C, X and K band accelerating modules

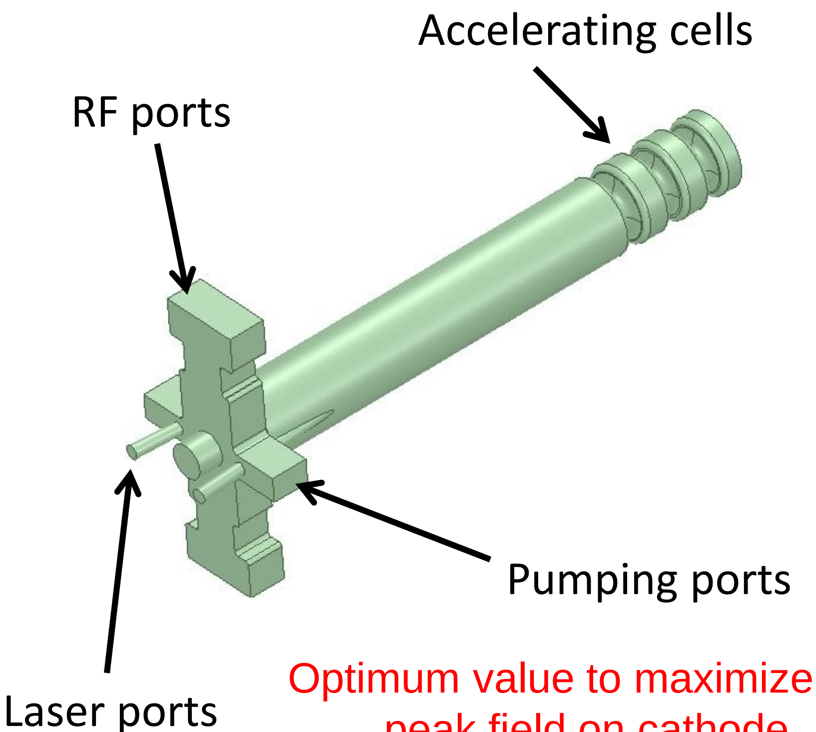
XLS injector layout, 02/10/2020

M. Diomede (INFN-LNF)

On behalf of CompactLight-XLS project

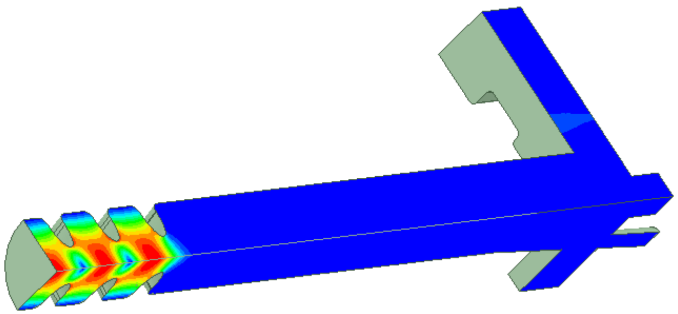
Funded by the European Union

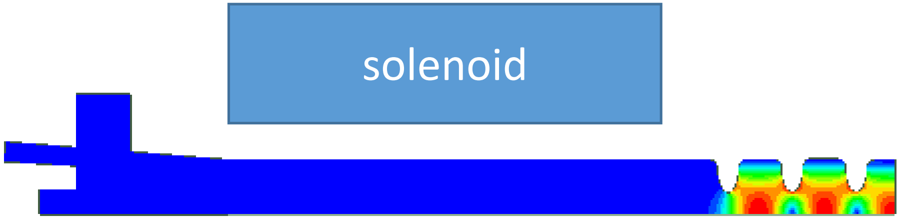
2.5 CELL GEOMETRY ELECTROMAGNETIC SIMULATIONS AND FINAL PARAMETERS



Optimum value to maximize the peak field on cathode

E_{cath}	160 MV/m
$\Delta f_{\pi/2-\pi}$	≈ 52 MHz
Q_0	11600
β	3
Filling time (τ_F)	160 ns
P_{diss} @160MV/m	9.7 MW
$E_{CAT}/\sqrt{P_{diss}}$	51.4 [MV/m/(MW)$^{0.5}$]
Rep. Rate	1000 Hz
Peak Input power P_{IN}	17.5 MW
Pulsed heating (T_{puls})	<20 °C
RF pulse length (T_{RF})	300 ns
Av diss power (P_{av})	2300 W





NB: in the present configuration **2 klystrons** are needed to reach **160 MV/m** on the cathode at **1 kHz**.
With **1 klystron**, simply scaling the performances of the present C-band sources (w/o R&D), we obtain **120 MV/m** at **1 KHz**

UPDATE: 1 high rep rate klystron is enough

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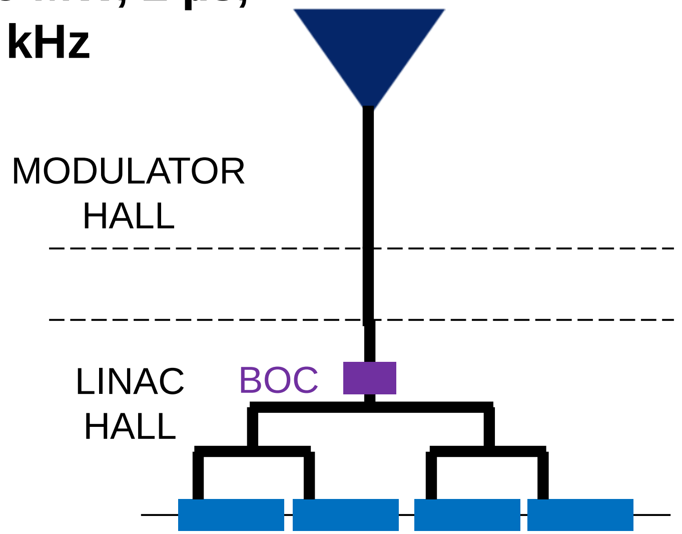
NEW C-BAND MODULE WITH BOC

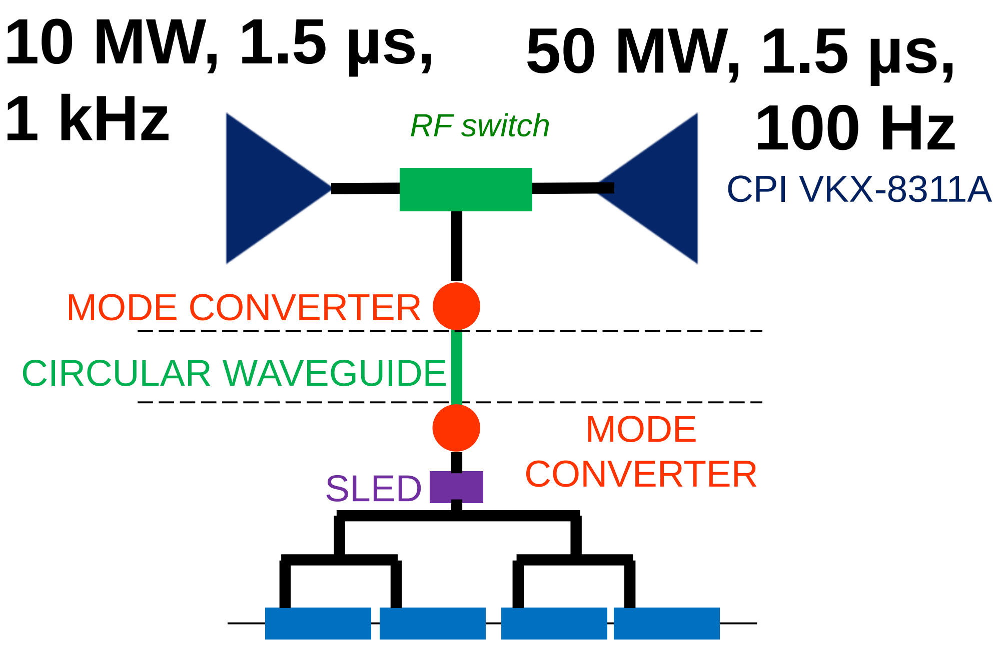
RF System	
Operating frequency [GHz]	5.996
Klystron pulse length [us]	2
Klystron peak power [MW]	15
Pulse rate [pps]	1000
Q0 of BOC	216000
Qe of BOC	19100

**15 MW, 2 µs,
1 kHz**



Acc. Structure	
Phase advance	2pi/3
Cell length [mm]	16.667
Number of cells	120
Total length [m]	2
Average iris radius [mm]	6.6
Tapering angle [deg]	0.02
Iris radius (first - last) [mm]	6.943 – 6.257
Shunt imp. [MΩ/m]	71 - 77
Q	9986 - 9943
Group velocity/c [%]	2.4 – 1.6
Filling time [ns]	336
Repetition rate [Hz]	1000
Avg. acc. gradient [MV/m]	15
Kly. Power per module [MW]	9

X-BAND MODULE



Module (linear t No. 2)			
Frequency [GHz]	11.994		
RF pulse (250 Hz) [µs]	1.5 (0.15)		
Average iris radius <a> [mm]	3.5		
Iris radius a [mm]	4.3-2.7		
Iris thickness t [mm]	2.0-2.24		
Structure length L_s [m]	0.9		
Unloaded SLED Q-factor Q_0	180000		
External SLED Q-factor Q_E	23300		
Shunt impedance R [MΩ/m]	85-111		
Effective shunt Imp. R_s [MΩ/m]	349		
Group velocity v_g/c [%]	4.7-0.9		
Filling time [ns]	146		
Repetition rate [Hz]	100	250	1000
SLED	ON	OFF	ON
Kly. Power per module [MW]	44	44	9
Avg. acc. gradient [MV/m]	65	30	30

Linearizer Standing Wave Ka-Band Updates

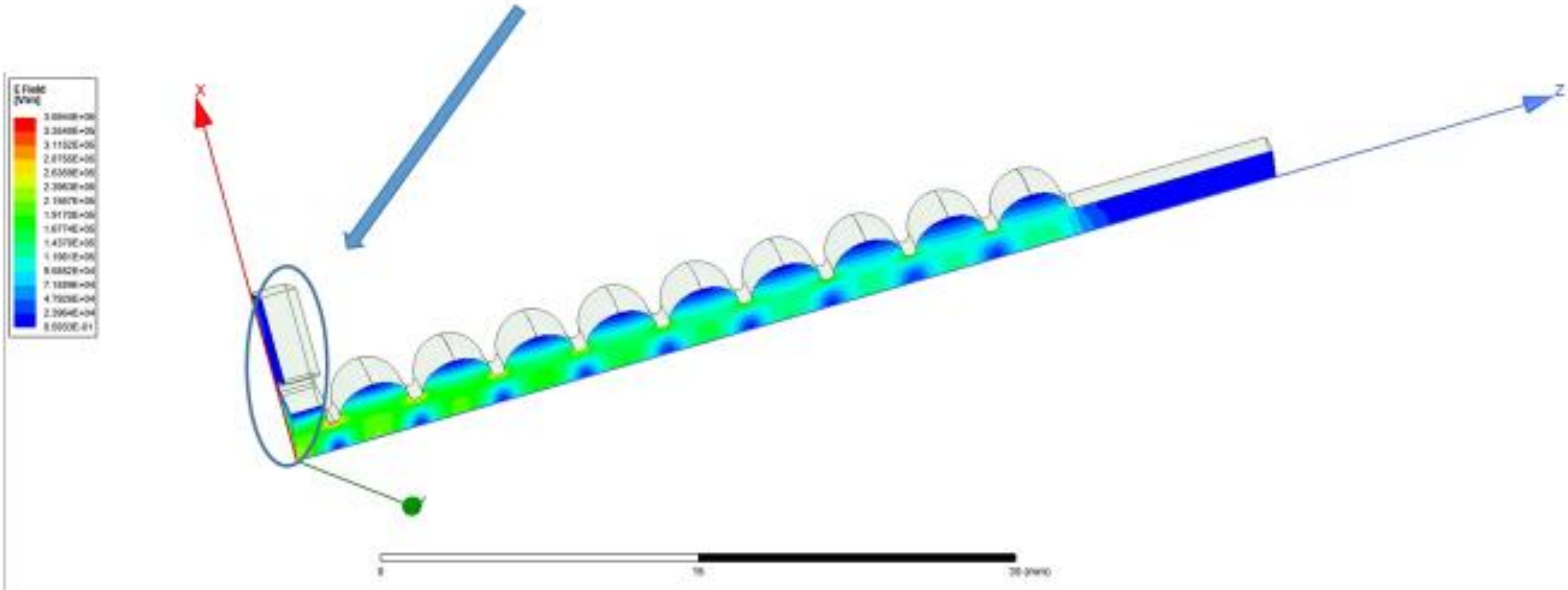
M. Bethouei – L. Faillace – M. Migliorati - B. Spataro

On behalf of Compact Light XLS project

CERN - Miniworkshop - August– 27- 2020

Simulated geometry with the coupler (one quarter of the whole structure)

Mode launcher with 4 symmetric port coupler in order to feed the structure in the central cell



Conclusions

The goal is to obtain an integrated voltage of 15 MeV (A. Latina et al.)

Normal conducting operation case

We assume a 8 cm structure length (19 cells), 10 MW matched input power

Summary results of the normal conducting case

Iris radius (mm)	Shunt impedance (MΩ/m)	Matched Input Power (MW)	Integrated Voltage (MV)/structure
2	100	10	9
1.333	154	10	11

As a result, two separated structures are needed in order to obtain an integrated voltage of 15 MeV

In all cases, the Modified Poynting vector and pulse heating are well below the safety treshold. The longitudinal and transvere wakefields effects on the beam dynamic are negligible, too. We already discussed that.

Cryostructure option

Summary results of the cryostructure option

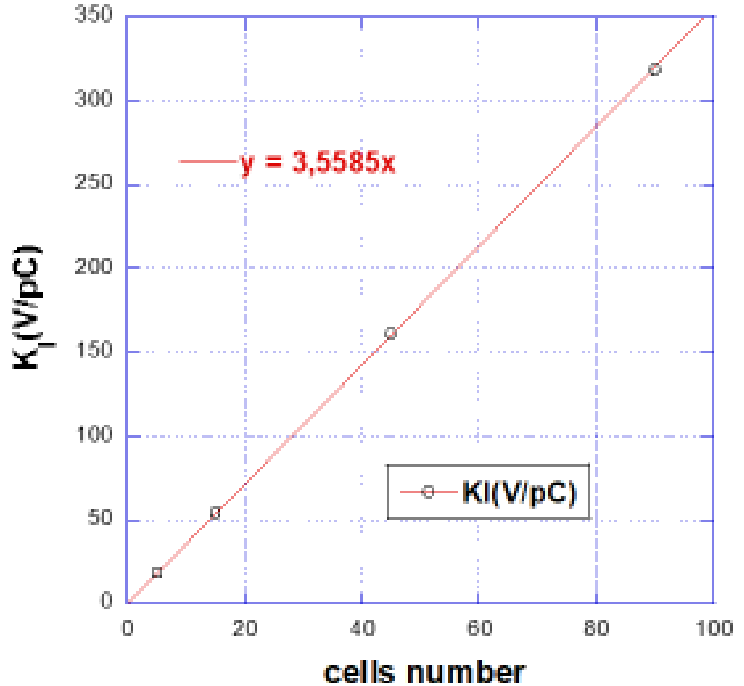
Iris radius (mm)	Shunt impedance (MΩ/m)	Matched Input Power (MW)	Temperature (Kelvin degree)	Enhancement Factor	Integrated Voltage (MV)/structure
2	100	10	77	2.2	13
1.333	154	10	77	2.2	16.5
2	100	10	40	3.3	16.2
1.333	154	10	40	3.3	20

Operating at 77 Kelvin degree with a iris radius of 1.333 mm it is possible to use only one structure in order to get an integrated voltage of 15 MeV

Operating at 40 Kelvin degree both an iris radius 1.333 mm and 2 mm it also is possible use only one structure

Wake fields studies on the 35.982 GHz structure with a 1.333 mm iris radius

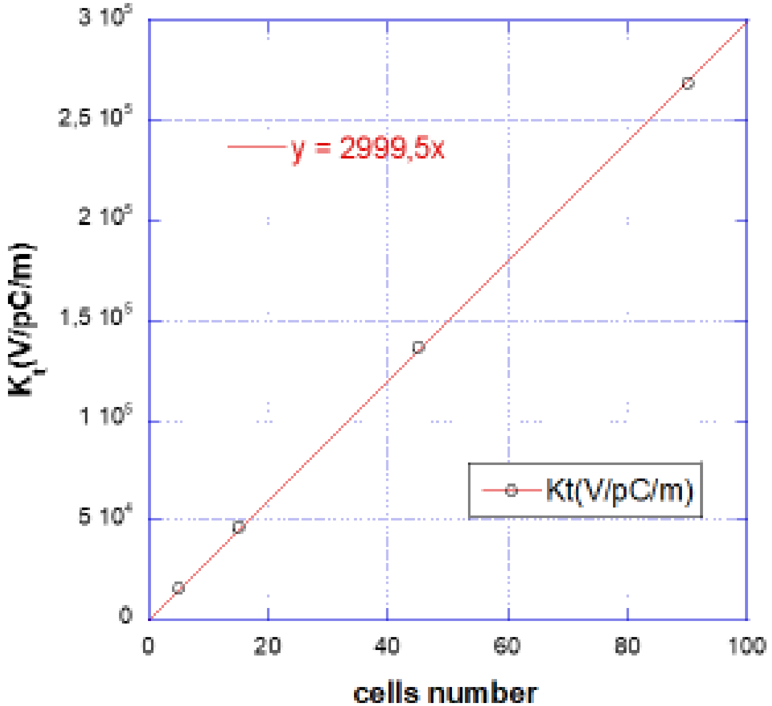
Longitudunal loss parameter as function of the cells number of the structure at F = 35.982 GHz



By assuming N = 19 cells (L= 80 mm), $K_l \cong 76$ V/pC, Q = 75 pC

$E_{losses} \cong 5.7$ KeV

Transverse loss parameter as function of the cells number of the structure at F = 35.982 GHz



Assuming N = 19 cells (L = 80 mm), $K_t \cong 6.4\ 10^4$ V/pC/m, $y(0) = 5\ 10^{-6}$ m (pessimistic !), Q = 75 pC ; E = 250 MeV

$$\theta = \frac{y(0)}{E/e} Q K_t \cong 0.096\ 10^{-6} \text{ rad}$$

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Thank you!

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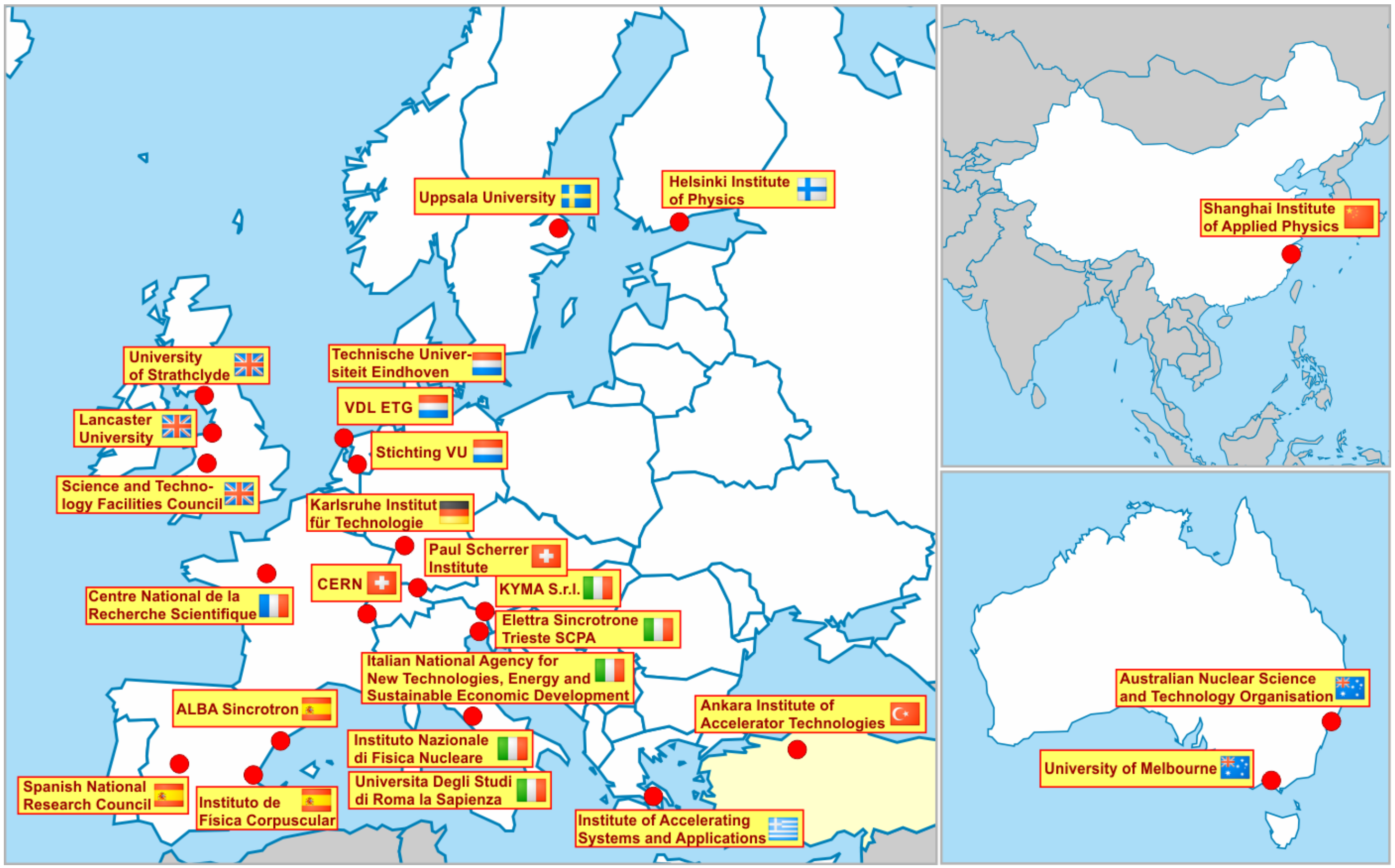

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