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# European Industries Potential Capabilities on Superconducting RF Accelerator Modules for the future ILC

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- **Review of European industrial supplies in the past and present (some examples)**
- **Review of the industrial supplies in view of guaranteed parameters**
- **Conclusion and outlook for X-FEL and ILC**



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## **Review of European industrial supplies in the past and present: Example: CEBAF cavities**

**360 cavities (1.5 GHz five cell) were supplied by Interatom, a Siemens subsidiary (later ACCEL) in about a three years period**



### **Achieved performances:**

**Accelerating fields up to 10.0 to 15.0 MV/m**

**$Q_0$  between 6.0 and 10  $10^9$  at 5.0 MV/m**

**Contractual:  $Q_0 > 2.4 \cdot 10^9$  at 5.0 MV/m**



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## Review of European industrial supplies in the past and present: Example: LEP srf Modules

Based on CERN developed coating technology (Nb on copper) and procedures the LEP modules were supplied by Ansaldo, CERCA, and Siemens (later ACCEL)



**Achieved performances:**

**Accelerating fields up to 8.0 to 9.0 MV/m**

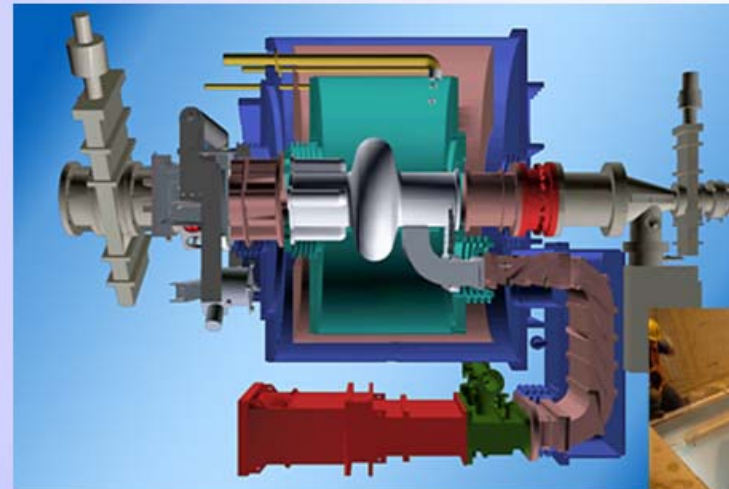
**$Q_0 \sim 4.0$  to  $4.2 \cdot 10^9$  at fields of 4.0 to 6.0 MV/m**

**Contractual:  $Q_0 > 3.4 \cdot 10^9$  at 6.0 MV/m**



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# Review of European industrial supplies in the past and present: Example: CORNELL design srf modules



Based on proven design and a series of operating modules, industry is ready to deliver turn-key

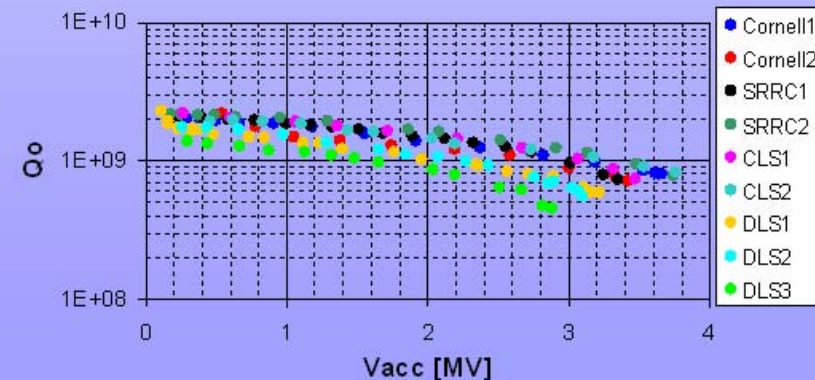
## Achieved performances:

Accelerating fields up to 10.0 to 11.0 MV/m

$Q_0 \sim 1.0 \cdot 10^9$  at field of 5.0 MV/m resp. 1.5 MV  
(cavity tests)

Contractual:  $Q_0 > 5.0 \cdot 10^8$  at 6.5 to 8.5 MV/m (in the module) plus: RF power, cryogenic losses etc.

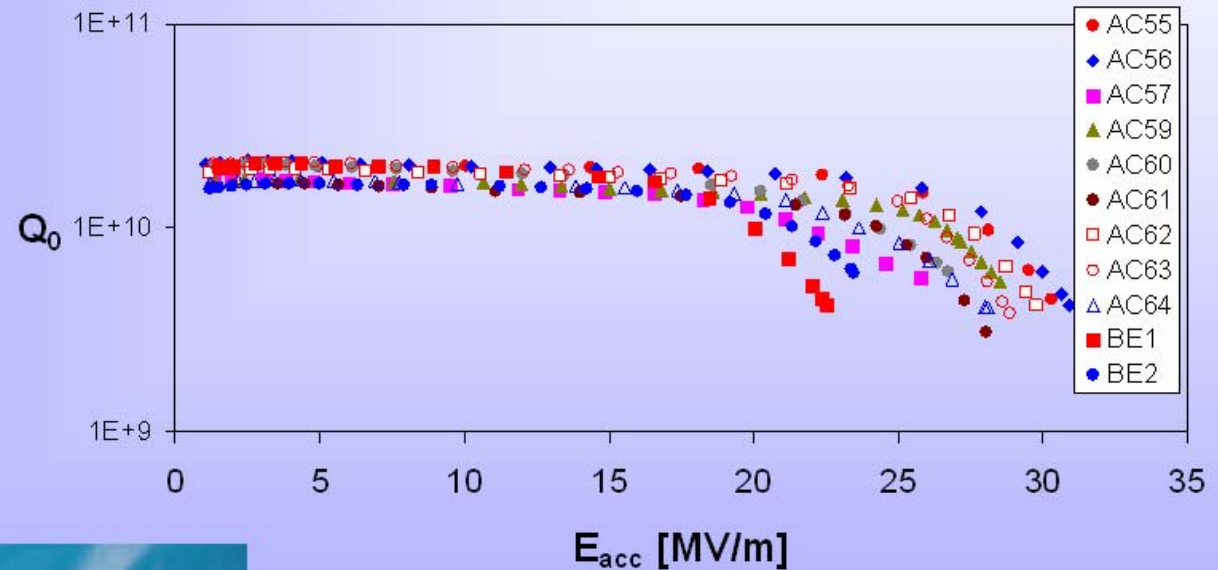
Summary 500 MHz Single Cell Cavity vertical cold Tests



## Review of European industrial supplies in the past and present: Examples: cavities in recent series productions

All 109 cavities for the SNS linac have been supplied by industry.

Over 120 cavities have been supplied mainly by ACCEL and Zanon to DESY



Typical X-FEL cavity performance achieved with production run 3 at DESY:

Accelerating fields up to 25.0 to 30.0 MV/m

$Q_0 > 1.0 \cdot 10^{10}$  at field of 23.5 MV/m

BE1 and BE2 prepared for test at industry

SNS low beta cavity and X-FEL cavity



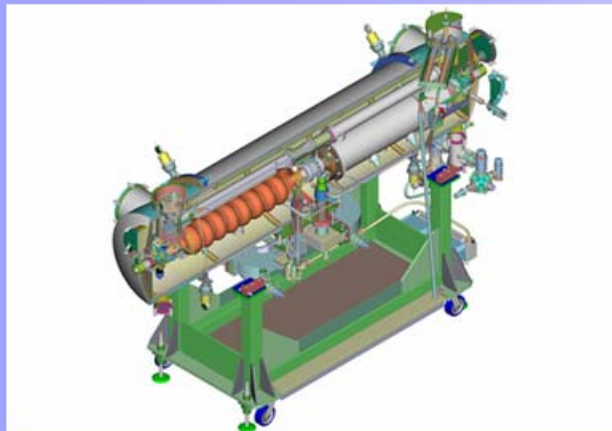
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Review of European industrial supplies in the past and present:

Example: srf modules using X-FEL cavities, Rossendorf design

srf module with two 1.3 GHz nine cell cavities (X-FEL) designed for cw operation by Forschungszentrum Rossendorf supplied to the 4GLS project.

Includes power couplers, tuners, auxiliaries



Achieved performances (with X-FEL cavities)

Accelerating fields up to 25.0 to 30.0 MV/m

$Q_0 > 1.0 \cdot 10^{10}$  at field of 23.5 MV/m

Contractual:  $Q_0 > 3.3 \cdot 10^9$  at 12.5 MV/m (in the module) and: RF power, cryogenic losses etc.



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## Review of European industrial supplies in the past and present: Example for manufacturing and industrialization

Up to now more than 100 couplers have been delivered or are under production.

One of the issues currently under investigation in view of X-FEL is the **industrial production of a series of 1000 power couplers.**

Studies on **series production of cavities and X-FEL module assembly** have been launched to industry by DESY

3 companies are performing detailed design and production studies for the series production of couplers (ACCEL, E2V, Toshiba)

Specific installations (e.g. ceramic coating/TiN) are being set up recently at industry.



## “Guaranteed performance” or “working to procedures and prints”

In projects with guarantees industry takes responsibility for the delivery of a functional srf module or operating cavity (LEP, 4GLS, synchrotron projects).

**If specifications are not met, it is industries responsibility to fix it**

In projects based on a “working to procedures and prints”- approach industry supplies cavities, couplers, modules by following and repeating precisely production procedures developed and detailed by the laboratory

**If specifications are not met, the reason and its cure has to be found in a common effort.**

(CEBAF, LEP, SNS, DESY up to now)





## Review of the industrial supplies in view of guaranteed parameters (accelerating fields and quality factors)

### Guaranteed performance or work to procedure and print

Project	scope	Average $Q_0$ at operating $E_{acc}$ [MV/m]	$E_{acc}^{max}$ [MV/m]	$E_{acc}/Q_0$ [MV/m] Contractually agreed	Industry's Obligation
LEP Modules	~ 80 modules	4.0 to 4.2 * $10^9$ at fields of 6.0	9.0 to 10.0	$3.4 \cdot 10^9$ at 6.0	Work to procedure and print
Cavities for SNS	35 cavities (MB)	$2.0 \cdot 10^{10}$ at 10.0	> 14.0	$5 \cdot 10^9$ at 10.1	Work to procedure and print
	74 cavities (HB)	$2.0 \cdot 10^{10}$ at 12.5	> 16.0	$5 \cdot 10^9$ at 12.5	
X-FEL	Tbd.	$1.0 \cdot 10^{10}$ min. at 23.4	25.0 to about 30.0	Tbd.	Tbd.
BESSY FEL	X-FEL cavities operating at $1.3 \cdot 10^{10}$ at 16.0 MV/m	See X-FEL	See X-FEL	$\cdot 10^{10}$ at 16.0 and 20.0	Guarantee for Cavity performance
4GLS	2 SRF Modules with 2 X- FEL cavities each operating at $3.3 \cdot 10^9$ at 12.5 MV/m	See X-FEL	See X-FEL	$3.3 \cdot 10^9$ at 12.5	Guarantee for Module performance

**Review of European industrial supplies in the past and present:**

## **Conclusion**

**For major projects in the past and present European industry has successfully supported or is supporting cavities, couplers, and turn-key modules over the last 30 years**

**Several European companies are actively supporting the preparation of series production for the X-FEL project with production of components, performing studies and setting up specific installations**

**For X-FEL the required performance of cavities has been shown by DESY and industry on a regular basis.**

## **Outlook**

**The required performances for X-FEL have been shown to be achievable by DESY and industry on a regular basis. Based on this, European industry is ready to deliver cavities, components, modules to X-FEL with performance guarantees by application of the DESY developed designs and procedures.**

**Looking to the ILC the specified performance still needs to be demonstrated on a regular basis. If shown so, there should be sufficient industrial support to realize ILC**