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A DC Injector for a Compact Free Electron Laser

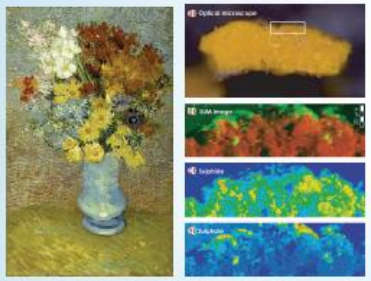
Thomas G. Lucas

ARCNL

Applications X-ray Sources

Synchrotron research in heritage studies

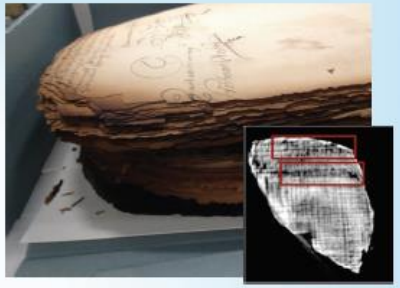
hidden paintings



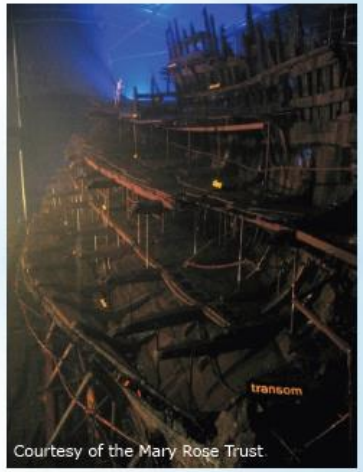
degradation of pigments

paleontology

Varnishes on musical instruments



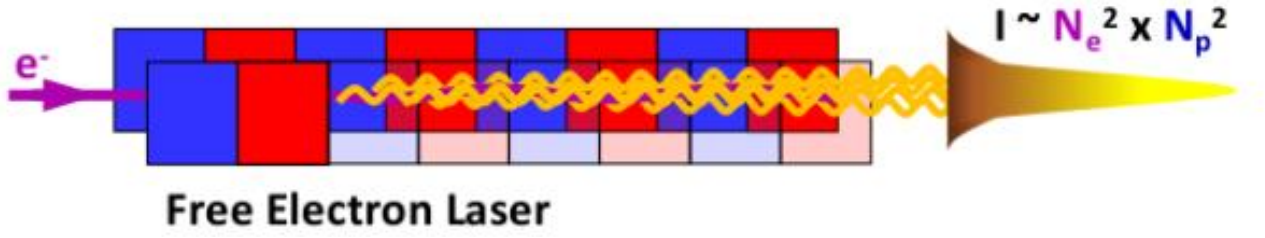
archival research

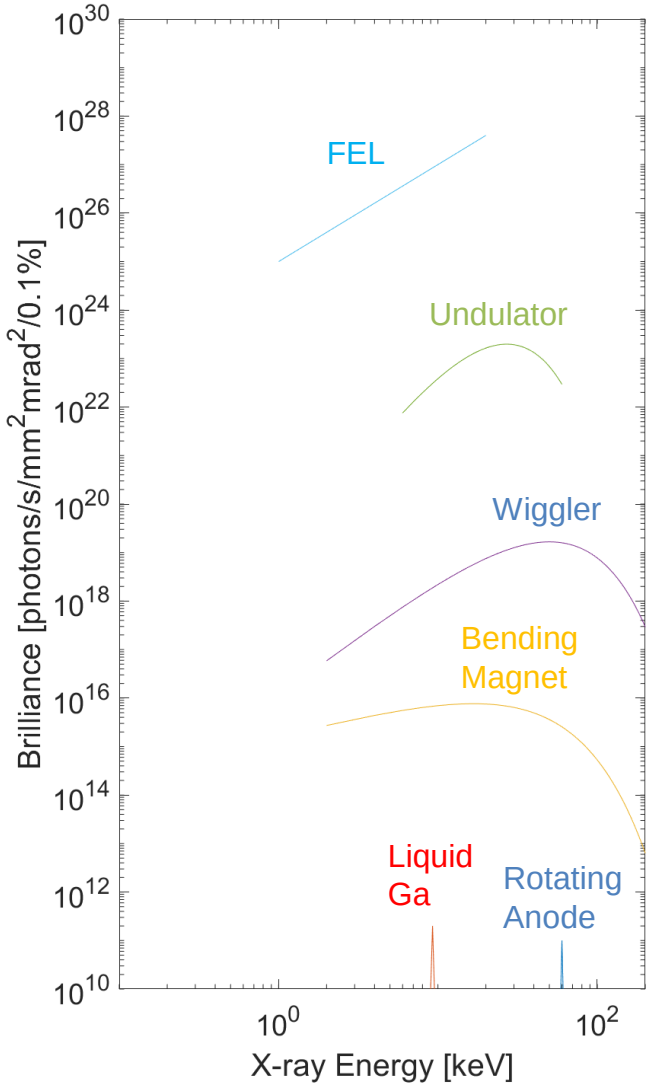


Conservation wreck of warship

Free electron lasers

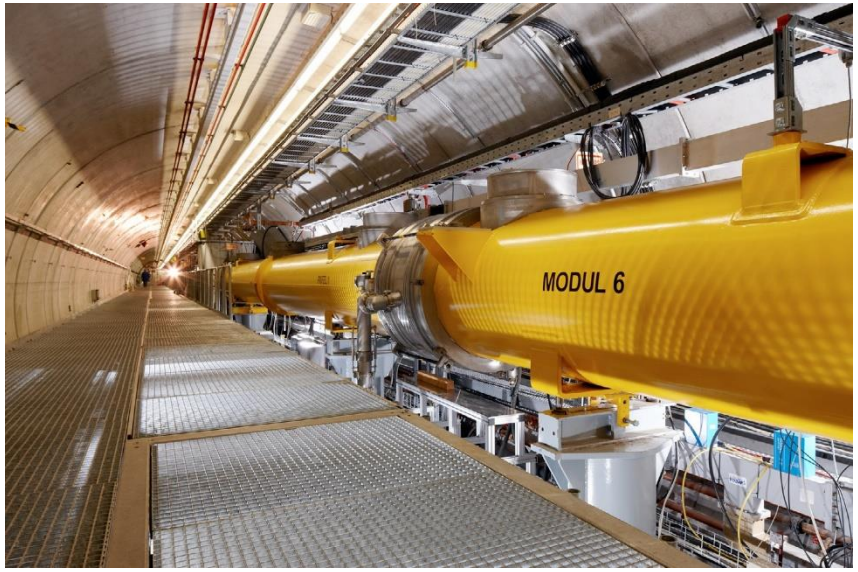
- Based on undulator idea.
- High electromagnetic fields modulate beam into “micro-bunches”.
- Self Amplification of Spontaneous Emission.





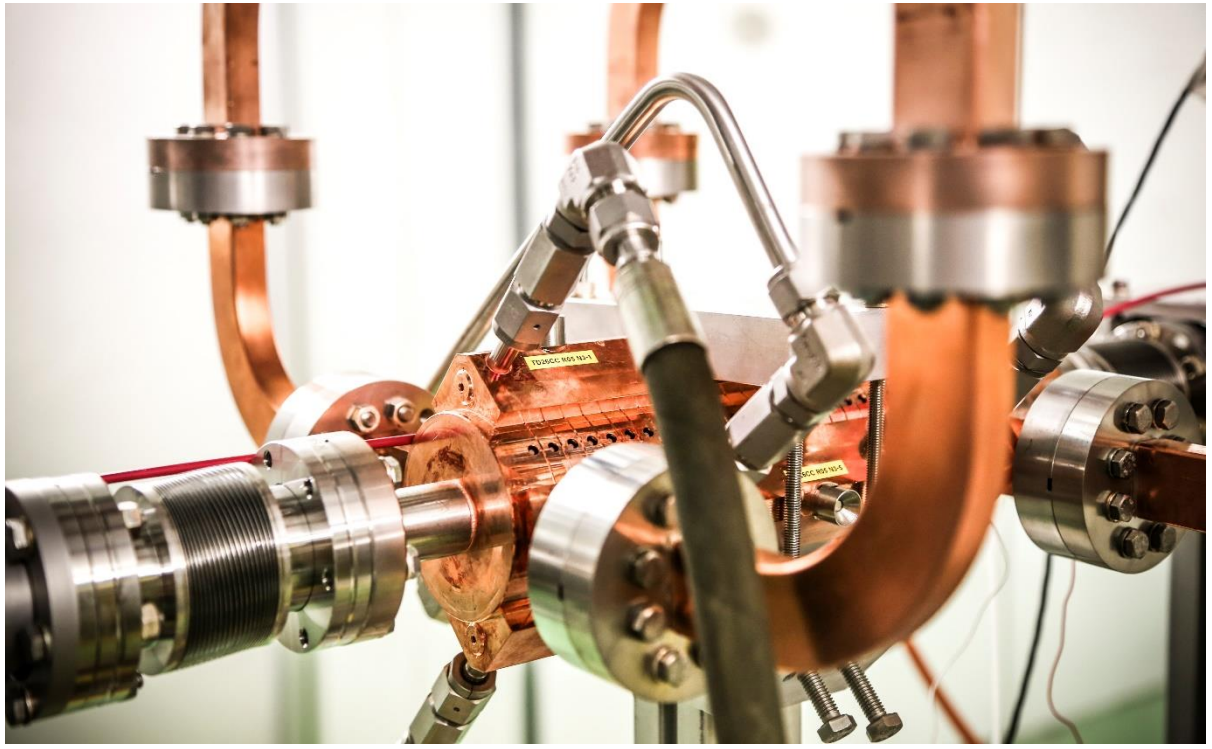
Taken from: Anatoly Shabalin PhD thesis DOI: 10.13140/RG.2.1.4004.5680

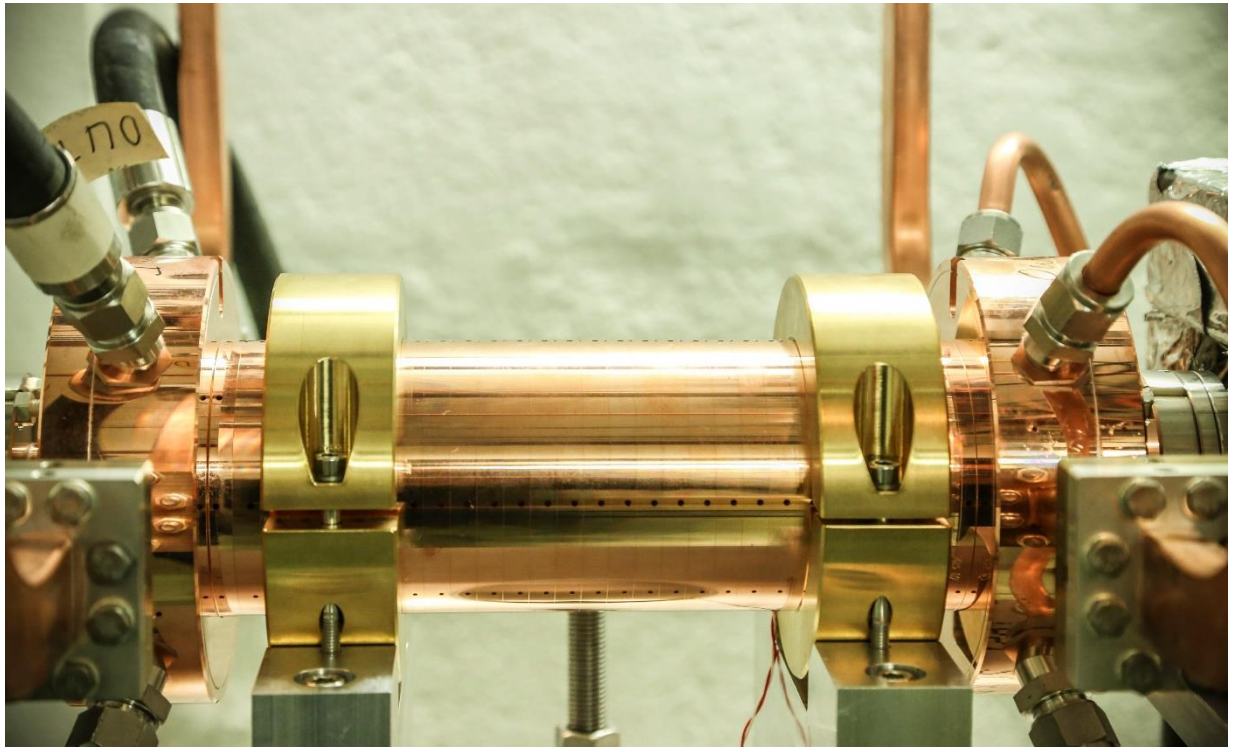
Free electron lasers



Compact Linear Collider

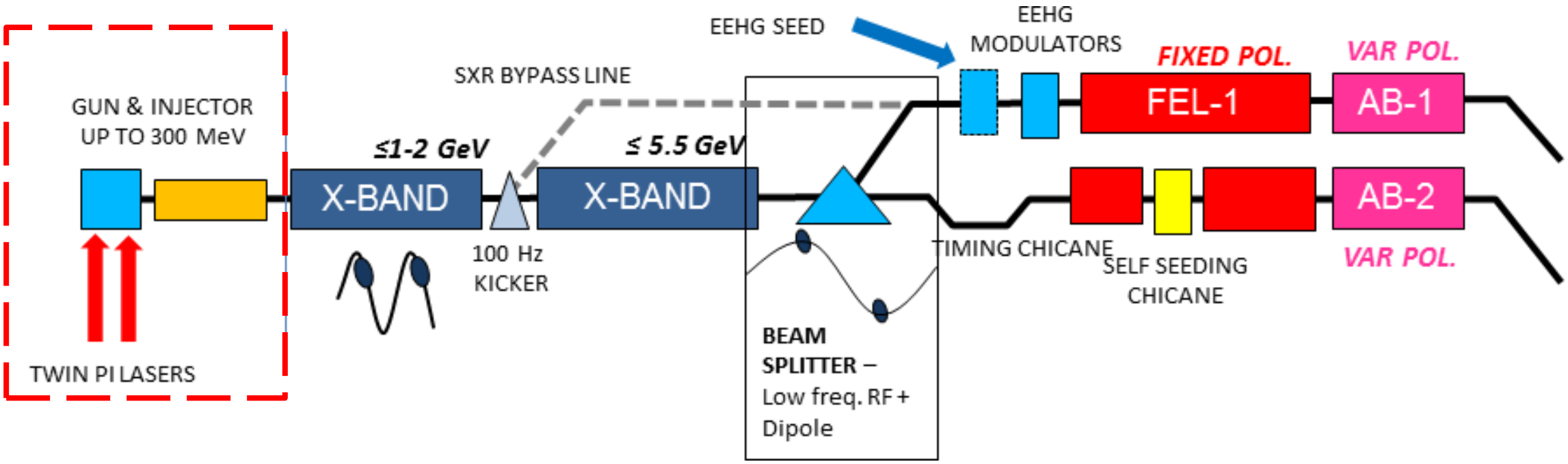
- Compact Linear Collider (CLIC) is a design proposal for the next high energy collider.





Compact Light

- Compact Light is a design study which aims to use the high gradient technology designed for the Compact Linear Collider (CLIC) for the design of a new FEL.



Compact Light

- Compact Light is a design study which aims to use the high gradient technology designed for the Compact Linear Collider (CLIC) for the design of a new FEL.

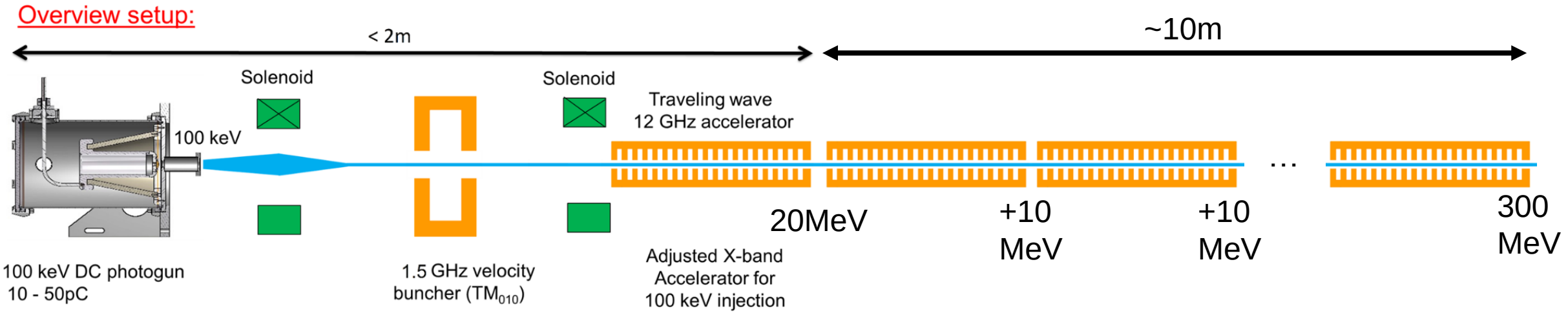
Parameter	Unit	Soft x-ray FEL	Hard x-ray FEL
Photon energy	KeV	0.25 - 2.0	2.0 - 16.0
Wavelength	nm	5.0 - 0.6	0.6 - 0.08
Repetition rate	Hz	100 to 1000*	100
Pulse duration	fs	0.1 - 50	
Pulse energy	mJ	< 0.3	
Polarization		Variable - Selectable	
Two-pulse delay	fs	± 100	
Two-colour separation	%	20	10
Synchronization	fs	< 10	

Our role

- The role of ARCNL and TU/e is to study the feasibility of a DC injector.
- Why a DC injector?
  - Cost effective injection and bunch method.
    - Low energy bunching significantly simpler!
  - High reliability and robustness.
  - High duty factor.

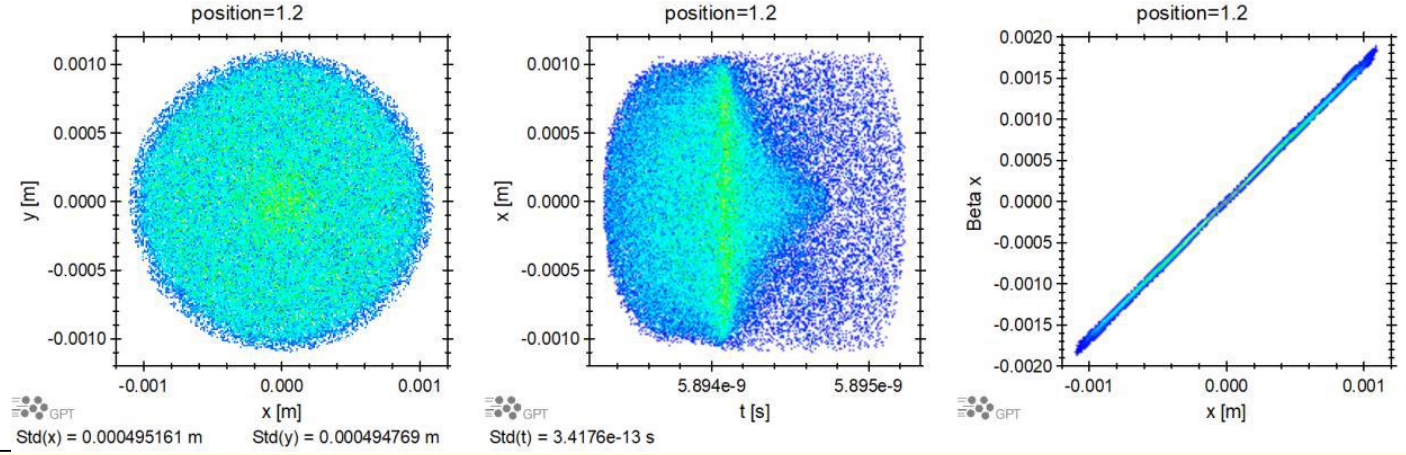
300 MeV Injector

- Current status
  - The injector has been scaled up to 300 MeV to bring it in line with the other injectors.
  - The emittance was reduced by pushing the gun to its peak field possible.
- Next step is to explore different DC guns.



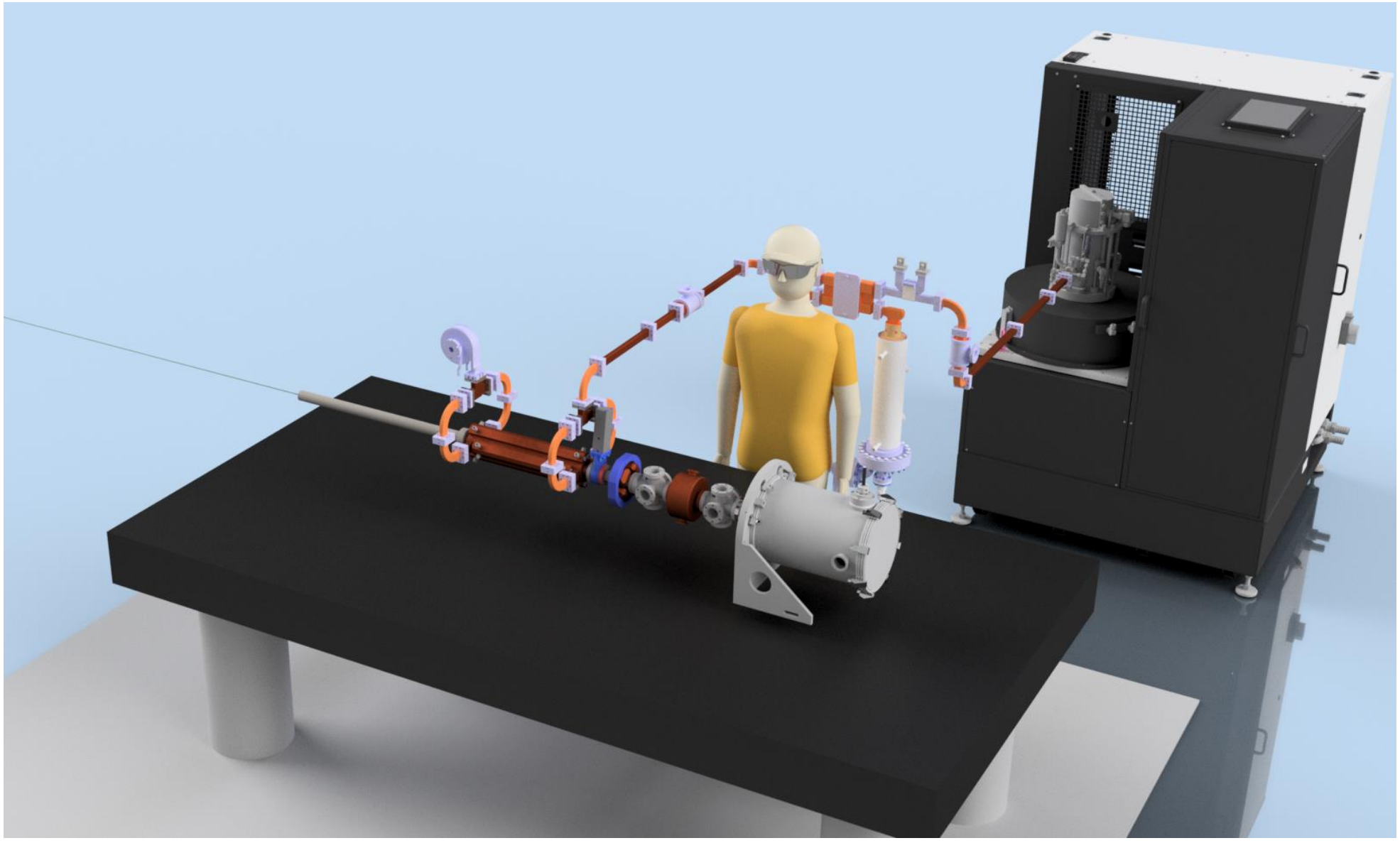
Main Parameters

Bunch Property	Exit of DC Photogun	At 300 MeV
Charge [pC]	10	10
Kinetic Energy [MeV]	0,1	300
Repetition Rate	1000	1000
RMS Energy Spread [%]	0,01	0,5
RMS Bunch Length [ps]	2	0,35
Normalised Emittance [µm]	0,1	0,275



Implementation

- A test of the injector is being built.
- Low and high power RF under construction
- Components are arriving in waves:
  - Most LLRF components have arrived and are starting to be assembled.
  - Accelerating structure disks arrive November 15
  - Pulse compressor November 15
  - Klystron/modulator first testing late November.



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Compact

Thank you!

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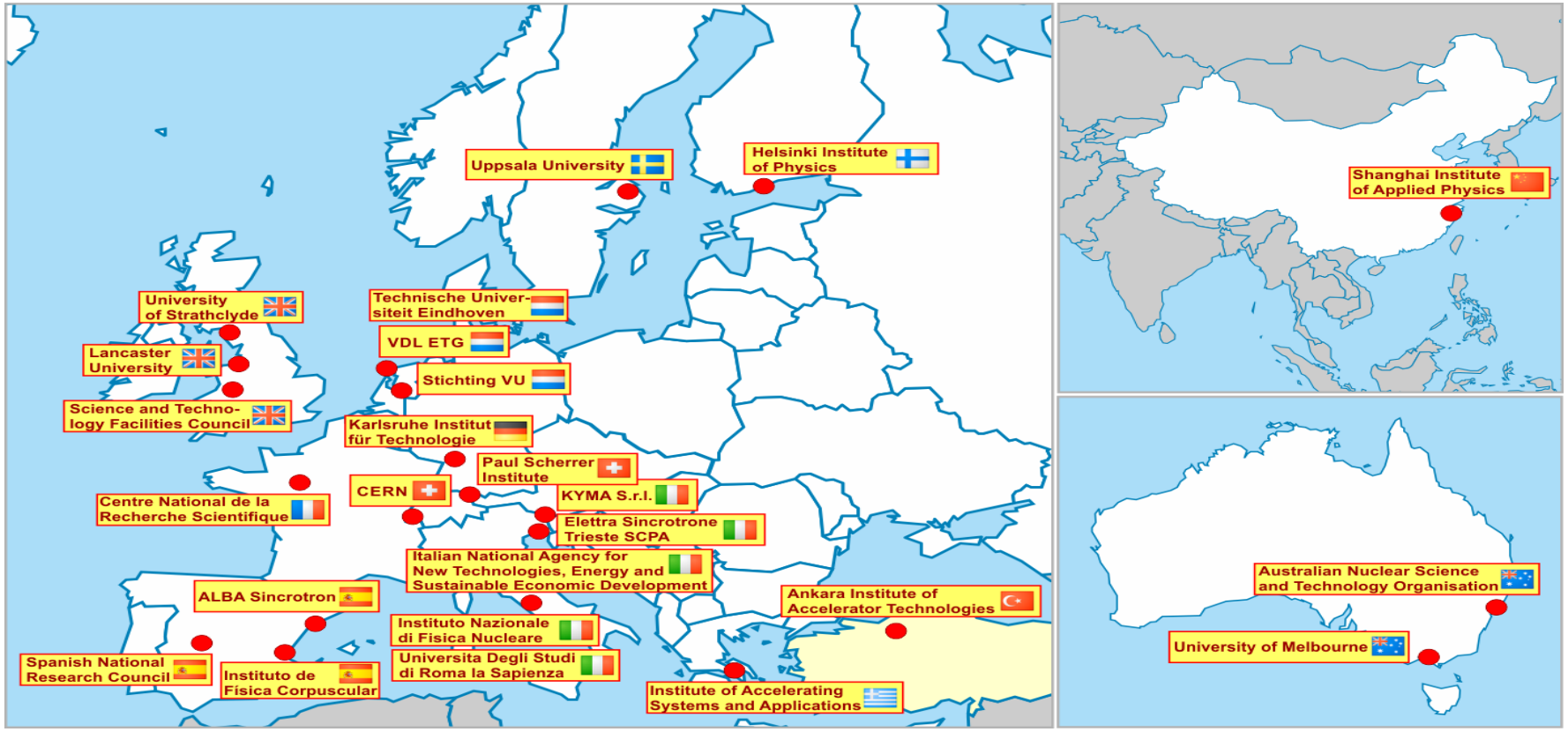

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