Report from WP9: NCLinac

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EuCARD 3rd Annual Meeting

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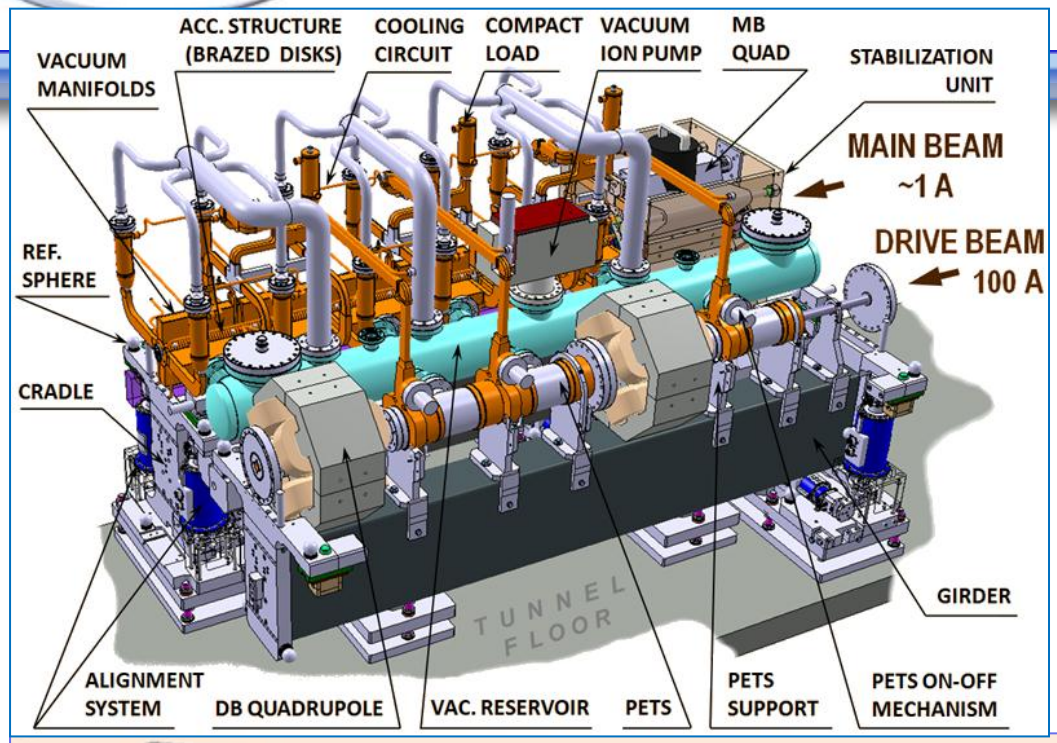
NCLinac People – update April '12

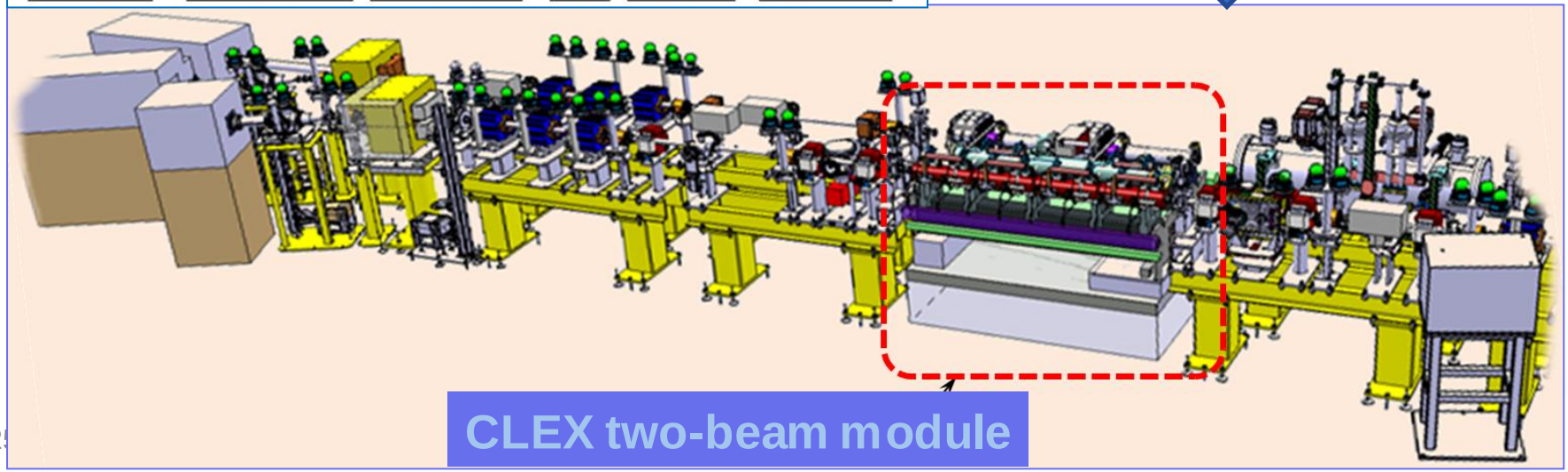
	Coordination	High Gradient	Stabilisation	BDS	Phase control
CERN	**Jensen**	**Riddone,** Kahn	Mainaud-Durand, Artoos, Esposito, Fernandez Carmona, Modena		Andersson
CIEMAT		Toral, Sánchez			
CNRS/LAPP			**Jeremie**, Balik, Deleglise, Brunetti, Allibe		
INFN/LNF					**Marcellini**
PSI					Dehler, Kaiser, Arsov
RHUL	**Blair**			**Blair**, Boogert, Lyapin	
STFC/ASTEC				Angal-Kalinin, J. Jones, Scarfe	
UH		Österberg, Djurabekova, Raatikainen, Nordlund			
UNIMAN		R. Jones, D'Elia		Appleby, Toader, Tygier	
UOXF-DL			Burrows, Christian		
UU		Ziemann, Ruber, (Blom), Muranaka, Leifer			

EuCARD NCLinac – WP9.2



CLIC two-beam module

UH: High-precision assembly and breakdown studies
UNIMAN: HOM damping studies
UU: diagnostic equipment
CIEMAT: PETS design and fabrication

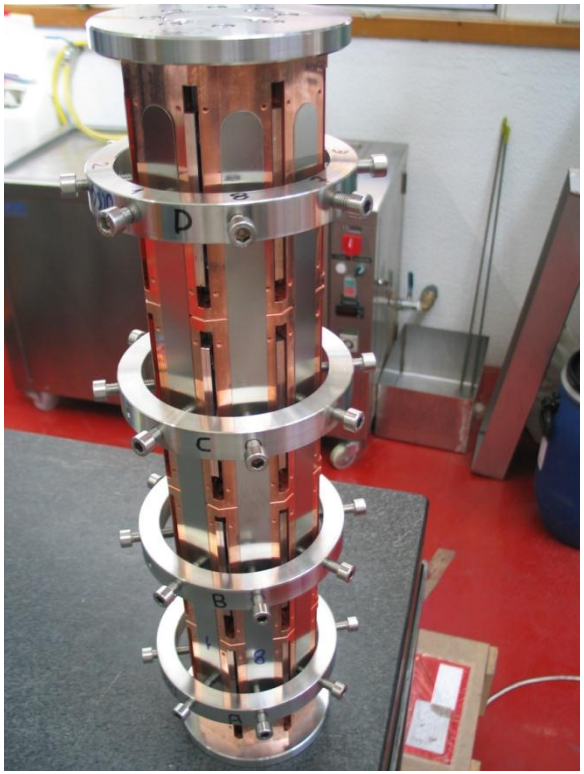


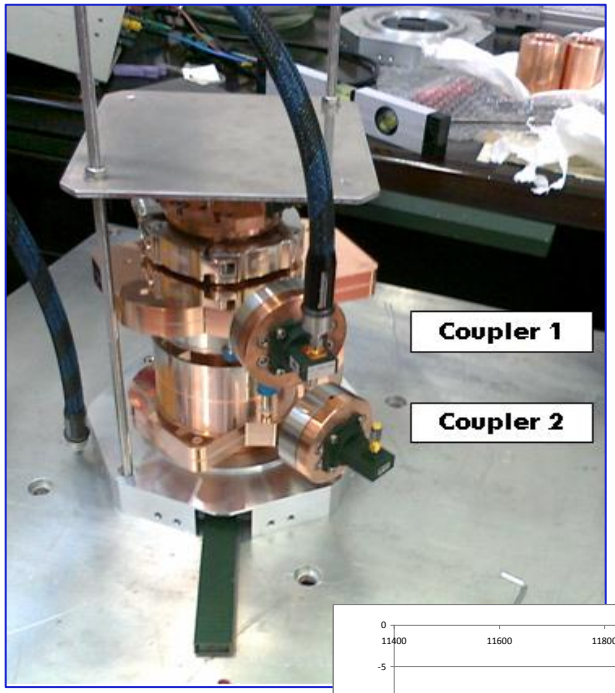
CLEX two-beam module

NCLinac – WP9.2

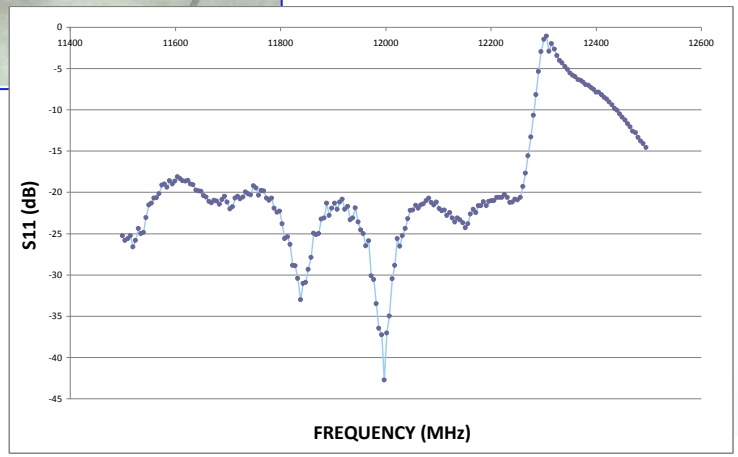
CIEMAT: PETS design and fabrication

Bars for the first double-length PETS successfully assembled. At current at CERN for EBW





Coupler machining completed and couplers successfully tested



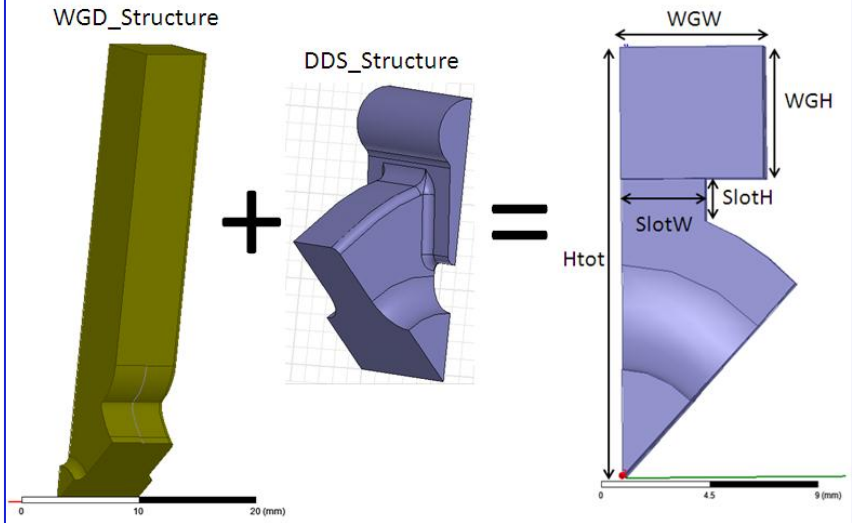
NCLinac – WP9.2

UNIMAN: HOM damping studies

- **DDSA (detuned damping) structure**
- **Prototype disks from Morikawa fully qualified: dimensional control and RF measurements**
- **Machining of a complete accelerating structure under way – disks competed by July**

New Hybrid structure

- Design largely improves the performances of conventional DDS but further studies are needed



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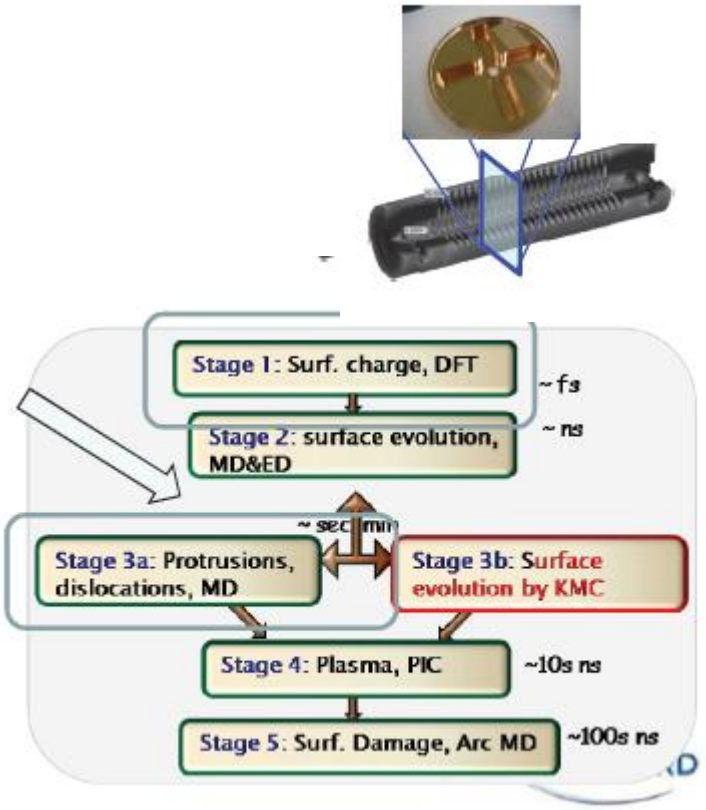
UH: breakdown studies

- **Currently developing a multiscale model to understand the mechanisms in or close to the surface of the materials due to the effect of static electric field.**
- **Currently pursuing parallel activities in all steps of the *multiscale model:***
  - – simulating plastic deformations of metal surfaces due to tensile stresses leading to tips on the surface
  - combining electro-dynamic effects and atomistic simulations to predict behavior of surface atoms;
  - simulation of created plasma and subsequent surface damage.
- **Today's focus on new results in 1 and 3a**



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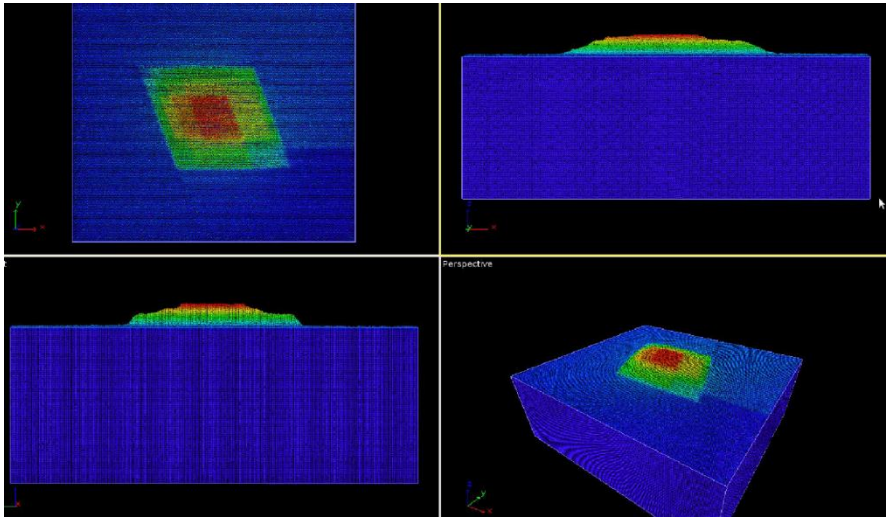
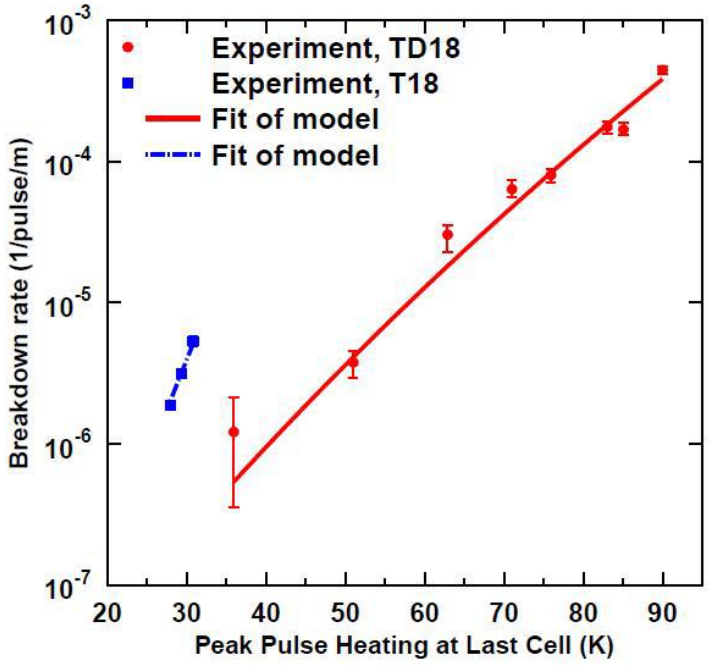
UH: breakdown studies

A single void can also act as a source - recently shown that this can lead to major growth on top of the void => origin of tips!?



Also formulated a mathematical model based on dislocation activity that can reproduce all the experimentally observed Electric field and Temperature dependence of electric breakdown rates



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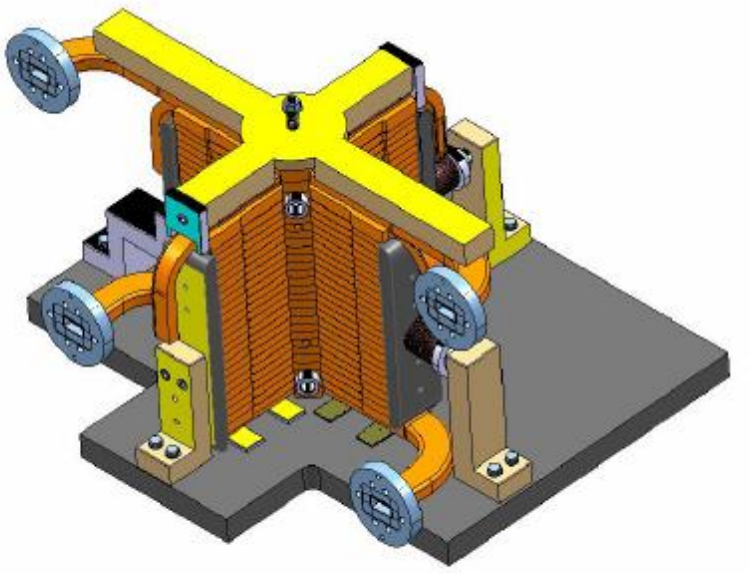
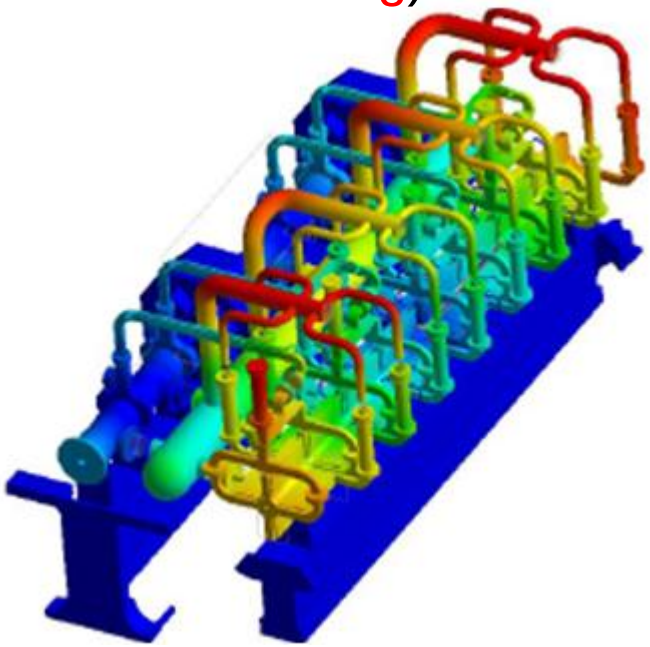
UH: high-precision assembly

Development of tooling for the assembly of the accelerating structures and PETS



Tooling for brazing of AS manifolds

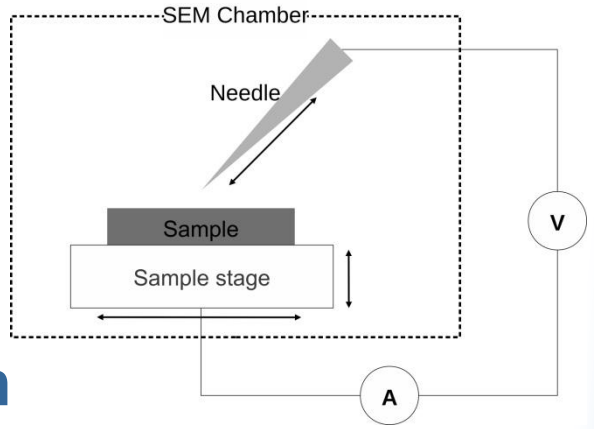
Continuation of the thermo-mechanical simulation of the entire two-beam module (see Highlight talk by Kenneth Österberg)



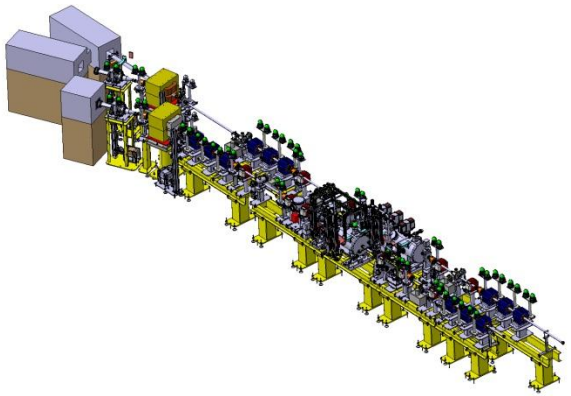
NCLinac – WP9.2

UU: diagnostic equipment

- **In-situ discharge experiments inside an Electron-microscope**
  - Field emission probe
  - Simple scanning
  - Cut and Slice, voids

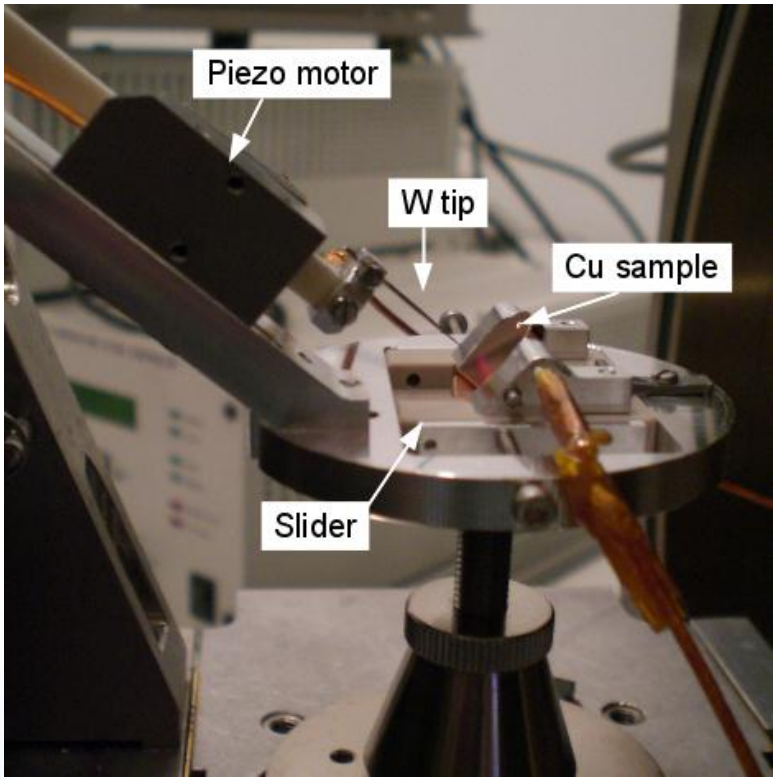


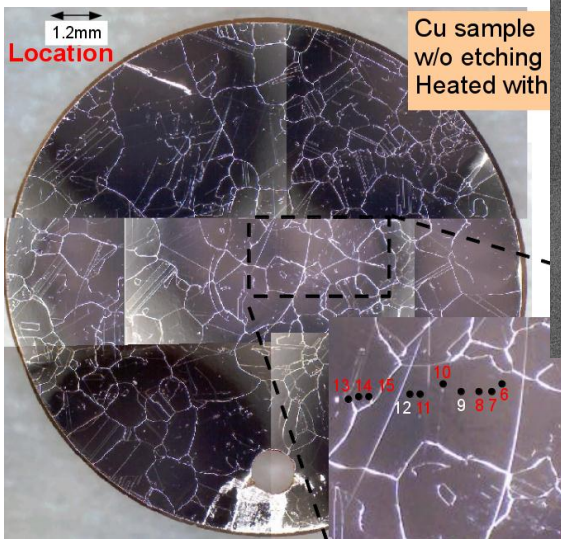
- **Upgrade of the Two-beam test stan in CTF3**
  - Upgrade diagnostics: positi screens, and FlashBox
  - PETS based phase monitor

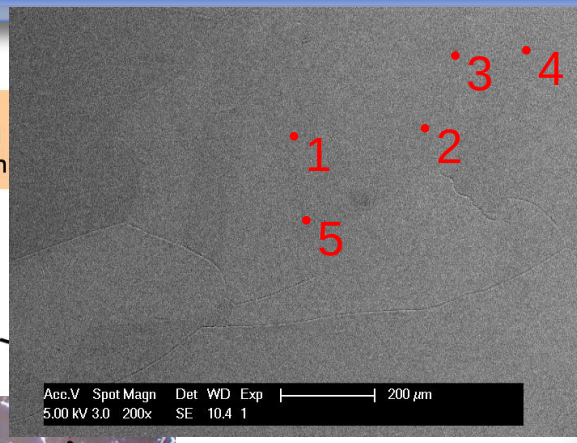


NCLinac – WP9.2

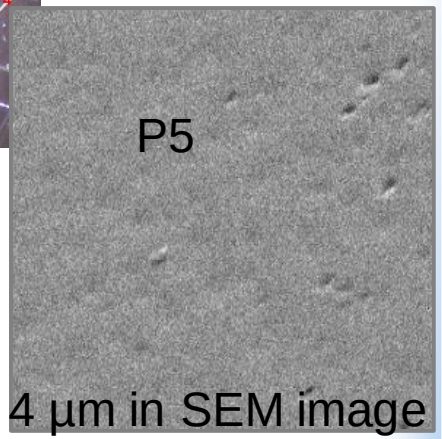
UU: diagnostic equipment







Breakdown in SEM



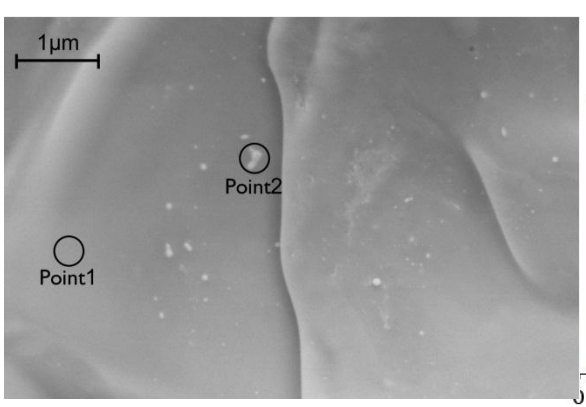
- Included basic scanning capability in the piezo-motor probe stage
- Grains visible in optical and electron-microscope, also done EBSD
- Voltage at which 10 nA FE current is reached varies and is not really correlated with grains.

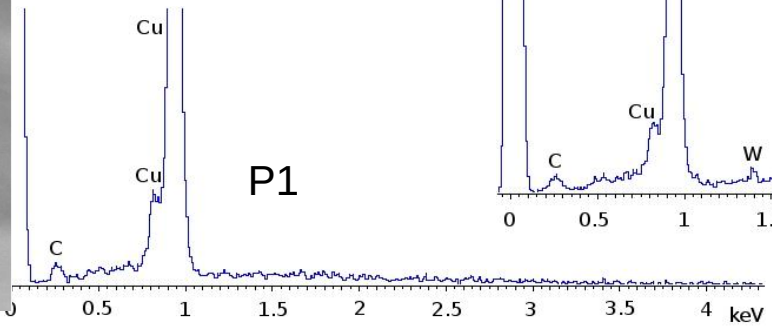
NCLinac – WP9.2

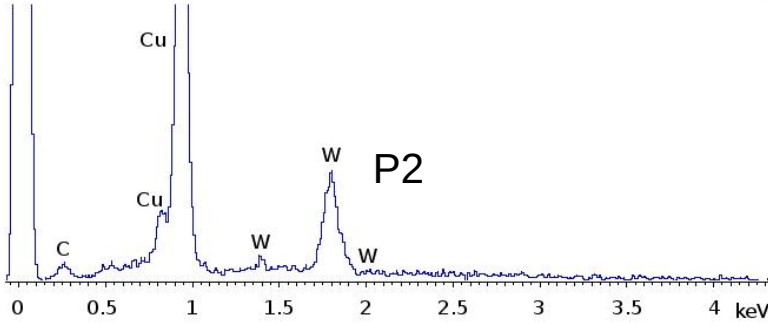
UU: diagnostic equipment

Surface and underneath

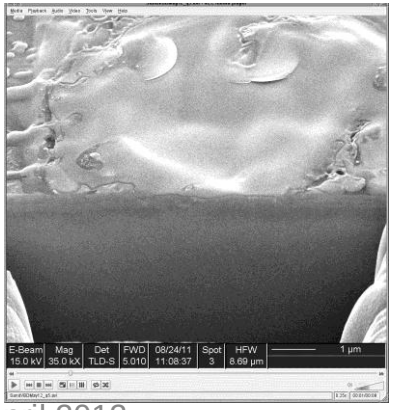
- **Initiate discharge with W tip on copper sample and analyze the discharge site with EDX**

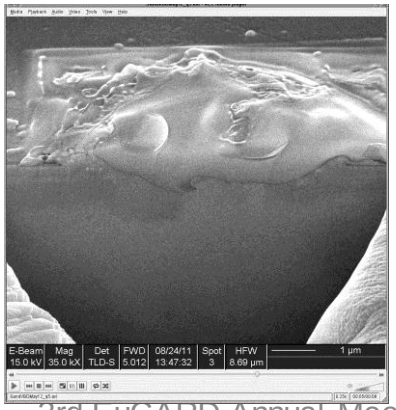


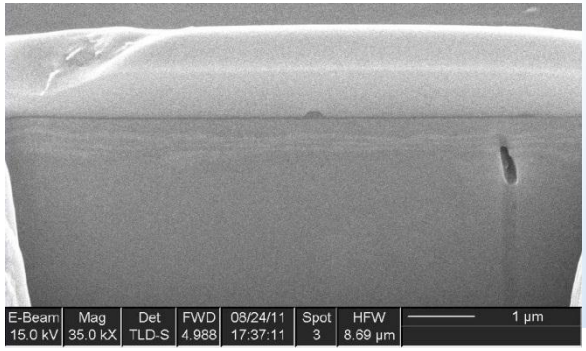




- **Cut and slice, observed sub-surface voids**





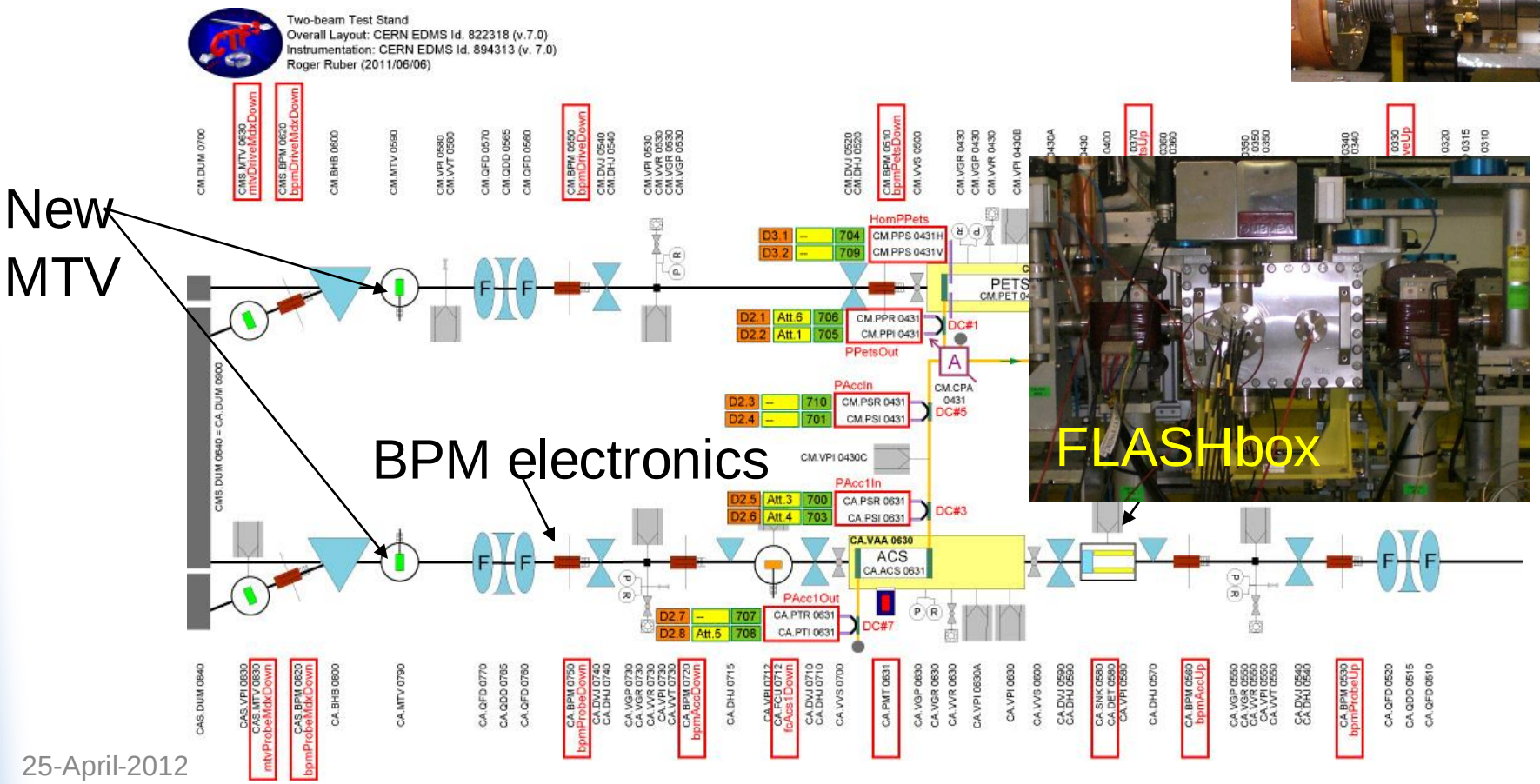


NCLinac – WP9.2

UU: diagnostic equipment

TBTS upgrade

- New BPM electronics; new MTV; FLASHbox
- New photo tubes and cavity BPMs



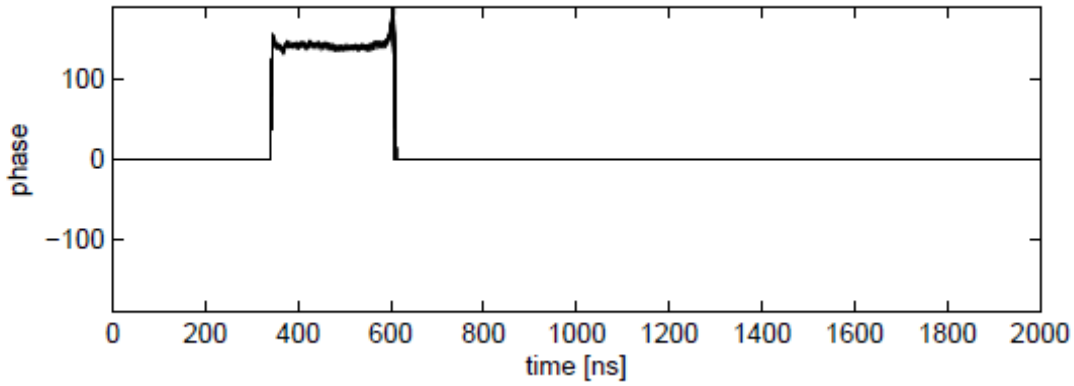
NCLinac – WP9.2

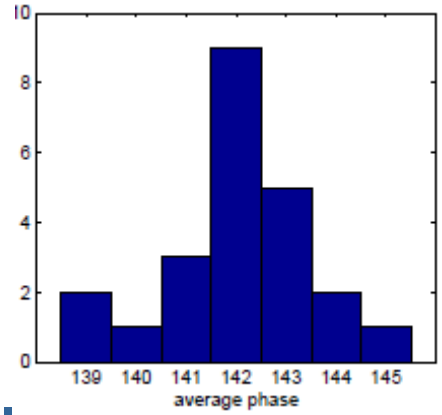
UU: diagnostic equipment

PETS as φ monitor

- **Idea: Use PETS with recirculation as phase monitor (link to 9.5)**
- **Electric field at sample *m* depends on field at time one round-trip time earlier and the driving current Im and its arrival phase α_m**

$$E_m = qE_{m-1} + ce^{i\alpha_m} I_m$$





- **Phase for 23 different beam pulses are very similar**

NCLinac – WP9.3

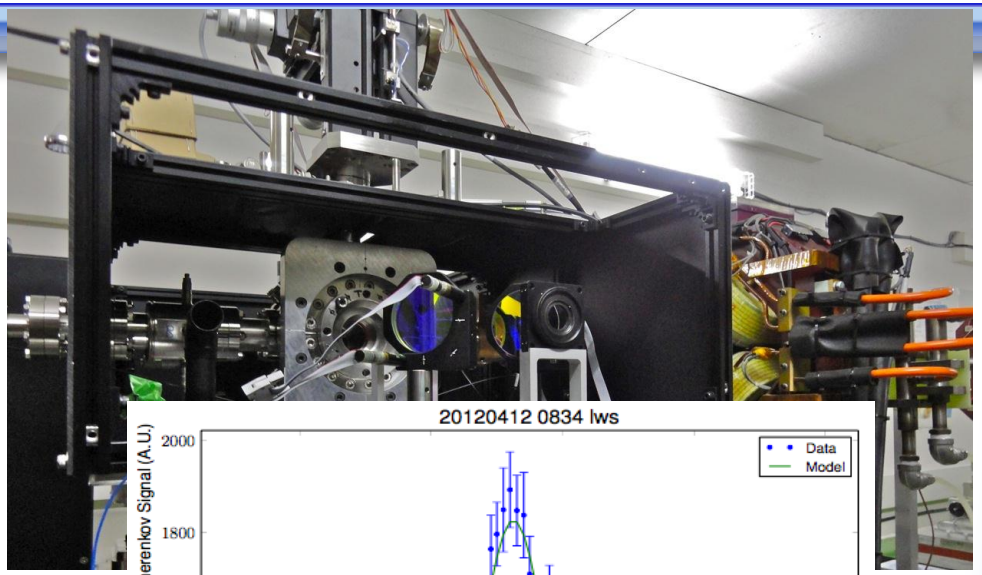
→ **Highlight talk by**

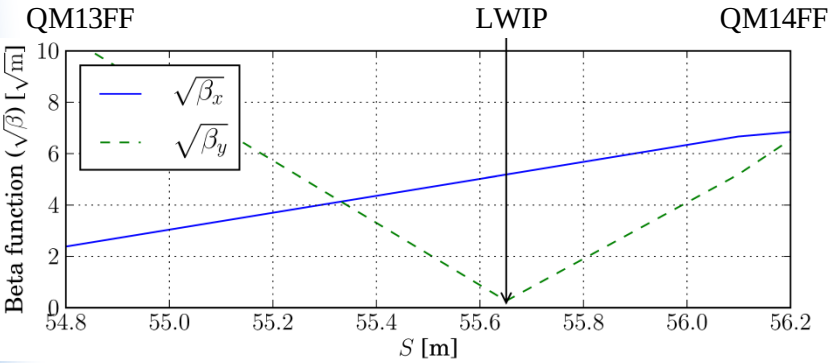
Andrea Jeremie, LAPP Annecy (CNRS)

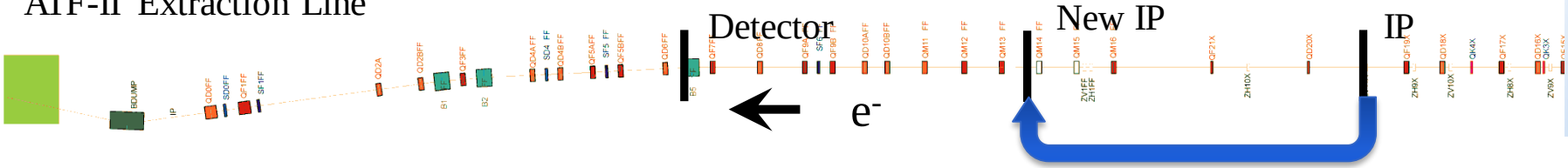
NCLinac – WP9.4

RHUL/UOXF-DL: ATF2 Laser wire

- LW moved post earthquake
- 1μm V x 100 μm H e^- beam
- Initial collisions found
- 4 μm vertical scan so far



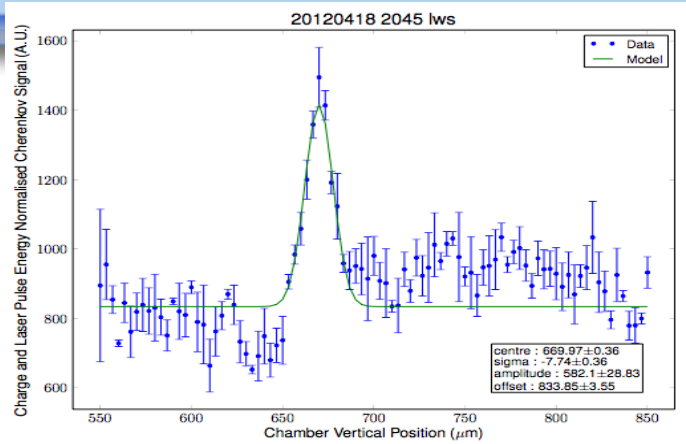


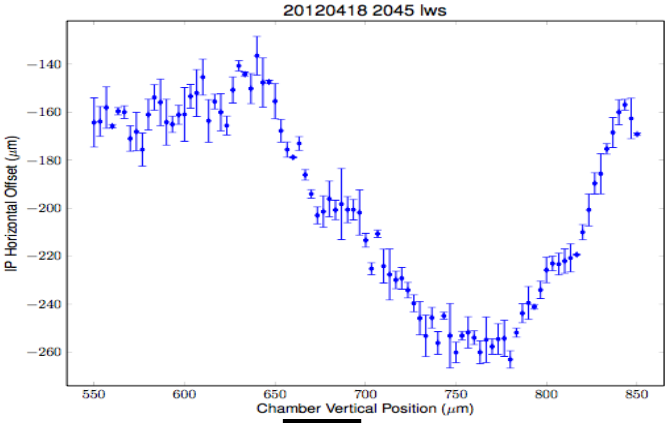


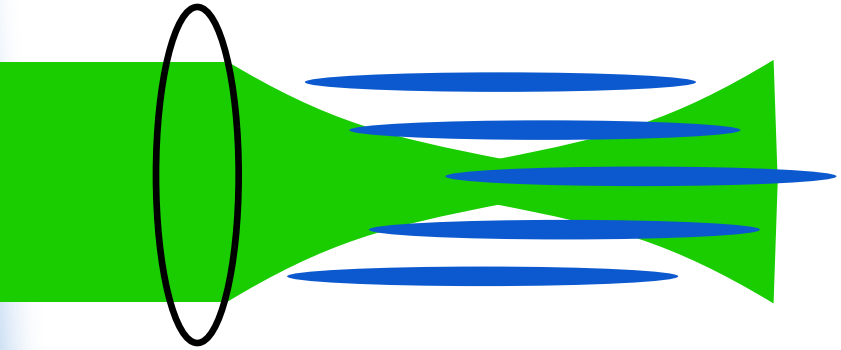
NCLinac – WP9.4

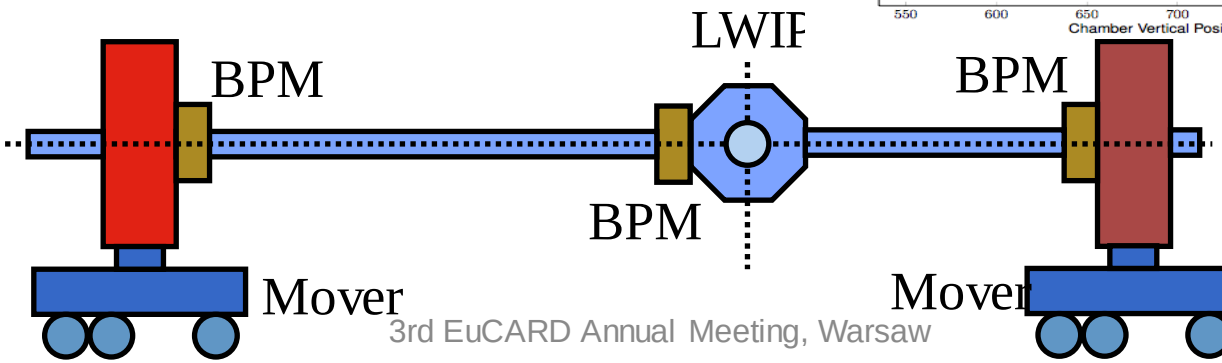
RHUL/UOXF-DL: ATF2 Laser wire with CBPMs

- Electron beam moves horizontally
- modulates Signal
- Use CBPMs to measure position
- LW follows electron beam







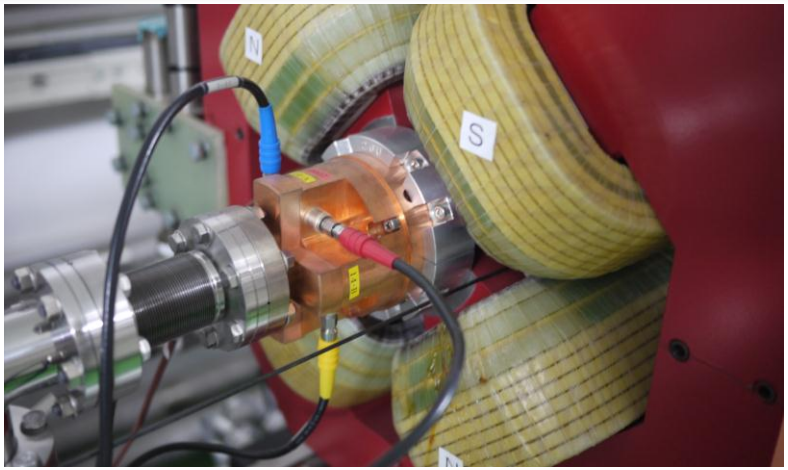


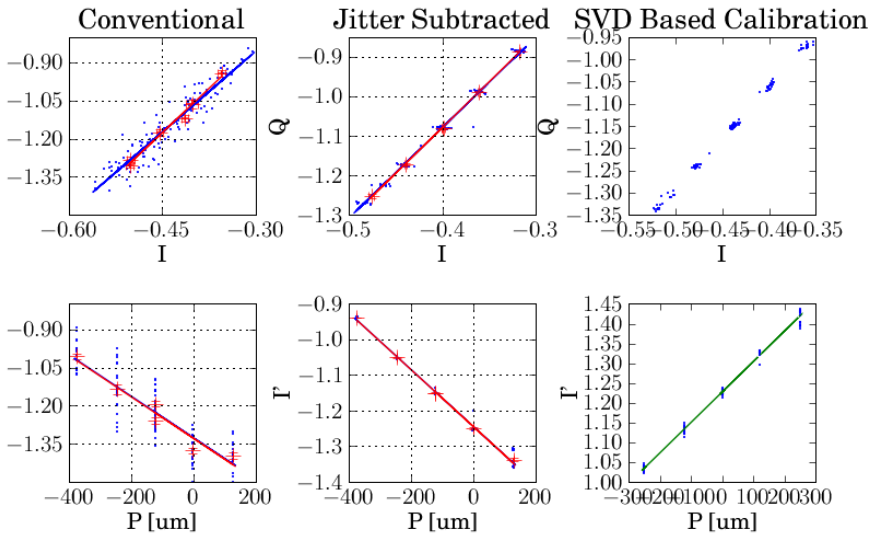
NCLinac – WP9.4

RHUL: Beam position monitors

ATF2 cavity BPM system:

- **44 BPM system operating well (36 c-band, 4 s-band, 4 IP)**
  - Average resolution 200 nm (with attenuation)
  - Best resolution 27 nm
  - Working on developing interaction point region (4 BPMs to monitor focus)
- **Calibration difficult due to large orbit changes**
  - Previously variation 20 % calibration scale change
  - Now less than 1 % with beam orbit subtraction

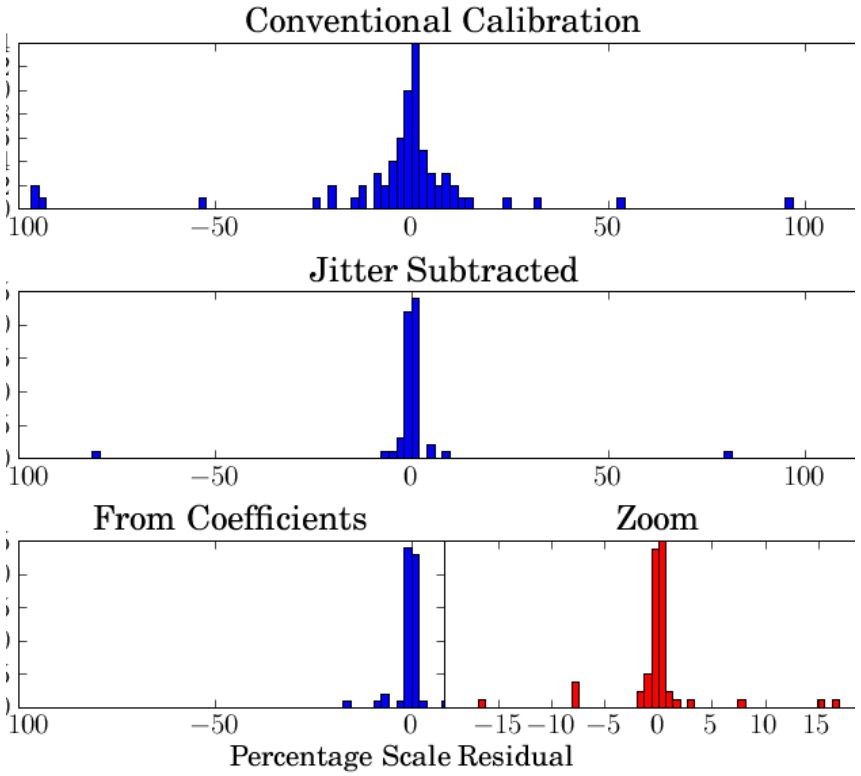




Cavity BPM long term stability

- **Calibration constant over weeks**
- **Two calibration constants required for each BPM**
  - Cavity output is single complex number
  - Calibration constant single complex number (magnitude and phase)
- **Monitor for 3 week period and conclude EuCARD deliverables with paper/report**

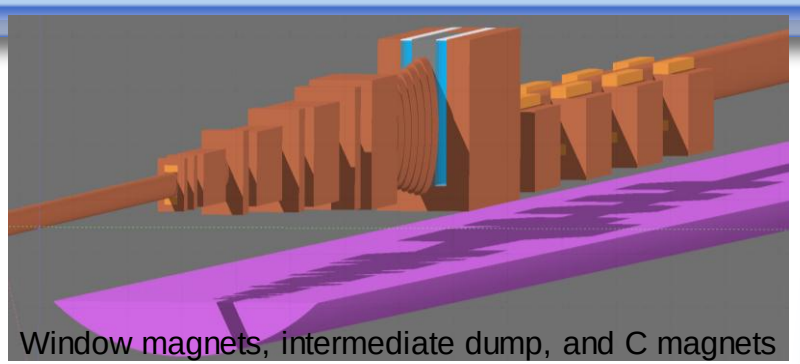
- **Calibration scale**



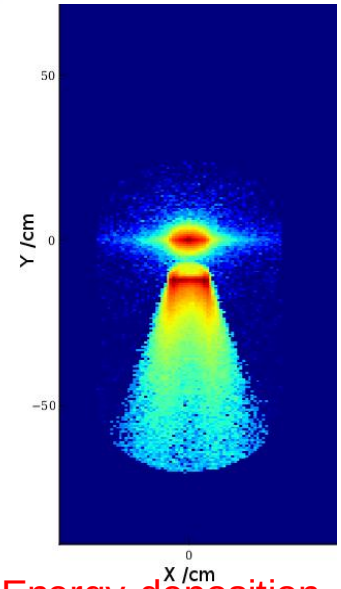
NCLinac – WP9.4

ASTEC/UNIMAN: Post-IP line modelling

CLIC post-IP line: ~10 MW of disrupted beam, ~3 MW beamstrahlung photons & other products. Opportunity to measure and optimise the collision luminosity through direct beam-beam products diagnostics.
EuCARD goal: model post-IP region in FLUKA & study backgrounds, diagnose & optimise luminosity



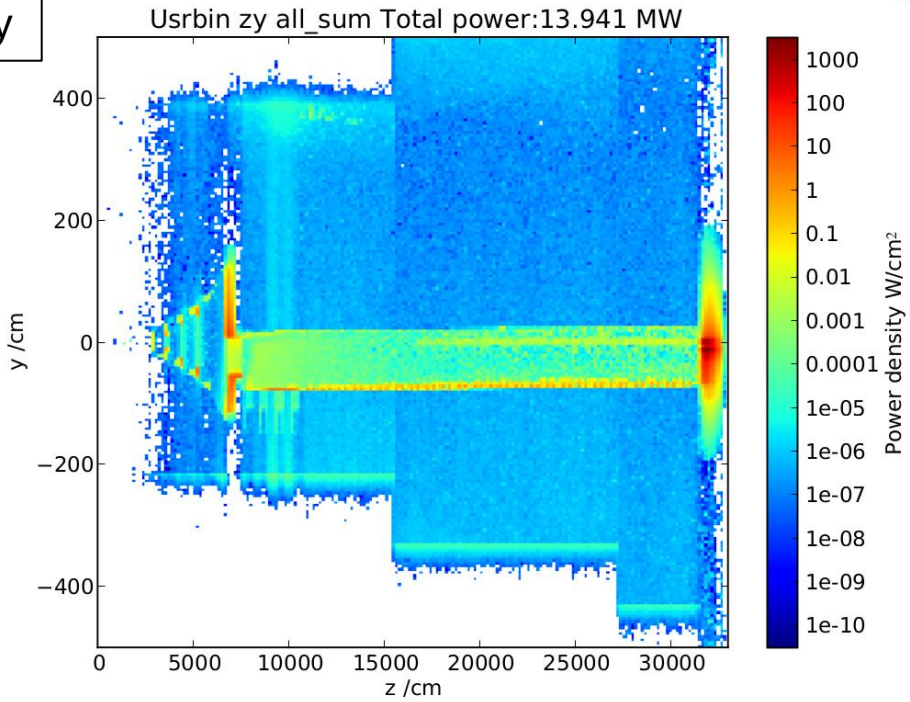
Window magnets, intermediate dump, and C magnets



Energy deposition on main dump

Model complete & validated, including tunnel and dump. Used for P deposition & to measure particle fluxes @ candidate positions for lumi monitors.
This summer to be extended to IP beam offsets to map signals to beam collision parameters.

Appleby/Tygier



Energy deposition along beam line

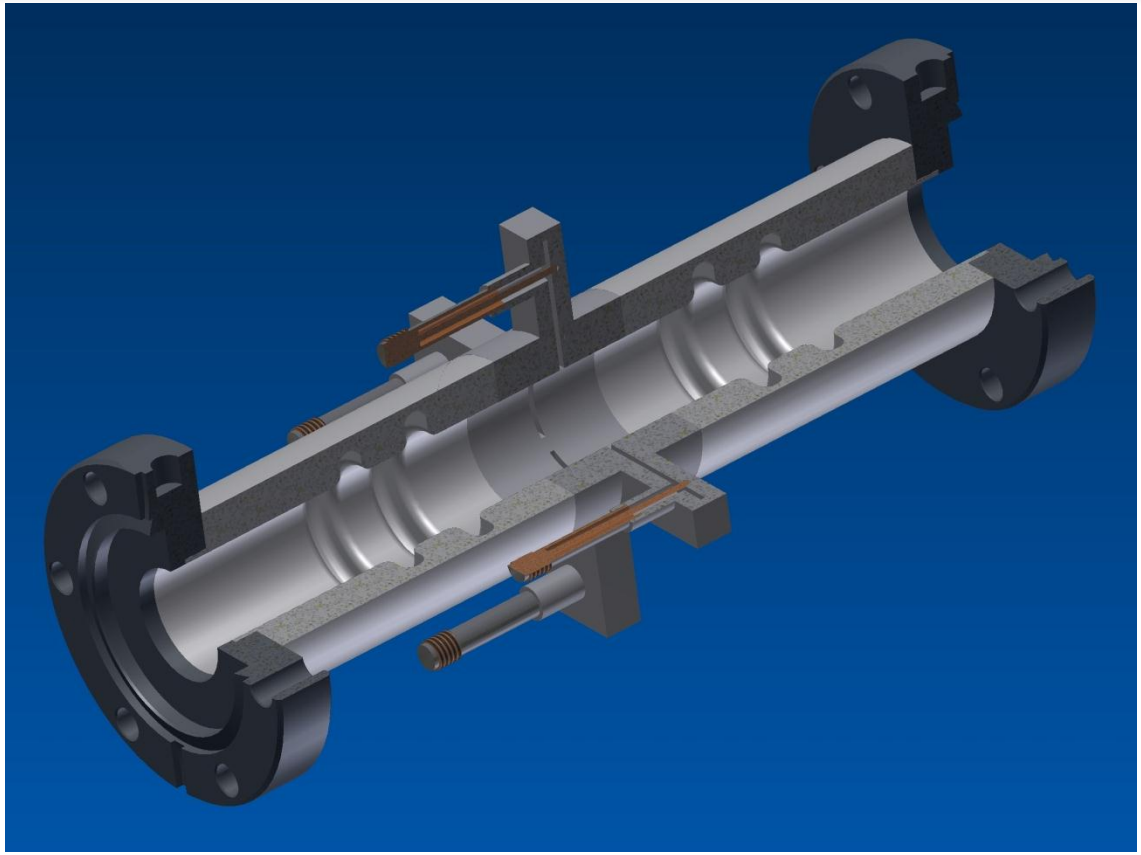
NCLinac – WP9.4

Plus:

- **Simulations – linking with WP 10.4:**
  - The CLIC crab-cavity induces a higher order correlation in the beam dynamics at the IP, leading to luminosity loss within the CLIC BDS design. To compensate for this effect, simulation work was performed on re-optimising the non-linear elements in the CLIC BDS, between the crab-cavity and the Interaction Point, to minimise the luminosity loss and restore the design luminosity of the machine.
- **Need for non-linear optimizations of other areas was highlighted.**

NCLinac – WP9.5

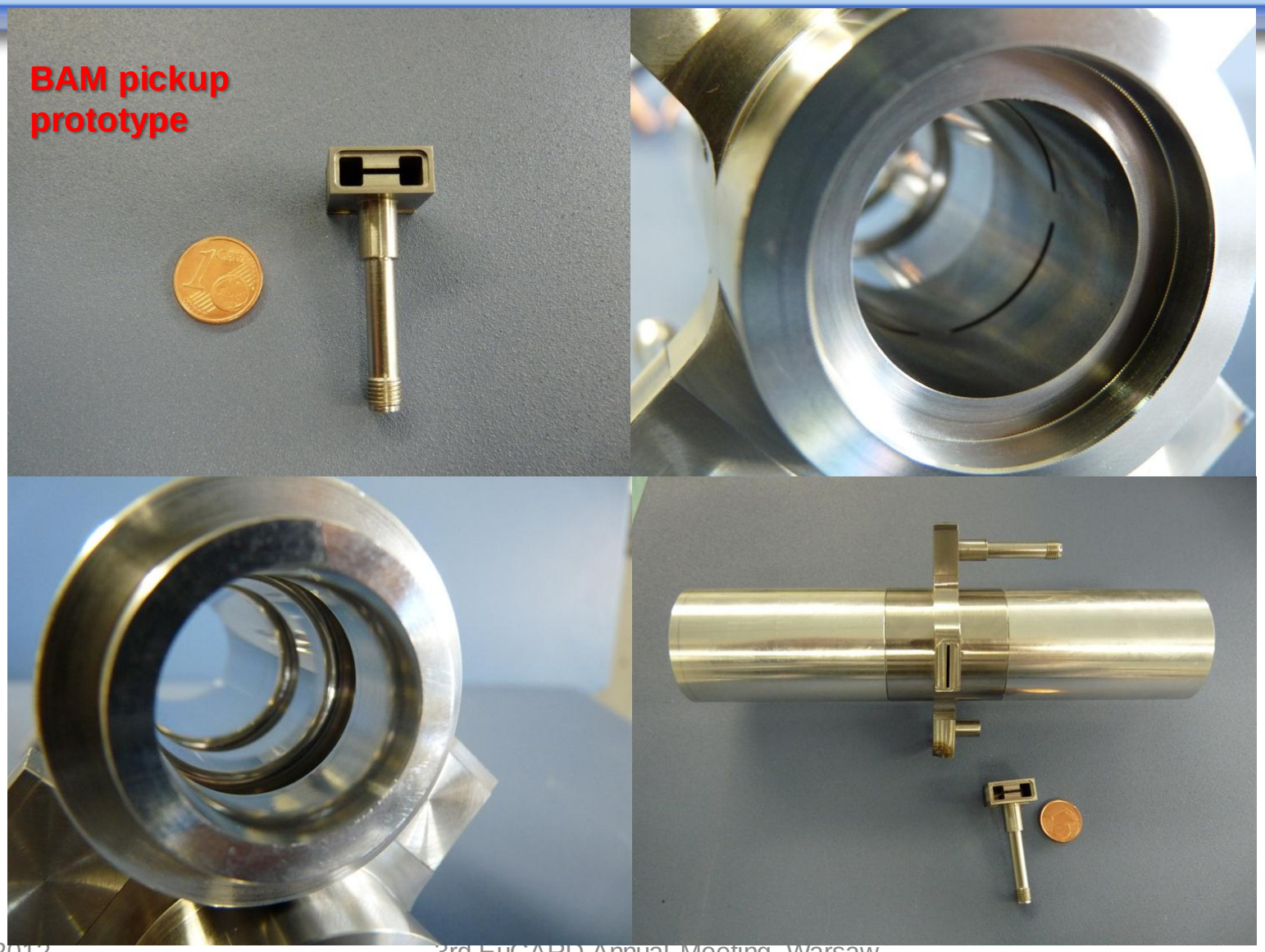
INFN/PSI/CERN: Phase PU, BAM



Pickup drawing cut-view

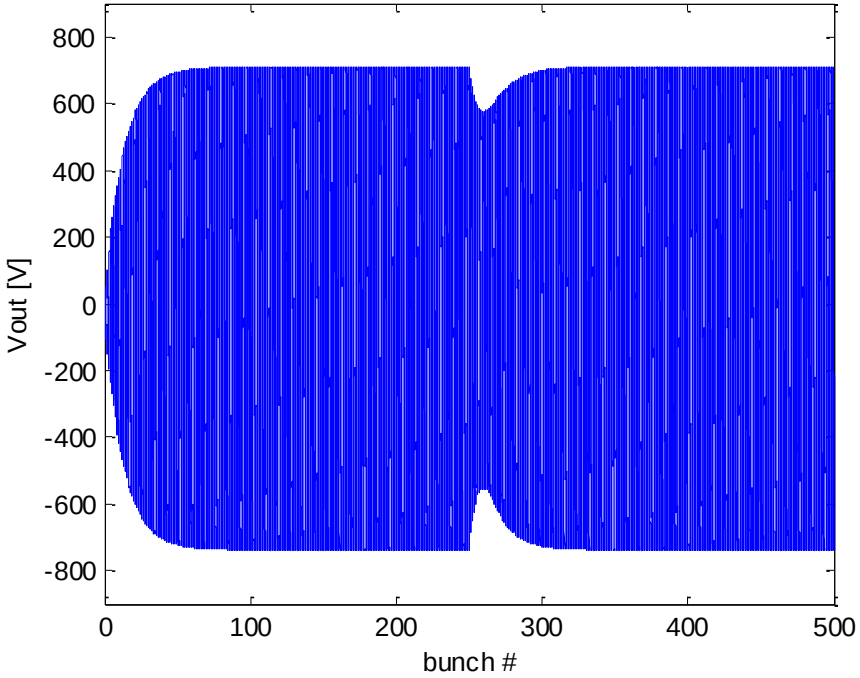
NCLinac – WP9.5

INFN/PSI/CERN: Phase PU, BAM



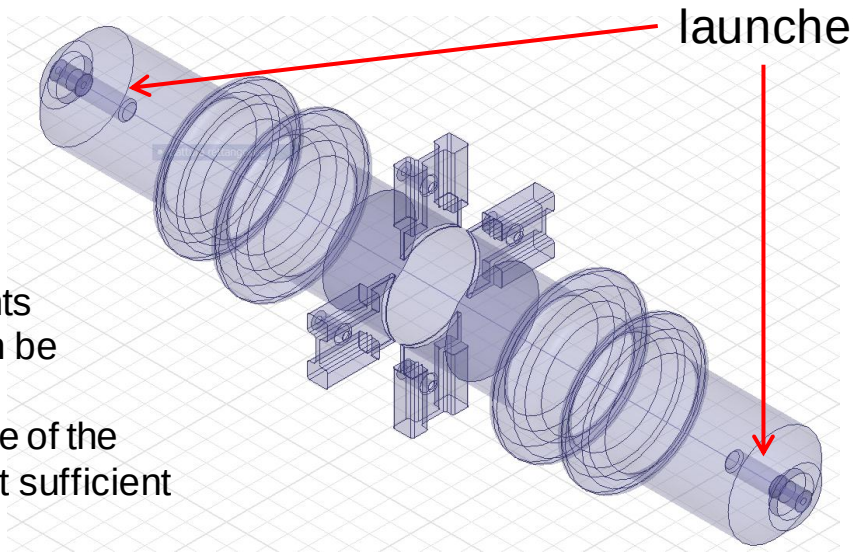
NCLinac – WP9.5

INFN/PSI/CERN: Phase PU, BAM



Calculated pickup output given by a bunch train at the nominal beam current with a phase jump at bunch #250.

Prototype built and measured:



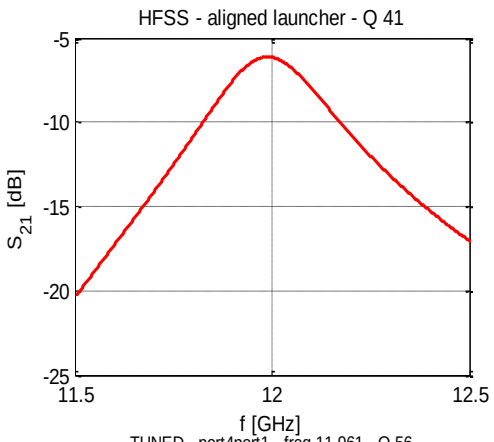
Launcher optimized for launching TM01 mode in the 23 mm diameter beam pipe.
The real device has some small misalignements of the launcher antennas and other modes can be excited in the structure.
For these modes, the matching with TEM mode of the coaxial output lines done by the launcher is not sufficient to avoid resonances inside the structure.
Both the cases, ideally aligned antennas and antennas with small alignement error have been simulated.

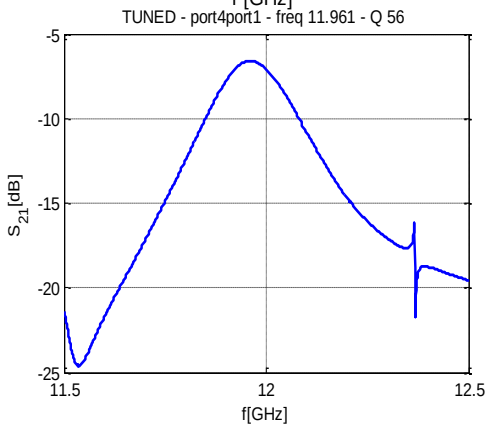
In the following results from simulations and from measurements are summarized.
Red trace plots: simulation
Blue trace plots: measurements

NCLinac – WP9.5

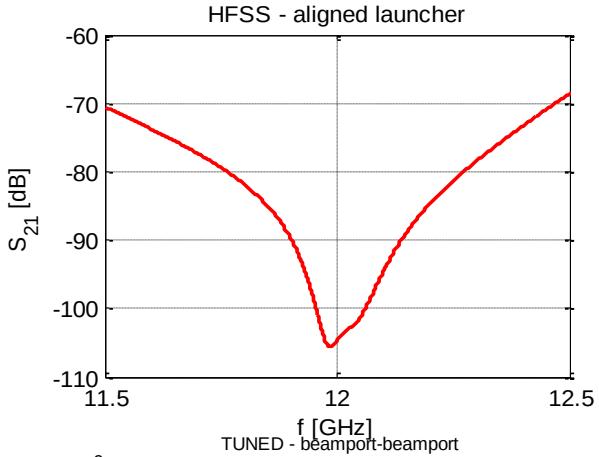
INFN/PSI/CERN: Phase PU, BAM

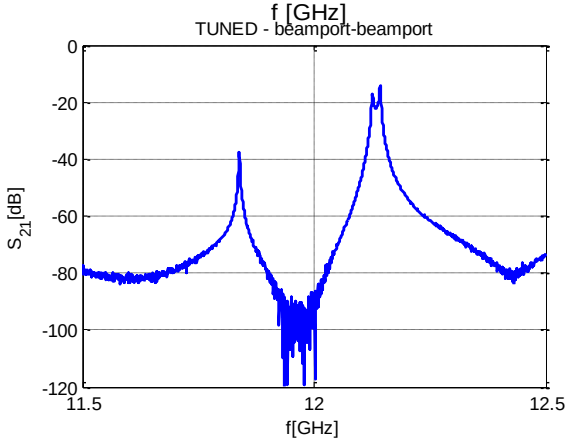
wg to wg



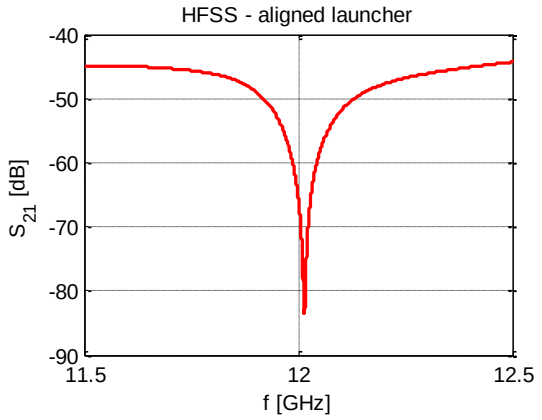


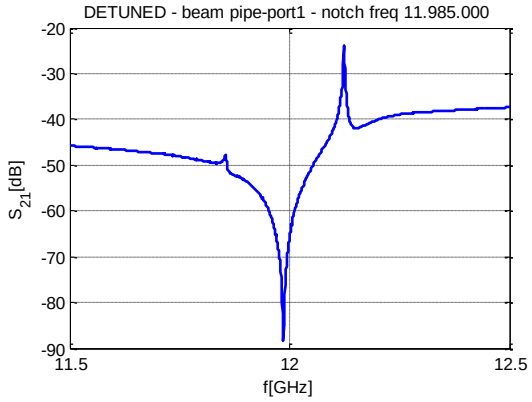
beam pipe to beam pipe





beam pipe to wg

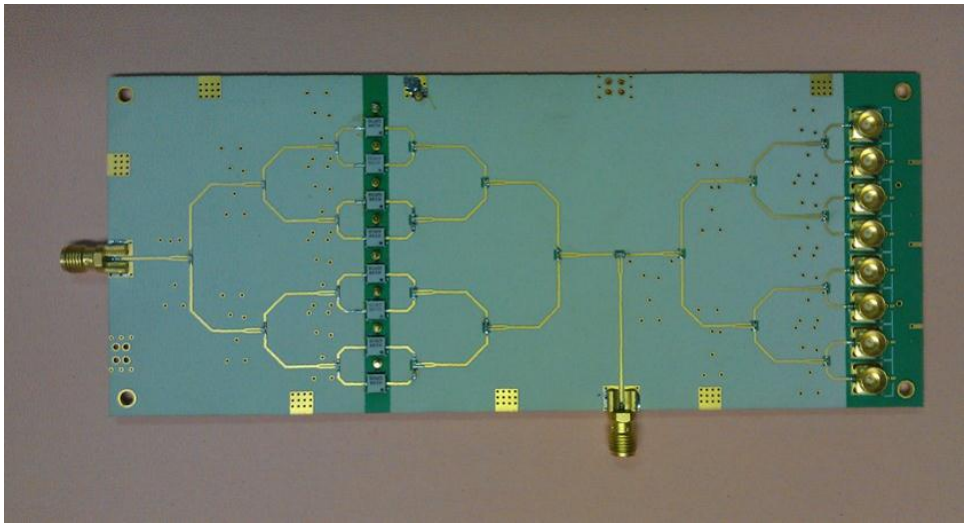


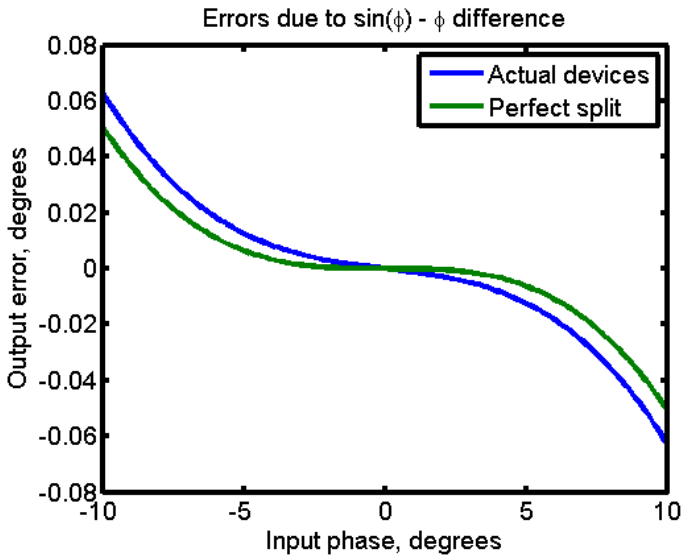


NCLinac – WP9.5

INFN/PSI/CERN: Phase PU, BAM

BAM electronics:





Conclusions

- **NCLinac has made correct progress and is approximately on track.**
- **Found additional connections/synergies:**
  - Uppsala saw voids "predicted" by Helsinki,
  - Royal Holloway simulated nonlinear effects of crab cavities (10.4)
- **Education: Excellent sourcing of future experts from NCLinac student collaborators (e.g. D'Elia, Timko, Khan, Muranaka …)**