Task 5.

Drive Beam Phase Control

Partners: CERN, INFN/LNF, PSI

GOAL: Study, design, build and test systems for longitudinal position detection of CLIC drive beam phase with very high resolution (0.1 deg → ~20fs @12GHz).

Phase stabilization (feedback) between drive and main beams important to optimize CLIC luminosity.

Two different solutions will be investigated:

Sub-task 1: RF monitor.

Electromagnetic design by CERN and INFN. Electronics development and realization by CERN. Monitor prototypes realization by INFN. Test of final version of the system in CTF3.

Sub-task 2: Electro-optical monitor.

PSI will design the system (pickup, laser, e.o. detector and electronics), and will build and test prototypes at the existing facilities at PSI.

Common characteristics:

- **Very low coupling impedance**
- **Filters to reject wake fields and RF noise**
- **Application also in other machines where precise high freq beam phase detection is necessary.**

D

9.5.1 RF phase monitor final report - M45 (December '12)

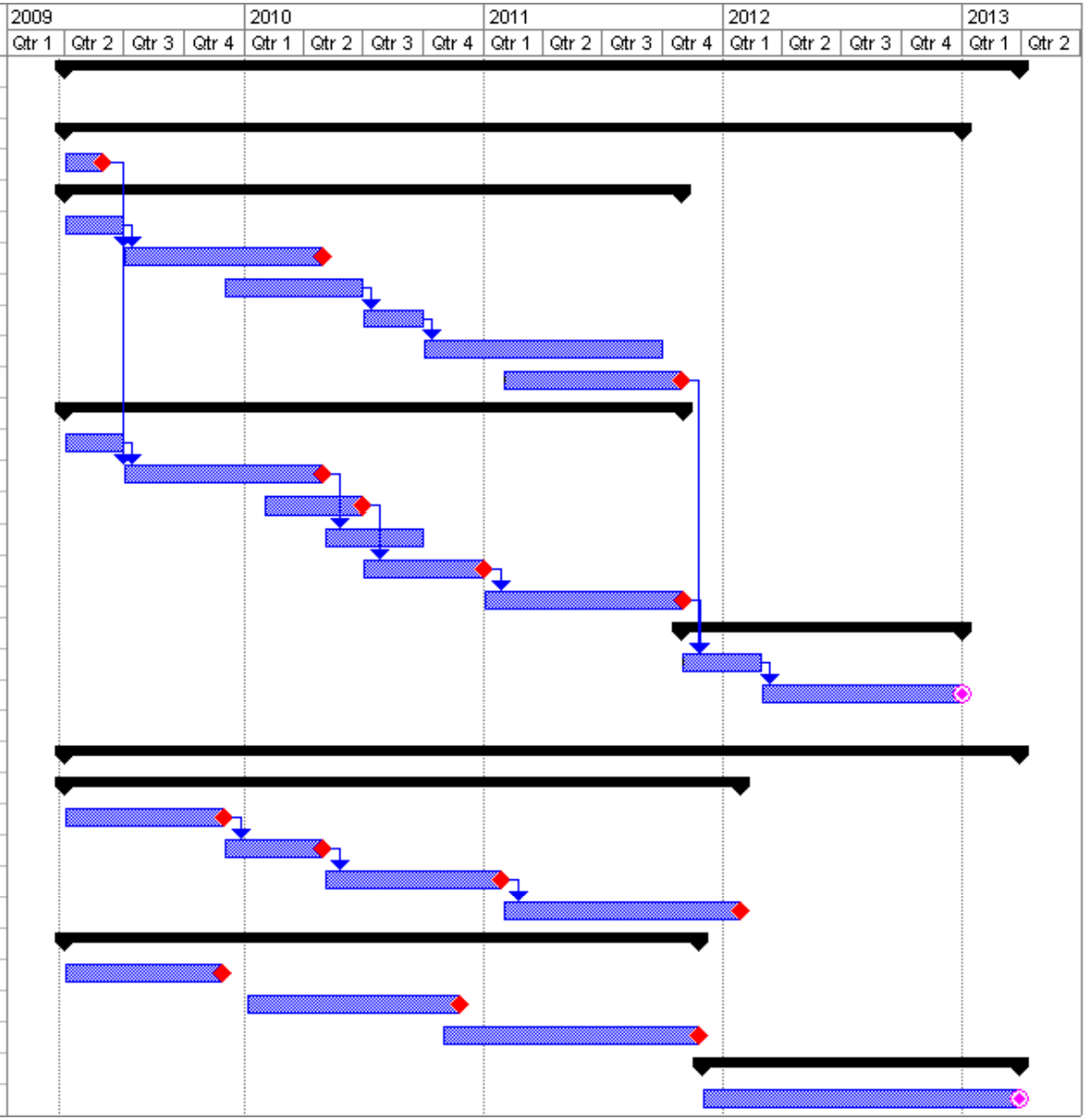
9.5.2 Electro optical monitor final report - M48 (March '13).

M

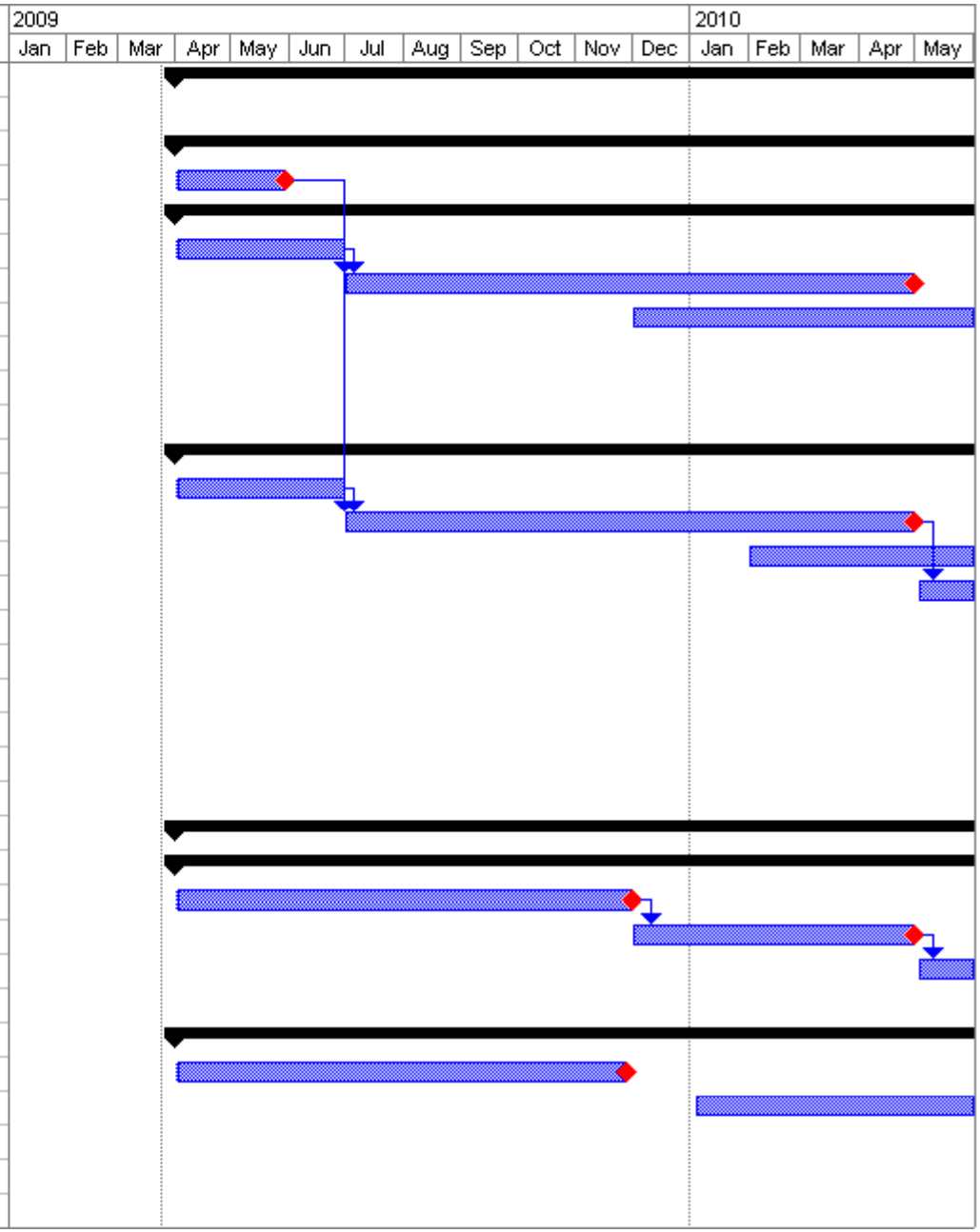
9.5.1 RF phase monitor prototype finished (ready for test) - M36 (March '12)

9.5.2 Electro optical monitor prototype finished (ready for test) - M40 (July '12)

ID	Task Name
1	**drive beam phase control**
2	
3	**RF phase monitor**
4	define specs
5	**electronics**
6	study
7	design
8	component procurement
9	assembly
10	test
11	revision
12	**monitor pickup**
13	study
14	e.m. design
15	mechanical design
16	feedthrough procurement
17	mechanical realization
18	RF test/lab measurements
19	**full system test**
20	electronics and monitor integration and test
21	beam measurement at CTF3
22	
23	**electro-optical phase monitor**
24	**bunch phase pickup**
25	electrical/mechanical design
26	fabrication
27	beam test
28	revision
29	**optical system**
30	lab test optical link and stabilization
31	test lockin laser
32	setup prototype with readout system
33	**full system test**
34	beam meas, refine and adapt to CLIC specs



ID	Task Name
1	**drive beam phase control**
2	
3	**RF phase monitor**
4	define specs
5	**electronics**
6	study
7	design
8	component procurement
9	assembly
10	test
11	revision
12	**monitor pickup**
13	study
14	e.m. design
15	mechanical design
16	feedthrough procurement
17	mechanical realization
18	RF test/lab measurements
19	**full system test**
20	electronics and monitor integration and test
21	beam measurement at CTF3
22	
23	**electro-optical phase monitor**
24	**bunch phase pickup**
25	electrical/mechanical design
26	fabrication
27	beam test
28	revision
29	**optical system**
30	lab test optical link and stabilization
31	test lockin laser
32	setup prototype with readout system
33	**full system test**
34	beam meas, refine and adapt to CLIC specs



Tentative spending Profile - LNF

EuCARD - WP9 NCLinac - Task 9.5: DB Phase

Beneficiary short name [a]	Average direct monthly salary * (€)	Rate for personnel indirect costs (%)	Rate for material and travel indirect costs (%)
LNF	6,200 €	60	60

Expenses 04/2009-04/2010

Beneficiary short name (all costs in €)	Person-Months	Personnel direct costs	Personnel indirect costs	Sub-contracting cost	Consumable and prototype direct costs	Travel direct costs	Material and travel indirect costs	Total direct costs	Toal indirect costs	Total costs (direct +indirect)
LNF	11	68,200	40,920	0	12,000	1,000	7,800	81,200	48,720	129,920

Expenses 04/20010-04/2011

Beneficiary short name (all costs in €)	Person-Months	Personnel direct costs	Personnel indirect costs	Sub-contracting cost	Consumable and prototype direct costs	Travel direct costs	Material and travel indirect costs	Total direct costs	Toal indirect costs	Total costs (direct +indirect)
LNF	11	68,200	40,920	0	18,000	1,500	11,700	87,700	52,620	140,320

Expenses 04/2011-04/2012

Beneficiary short name (all costs in €)	Person-Months	Personnel direct costs	Personnel indirect costs	Sub-contracting cost	Consumable and prototype direct costs	Travel direct costs	Material and travel indirect costs	Total direct costs	Toal indirect costs	Total costs (direct +indirect)
LNF	4	24,800	14,880	0	1,300	1,000	1,380	27,100	16,260	43,360

Expenses 04/2012-04/2013

Beneficiary short name (all costs in €)	Person-Months	Personnel direct costs	Personnel indirect costs	Sub-contracting cost	Consumable and prototype direct costs	Travel direct costs	Material and travel indirect costs	Total direct costs	Toal indirect costs	Total costs (direct +indirect)
LNF	4	24,800	14,880	0	0	1,500	900	26,300	15,780	42,080

EuCARD - WP9 NCLinac - Task 9.5: DB Phase v2

Tentative spending Profile - PSI

Beneficiary short name [a]	Average direct monthly salary * (€)	Rate for personnel indirect costs (%)	Rate for material and travel indirect costs (%)
PSI (Task leader)	14,300 €	20	20
PSI (Post doc)	10,100 €	20	20

Expenses 04/2009-04/2010

Beneficiary short name (all costs in €)	Person-Months	Personnel direct costs	Personnel indirect costs	Sub-contracting cost	Consumable and prototype direct costs	Travel direct costs	Material and travel indirect costs	Total direct costs	Toal indirect costs	Total costs (direct +indirect)
PSI (Task leader)	2	28,600	5,720	0	107,500	0	21,500	136,100	27,220	163,320
PSI (Post doc)	3	30,300	6,060	0		0	0	30,300	6,060	36,360
Totals:	**5**	**58,900**	**11,780**	**0**	**107,500**	0	21,500	166,400	**33,280**	**199,680**

Expenses 04/20010-04/2011

Beneficiary short name (all costs in €)	Person-Months	Personnel direct costs	Personnel indirect costs	Sub-contracting cost	Consumable and prototype direct costs	Travel direct costs	Material and travel indirect costs	Total direct costs	Toal indirect costs	Total costs (direct +indirect)
PSI (Task leader)	1	14,300	2,860	0	0	1,350	270	15,650	3,130	18,780
PSI (Post doc)	3	30,300	6,060	0		1,350	270	31,650	20,740	52,390
Totals:	**4**	**44,600**	**8,920**	**0**	**0**	2,700	540	47,300	**23,870**	**71,170**

Expenses 04/2011-04/2012

Beneficiary short name (all costs in €)	Person-Months	Personnel direct costs	Personnel indirect costs	Sub-contracting cost	Consumable and prototype direct costs	Travel direct costs	Material and travel indirect costs	Total direct costs	Toal indirect costs	Total costs (direct +indirect)
PSI (Task leader)	1	14,300	2,860	0	0	0	0	14,300	2,860	17,160
PSI (Post doc)	2	20,200	4,040	0		0	0	20,200	20,740	40,940
Totals:	**3**	**34,500**	**6,900**	**0**	**0**	0	0	34,500	**23,600**	**58,100**

Expenses 04/2012-04/2013

Beneficiary short name (all costs in €)	Person-Months	Personnel direct costs	Personnel indirect costs	Sub-contracting cost	Consumable and prototype direct costs	Travel direct costs	Material and travel indirect costs	Total direct costs	Toal indirect costs	Total costs (direct +indirect)
PSI (Task leader)	1	14,300	2,860	0	0	1,350	270	15,650	3,130	18,780
PSI (Post doc)	2	20,200	4,040	0		1,350	270	21,550	20,740	42,290
Totals:	**3**	**34,500**	**6,900**	**0**	**0**	2,700	540	37,200	**23,870**	**61,070**

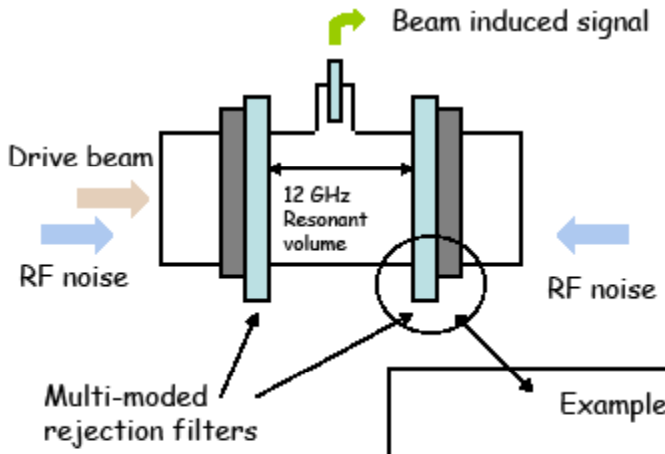
Sub task 1: RF phase monitor

contribution from Igor Syratchev

12 GHz low impedance noise-free pick-up concept

Igor Syratchev

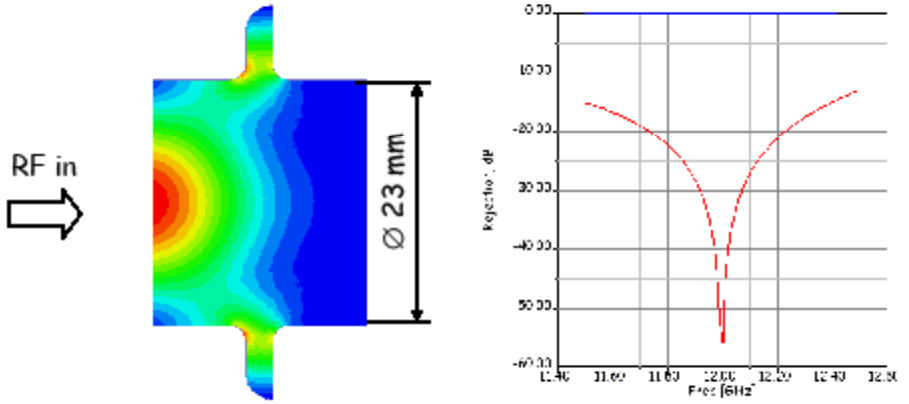
Schematic view of the 12 GHz pick-up concept

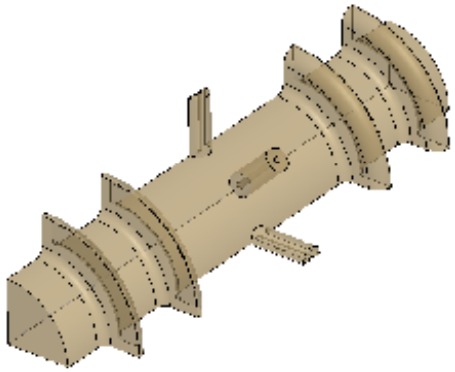


Considerations:

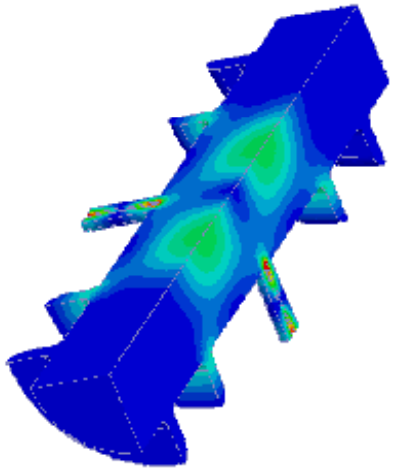
1. We have to keep big aperture of the pick up (I used 23 mm – similar to one in the PETS).
2. Low impedance!
3. The sensitivity of the device will depends on the RF nose rejection level
4. We need a resonant volume anyway (Q loaded to be defined)

Example: TM01 choke-type rejection filter





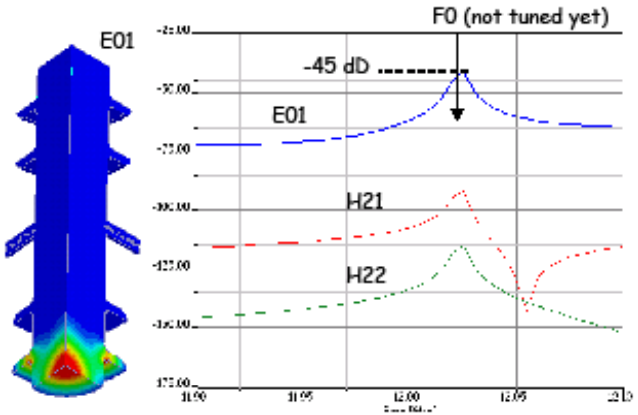
12 GHz resonant field configuration
(here excited via coax. ports)



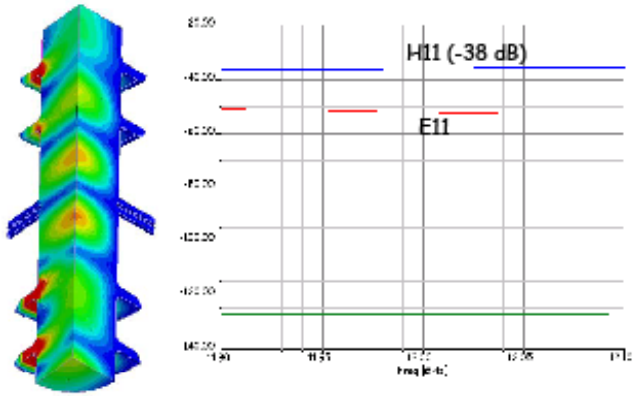
Double-mirror concept.
High Q-factor, small coupling configuration (QL ~ 3000)

This configuration allows to reduce to ~ -40 dB coupling of the RF noise arrived/reflected with the beam to the detection point. The dipolar component will be further reduced by connecting coax. ports in pairs.

Symmetric modes rejection (coupling. to coax.)



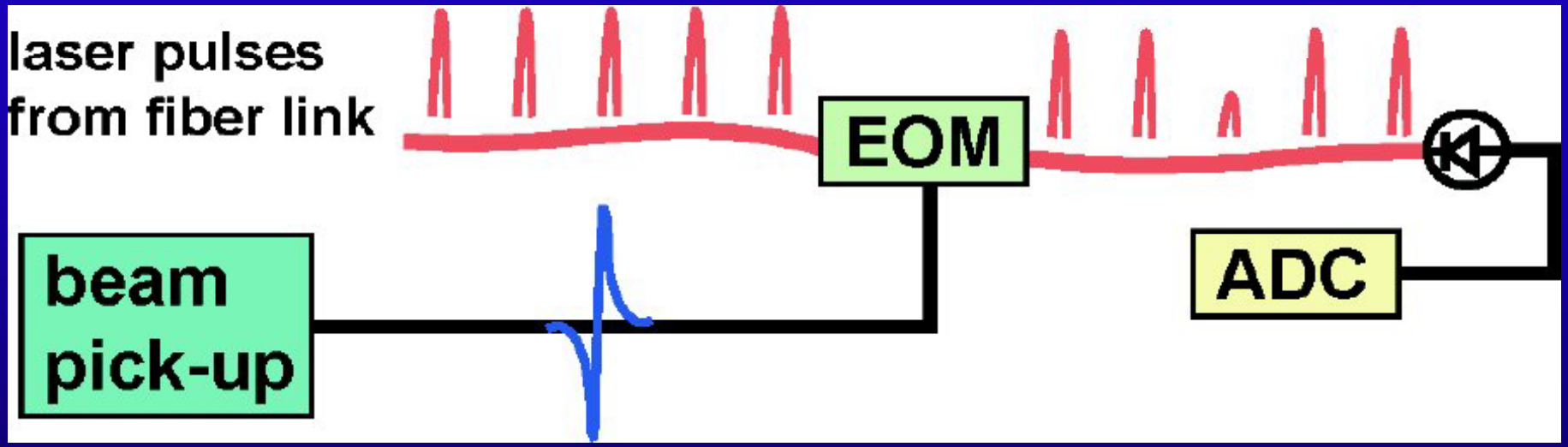
Dipolar modes rejection (coupling. to coax.) (zero-crossing tune)



Sub task 2: electro-optical phase monitor

contribution from Micha Dehler

Bunch phase monitoring using Electro optical sampling



Original idea from DESY:

Use periodic train of laser pulses to sample signal from wide bandwidth beam pickup

Sampling near zero crossing – variations in the bunch phase get converted to amplitude changes

Electro optical sampling allows direct use of high precision signals from fiber laser based timing/synchronization system

Pros and Cons

- **Single bunch measurement**
- **High resolution: 50 fs demonstrated by DESY**
- **Optional use of multiple EOS modules to obtain intra bunch charge distribution for longer bunches**
- **Need wide bandwidth pickup: Deterioration of resolution due to beam echos/wake fields in the beam chamber?**

R&D

Pickup:

- **Optimize bandwidth and slew rate of output signal to increase resolution**
- **Minimize spurious signals from beam echos and wakes by adequate chamber design**

Make Electronics, Laser system 'real time feedback' ready:

- **Bunch rep rate**
- **Minimum measurement latency**
- **Reliability and stability of system**