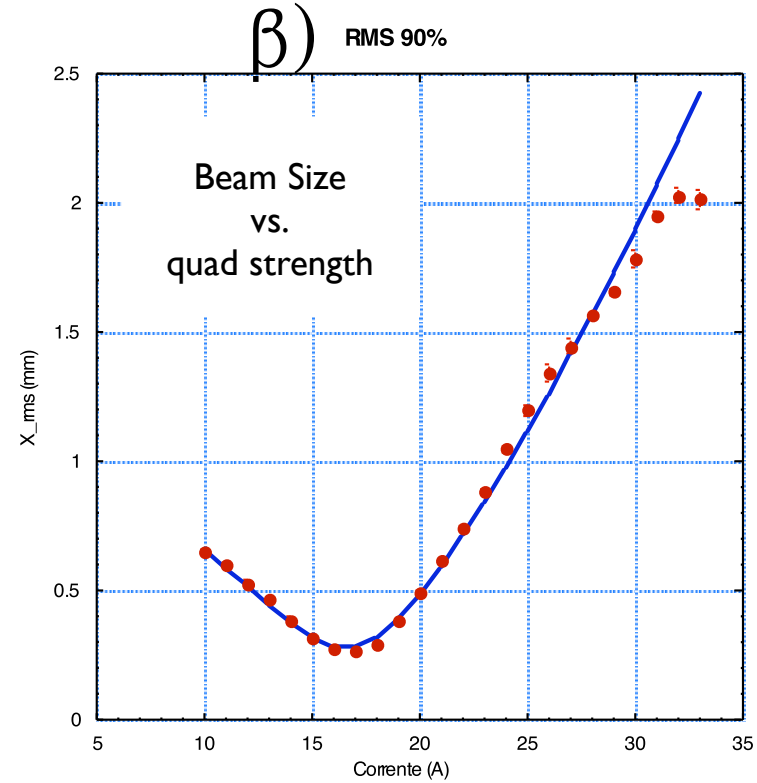


$\sqrt{(\varepsilon \beta)}$

Beam matrix

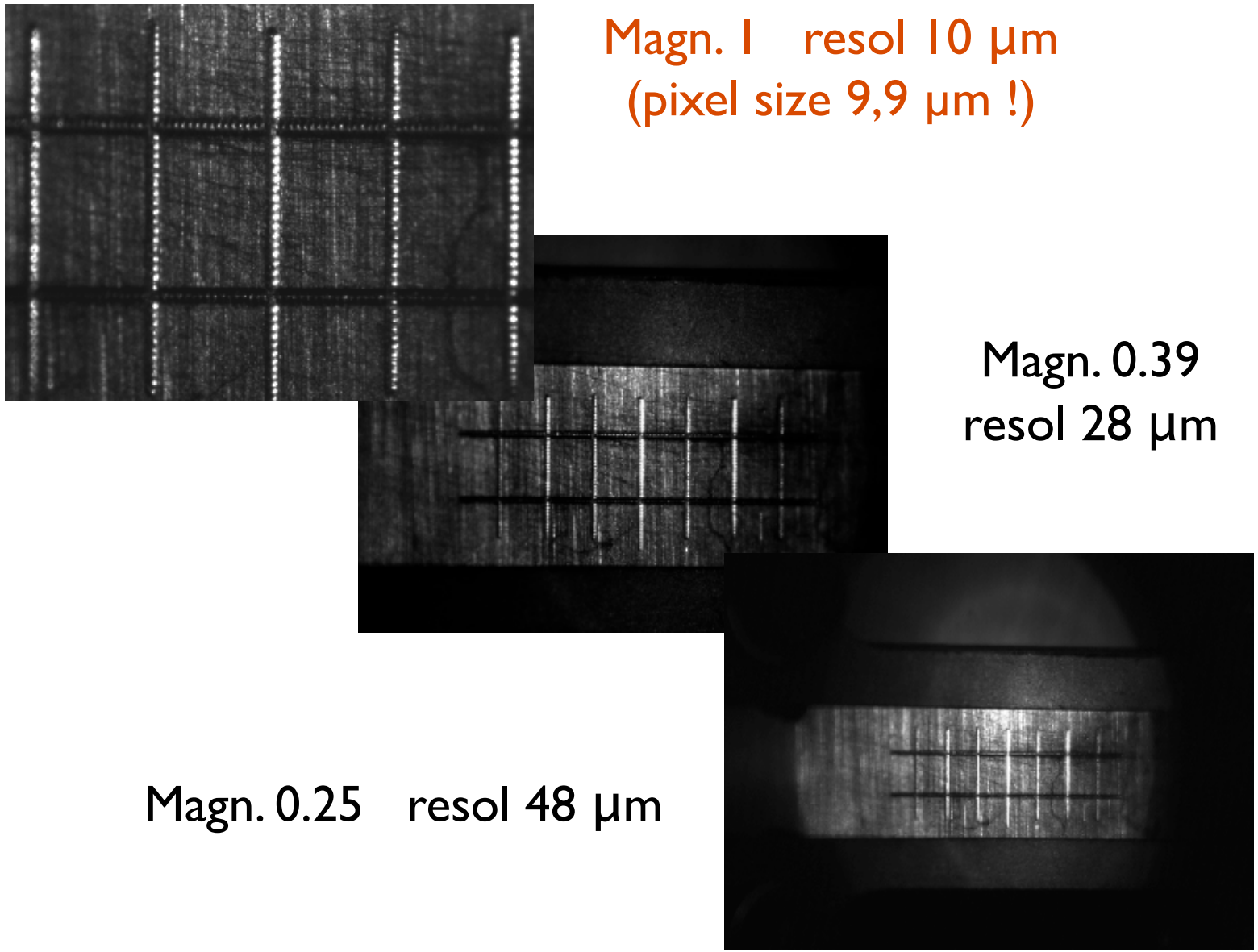
$$\sigma_{11}\sigma_{22} - \sigma^2_{12} = \varepsilon^2$$

$$\sigma_{1,11}(k) = C^2(k)\sigma_{11} + 2C(k)S(k)\sigma_{12} + S^2(k)\sigma_{22}$$



Design of the optical system

1. Adapt TTF2 optical system, robust, flexible, with several magnification and attenuation filter
2. Use a standard commercial Macro lens
3. Custom solution



Magn. 1 resol 10 µm
(pixel size 9,9 µm !)

Magn. 0.39
resol 28 µm

Magn. 0.25 resol 48 µm

CCD digital camera

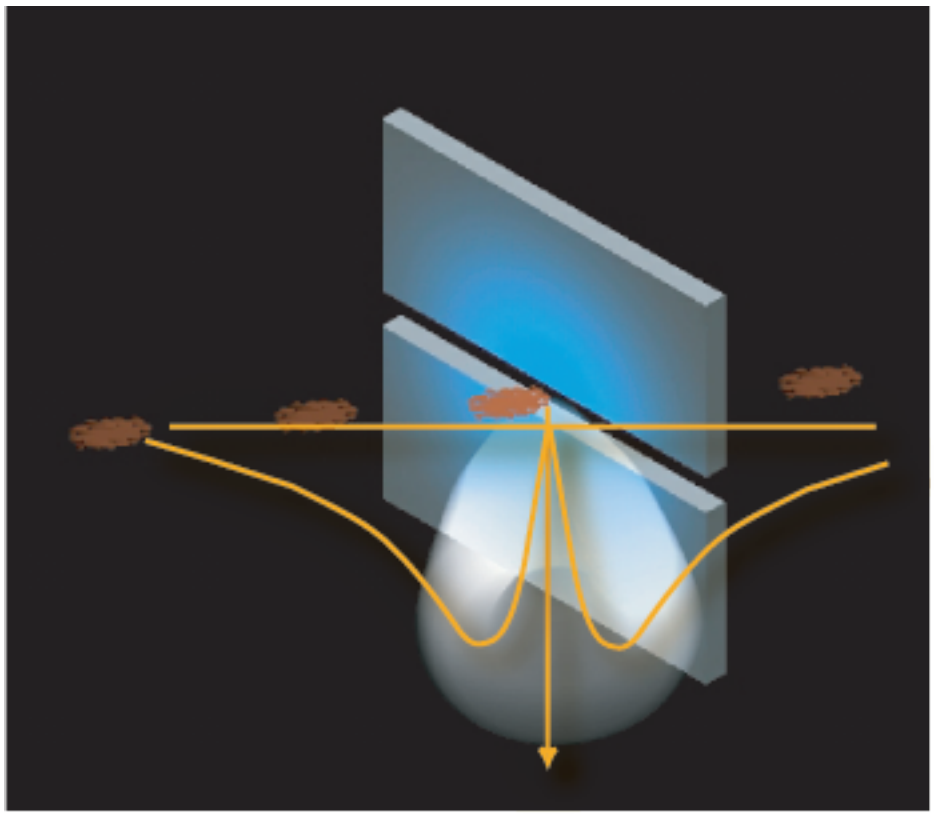
- Digitalization inside the camera: low noise
- Fast developing technology (consumer market support it)
- Features and performances rapidly growing (and the read-out system is able to integrate different cameras at the same time)
- Tests needed to check the possibility to use standard CCD camera (when the beam is large the photon density is small). Search for high-sensitivity CCD (cooled? low-noise?)
- A number of mid-prize (3-4 k€) high QE cameras already available

Bunch Length measurement with coherent DR

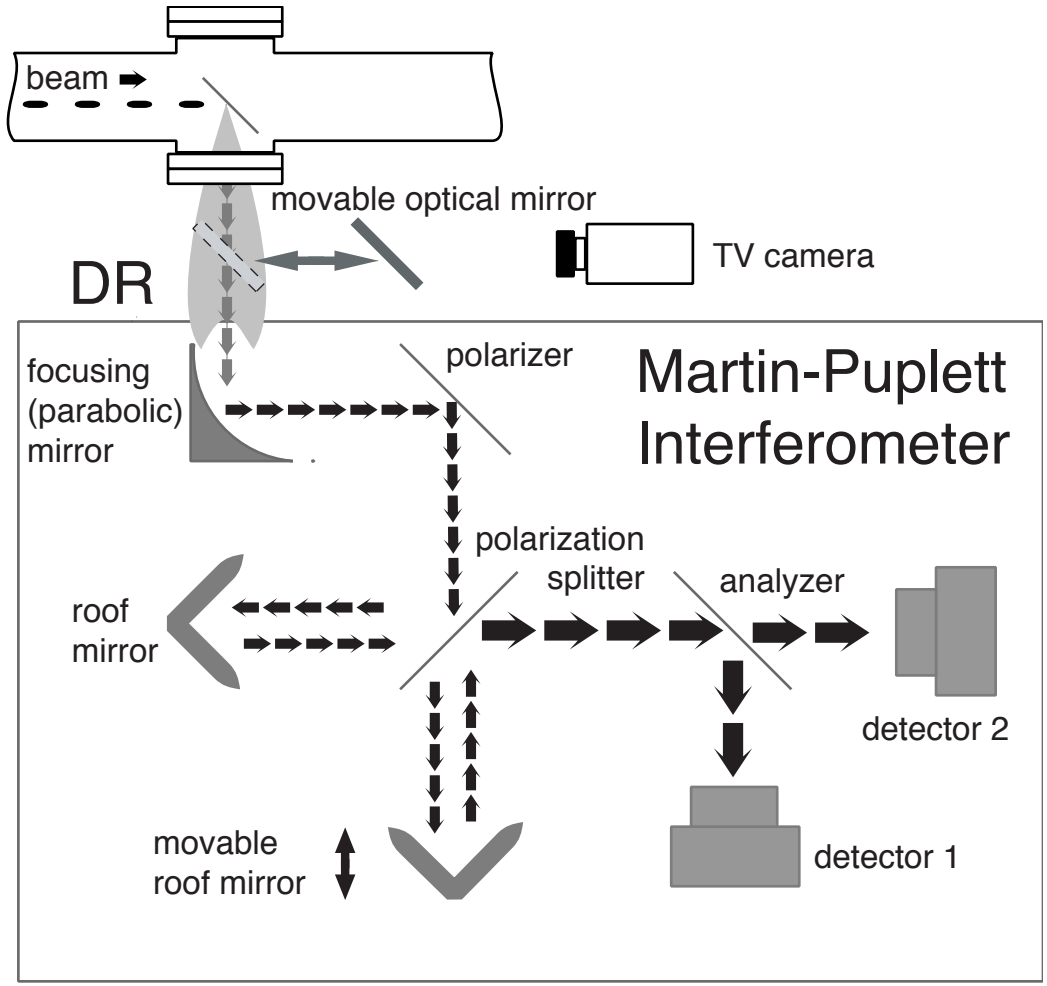
- PhD thesis at INFN-Roma2
- complementary to RF-deflector
- good candidate for high-energy/high-intensity beams

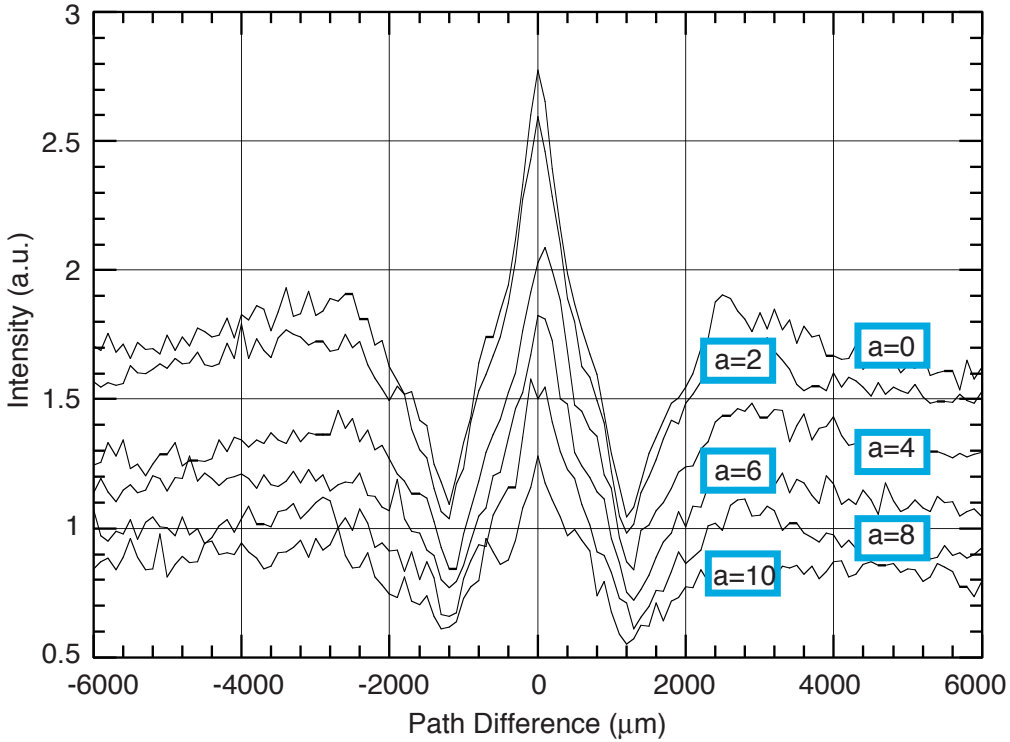
Bunch Length Measurement at TTF using Coherent Diffraction Radiation

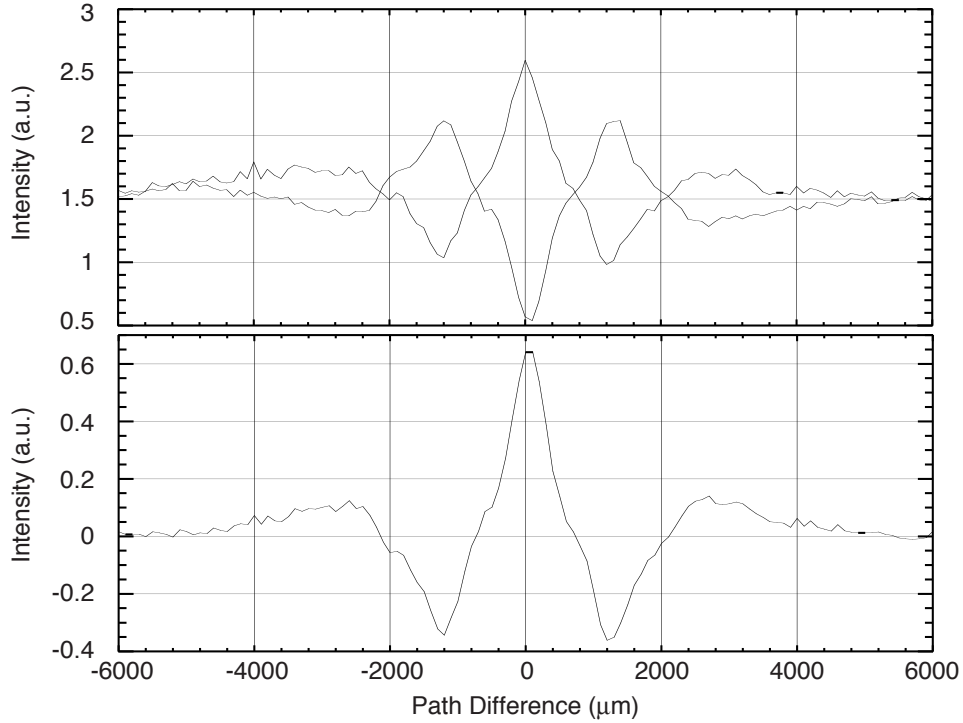
The electric field of a travelling charge interacts with a metallic screen, even if the particle itself passes thought a slit in the foil. The radial dimension of the field depends strongly by the energy, charge and the observed wavelength. A wire grid admits transmission of the vertically polarized component of the radiation into the interferometer.

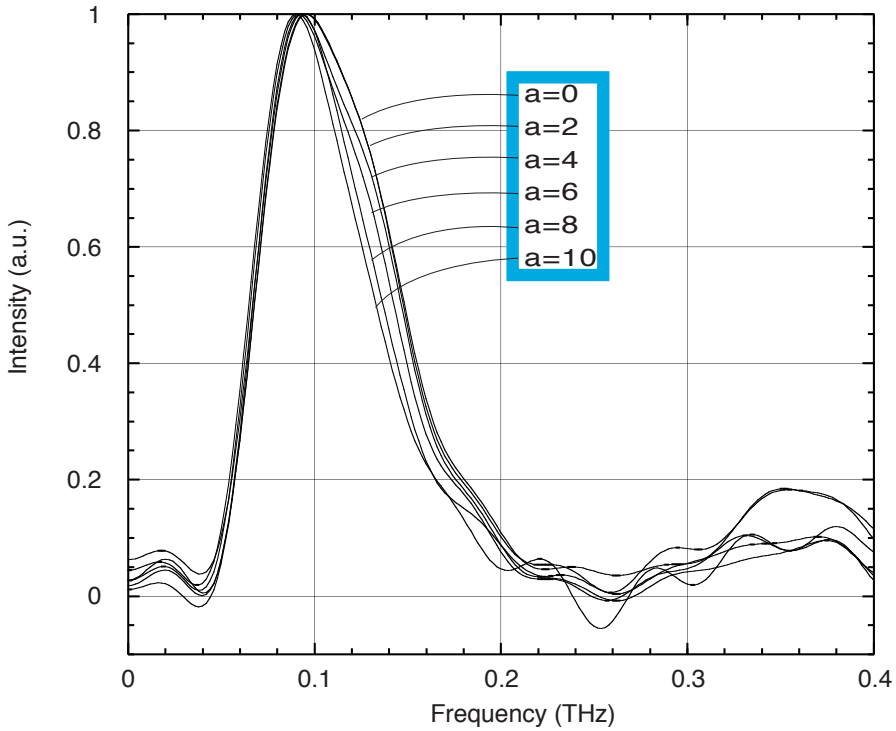


It is a two arms interferometer, like the Michelson one, in which a polarization separator substitutes the amplitude beam splitter, so that orthogonal polarization components going along the two different arms are rotated by the roof mirrors and recombined before the detector.

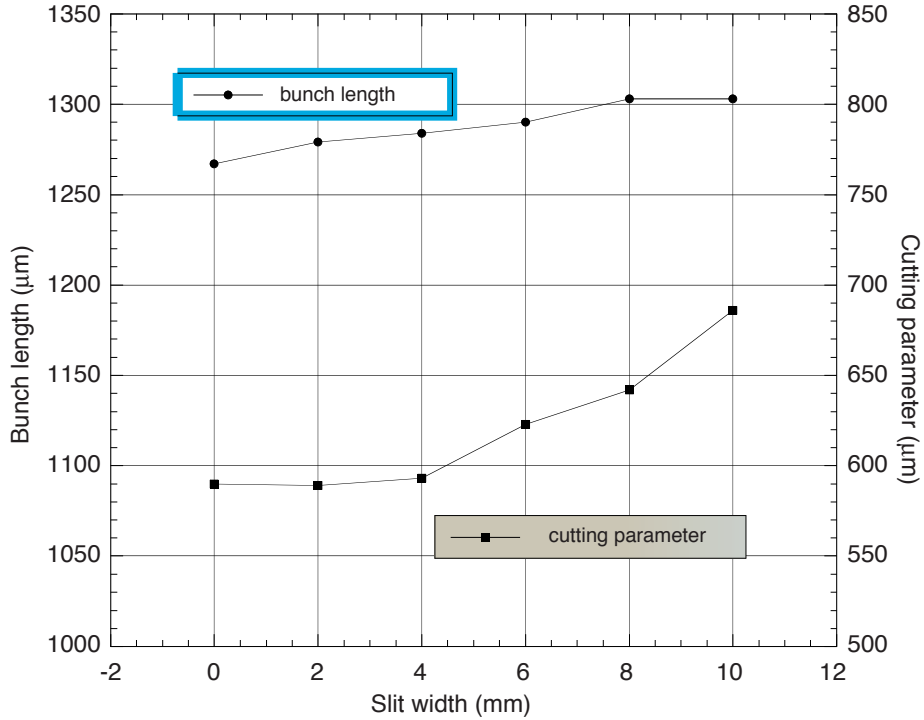






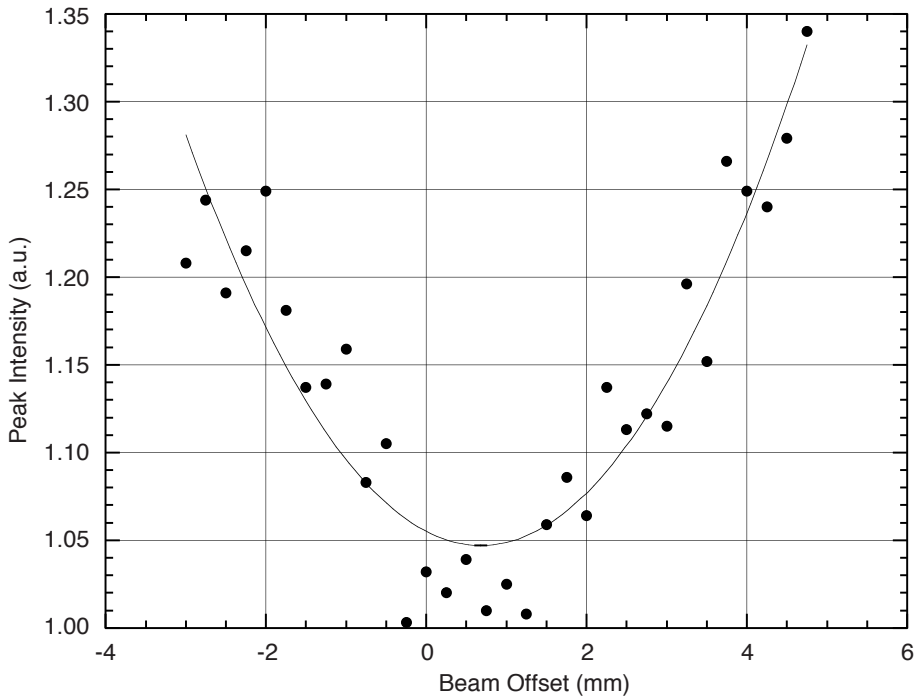


The Fourier transform of the autocorrelation function is by definition the power spectrum. The shape of the spectrum is determined by the product of the spectrum emitted from the single charge and the bunch form factor that it is the Fourier transform of the bunch charge distribution.

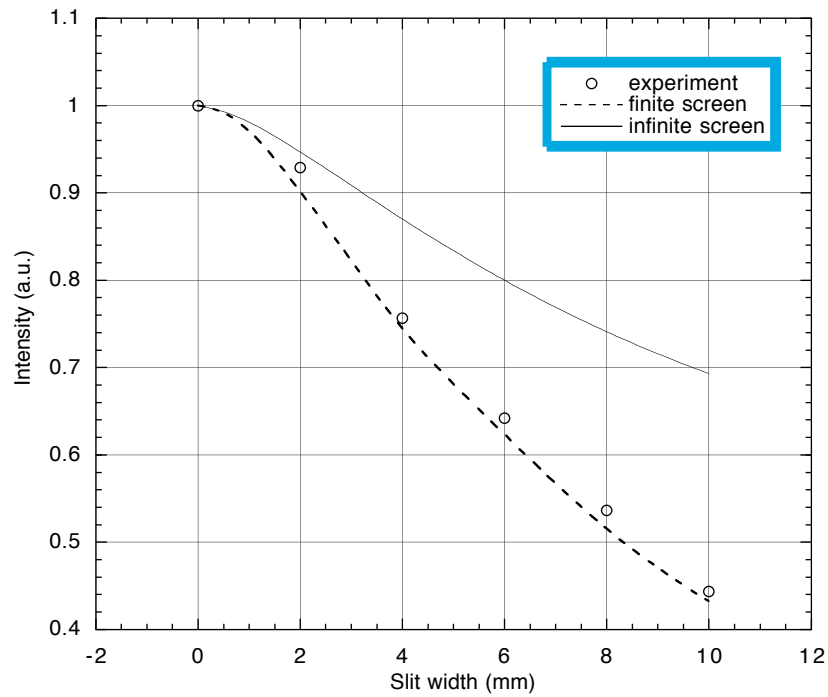


bunch length (independent from slit width)

dependence of peak intensity on beam position



finite screen effect



program

- improve the system used at TTF: new detector, new DR radiator, …)
- collaboration with Sincrotrone Trieste
- test at TTF2

ISTITUTO NAZIONALE DI FISICA NUCLEARE

Preventivo per l'anno ***2004***

Codice	Esperimento	Gruppo
	SPARC	Progetti Speciali
Resp. loc.: Luciano Catani		

Struttura
RM2

COMPOSIZIONE DEL GRUPPO DI RICERCA

N	RICERCATORE Cognome e Nome	Qualifica: Dipendenti – Ruolo	Qualifica: Dipendenti – Art. 23	Qualifica: Incarichi – Ricerca	Qualifica: Incarichi – Assoc.	Affer. al gruppo	%
1	M.Raparelli						100%
2	Catani L.	Ric.				5	30
3	Chiadroni E.				Dott.	5	60
4	Cianchi A.				AsRic	5	40
5	Fantini A.				AsRic	3	30
6	Schaerf C.			P.O.		3	30
7	Tazzari S.			P.O.		5	40
8	E.Gabrielli						100%
	Numero totale dei ricercatori						8
	Ricercatori Full Time Equivalent						4.3

N	TECNOLOGI Cognome e Nome	Qualifica: Dipendenti – Ruolo	Qualifica: Dipendenti – Art. 23	Qualifica: Incarichi – Ass. Tecnol.	%
	Numero totale dei Tecnologi				0
	Tecnologi Full Time Equivalent				0

N	TECNICI Cognome e Nome	Qualifica: Dipendenti – Ruolo	Qualifica: Dipendenti – Art. 15	Qualifica: Incarichi – Collab. tecnica	Qualifica: Incarichi – Assoc. tecnica	%
	Numero totale dei Tecnici					0
	Tecnici Full Time Equivalent					0

Attività Prevista (Allegato 2)

L'attività prevista per il 2004 consisterà nella progettazione e sviluppo del sistema di misura dell'emittanza e caratterizzazione dell'iniettore con particolare attenzione alle problematiche relative al sistema di acquisizione delle immagini (ottiche, telecamera, digitalizzazione, procedure di analisi). Verrà inoltre fornito un contributo allo studio e realizzazione degli altri sistemi di diagnostica dell'iniettore e del sistema di controllo.

Struttura
RM2

Resp. loc.: Luciano Catani

PREVENTIVO LOCALE DI SPESA PER L'ANNO 2004

In KEuro

VOCI DI SPESA		DESCRIZIONE DELLA SPESA	IMPORTI Parziali SJ		IMPORTI Totale Compet.	IMPORTI Totale Compet. SJ	A cura della Comm.ne Scientifica Nazionale
Viaggi e missioni	Interno	meeting collaborazione, sviluppo e collaudo a LNF di componenti	3.0		**3.0**	**0.0**	
	Estero	conferenze (EPAC, PCaPAC) collaborazione con DESY/Zeuthen e incontri scientifici	5.0 7.0		**12.0**	**0.0**	
Materiale Consumo		licenze software (Windows XP Embebbed, LabVIEW) modulistica CAN e kit di sviluppo sistemi ottici e movimentazioni	3.0 5.0		**8.0**	**0.0**	
Trasp. e facch.					**0.0**	**0.0**	
Spese Calcolo		Consorzio / Ore CPU / Spazio Disco / Cassette / Altro			**0.0**	**0.0**	
Affitti e manutenz. apparecchiat.					**0.0**	**0.0**	
Materiale inventariabile		telecamera digitale Alta Risoluzione e software di controllo PC104 + kit di sviluppo server rack–mounting scheda IEEE1394 per il controllo della telecamera cavi IEEE1394 alta qualità e ripetitore ottico IEEE1394	4.5 2.5 3.0 3.0		**13.0**	**0.0**	
Costruzione Apparati					**0.0**	**0.0**	
				Totale	**36.0**	**0.0**	

Sono previsti interventi e/o impiantistica che ricadono sotto la disciplina della legge Merloni ? ☐
Breve descrizione dell'intervento:

Mod EC./EN. 2 (a cura del responsabile locale)

+2.0 k€ DAQ, e-Logbook collaboration

- components for the optical resolution test-stand
- camera objective remote control

+1.5 k€ Switch Gigabit Ethernet
+2.0 k€ RAID system

41.5 k€ (total)